Trustpower Ltd
Mangorei Hydroelectric Power Scheme
Monitoring Programme
Annual Report
2017-2018

Technical Report 2018-93

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Executive summary

Trustpower Ltd (Trustpower) operates the Mangorei hydroelectric power (HEP) scheme in the Waiwhakaiho River catchment to the south of New Plymouth. Trustpower diverts water from the Waiwhakaiho River into Lake Mangamahoe, from where it is directed through penstocks through to the Mangorei Power Station, located on Hydro Road. The water is returned to the Waiwhakaiho River at the Meeting of the Waters, six kilometres downstream of the original diversion. This report for the period July 2017 to June 2018 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess Trustpower'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 Trustpower's activities.

Trustpower holds seven resource consents, which include a total of 35 conditions setting out the requirements that Trustpower must satisfy. Trustpower holds three consents to allow it to divert, use and discharge water and four consents for various structures, including to dam the Mangamahoe Stream, the Waiwhakaiho River intake weir and an access culvert related to this site.

During the monitoring period, Trustpower Ltd demonstrated an overall high level of environmental performance, in relation to the Mangorei HEP scheme.

The Council's monitoring programme for the year under review included 12 hydrological inspections, which included a gauging of the residual flow on each occasion, two macroinvertebrate surveys, the auditing of data provided by Trustpower and water temperature monitoring of the Waiwhakaiho River.

Gauging of the residual flow recorded a compliant flow on all occasions. The inspections undertaken in conjunction with the gaugings took note of on-site activities, including maintenance of the fish pass and management of an access culvert. During these inspections all aspects of the scheme appeared in good order, with maintenance of the fish pass performed as soon as practicable following a fresh. Data provided by Trustpower showed good compliance with lake level restrictions, residual flow requirements and the requirement to generate at least 950 L/s during the day to provide adequate flow downstream of the scheme. Trustpower is now exercising the variation to their abstraction consent, which allows for the abstraction of flood flows up to a river flow of 85 cumecs.

A moderate number of elvers were transferred from the Mangorei Power Station to the Waiwhakiaho River during the period under review. The number transferred was similar to the median of previous transfers, indicative of a relatively typical season for elver migration. Downstream migratory adult eel passage was also provided by Trustpower, with manual trapping and transfer of a number of migrant eels on several occasions after river fresh events mainly in autumn 2018.

Water temperatures in the lower river have not increased significantly, nor reached excessive levels, principally because of the increased spread of power generation releases during daylight hours, a condition of consent. Due to a particularly hot and dry spring and early summer, water temperatures were well above average at all sites, although they returned to normal over the latter half of the monitoring period.

Although the water temperature in the lower river has warmed very slightly over the 17 year period since an increased summer residual flow was implemented, this appears to be due to climatic changes, as a similar trend is apparent upstream of the scheme.

During the year, Trustpower demonstrated a high level of environmental and administrative performance with the resource consents related to the Mangorei HEP scheme. There were no unauthorised incidents recorded in respect of this scheme during the period under review.

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 Trustpower's performance remains at a high level in respect of this scheme.

This report includes recommendations for the 2018-2019 year.

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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 Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Trustpower Ltd (Trustpower) in relation to the Mangorei hydroelectric power (HEP) scheme. The scheme diverts water from the Waiwhakaiho River to Lake Mangamahoe, and then on to the Mangorei Power Station, located on Hydro Road.

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Trustpower that relate to diversions of water and related in-stream structures within the Waiwhakaiho catchment.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of Trustpower's use of water and land, and is the 22nd combined annual report by the Council covering activities associated with the Mangorei HEP scheme.

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 Trustpower in the Waiwhakaiho catchment;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted in Trustpower's site/catchment.

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 2018-2019 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 consent holder, 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 the consent holder'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 were 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

The Mangorei HEP scheme diverts water from the Waiwhakaiho River to Lake Mangamahoe via an intake weir and tunnel (Figure 1). Water is taken from the lake for the Mangorei Power Station, and returned to the Waiwhakaiho River approximately six kilometres downstream of the intake weir. The New Plymouth Water Treatment Plant also takes water from Lake Mangamahoe for the New Plymouth and Waitara water supplies.

When the Mangorei HEP scheme consents were renewed in 1996, the main areas of concern related to the flow in the reach between the intake weir and the Meeting of the Waters, known as the residual flow reach, and fish passage at the intake weir. These concerns were addressed by specifying a residual flow regime, with flows ranging from 400 L/sec to 700 L/sec depending on the time of year, and by requiring modifications to the fish pass, to ensure trout and native fish species were able to migrate upstream past the weir.

Historical points of note are discussed in previous reports, listed in the bibliography and references section.

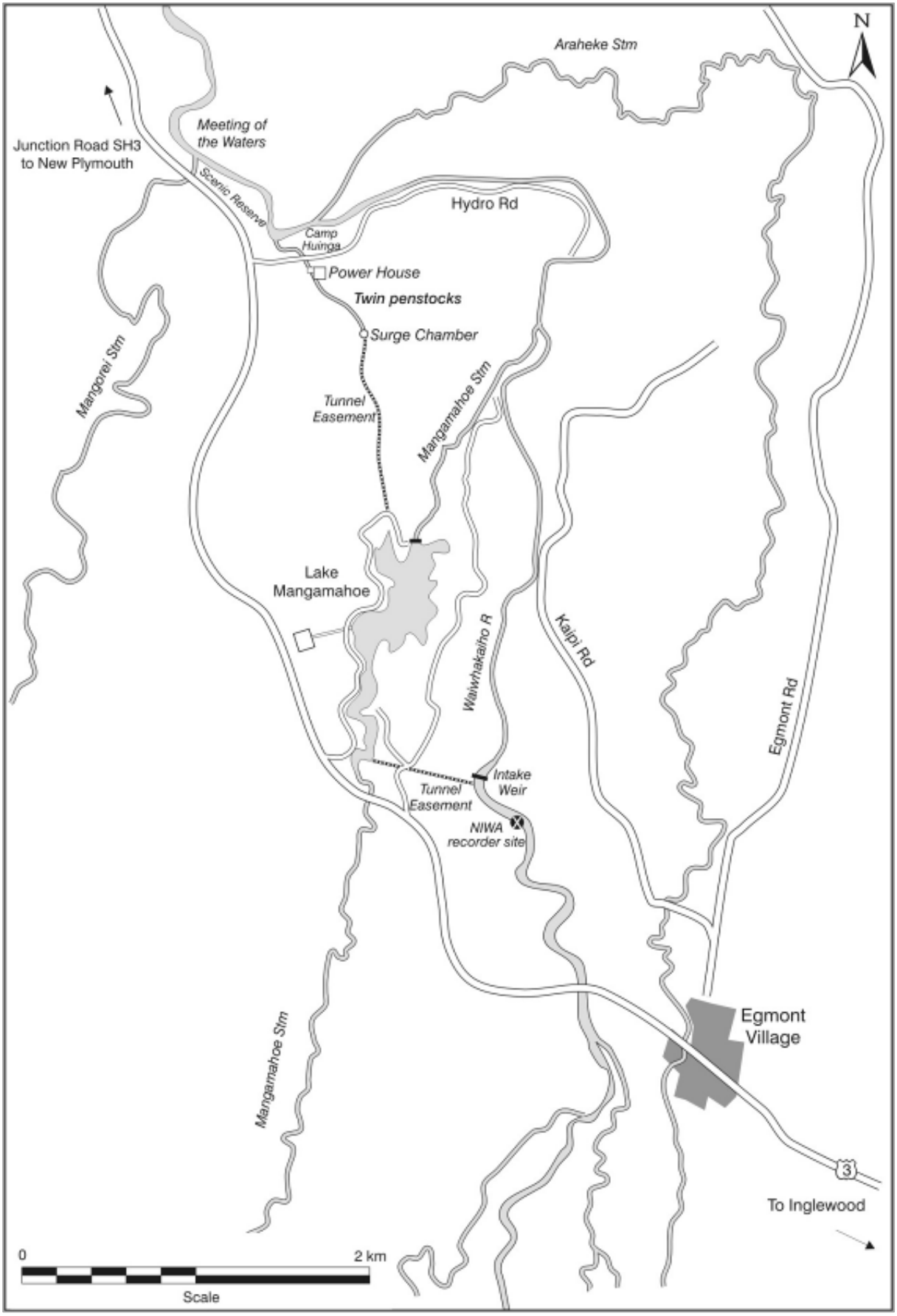

Figure 1 Lake Mangamahoe environs showing the Waiwhakaiho diversion, community water supply, and Trustpower hydroelectric power generating system

1.3 Resource consents

Trustpower holds seven resource consents the details of which are summarised in the table below and outlined in sections 1.3.1 to 1.3.3.

Table 1 Resource consents held by Trustpower Ltd in relation to the Mangorei HEP scheme

Consent number	Purpose	Granted	Review	Expires
2053-3.2	To divert up to 10 cubic metres/second of water from the Waiwhakaiho River via a diversion weir and associated intake structures into Lake Mangamahoe through the Mangorei HEP Scheme and back into the river approximately six kilometres downstream of the diversion point	4 September 1996 Varied 1 August 2017	-	1 June 2021
2054-3	To dam the Mangamahoe Stream in the Waiwhakaiho Catchment to form Lake Mangamahoe to act as a reservoir of water for hydroelectric power generation purposes	4 September 1996	-	1 June 2021
2056-3.1	To use up to 864,000 cubic metres/day of water from Lake Mangamahoe in the Waiwhakaiho catchment for hydroelectric power generation purposes	4 September 1996 Varied 16 June 2016	-	1 June 2021
4886-1	To erect and maintain structures in the Mangamahoe Stream in the Waiwhakaiho Catchment to dam the stream to form Lake Mangamahoe for hydroelectric power generation purposes	4 September 1996	-	1 June 2021
4887-1	To erect and maintain structures associated with the diversion of water from the Waiwhakaiho River into Lake Mangamahoe for hydroelectric power generation purposes	4 September 1996	-	1 June 2021
4888-1	To discharge up to 150,000 litres/second of water from Lake Mangamahoe via a spillway into the Mangamahoe Stream in the Waiwhakaiho Catchment under emergency conditions associated with hydroelectric generation purposes	4 September 1996	-	1 June 2021
6810-1	To erect, place and maintain a culvert in an unnamed tributary of the Waiwhakaiho River for access purposes	6 March 2006	-	1 June 2020

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.

Trustpower holds water permit **2053-3** to cover the diversion of up to 10 cumecs of water from the Waiwhakaiho River, through Lake Mangamahoe and back to the Waiwhakaiho River through the Mangorei Power Station, for hydroelectric power generation. This permit was originally issued by the Council on 4 September 1996 under Section 87(d) of the RMA. A variation to this consent, to permit an increased rate of diversion from 7 cumecs to 10 cumecs, for the purposes of harvesting flood flows in the river, was granted

on 19 April 2013, while in August 2017, Trustpower was granted a variation to this consent, to change the reporting date of the bathymetry survey. This consent is due to expire on 1 June 2021.

Condition 1 requires a continuous generation flow of at least 950 L/s during the day (8am to 6pm), and condition 2 specifies the different residual flows required at different times of the year.

Condition 3 prevents the diversion of water when flow in the Waiwhakaiho River is greater than or equal to 85 cumecs.

Condition 4 requires the consent holder to measure and record the residual flow downstream of the weir, and to provide the records to the Council.

Condition 5 requires the consent holder to maintain the river channel below the diversion weir to the Meeting of the Waters for the purpose of enhancing fish passage and habitat. As Trustpower does not hold a separate resource consent for this activity, it is important that such works comply with the permitted activity rules of the Regional Freshwater Plan for Taranaki, or that a resource consent is gained prior to undertaking any such works.

Condition 6 requires the consent holder to undertake a monitoring programme that includes sediment sampling of the inflow to Lake Mangamahoe and bathymetry surveys of Lake Mangamahoe, while condition 7 requires the erection of notices and warnings for public safety.

Condition 8 requires an annual payment of $5,000 to provide for riparian planting and management in the Waiwhakaiho River catchment.

Condition 9 requires an annual meeting with stakeholders and condition 10 is a review provision.

Trustpower also holds water permit **2056-3** to cover the daily use of up to 735,000 cubic meters of water from Lake Mangamahoe for hydroelectric power generation. This permit was issued by the Council on 4 September 1996 under Section 87(d) of the RMA. A variation to this consent, to permit an increased rate of diversion from 735,000 cubic meters of water per day to 864,000 cubic meters of water per day, to make use of the increased diversion of flood flows provided for by the variation to consent 2053-3, was granted on 16 June 2016, and it is due to expire on 1 June 2021.

Condition 1 of this consent requires the consent holder to, as far as reasonably practicable, spread its generation during daylight hours, while condition 2 is a review provision.

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.

Trustpower holds water discharge permit **4888-1** to discharge up to 150,000 L/s of water from Lake Mangamahoe into the Mangamahoe Stream under emergency conditions. This permit was issued by the Council on 4 September 1996 under Section 87(e) of the RMA. It is due to expire on 1 June 2021.

Condition 1 of this consent is a review provision. There are no other conditions.

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.

Trustpower holds land use permit **2054-3** to cover the damming of the Mangamahoe Stream to form Lake Mangamahoe. This permit was issued by the Council on 4 September 1996 under Section 87(a) of the RMA. It is due to expire on 1 June 2021.

Condition 1 requires the consent holder to maintain and operate the dam to the Council's satisfaction.

Condition 2 stipulates a minimum lake level, unless it is necessary to lower the water level for lake weed maintenance. If this is programmed, condition 3 requires the consent holder to notify the Council at least seven days prior.

Condition 4 is a review provision.

Trustpower holds land use permit **4886-1** to erect and maintain structures which dam the Mangamahoe Stream. This permit was issued by the Council on 4 September 1996 under Section 87(a) of the RMA. It is due to expire on 1 June 2021.

Condition 1 requires the consent holder to maintain and operate the dam to the Council's satisfaction.

Condition 2 is a review provision.

Trustpower holds land use permit **4887-1** to erect and maintain structures associated with the diversion of water from the Waiwhakaiho River. This permit was issued by the Council on 4 September 1996 under Section 87(a) of the RMA. It is due to expire on 1 June 2021.

Condition 1 requires the consent holder to maintain and operate the structure to the satisfaction of the Council, and a fish pass is to be installed and maintained, as per condition 2.

Condition 3 requires the consent holder to maintain a device capable of supplying the required residual flow and condition 4 is a review provision.

Trustpower holds land use permit **6810-1** for an access culvert located on an unnamed tributary of the Waiwhakaiho River. This permit was issued by the Council on 6 March 2006 under Section 87(a) of the RMA. It is due to expire on 1 June 2020.

Conditions 1 and 2 require the consent holder to use the best practicable option during installation, while undertaking this installation generally in accordance with the application.

Conditions 3 to 6 require the consent holder to notify the Council prior to commencement of works, restricts the timing of works, requires the amount of riverbed disturbance to be minimised and sets receiving environment conditions that are to be met during installation.

Condition 7 requires the structure to be removed should it no longer be required.

Conditions 8 and 9 state that the culvert shall not alter the natural flow of the river, restrict the passage of fish or result in significant ponding of water upstream.

Condition 10 requires a site erosion and sediment control management plan. Condition 11 is a lapse provision, and condition 12 is a review provision.

As this consent has been exercised and the culvert is in place, many of these conditions are no longer relevant.

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 Mangorei HEP scheme 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 Mangorei HEP scheme was visited 12 times during the monitoring period. These were all hydrological inspections, which focused largely on hydrological aspects of the scheme, with a gauging of the residual flow reach undertaken on each occasion and some water level readings also taken. The fish pass was inspected, as was the access culvert.

1.4.4 Data audit

Trustpower provided the Council with data on generation, flow from the power station, residual flow below the weir and the water level of Lake Mangamahoe. This data was assessed by the Council to determine whether consented generation and lake level requirements were complied with.

1.4.5 Water temperature monitoring

Water temperature was monitored at three locations, to assess the impacts of the reduced flow through the residual flow reach, and the release of water through generation on water temperatures of the middle and lower reaches of the Waiwhakaiho River. The details of these sites are provided in Table 2.

Table 2 Water temperature monitoring sites in the Waiwhakaiho River

Site	Location	GPS Location	Site code
W1	State Highway 3 (approximately 2 km upstream of weir)	E1698297 N5666893	WKH000500
W5	Hydro Road (within residual flow reach, approximately 5 km downstream of weir)	E1697474 N5671435	WKH000650
W7	Rimu Street track extension (approximately 13 km downstream of weir)	E1696149 N5675261	WKH000820

1.4.6 Biological inspection and surveys

The programme also included a biennial biological inspection, which is next scheduled for completion in the 2018-2019 monitoring period. This inspection includes an inspection of the river channel and various structures to assess continuing suitability for fish passage.

Macroinvertebrate monitoring was reintroduced to the monitoring programme in the 2016-2017 monitoring period. This monitoring involves the collection of one macroinvertebrate sample at Hydro Road,

on the same day as the greater Waiwhakaiho Catchment is sampled by the Council for State of the Environment monitoring purposes. This monitoring is undertaken in spring and summer.

