Report

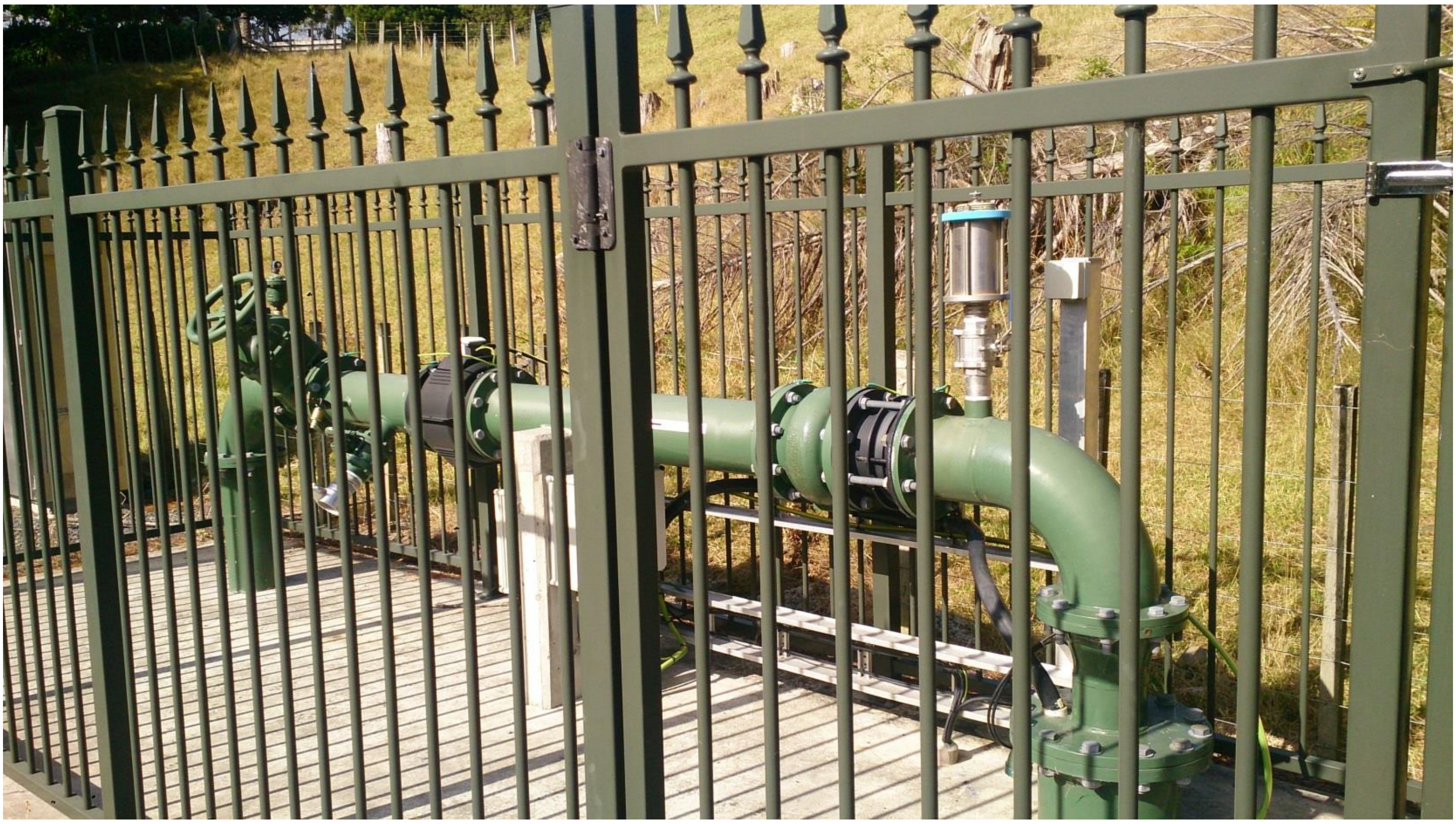
# Annual Waikanae Borefield Report 2014/15 (Consent WGN130103 [33250])

Prepared for Greater Wellington Regional Council

On behalf of Kāpiti Coast District Council

Prepared by CH2M Beca Ltd

22 September 2015



## Revision History

| Revision Nº | Prepared By | Description | Date |
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| 1 | Kirsten Fraser, Simon Newton, Naomi Maciver, Dora Avanidou | Draft for Council review | 14 July 2015 |
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## Document Acceptance

| Action | | | |
|---|---|---|---|
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| Reviewed by | **Michael Goff**<br>**Kirsten Fraser**<br>**Tracy Clode** | | |
| Approved by | **Andrew Watson** | **Signed:** | **Date:**<br>22 September 2015 |
| on behalf of | CH2M Beca Ltd | | |

# Highlights

This 2014/15 annual report has been prepared for Kāpiti Coast District Council as part of the consenting requirements for the River Recharge with Groundwater scheme. It reports on operational aspects and monitoring undertaken in relation to the Council's groundwater take from the Waikanae Borefield during the year 1 July 2014 to 30 June 2015.

The Waikanae Borefield was used for supplementary water supply in March and April 2015 due to low flows in the Waikanae River. The Council's take from the Waikanae Borefield was within the requirements of the consent, except for six brief operational exceedances in the year each less than 15 minutes. Two being due to a faulty flow meter and four individual bore instantaneous flow rate exceedances less than 5% over the consented yield that occurred on pump start up.

A comprehensive monitoring regime for the Borefield is in place with the drilling of 12 new monitoring wells completed during the year. Most of these new wells have been sited along the coast to monitor groundwater levels and electrical conductivity to check that saline intrusion is not occurring.  Similarly, there was a comprehensive programme for monitoring 7 small coastal stream sites and 13 wetlands during the months of December 2014 to April 2015.

This monitoring will continue for a further two summers and the data collected over the three years will be used to develop a longer term monitoring programme and triggers with a series of actions in case of potential adverse effects from pumping groundwater from the Waikanae Borefield.

The Adaptive Management Group which comprises representatives of the Council, Greater Wellington Regional Council and Te Āti Awa ki Whakarongotai met in August 2015 to discuss this report, alongside representatives of key stakeholder groups. Recommendations from the Adaptive Management Group included:

- No further fish or insect (macroinvertebrate) sampling at small coastal stream sites.  Along with removal of the manual stream temperature, stream cross sections and dissolved oxygen and electrical conductivity testing requirements at small coastal stream sites (automated data collection to remain). The data collected over the last year has shown that the ecology of the small coastal streams is very resilient meaning effects from groundwater pumping for river recharge would not be identifiable using the above methods.
- Removal of two small coastal stream sites (Kowhai and Paetawa) from the monitoring programme.  Both sites dry up over the summer period and do not provide information needed to determine effects from groundwater pumping for river recharge.  Five sites will continue to be monitored this coming summer.
- Monthly baseline monitoring reports are no longer required as these are not being reviewed by the Regional Council. Seasonal reports are to be appended to the annual report rather than submitted to the Regional Council separately.

# Executive Summary

This annual report for the Waikanae Borefield has been prepared on behalf of Kāpiti Coast District Council (Council) in accordance with Condition 42 of consent WGN130103 [33250]. This is the second annual Waikanae Borefield report, and covers the period from 1 July 2014 through to 30 June 2015. The report includes recommendations of the Adaptive Management Group that met on 26 August 2015 to discuss this annual report.

The consent authorises the abstraction of groundwater from eight wells within the Waikanae Borefield. Four of these wells (K4, K5, K6 and KB4) were operable throughout the 2014/15 year. Construction works associated with bringing the remaining four wells (K10, Kb7, K12 and N2) into service were completed by April 2015.

The Waikanae Borefield was used for supplementary public water supply on four occasions during 2014/15 due to low river flows: 26 February to 7 March 2015, 12 March 2015, 18 to 30 March 2015 and 4 to 8 April 2014. The other periods of the Borefield use were associated with operation and maintenance activities, or the commissioning of new infrastructure for the River Recharge with Groundwater scheme. Bore K4 has also been used for construction water supply for the Mackays to Peka Peka (M2PP) Expressway, although this use is under a separate consent. The maximum total daily take was 15,830 $m^3$/day on 27 February 2015. This is significantly less than 23,600 $m^3$/day which is the maximum take for Stage 1 of the river recharge with groundwater scheme (RRwGW).

Baseline monitoring of the aquifers, small coastal streams and wetlands was carried out in accordance with the relevant baseline monitoring plans. 12 new monitoring wells have been constructed to monitor groundwater levels and conductivity in the vicinity of the Waikanae Borefield and 13 new piezometers have been installed for monitoring shallow groundwater levels adjacent to small coastal streams or within wetlands.

From the borefield monitoring results, none of the established interim trigger levels for groundwater levels (deep and shallow) or electrical conductivity have been reached. Similarly none of the interim triggers for wetlands monitoring were exceeded.

The borefield is monitored all year round and further baseline monitoring for the small coastal streams and wetlands will be carried out over the 2015/16 summer. Boffa Miskell has recommended no further monitoring for fish and aquatic macroinvertebrates as part of the small coastal streams monitoring programme due to the low presence of fish and sensitive macroinvertebrate communities.

Any changes to the Borefield, Wetland and Streams baseline monitoring plans will be discussed with GWRC and agreed amendments will be incorporated in updated plans.

Council has identified, to the extent reasonably practicable, authorised existing wells within a one kilometre radius of each of the Waikanae Borefield production wells that may be a sole source of domestic or stock water. A website providing groundwater level monitoring information for these well users and the general public will be launched in the coming months. No complaints relating to abstraction from the Borefield were received by Council during this period.

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# 1 Introduction

Kāpiti Coast District Council (Council) holds resource consent (WGN130103 [33250]) to take groundwater from bores within the Waikanae Borefield for the purpose of supplementary public water supply through river recharge or emergency public water supply.

The consent authorises the abstraction of groundwater from eight production wells within the Waikanae Borefield. Four of these wells (K4, K5, K6 and KB4) were operable throughout the 2014/15 year. Well K10 was brought back into operation in the second half of 2014/15 following replacement of the pump within this well. Construction works to bring the remaining three wells (KB7, K12 and N2) in the northern sector of the extended borefield into operation (installation of pumps and headworks) and pipe the water abstracted from them to the Waikanae water treatment plant (WTP) were completed in April 2015. The locations of the eight production wells and monitoring bores are shown in Figure 2.

An annual Waikanae Borefield report is required by Condition 42 of consent WGN130103 [33250]. This is the second annual Waikanae Borefield report, and covers the period from 1 July 2014 through to 30 June 2015. The requirements of Condition 42 are listed in the table below with cross-references to the relevant section in this report.

Table 1: Requirements for Annual Waikanae Borefield report

| Condition 42 of consent WGN130103 [33250] | | Section in this annual report |
|---|---|---|
| The consent holder shall, by 30th August each year, submit an annual Waikanae Borefield report to the Manager, or by another date as agreed with the Manager.<br>The annual Waikanae Borefield report shall report on the year 1st July to 30th June inclusive, and include the following information: | | |
| a) | A copy of the records to demonstrate compliance with Condition 20 of this consent; | Sections 2.1 and 2.2 |
| b) | Details of the use (including daily and total volumes of groundwater abstracted) and reasons for that use of the water from the Borefield; | Section 2.1 |
| c) | A summary of Waikanae River flow gauging required by Condition 25 of this consent, if undertaken that year; | Section 3 |
| d) | Results of all monitoring undertaken that year required by conditions of this consent (if applicable), including a comprehensive analysis of the monitoring results, assessment against any relevant guidelines and comparison with previous years' results (i.e. trend analysis); | Sections 4, 5 and 6 |
| e) | Results or evidence to demonstrate compliance with Condition 7 of this consent | Section 8 |
| f) | Details of any trigger levels or compliance limits that were reached (if occurred that year) and specifically the findings of saline monitoring compared with the 'alert', 'action' or 'cease' triggers; | Sections 4 and 5 |
| g) | Details of any actions and/or mitigation/adaptive management taken in response to trigger levels or compliance limits being reached, including an assessment of the effectiveness of these actions and/or mitigation/adaptive management; | Sections 4 and 5 |
| h) | Any recommendations for changes to the monitoring plan required by conditions of this consent, including triggers, compliance limits or actions and/or mitigation measures or changes to the operations and maintenance manual, required by Condition 19 of this consent, including any recommendations of the Adaptive Management Committee (referred to in Condition 43 of this consent); | Section 7, Section 2.3 and Section 11 |
| i) | A discussion on any mitigation/adaptive management that may be required in the coming year; | Section 10 |
| j) | A copy of the complaints record required by Condition 45 of this consent; | Section 9 |
| k) | Summary of any maintenance undertaken. | Section 2.2 |
| The annual Waikanae Borefield report shall be made available to the public on the | | Refer www.kapiticoast.govt.nz |

| Condition 42 of consent WGN130103 [33250] | Section in this annual report |
|---|---|
| Kāpiti Coast District Council website by 30th August each year, or by another date as agreed with the Manager.<br>*Note: The consent holder may request, with the Manager's approval, an extension of time to submit the annual report to the Manager and make it avilble to the public on the website, if the Adaptive Management Group requires more time to consider the draft annual report and provide their recommendations as required by part (h) of this condition.* | |

There are a number of plans and manuals required by the RRwGW suite of consents and various reports have been produced from the 2014/15 monitoring. These documents are set out in the following figure (Figure 1).

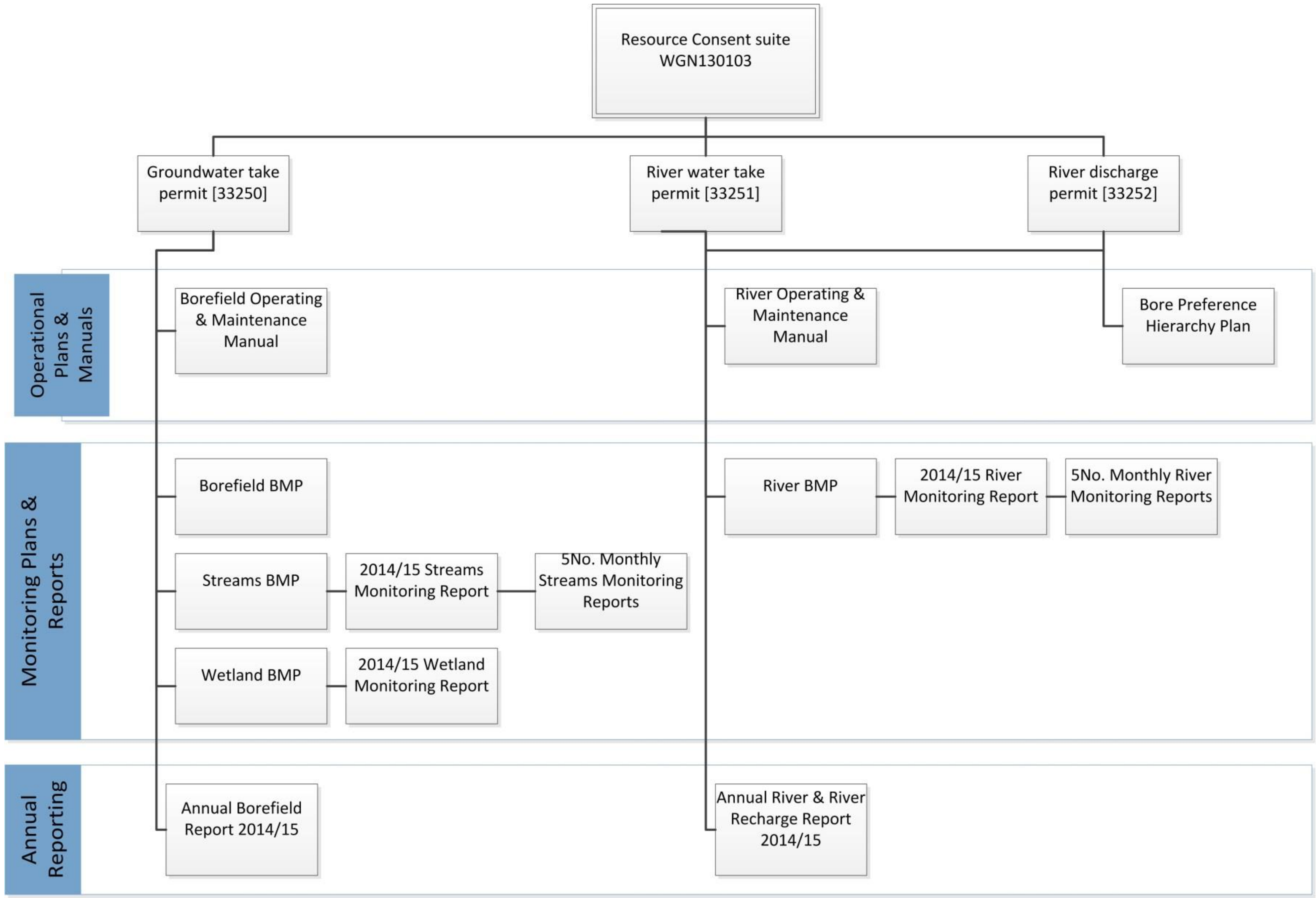



Figure 1: Key documents for RRwGW consents and 2014/15 monitoring

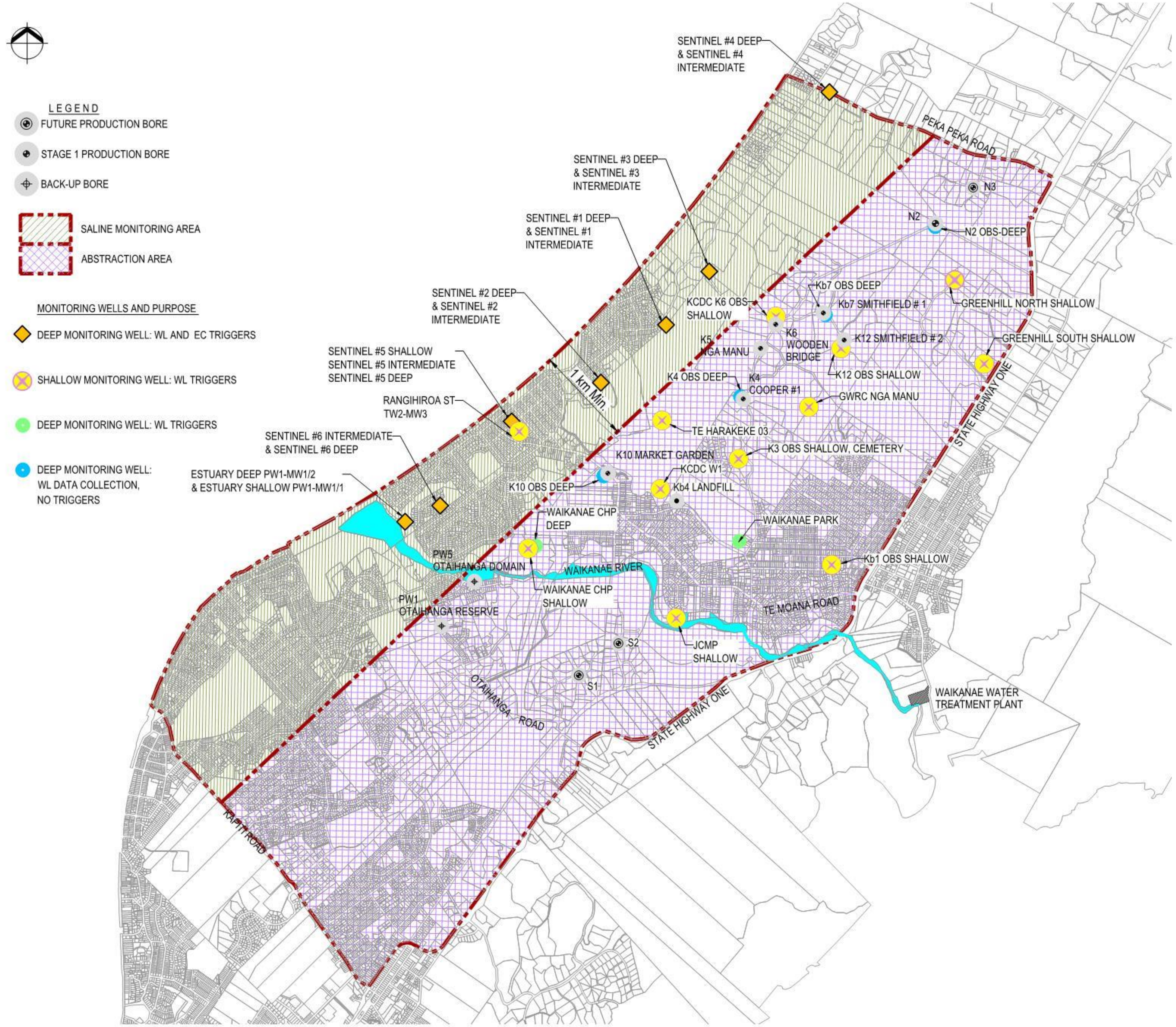



Figure 2: Location Plan – Waikanae Borefield Abstraction Wells and Monitoring Bores

# 2 Borefield Operation

## 2.1 Abstraction Volumes and Rates

Abstraction from each production well (L/s and $m^3$/day) is measured and recorded in accordance with Conditions 13,14 and 20 of consent WGN130103 [33250]. Council regularly submits full abstraction records to GWRC as required by Condition 18. A summary of the abstraction for this reporting period is provided below.

The total volume pumped from the production wells for the period 1 July 2014 to 30 June 2015 was 308,118 $m^3$, which is significantly less than the annual volume permitted by Condition 8 of the groundwater take consent (2,300,000 $m^3$/year). Of this volume, 23,807 $m^3$ was abstracted from bore K4 for construction water supply for the Mackays to Peka Peka (M2PP) Expressway. The use of bore K4 by the M2PP Alliance is outside the consent WGN130103 [33250] and is exercised under a separate consent.

The maximum total daily take was 15,830 $m^3$/day on 27 February 2015, which is also less the maximum daily take permitted by Condition 8.

The daily abstraction volumes for each production well during the reporting period are plotted in Figure 3. The Waikanae Borefield was used for supplementary supply on four occasions during 2014/15 due to low river flows: 26 February to 7 March 2015 (10 days), 12 March 2015 (1 day), 18 to 30 March 2015 (13 days), and 4 to 8 April 2014 (5 days).

The other periods of Borefield use were associated with operation and maintenance activities, or commissioning of the new infrastructure for the River Recharge with Groundwater (RRwGW) scheme, or use by the M2PP Alliance. The production wells are generally pumped once per month (towards the end of the month) at maximum flow for two or three hours to flush the pipeline, check the operation of the bore pumps and collect water samples for water quality testing.

The total instantaneous abstraction rate is plotted in Figure 4. The maximum combined abstraction was 223 L/s, which occurred for 1.5 hours on 1 May (maintenance testing).

A summary table of the instantaneous rates for the individual wells is included in Appendix A. On a few occasions (six) the maximum pumping rates for the production wells K4, KB4 and K6 exceeded the maximum instantaneous abstraction rates given by Table 2 of Condition 8. These operational exceedances were for no more than 15 minutes. Two of these occasions were related to a faulty flow meter for well K6, which was replaced in November 2014. The other four occasions occurred at pump start up and were less than 5% over the consented maximum yields. Council has implemented controls for the bore pumps to limit the maximum pumping rates to match the maximum instantaneous abstraction rates specified by the consent for each well, but the pumps can occasionally run over these limits at pump start up especially if there is only limited pressure to pump against. From the monitoring of groundwater levels and groundwater conductivity, there were no deleterious environmental effects from these short instances of higher instantaneous pumping rates at the individual wells. In particular, none of the interim trigger levels for the deep and shallow aquifers were reached. During this reporting period, the total abstraction volume and duration of pumping were both much less than the scenario of borefield use presented during the consent hearing.

## 2.2 Operations Log and Maintenance Undertaken

Council has confirmed that its existing SCADA system together with the NCS system are an ‘electronic data management system’ which records and stores the information required by Condition 20 of consent WGN130103 [33250]. Council regularly emails borefield abstraction records to GWRC. Once HydroTel numbers have been issued by GWRC the borefield abstraction data will be supplied automatically from Council 's SCADA system to GWRCs Water Use Data Management System. Council is also implementing WaterOutlook as a system to store and report data and operational information relating to the Waikanae Borefield

A copy of the site logs for each production well is included in Appendix B. The following key events are noted:

- The flow meter for well K6 was replaced on 3 November 2014.
- A replacement pump for well K10 was installed around February 2015.
- Well K4 was used by the M2PP Alliance for construction water. The supply to M2PP was locked off in March when the well was needed for supplementary water supply due to low flows in the Waikanae River.
- Wells N2, Kb7 and K12 were commissioned in April 2015.
- The back-up power supply for well K6 was damaged in the flooding of May 2015
- Water quality sampling for wells K10, N2, Kb7 and K12 commenced in May 2015.

## 2.3 Operation and Maintenance Manual

The Waikanae Borefield Operation and Maintenance Manual (BOMM) was submitted to GWRC, for approval, on 2 April 2015 in accordance with Condition 19 of consent WGN130103 [33250]. Prior to completion of the BOMM, Council continued to use the operations and maintenance manual from the previous water permit WGN050025 [32191].

There are no recommended changes to the BOMM at this time.

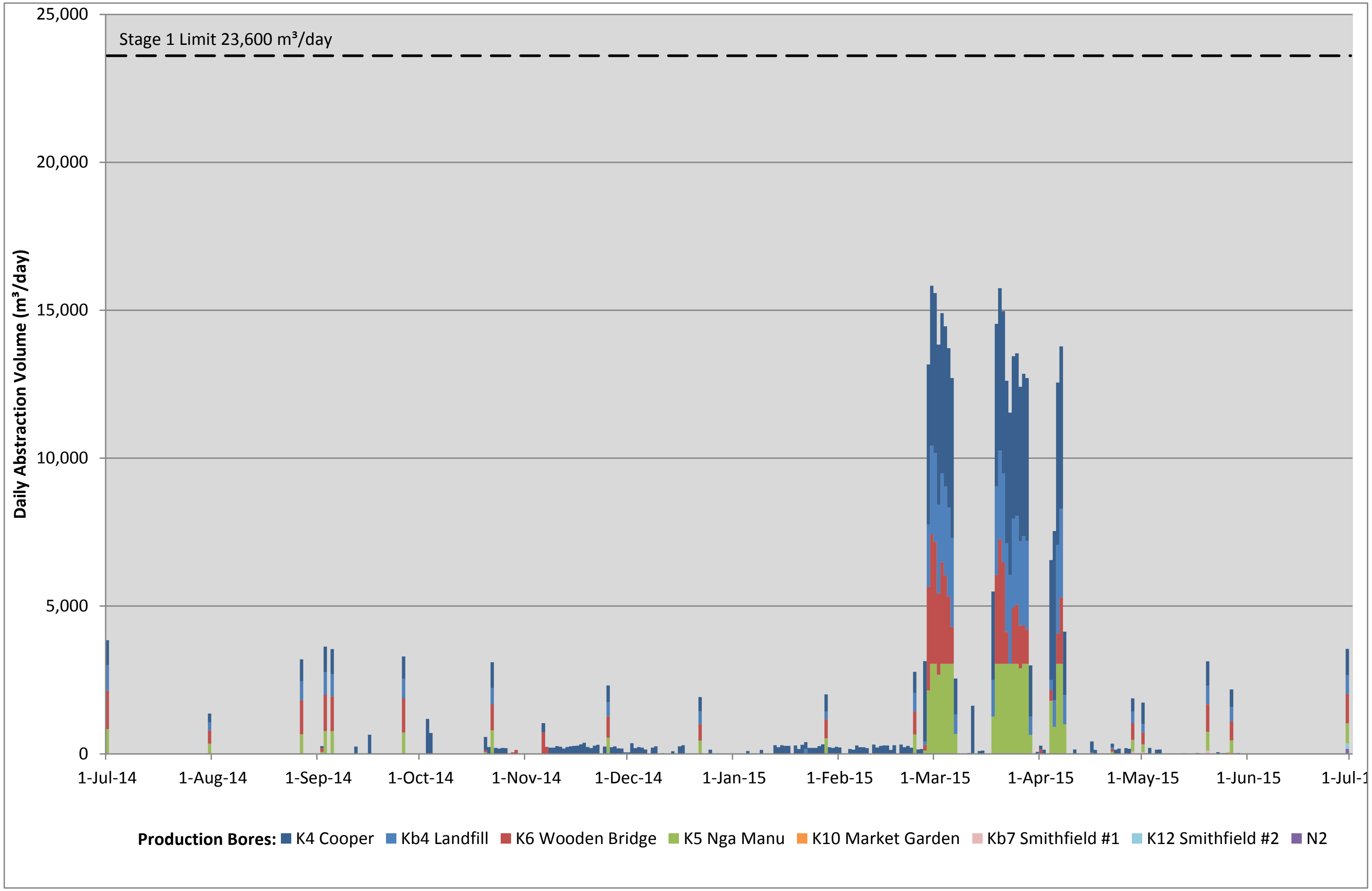



Figure 3: Daily Abstraction Volumes from Production Wells

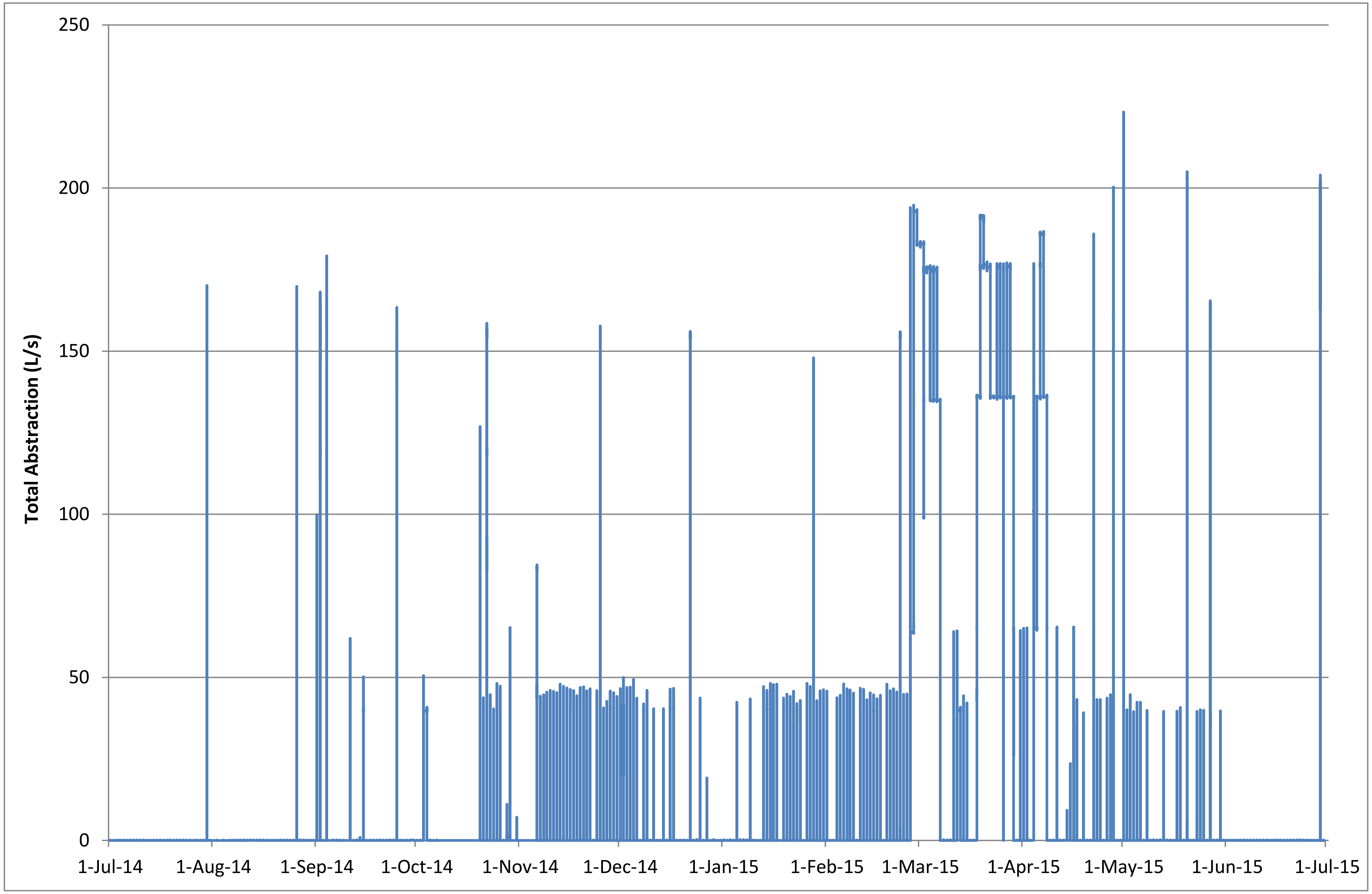



Figure 4: Total Instantaneous Abstraction from Production Wells

# 3 Waikanae River Flow Gauging

Flow gauging of the Waikanae River is required by Condition 25 of consent WGN130103 [33250]. One of the aims of this gauging is to determine whether a relationship between river flows, river abstraction rates and groundwater pumping can be identified by monitoring flows in the river downstream of the Waikanae WTP. This is to establish whether additional groundwater pumping reduces flows in the Waikanae River downstream of the WTP due to increased losses through the bed of the river as a result of lowered groundwater levels.

Two sets of flow gauging were conducted by NIWA during the summer of 2014/15 at the locations specified in the Waikanae River Baseline Monitoring Plan (River BMP); just downstream of SH1 and alongside Jim Cooke Park. The gauging results are summarised in Table 2 together with the flow recorded at GWRC's monitoring site upstream of the WTP, the abstraction rate measured by Council and the calculated flow immediately downstream of the WTP.

Table 2: Gauging on the Waikanae River during Summer 2014/15

| Date | Water treatment plant | | | Site | Flow (L/s) | Area ($m^2$) | Velocity (m/s) | Time (NZST) |
|---|---|---|---|---|---|---|---|---|
| | Upstream flow (L/s) | River abstraction (L/s) | Calculated downstream flow (L/s) | | | | | |
| 12 February 2015 | 1010 | 144 | 866 | Below SH1 | 1127 | 6.36 | 0.177 | 10:45 |
| | | | | Jim Cooke Park | 830 | 2.98 | 0.278 | 12:16 |
| 10 March 2015 | 979 | 142 | 837 | Below SH1 | 895 | 8.56 | 0.105 | 10:25 |
| | | | | Jim Cooke Park | 658 | 2.6 | 0.253 | 12:45 |

The 2014/15 gaugings undertaken by NIWA indicate:

- Net gains of 261 L/s and 58 L/s between the water treatment plant and the gauging location just downstream of SH1. The greater gain occurred when upstream river flows were higher.
- Net losses of 297 L/s and 237 L/s between SH1 and Jim Cooke Park, with the greater loss occurring when river flows (as recorded at the water treatment plant) were slightly higher.

Two sets of flow gaugings were also conducted by NIWA during the 2013/14 summer. The gaugings carried out by NIWA last summer and this summer are plotted in Figure 5, which also shows the results of 12 sets of gaugings carried out between 1993 and 2008 by GWRC at the same locations.

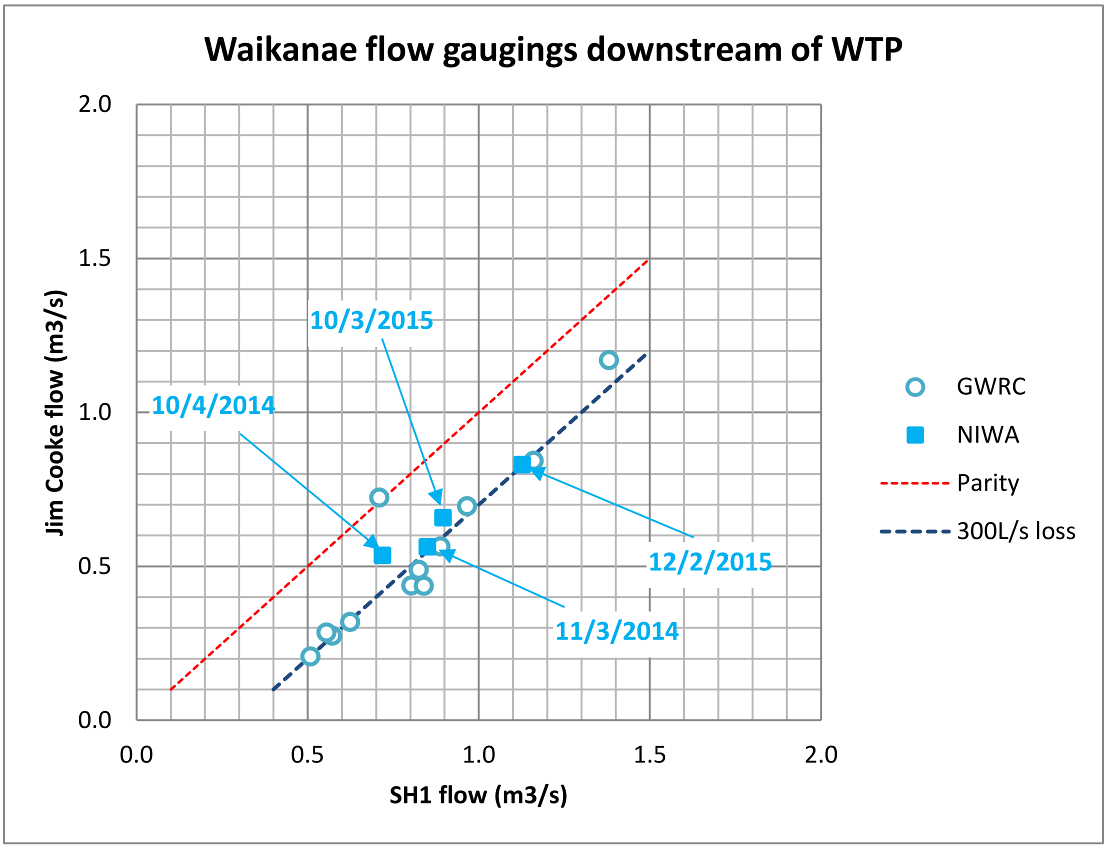



Figure 5: Waikanae River Flow Gaugings near SH1 and Jim Cooke Park

# 4 Borefield Monitoring

## 4.1 Borefield Baseline Monitoring

The Borefield Baseline Monitoring Plan (Borefield BMP) describes the procedures for collecting and reporting water level data from shallow and deep monitoring wells within the Waikanae Borefield, as well as electrical conductivity monitoring from saline intrusion monitoring wells along the coast. The locations of these monitoring wells are shown in Figure 2.

12 new borefield monitoring wells have been drilled within the vicinity of the Waikanae Borefield: 3 for shallow aquifer drawdown monitoring and 9 for deep aquifer drawdown and saline intrusion monitoring. In addition the wellhead for Sentinel #1 Deep at Rutherford Drive was repaired. These works were completed in November 2014. Water level and conductivity measurement equipment has been installed in the new monitoring wells, and existing equipment in Council's existing monitoring wells has also been replaced. Monitoring with the new equipment commenced in December 2014. Some of the borefield monitoring sites are operated by GWRC. For these sites GWRC and Council's monitoring systems have been configured such that water level information is automatically transferred from GWRC to Council's SCADA system approximately every two hours.

Interim trigger levels are in place for monitoring wells that were in existence at the commencement of the resource consent. These interim trigger levels are given in Condition 21 and Appendix A of consent WGN130103 [33250]. If interim trigger levels are exceeded, alarms are generated by Council's SCADA system and automatic notifications are emailed to Council, Greater Wellington Regional Council and CH2M Beca. Trigger levels for the new wells will be determined following a year of baseline monitoring.

## 4.2 Shallow Aquifer Drawdown Monitoring

The table below lists the shallow aquifer monitoring sites, the applicable interim trigger levels and the minimum water level (daily average) recorded during this year's report period compared to last year. Graphs of the shallow aquifer monitoring data for this reporting period are presented in Appendix C.

None of the interim alert trigger levels for the shallow monitoring bores were exceeded during the reporting period.

The following issues or unusual events are noted:

- Water levels in Kb1 Obs Shallow at Ngaio Road naturally dropped below the bottom of the well during the 2014/15 summer. This means that triggers will not be able to be set for this site. Nevertheless it is proposed that this site remains as a monitoring site because it provides useful data for groundwater modelling when the groundwater in the area is at higher levels. The groundwater rose again to a level that could be measured in early April 2015.
- GWRC replaced faulty equipment at GWRC Nga Manu during the first quarter of 2014/15.
- At KCDC K6 Obs Shallow, GWRC's monitoring equipment was removed on 24 March 2015 and replaced with Council equipment in early April 2015.
- GWRC replaced the water level logger at the Waikanae CHP around 16 March and subsequently experienced hardware issues on 25 March 2015. Trigger notifications were generated on both occasions but they were not true trigger exceedances.
- Monitoring equipment at KCDC K6 Obs Shallow and K12 Obs Shallow Smithfield Road was affected by the flooding in mid May 2015.

Table 3: Shallow Aquifer Drawdown Monitoring Wells and Interim Trigger Levels

| Well Name | GWRC Bore Number | Interim Trigger Level | | | Status | Min level last reporting period (mm AMSL) | Min level this reporting period (mm AMSL) |
|---|---|---|---|---|---|---|---|
| | | Alert (mm AMSL) | Action (mm AMSL) | Cease (mm AMSL) | | | |
| KCDC K6 Obs Shallow | R26/6992 | 2180 | 1980 | 1580 | Existing well previously monitored by GWRC, now monitored by KCDC. | 2929 | 2943 |
| GWRC Nga Manu | R26/6991 | 7460 | 7260 | 6860 | Existing well operated by GWRC | 7475 | 7472 |
| KCDC W1 | R26/7025 | 4440 | 4240 | 3840 | Existing well operated by GWRC | 4734 | 4905 |
| Rangihiroa St TW2-MW3 | R26/6287 | 1340 | 1140 | 740 | Existing well operated by GWRC | 1751 | 1797 |
| Te Harakeke 03 | R26/6886 | 2760 | 2560 | 2160 | Existing well operated by GWRC | 3310 | 3370 |
| Waikanae CHP Shallow | R26/6916 | 1740 | 1540 | 1140 | Existing well operated by GWRC | 1878 | 1967 |
| K12 Obs Shallow, Smithfield Road | R26/6300 | TBD | TBD | TBD | Manually measured weekly since 03/10/2013. Online monitoring since May 2015. | 5826 | 5596 |
| JCMP Shallow, Jim Cooke Memorial Park | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 7220 |
| Kb1 Obs Shallow, Ngaio Road | R26/6304 | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 15551 (well dry during summer) |
| K3A Obs Shallow, Cemetery | R26/6290 | TBD | TBD | TBD | Manually measured weekly since 03/10/2013 Online monitoring since Dec 2014 | 7198 | 7544 |
| Greenhill North Shallow, Greenhill Road North | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 6987 |
| Greenhill South Shallow, Greenhill Road South | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 12381 |

## 4.3 Deep Aquifer Drawdown Monitoring

The table below lists the deep aquifer monitoring sites, the applicable interim trigger levels and the minimum water level (daily average) recorded during this year's reporting period compared to last year. Graphs of the deep aquifer monitoring data for this reporting period are presented in Appendix C.

None of the interim alert trigger levels for the deep monitoring bores were exceeded during the reporting period.

The following issues or unusual events are noted:

- GWRC monitoring equipment was removed from Sentinel #1 Deep Rutherford Drive in May 2014 for repairs to the wellhead. Council's new monitoring equipment has been installed and monitoring re-started in December 2014.
- GWRC monitoring equipment was removed from Sentinel #5 Shallow and Sentinel #5 Intermediate at Taiata St in November 2014. Council's new monitoring equipment has been installed and monitoring re-started in December 2014.
- A number of trigger notifications associated with Sentinel #5 Shallow and Sentinel #5 Intermediate at Taiata St were generated in December 2014 and January 2015 as a result of work to investigate issues with the conductivity monitoring equipment also installed at this site. These notifications were not true trigger exceedances.
- An issue with silt accumulation in Sentinel #6 Deep at Tamati Place was identified during re-calibration of the conductivity sensor at this well. Arrangements are being made to redevelop the well to clear the accumulated silt.

Table 4: Deep Aquifer Drawdown Monitoring Wells and Interim Trigger Levels

| Well Name | GWRC Bore Number | Interim Trigger Level | | | Status | Min level last reporting period (mm AMSL) | Min level this reporting period (mm AMSL) |
|---|---|---|---|---|---|---|---|
| | | Alert [mm AMSL] | Action [mm AMSL] | Cease [mm AMSL] | | | |
| Sentinel #1 Deep, Rutherford Drive | R26/6378 | -1537 | -3787 | -5475 | Existing well. Equipment replaced and monitoring re-started Dec 2014 | -63 | 988 |
| Sentinel #1 Intermediate, Rutherford Drive | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1373 |
| Sentinel #2 Deep, Hodgkins Rd | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1899 |
| Sentinel #2 Intermediate, Hodgkins Rd | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1398 |
| Sentinel #3 Deep, Old WWTP | R26/6776 | TBD | TBD | TBD | Manually measured weekly since 03/10/2013<br>Online monitoring since Dec 2014 | 357 | 481 |
| Sentinel #3 Intermediate, Old WWTP | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1752 |
| Sentinel #4 Deep, Peka Peka Road | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 2958 |
| Sentinel #4 Intermediate, Peka Peka Road | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 2003 |

| Well Name | GWRC Bore Number | Interim Trigger Level | | | Status | Min level last reporting period (mm AMSL) | Min level this reporting period (mm AMSL) |
|---|---|---|---|---|---|---|---|
| | | Alert [mm AMSL] | Action [mm AMSL] | Cease [mm AMSL] | | | |
| Sentinel #5 Shallow, Taiata Street | R26/6673 | -404 | -1454 | -2242 | Existing well previously monitored by GWRC, now monitored by KCDC. Equipment replaced and monitoring re-started Dec 2014 | 1332 | 1415 |
| Sentinel #5 Intermediate, Taiata Street | R26/6955 | -393 | -1443 | -2231 | Existing well previously monitored by GWRC, now monitored by KCDC. Equipment replaced and monitoring re-started Dec 2014 | 1330 | 1418 |
| Sentinel #5 Deep, Taiata Street | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1781 |
| Sentinel #6 Deep, Tamati Place | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1874 |
| Sentinel #6 Intermediate, Tamati Place | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1981 |
| Old Estuary Shallow PW1-MW1/1 | R26/6566 | 694 | 64 | -409 | Existing well monitored by GWRC. To be discontinued at end of 2014/15 | 1611 | 1690 |
| Old Estuary Deep PW1-MW1/2 | R26/6956 | 682 | 52 | -421 | Existing well monitored by GWRC. To be discontinued at end of 2014/15 | 1686 | 1702 |
| Waikanae CHP Deep | R26/6594 | 540 | -510 | -1298 | Existing well operated by GWRC | 1442 | 2154 |
| Waikanae Park | R26/6284 | 4611 | 2511 | 936 | Existing well operated by GWRC | 8499 | 8455 |

## 4.4 Saline Intrusion Monitoring

The table below lists the saline intrusion monitoring sites, the applicable interim trigger levels and the maximum electrical conductivity (daily average) recorded during this year's reporting period compared to last year. Graphs of the electrical conductivity (EC) monitoring data for this reporting period are presented in Appendix C.

The interim EC trigger levels for previously existing monitoring wells (i.e. in existence and monitored for EC at the commencement of the consent) are a continuation of the already established triggers from the previous abstraction consent. However EC measurement equipment and sensor placement within the existing saline intrusion monitoring wells have changed over time such that the existing EC trigger values based on data collected over the period 2005 - 2009 may no longer be representative of current conditions.

For this reason, the current interim trigger levels will be revised following consideration of the first year of monitoring data collected.

None of the interim alert trigger levels for electrical conductivity were exceeded during the reporting period.

The following issues or unusual events are noted

- GWRC monitoring equipment was removed from Sentinel #1 Deep Rutherford Drive in May 2014 for repairs to the wellhead. Council's new monitoring equipment has been installed and monitoring re-started in December 2014.
- Anomalous EC measurements at Sentinel #1 Intermediate have been investigated. Monitoring equipment was checked and no problem was found with calibration of the sensor or reporting hardware. Further water quality sampling and testing has also taken place. The results of the investigation indicate that drilling fluid lost during the construction of the adjacent monitoring well (Sentinel #1 Deep) may be causing high pH in the water at the site and affecting electrical conductivity within the Sentinel #1 Intermediate bore. The recommended action includes tracking monitoring results over the pumping and non-pumping seasons to determine if trends allowing the setting of trigger levels are produced.
- Anomalous EC measurements at Sentinel #3 Intermediate have been investigated. The recommended action includes tracking monitoring through the pumping and non-pumping seasons as well as tracking water levels and electrical conductivity versus rainfall. Data collected thus far indicate that water levels and electrical conductivity measured in this monitoring well are somewhat sensitive to conditions within the aquifer and climatic conditions but may equilibrate to more representative values with time.
- GWRC monitoring equipment was removed from Sentinel #5 Shallow and Sentinel #5 Intermediate at Taiata St in November 2014. Council's new monitoring equipment has been installed and monitoring re-started in December 2014.
- A number of trigger notifications associated with Sentinel #5 Shallow and Sentinel #5 Intermediate at Taiata St were generated in December 2014 and January 2015 as a result of work to investigate issues with the conductivity monitoring equipment installed at this site. These notifications were not true trigger exceedances.
- Council identified during calibration of the EC sensors in June 2015 that the EC sensor at Sentinel #6 Intermediate was not functioning correctly and could not be fixed. This EC sensor has been replaced and installed.
- An issue with silt accumulation in Sentinel #6 Deep at Tamati Place was identified during re-calibration of the conductivity sensor at this well. Arrangements are being made to redevelop the well to clear the accumulated silt.
- The conductivity sensor (GWRC equipment) at Estuary Shallow PW1-MW1/1 has not been working at this site since 2012. This site has now been replaced by Sentinel #6 at Tamati Place.
- The conductivity sensor (GWRC equipment) at Estuary Deep PW1-MW1/2 was hit by lightning during a storm on 7 March 2015. GWRC have confirmed this sensor does not require replacement. This site has now been replaced by Sentinel #6 at Tamati Place.
- Manual monitoring of water level and EC at bore K14 Obs Deep is being carried out to better understand the water quality at Sentinel #5 and assist with the setting of triggers at the end of baseline monitoring. Monitoring has been conducted monthly during the pumping season (December 2014 to March 2015) and quarterly during the non-pumping season (March and June 2015). No indication of saline intrusion has been noted in the monitoring data.

While some of the EC monitoring data is unexpected, ongoing monitoring will assist with understanding of the limitations of the EC monitoring equipment as related to in-well and aquifer conditions. Council is continuing to investigate issues with the EC monitoring equipment and data and is liaising with GWRC on matters as they arise. Development of trends used to set trigger levels is the goal of current monitoring and not the determination of absolute values. Discussions with GWRC staff indicate that previous electrical conductivity monitoring experienced similar anomalies and the data is useful for trend identification but not absolute values of electrical conductivity.

The six-monthly check of conductivity measurement equipment against standard solutions was completed in late June 2015. The depth of the EC sensor was also checked and adjusted as necessary to ensure that the setting was within the screened section of the well.

Table 5: Saline Intrusion Monitoring Wells Electrical Conductivity Interim Trigger Levels

| Well Name | GWRC Bore Number | Interim Trigger Level | | | Status | Max last reporting period (µS/cm) | Max this reporting period (µS/cm) |
|---|---|---|---|---|---|---|---|
| | | Alert (µS/cm) | Action (µS/cm) | Cease (µS/cm) | | | |
| Sentinel #1 Deep, Ruther ford Drive | R26/6378 | 1500 | 1875 | 2188 | Existing well repaired. Equipment replaced and monitoring re-started Dec 2014 | 1201 | 1024 |
| Sentinel #1 Intermediate, Ruther ford Drive | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 4253 |
| Sentinel #2 Deep, Hodgkins Rd | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1339 |
| Sentinel #2 Intermediate, Hodgkins Rd | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1398 |
| Sentinel #3 Deep, Old WWTP | R26/6776 | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 1064 |
| Sentinel #3 Intermediate, Old WWTP | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 2351 |
| Sentinel #4 Deep, Peka Peka Road | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 804 |
| Sentinel #4 Intermediate, Peka Peka Road | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 648 |
| Sentinel #5 Shallow, Taiata Street | R26/6673 | 430 | 537 | 627 | Existing well previously monitored by GWRC, now monitored by KCDC. Equipment replaced and monitoring re-started Dec 2014 | No data | 271 |
| Sentinel #5 | R26/6955 | 3079 | 3849 | 4491 | Existing well | No data | 2943 |

| Well Name | GWRC Bore Number | Interim Trigger Level | | | Status | Max last reporting period (µS/cm) | Max this reporting period (µS/cm) |
|---|---|---|---|---|---|---|---|
| | | Alert (µS/cm) | Action (µS/cm) | Cease (µS/cm) | | | |
| Intermediate, Taiata Street | | | | | previously monitored by GWRC, now monitored by KCDC. Equipment replaced and monitoring re-started Dec 2014 | | |
| Sentinel #5 Deep, Taiata Street | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 5193 |
| Sentinel #6 Deep, Tamati Place | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 7817 |
| Sentinel #6 Intermediate, Tamati Place | To be advised by GWRC | TBD | TBD | TBD | Monitored since Dec 2014 | n/a | 967 |
| Old Estuary Shallow PW1-MW1/1 | R26/6566 | 7152 | 12500 | 15000 | Existing well monitored by GWRC. No data since 2012. To be discontinued as a monitoring site. | No data | No data |
| Old Estuary Deep PW1-MW1/2 | R26/6956 | 11797 | 12500 | 15000 | Existing well monitored by GWRC. No data since March 2015. To be discontinued as a monitoring site. | 9799 | 9775 |

## 4.5 Bore Water Quality Monitoring

The Bore Preference Hierarchy Plan, which is required by Condition 16 of consent WGN130103 [33252], was submitted to GWRC for approval on 26 March 2015. This plan included full water quality results for the production bores Kb4, K4, K5 and K6 from monthly sampling carried out between October 2013 and January 2015. Monthly sampling of these bores continued through February and March 2015. Additional sampling of bores Kb4, K4 and K5 was carried out in early April when these bores were turned on for supplementary supply and a second April sample was collected from bore K4 as it was operated for more than 3 days. This is a requirement of Condition 27(j) of the groundwater take permit WGN130103 [33250].

Sampling for the remaining production bores, K10, Kb7, K12 and N2, commenced in May 2015 following the installation of bore pumps and headworks piping. The Bore Preference Hierarchy Plan will be updated once a year of sampling has been completed for these four bores. This means that, subject to GWRC's approval of the current Bore Preference Hierarchy Plan, only bores Kb4, K4, K5 and K6 will be used for river recharge in the first instance. The proposed hierarchy for these bores from first to fourth preference is: 1st Kb4, 2nd K4, 3rd K5 and 4th K6. Kb4 is the most preferred bore as it has the lowest dissolved reactive phosphorus concentration and a chemical signature more similar to the Waikanae River, based on major ion chemistry, than the other three bores.

A summary of the bore water quality sampling results obtained during the reporting period is included in Appendix D.

# 5 Wetlands Monitoring

The consent requirements for wetland monitoring and interim trigger levels were revised in December 2014 under Section 127 of the Resource Management Act. The wetland interim trigger levels were altered to consider district-wide seasonal variations in groundwater levels and are now applicable only to wetlands that are less than 2 km from Council's operable production wells. The Wetland Baseline Monitoring Plan (Wetland BMP) was updated to reflect these changes and baseline monitoring of the 13 monitored wetlands was undertaken during 2014/15 in accordance with the updated Wetland BMP. The installation of six new piezometers for wetland water level monitoring was completed mid November 2014 and monitoring equipment was in place at all sites by mid December 2014.

The results of the 2014/15 baseline monitoring are documented in the report "Wetland Baseline Monitoring Annual Report" by Boffa Miskell, which is included as Appendix E.

Monitoring of changes to water levels in the wetlands (specified in parts 1F and 1G of Appendix A of the [33250] resource consent) is accomplished by recording groundwater levels in piezometers installed in close proximity to these wetlands. The "alert" and "action" trigger levels do not apply to the monitored wetlands located greater than 2 kilometres from any well in the Waikanae Borefield actively being pumped for water supply or river recharge. Graphs presenting the wetland groundwater levels for the monitoring period (July 2014-June 2015) are presented in the report in Appendix E.

For the 2014/15 reporting period the following wetlands were within 2 km from the Waikanae Borefield production wells: Nga Manu Wetland, El Rancho Wetland, Te Harakeke Wetland, Ngarara Rd Wetland, Ngarara Bush Wetland and Peka Peka Rd Swamp. These wetlands were checked against trigger levels. Water levels measured were within expected levels and no trigger levels have been exceeded. An overall decline of water levels was observed in most monitoring sites during the summer months (January - March 2015). This was also observed in the late summer/early autumn period in previous years.

The very shallow monitoring bore 2012/HA WM05 in the El Rancho Wetland has been dry since 27 January 2015. This appeared to be caused by dry climatic conditions and not related to pumping from the Waikanae Borefield or MacKays to Peka Peka project (M2PP) construction activities. A replacement monitoring bore (2015/HA WM05) that can monitor water levels in the shallow peat/silt layer of the El Rancho Weggery wetland has been installed and monitored since March 2015. Furthermore the area around piezometer 2008/BH 205 was flooded since mid-May 2015 due to extreme rainfall events and no data has been collected since.

In mid-November 2014 Council installed hired logging equipment for water level piezometer monitoring in the following wetlands: Poplar Ave Wetland, Crown Hill Manuka Bush Wetland, Peka Peka Swamp, and Muaupoko Swamp Forest. In early February 2015 the hired logging equipment was removed from the piezometers and replaced with Council-owned equipment. This equipment worked well for the month of February and the monitoring data was downloaded from the loggers at the beginning of March 2015. However, there were some issues re-starting the loggers following the data download and this was not picked up until the subsequent monthly visit to download the data at the beginning of April 2015. This has resulted in the loss of water level data between 6 March 2015 and 8 April 2015 for all four sites listed above. While this loss of data is unfortunate, water level data is available for this period for the other wetland sites (for which triggers apply) and there is no resulting environmental impact.

Whilst no trigger levels were exceeded, alarm notifications have been received and communicated to GWRC. These were all due to either maintenance or natural declines in shallow groundwater levels across the district.

# 6 Small Coastal Streams Monitoring

Baseline monitoring for small coastal streams commenced in December 2014 in accordance with the certified Small Coastal Streams Baseline Monitoring Plan (Streams BMP). The results of the 2014/15 baseline monitoring are documented in the report “Small Coastal Streams Baseline Aquatic Monitoring Annual Report” by Boffa Miskell, which is included as Appendix F.

There are seven small coastal stream monitoring sites. The small coastal streams baseline monitoring generally involved recording shallow groundwater level adjacent to each stream, instream water depth, and instream dissolved oxygen and temperature. Cross-section measurements and instream biota (fish and macroinvertebrates) surveys were also undertaken.

The installation of seven new monitoring piezometers on the banks of the monitored small coastal streams was completed mid November 2014. Equipment for monitoring shallow groundwater levels in these piezometers and for monitoring in stream depth and water quality (temperature and dissolved oxygen) was in place at all sites by mid December 2014.

There have been some on-going issues with the dissolved oxygen and temperature sensors at the Upper Muaupoko and Kowhai stream sites. Several options have been worked through and new firmware was installed in April 2015 by the supplier who believes this will resolve the issues with drop outs and loss of data. Nevertheless the monitoring data collected between 1 December 2014 and 1 May 2015 is useful in providing the first of three years of baseline monitoring.

The data collected over the 3 year baseline monitoring period will be used to develop an on-going monitoring regime for the streams and inform the development of management trigger as part of the On-going Mitigation Plan for the Small Coastal Streams.

There has been no detailed analysis of the relationship between stream depth and shallow groundwater level at this stage. This analysis will be carried out by hydrologists and hydrogeologists once the 3 year baseline monitoring period is complete.

The measures of local fish and aquatic macroinvertebrates in December 2015 found that there are no especially sensitive fish or macroinvertebrate communities present in the monitored small coastal streams. Dissolved oxygen fluctuates daily and the magnitude of fluctuation can be quite large, but there was no obvious monthly trend. Temperatures generally rose to a peak around February and then declined towards April.

# 7 Changes to Monitoring Plans

## 7.1 Borefield Baseline Monitoring Plan

There have been some minor changes to Borefield Baseline Monitoring Plan that have come about through the drilling of new borefield monitoring bores and installation of monitoring equipment. These changes generally relate to the naming and precise locations of the monitoring sites. These changes have been agreed with GWRC and are captured in an addendum to the certified Borefield BMP.

An updated Borefield BMP that incorporates the addendum and accepted recommendations of the Adaptive Management Group (refer Section 11) will be submitted to GWRC for approval prior to next summer (2015/16).

## 7.2 Wetlands Baseline Monitoring Plan

The wetlands baseline monitoring plan was revised on 21 November 2014 in line with the changes to the revised consent requirements for wetlands monitoring and interim trigger levels.

No further changes to the Wetland BMP are proposed at this stage.

## 7.3 Small Coastal Streams Baseline Monitoring Plan

There have been some changes to Small Coastal Streams Baseline Monitoring Plan (Streams BMP) that have come about through the implementation of the monitoring infrastructure. These changes generally relate to the naming and precise locations of the monitoring sites. One major change was the removal of the Upper Kakariki Stream site due to lack of water in the stream and also lack of landowner permission for continued access. These changes have been agreed with GWRC and are captured in an addendum to the certified Streams BMP.

The Small Coastal Streams monitoring report for 2014/15 (Appendix F) includes recommendations relating to changes to the baseline monitoring programme. These are summarised below; refer to Appendix F for further detail.

1. No further fish sampling for the rest of the baseline monitoring present due to the low numbers of fish present in the streams.

2. No further aquatic macroinvertebrate monitoring because the communities present are not generally sensitive to water depth or habitat quality changes.

These proposals will be discussed and agreed between Council's and GWRC's ecologists, and any changes will be incorporated into a revised BMP that will be submitted to GWRC for approval prior to the commencement of next summer's monitoring. The revised BMP will also incorporate the addendum of changes and accepted recommendations of the Adaptive Management Group (refer Section 11).

# 8 Potentially Affected Existing Private Wells

Condition 7 of consent [33250] requires work to be undertaken to identify potentially affected existing authorised wells (and also actions (b)-(d) listed in the condition) prior to implementing each stage of the project as referenced in Condition 6. Condition 6 outlines the staging plan for the Waikanae Borefield extension and abstraction. The Stage One construction works were recently completed and commissioned, but abstraction from the extended borefield (ie, the new bores Kb7, K12 and N2) for water supply will not be required until at least summer 2015/16. As such, Stage One will be implemented when abstraction from bores Kb7, K12 or N2 for either water supply or river recharge commences.

Private properties that are within a one kilometre radius of each of the Waikanae Borefield production wells and may be solely reliant on an existing well for domestic or stock water have been identified and contacted by the Council to provide details of wells on the property and the use of the groundwater abstracted from these wells. The information received is now being assessed to confirm that the locations of Council's monitoring bores and interim trigger levels are adequate and appropriate for representing and detecting potential drawdown effects in potentially-affected existing authorised wells. A website has also been developed that will provide groundwater level monitoring information as well as contact details if well users wish to discuss issues arising or make complaints. This website will be launched to the public in the coming months, prior to the 2015/16 summer period.

# 9 Complaints Record

Condition 45 requires Council to maintain an on-going record of any complaints received alleging adverse effects from or related to abstraction from the Waikanae Borefield, including complaints of any adverse effects on private bores. During the reporting period Council did not receive any complaints regarding effects related to abstraction from the Borefield.

# 10 Mitigation/Adaptive Management in the Coming Year

Looking ahead to the coming year (2015/16), there is no additional mitigation or adaptive management that is anticipated at this stage other than the proposed changes to the BMPs, outlined in Section 7 above.

Further baseline monitoring will be carried out over the coming year in accordance with the certified Waikanae Borefield, Wetland and Small Coastal Streams BMPs.

Subject to the necessary approvals from GWRC, the Waikanae Borefield may be used for river recharge next summer (2015/16) if required due to low flows in the Waikanae River. Initially river recharge will be limited to no more than 20% of the downstream river flow in accordance with Condition 18 of consent WGN130103 [33252]. The recharge will be undertaken in accordance with the approved Bore Preference Hierarchy Plan.

# 11 Recommendations of the Adaptive Management Group

The Adaptive Management Group (AMG) for the RRwGW scheme comprises three members who are representatives of GWRC, Council and Te Āti Awa ki Whakarongotai. Figure 6 shows the stages of AMG and key stakeholder involvement in the lead up to the submission of this annual report to GWRC.

Council held a briefing session with the AMG and key stakeholders on 28 May 2015. Representatives of Wellington Fish and Game Council, Royal Forest and Bird Protection Society of New Zealand, The Kapiti Fly Fishing Club, Friends of the Waikanae River and Regional Public Health were present at the briefing. The purpose of this briefing session was to discuss the observations from the baseline monitoring undertaken to date as well as any observations of the AMG and key stakeholders, and to make an early start in the process of considering the potential for adaptive management in regards to these observations ahead of the AMG meeting in August 2014 on the annual reports.

The AMG met on 26 August 2015 to discuss the draft version of this annual report, as well as the annual Waikanae River and River Recharge report. Representatives from the following key stakeholders also attended this meeting: Wellington Fish and Game Council, Royal Forest and Bird Protection Society of New Zealand, The Kapiti Fly Fishing Club, Friends of the Waikanae River and Regional Public Health.

Recommendations received from the AMG are set out in the table below.

Table 6: Recommendations of the Adaptive Management Group

| Adaptive Management Observations & Opportunities | Consideration with AMG Recommendations |
|---|---|
| **Small Coastal Streams - Fish and macroinvertebrate surveys**<br>▪ Results suggest sampling is a poor indicator of effects on small coastal streams. | ▪ Consider no further fish or macroinvertebrate sampling.<br>AMG agreed.<br>▪ Removal of the manual stream temperature, stream cross sections and dissolved oxygen and EC testing requirements (automated data collection to remain).<br>AMG agreed. |
| **Small Coastal Streams - review of monitoring sites**<br>▪ Results suggest sampling is a poor indicator of effects at some small coastal stream sites. E.g. Kowhai dried up for a period over the summer. | ▪ Consider the value of continuing baseline monitoring at all seven Small Coastal Stream sites.<br>AMG agreed to the removal of Kowhai and Paetawa sites. |
| **Monthly and Seasonal Reports**<br>▪ The Baseline Monitoring Plans (BMPs) for the Small Coastal Streams and Waikanae River note that monthly and seasonal reports will be provided to GWRC outlining the data collected during each month and at the end of each season respectively, over the monitoring period set out in the BMP's | ▪ Consider the value and practicality of these monthly and seasonal reports when the data is assessed and presented in the annual report.<br>AMG agreed that monthly reports are no longer required and seasonal reports are to be submitted to GWRC appended to the relevant annual report. |

Other AMG recommendations:

- It was agreed that the consents' submission date for annual reports be updated via a section 127 application to end of September each year to allow for the AMG review period.
- It was agreed an amendment to the consent should be submitted via a section 127 application to make allowance for the bore pumps' ramp up as the environmental impact of a very short duration of the slightly higher than consented instantaneous pump rates was considered to be '*de minimis'*

Recommendations made by the AMG and included in the final annual reports still require the approval of GWRC before implementation.

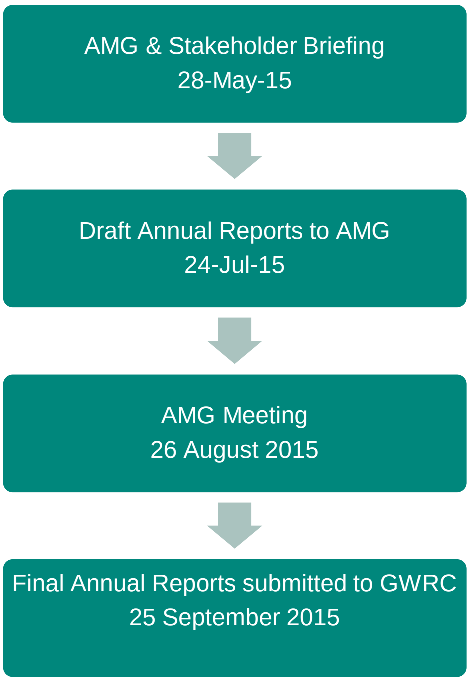



Figure 6: AMG activities associated with this year's annual report

Appendix A

# Borefield Abstraction Summary Table

Table A.1: Summary of instantaneous abstraction from each production well 1 July 2014 to 30 June 2015