Fish monitoring has also been undertaken previously, with the results presented in an earlier Annual Report (TRC, 2009). There is no fish monitoring included in the current programme.

2 Results

2.1 Water

2.1.1 Hydrological inspections

The primary purpose of the hydrological inspections was to gauge the flow downstream of the intake weir, to determine whether the residual flow provided by Trustpower met the requirements of the consent. A full historical context of residual flow compliance can be found in previous monitoring reports.

The gaugings undertaken in the 2017-2018 period are summarised in Table 3. This table shows that the required residual flow being provided on each occasion, maintaining the perfect compliance record noted over the last seven monitoring years (2009-2017).

During these inspections, some notes were also made regarding the condition of the fish pass. On occasion, the pass contained varying amounts of river gravel, deposited there by floods. This material is removed by Trustpower when possible, and overall, the fish pass has been well maintained.

Table 3 Results of gaugings undertaken in relation to the Mangorei HEP scheme, 2017-2018

Date	Time	Flow at SH3 (L/s)	Gauged flow downstream of weir (L/s)	Residual flow required at this time	Compliant?
07/07/2017	14:51	4,119	615	400	Yes
04/08/2017	10:45	5,800	699	400	Yes
05/09/2017	08:00	3,675	486	400	Yes
03/10/2017	07:20	7,540	1,008	400	Yes
01/11/2017	10:30	3,310	719	600	Yes
05/12/2017	07:31	2,250	682	600	Yes
03/01/2018	11:30	3,656	768	700	Yes
08/02/2018	07:20	2,520	787	700	Yes
02/03/2018	07:40	3,734	757	700	Yes
05/04/2018	14:08	3,145	762	600	Yes
04/05/2018	13:40	2,718	470	400	Yes
01/06/2018	09:00	4,630	541	400	Yes

2.1.2 Fish passage inspection

Added to the 2016-2017 monitoring programme was a biennial inspection of fish passage in relation to the scheme. This included inspection of the residual flow reach, to ensure that the river channel was suitable to provide adequate fish passage, an assessment of the access culvert just upstream of the intake and an assessment of the fish pass at the intake weir. At times notes are also made during the hydrological inspections when there are maintenance requirements at the fish pass.

No fish passage inspection was scheduled for the 2017-2018 period. The last inspection, completed on 9 June 2017, found that the access culvert just upstream of the intake could have fish passage improved as it was slightly perched, although fish passage was still possible, either during high flows in the Waiwhakaiho River or by fish using the flow that was coming through under the culvert. It was also noted at the time that

the fish pass at the intake weir itself was in good condition. This will be further investigated in the 2018–2019 survey.

The river channel downstream of the weir was inspected and there were no areas noted where fish passage appeared inhibited. It was noted that passage will be better at times when trout are actively migrating, as this often coincides with periods of higher flow. There appeared to be no issue for smaller fish. With regard to condition 5 of consent 2053-3.2, which requires Trustpower to maintain the river channel in the residual flow reach to enhance fish habitat and passage, there were no obvious maintenance works required.

2.1.3 Provision of consent holder data

Resource consent 2053-3 requires Trustpower to maintain a measuring device capable of measuring the residual flow downstream of the intake weir, and to provide these records to the Council upon request. This condition does not stipulate the required accuracy of the recorder, or the frequency by which measurements are to be taken, only that the device shall be installed and operated to the satisfaction of the Council. The data provided by Trustpower in fulfilment of this condition is shown in Figure 2. This data shows that water level was recorded throughout the monitoring period, with the exception of a five day period in June. This loss of data was due to the failure of communications equipment, and is the first loss of data that exceeded 5.5 hours since November 2012.

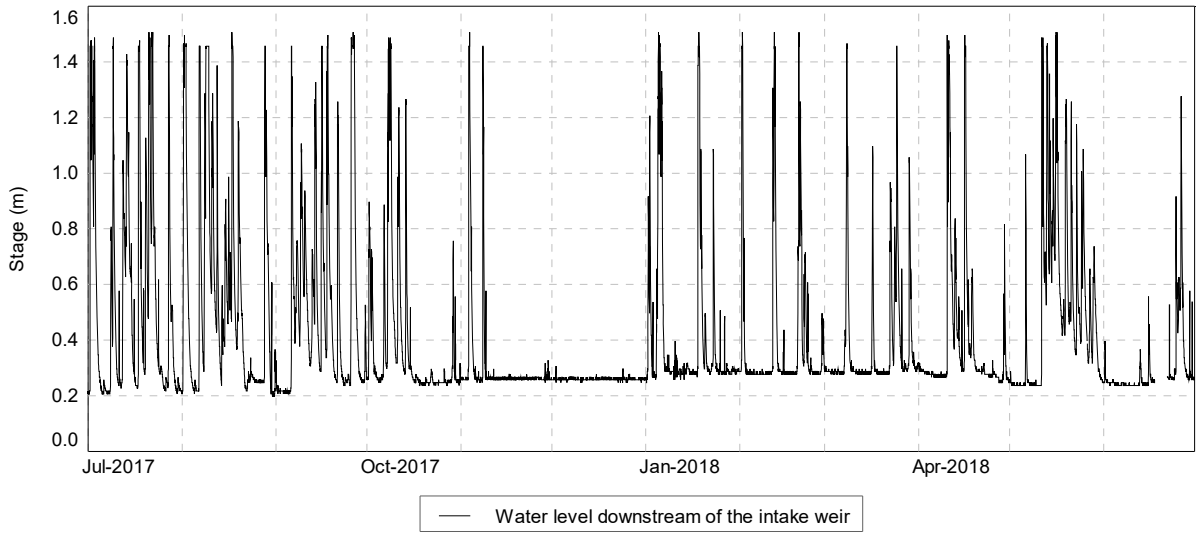

Figure 2 Water level data recorded by Trustpower, downstream of the intake weir

Table 4 compares the results of spot readings made during site visits with the recorded data provided by Trustpower. This shows that the accuracy of the meter has varied over the reported period, ranging from 20 mm too low to 24 mm too high. However, all twelve of readings were within 10% of each other. Although this data shows significant variation in recorder accuracy, this data was largely used by Trustpower to guide management of the residual flow. This has been successful, as demonstrated by the results of the gaugings undertaken (Table 3), and also by comparing this data against an indicative water level, above which adequate residual flow is provided (Figure 3).

Although the relevant consent condition requires the provision of residual flow data, Trustpower only provides water level data. This is done with the agreement of the Council, as the maintenance of a rating curve in the Waiwhakaiho River at this location is problematic, because the river bed cross section can change with every flood. This makes maintaining a rating curve at this location impractical. The Council undertakes monthly gaugings at this location to not only assess compliance with the residual flow requirements, but also to provide flow versus water level data to Trustpower, which they use to manage their residual flow.

Table 4 The results of spot calibration checks made of the Trustpower flow recorder located downstream of the intake weir

Date	Time	Manual Reading (mm)	Recorded Reading (mm)	Difference (mm)	Difference as % of Manual reading
07/07/2017	14:36	210*	215	-5	-2.38%
04/08/2017	10:57	232±3	237	-2	-0.86%
05/09/2017	08:05	220±2	207	11	5.00%
03/10/2017	07:31	277±5	297	-15	-5.42%
01/11/2017	10:38	252±2	267	-13	-5.16%
05/12/2017	06:58	265±2	257	6	2.28%
03/01/2018	11:40	265±3	277	-9	-3.36%
08/02/2018	07:50	290±1	284	5	1.73%
02/03/2018	07:42	273±1	293	-20	-7.35%
05/04/2018	13:45	279±1	282	-2	-0.72%
04/05/2018	13:42	262±1	237	24	9.16%
01/06/2018	09:15	245±3	247	-1	-0.41%
* Accuracy not recorded on this occasion					

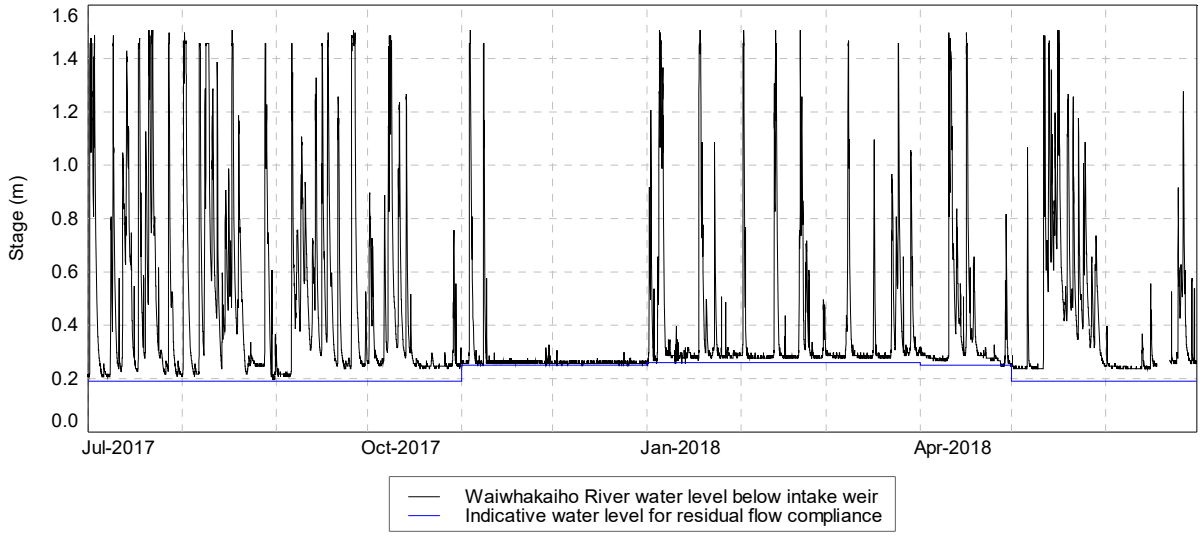

Figure 3 Water level downstream of the intake weir, compared with indicative water level required to ensure residual flow compliance

It was acknowledged in the 2015-2016 annual monitoring report (TRC, 2016) that the management of residual flow using water level data represents a potential compliance risk for Trustpower, in that although they endeavour to maintain a water level that equates to an adequate residual flow, a change to the rating curve may result in there being less flow at that water level than when the previous rating in use was established. It was considered appropriate that an agreed procedure be developed should a gauging discover inadequate flow. This procedure is as follows:

1. The Council shall notify Chris England, Technical Team Leader for the Taranaki Region, or a Taranaki staff member, upon completion of the gauging.

2. If Mr England is not contactable, the Council shall contact Chris Fern, Lead Environmental Advisor for Trustpower by telephone and email as soon as practicably possible.
3. Trustpower must confirm receipt of the notification via email.
4. As soon as practically possible, and within one hour of notification, Trustpower will adjust the head-pond level to ensure adequate residual flow is provided.
5. As soon as practicably possible after Trustpower has adjusted the residual flow, the Council shall undertake another gauging to determine flow within the Waiwhakaiho River.
6. The results of this gauging will be communicated to Trustpower by email and/or telephone.
7. If necessary, Trustpower may engage Council to undertake additional gaugings to confirm the rating curve.

It is likely that the Council will need to investigate such an incident further. If the cause of the inadequate residual flow is due to a change in the river bed resulting in a change to the rating curve, then it is unlikely that further action will be taken. If the inadequate residual flow is due to an inaccurate water level recorder, then Trustpower will be asked to explain the cause of any inaccuracies. As a part of this explanation, they will be asked to provide the data collected by this recorder, along with maintenance records, such as when the water level recorder was last calibrated. If this data suggests that Trustpower should have detected the faulty readings, and/or it is found that Trustpower did not adequately maintain the water level recorder, it is likely that some form of enforcement action would eventuate.

In summary, Trustpower are not required to provide residual flow data, but are expected to provide accurate water level data, which requires that the water level recorder is maintained to an appropriate accuracy. It is noted that the accuracy required for water level recording devices as per the National Environmental Monitoring Standards (NEMS, 2013) is the greater of 3 mm or 0.2% of the effective stage. The NEMS (2013) define effective stage as the height of the water surface above the zero measurement point of the sensor. Although the NEMS are considered best practice, and will be the starting point for the discussions, industries are not always required to follow best practice, especially where achieving such a high level of accuracy is either impractical or unachievable due to site specific issues. It may also be necessary to consider the intended use of the data, when determining an appropriate accuracy. It is likely that this issue will be resolved when the resource consents for the scheme are renewed. This will allow the resolution to be incorporated into the relevant consent conditions.

Trustpower has also provided lake level data to the Council. This data is presented in Figure 4, and shows that management with the minimum lake level was good, with no breaches recorded. The seven instances where the lake level exceeded the spillway level were all associated with floods in the contributing catchments.

Trustpower also provides the Council with generation data, and this allows an assessment of compliance with condition 1 of consent 2053-3, which requires that a continuous generation flow release of at least 950 L/s be maintained between 8 am and 6 pm each day. This requirement is intended to mitigate for the low flows and high water temperatures that can occur in mid to late summer, while also providing recreational opportunities, and maintaining water and habitat quality in general.

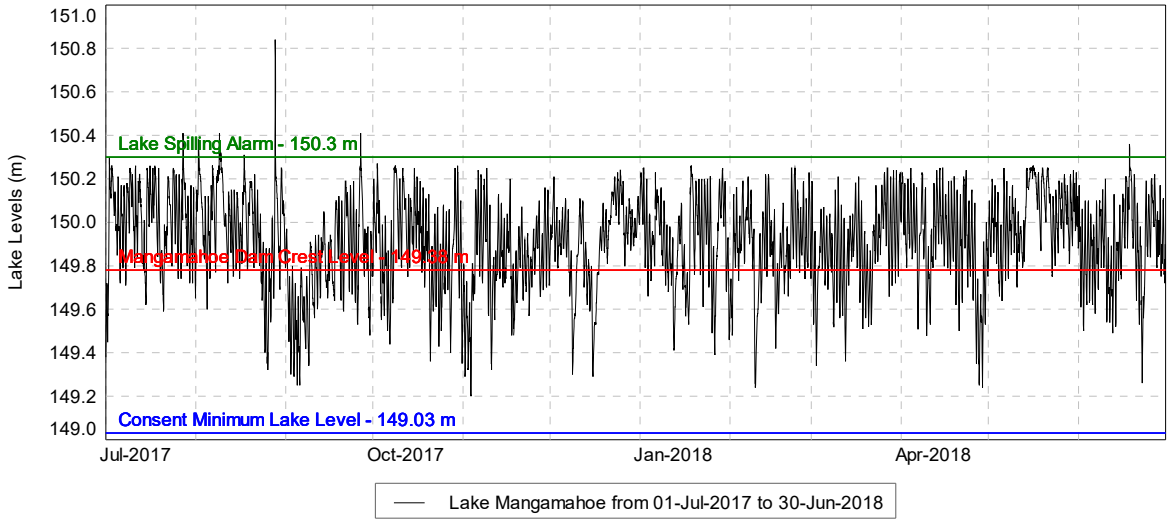

Figure 4 Lake Mangamahoe water level as recorded by Trustpower (2017-2018)

Figure 5 shows the exceedance time for the generation data, in essence showing what percent of the time that generation exceeded a certain rate. A generation rate of 0.575 MW approximately equates to a flow of 950 L/s, and this generation rate was exceeded 99.5% of the time between 9 am and 5pm during the 2017-2018 period. For those times when a generation flow was not provided as required, Trustpower notified the Council that a compensation flow was provided by reducing the abstraction of water from the Waiwhakaiho River, resulting in the release of water over the intake weir.