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) | Ave (L/s) | Max (L/s) |
| 01-Jul 14 to 29-Jul 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 |
| 30-Jul-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 35.0 | 5.4 | 58.2 | 4.1 | 36.0 | 3.8 | 41.0 | 0.0 | 0.0 |
| 31-Jul 14 to 25-Aug 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 26-Aug-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.3 | 35.1 | 12.7 | 58.4 | 7.5 | 36.0 | 8.8 | 41.0 | 0.0 | 0.0 |
| 27-Aug 14 to 31-Aug 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| 1-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 24.1 | 0.8 | 36.0 | 0.8 | 39.8 | 0.0 | 0.0 |
| 2-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.8 | 35.1 | 8.6 | 58.0 | 9.0 | 36.1 | 10.0 | 40.9 | 0.0 | 0.0 |
| 3-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 4-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.8 | 35.1 | 12.1 | 67.5 | 9.0 | 36.1 | 10.1 | 40.9 | 0.0 | 0.0 |
| 5-Sep 14 to 10 Aug 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 11-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 61.9 | 0.0 | 0.0 |
| 12 Sep 14 to 14 Sep 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 15-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.7 | 50.2 | 0.0 | 0.0 |
| 16-Sep 14 to 24-Sep 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-Sep-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.7 | 35.1 | 8.9 | 52.1 | 8.6 | 36.1 | 9.2 | 43.5 | 0.0 | 0.0 |
| 26-Sep 14 to 2-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 3-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.2 | 50.5 | 0.0 | 0.0 |
| 4-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.8 | 40.8 | 0.0 | 0.0 |
| 5-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 6-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 7-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-Oct 14 to 19-Oct 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 45.7 | 0.8 | 36.1 | 5.3 | 49.8 | 0.0 | 0.0 |
| 21-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 43.8 | 0.0 | 0.0 |
| 22-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.6 | 35.2 | 10.2 | 48.0 | 9.4 | 36.0 | 10.4 | 42.6 | 0.0 | 0.0 |
| 23-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 2.6 | 44.7 | 0.0 | 0.0 |
| 24-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 40.3 | 0.0 | 0.0 |
| 25-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 2.4 | 48.1 | 0.0 | 0.0 |
| 26-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 47.3 | 0.0 | 0.0 |
| 27-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 28-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 11.1 | 0.2 | 1.6 | 0.0 | 0.2 | 0.0 | 0.0 |
| 29-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 65.3 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| 30-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-Oct-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 7.1 | 0.0 | 0.0 |
| 1-Nov 14 to 5-Nov 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 8.3 | 47.9 | 0.0 | 0.0 | 3.8 | 40.6 | 0.0 | 0.0 |
| 7-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 44.2 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 8-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 44.6 | 0.0 | 0.0 |
| 9-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 45.4 | 0.0 | 0.0 |
| 10-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 46.0 | 0.0 | 0.0 |
| 11-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 45.8 | 0.0 | 0.0 |
| 12-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 45.3 | 0.0 | 0.0 |
| 13-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 47.9 | 0.0 | 0.0 |
| 14-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 47.2 | 0.0 | 0.0 |
| 15-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 46.8 | 0.0 | 0.0 |
| 16-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 46.3 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 45.9 | 0.0 | 0.0 |
| 18-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.2 | 44.4 | 0.0 | 0.0 |
| 19-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 46.9 | 0.0 | 0.0 |
| 20-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 47.1 | 0.0 | 0.0 |
| 21-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 45.9 | 0.0 | 0.0 |
| 22-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 46.5 | 0.0 | 0.0 |
| 23-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 24-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 46.0 | 0.0 | 0.0 |
| 25-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | 35.1 | 8.2 | 44.2 | 6.4 | 36.0 | 6.7 | 42.8 | 0.0 | 0.0 |
| 26-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 40.7 | 0.0 | 0.0 |
| 27-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 42.7 | 0.0 | 0.0 |
| 28-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 45.8 | 0.0 | 0.0 |
| 29-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 45.3 | 0.0 | 0.0 |
| 30-Nov-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 44.2 | 0.0 | 0.0 |
| 1-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 46.5 | 0.0 | 0.0 |
| 2-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 50.0 | 0.0 | 0.0 |
| 3-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 46.9 | 0.0 | 0.0 |
| 4-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 47.0 | 0.0 | 0.0 |
| 5-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 49.3 | 0.0 | 0.0 |
| 6-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 43.6 | 0.0 | 0.0 |
| 7-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 41.9 | 0.0 | 0.0 |
| 9-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 46.0 | 0.0 | 0.0 |
| 10-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 11-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 40.4 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12-Dec 15 to 13-Dec 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 14-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 40.4 | 0.0 | 0.0 |
| 15-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 16-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 46.4 | 0.0 | 0.0 |
| 17-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 46.6 | 0.0 | 0.0 |
| 18-Dec 14 to 19-Dec 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 20-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 21-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 22-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.1 | 35.1 | 6.4 | 44.4 | 5.2 | 36.0 | 5.8 | 41.0 | 0.0 | 0.0 |
| 23-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 24-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 25-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 43.7 | 0.0 | 0.0 |
| 26-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 27-Dec-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 19.2 | 0.0 | 0.0 |
| 28-Dec-14 to 4-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 42.4 | 0.0 | 0.0 |
| 6-Jan-15 to 8 Jan 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 9-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 43.4 | 0.0 | 0.0 |
| 10-Jan-15 to 12-Jan 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 13-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 47.1 | 0.0 | 0.0 |
| 14-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 46.0 | 0.0 | 0.0 |
| 15-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 | 48.1 | 0.0 | 0.0 |
| 16-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | 47.8 | 0.0 | 0.0 |
| 17-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | 47.9 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 43.6 | 0.0 | 0.0 |
| 20-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 44.9 | 0.0 | 0.0 |
| 21-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 44.2 | 0.0 | 0.0 |
| 22-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 35.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 45.7 | 0.0 | 0.0 |
| 23-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 41.9 | 0.0 | 0.0 |
| 24-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 42.9 | 0.0 | 0.0 |
| 25-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 48.2 | 0.0 | 0.0 |
| 27-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 | 47.2 | 0.0 | 0.0 |
| 28-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 27.4 | 7.8 | 44.2 | 6.4 | 36.0 | 7.1 | 42.1 | 0.0 | 0.0 |
| 29-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 42.9 | 0.0 | 0.0 |
| 30-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 45.8 | 0.0 | 0.0 |
| 31-Jan-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 46.2 | 0.0 | 0.0 |
| 1-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 45.8 | 0.0 | 0.0 |
| 2-Feb 15 to 3-Feb 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 43.8 | 0.0 | 0.0 |
| 5-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 44.5 | 0.0 | 0.0 |
| 6-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 48.0 | 0.0 | 0.0 |
| 7-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 46.5 | 0.0 | 0.0 |
| 8-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 46.1 | 0.0 | 0.0 |
| 9-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 45.2 | 0.0 | 0.0 |
| 10-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 46.7 | 0.0 | 0.0 |
| 12-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 46.3 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 43.1 | 0.0 | 0.0 |
| 14-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 45.3 | 0.0 | 0.0 |
| 15-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 44.6 | 0.0 | 0.0 |
| 16-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 43.4 | 0.0 | 0.0 |
| 17-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 44.5 | 0.0 | 0.0 |
| 18-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 19-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 | 47.9 | 0.0 | 0.0 |
| 20-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 45.9 | 0.0 | 0.0 |
| 21-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 46.5 | 0.0 | 0.0 |
| 22-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 45.5 | 0.0 | 0.0 |
| 23-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.3 | 35.2 | 8.7 | 44.1 | 7.8 | 36.3 | 8.4 | 41.2 | 0.0 | 4.2 |
| 24-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 44.8 | 0.0 | 0.0 |
| 25-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 44.9 | 0.0 | 0.0 |
| 26-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 35.1 | 2.4 | 60.2 | 1.5 | 36.0 | 29.4 | 66.7 | 0.0 | 0.5 |
| 27-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.0 | 35.1 | 38.1 | 58.5 | 23.6 | 36.0 | 64.0 | 64.5 | 0.1 | 2.6 |
| 28-Feb-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 51.4 | 58.3 | 36.0 | 36.0 | 64.0 | 64.6 | 0.0 | 0.0 |
| 1-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 48.0 | 48.6 | 36.0 | 36.1 | 64.0 | 64.5 | 0.0 | 0.0 |
| 2-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 32.6 | 48.6 | 31.5 | 36.1 | 64.0 | 64.7 | 0.0 | 0.1 |
| 3-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 40.1 | 40.7 | 36.0 | 36.1 | 64.0 | 64.4 | 0.0 | 0.0 |
| 4-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 36.7 | 40.7 | 36.0 | 36.0 | 64.0 | 64.7 | 0.0 | 0.0 |
| 5-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 26.6 | 40.8 | 36.0 | 36.0 | 64.0 | 64.5 | 0.0 | 0.0 |
| 6-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.3 | 14.5 | 40.7 | 36.0 | 36.1 | 64.0 | 64.6 | 0.0 | 0.0 |
| 7-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.5 | 35.1 | 0.0 | 0.0 | 9.7 | 36.0 | 17.3 | 64.3 | 0.0 | 0.0 |
| 8-Mar-15 to 11 Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 64.0 | 0.0 | 0.0 |
| 12-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 1.5 | 17.8 | 64.3 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 40.9 | 0.0 | 0.0 |
| 14-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 44.3 | 0.0 | 0.0 |
| 15-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 42.2 | 0.0 | 0.0 |
| 16-Mar-15 to 17-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 18-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.2 | 35.1 | 0.0 | 0.0 | 14.6 | 36.1 | 35.3 | 65.6 | 0.0 | 0.0 |
| 19-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 34.8 | 55.4 | 36.0 | 36.1 | 65.0 | 65.8 | 0.0 | 0.0 |
| 20-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 49.2 | 55.6 | 36.0 | 36.1 | 65.0 | 65.7 | 0.0 | 0.0 |
| 21-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 40.0 | 40.8 | 36.0 | 36.1 | 65.0 | 65.6 | 0.0 | 0.0 |
| 22-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 12.9 | 40.7 | 36.0 | 36.1 | 65.0 | 65.6 | 0.0 | 0.0 |
| 23-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 0.0 | 0.0 | 36.0 | 36.1 | 65.0 | 65.4 | 0.0 | 0.0 |
| 24-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 24.6 | 40.7 | 36.0 | 36.0 | 65.0 | 65.7 | 0.0 | 0.0 |
| 25-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 23.4 | 40.8 | 36.0 | 36.0 | 65.0 | 65.4 | 0.0 | 0.0 |
| 26-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 33.2 | 35.2 | 16.9 | 40.7 | 34.1 | 36.2 | 61.6 | 65.6 | 0.0 | 0.0 |
| 27-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 15.2 | 40.7 | 36.0 | 36.1 | 65.0 | 65.5 | 0.0 | 0.0 |
| 28-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.1 | 13.4 | 40.8 | 36.0 | 36.1 | 65.0 | 65.6 | 0.0 | 0.0 |
| 29-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 35.1 | 0.0 | 0.0 | 6.2 | 36.0 | 18.1 | 65.3 | 0.0 | 0.0 |
| 30-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 31-Mar-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 2.5 | 0.0 | 0.0 | 0.7 | 64.3 | 0.0 | 0.0 |
| 1-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.7 | 40.3 | 0.0 | 0.0 | 0.7 | 65.0 | 0.0 | 0.0 |
| 2-Apr-15 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 65.2 | 0.0 | 0.0 |
| 3-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 4-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 35.1 | 4.2 | 40.6 | 21.2 | 36.1 | 50.1 | 65.6 | 0.0 | 0.0 |
| 5-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.2 | 35.1 | 0.0 | 0.0 | 10.5 | 36.0 | 65.0 | 65.5 | 0.0 | 0.0 |
| 6-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 11.8 | 50.3 | 36.0 | 36.1 | 65.0 | 65.4 | 0.0 | 0.0 |
| 7-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | 35.2 | 26.6 | 50.5 | 36.0 | 36.1 | 65.0 | 65.6 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.7 | 35.1 | 0.0 | 0.0 | 12.0 | 36.1 | 25.7 | 65.6 | 0.0 | 0.0 |
| 9-Apr-15 to 10-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 11-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 65.5 | 0.0 | 0.0 |
| 12-Apr-15 to 13-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 14-Apr-15 | 0.0 | 0.0 | 0.2 | 9.3 | 0.7 | 52.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 15-Apr-15 | 0.5 | 23.5 | 0.0 | 0.5 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 16-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.9 | 0.6 | 35.8 | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 | 65.4 | 0.0 | 0.0 |
| 17-Apr-15 | 0.7 | 24.8 | 0.1 | 6.9 | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 43.2 | 0.0 | 0.0 |
| 18-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 19-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.2 | 0.0 | 0.0 |
| 20-Apr 15 to 21-Apr 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 22-Apr-15 | 0.5 | 25.0 | 0.2 | 8.2 | 0.2 | 8.0 | 1.1 | 35.7 | 1.0 | 50.0 | 0.8 | 36.0 | 1.8 | 65.0 | 0.0 | 0.0 |
| 23-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 43.2 | 0.0 | 0.0 |
| 24-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 43.2 | 0.0 | 0.0 |
| 25-Apr-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 26-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 43.6 | 0.0 | 0.0 |
| 27-Apr-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 44.7 | 0.0 | 0.0 |
| 28-Apr-15 | 3.1 | 25.1 | 1.0 | 8.0 | 0.9 | 7.1 | 4.5 | 34.6 | 6.3 | 50.2 | 4.6 | 35.6 | 5.4 | 40.1 | 0.0 | 0.0 |
| 29-Apr 15 to 30-Apr 15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 1-May-15 | 2.6 | 25.1 | 0.8 | 8.0 | 0.6 | 6.0 | 3.5 | 34.6 | 5.1 | 50.2 | 3.3 | 35.6 | 8.6 | 64.5 | 0.0 | 0.0 |
| 2-May-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 40.1 | 0.0 | 0.0 |
| 3-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 44.7 | 0.0 | 0.0 |
| 4-May-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.4 | 0.0 | 0.0 |
| 5-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 42.4 | 0.0 | 0.0 |
| 6-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 42.3 | 0.0 | 0.0 |

| Date | N2 | | K12 | | Kb7 | | Kb4 | | K6 | | K5 | | K4 | | K10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8-May-15 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.8 | 0.0 | 0.0 |
| 9-May-15 to 12-May-15 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 13-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.5 | 0.0 | 0.0 |
| 14-May-15 to 16-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 17-May-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.6 | 0.0 | 0.0 |
| 18-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 40.8 | 0.0 | 0.0 |
| 19-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 20-May-15 | 5.1 | 24.6 | 1.7 | 8.1 | 1.3 | 6.2 | 7.2 | 34.6 | 10.9 | 50.1 | 7.7 | 35.1 | 9.9 | 47.2 | 0.0 | 0.0 |
| 21-May-15 to 22-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 23-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 39.6 | 0.0 | 0.0 |
| 24-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 40.0 | 0.0 | 0.0 |
| 25-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.8 | 0.0 | 0.0 |
| 26-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 27-May-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 5.4 | 34.6 | 7.3 | 50.4 | 5.2 | 35.1 | 7.0 | 45.3 | 0.0 | 0.0 |
| 28-May-15 to 28-Jun-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 29-Jun-15 | 0.0 | 0.0 | 10.8 | 45.1 | 8.4 | 35.0 | 12.0 | 50.2 | 7.9 | 34.6 | 0.2 | 7.0 | 1.9 | 8.1 | 4.9 | 24.6 |
| 30-Jun-15 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Appendix B

# Borefield Log Books

## K4

| | |
|---|---|
| 3 July 2015 | Read meters and dipped –MCW |
| 10 July 2015 | Read meters and dipped –MCW |
| 17 July 2015 | Read meters and dipped –BB |
| 24 July 2015 | Read meters and dipped –CG |
| 30 July 2015 | Samples – BN and DB |
| 31 July 2015 | Read meters and dipped –TA |
| 7 August 2014 | Read meters and dipped – TA |
| 14 August 2014 | Read meters and dipped – TA |
| 21 August 2014 | Read meters and dipped – CG |
| 26 August 2014 | Samples – BN and DB |
| 28 August 2014 | Read meters and dipped – CK |
| 4 September 2014 | Read meters and dipped – TA |
| 11 September 2014 | Read meters and dipped – BB |
| 18 September 2014 | Read meters and dipped. Running to expressway pond – BB |
| 25 September 2014 | Take sample – BN and DB |
| | Read meters and dipped – CG |
| 2 October 2014 | Read meters and dipped – TA |
| 8 October 2014 | Shut down pump USD for main pipe install work – CK |
| 9 October 2014 | Read meters and dipped – TA |
| 16 October 2014 | Read meters and dipped – CCT |
| 20 October 2014 | Remove lock-out – BN |
| 22 October 2014 | Take sample – BN and DB |
| 23 October 2014 | Read meters and dipped – CK |
| 30 October 2014 | Read meters and dipped – TA |
| 6 November 2014 | Turned pump back on – CK |
| | Read meters and dipped – BB |
| 13 November 2014 | Read meters and dipped – CG |
| 20 November 2014 | Read meters and dipped – CK |
| 25 November 2014 | Take samples – BN and DB |
| 27 November 2014 | Read meters and dipped – TA |
| 4 December 2014 | Read meters – BB |
| 11 December 2014 | Read meters – CG |
| 18 December 2014 | Read meters – CK |
| 22 December 2014 | Take sample – BN and DB |
| 25 December 2014 | Read meters – TA |
| 1 January 2015 | Read meters – BB |
| 8 January 2015 | Read meters – CG |
| 15 January 2015 | Read meters and change cabinet filter – CK |
| 22 January 2015 | Read meters and dipped – TA |
| 28 January 2015 | Take sample – BN and DB |
| 29 January 2015 | Read meters and dipped – TA |
| 5 February 2015 | Read meters and dipped – CG |

| | |
|---|---|
| 12 February 2015 | Read meters and dipped – CK |
| 19 February 2015 | Read meters and dipped and M2PP meter – TA |
| 23 February 2015 | Sample – BN and DB |
| 26 February 2015 | Read meters and dipped – BB |
| 6 March 2015 | Read meters and dipped – CG |
| 12 March 2015 | Read meters, dipped and change filter - CK |
| 13 March 2015 | Removed padlock from M2PP isolation valve 20895$m^3$ – CK |
| 18 March 2015 | Locked out M2PP 21452$m^3$ – CK |
| 19 March 2015 | Read meters and dipped and M2PP meter still 21452$m^3$ – JA |
| 21 March 2015 | Checked fan because of temperature alarm – BB |
| 25 March 2015 | Sample – BN and DB |
| 26 March 2015 | Read meters |
| 30 March 2015 | M2PP 21452$m^3$ meter reading, remove lock out for M2PP – BN |
| 31 March 2015 | Reset pump drive – CG |
| 2 April 2015 | Read meters – CG |
| 4 April 2015 | Locked out M2PP valve flow meter 21824$m^3$ – CK |
| 5 April 2015 | Take sample – BN and DB |
| 8 April 2015 | Take sample, remove lock out M2PP, F/M 21824$m^3$ – BN and DB |
| 9 April 2015 | Read meters – CCT |
| 11 April 2015 | Check lock removed from M2PP valve – 0730hrs – TA |
| 16 April 2015 | Read meters and change gab filter – TA |
| 23 April 2015 | Read meters – BB |
| 28 April 2015 | Take bore sample – TA |
| 30 April 2015 | Read meters – CG |
| 7 May 2015 | Read meters – BB |
| 15 May 2015 | Read meters – CG |
| 20 May 2015 | Take sample – BB |
| 28 May 2015 | Read meters – TA |
| 3 June 2015 | Place bulk water padlock on M2PP. Take off valve from bore, until consent issues (M2PP to take water) has been sorted – TA |
| 4 June 2015 | Read meters – BB |
| 10 June 2015 | Read meters – CG |

## Kb4

| | |
|---|---|
| 3 July 2014 | Read meters – MCW |
| 10 July 2014 | Read meters – MCW |
| 17 July 2014 | Read meters – BB |
| 24 July 2014 | Read meters – CG |
| 30 July 2014 | Samples – BN and DB |
| 31 July 2014 | Read meters – CK |
| 7 August 2014 | Read meters – TA |
| 14 August 2014 | Read meters – TA |
| 21 August 2014 | Read meters – CG |
| 26 August 2014 | Take sample –BN and DB |
| 28 August 2014 | Read meters – CK |
| 4 September 2014 | Read meters – TA |
| 11 September 2014 | Read meters – BB |
| 18 September 2014 | Read meters BB |
| 25 September 2014 | Take samples BN and DB |
| | Read meters – CG |
| 2 October 2014 | Read meters – TA |
| 8 October 2014 | Shut down pump USD power supply for main pipe install – CK |
| 9 October 2014 | Read meters – TA |
| 16 October 2014 | Read meters – CG |
| 21 October 2014 | Remove lock out – BN |
| 22 October 2014 | Sample BN and DB |
| 23 October 2014 | Read meters – CK |
| 30 October 2014 | Read meters – TA |
| 6 November 2014 | Tuned pump back up – CK |
| | Read meters – BB |
| 13 November 2014 | Read meters – CG |
| 20 November 2014 | Read meters |
| 25 November 2014 | Take samples – BN and DB |
| 26 November 2014 | Read meters – TA |
| 4 December 2014 | Read meters – BB |
| 11 December 2014 | Read meters – CG |
| 18 December 2014 | Read meters – CK |
| 22 December 2014 | Take sample – BN and DB |
| 25 December 2014 | Read meters – TA |
| 1 January 2015 | Read meters – BB |
| 8 January 2015 | Read meters – CG |
| 15 January 2015 | Read meters – CK |
| 22 January 2015 | Read meters – TA |
| 28 January 2015 | Start bore – CG |
| | Take sample – BN and DB |
| 29 January 2015 | Read meters – TA |

| | |
|---|---|
| 5 February 2015 | Read meters – CG |
| 11 February 2015 | Relocate aerial to south end – BB |
| 12 February 2015 | Read meters |
| 19 February 2015 | Read meters – TA |
| 23 February 2015 | Sample – BN and DB |
| 26 February 2015 | Read meters – BB |
| 6 March 2015 | Read meters and change filter – CG |
| 12 March 2015 | Read meters – CK |
| 19 March 2015 | Read meters – TA |
| 26 March 2015 | Sample – BN and DB |
| | Read meters – CG |
| 2 April 2015 | Read meters – CG |
| 6 April 2015 | 1710 Take sample – BN and DB |
| 9 April 2015 | Read meters – CG |
| 16 April 2015 | Read meters and change filter – TA |
| 23 April 2015 | Read meters – BB |
| 28 April 2015 | Take bore sample – TA |
| 30 April 2015 | Read meters – CG |
| 7 May 2015 | Read meters – BB |
| 15 May 2015 | Read meters – CG |
| 20 May 2015 | Take sample – BB |
| 28 May 2015 | Read meters – TA |
| 3 June 2015 | VSD locked out while Mills Albert have pipe work dug up at K10 |
| 4 June 2015 | Read meters – BB |
| 10 June 2015 | Read meters - CG |

## K5

| Date | Comment |
|---|---|
| 3 July 2014 | Read meters and dipped – MCW |
| 10 July 2014 | Read meters and dipped – MCW |
| 17 July 2014 | Read meters and dipped – BB |
| 24 July 2014 | Read meters and dipped – CG |
| 30 July 2014 | Samples – BN and DB |
| 31 July 2014 | Read meters and dipped – CK |
| 7 August 2014 | Read meters and dipped – TA |
| 14 August 2014 | Read meters and dipped – TA |
| 21 August 2014 | Read meters and dipped – CG |
| 26 August 2014 | Take samples – BN and DB |
| 28 August 2014 | Read meters and dipped – CK |
| 4 September 2014 | Read meters and dipped – TA |
| 11 September 2014 | Read meters and dipped – BB |
| 18 September 2014 | Read meters and dipped – BB |
| 25 September 2014 | Taking sample – BN and DB |
| | Read meters and dipped – CG |
| 2 October 2014 | Read meters and dipped – TA |
| 8 October 2014 | Shut down pump for main pipe work install – CK |
| 9 October 2014 | Read meters and dipped – TA |
| 16 October 2014 | Read meters and dipped –CG |
| 20 October 2014 | Remove TAC out – BN |
| 22 October 2014 | Take sample – BN and DB |
| 23 October 2014 | Read meters and dipped – CK |
| 30 October 2014 | Read meters and dipped – TA |
| 6 November 2014 | Turned pump back on – CK |
| | Read meters and dipped – BB |
| 13 November 2014 | Read meters and dipped –CG |
| 20 November 2014 | Read meters and dipped – CK |
| 25 November 2014 | Take samples – BN and DB |
| 26 November 2014 | Read meters and dipped – TA |
| 4 December 2014 | Read meters – BB |
| 11 December 2014 | Read meters – CG |
| 18 December 2014 | Read meters – CK |
| 22 December 2014 | Take sample – BN and DB |
| 25 December 2014 | Read meters – TA |
| 1 January 2015 | Read meters – BB |
| 8 January 2015 | Read meters – CG |
| 15 January 2015 | Read meters and replace cabinet filters– CK |
| 22 January 2015 | Read meters – TA |
| 28 January 2015 | Take samples – BN and DB |

| | |
|---|---|
| 29 January 2015 | Read meters and dipped – TA |
| 5 February 2015 | Read meters and dipped – CG |
| 12 February 2015 | Read meters and dipped – CK |
| 19 February 2015 | Read meters and dipped – TA |
| 23 February 2015 | Take sample – BN and DB |
| 26 February 2015 | Read meters – BB |
| 6 March 2015 | Read meters and dipped – CG |
| 12 March 2015 | Read and replace filter |
| 19 March 2015 | Read meters – TA |
| 26 March 2015 | Sample – BN and DB |
| | Read meters – BB |
| 2 April 2015 | Read meters – CG |
| 4 April 2015 | 0700 reset drive fault PCT ext 22 – CK |
| 6 April 2015 | Take sample – BN and DB |
| 9 April 2015 | Read meters – CG |
| 16 April 2015 | Read meters and clean cabinet filter – TA |
| 23 April 2015 | Read meters – BB |
| 28 April 2015 | Take bore sample – TA |
| 30 April 2015 | Read meters – CG |
| 7 May 2015 | Read meters – BB |
| 15 May 2015 | Read meters – CG |
| 20 May 2015 | Take sample – BB |
| 28 May 2015 | Read meters –TA |
| 10 June 2015 | Read meters – CG |

## K6

| Date | Comment |
|---|---|
| 3 July 2014 | Read meter and dipped – MCW |
| 10 July 2014 | Read meter and dipped – MCW |
| 17 July 2014 | Read meter and dipped – BB |
| 24 July 2014 | Read meter and dipped – CG |
| 30 July 2014 | Take samples – BN and DB |
| 31 July 2014 | Read meter and dipped – CK |
| 7 August 2014 | Read meter and dipped – TA |
| 14 August 2014 | Read meter and dipped – TA |
| 21 August 2014 | Read meter and dipped – CCT |
| 26 August 2014 | Take samples – BN and DB |
| 28 August 2014 | Read meter and dipped – CK |
| 4 September 2014 | Read meter and dipped – TA |
| 11 September 2014 | Read meter and dipped – BB |
| 18 September 2014 | Read meter and dipped – BB |
| 25 September 2014 | Take sample – BN and DB |
| | Read meter and dipped – CCT |
| 2 October 2014 | Read meter and dipped – TA |
| 8 October 2014 | Shut down pump USD for main pipe work install – CK |
| 9 October 2014 | Read meter and dipped – TA |
| 16 October 2014 | Read meter and dipped – CCT |
| 20 October 2014 | Remove tag out – BN |
| 22 October 2014 | Take sample – BN |
| 23 October 2014 | Read meter and dipped – CK |
| 30 October 2014 | Read meter and dipped – TA |
| 3 November 2014 | Flow meter from K13 connected and reprogrammed |
| 6 November 2014 | Turned pump back on and checked for leaks after magflow install and bolt replacement – CK |
| | Read meter and dipped – BB |
| 13 November 2014 | Read meter and dipped – CCT |
| 20 November 2014 | Read meter and dipped – CK |
| 25 November 2014 | Take samples – BN and DB |
| 26 November 2014 | Read meter and dipped – TA |
| 4 December 2014 | Read meter – BB |
| 11 December 2014 | Read meter – CCT |
| 18 December 2014 | Read meter – CK |
| 22 December 2014 | Take sample – BN and DB |
| 25 December 2014 | Read meter – TA |
| 1 January 2015 | Read meter – BB |
| 8 January 2015 | Read meter – CG |
| 15 January 2015 | Read meter, replace cabinet filter – CK |

| | |
|---|---|
| 22 January 2015 | Read meter – TA |
| 28 January 2015 | Take sample – BN and DB |
| 29 January 2015 | Read meter and dipped – TA |
| 5 February 2015 | Read meter and dipped – CG |
| 12 February 2015 | Read meter and dipped |
| 19 February 2015 | Read meter and dipped – TA |
| 23 February 2015 | Samples – BN and DB |
| 26 February 2015 | Read meter – BB |
| 6 March 2015 | Read meter and dipped – CG |
| 12 March 2015 | Read meter and change filter – CK |
| 19 March 2015 | Read meter – TA |
| 24 March 2015 | Check out comms fail, no power to readouts – BB |
| 26 March 2015 | Samples – BN and DB |
| | Read meter – BB |
| 31 March 2015 | Turned off compressor tank reading 100%, bleed air out of system |
| 2 April 2015 | Read meter – CG |
| 9 April 2015 | Read meter – CG |
| 13 April 2015 | Put compressor control onto manual. Transducers playing up for level control – CK |
| 14 April 2015 | Checked tank level, level at 13 on gauge – CK and DB |
| 16 April 2015 | Read meter and clean cabinet filter – TA |
| 22 April 2015 | Fitted new level transducer – CK |
| 23 April 2015 | Read meter – BB |
| 28 April 2015 | Take bore sample – TA |
| | Check surge tank, level stuck at 80% after bores shut down, tank empty and air valves releasing air, turned off compressor and powered down transducer, powered up and reset ok, put compressor back to auto after removing excess air from tank – CK |
| 30 April 2015 | Read meter – CG |
| 7 May 2015 | Read meters – BB |
| 15 May 2015 | Read power meter, rest is flooded and shut down |
| 18 May 2015 | Checked flood damage – UPS had been submerged and is now dead and gone. No other damage anywhere. Pump station running on main power until new UPS arrive – BB |
| 20 May 2015 | Take sample – BB |
| 28 May 2015 | Meter reading – TA |
| 4 June 2015 | Meter reading – BB |
| 10 June 2015 | Meter reading - CG |

## K10

| | |
|---|---|
| 3 July 2014 | Meters checked and dipped – MCW |
| 10 July 2014 | Meters checked and dipped – MCW |
| 31 July 2014 | Meters read and dipped – CR |
| 7 August 2014 | Meters read and dipped – TA |
| 14 August 2014 | Meters read and dipped – TA |
| 28 August 2014 | Meters read and dipped – TA |
| 28 April 2015 | Start bore – then take sample manual – then shut down – TA |
| 15 May 2015 | Meters read - CG |
| 20 May 2015 | Take sample – BB |
| 22 May 2015 | PLC back plane changed observation bore hooked up – BB |
| 25 May 2015 | Check high level in pressure vessel, compressor off? - CK |
| 28 May 2015 | Site visit meter readings – TA |
| 3 June 2015 | Site visit, check on status of surge vessel. Everything set up to Auto, although no water in surge vessel. Valve supply must be shut will check with Bruce. Correct Mills Albert. Have watermain redirection work going on. Locked out USD to bore pump – till watermain back online – TA |
| 4 June 2015 | Read meters – BB |
| 10 June 2015 | Read meters – CG |
| 29 June 2015 | Take sample |

## Kb7

| | |
|---|---|
| 20 May 2015 | Take sample |
| 29 June 2015 | Take sample |

## K12

| | |
|---|---|
| 20 May 2015 | Take sample |
| 29 June 2015 | Take sample |

## N2

| | |
|---|---|
| 20 May 2015 | Take sample |
| 29 June 2015 | Take sample |

Appendix C

# Groundwater Level and Electrical Conductivity Monitoring Results

## C.1 Shallow Aquifer Water Level Monitoring

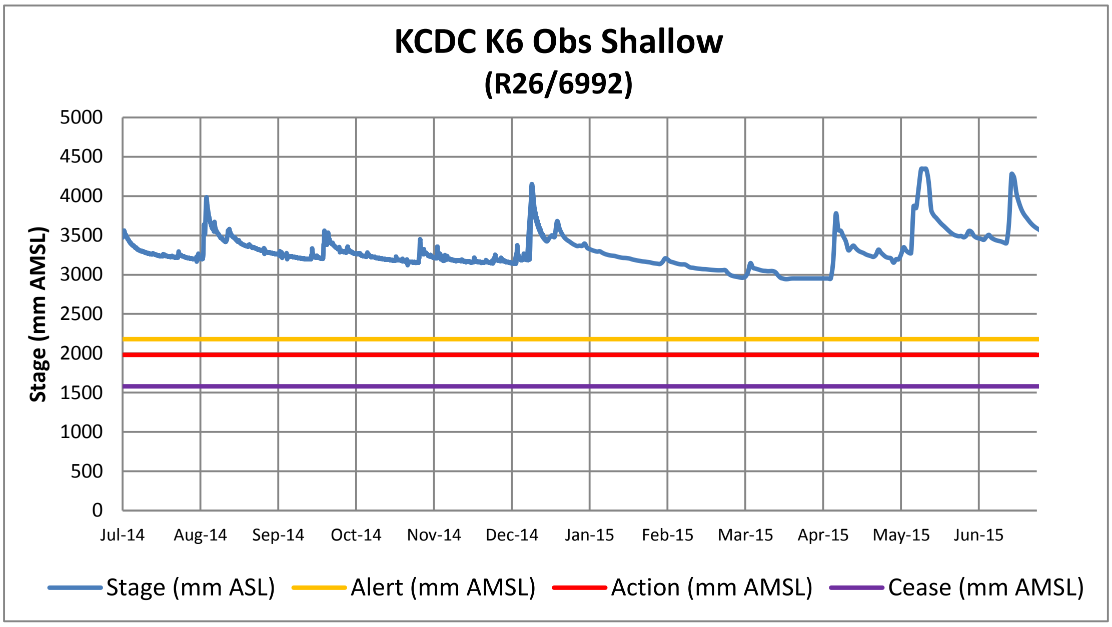



Figure C1.1: Water Levels at KCDC K6 Observation Shallow Monitoring Bore (R26/6992)

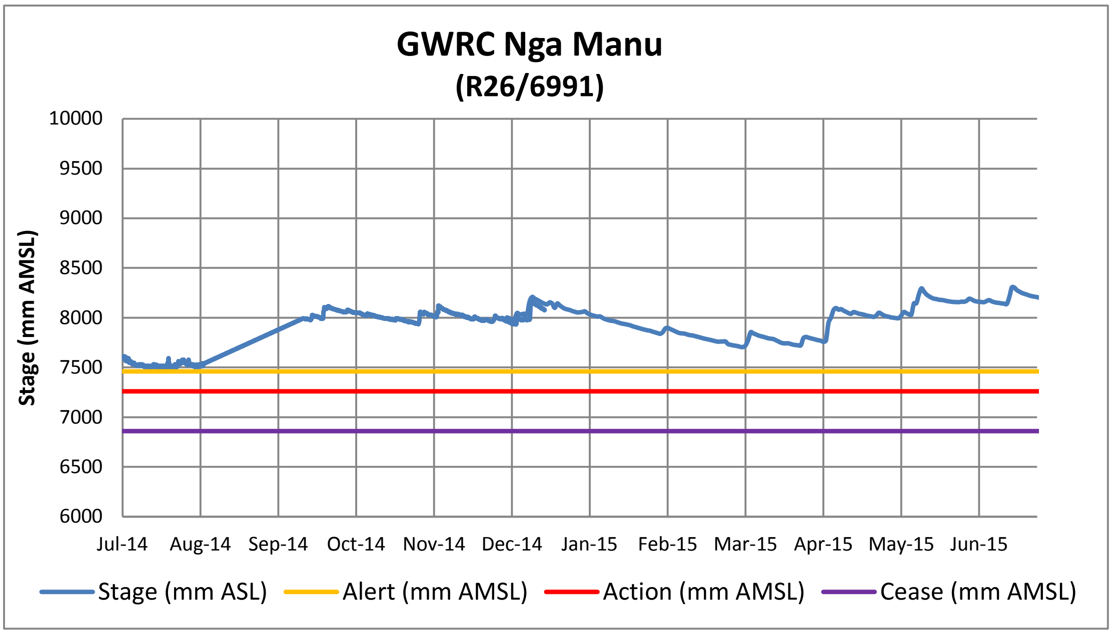



Figure C1.2: Water Levels at GWRC Nga Manu Monitoring Bore (R26/6991)

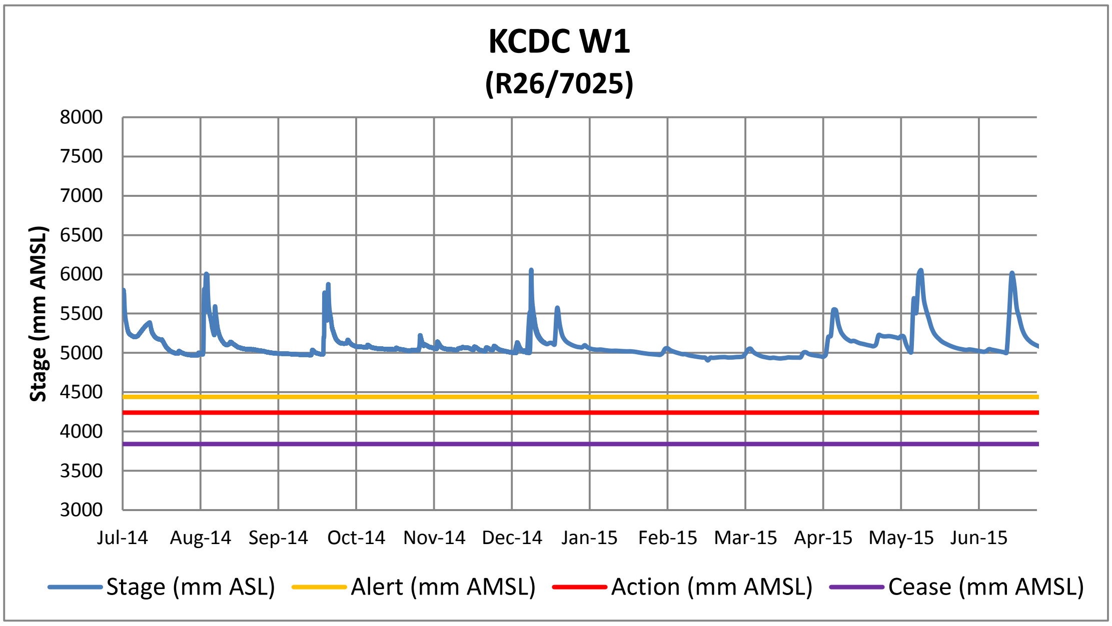



Figure C1.3: Water Levels at KCDC W1 Monitoring Bore (R26/7025)

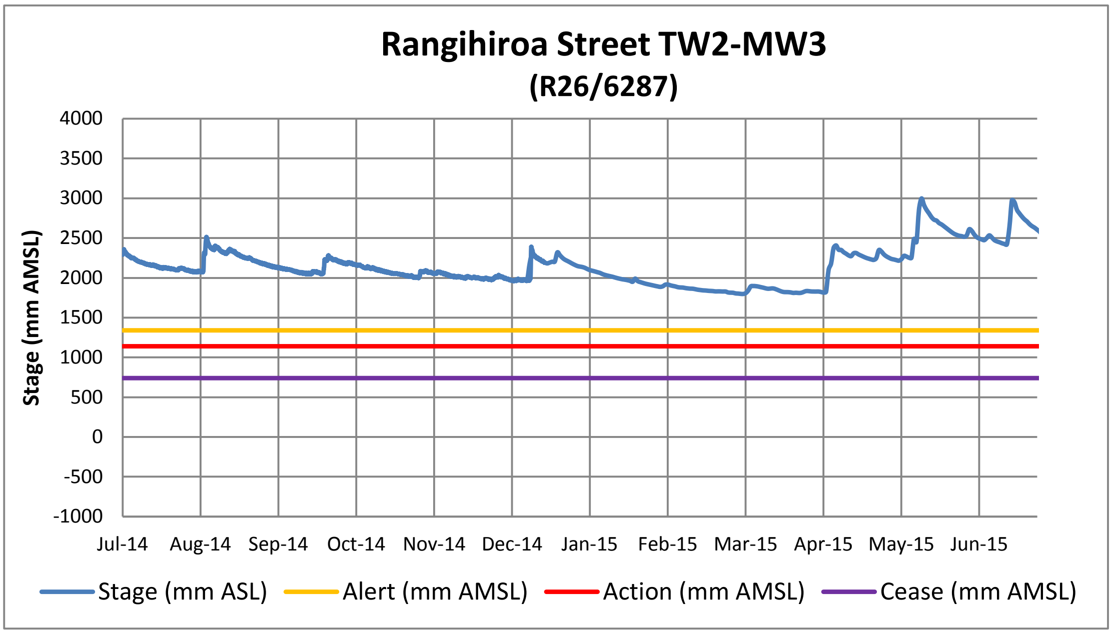



Figure C1.4: Water Levels at Rangihiroa St Monitoring Bore (R26/6287)

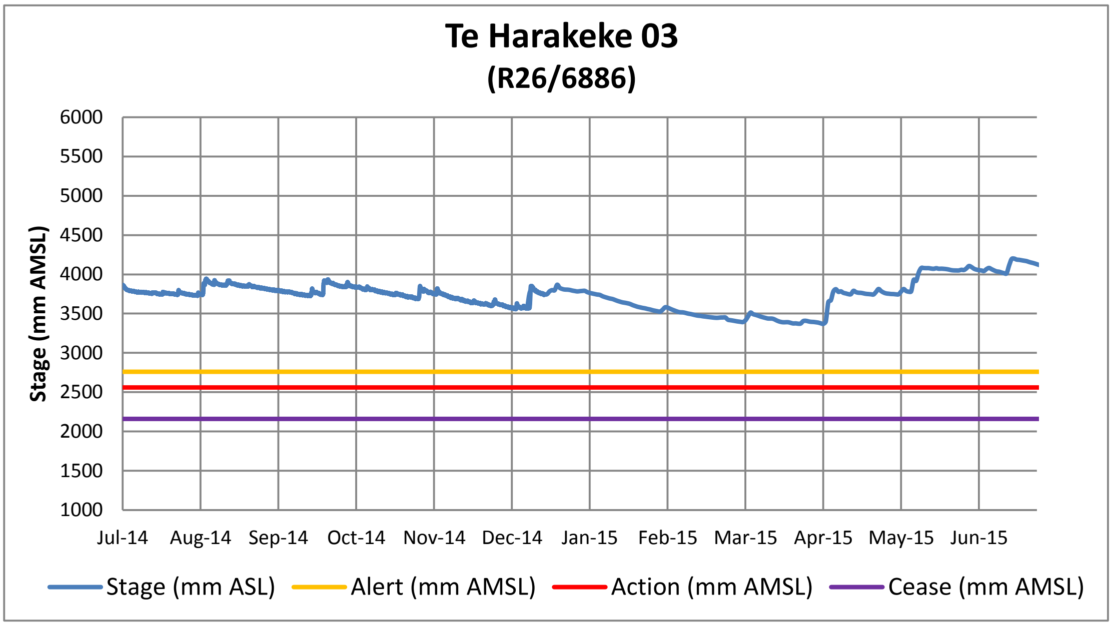



Figure C1.5: Water Levels at Te Harakeke 3 Monitoring Bore (R26/6286)

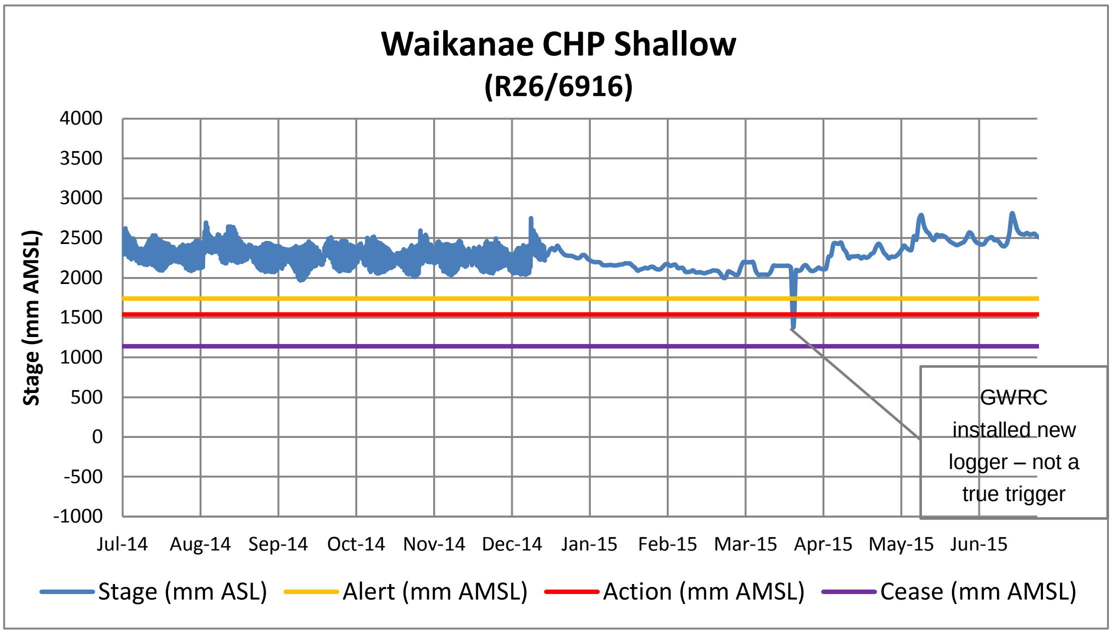



Figure C1.6: Water Levels at Waikanae CHP Shallow Monitoring Bore (R26/6916). Data from July to mid December 2014 is at 15-minute intervals, while data from mid December 2014 to June 2015 is daily averages. Low level in March due to installation of new water level logger by GWRC and was not a true trigger exceedance.

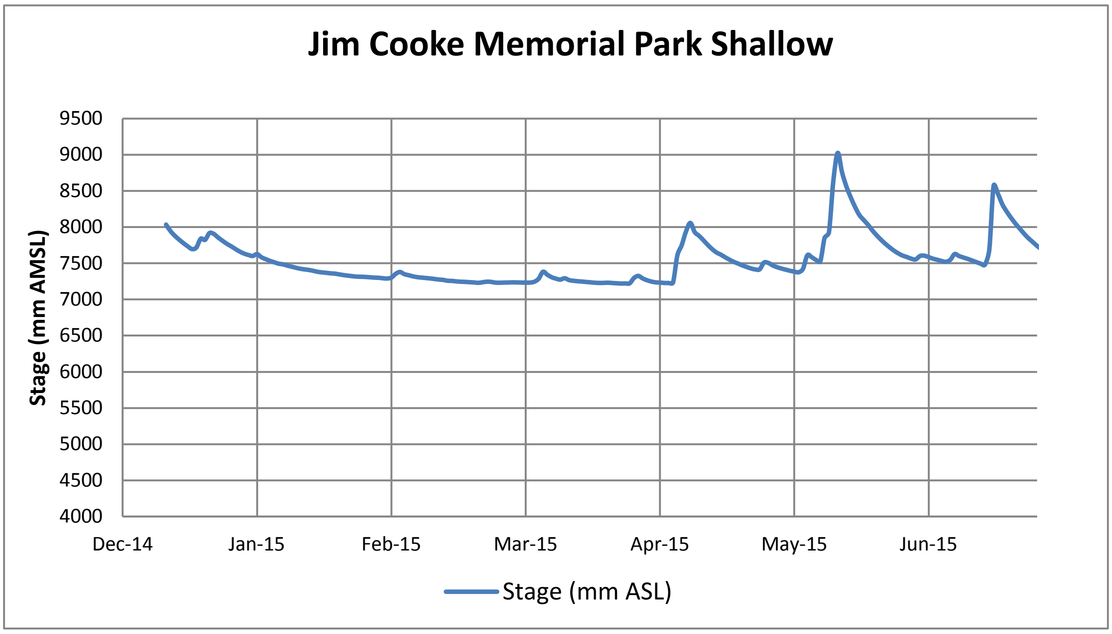



Figure C1.8: Water Levels at Jim Cooke Memorial Park Shallow Monitoring Bore (Bore ID tba)

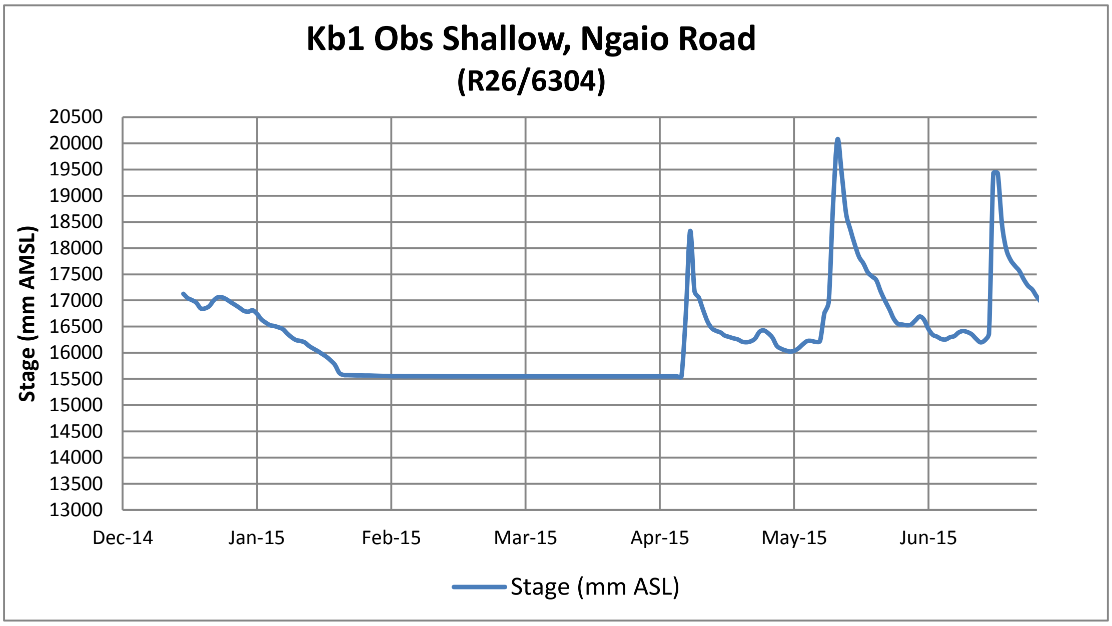



Figure C1.9: Water Levels at Kb1 Obs Shallow, Ngaio Road Monitoring Bore (R26/6304). Groundwater levels dropped below the bottom of the well in late January and rose again in early April 2015.

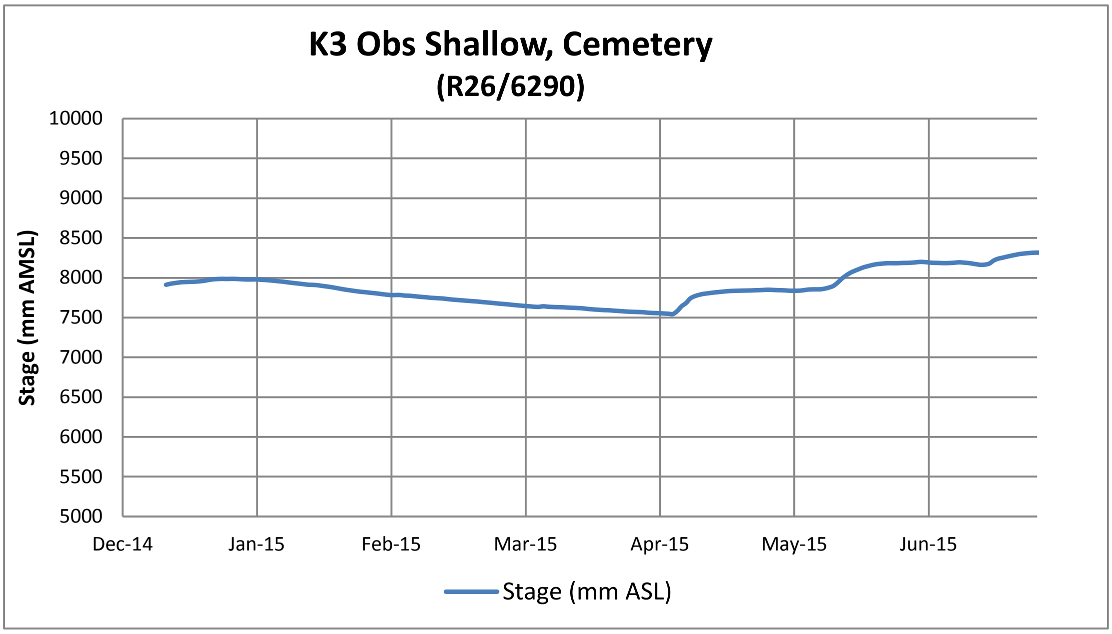



Figure C1.10: Water Levels at K3 Obs Shallow, Cemetery Monitoring Bore (R26/6290).

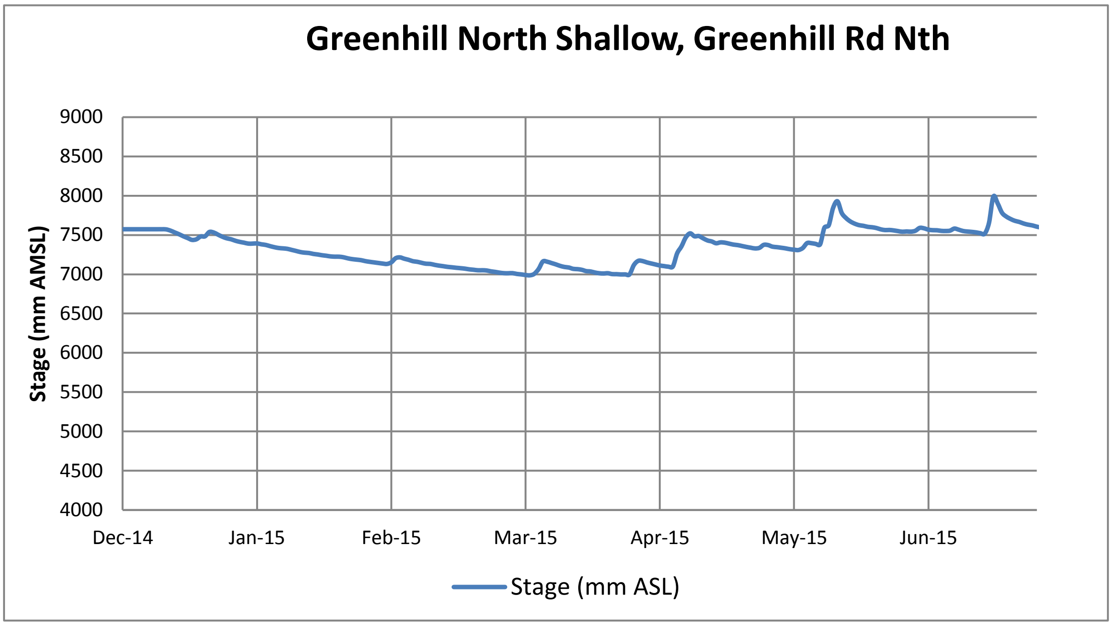



Figure C1.11: Water Levels at Greenhill North Shallow, Greenhill Rd North Monitoring Bore (Bore ID tba).

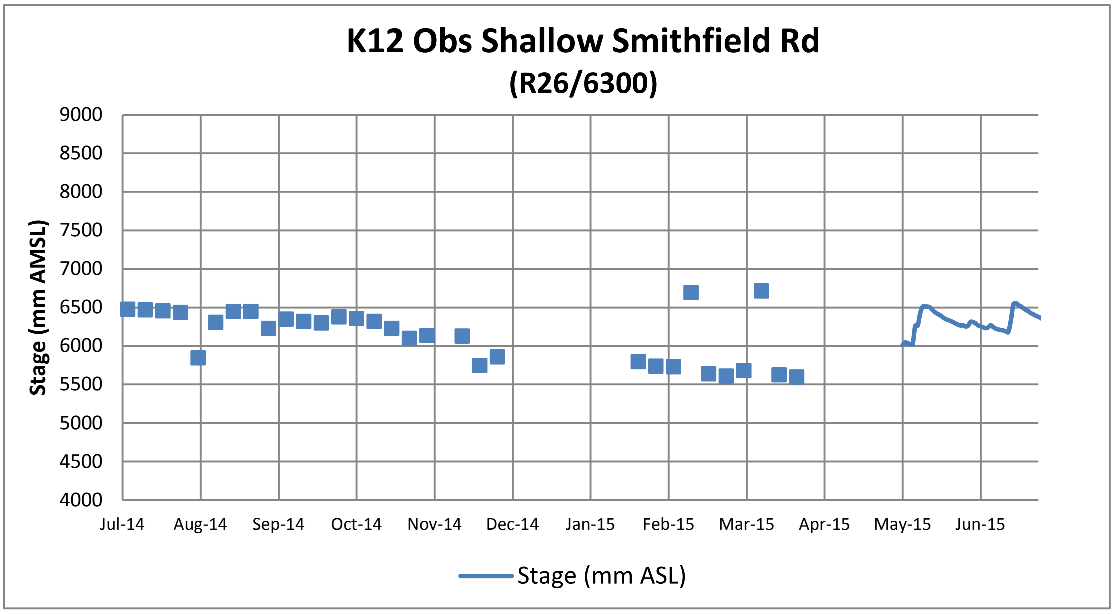



Figure C1.12: Water Levels at K12 Obs Shallow Smithfield Road (R26/6300)

## C.2 Deep Aquifer Water Level Monitoring

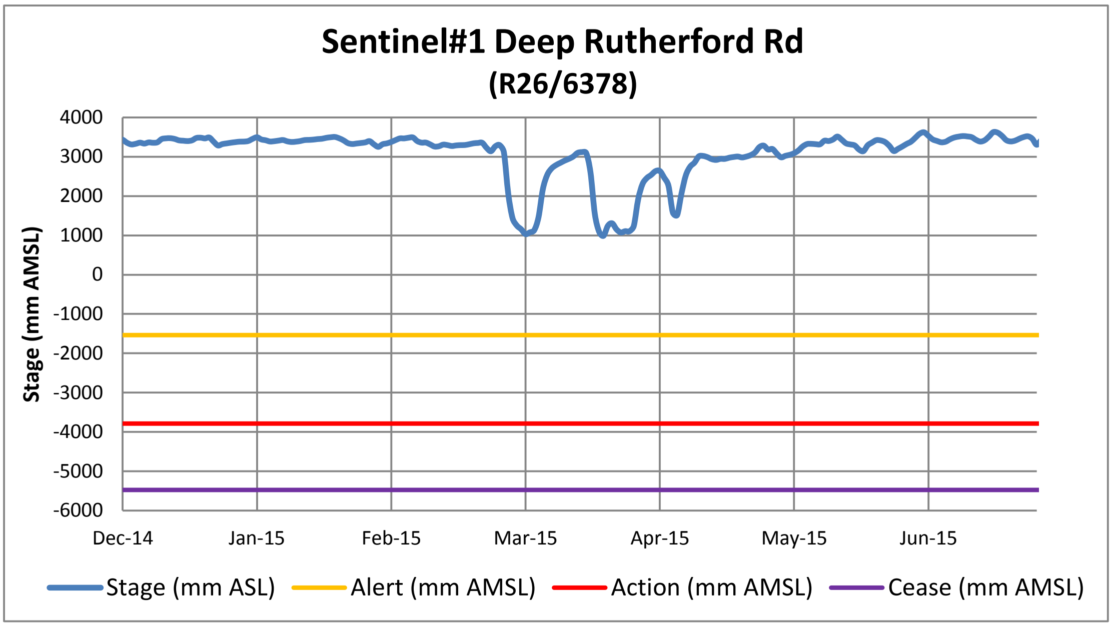



Figure C2.1: Water Levels in Sentinel #1 Deep Monitoring Bore at Rutherford Drive (R26/6378) Equipment removed on 26 May 2014 for borehead refurbishment, with monitoring recommencing in December 2014.

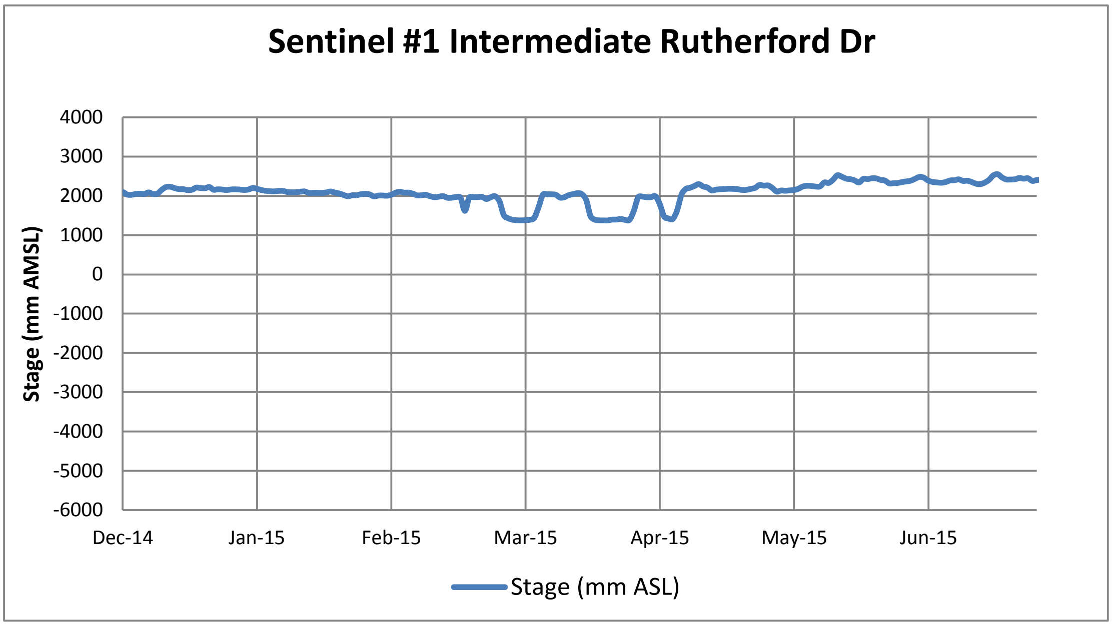



Figure C2.2: Water Levels in Sentinel #1 Intermediate Monitoring Bore at Rutherford Drive (Bore ID tba)

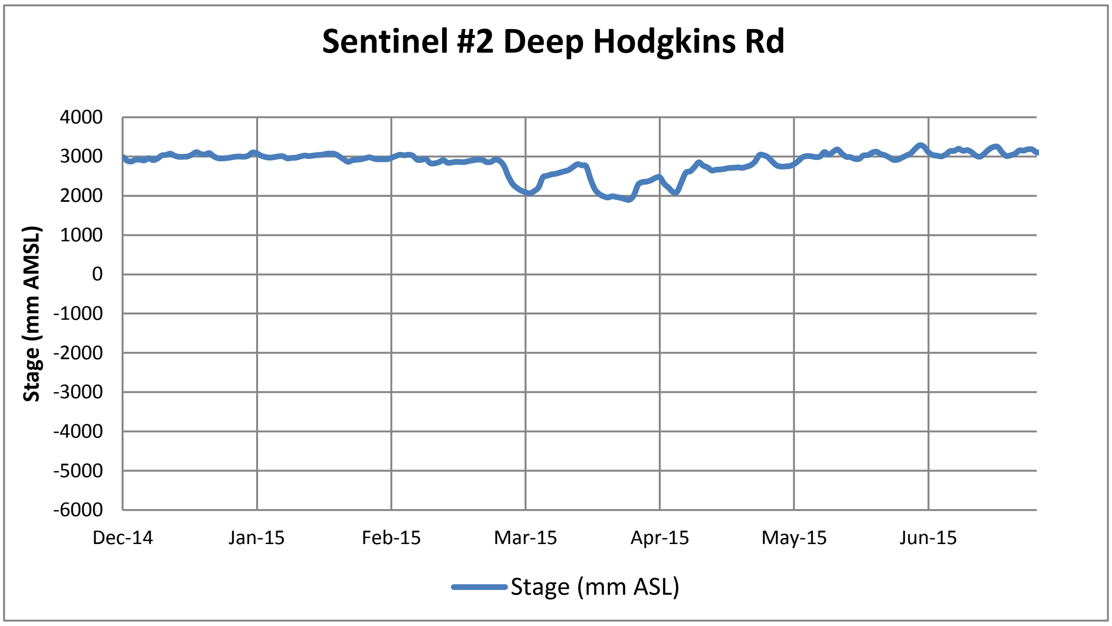



Figure C2.3: Water Levels in Sentinel #2 Deep Monitoring Bore at Hodgkins Rd (Bore ID tba)

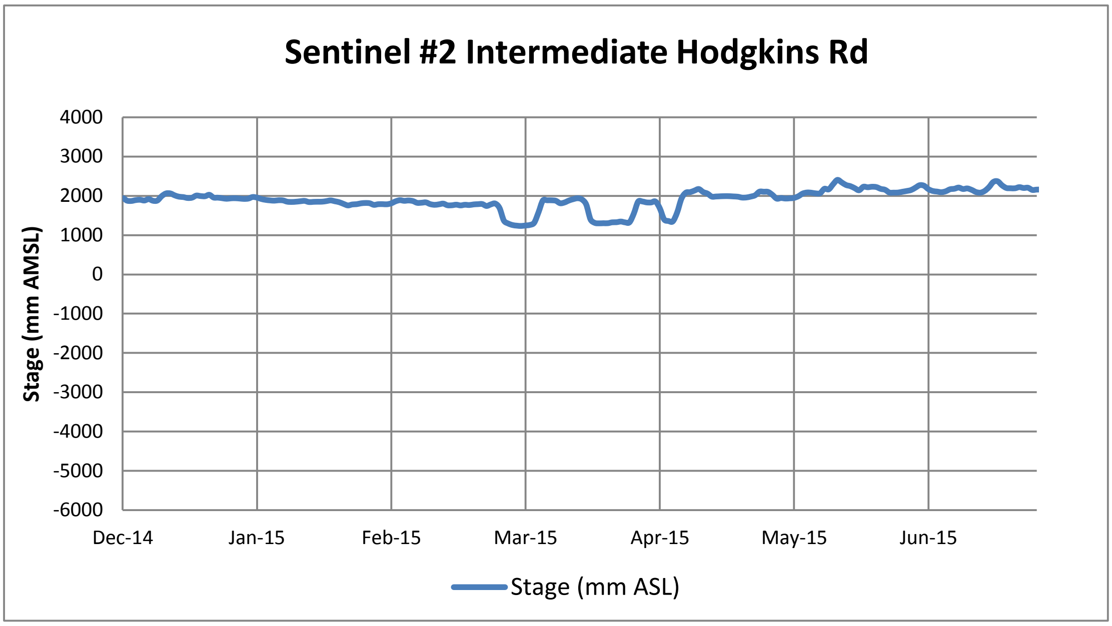



Figure C2.4: Water Levels in Sentinel#2 Intermediate Monitoring Bore at Hodgkins Rd (Bore ID tba)

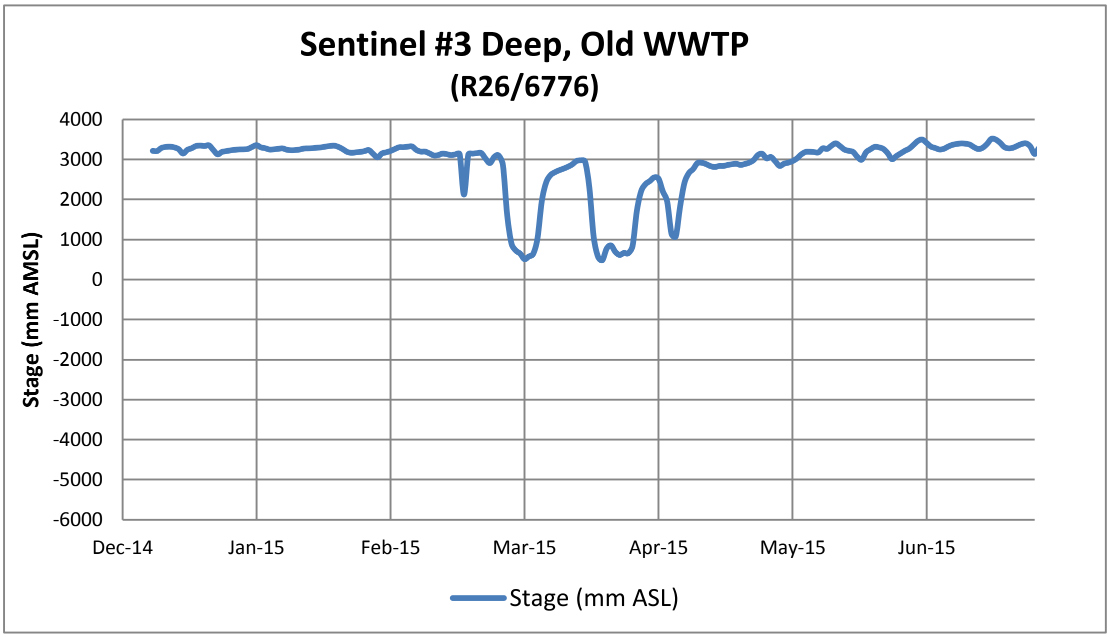



Figure C2.5: Water Levels in Sentinel #3 Deep Monitoring Bore at Old WWTP (R26/6776)

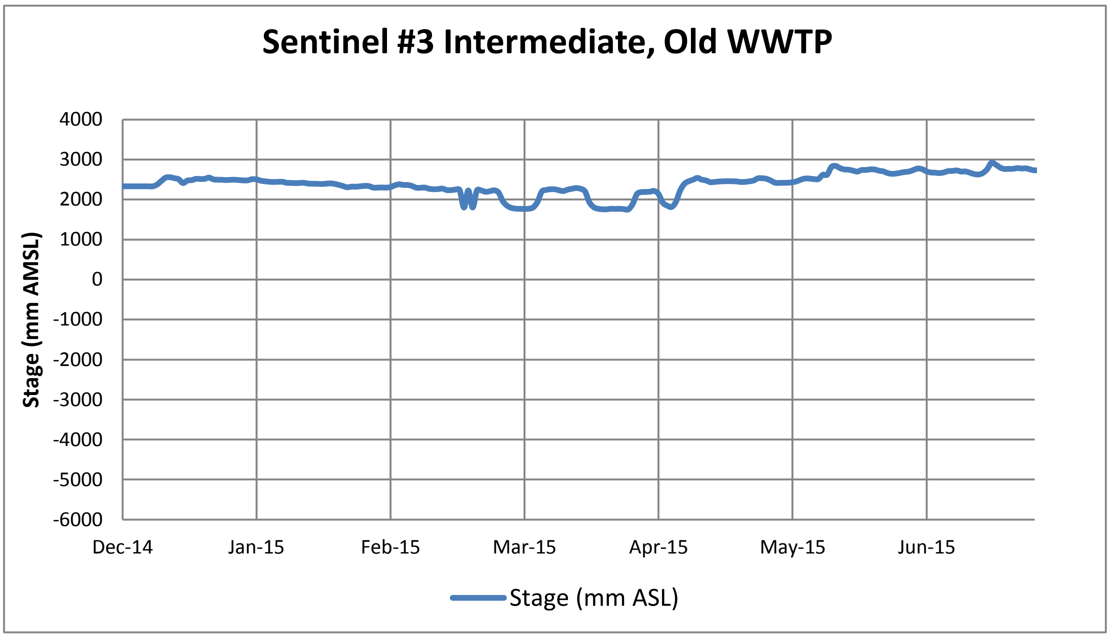



Figure C2.6: Water Levels in Sentinel #3 Intermediate Monitoring Bore at Old WWTP (Bore ID tba)

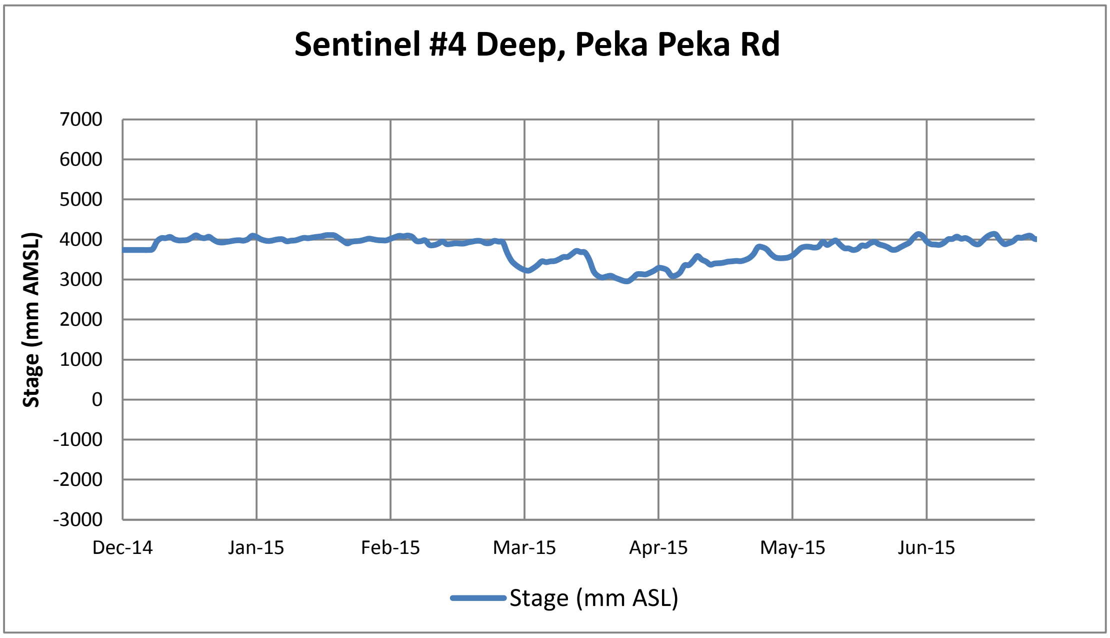



Figure C2.6: Water Levels in Sentinel #4 Deep Monitoring Bore at Peka Peka Rd (Bore ID tba)

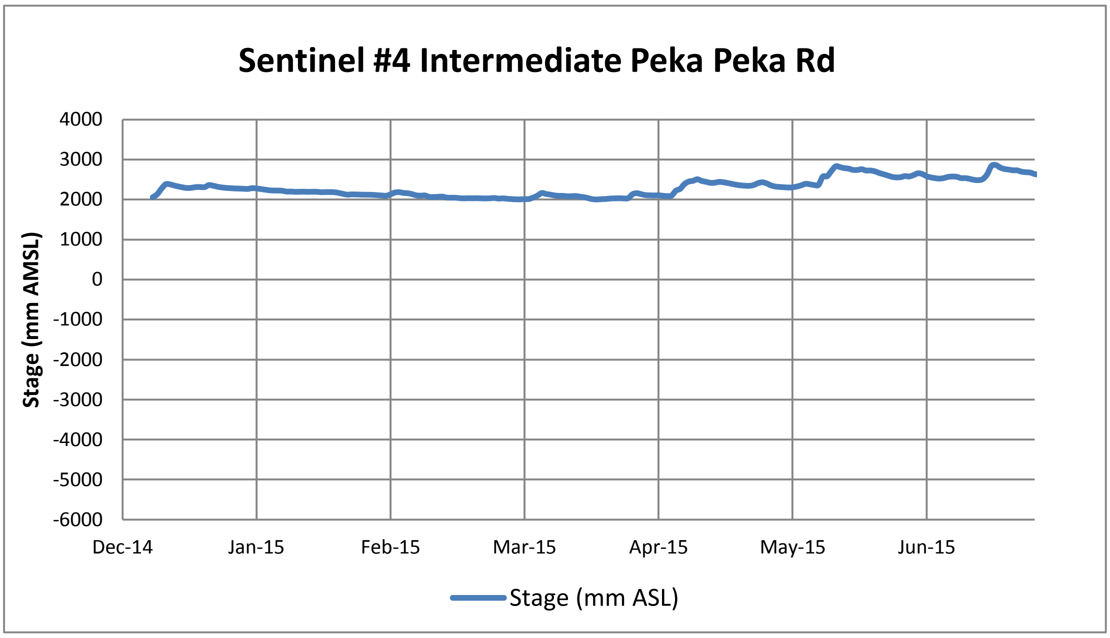



Figure C2.6: Water Levels in Sentinel #4 Intermediate Monitoring Bore at Peka Peka Rd (Bore ID tba)

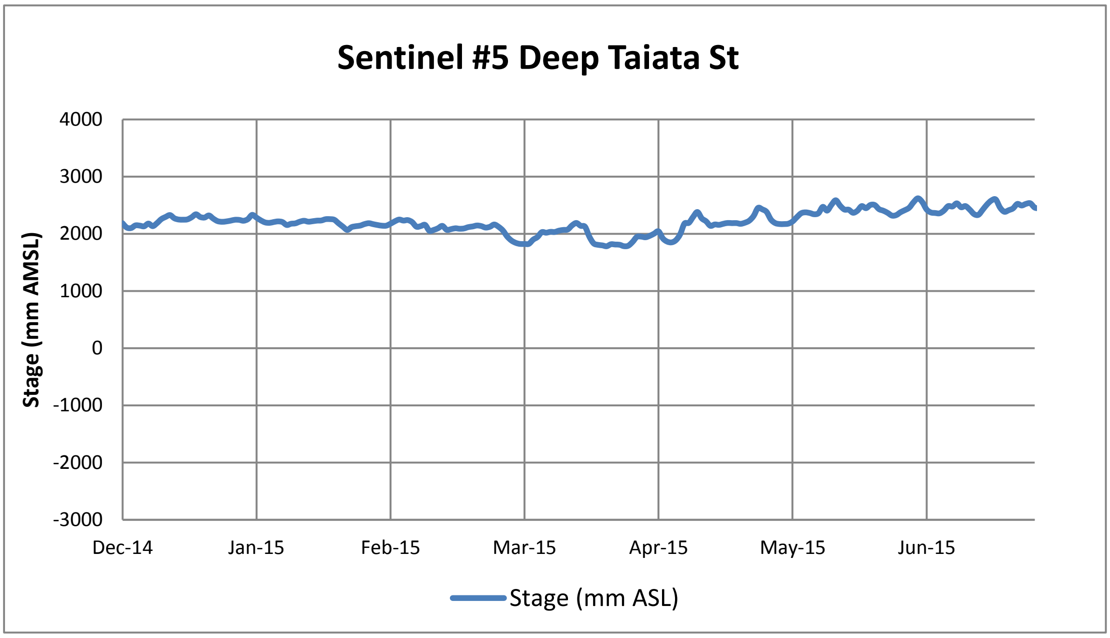



Figure C2.7: Water Levels in Sentinel #5 Deep at Taiata St (Bore ID tba)

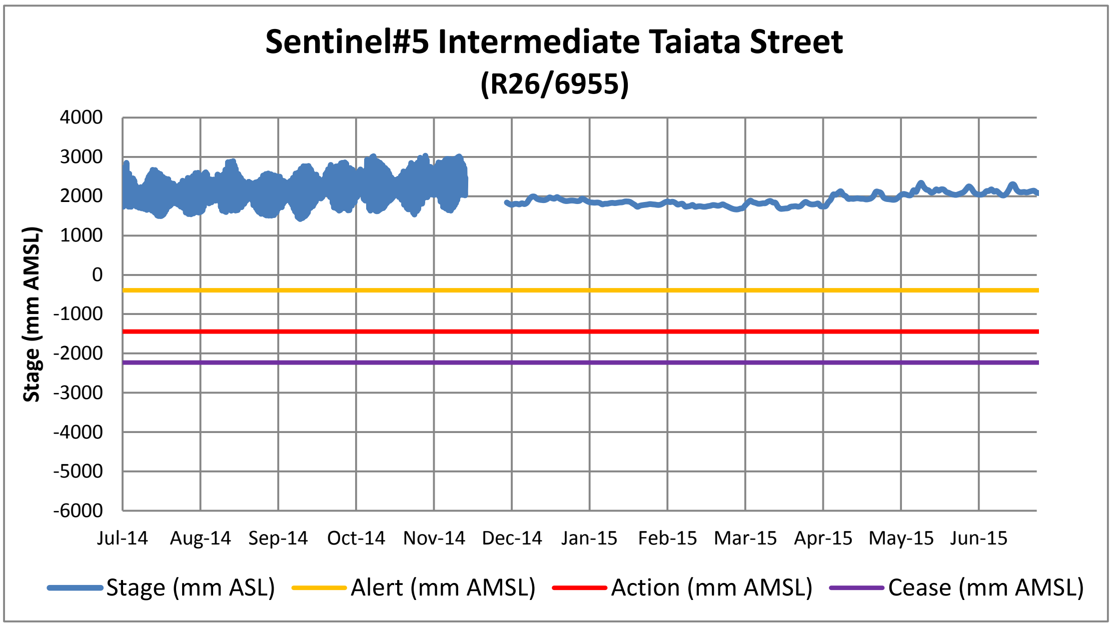



Figure C2.8: Water Levels in Sentinel #5 Intermediate at Taiata St (R26/6955). Equipment removed and replaced in November 2014. Data for July-November 2014 is 15 minute interval, while data for December 2014 to June 2015 is daily averages.