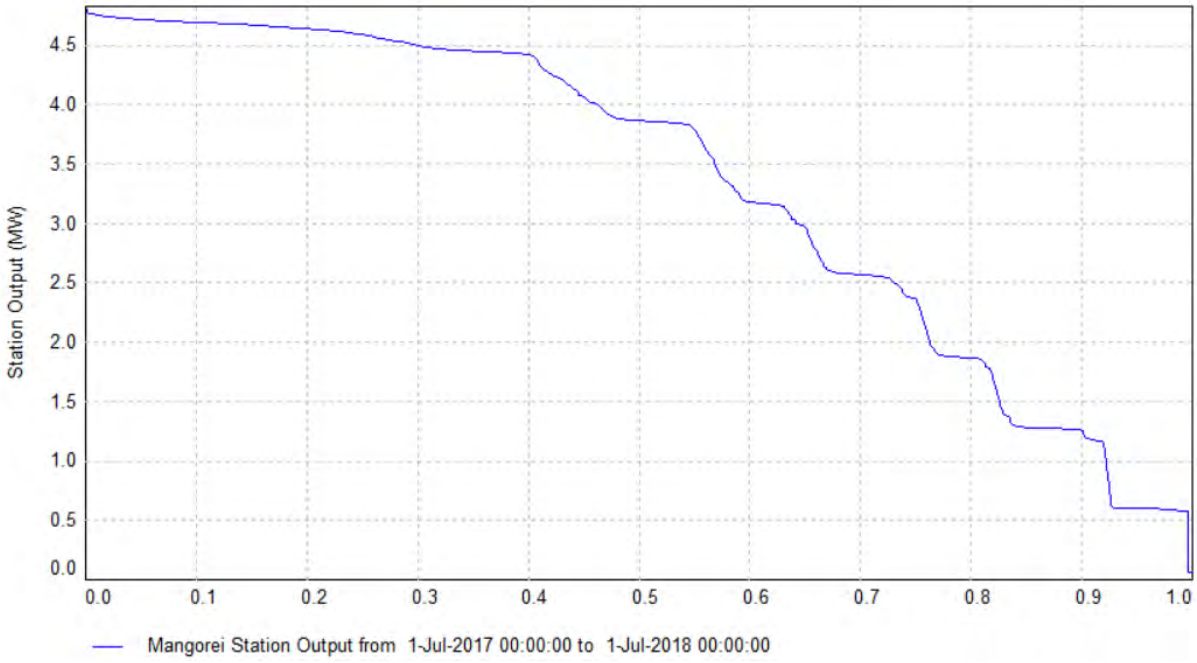

Figure 5 Generation at the Mangorei Power house, displayed as the percent of time a value was exceeded, 1 July 2017 – 1 July 2018, 9 am to 5 pm only

The impact on the flow regime of the lower Waiwhakaiho River is illustrated by data collected by the Council's flow recorder located on Rimu Street. Figure 6 shows how flow changes with changes in generation, and with changes in the residual flow requirements. Although a lower residual flow is provided in the winter months, the lowest flow recorded at Rimu Street is still higher than in summer, when a higher residual flow is provided. This is due to the higher winter flow in the tributaries that join the Waiwhakaiho River downstream of the Meeting of the Waters. It is also apparent that less generation occurs in the summer, a direct reflection of the reduced flows over this time.

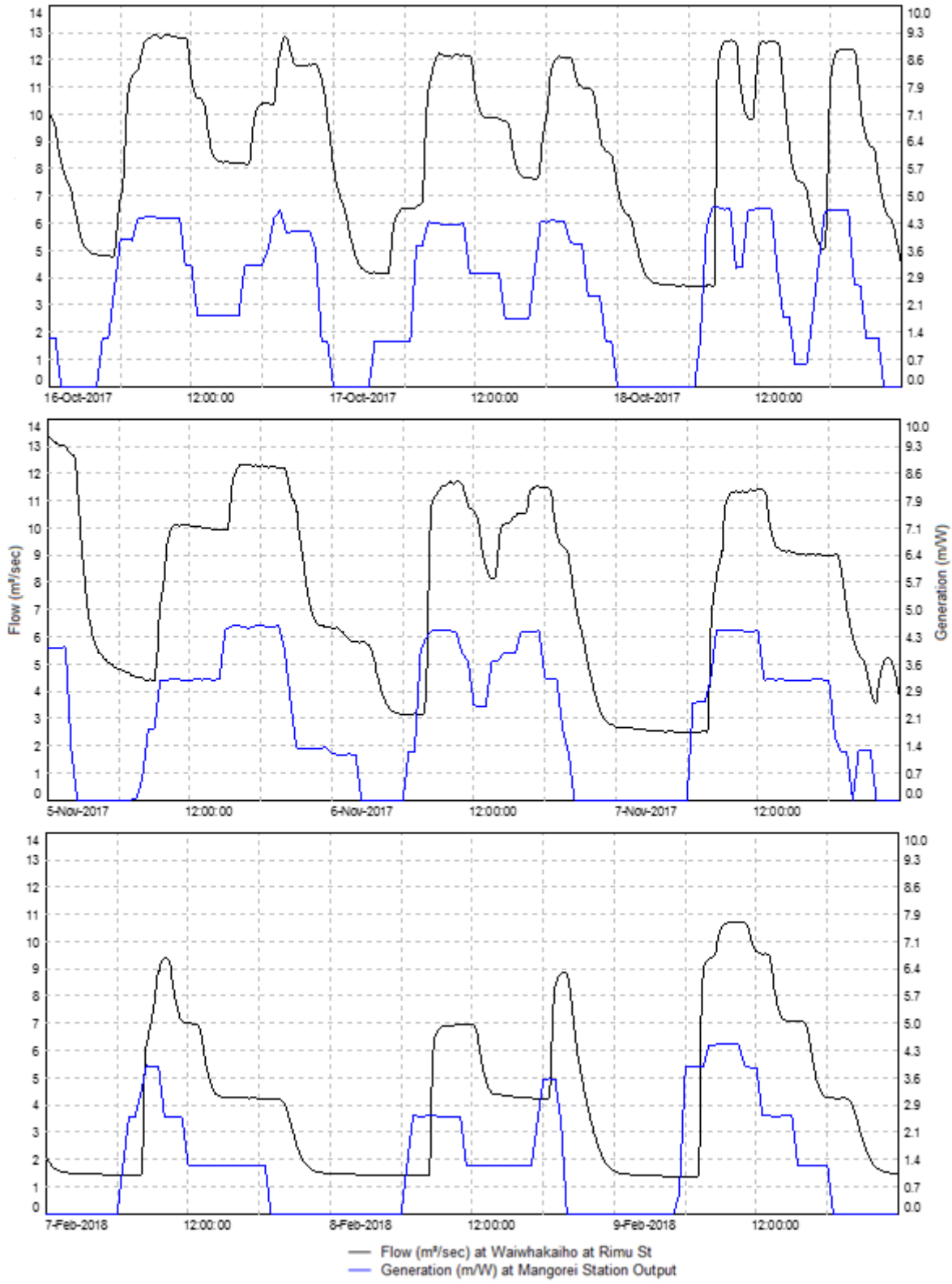

Figure 6 Flow variation in the Waiwhakaiho River at Rimu Street as a result of generation at the Mangorei Power Station

Condition 3 of consent 2053-3 requires the diversion of water to cease when flows exceed 85 cumecs. This consent does not include a requirement to record the rate that water is diverted from the river, and as such it is not possible to monitor this condition through the assessment of data. Therefore, the Council will continue to liaise with Trustpower to ensure that this consent condition is adhered to. During the 2016-2017

period the implementation of this condition was clarified. This is discussed in detail in TRC (2017), but in short it was agreed that the automatic control system will close the intake gates as quickly as possible as soon as the river is recorded to be flowing at 80 cumecs or more. It is acknowledged that this may result in some abstraction occurring when the river is flowing at more than 85 cumecs.

A condition of consent 2053-3 requires Trustpower to monitor the sedimentation of the lake. Trustpower undertook two bathymetric surveys of Lake Mangamahoe in May 2013 and prior to implementation of the diversion of 10 cumecs in March 2017, with both reports submitted to the Council[1]. The next bathymetry survey is scheduled to be completed in December 2020. Trustpower is still to undertake and report on sediment sampling that relates the flow in the Waiwhakaiho River to the rate of sediment entering Lake Mangamahoe via the diversion, the Council will be liaising with Trustpower in the 2018-2019 reporting period to establish an appropriate schedule for undertaking this monitoring.

2.1.4 Results of receiving environment monitoring

2.1.4.1 River Water Temperatures

Continuous river water temperature measurements have been performed throughout the term of the consents at three sites on the Waiwhakaiho River. Temperatures are monitored at one site upstream of the weir, one site within the residual flow reach of river between the weir and the power station outlet, and one site below the power station outlet. These locations are illustrated in Figure 7.

Data collected during the 2017-2018 period was fairly complete, with only one gap in the data. This was recorded in June 2018 at the upstream recorder (Egmont Village), when erroneous data was recorded for an unknown reason. The full data record for the 2017-2018 period for the three sites is displayed in Figure 8.

Fortunately, the period when data was lost at Egmont Village was at a time when water temperatures are not particularly high, being from 12 June to 21 June 2018 (Figure 8). However, this loss of data makes it difficult to assess the impact of the scheme during this period, although an analysis of long term data is still possible.

The Waiwhakaiho River exhibited average daily water temperatures during the start of the 2017-2018 monitoring period that were largely typical of the long term daily average, although Egmont Village did record slightly above average temperatures at this time (Figure 9). However, near the end of November 2017, temperatures were significantly warmer than the long term daily average. This continued through December, and although temperatures returned to normal around the New Year, January 2018 saw two more particularly warm periods. On 29 January 2018, the water temperatures were between 4.45 and 5.04 degrees warmer than average. This is a direct reflection of the hot weather Taranaki experienced over this time. Water temperatures began to return to normal in February 2018, being similar to the average for the last five months of the reported period. The highest exceedances were recorded on 30 January 2018 at Egmont Village (4.5˚C), 6 December 2017 at Hydro Road (5.0˚C), and 22 December 2017 at Rimu Street (5.3˚C) (Figure 9).

1 Document numbers 1219864 & 1894394

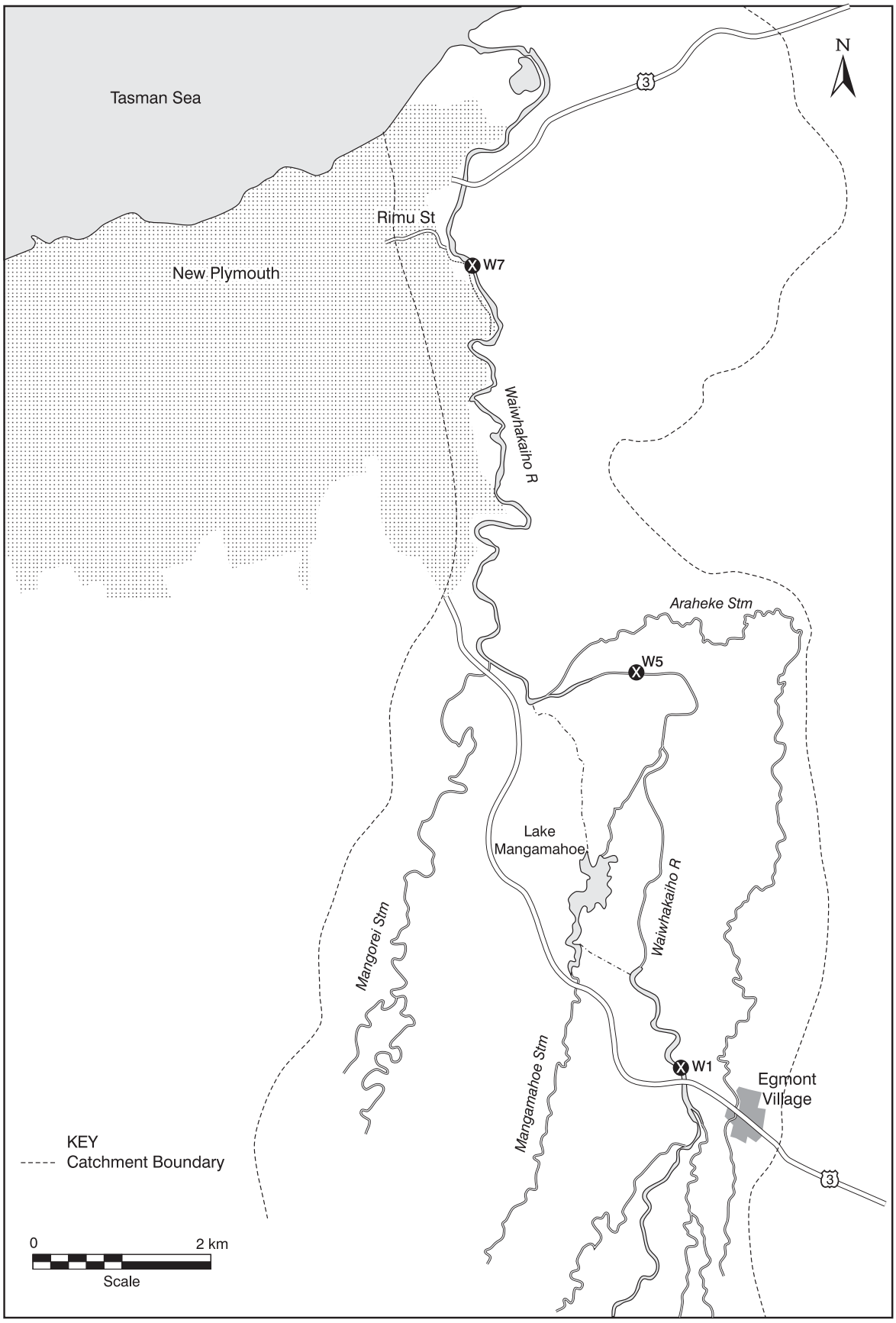

Figure 7 Water temperature monitoring sites (W1, W5, W7) in the lower Waiwhakaiho River catchment

When considering the impact on aquatic life, both the maximum temperatures and the proportion of time above certain temperatures are of relevance. Table 5 shows how often the maximum daily temperature exceeded particular values from December to March in the reported period, compared with historical data. Upstream of the intake, at Egmont Village, the river has never exceeded 25˚C, while downstream at Hydro Road, 25˚C is exceeded once per year on average. Due to the hot summer experienced in the 2017-2018 period, temperatures significantly exceeded this average at Hydro Road, with eight days exceeding 25˚C. Although Egmont Village did not exceed 25˚C, it did see a three-fold increase in the number of days that experienced water temperatures in excess of 20˚C. At Rimu Street, where on average less than one day a year exceeds 25˚C, this temperature was exceeded on eight days in the 2017-2018 period. This indicates that in the reported period, water temperatures at all three reported sites in the Waiwhakaiho River were much warmer than average.

Temperatures in excess of 25˚C can be lethal to some fish, including sportfish such as rainbow and brown trout. Temperatures in excess of 20˚C for extended periods may also negatively impact fish through stress. Over extended periods, this can make fish more susceptible to infection, can cause fish to lose body condition, and can even lead to fish death. This kind of warming can cause fish to change behaviours, including seeking cooler tributary flows.

Table 5 Summary of maximum daily water temperatures in the Waiwhakaiho River at three monitored locations, between 1 December and 31 March

		No. of days monitored	% of maximum temperatures in this range (no. of days)			
			10-15˚C	15-20˚C	20-25˚C	>25˚C
Egmont Village	1991-2017	2994	13.2	79.2	7.6	0.0
	2017-2018	121	1.7 (2)	75.2 (91)	23.1 (28)	0.0 (0)
Hydro Road	1991-2017	2777	2.2	49.6	47.2	1.0
	2017-2018	121	0 (0)	32.2 (39)	61.2 (74)	6.6 (8)
Rimu St	1991-2017	3130	1.1	53.0	45.2	0.7
	2017-2018	122	0.0(0)	32.0 (39)	61.5 (75)	6.6 (8)

Water temperature at all three sites was significantly higher than average temperatures in terms of both daily maximums and the average time per day that the water temperature exceeded both 20 ˚C and 25 ˚C (Table 5 and Figure 10).