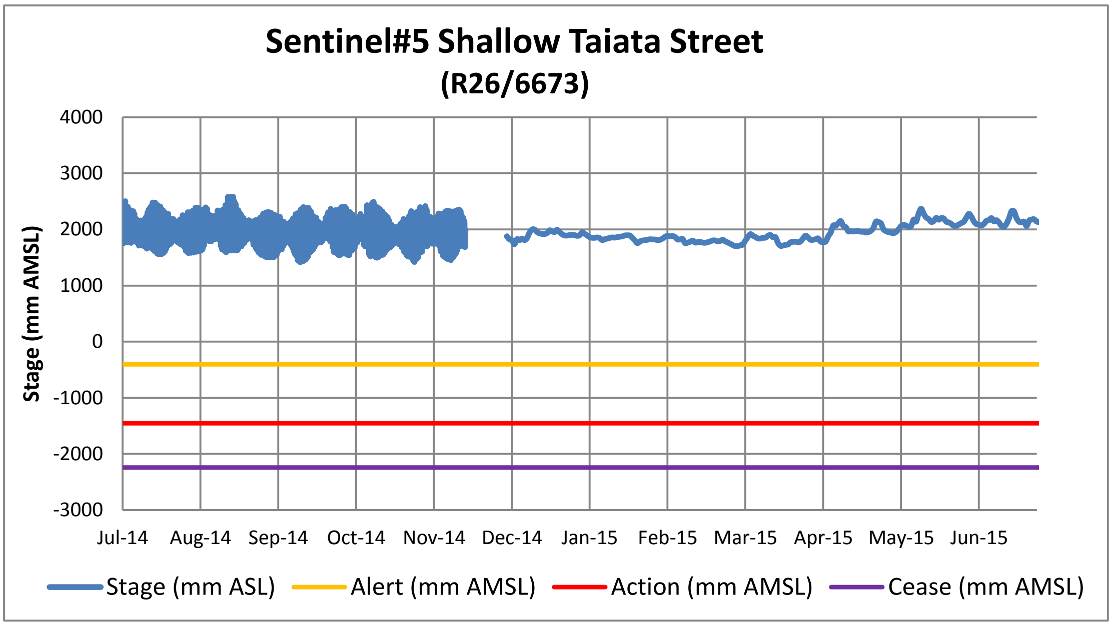



Figure C2.9: Water Levels in Sentinel #5 Shallow at Taiata St (R26/6673). Equipment removed and replaced in November 2014. Data for July-November 2014 is 15 minute interval, while data for December 2014 to June 2015 is daily averages.

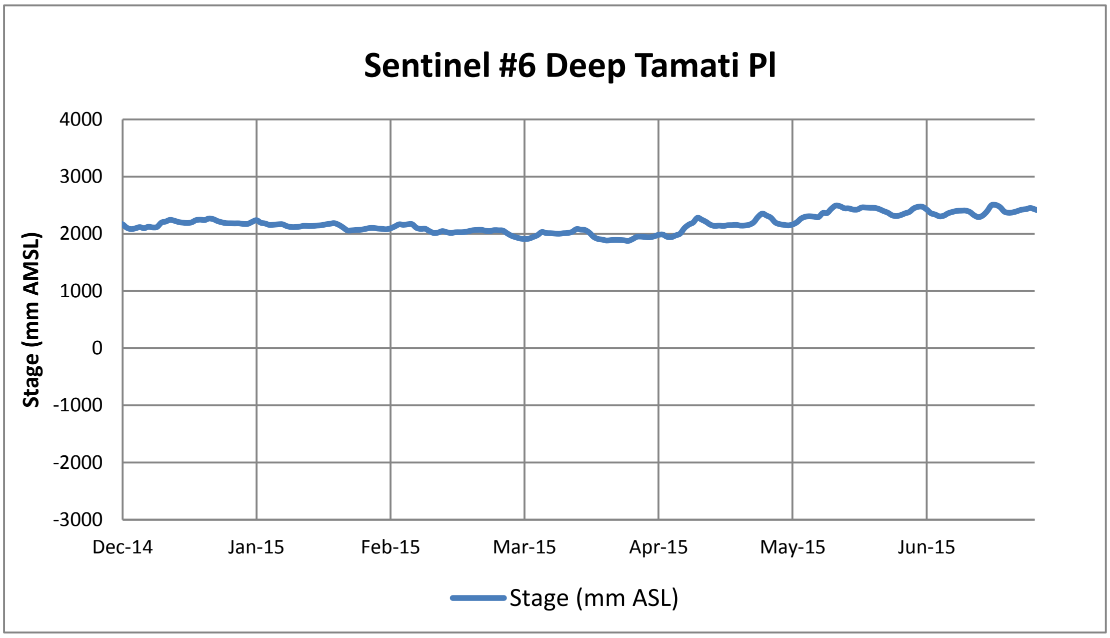



Figure C2.10: Water Levels in Sentinel #6 Deep at Tamati Place (Bore ID tba).

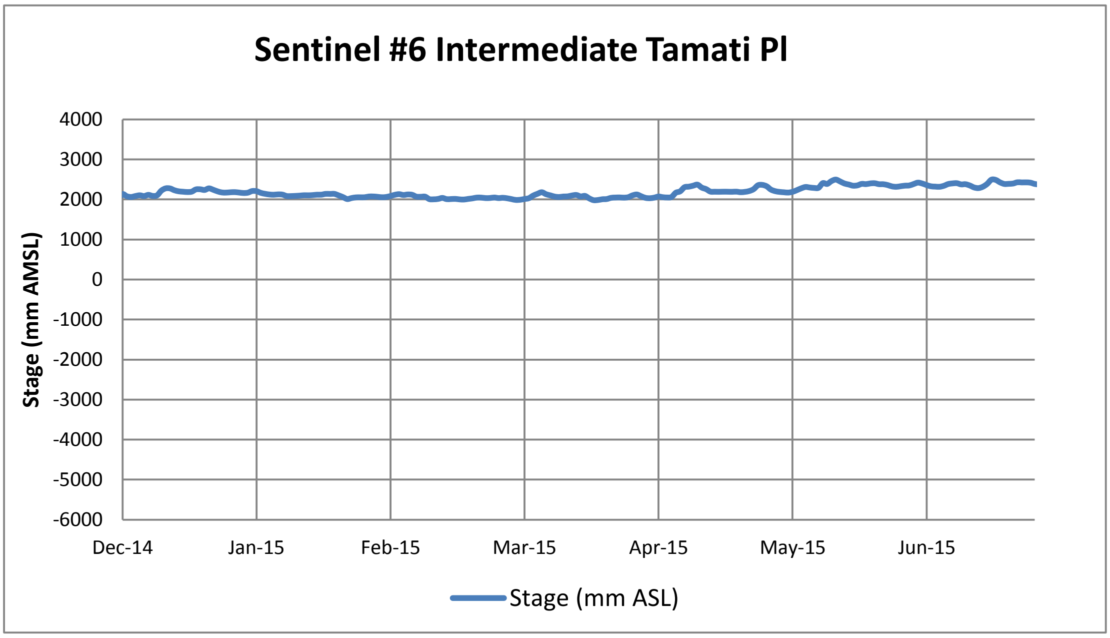



Figure C2.11: Water Levels in Sentinel #6 Intermediate at Tamati Place (Bore ID tba).

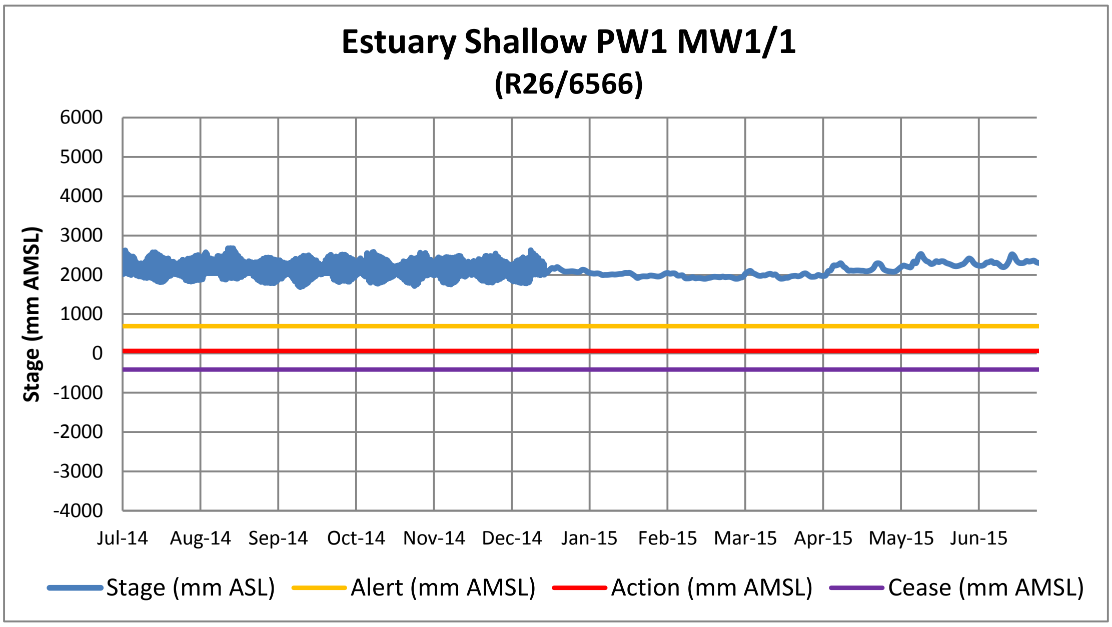



Figure C2.12: Water Levels in Old Estuary Shallow bore (R26/6566). Data for July-November 2014 is 15 minute interval, while data for December 2014 to June 2015 is daily averages.

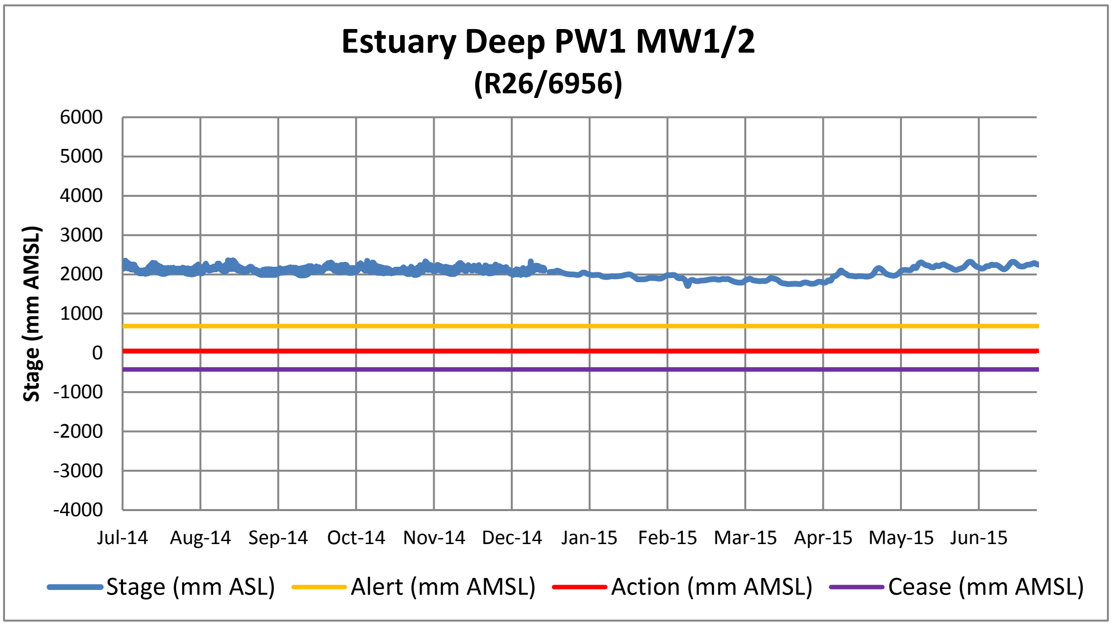



Figure C2.13: Water Levels in Old Estuary Deep Bore (R26/6956). Data for July-November 2014 is 15 minute interval, while data for December 2014 to June 2015 is daily averages.

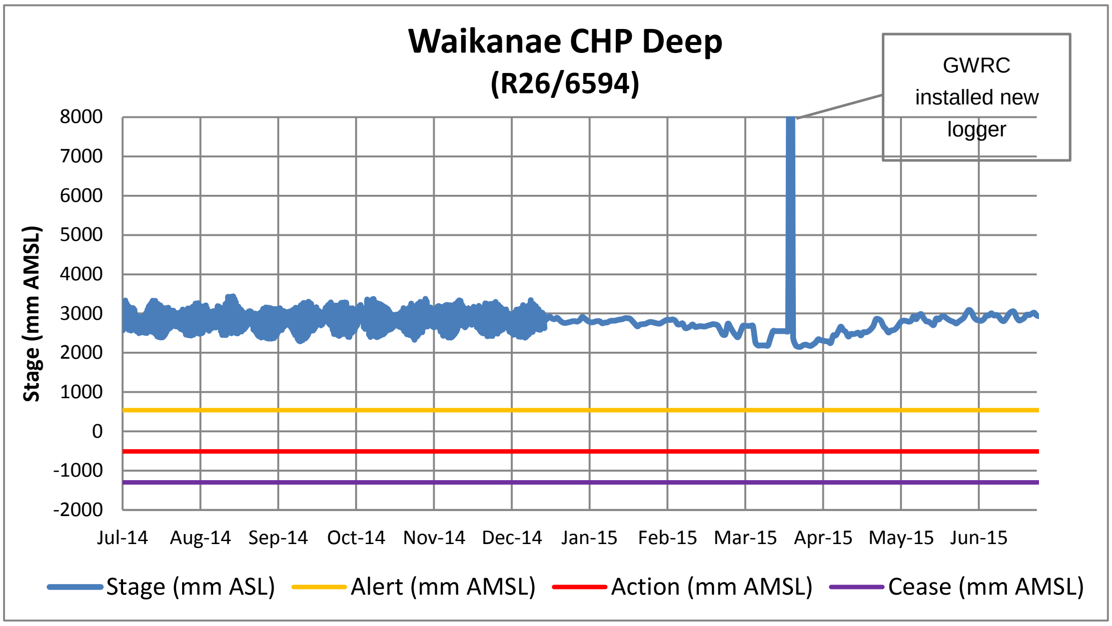



Figure C14: Water Levels in Waikanae CHP Deep Monitoring Bore (R26/6594). Data from July to mid December 2014 is at 15-minute intervals, while data from mid December 2014 to June 2015 is daily averages. High level in mid March 2015 due to equipment maintenance.

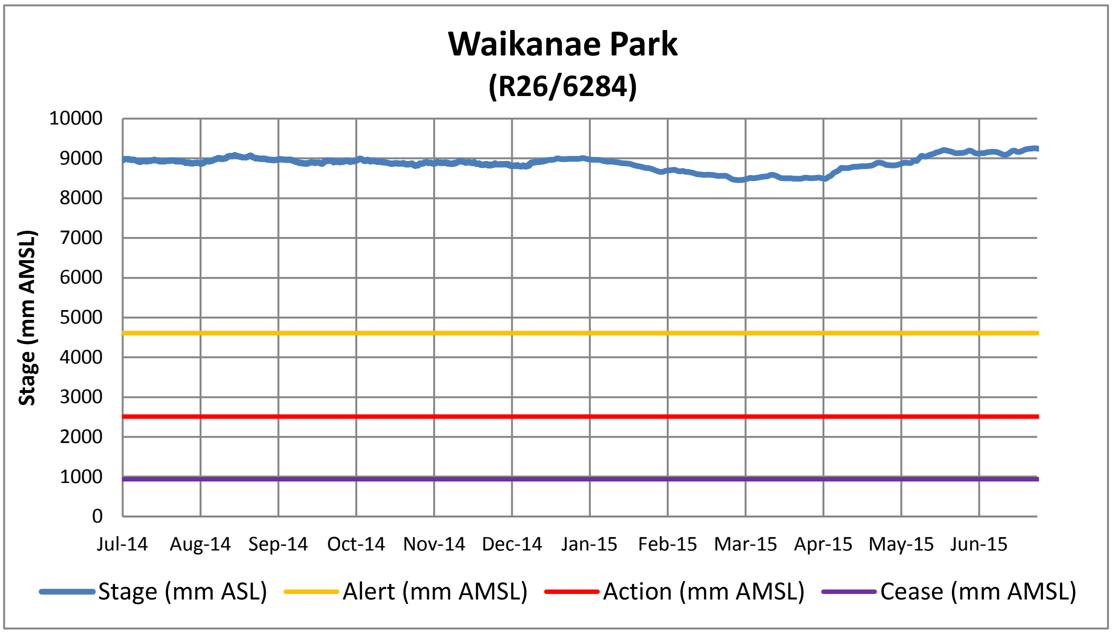



Figure C15: Water Levels in Waikanae Park Monitoring Bore (R26/6284). Data from July to mid December 2014 is at 15-minute intervals, while data from mid December 2014 to June 2015 is daily averages.

## C.3 Electrical Conductivity Monitoring

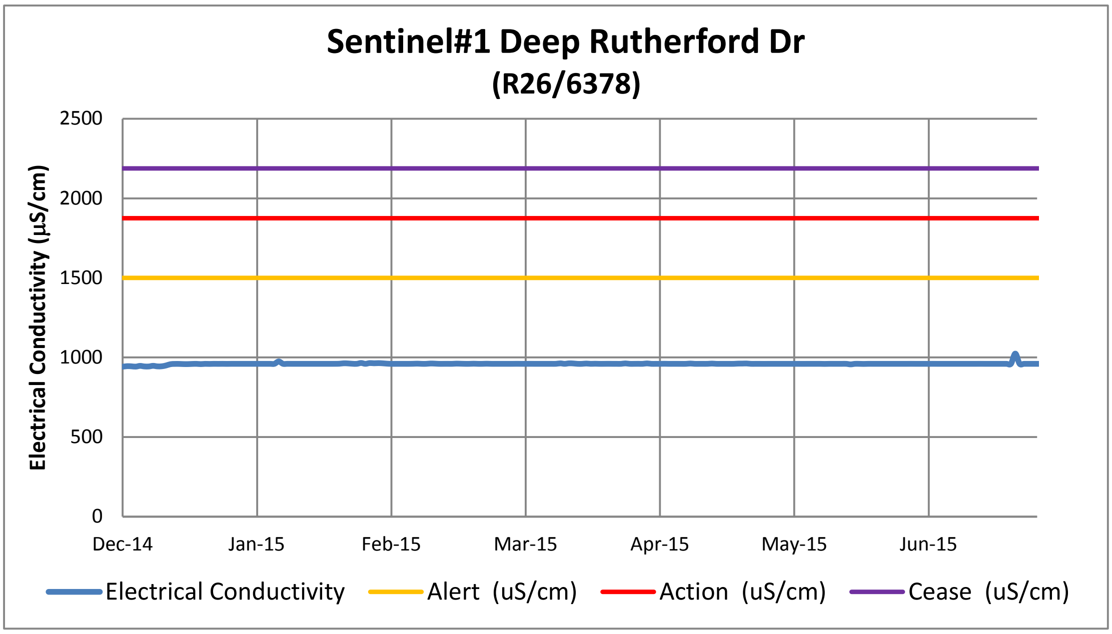



Figure C3.1: Electrical Conductivity in Sentinel #1 Deep Rutherford Drive Monitoring Bore (R26/6378). Equipment removed May 2014 for borehead refurbishment and monitoring restarted December 2014.

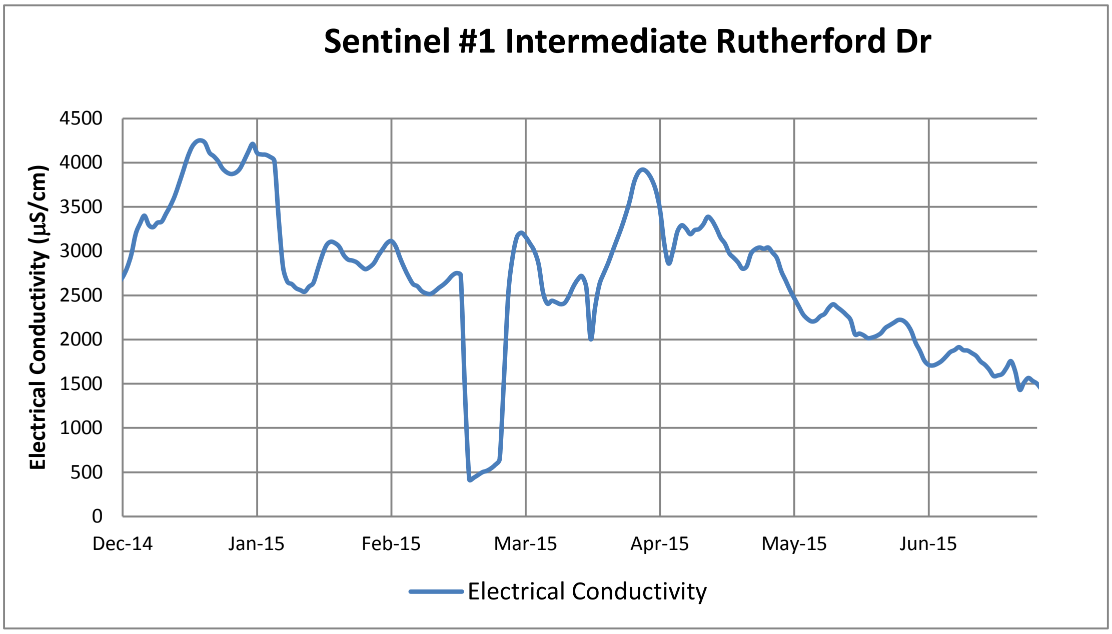



Figure C3.2: Electrical Conductivity in Sentinel #1 Intermediate Rutherford Drive Monitoring Bore (Bore ID tba)

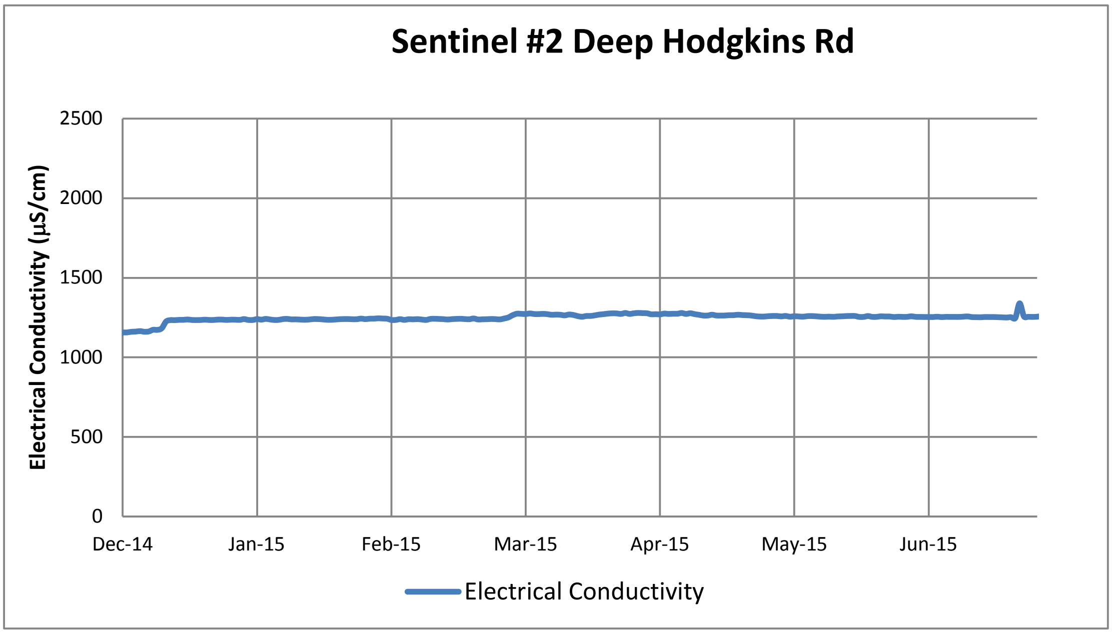



Figure C3.3: Electrical Conductivity in Sentinel #2 Deep Hodgkins Rd Monitoring Bore (Bore ID tba)

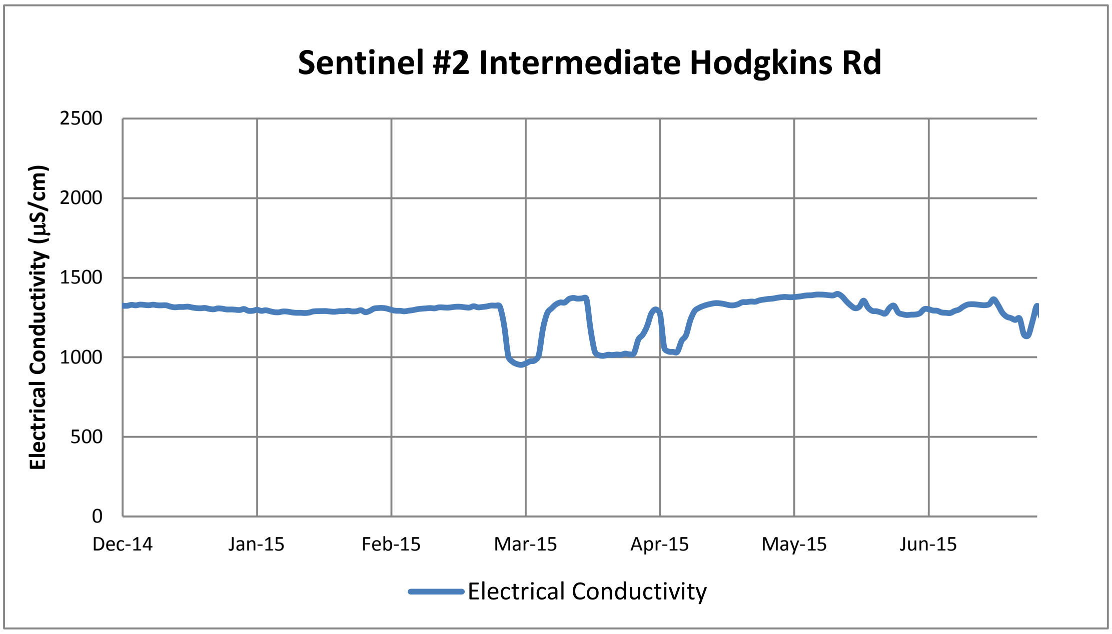



Figure C3.4: Electrical Conductivity in Sentinel #2 Intermediate Hodgkins Rd Monitoring Bore (Bore ID tba)

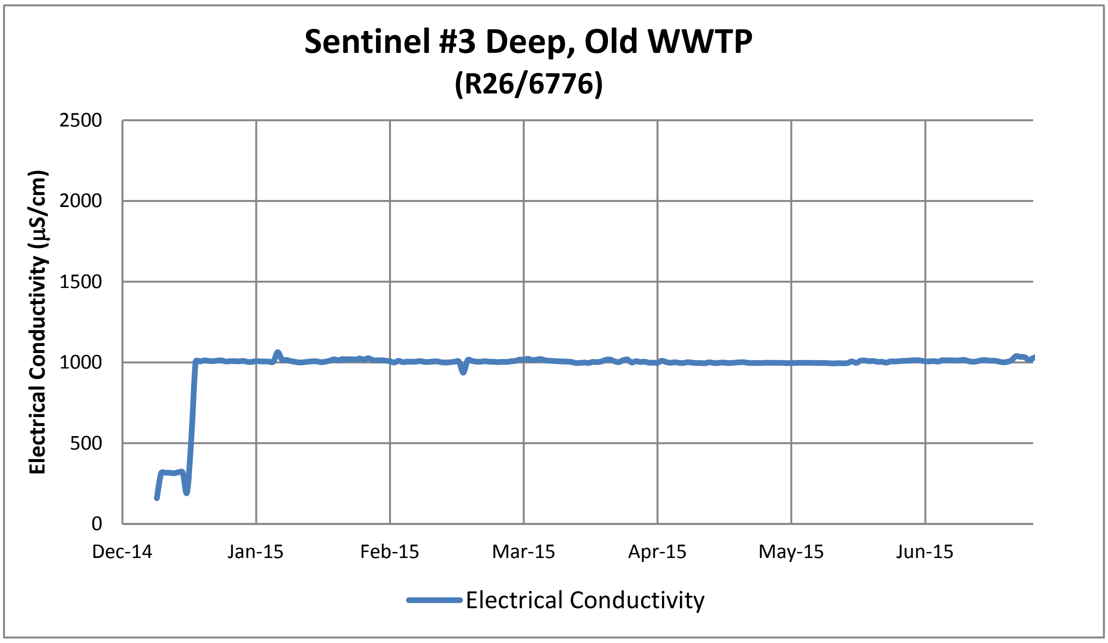



Figure C3.5: Electrical Conductivity in Sentinel #3 Deep Old WWTP Monitoring Bore (R26/6776)

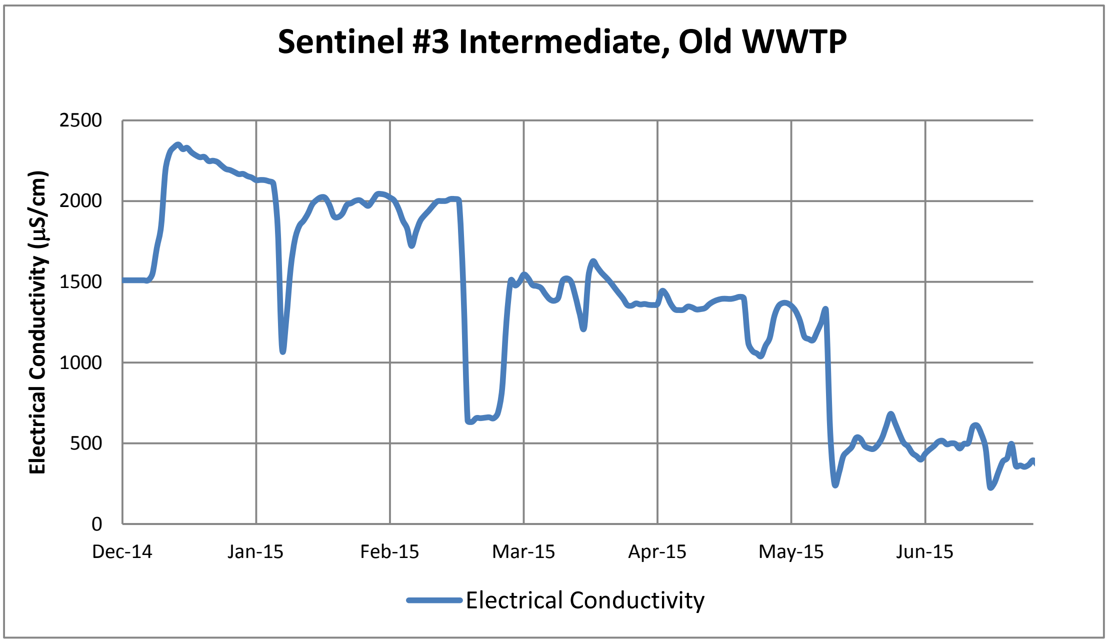



Figure C3.6: Electrical Conductivity in Sentinel #3 Intermediate Old WWTP Monitoring Bore (Bore ID tba)

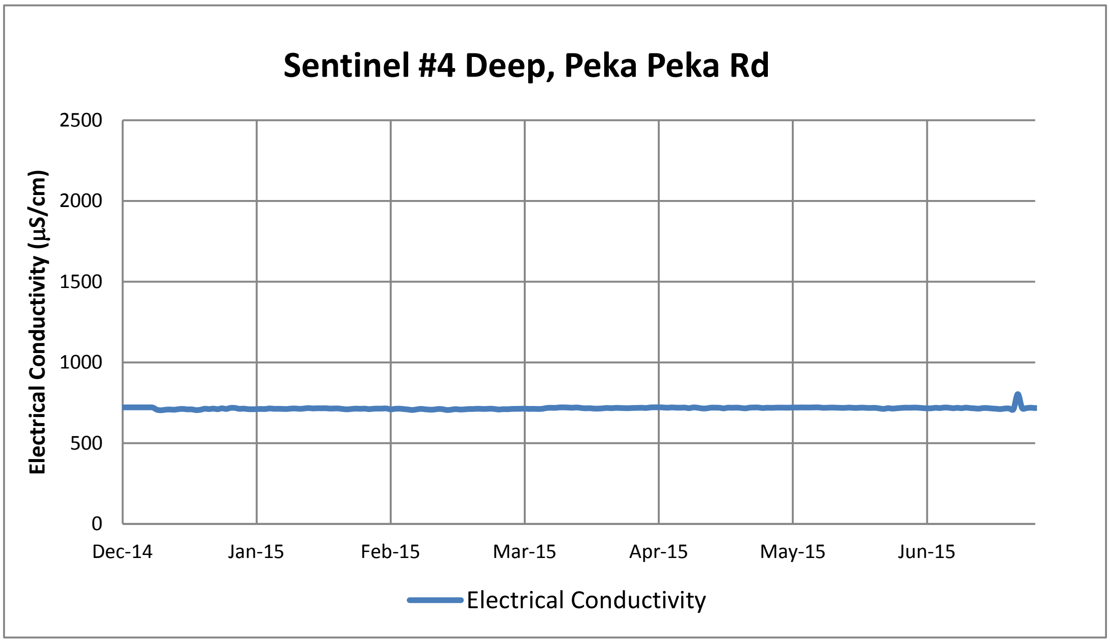



Figure C3.7: Electrical Conductivity in Sentinel #4 Deep Peka Peka Rd Monitoring Bore (Bore ID tba)

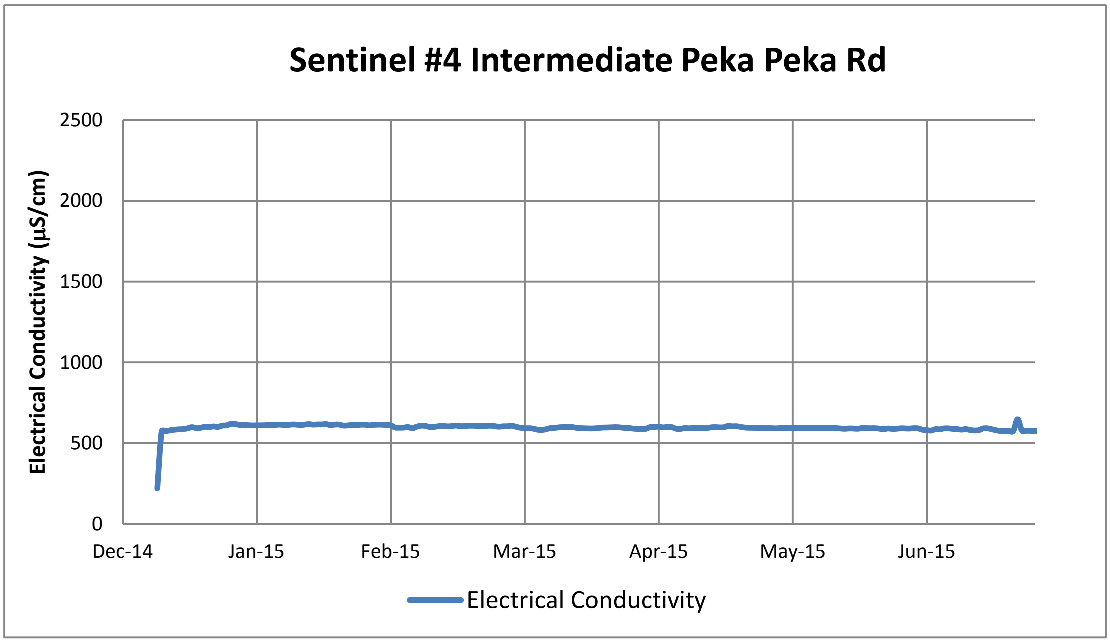



Figure C3.8: Electrical Conductivity in Sentinel #4 Intermediate Peka Peka Rd Monitoring Bore (Bore ID tba)

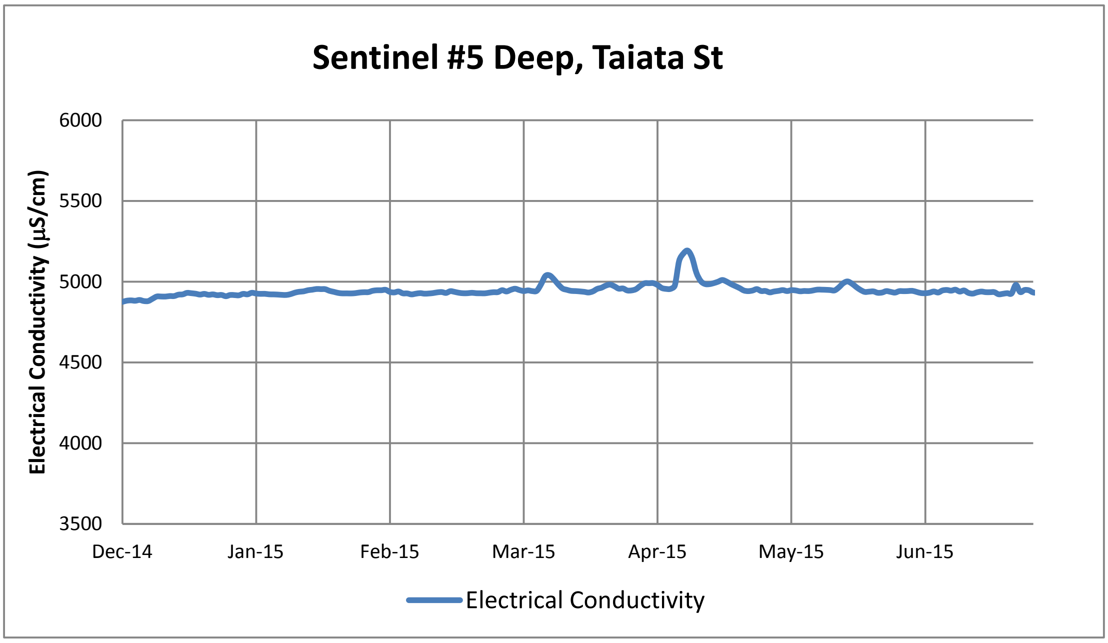



Figure C3.9: Electrical Conductivity in Sentinel #5 Deep Taiata St Monitoring Bore (Bore ID tba)

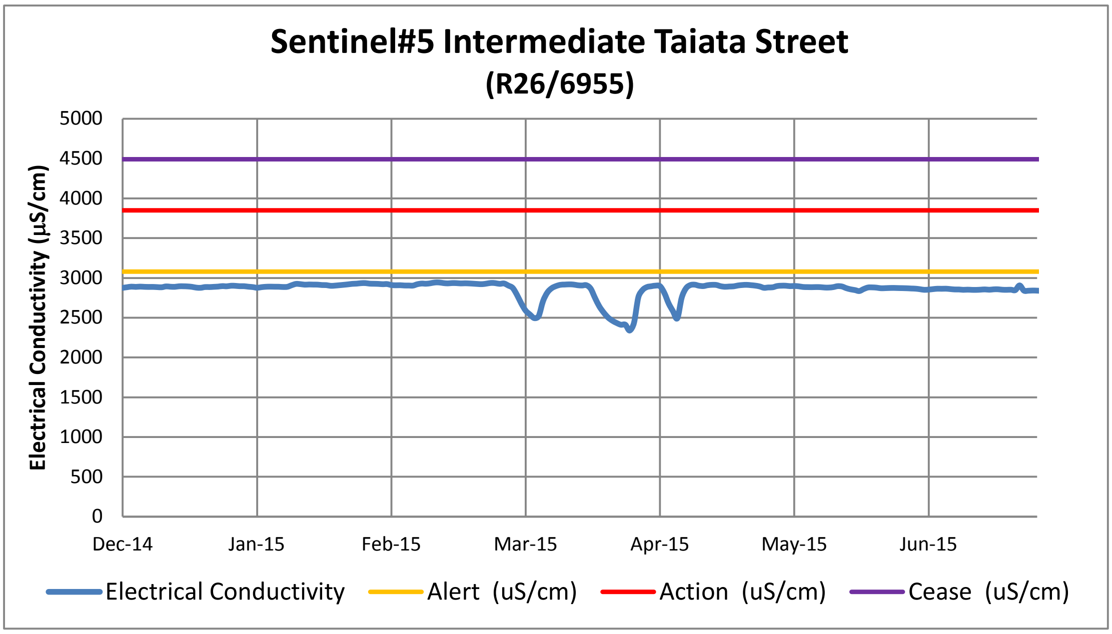



Figure C3.10: Electrical Conductivity in Sentinel #5 Intermediate Taiata St Monitoring Bore (Bore ID tba)

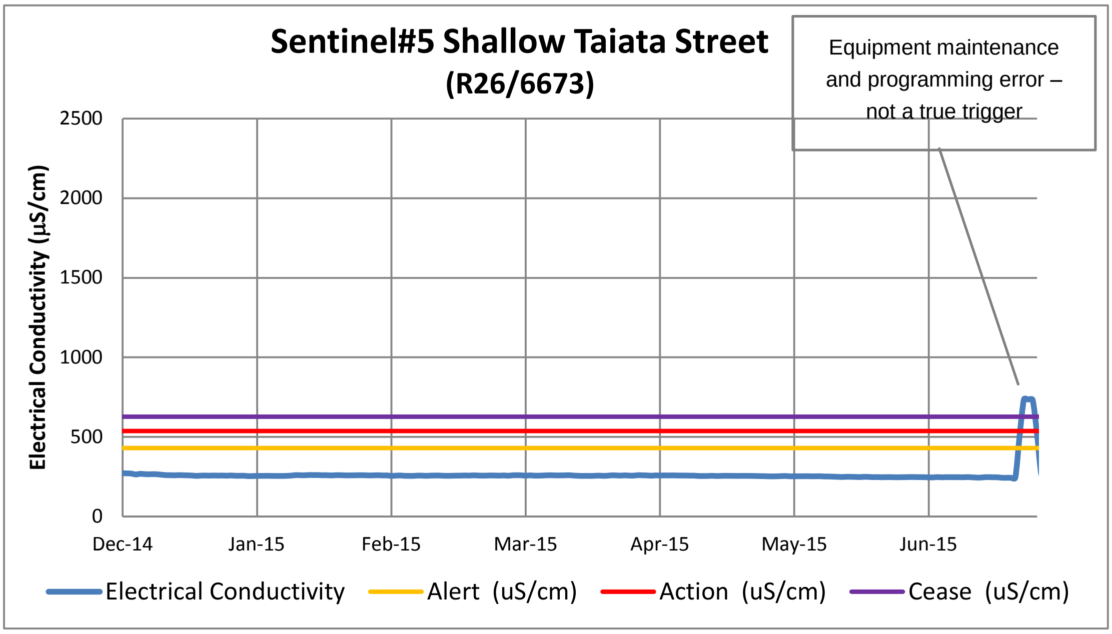



Figure C3.11: Electrical Conductivity in Sentinel #5 Shallow Taiata St Monitoring Bore (R26/6673). Spike in late June due to maintenance of equipment and incorrect programming of sensor.

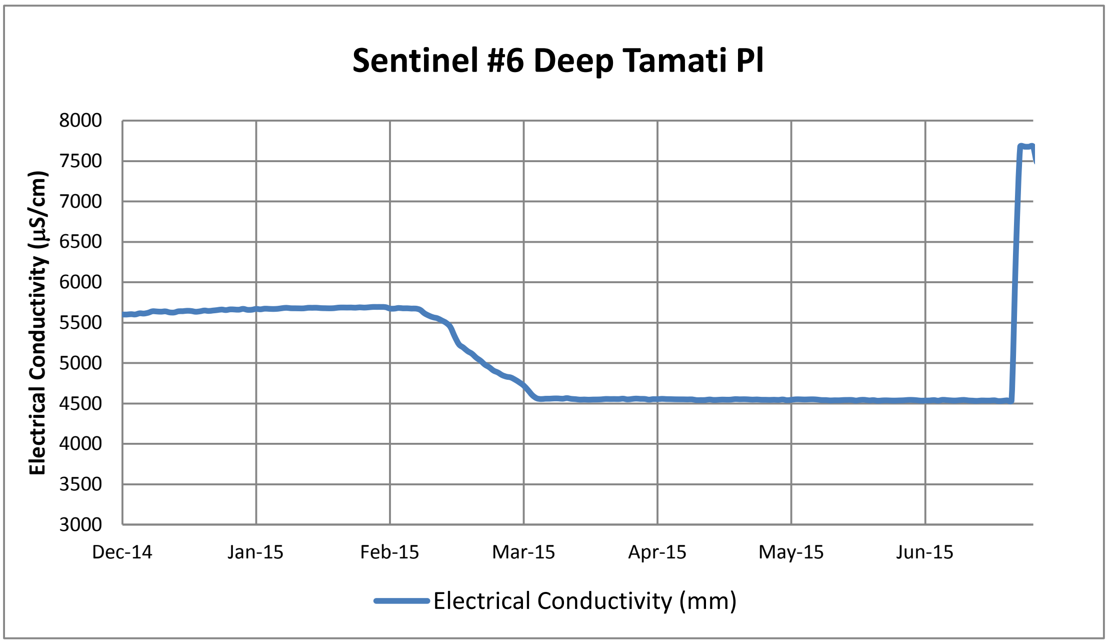



Figure C3.12: Electrical Conductivity in Sentinel #6 Deep Tamati Place Monitoring Bore (Bore ID tba). Issue with silt accumulation in well March to June 2015.

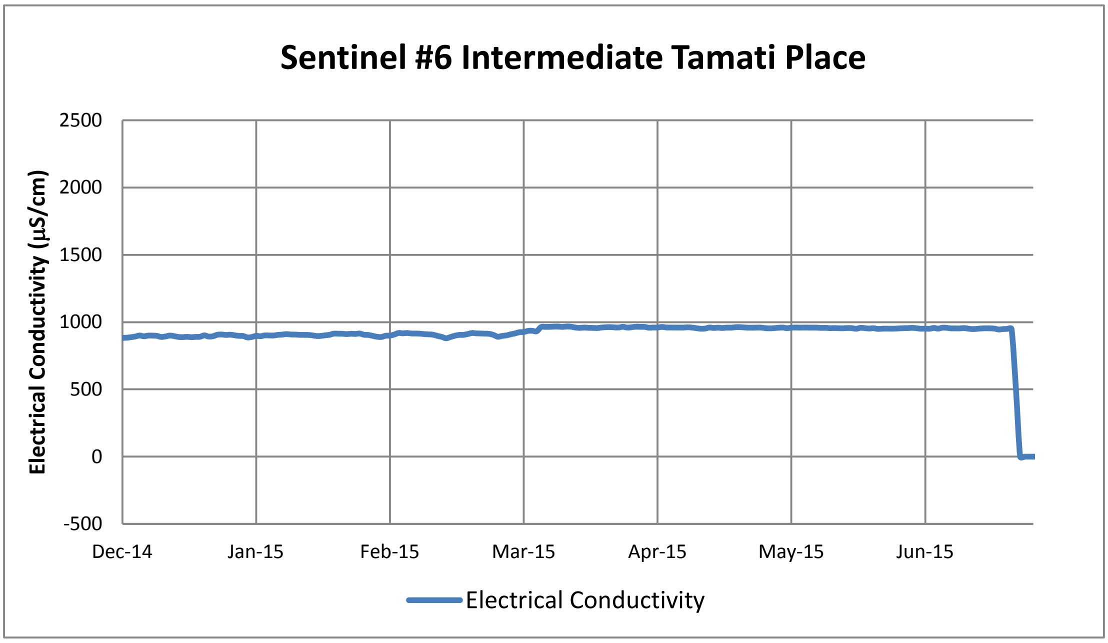



Figure C3.13: Electrical Conductivity in Sentinel #6 Intermediate Tamati Place Monitoring Bore (Bore ID tba). Issue with sensor operation March to June 2015. Sensor has subsequently been replaced.

Appendix D

# Bore Water Quality Summary

**Comments on following tables**

Laboratory detection limits, resource consent condition and water quality guideline values have been added to the following tables.

Note the ANZECC (2000) Guidelines are applicable to the receiving body of water (in this case the Waikanae River) rather than the bore water discharge. Although the bore water exceeds the guideline values for some parameters, once the groundwater enters the river and is diluted it is expected that the concentrations in the river will be acceptable.

The water from all bores meets the Drinking-water Guidelines for New Zealand 2005 (revised 2008) maximum acceptable values.

Table D.1 Bore Water Quality Summary (July 2014 to June 2015)

| Bore | | Temperature (field) (°C) | pH (field) - | pH (lab) - | Conductivity (field) mS/m | Conductivity (lab, @25°C) mS/m | Dissolved Oxygen (field) mg/l | Dissolved Oxygen (lab) g O2/m3 | Total (NP) Organic Carbon g/m3 | Alkalinity - Total g CaCO3/m3 | Total Dissolved Solids g/m3 | Bicarbonate g CaCO3/m3 | Free CO2 g CO2/m3 | Anion Sum meq/l | Cation Sum meq/l | Ion Balance % | Fluoride g/m3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Laboratory detection limit | | | | 0.1 | | 0.1 | 0.1 | 1 | 0.5 | 0.3 | 1 | 1 | 1 | 1 | 0.001 | 0.001 | 0.01 |
| Resource consent WGN130103 [33252] condition 7 | | n/a | 7.0 - 8.8 | 7.0 - 8.8 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Drinking-water Standards for New Zealand 2005 (revised 2008) | | n/a | 7.0-8.5 (GV) | 7.0-8.5 (GV) | n/a | n/a | n/a | n/a | n/a | n/a | 1000 (GV) | n/a | n/a | n/a | n/a | n/a | 1.5 |
| ANZECC 2000 Guidelines | 99% | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 95% | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| KB4 | Maximum | 16.7 | 7.7 | 7.8 | 104.2 | 122 | 0.46 | 1.2 | 0.5 | 204 | 673 | 203 | 40 | 11.0 | 10.6 | 14.3 | 0.04 |
| | Minimum | 14.8 | 7.2 | 7 | 87.5 | 107 | 0.08 | <0.5 | <0.3 | 187 | 589 | 186 | 6 | 7.3 | 9.72 | 0.3 | 0.03 |
| | Average | 15.3 | 7.5 | 7.7 | 92.8 | 113 | 0.20 | 0.8 | 0.3 | 194 | 619 | 193 | 11 | 9.6 | 10.1 | 3.61 | 0.03 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K4 | Maximum | 15.3 | 7.6 | 7.6 | 60.1 | 63 | 0.24 | 1.4 | 1.2 | 127 | 346 | 127 | 9 | 5.4 | 6.01 | 7.24 | 0.26 |
| | Minimum | 14.5 | 7.0 | 7.4 | 47.2 | 47 | 0.07 | <0.5 | 0.7 | 102 | 261 | 102 | 6 | 4.2 | 4.15 | 0.98 | 0.17 |
| | Average | 14.8 | 7.4 | 7.5 | 55.4 | 58 | 0.14 | 0.9 | 0.8 | 109 | 317 | 109 | 7 | 4.9 | 5.2 | 2.82 | 0.21 |
| | Number of Samples | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| K5 | Maximum | 15.5 | 8.0 | 8.1 | 100 | 107 | 0.40 | 8.8 | 0.7 | 248 | 589 | 245 | 6 | 9.64 | 11.2 | 11.5 | 0.11 |
| | Minimum | 15.4 | 7.6 | 7.9 | 70.4 | 101 | 0.05 | 0.6 | <0.3 | 194 | 554 | 192 | 4 | 8.4 | 9.2 | 0.34 | 0.04 |
| | Average | 15.5 | 7.9 | 8.0 | 90.8 | 104 | 0.17 | 1.5 | 0.5 | 223 | 573 | 220 | 4 | 9.0 | 9.6 | 3.25 | 0.06 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K6 | Maximum | 15.9 | 7.6 | 7.7 | 103.5 | 111 | 1.39 | 1.2 | 0.5 | 277 | 612 | 276 | 52 | 10 | 11.9 | 11.8 | 0.05 |
| | Minimum | 15.2 | 7.2 | 7 | 91.9 | 109 | 0.06 | 0.6 | <0.3 | 251 | 597 | 249 | 9 | 8.8 | 9.9 | 0.45 | 0.03 |
| | Average | 15.3 | 7.5 | 7.6 | 97.3 | 110 | 0.35 | 0.81 | 0.3 | 262 | 606 | 261 | 16 | 9.6 | 10.4 | 4.23 | 0.04 |
| | Number of Samples | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| K10 | Maximum | 15.1 | 7.4 | 7.7 | 63.4 | 80.5 | 0.65 | 1.1 | 0.3 | 208 | 443 | 207 | 11 | 6.75 | 7.59 | 6.02 | 0.03 |
| | Minimum | 14.8 | 7.4 | 7.6 | 61.3 | 80.2 | 0.09 | 0.9 | 0.3 | 205 | 441 | 204 | 9 | 6.7 | 7.5 | 5.07 | 0.03 |
| | Average | 15.0 | 7.4 | 7.7 | 62.4 | 80 | 0.37 | 1.00 | 0.3 | 207 | 442 | 206 | 10 | 6.7 | 7.5 | 5.55 | 0.03 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Kb7 | Maximum | 15.1 | 7.7 | 7.8 | 55.4 | 62.3 | 0.15 | 1 | 0.1 | 91 | 343 | 91 | 3 | 5.28 | 5.64 | 4.27 | 0.07 |
| | Minimum | 15.1 | 7.7 | 7.8 | 54.9 | 61.1 | 0.15 | 0.9 | 0.1 | 90 | 336 | 90 | 3 | 5.2 | 5.5 | 2.13 | 0.07 |
| | Average | 15.1 | 7.7 | 7.8 | 55.2 | 62 | 0.15 | 0.95 | 0.1 | 91 | 340 | 91 | 3 | 5.2 | 5.6 | 3.20 | 0.07 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| K12 | Maximum | 14.8 | 7.8 | 7.9 | 44.7 | 50.4 | 0.73 | 0.9 | 0.2 | 84 | 277 | 84 | 2 | 4.18 | 4.48 | 3.46 | 0.08 |
| | Minimum | 14.7 | 7.8 | 7.8 | 44 | 50.3 | 0.24 | 0.9 | 0.1 | 82 | 277 | 81 | 2 | 4.2 | 4.4 | 2.8 | 0.08 |
| | Average | 14.8 | 7.8 | 7.9 | 44.4 | 50 | 0.49 | 0.90 | 0.2 | 83 | 277 | 83 | 2 | 4.2 | 4.4 | 3.13 | 0.08 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| N2 | Maximum | 14.5 | 7.4 | 7.5 | 38.1 | 42.9 | 0.46 | 0.9 | 0.4 | 70 | 236 | 70 | 5 | 3.62 | 4.04 | 7.74 | 0.16 |
| | Minimum | 14.3 | 7.3 | 7.4 | 37.2 | 42.9 | 0.3 | 0.7 | 0.2 | 70 | 236 | 70 | 4 | 3.5 | 3.8 | 2.53 | 0.15 |
| | Average | 14.4 | 7.3 | 7.5 | 37.7 | 43 | 0.38 | 0.80 | 0.3 | 70 | 236 | 70 | 5 | 3.5 | 3.9 | 5.14 | 0.16 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River Sampling Dec 2014 to Apr 2015 (5 sites)** | Maximum | 20.70 | 7.90 | 8.2 | 30.0 | | 49.0 | | | | | | | | | | |
| | Minimum | 11.67 | 4.22 | 7.3 | 0.0 | | 0.00 | | | | | | | | | | |
| | Average | 16.3 | 7.02 | 7.6 | 9.5 | | 14.4 | | | | | | | | | | |
| | Number of Samples | 50 | 48 | 60 | 50 | | 50 | | | | | | | | | | |

| Bore | | Chloride g/m3 | Nitrite - Nitrogen g/m3 | Bromide g/m3 | Nitrate - Nitrogen g/m3 | Sulphate g/m3 | Ammonia Nitrogen g/m3 | Total Hardness gCaCO3/m3 | Boron - Dissolved g/m3 | Calcium - Dissolved g/m3 | Iron - Dissolved g/m3 | Magnesium - Dissolved g/m3 | Manganese - Dissolved g/m3 | Potassium - Dissolved g/m3 | Sodium - Dissolved g/m3 | Total Phosphorus g/m3 | Dissolved Reactive Phosphorus g/m3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Laboratory detection limit | | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 1 | 0.005 | 0.01 | 0.005 | 0.01 | 0.005 | 0.01 | 0.02 | 0.005 | 0.005 |
| Resource consent WGN130103 [33252] condition 7 | | n/a | n/a | n/a | n/a | n/a | 2 | n/a | 0.9 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Drinking-water Standards for New Zealand 2005 (revised 2008) | | 250 (GV) | 0.06 | n/a | 11.3 | 250 (GV) | n/a | 200 (GV) | 1.4 | n/a | 0.2 (GV) | n/a | 0.4 | n/a | 200 (GV) | n/a | n/a |
| ANZECC (2000) Guidelines | 99% protection | n/a | n/a | n/a | 4.9 | n/a | 0.32 | n/a | 0.09 | n/a | n/a | n/a | 1.2 | n/a | n/a | n/a | n/a |
| | 95% protection | n/a | n/a | n/a | 7.2 | n/a | 0.9 | n/a | 0.37 | n/a | n/a | n/a | 1.9 | n/a | n/a | n/a | n/a |
| KB4 | Maximum | 275 | 0.06 | 1.07 | <0.01 | 2.15 | 0.06 | 147 | 0.268 | 38.7 | 0.005 | 12.3 | 0.030 | 7.07 | 176 | 0.037 | 0.041 |
| | Minimum | 149 | <0.01 | 0.8 | <0.01 | 1.08 | 0.04 | 123 | 0.233 | 31.0 | <0.005 | 10.9 | 0.018 | 6.01 | 157 | 0.029 | 0.028 |
| | Average | 227 | 0.01 | 0.90 | <0.01 | 1.469 | 0.05 | 136 | 0.249 | 34.9 | <0.005 | 11.8 | 0.024 | 6.39 | 165.4 | 0.033 | 0.036 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K4 | Maximum | 113 | <0.01 | 0.42 | <0.01 | 19.10 | 0.02 | 38 | 0.105 | 5.5 | 0.02 | 6.0 | 0.183 | 2.01 | 121 | 0.105 | 0.104 |
| | Minimum | 75 | <0.01 | 0.14 | <0.01 | 12.9 | <0.01 | 25 | 0.063 | 3.7 | <0.005 | 3.9 | 0.128 | 1.67 | 82.9 | 0.092 | 0.074 |
| | Average | 99 | <0.01 | 0.35 | <0.01 | 16.16 | 0.01 | 32 | 0.095 | 4.6 | 0.011 | 5.1 | 0.161 | 1.81 | 102.5 | 0.098 | 0.093 |
| | Number of Samples | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| K5 | Maximum | 201 | 0.04 | 1.01 | <0.01 | 0.67 | 0.32 | 136 | 0.53 | 31.9 | 0.04 | 13.7 | 0.080 | 8.56 | 195 | 0.128 | 0.136 |
| | Minimum | 181 | <0.01 | 0.52 | <0.01 | 0.33 | 0.13 | 100 | 0.319 | 22.6 | 0.007 | 10.5 | 0.052 | 6.74 | 151 | 0.094 | 0.085 |
| | Average | 190 | <0.01 | 0.73 | <0.01 | 0.49 | 0.28 | 122 | 0.423 | 27.8 | 0.025 | 12.6 | 0.061 | 7.42 | 160 | 0.109 | 0.109 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K6 | Maximum | 196 | 0.03 | 0.78 | <0.01 | 0.84 | 0.4 | 148 | 0.683 | 35.2 | 0.005 | 15.3 | 0.1 | 9.51 | 202 | 0.08 | 0.073 |
| | Minimum | 163 | <0.01 | 0.58 | <0.01 | 0.34 | 0.33 | 137 | 0.58 | 31.1 | <0.005 | 14.3 | 0.07 | 8.35 | 156 | 0.064 | 0.054 |
| | Average | 186 | <0.01 | 0.72 | <0.01 | 0.55 | 0.37 | 143 | 0.627 | 33.1 | <0.005 | 14.6 | 0.078 | 9.10 | 168 | 0.074 | 0.066 |
| | Number of Samples | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| K10 | Maximum | 119 | <0.01 | 0.51 | <0.01 | <0.02 | 0.22 | 182 | 0.202 | 49.9 | 0.011 | 13.8 | 0.187 | 7.40 | 90.5 | 0.057 | 0.037 |
| | Minimum | 119 | <0.01 | 0.46 | <0.01 | <0.02 | 0.21 | 167 | 0.141 | 46.3 | 0.009 | 12.4 | 0.157 | 7.27 | 86.4 | 0.05 | 0.035 |
| | Average | 119 | <0.01 | 0.49 | <0.01 | <0.02 | 0.22 | 175 | 0.172 | 48.1 | 0.01 | 13.1 | 0.172 | 7.34 | 88 | 0.054 | 0.036 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Kb7 | Maximum | 122 | <0.01 | 0.4 | <0.01 | 14.5 | <0.01 | 65 | 0.555 | 13.1 | 0.024 | 7.8 | 0.015 | 2.64 | 98.3 | 0.03 | 0.034 |
| | Minimum | 119 | <0.01 | 0.36 | <0.01 | 14.10 | <0.01 | 62 | 0.519 | 12.7 | 0.022 | 7.31 | 0.015 | 2.58 | 96.7 | 0.03 | 0.026 |
| | Average | 121 | <0.01 | 0.38 | <0.01 | 14.30 | <0.01 | 64 | 0.537 | 12.9 | 0.023 | 7.6 | 0.015 | 2.61 | 98 | 0.030 | 0.030 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| K12 | Maximum | 88.7 | <0.01 | 0.29 | <0.01 | 15.3 | 0.01 | 78 | 0.427 | 18 | <0.005 | 8.31 | 0.052 | 1.96 | 65.9 | 0.042 | 0.048 |
| | Minimum | 86.3 | <0.01 | 0.27 | <0.01 | 15.00 | 0.01 | 78 | 0.396 | 17.6 | <0.005 | 7.92 | 0.049 | 1.92 | 64.4 | 0.042 | 0.044 |
| | Average | 88 | <0.01 | 0.28 | <0.01 | 15.15 | 0.01 | 78 | 0.412 | 17.8 | <0.005 | 8.1 | 0.051 | 1.94 | 65 | 0.042 | 0.046 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| N2 | Maximum | 72.6 | <0.01 | 0.24 | <0.01 | 20.2 | 0.05 | 100 | 0.095 | 28.5 | 0.005 | 7.7 | 0.098 | 3.12 | 43.6 | 0.122 | 0.124 |
| | Minimum | 67.3 | <0.01 | 0.22 | <0.01 | 19.50 | 0.05 | 96 | 0.059 | 26.7 | <0.005 | 7.21 | 0.088 | 2.9 | 41.5 | 0.119 | 0.124 |
| | Average | 70 | <0.01 | 0.23 | <0.01 | 19.85 | 0.05 | 98 | 0.077 | 27.6 | <0.005 | 7.5 | 0.093 | 3.01 | 43 | 0.121 | 0.124 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River Sampling Dec 2014 to Apr 2015 (5 sites)** | Maximum | | | | | | <0.01 | | | 6.29 | | | | | | 0.020 | 0.014 |
| | Minimum | | | | | | <0.01 | | | 4.72 | | | | | | 0.008 | 0.005 |
| | Average | | | | | | <0.01 | | | 5.59 | | | | | | 0.012 | 0.010 |
| | Number of Samples | | | | | | 60 | | | 60 | | | | | | 60 | 60 |

| Bore | | Total Nitrogen g/m3 | Arsenic - Dissolved g/m3 | Cadmium - Dissolved g/m3 | Chromium - Dissolved g/m3 | Copper - Dissolved g/m3 | Lead - Dissolved g/m3 | Nickel - Dissolved g/m3 | Zinc - Dissolved g/m3 |
|---|---|---|---|---|---|---|---|---|---|
| Laboratory detection limit | | 0.05 | 0.001 | 0.0002 | 0.001 | 0.0005 | 0.0005 | 0.0005 | 0.002 |
| Resource consent WGN130103 [33252] condition 7 | | n/a | 0.03 | 0.0005 | 0.0022 | 0.0033 | n/a | n/a | 0.018 |
| Drinking-water Standards for New Zealand 2005 (revised 2008) | | n/a | 0.01 | 0.004 | 0.05 | 2 | 0.01 | 0.08 | 1.5 (GV) |
| ANZECC 2000 Guidelines | 99% protection | n/a | 0.001 (As III) 0.0008 (As V) | 0.00006 | 0.00001 | 0.001 | 0.001 | 0.008 | 0.0024 |
| | 95% protection | n/a | 0.024 (As III) 0.013 (As V) | 0.0002 | 0.001 | 0.0014 | 0.0034 | 0.011 | 0.008 |
| KB4 | Maximum | 0.08 | <0.001 | <0.0002 | <0.001 | 0.0025 | <0.0005 | <0.0005 | 0.010 |
| | Minimum | <0.05 | <0.001 | <0.0002 | <0.001 | <0.0005 | <0.0005 | <0.0005 | 0.004 |
| | Average | 0.06 | <0.001 | <0.0002 | <0.001 | 0.0009 | <0.0005 | <0.0005 | 0.006 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K4 | Maximum | 0.06 | 0.007 | <0.0002 | 0.002 | 0.0025 | <0.0005 | <0.0005 | 0.010 |
| | Minimum | <0.05 | <0.001 | <0.0002 | <0.001 | <0.0005 | <0.0005 | <0.0005 | 0.003 |
| | Average | <0.05 | <0.001 | <0.0002 | 0.0006 | 0.0008 | <0.0005 | <0.0005 | 0.006 |
| | Number of Samples | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| K5 | Maximum | 0.34 | 0.001 | 0.0001 | <0.001 | 0.0025 | <0.0005 | <0.0005 | 0.007 |
| | Minimum | 0.26 | <0.001 | <0.0002 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.002 |
| | Average | 0.31 | 0.001 | <0.0002 | <0.001 | 0.0007 | <0.0005 | <0.0005 | 0.002 |
| | Number of Samples | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| K6 | Maximum | 0.43 | 0.001 | <0.0002 | <0.001 | 0.0053 | <0.0005 | 0.0011 | 0.018 |
| | Minimum | 0.33 | <0.001 | <0.0002 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.002 |
| | Average | 0.387 | <0.001 | <0.0002 | <0.001 | 0.0018 | <0.0005 | <0.0005 | 0.009 |
| | Number of Samples | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| K10 | Maximum | 0.23 | 0.001 | <0.0002 | <0.0002 | 0.0119 | <0.0005 | <0.0005 | 0.028 |
| | Minimum | 0.22 | 0.001 | <0.0002 | <0.0002 | 0.002 | <0.0005 | <0.0005 | 0.01 |
| | Average | 0.225 | 0.001 | <0.0002 | <0.0002 | 0.0070 | <0.0005 | <0.0005 | 0.019 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Kb7 | Maximum | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.005 |
| | Minimum | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.002 |
| | Average | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.004 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| K12 | Maximum | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.004 |
| | Minimum | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.003 |
| | Average | <0.05 | <0.001 | <0.0002 | <0.0002 | <0.0005 | <0.0005 | <0.0005 | 0.004 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| N2 | Maximum | 0.05 | <0.001 | <0.0002 | <0.0002 | 0.0034 | <0.0005 | <0.0005 | 0.016 |
| | Minimum | <0.05 | <0.001 | <0.0002 | <0.0002 | 0.0006 | <0.0005 | <0.0005 | 0.008 |
| | Average | <0.05 | <0.001 | <0.0002 | <0.0002 | 0.0020 | <0.0005 | <0.0005 | 0.012 |
| | Number of Samples | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **River Sampling Dec 2014 to Apr 2015 (5 sites)** | Maximum | 0.9 | | | | | | | |
| | Minimum | 0.09 | | | | | | | |
| | Average | 0.20 | | | | | | | |
| | Number of Samples | 60 | | | | | | | |

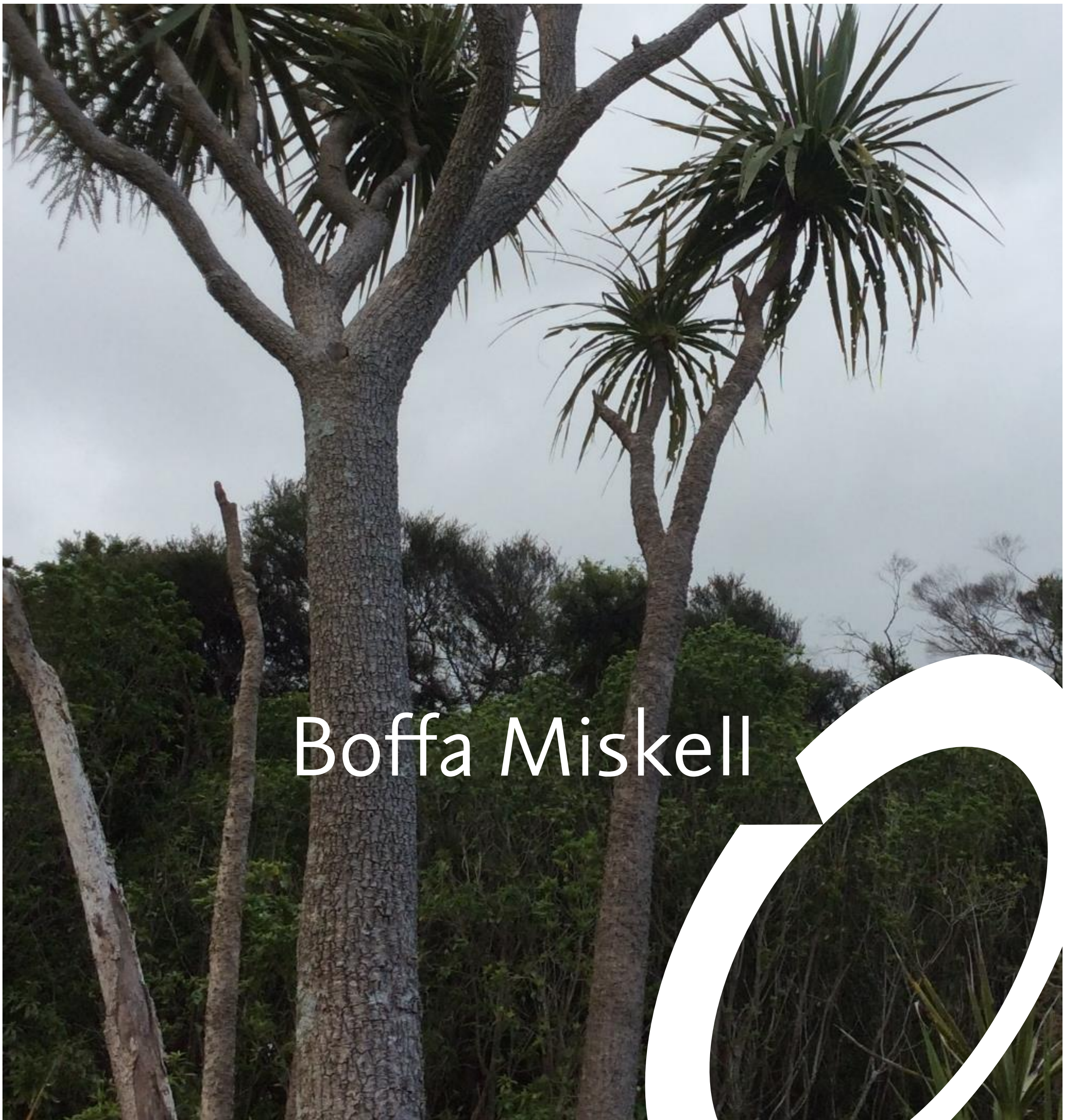
Appendix E

# Wetlands Baseline Monitoring Annual Report 2014/15

# Wetland Baseline Monitoring Annual Report

A report on 2014/15 data collection for water permit
WGN130103[33250]
Prepared for Kapiti Coast District Council

15 September 2015



Document Quality Assurance

| | | |
|---|---|---|
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| Prepared by: | Tessa Roberts<br>Ecologist<br>Boffa Miskell Limited | |
| Reviewed by: | Dr Vaughan Keesing<br>Senior Ecologist<br>Boffa Miskell Limited | |
| Status: Final | Revision D | Issue date: 15 September 2015 |
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*Cover photograph:* Cabbage Tree at Otaihanga © Boffa Miskell, 2015

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# Appendices

Appendix 1 Raw data sheets

Appendix 2: Photo points.