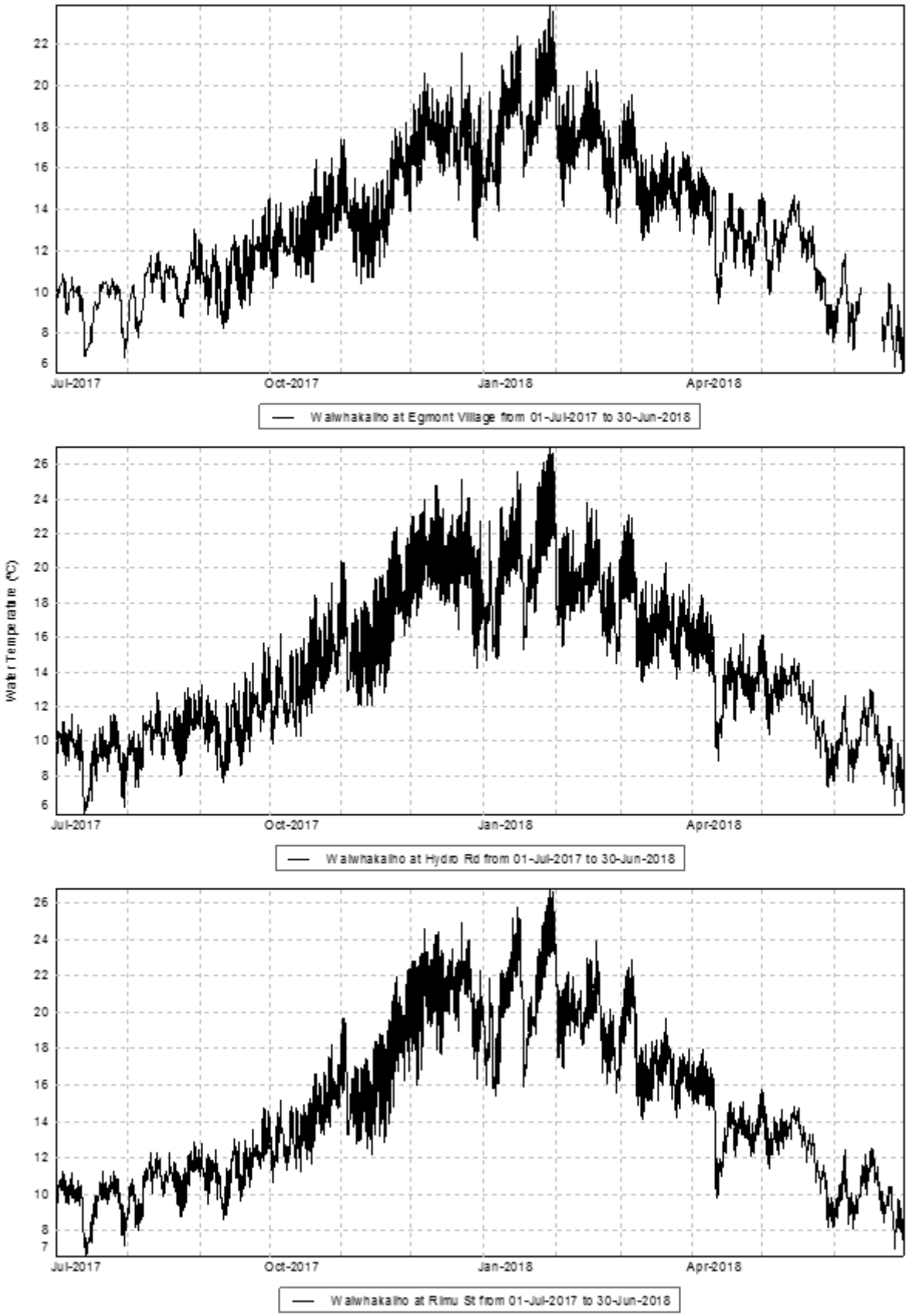

Figure 8 Waiwhakaiho River water temperature data collected at Egmont Village, Hydro Road and Rimu Street (2017-2018)

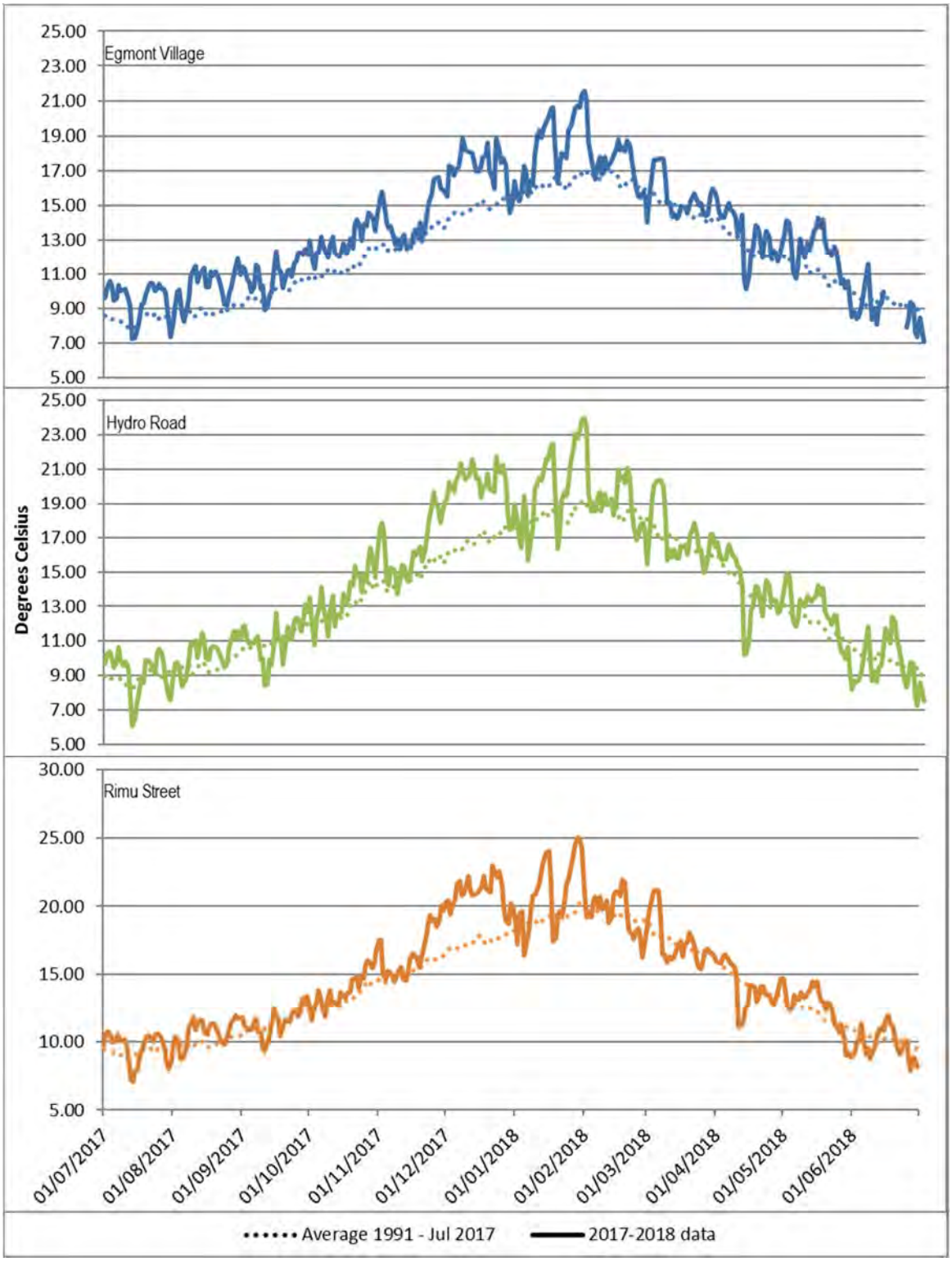

Figure 9 Average daily water temperature at three sites in the Waiwhakaiho River for the monitoring period, compared with historical data

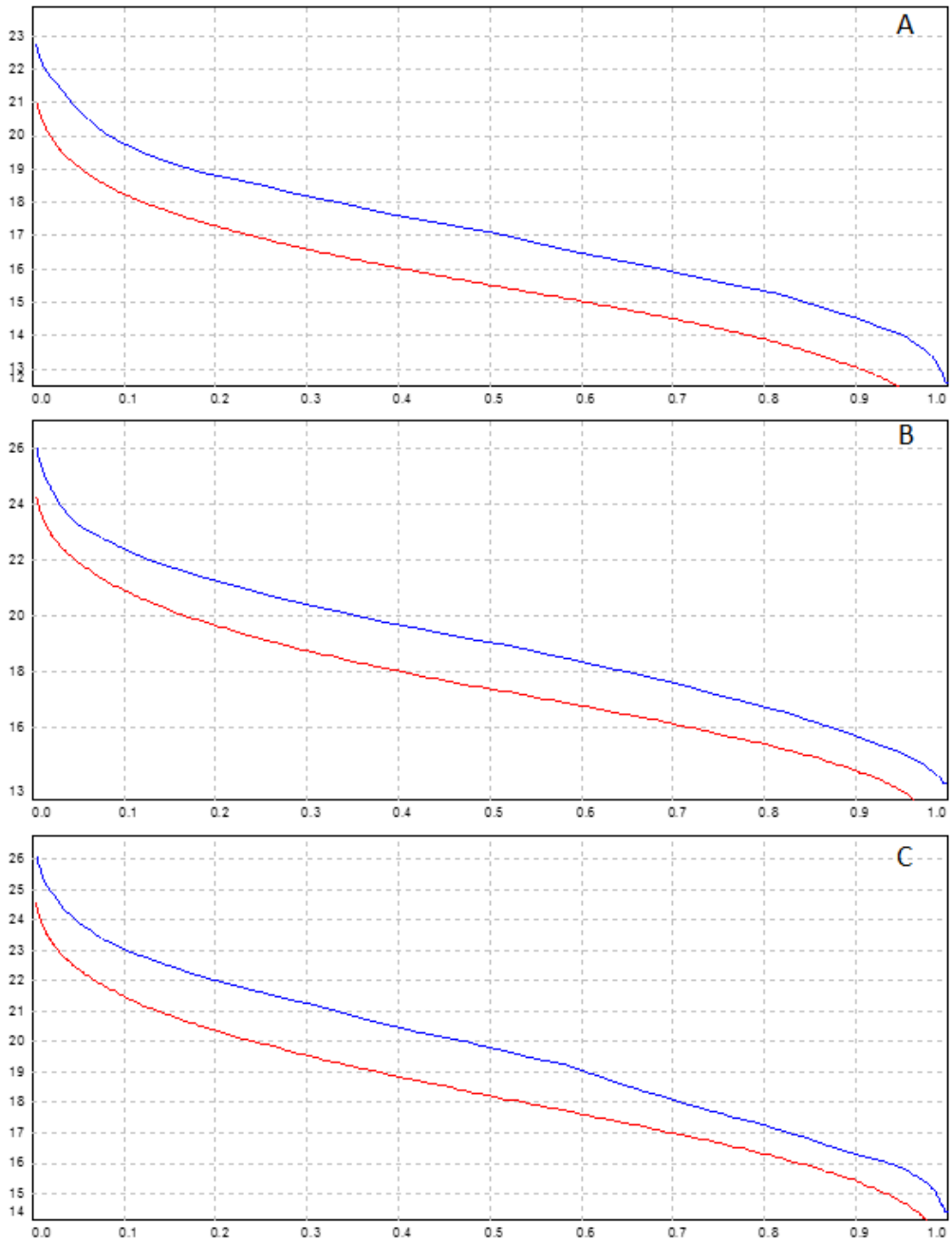

Figure 10 Exceedance time (x-axis is the percentage of time a temperature value was exceeded with 1.0 equal to 100%) for temperature (˚C on y-axis) at Egmont Village (A), Hydro Road (B)and Rimu Street (C) for the months of January to February 2017-2018 (blue), compared with historical data post 1997 (red)

In terms of the warming of waters in a downstream direction, the abstraction of water results in less buffering of the temperature, and consequently can result in much warmer waters than would occur naturally. This was acknowledged when the current consents were granted in 1998, with a higher residual flow required in summer than winter.

Figure 11 shows the temperature differences between the three sites over the 2017-2018 period, compared with all the data collected since 1998. It is clear that the river typically warms in a downstream direction, although the amount of warming is less in the winter, despite the reduced residual flow at this time. The greatest difference in water temperature is recorded between Egmont Village and Rimu Street, the two sites that are furthest apart (13.8 km). The average (by month) daily water temperature differences between Hydro Road and Egmont Village, 5.7 km upstream, ranged from -0.60 and 2.21 (Figure 11). The 2017-2018 period recorded results higher than average in the early part of the summer (November and December), but lower than average for the second half of the summer. The smallest change in water temperature was recorded between Hydro Road and Rimu Street, which are 8.1 km apart. Rimu Street was on average no more than one degree warmer than Hydro Road, with the 2017-2018 period recording an even smaller average difference. This degree of warming is less than the warming recorded between Egmont Village and Hydro Road, despite the sites being further apart. This is a direct reflection of the higher flow rate present between the hydro Road and Rimu Street sites providing improved buffering against warming.

Of particular note from the 2017-2018 period was that due to an unusually dry and warm spring and early summer the highest temperature differences were recorded in December, when the required residual flow was 400 L/s. This is in contrast to previous years that typically recorded the highest differences in late summer, when the required residual flow is higher.

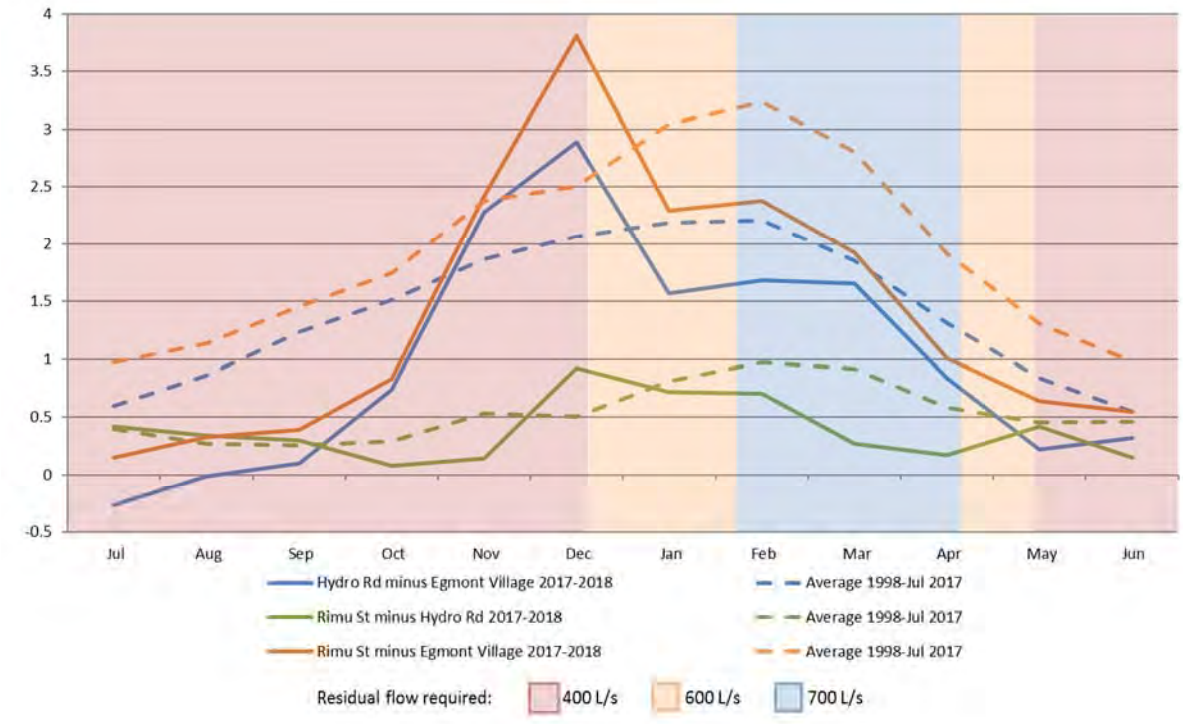

Figure 11 Monthly average water temperature (˚C) differences between three sites monitored in the Waiwhakaiho River, compared with residual flow requirements

A brief comparison of the previous residual flow regime and the new residual flow regime is provided in Table 6 and Figure 12. Table 6 presents a summary of water temperatures over the time periods, and shows that the Egmont Village site has experienced a gradual increase in water temperature, with the mean temperature increasing by 0.6˚C. A similar increase has been recorded downstream at both Hydro Road and Rimu Street. Although it is likely that the increased residual flow has resulted in cooler temperatures downstream, especially at Hydro Road, it is apparent that this cooling influence is of a smaller influence than the natural increase in temperature that has occurred over time.

In terms of temperature differences between Egmont Village and Hydro Road, there has been a slight increase in the frequency of maximum daily differences between 3 and 5˚C in a downstream direction since

the higher residual flow has been implemented. During the 2017-2018 period the majority of recorded differences were in the range of 2-4˚C, although the number of maximum daily differences in the 1-3˚C range was above average.

Figure 13 shows how the difference in water temperature between Egmont Village and Hydro Road changes with a change in flow. During a low flow there is a clear diurnal variation, but when flows increase, the water temperature does not change significantly as it flows downstream. This is likely to be because of the volume of water, but also the speed of flow, meaning that the water has less time to warm as it flows downstream.

Table 6 Waiwhakaiho River water temperature data at three sites prior to, and after, the requirement for the 700 L/s summer (January- March) residual flow

River	SH3@Egmont Village		Hydro Rd		Rimu St	
Site	**1992-97**	**1998-2018**	**1992-97**	**1998-2018**	**1992-97**	**1998-2018**
Maximum (˚C)	21.1	23.9	25.6	27.0	24.8	27.0
Minimum (˚C)	9.2	8.2	9.4	10.2	10.8	10.7
Mean (˚C)	15.3	15.9	17.2	17.8	18.0	18.8
Std Devn (˚C)	2.0	2.1	2.6	2.5	2.3	2.3
% exceedance						
>25˚C	0	0	<1	<1	0	<1
>23˚C	0	<1	1	2	1	4
>20˚C	<1	2	13	19	21	30
>18˚C	10	15	37	44	50	61
>16˚C	37	46	66	76	79	88
>14˚C	74	82	88	95	96	98
>12˚C	95	98	98	>99	99	99
>10˚C	>99	>99	>99	100	100	100
Data record (percentage of period)	80	99	60	95	100	99

Note: 600 L/s residual flow at Hydro Road: 1992-97 and 700 L/s residual flow at Hydro Road: 1998-2015

In summary the water temperature results for the 2017-2018 monitoring period indicated the effect of an unusually hot early summer, coupled with a typical change in water temperature in a downstream direction attributable to the HEPS.