# 1. Introduction

There are thirteen wetlands being monitored on the Kapiti coast associated with the Kapiti Coast District Council (KCDC) consents River Recharge with Groundwater project (RRwGW). The monitoring is being carried out in accordance with the approved wetland baseline monitoring plan (WBMP) under consent WGN 130103[33250] condition 29.

The purpose of the baseline monitoring is to gather information that will form the pre- activity measures of the wetlands condition and variability in the absence of the predicted effect.

The wetlands are as follows (wetlands are shown on Figure 1):

1. Muaupoko Swamp Forest
2. Nga Manu Wetland
3. Te Hapua Swamp Complex A
4. Te Hapua Swamp Complex D
5. Te Harakeke / Kawakahia Wetland
6. El Rancho Wetland (Weggery)
7. Peka Peka Road Swamp
8. Tini Bush Wetland
9. Ngarara Bush Wetland
10. Ngarara Wetland
11. Otaihanga Southern Wetland
12. Crown Hill Manuka Bush Wetland
13. Poplar Ave Wetland

The baseline monitoring comprises:

- Water level piezometer monitoring;
- Wetland condition monitoring, including photo points and set RECCE plots;
- High resolution aerial photography and vegetation mapping.

This report details the results of the first year of three baseline monitoring years and is required to present:

- Details of the results of Wetland Condition Monitoring as prescribed in the Wetland Condition Monitoring Sheets (Clarkson et al., 2004), including photographs of fixed photo-points and botanical survey information for each wetland.
- A detailed A3 high-resolution aerial photograph of the full extent of each monitored wetland, with the vegetation communities within the wetland and immediately adjacent mapped as per Atkinson (1985).
- Updated information of fauna presence, based on observations during Wetland Condition Monitoring and botanical survey work (and any other known information).
- Updated information on wetland classification as per Johnson and Gerbeaux (2004).

- Details of monthly water levels from each of the dataloggers in each of the water level piezometers.

These areas will be covered site by site in the following report, except for wetland condition indices (Section 3.1) and wetland class (Section 4 page 47) which are covered by one table addressing all sites.

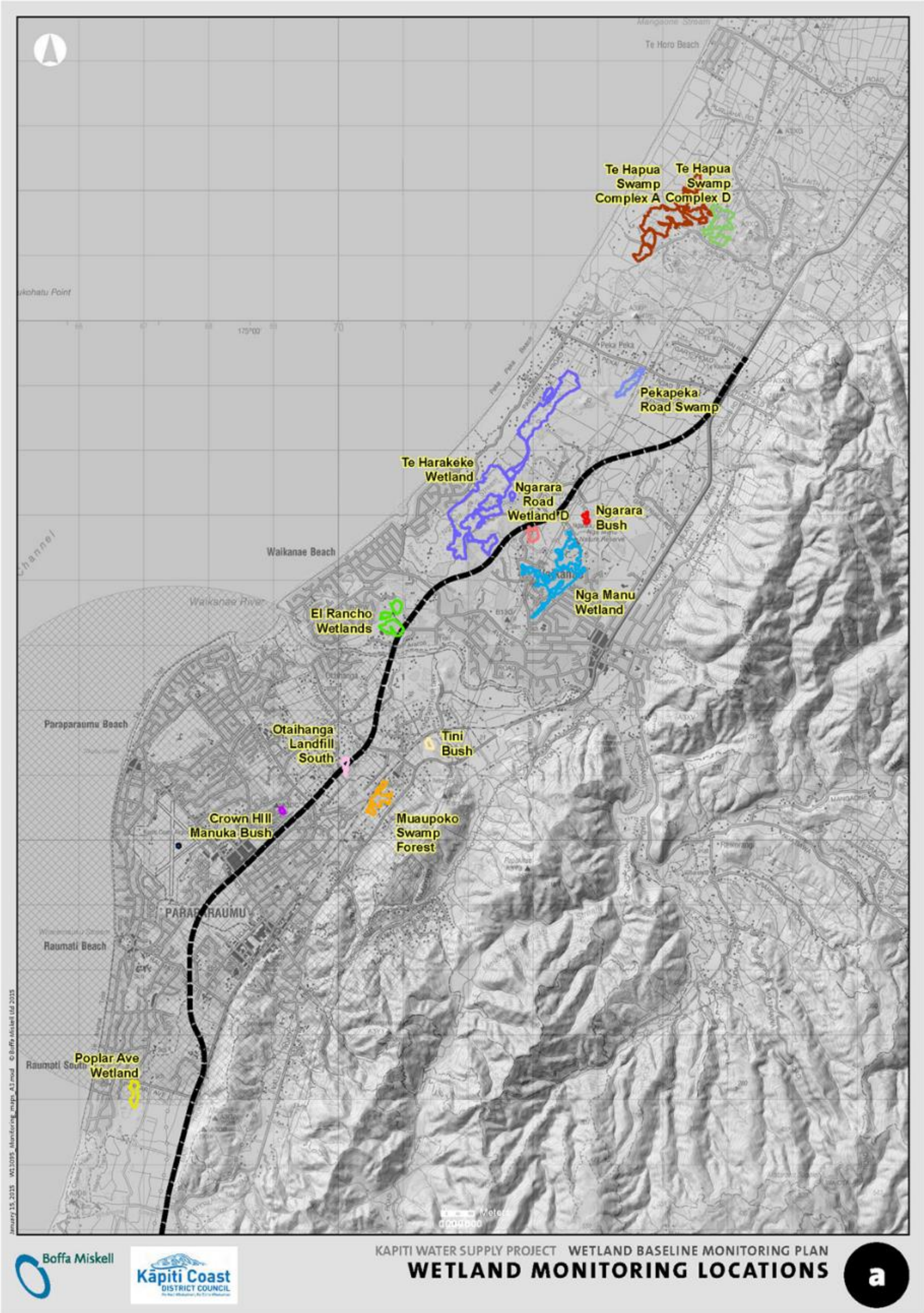



*Figure 1. Monitored wetland locations*

# 2. Methods

The monitoring methods are set out in the Wetland BMP and follow (Clarkson et al., 2004). In February 2015 two monitoring plots were established in each of the monitored wetlands and the species and condition measures made.  Plots targeted representative vegetation communities that boarded most obvious wet to dry ecotone. Photo points where established and staked for future reference.

The Aerial photography was undertaken in March 2015 using a DJI Phantom drone with 12Mp camera and the photos stitched together to form the aerial using Pix4D mapping.

The weather preceding the surveys was exceptionally dry, with the driest January on record for Paraparaumu with only 2mm of rain (NIWA, 2015).

The wetland condition monitoring and analysis were carried out by BML Staff and Pat Enright, a local botanist, with soil and plant leaf samples sent to Hills Laboratory for processing.

With regard to the piezometers, in mid-November Council installed hired logging equipment for water level piezometer monitoring in Muaupoko Swamp Forest, Peka Peka Rd Swamp, Crown Hill Manuka Bush, and Poplar Ave Wetland. In early February the hired equipment was replaced with new Council owned equipment.

There were some initial “teething” issues with re-starting the logger following data downloading at the beginning of March 2015.This was not discovered until the next down load period (beginning of April). This has resulted in a data gap for March (6$^{th}$ March to 8$^{th}$ April). While this loss of data in undesirable it has little effect long term on the baseline data and data is available for the other nine wetland sites.

# 3. Results

## 3.1 Wetland Condition Indices

Four elements make up the wetland condition monitoring system and the results of these are summarised below (Table 1).

The wetland condition index uses hydrological integrity, physio-chemical parameters, fire, intactness, dominance of native species, as sub-indices.

The *wetland pressure index* uses assessments of modification, water quality, animal access, and weed presence sub-indices. These indices are applied to the entire wetland (not to each plot).

The third index set is the “*Indicator score”* and this uses canopy cover, understory and species “health” sub-indices. This index is scored on permanent plot basis.

The scores established are out of a total possible of 25 for condition, 30 for pressure and 20 for plot indices. These scores set the basis for the wetland monitoring programme.

*Table 1 Baseline wetland condition indices results for each monitored wetland*

| Wetland | Condition index | Pressure index | Indicator index plot 1 | Indicator index plot 2 |
|---|---|---|---|---|
| Muaupoko Swamp Forest | 20.6 | 16 | 20 | 20 |
| Nga Manu Wetland | 20.2 | 12 | 18 | 19 |
| Te Hapua Swamp Complex A | 18.75 | 18 | 9 | 15 |
| Te Hapua Swamp Complex D | 20.7 | 20 | 17 | 20 |
| Te Harakeke / Kawakahia Wetland | 16.8 | 7 | 16 | 12 |
| El Rancho Wetland (Weggery) | 18 | 15 | 17 | 17 |
| Peka Peka Road Swamp | 19.6 | 15 | 20 | 18 |
| Tini Bush Wetland | 19.7 | 15 | 20 | 18 |
| Ngarara Bush Wetland | 17.9 | 17 | 19 | 17 |
| Ngarara Wetland | 15.4 | 18 | 18 | 12 |
| Otaihanga Southern Wetland | 14.2 | 24 | 12 | 17 |
| Crown Hill Manuka Bush Wetland | 16.7 | 16 | 19 | 19 |
| Poplar Ave Wetland | 19 | 14 | 17 | 18 |

Each of the monitored wetlands are further discussed below in respect to their baseline vegetation communities, fauna present and piezometer records.

## 3.2 Muaupoko Swamp Forest

### 3.2.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

Table 2 summarises the plot vegetation species presence and cover data.

Plot 1 is a wetland forest with pukatea, nikau and *Freycinetia banksii*; Plot 2 is a coastal wetland forest with swamp maire, ngaio and broadleaf over hen and chicken fern.

*Table 2 Summary vegetation plot statistics (Muaupoko swamp forest).*

| Parameters | Plot 1 (southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 107% | 90% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 10% | 76% |
| Proportion of lower tiers exotic | 0% | 0% |
| Proportion of lower tiers native | 100% | 100% |
| Total no. spp | 10 | 8 |
| No. exotic spp | 0 | 0 |
| No. native spp | 10 | 8 |
| % native | 100% | 100% |

### 3.2.2 Vegetation community map

The aerial was used (with field survey) to allocate dominant wetland and wetland edge vegetation types showing the "communities" present around the monitoring plots. The resultant map is presented as Figure 2.

The community boundaries are indicative only. They change seasonally to a small degree but where hydrology is stable the boundaries should also be relatively stable.

### 3.2.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.2.4 Wetland fauna

Kereru were observed during the 2014/15 survey.


*Figure 2: Local wetland vegetation communities at Muaupoko Swamp forest with position of permanent monitoring plots and photopoints (March 2015 aerial photograph).*

### 3.2.5 Piezometer records

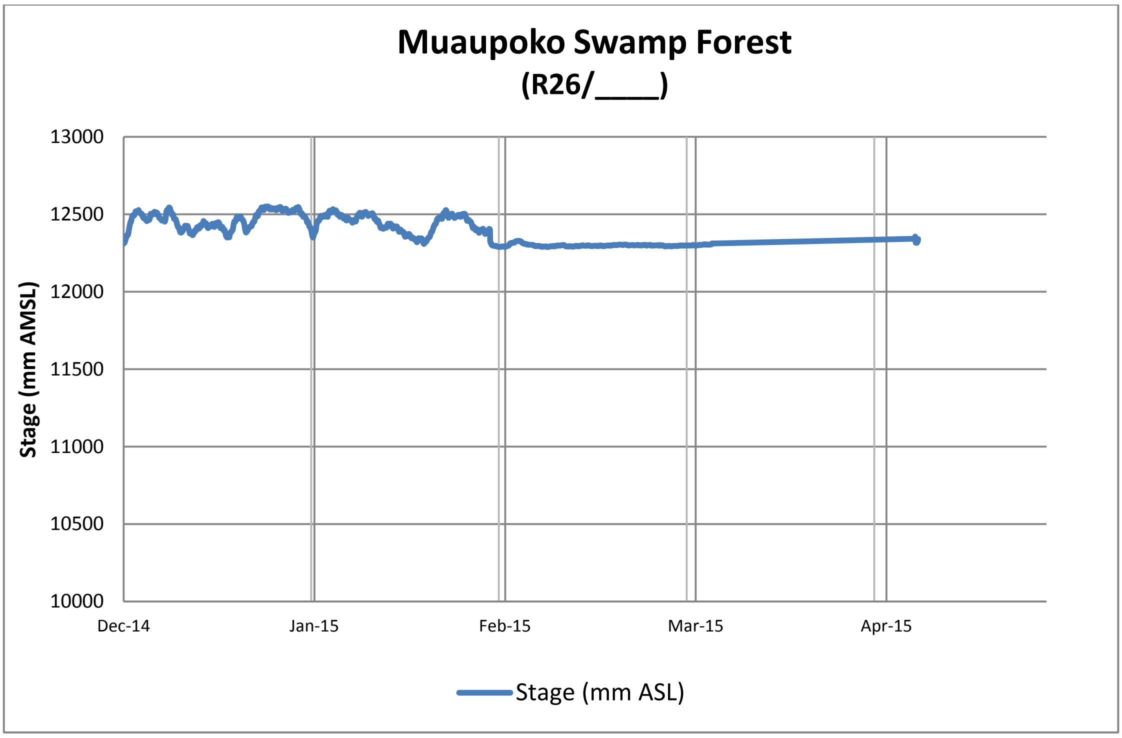



*Figure 3: Shallow groundwater levels for Muaupoko swamp forest during the monitoring period of December 2014 to April 2015*

## 3.3 Nga Manu Wetland

### 3.3.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

There are several wetland types present, but the dominant classes are carex sedgeland and flaxland-wet shrubland.

Table 3 summarises the plot vegetation species presence and cover data.

Plot 1 is a flaxland fen with wetland shrubs; Plot 2 is a sedge/grassland fen with a dominance of *Carex virgata*, and bracken*.*

*Table 3. Summary vegetation plot statistics (Nga Manu)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 72% | 12% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 29% | 83% |
| Proportion of lower tiers exotic | 5% | 1% |
| Proportion of lower tiers native | 95% | 99% |
| Total no. spp | 17 | 8 |
| no. exotic spp | 1 | 1 |
| no. native spp | 16 | 7 |
| % native | 94% | 88% |

### 3.3.2 Vegetation community map

The resultant map is presented as Figure 4. Note the community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

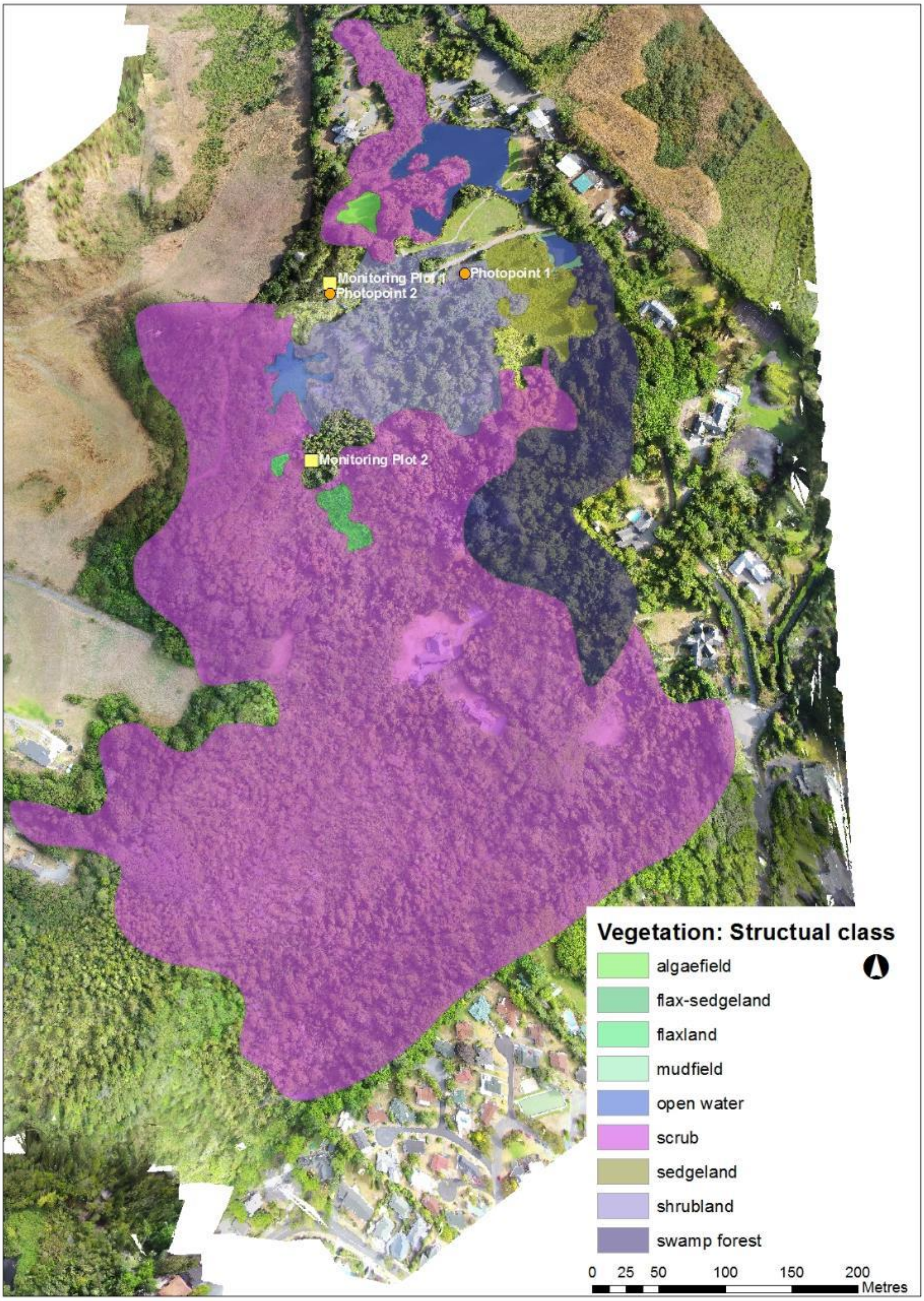



*Figure 4. Local wetland vegetation communities of Nga Manu wetland over the March 2015 aerial photograph.*

### 3.3.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.3.4 Wetland fauna

Tui, kereru and a large number of waterfowl were observed at the site.

### 3.3.5 Piezometer records

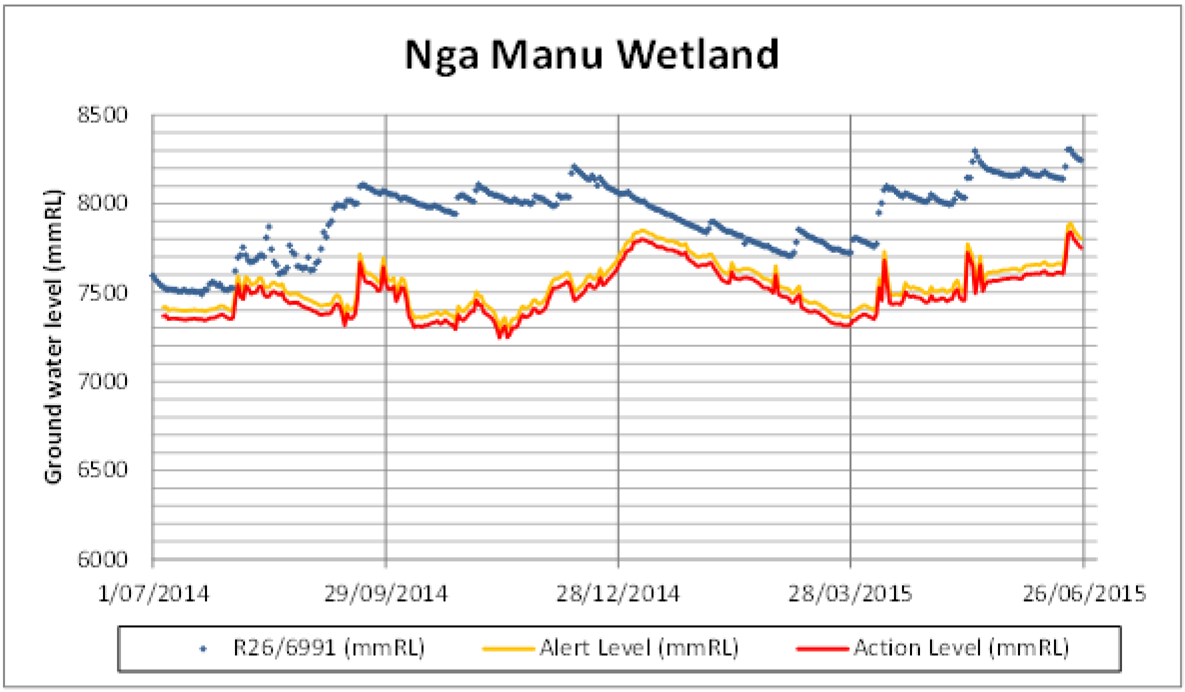



*Figure 5: Shallow groundwater levels for Nga Manu wetland during the 2014/15 reporting period.*

## 3.4 Te Hapua Swamp Complex A

### 3.4.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

The wetland is largely a wet reed and sedgeland with *Isolepis* and *Carex-Juncus* and bracken.

Table 4 summarises the plot vegetation species presence and cover data.

Plot 1 is an *Isolepis* reedland. Plot 2 is a *Juncus* reedland with exotic weeds.

*Table 4 Summary vegetation plot statistics (Te Hapua Swamp Complex A)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 0% | 44% |
| Proportion of canopy exotic | 0% | 25% |
| % cover canopy native | 0% | 75% |
| Total cover other tiers (%) | 100% | 68% |
| Proportion of lower tiers exotic | 30% | 2% |
| Proportion of lower tiers native | 70% | 98% |
| Total no. spp | 9 | 12 |
| No. exotic spp | 4 | 4 |
| No. native spp | 5 | 8 |
| % native | 55.5% | 66.6% |

### 3.4.2 Vegetation community map

The resultant map is presented as Figure 6.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

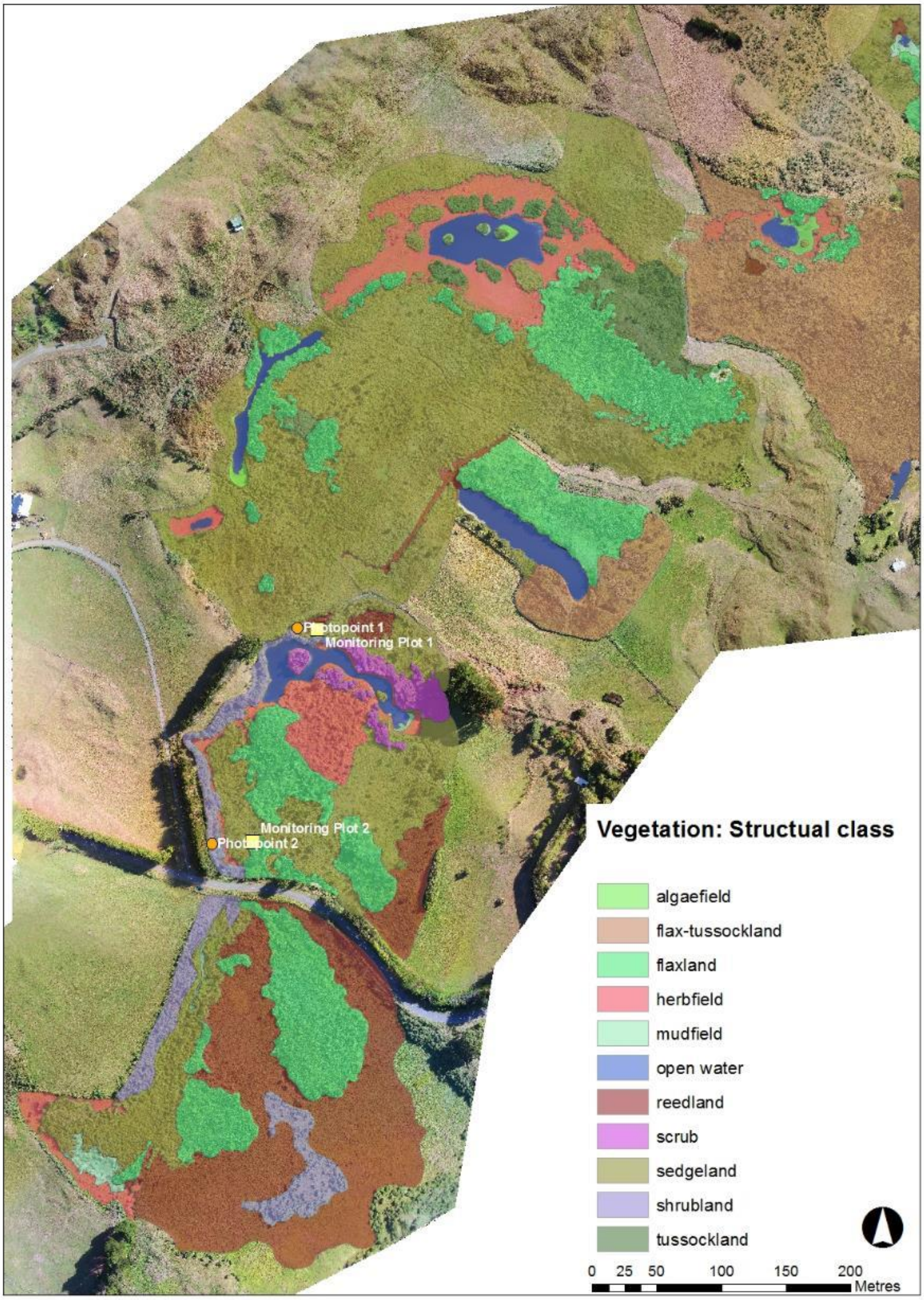



*Figure 6. Local wetland vegetation communities of Te Hapua Swamp Complex A over the March 2015 aerial photograph.*

### 3.4.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.4.4 Wetland fauna

No fauna were observed during the vegetation surveys.

### 3.4.5 Piezometer records

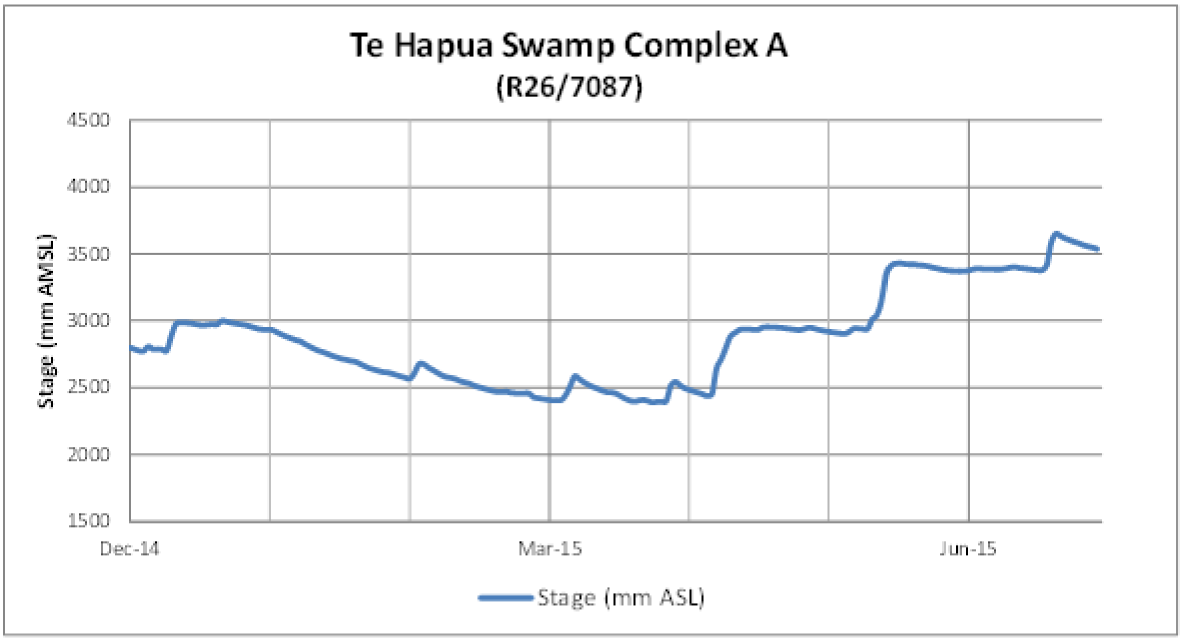



*Figure 7: Shallow groundwater levels for Te Hapua Swamp Complex A during the 2014/15 reporting period.*

## 3.5 Te Hapua Swamp Complex D

### 3.5.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

There are several wetland types present, ranging from carex sedgeland fen, raupo swamp, to harakeke semi-swamp.

Table 5 summarises the plot vegetation species presence and cover data.

Plot 1 and 2 are a sedgelands with a dominance of *Carex geminate.*

*Table 5 Summary vegetation plot statistics (Te Hapua Swamp Complex D)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 87% | 105% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 17% | 0% |
| Proportion of lower tiers exotic | 100% | 0% |
| Proportion of lower tiers native | 0% | 0% |
| Total no. spp | 5 | 2 |
| No. exotic spp | 2 | 0 |
| No. native spp | 3 | 2 |
| % native | 60% | 100% |

### 3.5.2 Vegetation community map

The resultant map is presented as Figure 8.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

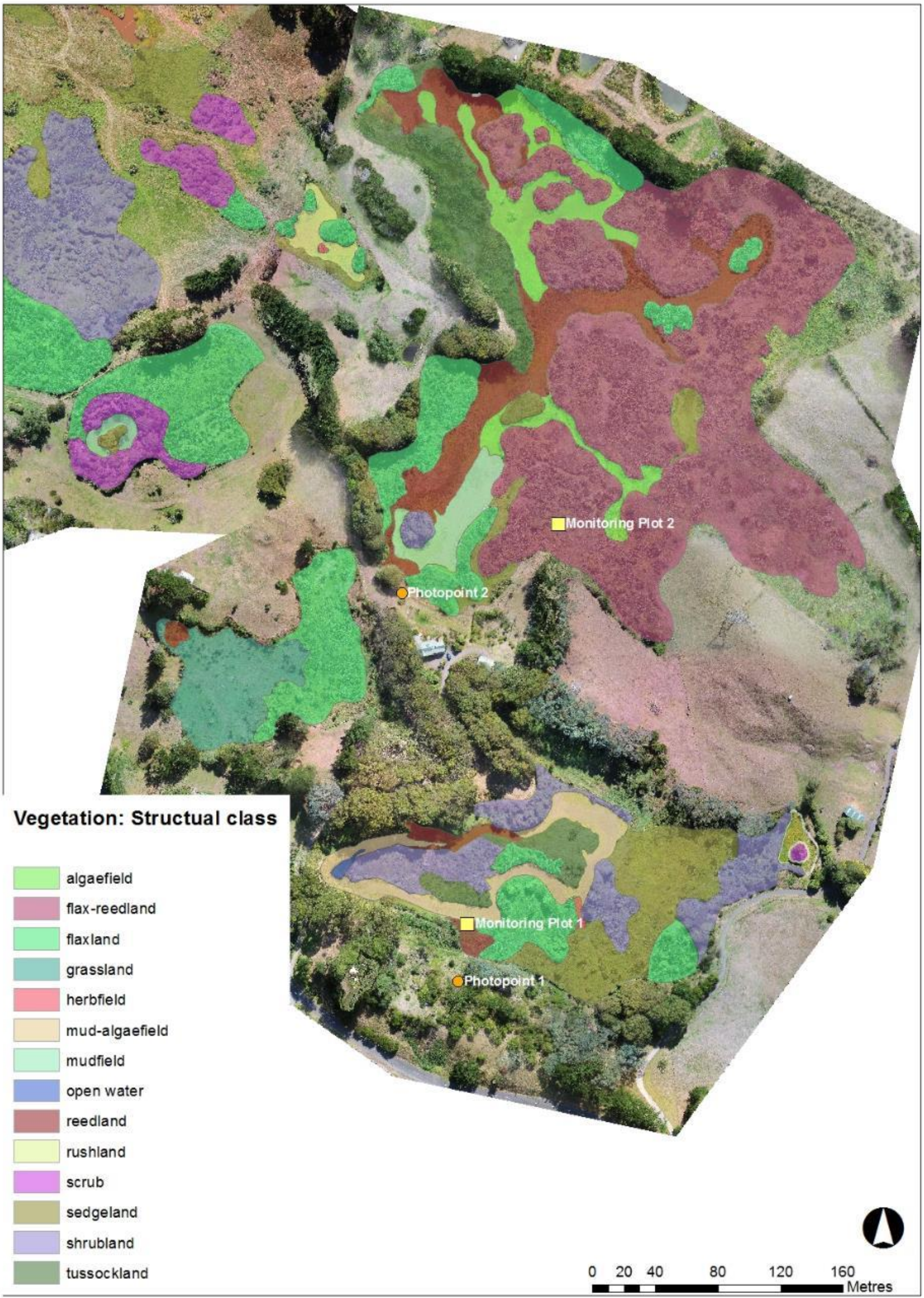



*Figure 8. Local wetland vegetation communities of Te Hapua Swamp Complex D over the March 2015 aerial photograph.*

### 3.5.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.5.4 Wetland fauna

Native harrier hawk and pukeko were observed on site. Royal spoonbill, also native, was reported as present by the land owner.

### 3.5.5 Piezometer records

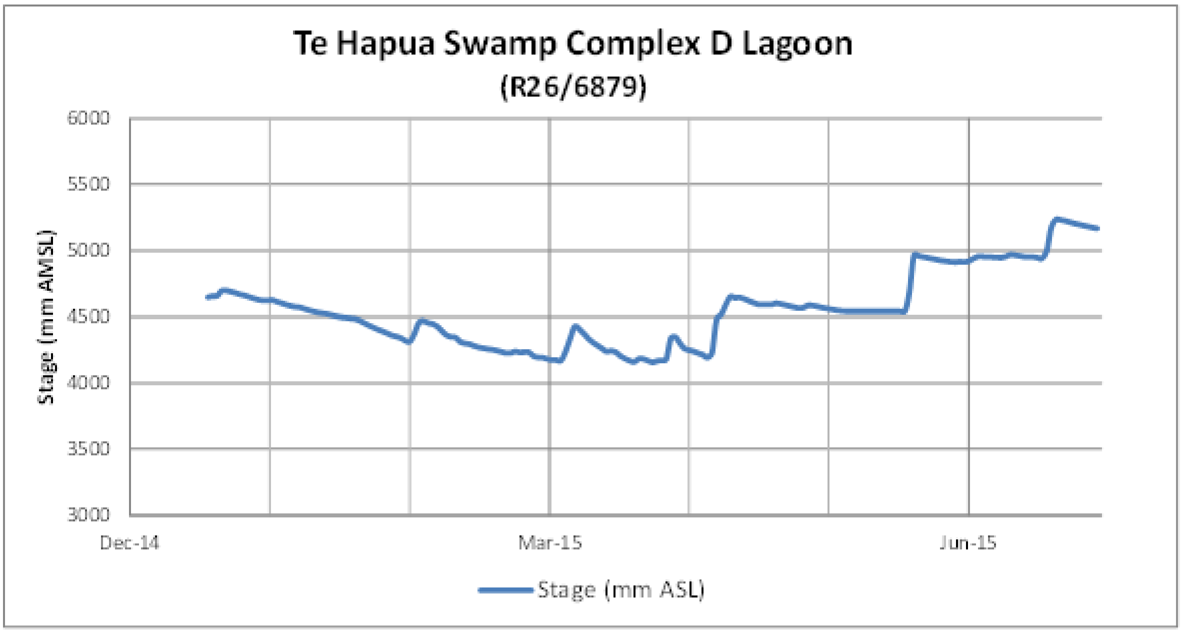



*Figure 9: Shallow groundwater levels for Te Hapua Swamp Complex D during the 2014/15 reporting period.*

## 3.6 Te Harakeke / Kawakahia Wetland

### 3.6.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

There are several wetland types present, ranging from *Carex* sedgeland, raupo swamp, to manuka semi-swamp.

Table 6 summarises the plot vegetation species presence and cover data.

The plots are in Palustrine fens in basins (depressions). Plot 1 is a sedgeland with a dominance of *Carex lessoniai* and the creeper (convolvulus: *Calystegia sepium*) Plot 2 is a sedge/grassland fen with a dominance of raupo, *Juncus pallidus* and willow-weed.