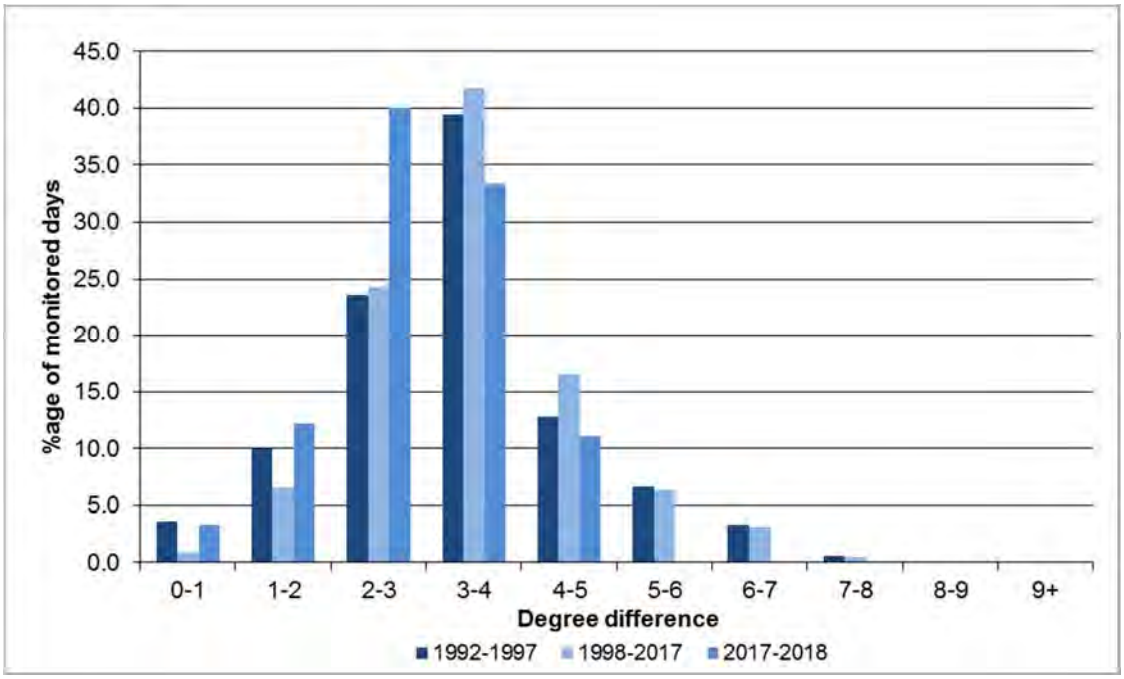

Figure 12 The distribution of maximum daily temperature differences (Hydro Road minus Egmont Village), displayed as a percentage of total days monitored. Data has been split into 600 L/s residual flow (1992-1997) and 700 L/s residual flow (1998-present), and is for January to March only

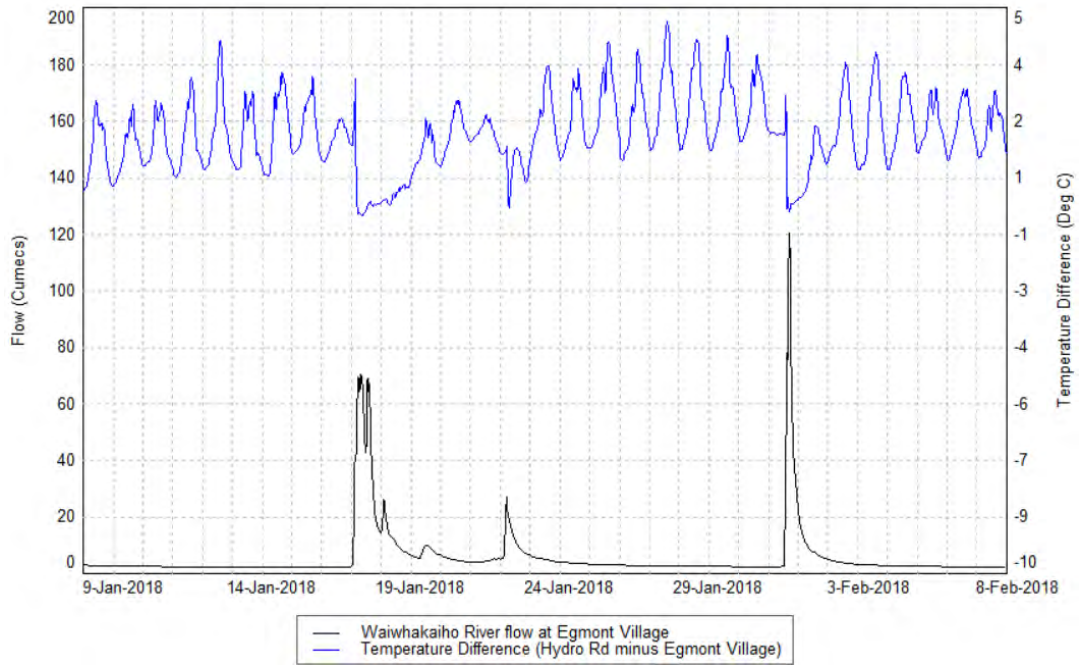

Figure 13 Difference in water temperature compared with flow in the Waiwhakaiho River

2.1.4.2 Macroinvertebrate Monitoring

When the change to resource consent 2053-3 was granted, providing for a greater rate of take, Trustpower agreed to the addition of a macroinvertebrate sampling component to the annual monitoring programme. This was incorporated into the 2016-2017 monitoring programme, with the first survey completed in February 2017. In the current monitoring period, two surveys were completed, on 25 October 2017 and 2 March 2018.

The Council's standard 'kick-sampling' technique was used at one established site (Hydro Road) to collect streambed macroinvertebrates from the Waiwhakaiho River on each sampling occasion. Samples were processed to provide number of taxa (richness), MCI and $SQMCI_S$ scores for each site. On the same day, samples were collected from upstream of SH3 and downstream at Constance Street. The SH3 site is located approximately 1.5 km upstream of the intake weir, while the Constance Street site is located approximately 9 km downstream of the Hydro Road site. The results from these samples are used to provide some perspective.

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. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

Both surveys showed similar results when compared with the results of the sample collected at SH3. It is clear that there was deterioration from that recorded at SH3, with both the MCI and $SQMCI_S$ scores deteriorating significantly (Stark, 1998). This decrease is particularly evident in the $SQMCI_S$ score, which categorised the SH3 site as having 'excellent' health, while the site upstream of Hydro Road was categorised as having 'poor' health.

A closer examination of the taxa recorded at this site shows that the primary reason for the deterioration in MCI and $SQMCI_S$ scores at this site is the increased abundance of taxa commonly associated with higher algal biomass. There is also a consequent reduction in the abundance of 'sensitive' taxa, most of which require a streambed which is relatively clear of algae. This is reflected strongly in the large drop in $SQMCI_S$ score compared to the upstream site. Observations made at the time of sampling indicated that algal biomass at the Hydro Road site was higher than that at the other sites, during both surveys. This is consistent with the lower, stable flows the site experiences, not only reducing the amount of scour the periphyton community experiences, but also improving conditions for algal growth by resulting in warmer water temperatures and more light reaching the riverbed, due to reduced water depth.

The water temperature at the time of this summer survey was also elevated by approximately 5°C compared to that upstream at SH3, which in addition to promoting algal growth, is likely to have directly impacted the macroinvertebrate community, reducing the number and abundance of 'sensitive' taxa, which generally prefer cooler water temperatures.

With regards to any change in the influence of flushing flows caused by the increased rate of take allowed by the variation of consent 2053, the increased rate of take had been exercised in the year prior. Subsequent monitoring showed an increase in both the number and abundance of 'tolerant' taxa, as well as the proportion of the community comprising 'tolerant' taxa, compared to the two prior surveys (one of which was prior to the increase in take rate being exercised). This most likely reflects the effects of the water abstraction combined with natural seasonal variation. Although the spring survey also noted some effects of the water abstraction, the macroinvertebrate community was overall in a slightly healthier state due to the natural seasonal variation.

Overall, the survey results highlight the decreased macroinvertebrate health at the Hydro Road site. The decrease in MCI and $SQMCI_S$ scores were a reflection of the decreased abundance of 'sensitive' taxa caused by the algal proliferation in the residual flow reach, likely due to the upstream water abstraction. Future surveys will continue to assess the potential effects of the increased rate of water abstraction. Based on this result and the previous survey results it is recommended that an additional sample site within the residual reach be established in order to better validate this finding.

The full reports are provided in Appendix II

2.1.4.3 Fish monitoring

Although the monitoring programme for the Mangorei HEP scheme does not include any routine fish monitoring, there has been some fish monitoring undertaken in the past. The results of this work was collated and presented in the report attached as Appendix II in TRC, 2009. In summary, this survey found:

- the diadromous fish community found upstream of the HEP scheme intake weir closely resembled that predicted by the Leathwick *et al* (2009) model;
- the fish pass provides adequate passage for those diadromous fish which reach the intake weir;
- there is some evidence suggesting a lack of recruitment of shortjaw kokopu and banded kokopu to the headwaters;
- this lack of recruitment may be due to the absence of an adult population providing attractant pheromones; and
- trout are able to negotiate the fish pass, although whether a significant number do so is uncertain.

Recommendations arising from the outcomes of the survey include the incorporation of appropriate monitoring sites in the Waiwhakaiho catchment in the Council's proposed State of the Environment Freshwater Fish Monitoring Programme, with these sites to be monitored at a frequency of at least five-yearly intervals.

The Council's State of the Environment Freshwater Fish Monitoring Programme is in the early stages of implementation and at this stage there is limited monitoring coverage in the Waiwhakaiho Catchment. Therefore liaison with Trustpower regarding the inclusion of a fish monitoring component in future monitoring programmes will be undertaken in the forthcoming monitoring period.

Discussions should include consideration of the frequency and scale of the following tasks:

1. An assessment of fish passage through the residual flow reach, to assess compliance with condition 5 of consent 2053-3.
2. An assessment of the fish communities in the residual flow reach.
3. An assessment of the fish communities present upstream of the intake weir.
4. An inspection of fish passage at the access culvert and at the intake weir fish pass.

2.1.4.4 Adult eel and elver transfers

Every year, Trustpower transfers adult eels that are attempting to migrate downstream through Lake Mangamahoe, so that they can continue their migration downstream of the HEP scheme. These eels tend to accumulate where water is taken from the lake for generation purposes, and can be captured using nets set in this location. This system has been employed each autumn since 2009, with the number of eels transferred varying significantly. The numbers transferred are presented in Table 7. A total of 21 adult eels were transferred in the reported period. This included the 11 longfin eel and 10 shortfin eel (Table 7). Overall, the number of eels transferred in the 2017-2018 period was similar to the median result for this transfer programme.

In early summer, juvenile eels, known as elvers, migrate up the Waiwhakaiho River. Some of these elvers are attracted by the generation flow from the station, and move up the powerhouse outlet canal and into the power station. In 2002, a trap was installed within the power station, this trap being a smaller version of the one used at the Patea hydro dam. Elvers are collected from this trap, weighed and then transferred to the Waiwhakaiho River residual flow reach upstream of the Meeting of the Waters.

Table 7 Numbers of adult eels transferred at the Mangorei HEP scheme since 2009

Year	Number of longfin eels transferred	Number of shortfin eels transferred	Number of unidentified eels transferred	Total number of eels transferred
2009	-	-	171	171
2010	-	-	4	4
2011	-	-	7	7
2012	-	-	7	7
2013	-	-	21	21
2014	13	30	44	87
2015	21	8	-	29
2016	11	1	-	12
2017	40	17	-	57
2018	11	10	-	21

This trapping and transfer programme commenced in the 2002-2003 period with the numbers of elver trapped and transferred summarised in Table 8. This data was collected and supplied by Trustpower. Numbers of elvers were calculated from a calibration exercise performed at the trap (in late January 2003) when it was determined that 1 kg equated to 1,200 elvers, although subsequent calibration exercises in mid-December 2005 and late January 2009 found that 1 kg equated to 760 and 1,030 elvers at these times, respectively.

The total number of elver numbers trapped in the monitoring period was less than that transferred in the previous year, being similar to the median number trapped over the 14 preceding monitoring periods Table 8 indicative of a relatively typical season for elver migration.

Table 8 Estimated numbers of elvers trapped and transferred at the Mangorei HEP scheme powerhouse in the monitoring years to date

Monitoring year	Transfer period	Total number of elvers	Peak daily number	Peak month
2002-2003	9 Jan 03-25 Apr 03	18,160	1,020	Jan 2003
2003-2004	4 Dec 03-25 Mar 04	19,445	1,715	Jan 2004
2004-2005	14 Jan 04-21 Mar 05	9,780	600	Jan 2005
2005-2006	30 Nov 05-20 Mar 06	19,965	1,140	Feb 2006
2006-2007	3 Jan 07-26 Apr 07	25,230	1,910	Jan 2007
2007-2009	30 Nov 07- 26 Mar 08	29,668	940	Jan 2008
2008-2009	2 Dec 08-16 Mar 09	38,040	1,140	Jan 2009
2009-2010	18 Dec 09- 25 Feb 10	8,566	237	Jan 2010
2010-2011	8 Nov 10-28 Feb 11	18,776	525	(late) Dec 2010
2011-2012	21 Jan 12-31 Mar 12	640	96	Feb 2012
2012-2013	14 Dec 12-12 Apr 13	15,972	270	Jan 2013
2013-2014	20 Dec 13-28 Mar 14	19,680	566	Jan 2014
2014-2015	1 Nov 14-30 Apr 15	13,200	471	Jan 2015

Monitoring year	Transfer period	Total number of elvers	Peak daily number	Peak month
2015-2016	11 Dec 15-24 Mar 16	24,588	906	Jan 2016
2016-2017	16 Dec 16-7 Apr 17	18,696	411	Feb 2017
2017-2018	8 Dec 17- 5 Apr 18	15,828	1,200	Dec-17

The traps are typically operative from 1 November each year, with elvers usually arriving mid-December. In the monitoring period the first elvers were trapped on 8 December 2017. The trap was shut down in April 2018, as the elver run had effectively stopped at that time.

During the four month period (December 2017 to late March 2018), a moderate number of elvers (approximately 16,000) was caught and transferred. The majority of numbers were recorded in December 2017 (Table 9), earlier than usual.

Although the number of elvers transferred at the Mangorei scheme are low compared to those transferred at the Company's Patea scheme, it is likely that a significant proportion of upstream elver movements would follow the main channel of the Waiwhakaiho River rather than enter the smaller outlet channel of the powerhouse outlet canal.

Table 9 Numbers of elvers transferred during the 2017-2018 period

Date	Elver numbers		Cumulative total
	Interval (days)	Elver per day	
08 December 2017	1	600	600
11 December 2017	3	576	2,328
22 December 2017	11	87	3,288
27 December 2017	5	888	7,728
29 December 2017	2	1200	10,128
15 January 2018	17	34	10,704
19 January 2018	4	375	12,204
25 January 2018	6	94	12,768
01 February 2018	7	130	13,680
09 February 2018	8	75	14,280
15 February 2018	6	80	14,760
23 February 2018	8	36	15,048
01 March 2018	6	50	15,348
09 March 2018	8	42	15,684
05 April 2018	27	5	15,828

2.2 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 Trustpower. 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 causes 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 Trustpower 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 not required to undertake significant additional investigations and interventions, or record incidents, in association with Trustpower's conditions in resource consents or provisions in Regional Plans.

2.3 Riparian planting

As per special condition 8 of consent 2053, Trustpower donates annually to the Council ($5,000-adjusted to the consumer price index) for the purpose of providing riparian planting and management in the Waiwhakaiho River catchment.

At the time of compiling this report, nine landholders in the Waiwhakaiho catchment had applied for the subsidy in the 2017-2018 period, which covers 50% of the cost of plants planted within the catchment for riparian protection. At the time of compiling this report, there was just over $15,000 available to landowners.

2.4 Stakeholders' meeting

As a requirement under a special condition in various Mangorei HEP scheme consents, an annual meeting of interested stakeholders is held to discuss any matters relating to the exercise of these consents, but particularly monitoring programme design, implementation and interpretation, in order to facilitate ongoing consultation.

Previously, stakeholders meetings have only been held when warranted i.e. when particular issues warranted a round table discussion. No such issues were raised during the reported period, and as such, no meeting was held. Trustpower are in the early stages of investigating the renewal of the Mangorei HEP resource consents, most of which expire in 2021. The stakeholder meeting may be a good mechanism for Trustpower to engage with adjacent landowners and other interested parties in initiating the resource consent renewal process.

3 Discussion

3.1 Discussion of site performance

Monitoring undertaken over the 2017-2018 period has concentrated on the provision and maintenance of appropriate residual flow releases below the intake weir, maintenance of lake levels and discharge flows, provision of fish passage and the provision of data from Trustpower as required.

The station is largely controlled automatically, with the river intake gates opening or closing dependant on flows in the Waiwhakaiho River. The data recorded by Trustpower's water level recorder located downstream of the intake weir is used in this control system and has resulted in a high standard of compliance with the required residual flows.

Compliance with the residual flow requirements was determined through monthly gaugings, which found residual flow requirements were being complied with on each occasion, a continuation of the high level of performance reported in the last eight monitoring periods (2009-2017). Despite the presence of telemetered water level monitoring immediately downstream of the intake weir, these gaugings retain their importance, as maintaining the accuracy of flow rates calculated with level data from this recorder is often difficult, given the frequent changes in the river bed cross section at the monitoring location.

Daily minimum powerhouse generation releases of 950 L/s during daylight hours were successfully maintained by Trustpower throughout the period. The automatic compensation valve at the powerhouse, which removed the need for spillages via the intake weir during power station outages, did not need to be used during the reported period. At times, spillage over the intake weir was necessary when maintenance precluded a discharge from the station. The spreading of daily power generation flows over longer daylight periods has benefits for water quality and ecology in the lower river, as well as providing recreational opportunities in reaches commonly used by the public near and within New Plymouth city boundaries.

Compliance with Lake Mangamahoe minimum lake levels was also achieved throughout the period, with few lake spillages, all occurring during winter periods. Furthermore, liaison with Trustpower indicated good compliance with the new maximum abstraction rate of 10 cumecs.

The fish pass was maintained and operated successfully during the monitoring period although there were occasions where floods deposited a large amount of river gravels and cobbles in the pass, Trustpower cleared the pass as quickly as practicable following these events.

Overall, in terms of compliance with consent conditions, the performance of Trustpower in relation to the Mangorei HEP scheme has been of a very high standard.

3.2 Environmental effects of exercise of consents

The primary impact of the Mangorei HEP scheme is the reduced flow in the Waiwhakaiho River. This reduced flow is largely limited to the residual flow reach, as the release of at least 950 L/s during the day from the station results in higher flows in the river downstream of the scheme. In addition, the variable residual flow requirements ensures that the scheme can make good use of winter flows, while providing a higher residual flow in the summer.

River water temperature records illustrate the impacts of residual flow releases on the lower river reaches and also indicate a general trend of a very small rise in water temperatures along the length of the river in more recent years, despite the increase in the summer residual flow release. This is probably attributable to warmer weather, possibly related to climate change. Water temperatures recorded in the 2017-2018 period were warmer than typical of historical results, attributable to the dry and hot spring to early summer period. This hot weather resulted in higher maximum daily temperatures, and higher temperatures in the residual flow reach and down through to Rimu Street. However, the degree of warming was not as severe, primarily

due to the warming that had already occurred upstream of the weir. As a result, the water did not have the same capacity to warm up, as the water arriving at the scheme was already unusually warm.

In terms of fish passage, the fish pass is considered adequate to provide for the passage of all fish species expected to migrate up to and beyond the weir. This includes all native migratory species recorded as present in the residual flow reach, and adult trout, which have been shown to be capable of negotiating the pass. Although maintenance was required to maintain this passage, it was done without excessive delay.

Trustpower also transferred elvers that were trapped at the power station for release in the residual flow reach, and transferred migrating adult eels from Lake Mangamahoe into the lower Waiwhakaiho River. A moderate number of adult eels were transferred in the 2017-2018 period, and an average number of elvers were transferred, slightly less than that transferred in the previous year.

Macroinvertebrate sampling reflected the high water quality and habitat conditions found in the residual flow reach, but also reflected the algal proliferation that occurs there. While not greatly impacting on the presence of 'sensitive' taxa, it did influence their relative abundance, causing the community to be numerically dominated by 'tolerant' taxa. This sampling did not suggest any impact from the increased rate of take allowed by the variation of consent 2053.

Trustpower is required to provide some mitigation for the effects of the diversion of the river flow by financially contributing to riparian management elsewhere in the Waiwhakaiho catchment. This is done by subsidising the cost of plants sold to landowners in the catchments, an opportunity taken up by nine landowners during the reported period.

Finally, Trustpower is also required to undertake sediment and lake bathymetric monitoring, in relation to a consent variation that provided for an increased rate of take, so that Trustpower can take advantage of flood flows. The initial bathymetric survey of Lake Mangamahoe was commissioned by Trustpower and performed in mid-2013, with another survey completed March 2017. The next bathymetry survey is scheduled to be completed in December 2020.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 10 to 16.

Table 10 Summary of performance for consent 2053-3

Purpose: ***To divert water from the river into Lake Mangamahoe***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Continuous daily generation of 950 L/s between 8am & 6pm	Supply of data by consent holder	Yes
2. Seasonal residual flows released over the weir	Inspections, gaugings (TRC), and automatic flow recording (by consent holder)	Yes
3. Cessation of diversion when Waiwhakaiho River ≥85 cumecs	Liaison with consent holder	Yes
4. Maintenance of residual flow recording device and supply of records	Supply of levels by consent holder	Yes
5. Provision of suitable fish passage in residual flow channel	Inspections	Yes
6. Provision of sediment/lake bathymetry monitoring programme by Trustpower	Consent holder to undertake and provide data	Yes
7. Provision of public safety notices	Liaison with consent holder and inspections	Yes
8. Mitigation by riparian management	TRC Land Management records	Yes
9. Stakeholders bi-annual meetings	Consent holder liaison	Yes (not required)
10. Optional review provision	No reviews remaining	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 11 Summary of performance for consent 2054-3

Purpose: To dam the Mangamahoe Stream for HEP scheme generation purposes		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Operation and maintenance of dam to satisfaction of the Council	Liaison with consent holder	Yes
2. Maintenance of minimum level in Lake Mangamahoe	Supply of data by consent holder	Yes
3. Notification if lake level to be lowered for weed maintenance purposes	Liaison with consent holder	N/A
4. Optional review provision	No reviews remaining	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**

Table 12 Summary of performance for consent 2056-3

Purpose: *To use up to 750,000 cubic metres per day of water from Lake Mangamahoe for HEP scheme generation purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Spread generation during daylight hours as far as reasonably practical	Review of data	Yes
2. Optional review provision	No reviews remaining	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**

Table 13 Summary of performance for consent 4886-1

Purpose: *To erect and maintain structures in, and dam, the Mangamahoe Stream for the formation of Lake Mangamahoe for HEP scheme generation purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Operation and maintenance of structures to satisfaction of the Council	Liaison with consent holder	Yes
2. Optional review provision	No reviews remaining	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**

Table 14 Summary of performance for consent 4887-1

Purpose: *To erect and maintain structures associated with the diversion of Waiwhakaiho River water into Lake Mangamahoe for HEP scheme generation purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Operation and maintenance	Inspections and liaison with consent holder	Yes
2. Installation and maintenance of fish pass	Inspections and liaison with consent holder	Yes
3. Maintain residual flow device	Inspections and liaison with consent holder	Yes
4. Optional review provision	No reviews remaining	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**

Table 15 Summary of performance for consent 4888-1

Purpose: *Emergency discharge of Lake Mangamahoe water to the Mangamahoe Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Optional review provision	No reviews remaining	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**

Table 16 Summary of performance for consent 6810-1

Purpose: *To erect, place and maintain a culvert for access purposes, in an unnamed tributary of the Waiwhakaiho River*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Silt discharge and riverbed disturbance minimisation	Liaison with the Council by consent holder	N/A
2. Exercise in accordance with documentation	Inspections	N/A
3. Notification of installation and maintenance works	Notification by consent holder	N/A
4. Timing of works	Inspections	N/A
5. Riverbed disturbance limits	Inspections	N/A
6. Limits to effects on receiving waters	Inspections	N/A
7. Removal of structure if no longer required	Liaison with consent holder	N/A

Purpose: *To erect, place and maintain a culvert for access purposes, in an unnamed tributary of the Waiwhakaiho River*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
8. Flow and fish passage restrictions	Inspections	In part (with remedial work to be addressed when necessary)
9. Ponding restrictions	Inspections	Yes
10. Erosion and sediment control plan	Provision by consent holder	N/A
11. Lapse of consent	Consent exercised	N/A
12. Optional review provision	No reviews remaining	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, Trustpower demonstrated a high level of environmental and administrative performance with the resource consents as defined in Section 1.1.4. All components of the Mangorei HEP scheme were operated well, with Trustpower being active in maintaining fish passage at the weir, and assisting with the migration of both adult and juvenile eels when these fish congregate at the scheme. Trustpower has been proactive in gaining a mutual understanding of how compliance with certain conditions will be assessed, and continues to undertake maintenance of the residual flow recorder in an effort to uphold its accuracy.

3.4 Recommendations from the 2016-2017 Annual Report

In the 2016-2017 Annual Report, it was recommended:

1. THAT in the first instance, monitoring of consented activities at Mangorei HEP scheme in the 2017-2018 year continue at the same level as in 2016-2017.
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.
3. THAT the Council liaises with Trustpower regarding the inclusion of a fish monitoring component in the 2017-2018 monitoring programme.

These recommendations were implemented in the 2017-2018 monitoring period, with the exception of recommendation 3, which will be carried over to the 2018-2019 period.

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 all components of the monitoring programme for the 2018-2019 year remain at the same level as that undertaken in the 2017-2018 year with one exception. When assessing the macroinvertebrate data it was determined that to better validate the results, it was appropriate to include an additional sampling site within the residual flow reach. Therefore it is recommended to increase the macroinvertebrate monitoring component by one site in the 2018-2019 period.

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 Recommendations

1. THAT the macroinvertebrate monitoring component of future monitoring programmes increase with the addition of one extra sampling site, located within the residual flow reach.
2. THAT all other monitoring of consented activities at Mangorei HEP scheme in the 2018-2019 year continue at the same level as in 2017-2018.
3. THAT should there be issues with environmental or administrative performance in 2018-2019, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
4. THAT the Council liaises with Trustpower regarding the inclusion of a fish monitoring component in future monitoring programmes.

Glossary of common terms and abbreviations

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

Biomonitoring	Assessing the health of the environment using aquatic organisms.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1}).
Diadromous	A fish with life-cycles encompassing fresh and salt water stages.
Elver	Juvenile eel(s) that has entered freshwater from the sea.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
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.
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.
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.
Residual flow	Flow required to maintain fish passage and/or aquatic habitat.
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.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).

For further information on analytical methods, contact a Science Services Manager.

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Appendix I

Resource consents held by Trustpower Mangorei HEPS

(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:	Trustpower Limited Private Bag 12023 Tauranga 3143	
Decision Date (Change):	01 August 2017	
Commencement Date (Change):	01 August 2017	(Granted Date: 01 August 2017)

Conditions of Consent

Consent Granted:	To divert up to 10 cubic metres per second of water from the Waiwhakaiho River via a diversion weir and associated intake structures into Lake Mangamahoe through the Mangorei Hydroelectric Power Scheme and back into the river approximately six kilometres downstream of the diversion point
Expiry Date:	01 June 2021
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697720E - 5668050N
Catchment:	Waiwhakaiho
Tributary:	Lake Mangamahoe

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. That the consent holder shall maintain a continuous generation flow release of at least 950 litres/second between 8:00 am and 6:00 pm each day.

2. That the consent holder shall maintain, each 12-month period, the following minimum residual flows in the Waiwhakaiho River below the diversion weir:

    i) at least 700 litres/second between 1 January and 31 March, effective from 1 January 1998;

    ii) at least 600 litres/second between 1 January and 31 March, until 31 December 1997;

    iii) at least 600 litres/second between 1 November and 31 December and during April; and

    iv) at least 400 litres/second between 1 May and 31 October.

3. No water shall be diverted when the flow in the Waiwhakaiho River is greater than or equal to 85 cubic metres per second.

4. That the consent holder shall install and operate, to the satisfaction of the Chief Executive, Taranaki Regional Council, a measuring device capable of measuring the residual flow to be maintained in the Waiwhakaiho River downstream of the diversion weir, and shall provide records of such measurements to the Chief Executive, Taranaki Regional Council, upon request.

5. That the consent holder shall maintain, as far as reasonably practicable, the river channel below the diversion weir to the `Meeting of Waters' for the purpose of enhancing available fish passage and habitat, to the satisfaction of the Chief Executive, Taranaki Regional Council; and, the Taranaki Regional Council will inspect the fish passage device and river channel for compliance after any significant river fresh.

6. The consent holder shall ensure a monitoring programme is undertaken that includes:

    a) sediment sampling that relates the flow in the Waiwhakaiho River to the rate of sediment entering Lake Mangamahoe via the diversion;
    b) bathymetric surveys that record the change in bathymetry of Lake Mangamahoe between winter 2013 and 31 December 2020; and
    c) a report assessing the effects of this application and any significant change in bathymetry.

7. That the consent holder shall erect and maintain notices and other warnings as may be required, to the satisfaction of the Chief Executive, Taranaki Regional Council, for adequate protection of public safety to warn the public using the river downstream of the scheme of fluctuations in river flow and of the extent of those fluctuations.

8. The consent holder shall mitigate the environmental effects of the diversion by making annual payments of $5,000 (GST exclusive) to the Taranaki Regional Council as a financial contribution for the purpose of providing riparian planting and management in the Waiwhakaiho River catchment. The amount to be paid shall be adjusted annually according to the consumer price index, or similar index, to account for the effects of inflation, and be made no later than 1 September each year.

9. That the consent holder and staff of the Taranaki Regional Council shall meet as appropriate, and at least once every two years, with submitters to the consent to discuss any matter relating to the exercise of this resource consent.

10. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the diversion on the environment.

Signed at Stratford on 01 August 2017

For and on behalf of
Taranaki Regional Council

_____

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:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date:	4 September 1996
Commencement Date:	4 September 1996

Conditions of Consent

Consent Granted:	To dam the Mangamahoe Stream in the Waiwhakaiho Catchment to form Lake Mangamahoe to act as a reservoir of water for hydroelectric power generation purposes
Expiry Date:	1 June 2021
Site Location:	Lake Mangamahoe Junction Road New Plymouth
Grid Reference (NZTM)	1697320E-5669450N
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe

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;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the dam and associated structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the consent holder shall maintain a minimum lake level of 750 mm below the crest of the Mangamahoe spillway except during lake weed maintenance periods.

3. That the consent holder shall notify the Chief Executive, Taranaki Regional Council, of its intention to temporarily lower Lake Mangamahoe for weed management purposes at least seven days prior to commencing lake dewatering.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the dam on the environment.

Transferred at Stratford on 31 October 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Water Permit

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

Name of Consent Holder:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date (Change):	16 June 2016
Commencement Date (Change):	16 June 2016

Conditions of Consent

Consent Granted:	To use up to 864,000 cubic metres/day of water from Lake Mangamahoe in the Waiwhakaiho catchment for hydroelectric power generation purposes
Expiry Date:	1 June 2021
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697220E-5669450N
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

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;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall, as far as reasonably practicable, spread its generation during daylight hours in order to maximise the beneficial effect of artificial flows in the lower Waiwhakaiho River.

2. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the water use on the environment.

Transferred at Stratford on 31 October 2016

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:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date:	4 September 1996
Commencement Date:	4 September 1996

Conditions of Consent

Consent Granted:	To erect and maintain structures in the Mangamahoe Stream in the Waiwhakaiho Catchment to dam the stream to form Lake Mangamahoe for hydroelectric power generation purposes
Expiry Date:	1 June 2021
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697318E-5669451N
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

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;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the structures on the environment.

Transferred at Stratford on 31 October 2016

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:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date:	4 September 1996
Commencement Date:	4 September 1996

Conditions of Consent

Consent Granted:	To erect and maintain structures associated with the diversion of water from the Waiwhakaiho River into Lake Mangamahoe for hydroelectric power generation purposes
Expiry Date:	1 June 2021
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697719E-5668051N
Catchment:	Waiwhakaiho
Tributary:	Lake Mangamahoe

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;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the consent holder shall install and maintain, to the satisfaction of the Chief Executive, Taranaki Regional Council, a structure at the diversion weir to enable the passage of native fish, juvenile trout and adult trout.

3. That the consent holder shall maintain a device capable of meeting the residual flow requirements of the consent, to the satisfaction of the Chief Executive, Taranaki Regional Council.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the structures on the environment.

Transferred at Stratford on 31 October 2016

For and on behalf of
Taranaki Regional Council

_____

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:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date:	4 September 1996
Commencement Date:	4 September 1996

Conditions of Consent

Consent Granted:	To discharge up to 150,000 litres/second of water from Lake Mangamahoe via a spillway into the Mangamahoe Stream in the Waiwhakaiho Catchment under emergency conditions associated with hydroelectric generation purposes
Expiry Date:	1 June 2021
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697318E-5669451N
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

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;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special condition

1. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the discharge on the environment.

Transferred at Stratford on 31 October 2016

For and on behalf of
Taranaki Regional Council

_____

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:	Trustpower Limited Private Bag 12023 Tauranga 3143
Decision Date:	6 March 2006
Commencement Date:	6 March 2006

Conditions of Consent

Consent Granted:	To erect, place and maintain a culvert in an unnamed tributary of the Waiwhakaiho River for access purposes
Expiry Date:	1 June 2020
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Grid Reference (NZTM)	1697023E-5668380N
Catchment:	Waiwhakaiho

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 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 consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to avoid or minimise the discharge of silt or other contaminants into water or onto the riverbed and to avoid or minimise the disturbance of the riverbed and any adverse effects on water quality.

2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 4114. In the case of any contradiction between the documentation submitted in support of application 4114 and the conditions of this consent, the conditions of this consent shall prevail.

3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the commencement and upon completion of the initial installation and again at least 48 hours prior to and upon completion of any subsequent maintenance works which would involve disturbance of or deposition to the riverbed or discharges to water.

4. Any instream works shall take place only between 1 November and 30 April inclusive, except where this requirement is waived in writing by the Chief Executive, Taranaki Regional Council.

5. The consent holder shall ensure that the area and volume of riverbed disturbance shall, so far as practicable, be minimised and any areas which are disturbed shall, so far as practicable, be reinstated.

6. After allowing for reasonable mixing, being a mixing zone extending seven times the width of the surface water body at the point of discharge, the discharge shall not give rise to any of the following effects in any surface water body:

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.

7. Except with the written agreement of the Chief Executive, Taranaki Regional Council, 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.

8. The exercise of this consent shall not alter the natural flow of the river or restrict the passage of fish.

9. The exercise of this consent shall not result in the significant ponding of water upstream of the culvert.

10. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, a site erosion and sediment control management plan.

11. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

12. 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 2008 and/or June 2014, 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 31 October 2016

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, Bart Jansma
From	Environmental Scientists, Bart Jansma and Katie Blakemore
Report No	KB066
Doc No	2118281
Date	5 September 2018

Biomonitoring of the Waiwhakaiho River in relation to the Mangorei H.E.P diversion of water, October 2017

Introduction

This was the first biomonitoring survey completed of the two scheduled in the monitoring programme for the Mangorei HEP scheme for the 2017-2018 monitoring year. Macroinvertebrate monitoring, which had been a part of previous programmes, was reintroduced into the monitoring programme in the 2016-2017 period following a variation to the conditions of resource consent 2053. This variation allows the consent holder to take an extra three cumecs, increasing the consented rate of take from seven cumecs to ten cumecs. There was some concern that the increased rate of take may reduce the degree of flushing the residual flow reach experienced during higher flows, and as a result, the macroinvertebrate monitoring was reinstated. With regards to the current survey, the preceding flows had been typified by frequent high flow events, with the river flows being stable for eleven days prior to this survey (Figure 1).

The current survey was the first survey undertaken since the enactment of the higher abstraction rate by Trustpower. When the previous survey results are included, a useful data set exists to compare survey results following Trustpower taking advantage of the increased consented abstraction rate.

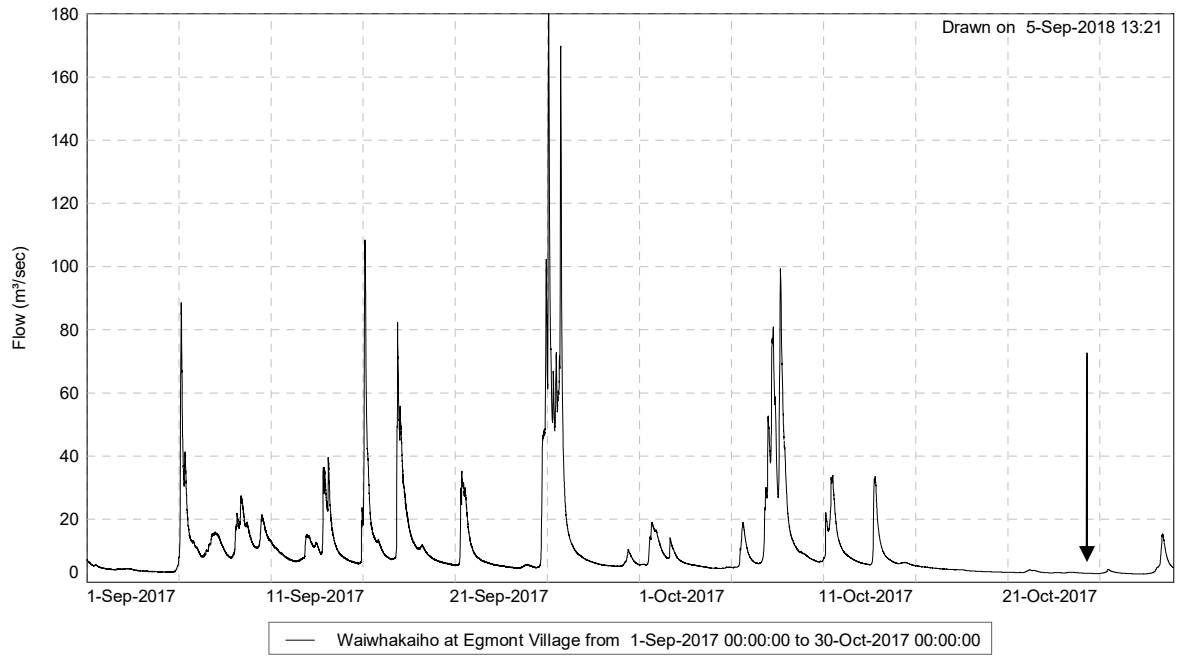

Figure 1 The flow (cubic meters per second) in the Waiwhakaiho River at the State Highway 3 recorder site. The arrow indicates the time of sampling.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from one site in the Waiwhakaiho River (Table 1, Figure 2) on 25 October 2017, eleven days after flows in excess of three and twelve days after flows in excess of seven times the median flow. This '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 also collected at other sites in the Waiwhakaiho Catchment on this day, including just upstream of State Highway 3 and at Constance St, 9 km downstream. The samples were also collected using the '400ml kick-sampling' technique, and the results are included to provide some perspective.

Table 1 Biomonitoring sites in the Waiwhakaiho River discussed in relation to the Mangorei HEP scheme

Site Name.	Site code	GPS Reference	Location
SH3	WKH000500	E1698297 N5666893	Upstream of SH3
Hydro Road	WKH000655	E1697061 N5671279	Approximately 550m upstream of station discharge
Constance Street	WKH000920	E1695827 N5677271	At end of Constance Street

Samples were preserved with Kahle's Fluid 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 as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

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. Communities that are more 'sensitive' inhabit less polluted waterways. 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 and Boothroyd and Stark, 2000) (Table 2).

However, the establishment of lengthy historical records of taxa richness, community composition and MCI scores may be useful in assessing trends in the 'health' of macroinvertebrate communities associated with rivers and streams subject to environmental perturbations such as those caused by HEP abstractions.

Table 2 Macroinvertebrate health based on MCI and $SQMCI_s$ ranges which has been adapted for Taranaki streams and rivers (TRC, 2015) from Stark's classification (Stark, 1985, Boothroyd and Stark, 2000, and Stark and Maxted, 2007)

TRC Grading	MCI	$SQMCI_s$
Excellent	>140	>7.00
Very Good	120-140	6.00-7.00
Good	100-119	5.00-5.99
Fair	80-99	4.00-4.99
Poor	60-79	3.00-3.99
Very Poor	<60	<3.00

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 & 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 values range from 0 to 10.

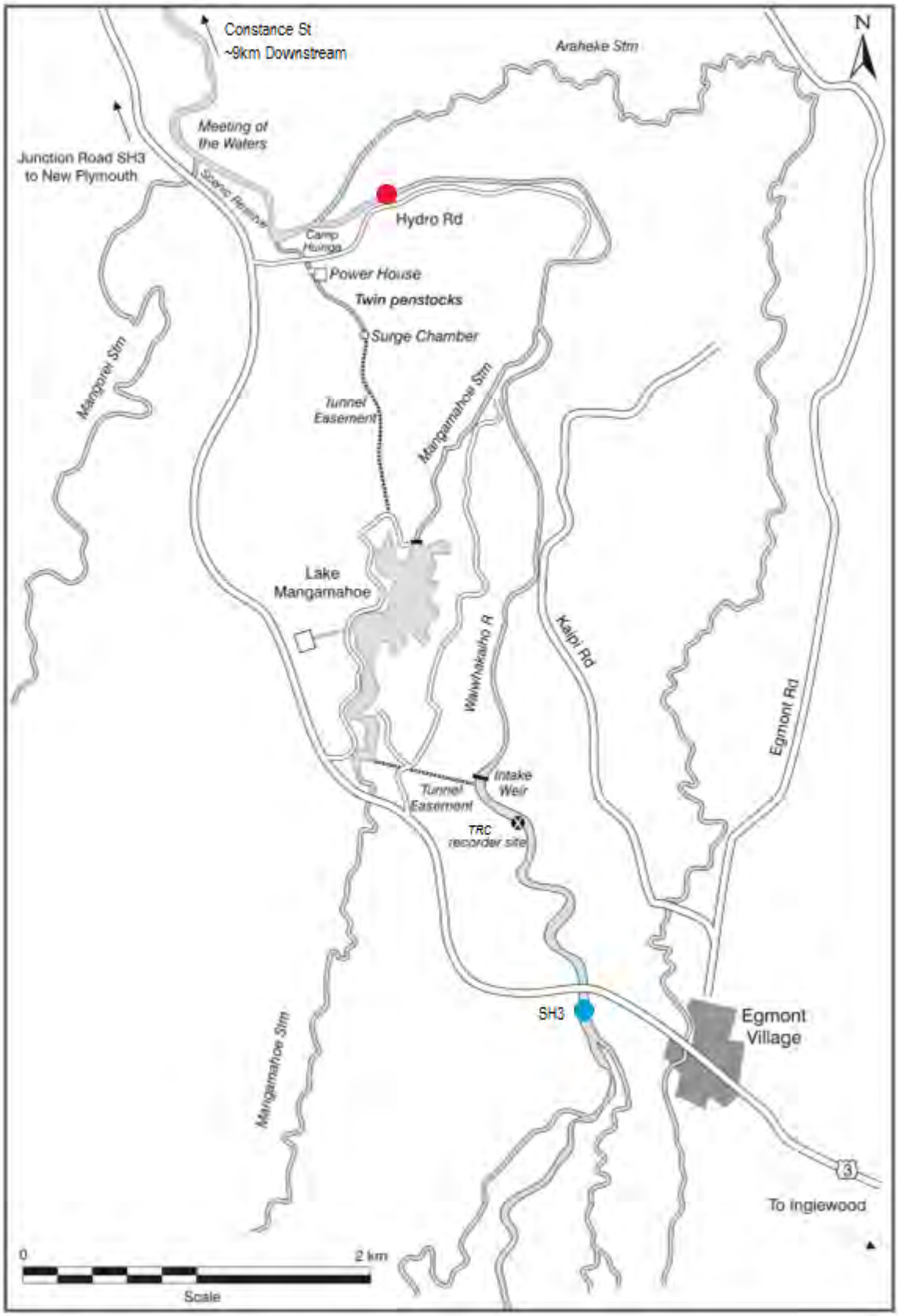

Figure 2 Biological monitoring sites in the Waiwhakaiho River in relation to the Mangorei Power Scheme Hydro Road (red dot). Upstream of SH3 (blue dot)

Results and discussion

At the time of this morning survey, the water temperature in the Waiwhakaiho River at Hydro Road was 14.7˚C. There was a moderate flow (for this site), which was swift, clear and uncoloured.

The substrate at this site comprised predominantly cobbles and boulders, with some gravels and sand present also. There was a much higher algal biomass than that observed upstream, with algal mats and filaments widespread on the streambed.

Macroinvertebrate communities

A summary of the results from previous macroinvertebrate surveys performed in the Waiwhakaiho River in relation to the Mangorei HEP scheme is presented in Table 3, together with current results (which are presented in full in Table 4).

Table 3 Summary of previous numbers of taxa and MCI values recorded in surveys performed in the Waiwhakaiho River in relation to the Mangorei HEP water abstraction, together with current results

Site	N	Numbers of taxa			MCI values			$SQMCI_S$ values			
		Median	Range	Current survey	Median	Range	Current survey	N	Median	Range	Current survey
SH3	45	22	9-32	17	110	67-125	114	37	5.8	1.9-7.5	7.6
Hydro Road	4	24	18-25	19	97	91-104	103	2	3.5	3.0-3.9	3.4
Constance Street	62	20	12-29	16	90	66-110	106	38	3.3	1.7-7.3	5.0

Nineteen taxa were recorded at Hydro Road, five taxa less than the median of the four surveys completed previously and the preceding (February 2017) survey. This is higher than that recorded at SH3 upstream, and Constance Street downstream (Table 3). The presence of three 'highly sensitive' taxa was indicative of good preceding physicochemical water quality. The community was characterised by one of these 'highly sensitive' taxa (mayfly (*Deleatidium*)), along with two 'moderately sensitive' taxa (free-living caddisfly (*Costachorema*) and cranefly (*Aphrophila*)), and one 'tolerant' taxon (midge larvae (orthoclads)). The numerical dominance of the 'tolerant' midge taxa reflected the proliferation of algae observed at this site, resulting in a $SQMCI_S$ score of 3.4 units. This was not significantly different to either of the two other $SQMCI_s$ score recorded at this site to date (Stark, 1998). However, this score was significantly lower than the scores recorded upstream at SH3 and downstream at Constance Street. The proportion of the community made up by 'tolerant' taxa was moderate, resulting in an MCI score of 103 units. This is six units higher than the median for this site and only one unit less than the preceding result, but significantly less (Stark, 1998) than that recorded 7km upstream at SH3.

When compared with the results of sample collected upstream of Hydro Road, it is clear that there is deterioration from that recorded at SH3, with both the MCI and $SQMCI_S$ scores deteriorating significantly (Stark, 1998). This decrease is particularly evident in the $SQMCI_s$ score, which categorises the upstream site as having 'excellent' health, while the site upstream of Hydro Road is categorised as having 'poor' health (Table 2). There is also a slight increase in taxa richness at Hydro Road, which is likely a reflection of the more stable flows this site experiences. To provide some further perspective, the MCI scores recorded in the current survey are compared with predicted scores, calculated using equations developed by Stark and Fowles (2009) (Table 4).

This comparison shows that for the current survey, the scores recorded at SH3, Hydro Road and Constance Street were higher than that predicted, significantly so at Constance Street (Stark, 1998). Coupled with the

fact that these sites also recorded MCI scores in excess of their respective medians, this suggests that the communities at these sites are in better than expected condition. This is considered a direct reflection of the spring conditions that preceded the survey, providing high baseflows and frequent flushing flows, conditions that tend to favour more 'sensitive' taxa. This indicates that the Hydro Road community was in better than typical condition.

Table 4 Predicted MCI scores for the discussed sites, compared with previous results and that recorded in the current survey

Site	N	Median	Range	Current survey	Predicted MCI scores*
SH3	45	110	67-125	114	111
Hydro Road	4	97	91-98	103	101
Constance Street	62	90	66-110	106	87

*Predicted scores calculated using equation 9 from Stark and Fowles (2009)

A closer examination of the taxa recorded at this site (Table 5) shows that the primary reason for the deterioration in MCI and $SQMCI_S$ scores at this site is the increased abundance of taxa commonly associated with higher algal biomass. There is also a consequent reduction in the abundance of 'sensitive' taxa, most of which require a streambed which is relatively clear of algae. This is reflected strongly in the large drop in the $SQMCI_s$ score compared to the upstream site. Observations made at the time of sampling indicated that algal biomass at the Hydro Road site was significantly higher than that at the other sites. This was due to reduced flood peaks decreasing the amount of periphyton scour, in conjunction with lower flows increasing water temperatures and the light reaching the riverbed, due to reduced water depth, which would increase periphyton growth rates and ultimately periphyton biomass.

With regards to any change in the influence of flushing flows caused by the increased rate of take allowed by the variation of consent 2053, this was the first survey since the increased rate of take had been exercised. This survey showed that taxa commonly associated with algal proliferation were abundant. Subsequent surveys will examine the data to assess whether those taxa commonly associated with higher algal biomass are even more abundant, and whether those more 'sensitive' taxa reduce in abundance, or become absent at this site.

Overall, the survey results highlight the decreased macroinvertebrate health at the Hydro Rd site. The decrease in MCI and $SQMCI_s$ scores were a reflection of the decreased abundance of 'sensitive' taxa caused by the algal proliferation in the residual flow reach likely due to the upstream water abstraction. Based on this result it is recommended that an additional sample site within the residual reach be established in order to better validate this finding.

Table 5 Macroinvertebrate fauna of the Waiwhakaiho River sampled in relation to Mangorei H.E.P scheme on 25 October 2017

Taxa List	Site Number / Site Code / Sample Number	MCI score	WKH000500 FWB17331	WKH000655 FWB17332	WKH000920 FWB17319
ANNELIDA (WORMS)	Oligochaeta	1	-	C	R
	Lumbricidae	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	-
	Coloburiscus	7	C	C	C
	Deleatidium	8	XA	VA	VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R	R
	Zelandobius	5	C	-	R
	Zelandoperla	8	A	R	R
COLEOPTERA (BEETLES)	Elmidae	6	C	R	C
	Hydraenidae	8	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	R	C
	Costachorema	7	R	A	-
	Hydrobiosis	5	R	R	R
	Neurochorema	6	-	R	-
	Beraeoptera	8	C	R	R
	Confluens	5	R	R	-
	Olinga	9	R	-	-
	Pycnocentrodes	5	R	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	VA	A
	Maoridiamesa	3	C	C	R
	Orthocladiinae	2	A	XA	VA
	Tanytarsini	3	-	R	C
	Empididae	3	-	R	-
	No of taxa		17	19	16
	MCI		114	103	106
	SQMCIs		7.6	3.4	5.0
	EPT (taxa)		12	12	8
	%EPT (taxa)		71	63	50

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

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

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To	Job Manager, Bart Jansma
From	Environmental Scientists, Bart Jansma and Katie Blakemore
Report No	KB067
Doc No	2118477
Date	5 September 2018

Biomonitoring of the Waiwhakaiho River in relation to the Mangorei H.E.P diversion of water, March 2018

Introduction

This was the second biomonitoring survey completed of the two scheduled in the monitoring programme for the Mangorei HEP scheme for the 2017-2018 monitoring year. Macroinvertebrate monitoring, which had been a part of previous programmes, was reintroduced into the monitoring programme in the 2016-2017 period following a variation to the conditions of resource consent 2053. This variation allows the consent holder to take an extra three cumecs, increasing the consented rate of take from seven cumecs to ten cumecs. There was some concern that the increased rate of take may reduce the degree of flushing the residual flow reach experienced during higher flows, and as a result, the macroinvertebrate monitoring was reinstated. With regards to the current survey, the preceding flows had been typified by frequent high flow events, with the river flows being stable for eleven days prior to this survey (Figure 1).

The current survey was the second survey undertaken following the enactment of higher abstraction rate by Trustpower. When the previous survey results are included, a useful data set exists to compare survey results following Trustpower taking advantage of the increased consented abstraction rate.

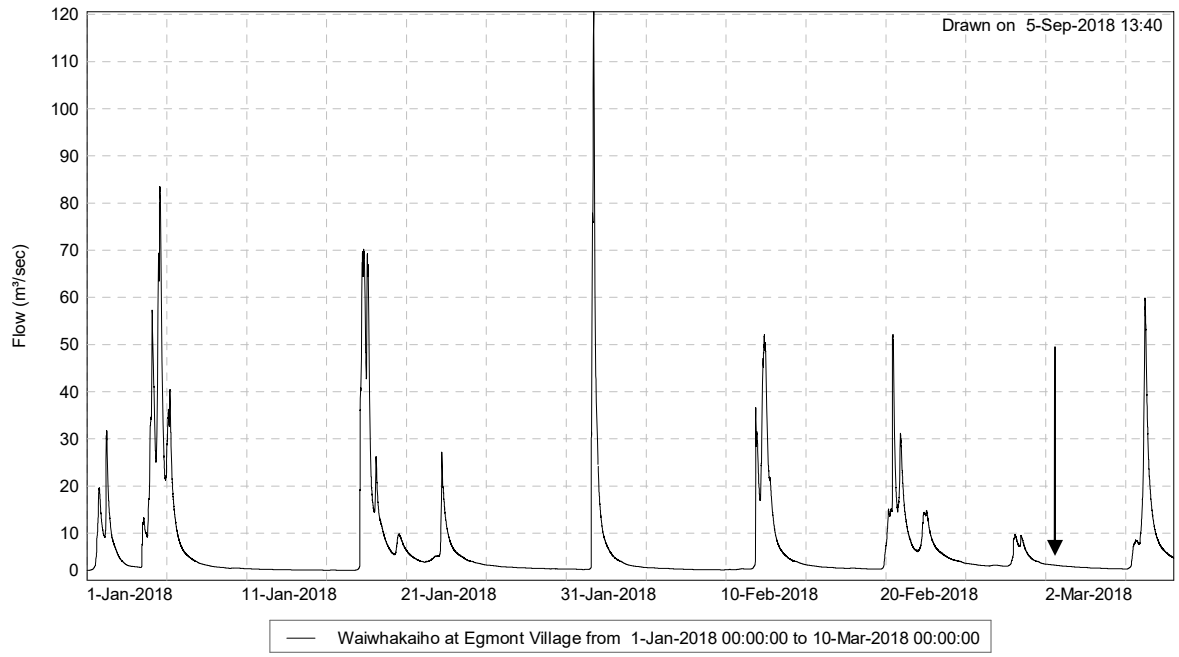

Figure 1 The flow (cubic meters per second) in the Waiwhakaiho River at the State Highway 3 recorder site. The arrow indicates the time of sampling.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from one site in the Waiwhakaiho River (Table 1 and Figure 2) on 2 March 2018, eight days after flows in excess of three and ten days after flows in excess of seven times the median flow. This '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 also collected at other sites in the Waiwhakaiho Catchment on this day, including just upstream of State Highway 3 and at Constance St, 9 km downstream. The samples were also collected using the '400ml kick-sampling' technique, and the results are included to provide some perspective.

Table 1 Biomonitoring sites in the Waiwhakaiho River discussed in relation to the Mangorei HEP scheme

Site Name.	Site code	GPS Reference	Location
SH3	WKH000500	E1698297 N5666893	Upstream of SH3
Hydro Road	WKH000655	E1697061 N5671279	Approximately 550m upstream of station discharge
Constance Street	WKH000920	E1695827 N5677271	At end of Constance Street

Samples were preserved with Kahle's Fluid 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 as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

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. Communities that are more 'sensitive' inhabit less polluted waterways. 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 and Boothroyd and Stark, 2000) (Table 2).

However, the establishment of lengthy historical records of taxa richness, community composition and MCI scores may be useful in assessing trends in the 'health' of macroinvertebrate communities associated with rivers and streams subject to environmental perturbations such as those caused by HEP abstractions.

Table 2 Macroinvertebrate health based on MCI and SQMCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2015) from Stark's classification (Stark, 1985, Boothroyd and Stark, 2000, and Stark and Maxted, 2007)

TRC Grading	MCI	SQMCI
Excellent	>140	>7.00
Very Good	120-140	6.00-7.00
Good	100-119	5.00-5.99
Fair	80-99	4.00-4.99
Poor	60-79	3.00-3.99
Very Poor	<60	<3.00

A semi-quantitative MCI value (SQMCI) 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 & 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 is not multiplied by a scaling factor of 20, so that its corresponding values range from 0 to 10.

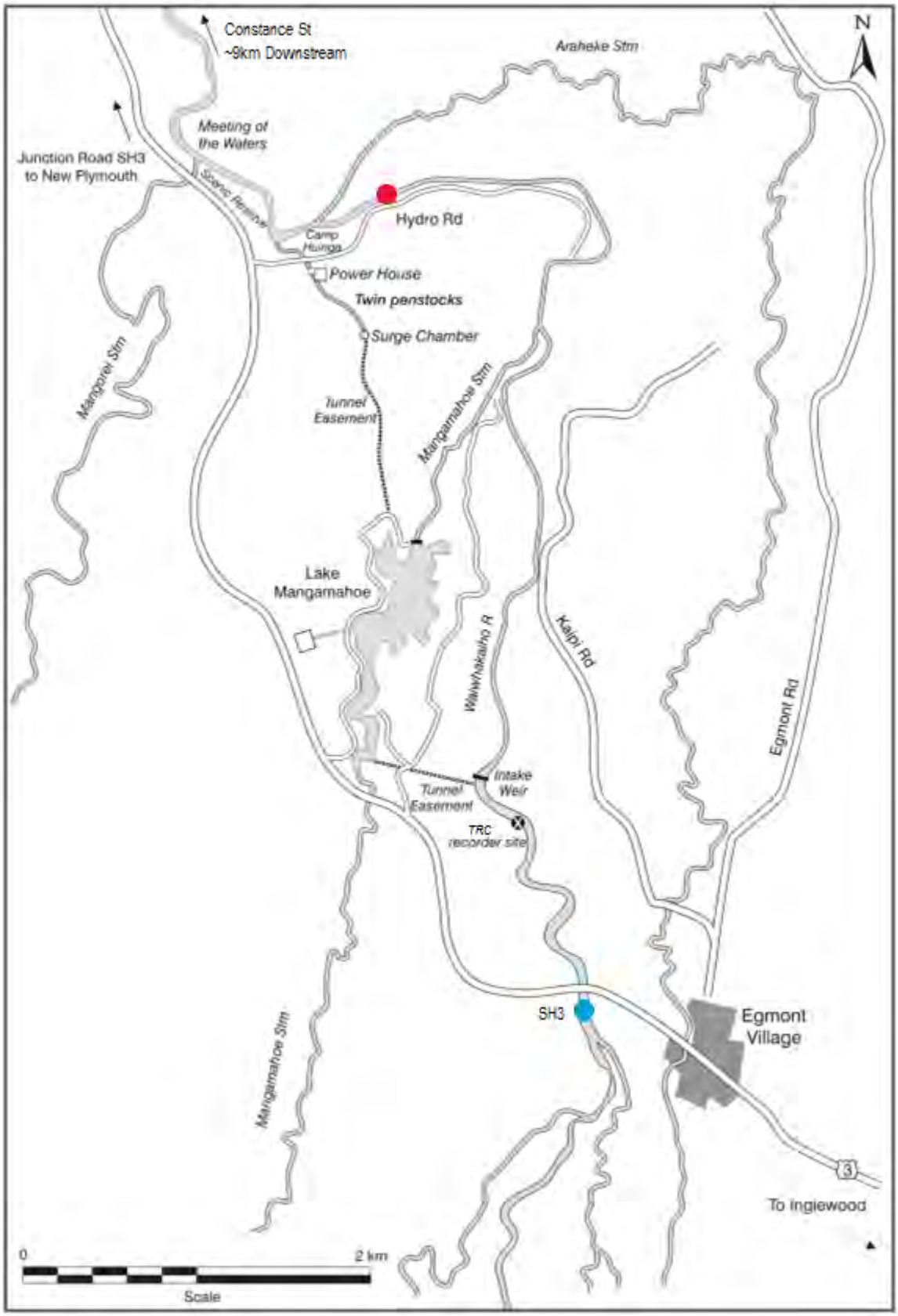

Figure 2 Biological monitoring sites in the Waiwhakaiho River in relation to the Mangorei Power Scheme Hydro Road (red dot). Upstream of SH3 (blue dot)

Results and discussion

At the time of this morning survey, the water temperature in the Waiwhakaiho River at Hydro Road was 22.2˚C. There was a low flow (for this site), which was swift, clear and uncoloured.

The substrate at this site comprised predominantly cobbles and boulders, with some gravels and sand present also. There was a much higher algal biomass than that observed upstream, with algal mats patchy and algal filaments widespread on the streambed.

Macroinvertebrate communities

A summary of the results from previous macroinvertebrate surveys performed in the Waiwhakaiho River in relation to the Mangorei HEP scheme is presented in Table 3, together with current results (which are presented in full in Table 4).

Table 3 Summary of previous numbers of taxa and MCI values recorded in surveys performed in the Waiwhakaiho River in relation to the Mangorei HEP water abstraction, together with current results

Site	N	Numbers of taxa			MCI values			SQMCI values			
		Median	Range	Current survey	Median	Range	Current survey	N	Median	Range	Current survey
SH3	46	22	9-32	19	111	67-125	98	38	5.9	1.9-7.6	6.6
Hydro Road	5	24	18-25	17	98	91-104	87	3	3.4	3.0-3.9	2.9
Constance Street	63	20	12-29	13	90	66-110	71	39	3.3	1.7-7.3	3.0

Seventeen taxa were recorded at Hydro Road, seven taxa less than the median of the five surveys completed previously and two taxa less than the preceding (October 2017) survey. This is two taxa lower than that recorded at SH3 upstream, but is four taxa higher than that recorded at Constance Street downstream (Table 3). The community was characterised by five 'tolerant' taxa (worms (Oligochaete), purse caddis (*Oxyethira*), midge larvae (orthoclads and Tanytarsids) and house fly larvae (Muscidae)). No 'highly sensitive' or moderately sensitive' taxa were present in abundance. The numerical dominance of the 'tolerant' taxa reflected the proliferation of algae observed at this site, resulting in a SQMCI score of 2.9 units. This was the lowest SQMCI score recorded at this site to date, but was not significantly different to either the score recorded in the preceding (October 2017) survey or the historical median of the three previous SQMCI scores recorded at this site (Stark, 1998). The proportion (53%) of the community made up by 'tolerant' taxa was moderate, resulting in an MCI score of 87 units. This is a significant eleven units lower than the median for this site and sixteen units less than the preceding result. It is also significantly less (Stark, 1998) than that recorded 7km upstream at SH3.

When compared with the results of sample collected upstream of Hydro Road, it is clear that there is deterioration from that recorded at SH3, with both the MCI and SQMCI scores deteriorating significantly (Stark, 1998). This decrease is particularly evident in the SQMCI score, which categorises the upstream site as having 'excellent' health, while the site upstream of Hydro Road is categorised as having 'poor' health (Table 2). There is also a slight decrease in taxa richness at Hydro Road, which is likely a reflection of habitat limitation caused by water abstraction. To provide some further perspective, the MCI scores recorded in the current survey are compared with predicted scores, calculated using equations developed by Stark and Fowles (2009) (Table 4).

This comparison shows that for the current survey, the scores recorded at SH3, Hydro Road and Constance Street were all significantly lower than that predicted (Stark, 1998). Coupled with the fact that these sites

also recorded MCI scores significantly lower than their respective medians, this suggests that the communities at these sites are in poorer than expected condition. It is typical for sites to show seasonal variation, with spring results generally better than those recorded in summer. The results of this survey may also reflect the effects of water abstraction, combined with the low flows recorded at the time of the survey.

Table 4 Predicted MCI scores for the discussed sites, compared with previous results and that recorded in the current survey

Site	N	Median	Range	Current survey	Predicted MCI scores*
SH3	45	110	67-125	98	111
Hydro Road	4	97	91-98	87	101
Constance Street	62	90	66-110	71	87

*Predicted scores calculated using equation 9 from Stark and Fowles (2009)

A closer examination of the taxa recorded at this site (Table 5) shows that the primary reason for the deterioration in MCI and SQMCI scores at this site is the increased abundance of taxa commonly associated with higher algal biomass. There is also a consequent reduction in the abundance of 'sensitive' taxa, most of which require a streambed which is relatively clear of algae. This is reflected strongly in the large drop in SQMCI score compared to the upstream site. Observations made at the time of sampling indicated that algal biomass at the Hydro Road site was higher than that at the other sites. This is consistent with the lower, stable flows the site experiences, not only reducing the amount of scour the periphyton community experiences, but also improving conditions for algal growth by resulting in warmer water temperatures and more light reaching the riverbed, due to reduced water depth. The water temperature at the time of this survey was also elevated by approximately 5°C compared to that upstream at SH3, which is in addition to promoting algal growth, is likely to have directly impacted the macroinvertebrate community, reducing the number and abundance of 'sensitive' taxa, which generally prefer cooler water temperatures.

With regards to any change in the influence of flushing flows caused by the increased rate of take allowed by the variation of consent 2053, the increased rate of take had been exercised for a year prior to this survey. This survey showed an increase in both the number and abundance of 'tolerant' taxa, as well as the proportion of the community comprising 'tolerant' taxa, compared to the two prior surveys (one of which was prior to the increase in take rate being exercised). This most likely reflects the effects of the water abstraction combined with natural seasonal variation. Although the spring survey also noted some effects of the water abstraction, the macroinvertebrate community was overall in a slightly healthier state due to the natural seasonal variation.

Overall, the survey results highlight the decreased macroinvertebrate health at the Hydro Rd site. The decrease in MCI and SQMCI scores were a reflection of the decreased abundance of 'sensitive' taxa caused by the algal proliferation in the residual flow reach, likely due to the upstream water abstraction. Future surveys will continue to assess the potential effects of the increased rate of water abstraction. Based on this result and the previous survey results it is recommended that an additional sample site within the residual reach be established in order to better validate this finding.

Table 5 Macroinvertebrate fauna of the Waiwhakaiho River sampled in relation to Mangorei H.E.P scheme on 2 March 2018

Taxa List	Site Number / Site Code / Sample Number	MCI score	WKH000500 FWB18136	WKH000655 FWB18137	WKH000920 FWB18132
NEMERTEA	Nemertea	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	A	C
MOLLUSCA	*Potamopyrgus*	4	-	-	R
CRUSTACEA	Ostracoda	1	R	-	-
	Paratya	3	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	-
	Coloburiscus	7	C	-	-
	Deleatidium	8	XA	C	R
	Nesameletus	9	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	C	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	C	C
	Costachorema	7	C	-	-
	Hydrobiosis	5	A	C	-
	Neurochorema	6	R	R	-
	Oxyethira	2	R	A	R
	Pycnocentrodes	5	R	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	R	-
	Maoridiamesa	3	C	R	-
	Orthocladiinae	2	A	A	A
	Tanytarsini	3	A	A	R
	Ephydridae	4	-	-	A
	Muscidae	3	C	A	R
	Austrosimulium	3	R	R	C
	Tanyderidae	4	-	R	-
	No of taxa		19	17	13
	MCI		98	87	71
	SQMCI		6.6	2.9	3.0
	EPT (taxa)		9	6	2
	%EPT (taxa)		47	35	15

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

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

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