*Table 6. Summary vegetation plot statistics (Te Harakeke / Kawakahia wetland)*

| **Parameters** | **Plot 1 (Southern)** | **Plot 2 (northern)** |
|---|---|---|
| Total % cover canopy | 100% | 65% |
| Proportion of canopy exotic | 40% | 23% |
| % cover canopy native | 60% | 77% |
| Total cover other tiers (%) | 0% | 32% |
| Proportion of lower tiers exotic | 0% | 84.5% |
| Proportion of lower tiers native | 0% | 15.5% |
| Total no. spp | 4 | 7 |
| No. exotic spp | 2 | 4 |
| No. native spp | 2 | 3 |
| % native | 50% | 43% |

### 3.6.2 Vegetation community map

The resultant map is presented as Figure 10.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

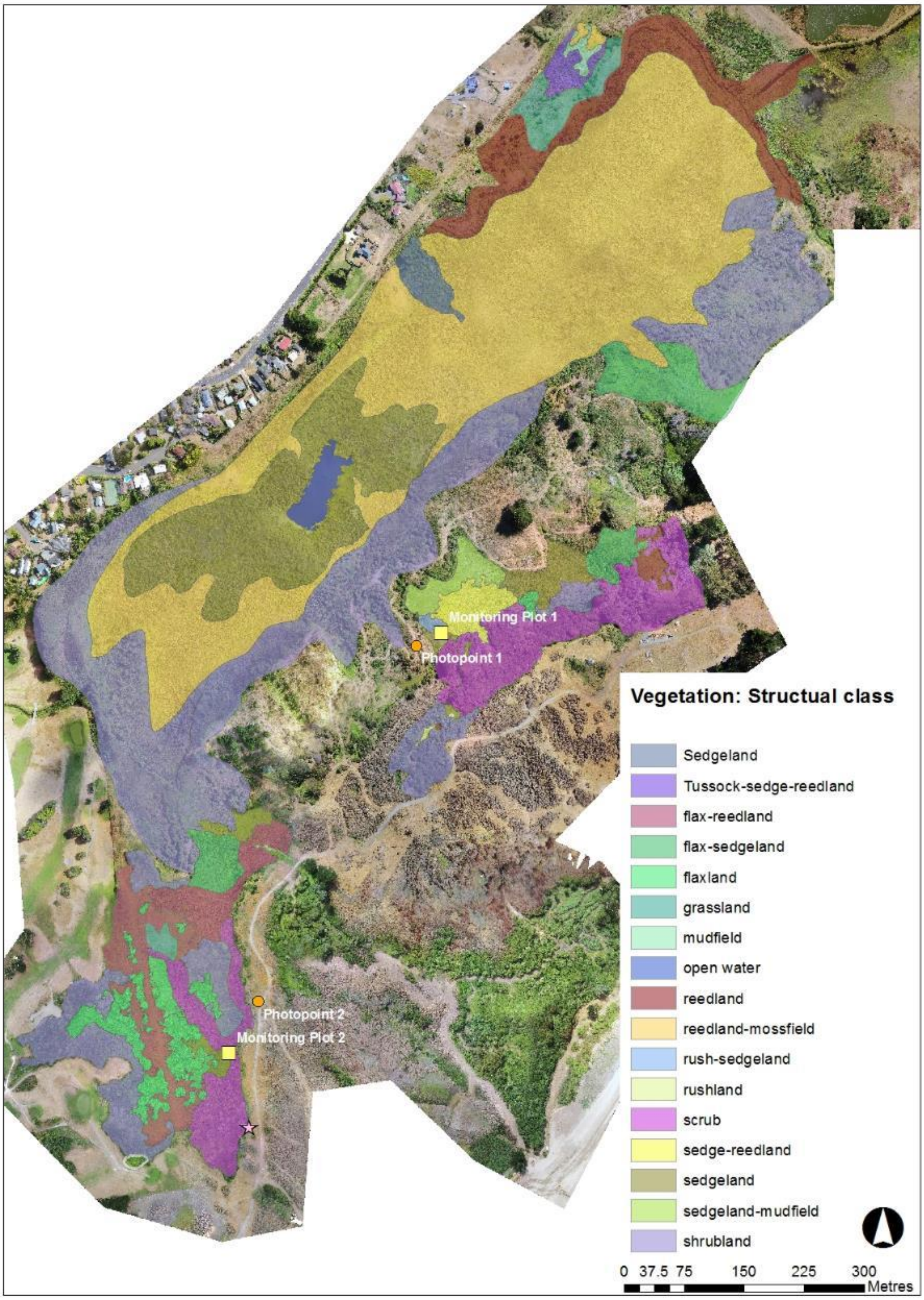



*Figure 10. Local wetland vegetation communities Te Harakeke / Kawakahia wetland over the March 2015 aerial photograph.*

### 3.6.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.6.4 Wetland fauna

Te Harakeke is a moderately sized area of harakeke flaxland and raupo reedland with more mixed edge communities. It remains the second largest of its type in the Kāpiti District and is an important representation of habitat once common in the area. The wetland is protected under a QEII Covenant. The area provides diverse habitat for a range of wildlife (SSW1 M-H), including *Threatened* and *At Risk* species such as Australasian bittern, spotless crake and dabchick; North Island fernbird have been recorded nearby and are presumed present. Whitebait spawning habitat is abundant as is habitat for young eel (including long fin), giant kokopu. Wetland invertebrates will also be abundant.

While most of the rarer cryptic wetland birds are not expected to be seen, being deeper into the wetland, during the 2014/15 survey common native bird species were observed, i.e.: grey warbler, fantail and tui.

### 3.6.5 Piezometer records

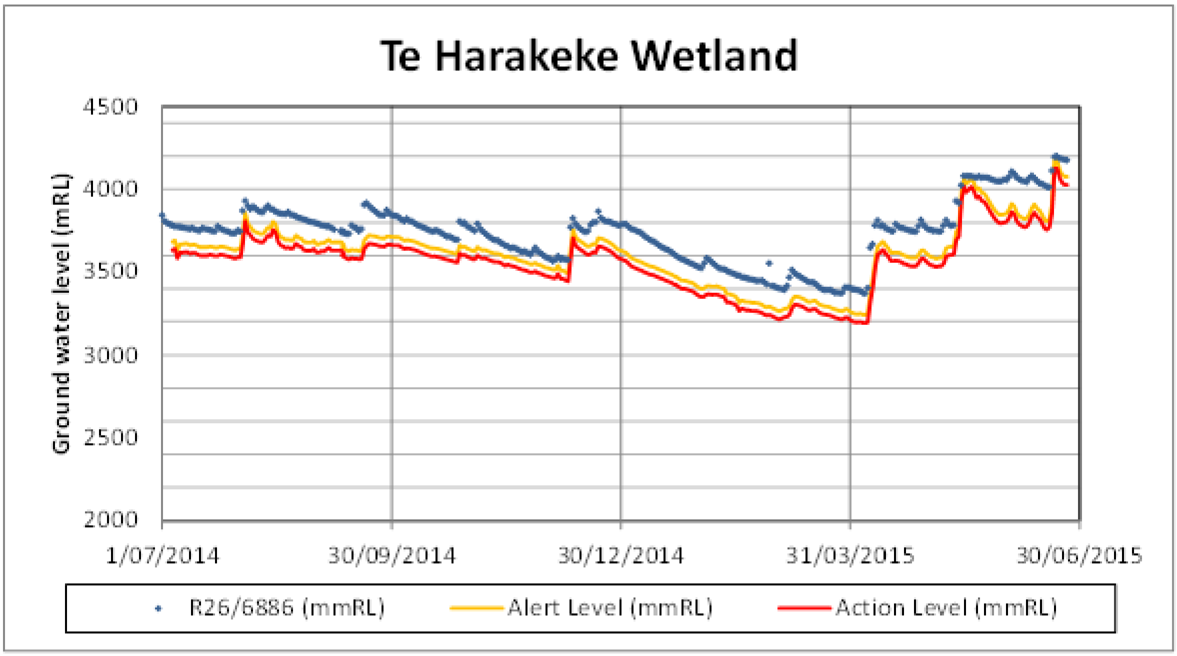



*Figure 11: Shallow groundwater levels for Te Harakeke wetland during the monitoring period of December 2014 to April 2015*

## 3.7 El Rancho Wetland (Weggery)

### 3.7.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

Table 7 summarises the plot vegetation species presence and cover data.

Plot 1 is a manuka swamp; Plot 2 is also a manuka swamp.

*Table 7 Summary vegetation plot statistics (El Rancho (Weggery) wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 70% | 60% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 71% | 14% |
| Proportion of lower tiers exotic | 0% | 21% |
| Proportion of lower tiers native | 100% | 89% |
| Total no. spp | 5 | 10 |
| No. exotic spp | 0 | 2 |
| No. native spp | 5 | 8 |
| % native | 100% | 80% |

### 3.7.2 Vegetation community map

The resultant map is presented as Figure 12.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

### 3.7.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.7.4 Wetland fauna

No wetland fauna recorded during the 2014/15 survey.


*Figure 12: Local wetland vegetation communities at El Rancho wetland (March 2015 aerial photograph).*

### 3.7.5 Piezometer records

The very shallow monitoring bore 2012/HA WM05 in the El Rancho Wetland has been dry since 27 January 2015. This appeared to be caused by dry climatic conditions and not related to groundwater pumping or McKay's to Peka Peka project (M2PP) construction activities. A replacement monitoring bore (2015/HA WM05) that can monitor water levels in the shallow peat/silt layer of the El Rancho Weggery wetland has been installed and monitored since March 2015. Furthermore the area around piezometer 2008/BH 205 was flooded since mid-May 2015 due to extreme rainfall events and no data have been collected since then.

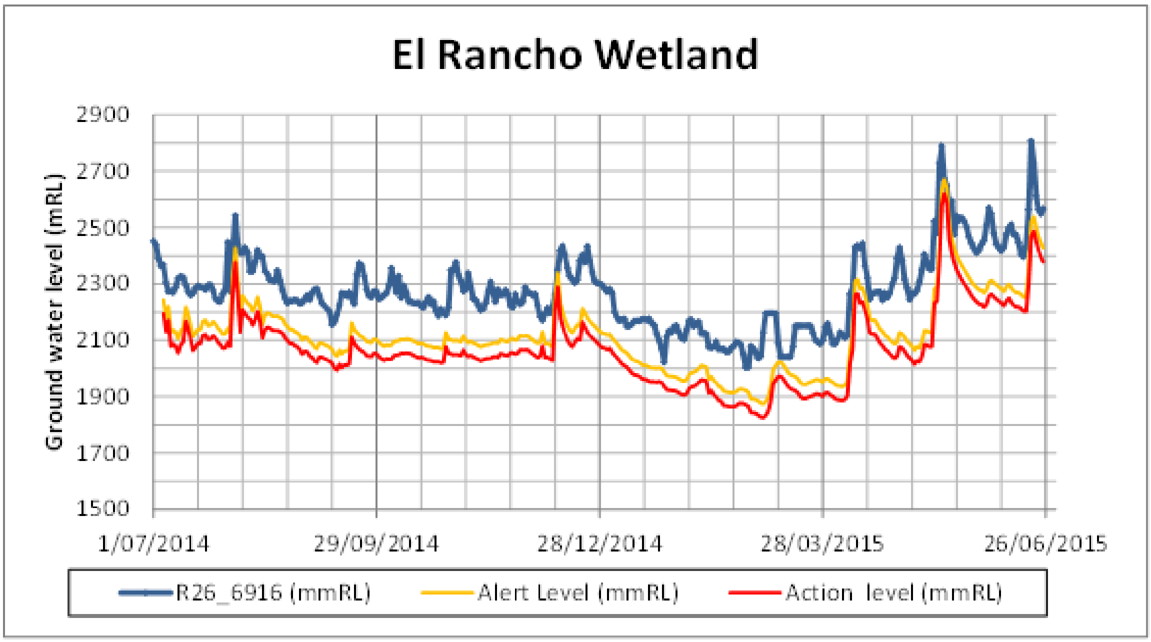



*Figure 13: Shallow groundwater levels for El Rancho (Weggery) wetland logger R26_6916 during the 2014/15 reporting period.*

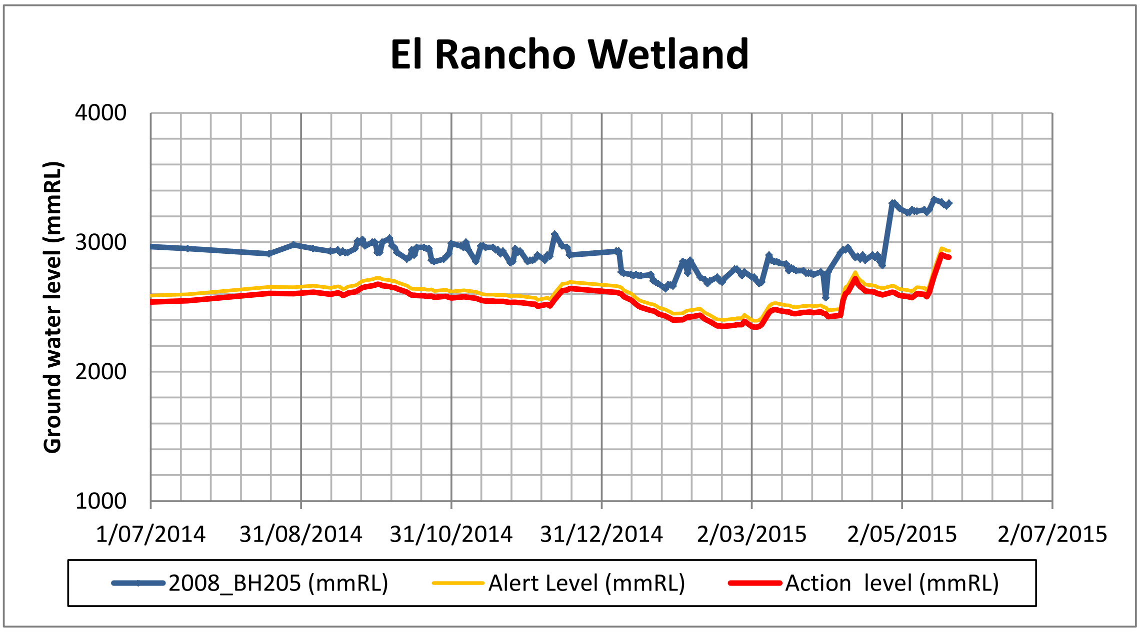



*Figure 14 Shallow groundwater levels for El Rancho (Weggery) wetland logger BH205, during 2014/15 reporting period.*

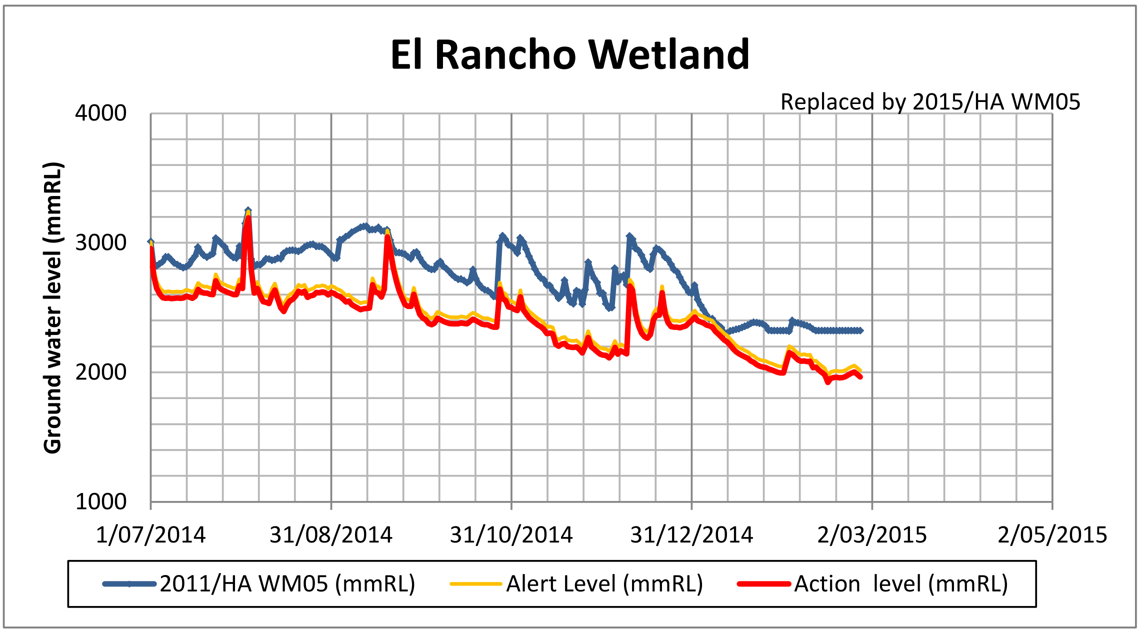



*Figure 15 Shallow groundwater levels for El Rancho (Weggery) wetland logger HA WM05, during the 2014/15 reporting period.*

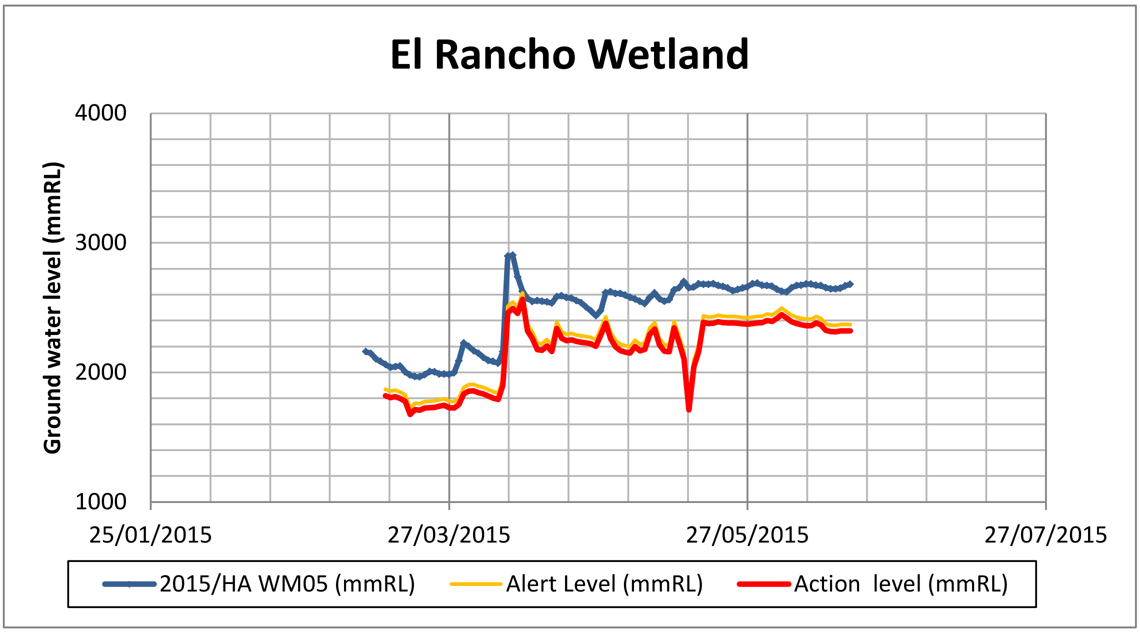



*Figure 16 Shallow groundwater levels for El Rancho (Weggery) wetland logger HA WM05, during the 2014/15 reporting period.*

## 3.8 Peka Peka Road Swamp

### 3.8.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

The Peka Peka site is a “fen” with toitoi, raupo and native wetland shrubs with areas of blackberry and poisoned willow. Table 8 summarises the plot vegetation species presence and cover data.

Plot 1 is a harakeke, raupo fen with edge wetland mingimingi. Plot 2 is a toitoi, wetland mingimingi wetland shrubland.

*Table 8 Summary vegetation plot statistics (Peka Peka Road swamp)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 5% | 45% |
| Proportion of canopy exotic | 0 | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 85% | 35% |
| Proportion of lower tiers exotic | 3% | 0 |
| Proportion of lower tiers native | 97% | 100% |
| Total no. spp | 9 | 10 |
| No. exotic spp | 3 | 0 |
| No. native spp | 6 | 10 |
| % native | 66% | 100% |

### 3.8.2 Vegetation community map

The resultant map is presented as Figure 17.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

### 3.8.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.8.4 Wetland fauna

No wetland fauna recorded in the 2014/15 survey.

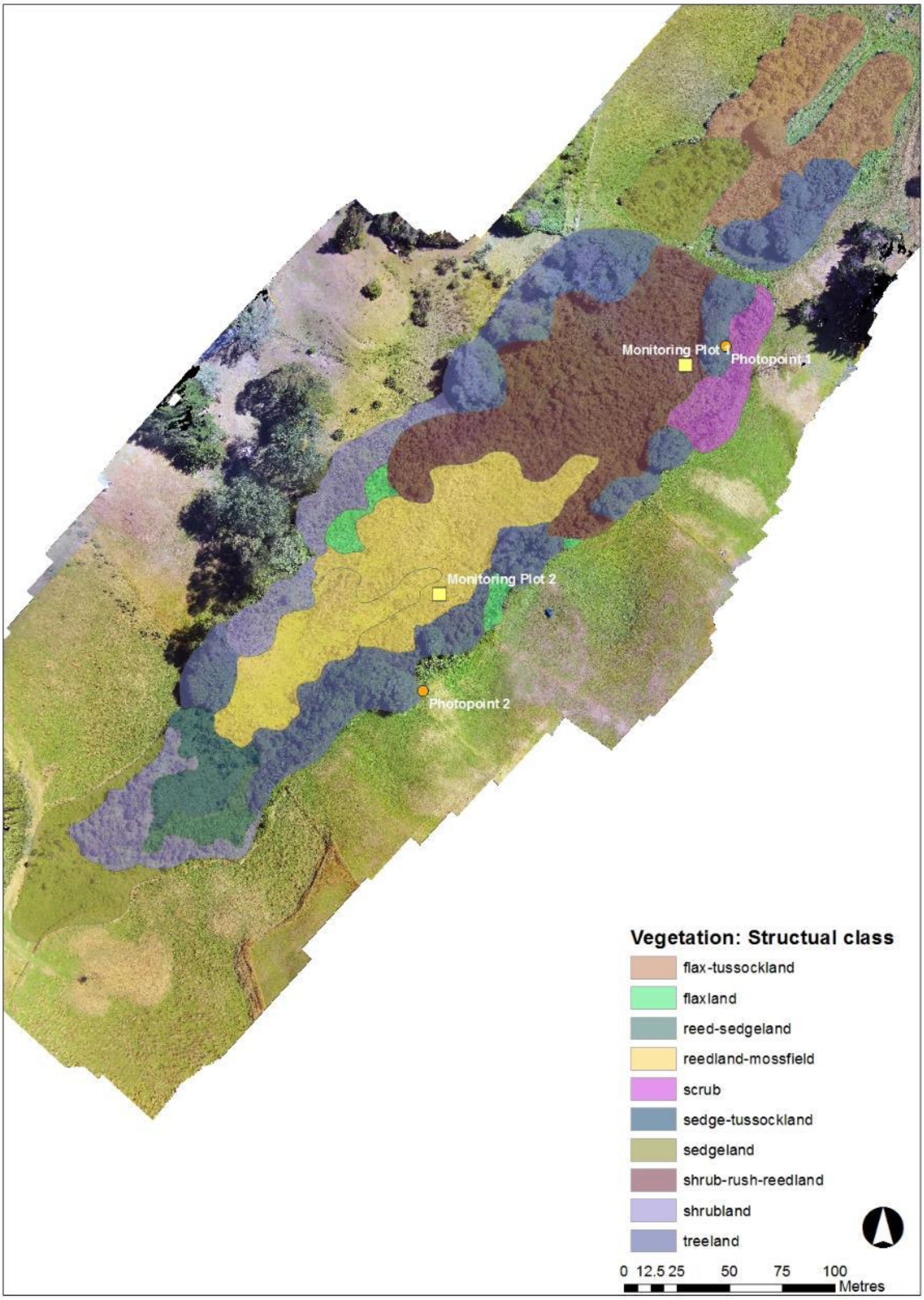



*Figure 17. Local wetland vegetation communities of Peka peka Road swamp over the March 2015 aerial photograph.*

### 3.8.5 Piezometer records

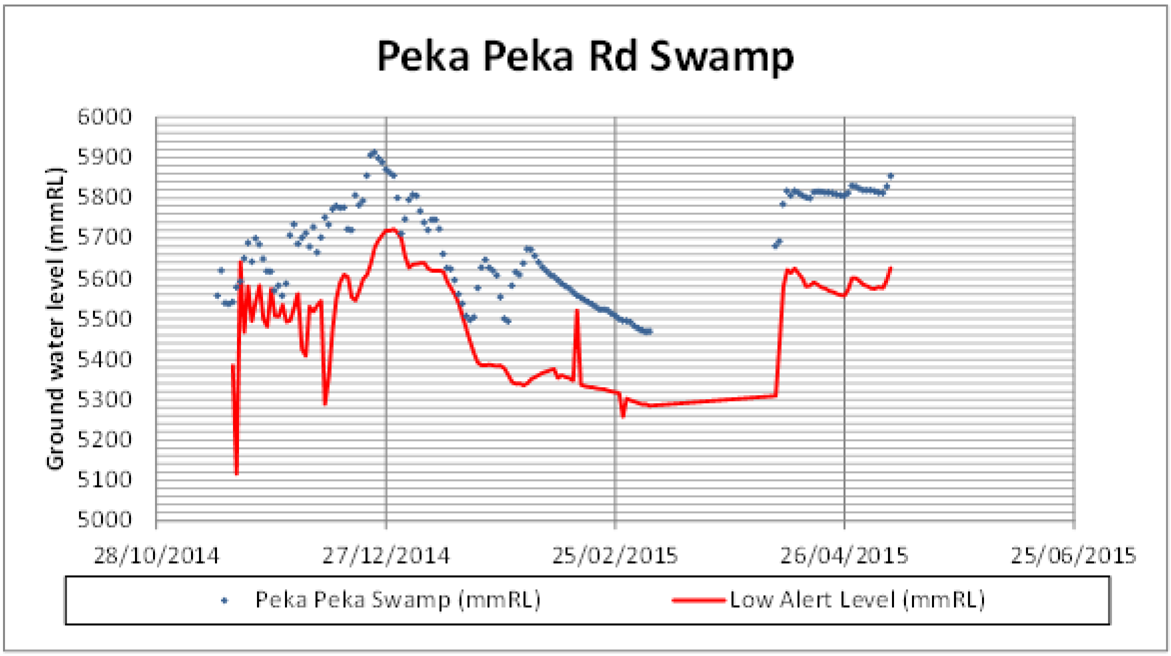



*Figure 18 Shallow groundwater levels for Peka Peka Road swamp during the 2014/15 reporting period.*

## 3.9 Tini Bush Wetland

### 3.9.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

Table 9 summarises the plot vegetation species presence and cover data.

Plot 1 is a Pukatea swamp forest with *Freycinetia banksii*; Plot 2 is a tree fern developing wetland forest with young kahikatea and pukatea under mamaku.

*Table 9 Summary vegetation plot statistics (Tini Bush wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 40% | 58% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 45% | 12% |
| Proportion of lower tiers exotic | 0 | 25% |
| Proportion of lower tiers native | 100% | 75% |
| Total no. spp | 6 | 17 |
| No. exotic spp | 0 | 3 |
| No. native spp | 6 | 14 |
| % native | 100% | 82% |

### 3.9.2 Vegetation community map

The resultant map is presented as Figure 19.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

### 3.9.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.9.4 Wetland fauna

Tui were observed in the 2014/15 survey.

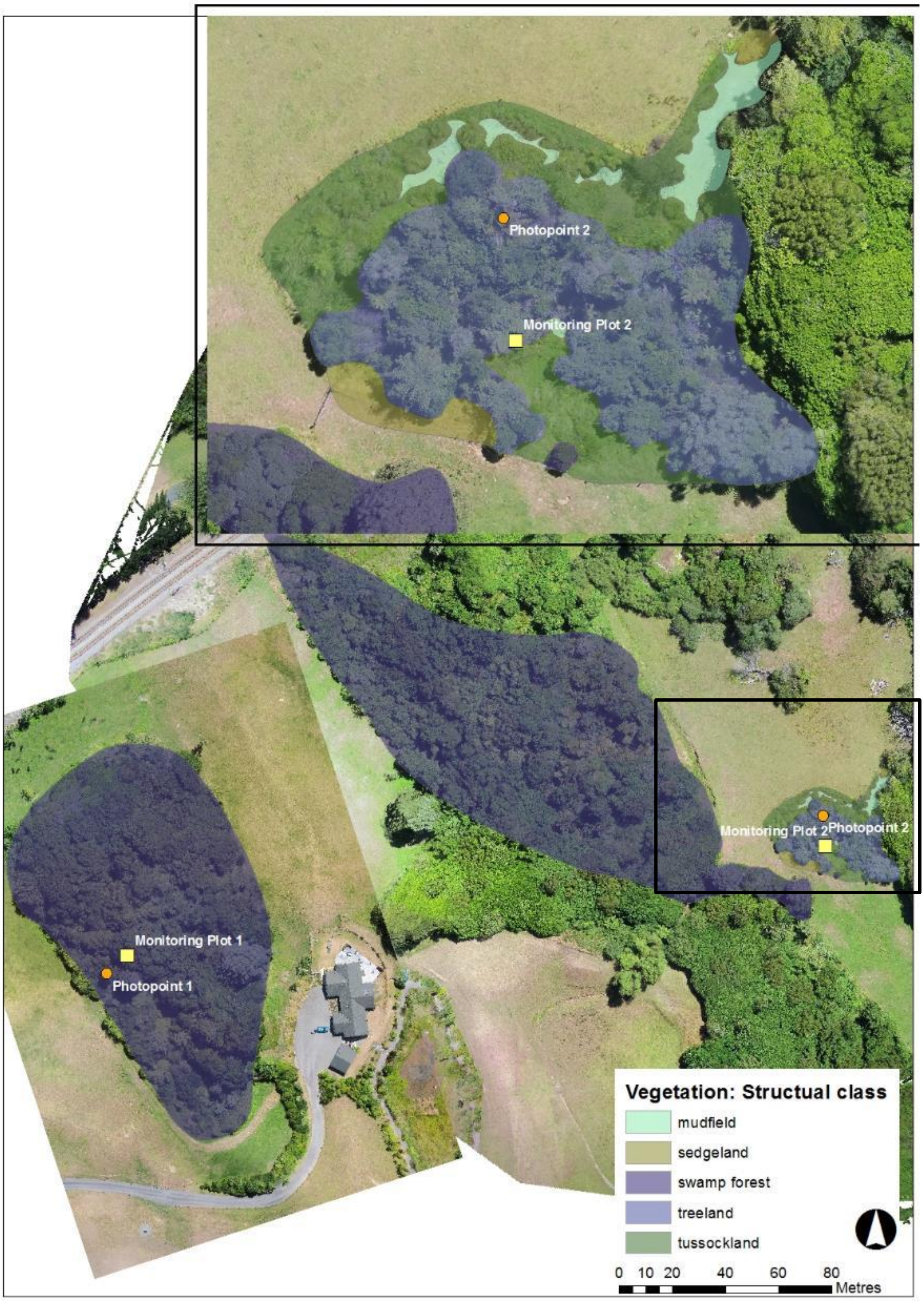



*Figure 19. Local wetland vegetation communities at Tini Bush Wetland (March 2015 aerial photograph), Note second plot is enlarged in insert for clarity..*

### 3.9.5 Piezometer Records

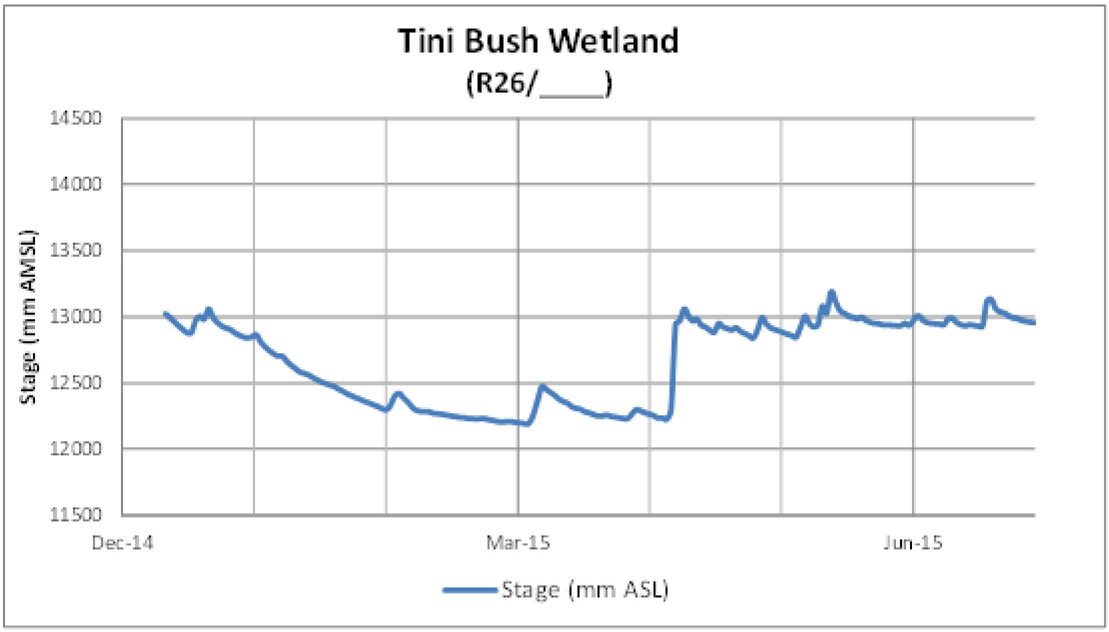



*Figure 20: Shallow groundwater levels for Tini Bush wetland during the 2014/15 reporting period.*

## 3.10 Ngarara Bush Wetland

### 3.10.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

The vegetation is principally a pukatea, kahikatea, semi-swamp forest, with kohekohe on margins.

Table 10 summarises the plot vegetation species presence and cover data.

Plot 1 is a mahoe-kahikatea swamp forest with a drier kohekohe edge and typical limited (by shading) damp forest under canopy species. Plot 2 is a mahoe forest with regenerating pukatea and kohekohe and broadleaf native shrub and lower canopy species.

*Table 10. Summary vegetation plot statistics (Ngarara Bush wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 45% | 15% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 38% | 72% |
| Proportion of lower tiers exotic | 0% | 22% |
| Proportion of lower tiers native | 100% | 78% |
| Total no. spp | 10 | 10 |
| No. exotic spp | 0 | 2 |
| No. native spp | 10 | 8 |
| % native | 100% | 80% |

### 3.10.2 Vegetation community map

The resultant map is presented as Figure 21.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.


*Figure 21. Local wetland vegetation communities at Ngarara Bush wetland over the March 2015 aerial photograph.*

### 3.10.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.10.4 Wetland fauna

During the 2014/15 survey common native bird species were observed i.e.: grey warbler, fantail, tui and kereru.

### 3.10.5 Piezometer records

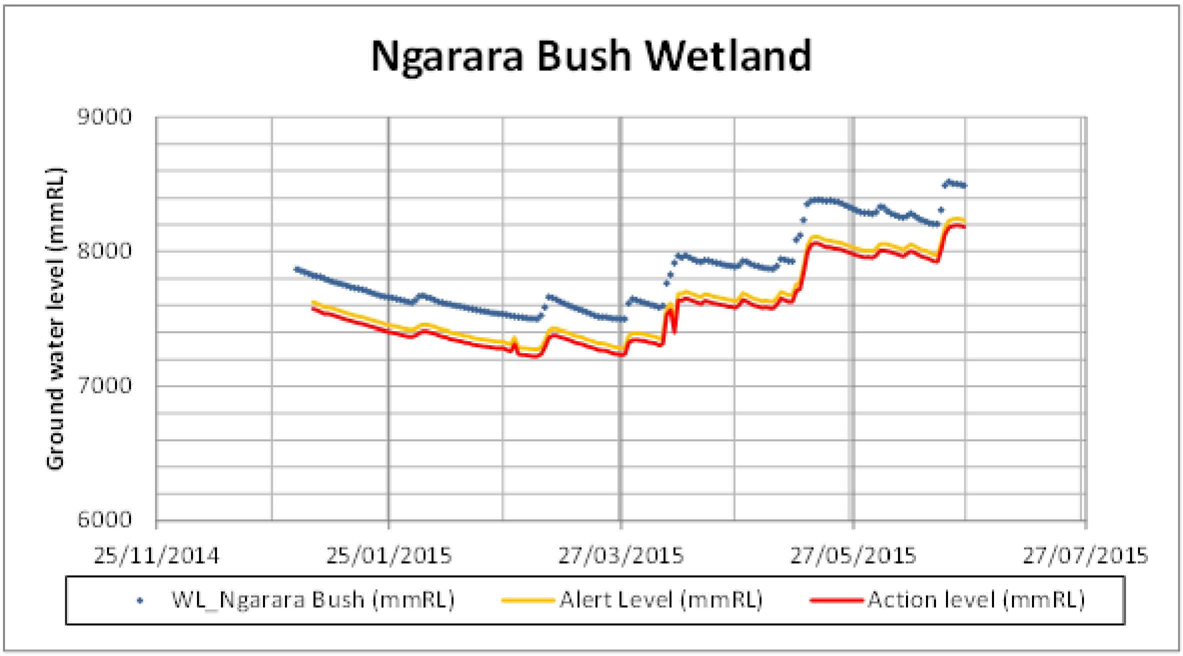



*Figure 22: Shallow groundwater levels for Ngarara Bush wetland during the 2014/15 reporting period.*

## 3.11 Ngarara Wetland

### 3.11.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

The fens here are Carex sedgeland that are strongly invaded by blackberry.

Table 11 summarises the plot vegetation species presence and cover data.

Plot 1 is a blackberry growth over Carex. Plot 2 is a *Carex virgata* sedgeland.

*Table 11. Summary vegetation plot statistics (Ngarara Wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 120% | 92% |
| Proportion of canopy exotic | 50% | 11% |
| % cover canopy native | 50% | 89% |
| Total cover other tiers (%) | 2% | 2% |
| Proportion of lower tiers exotic | 100% | 0% |
| Proportion of lower tiers native | 0 | 100% |
| Total no. spp | 5 | 5 |
| No. exotic spp | 2 | 2 |
| No. native spp | 3 | 3 |
| % native | 60% | 60% |

### 3.11.2 Vegetation community map

The resultant map is presented as Figure 23.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

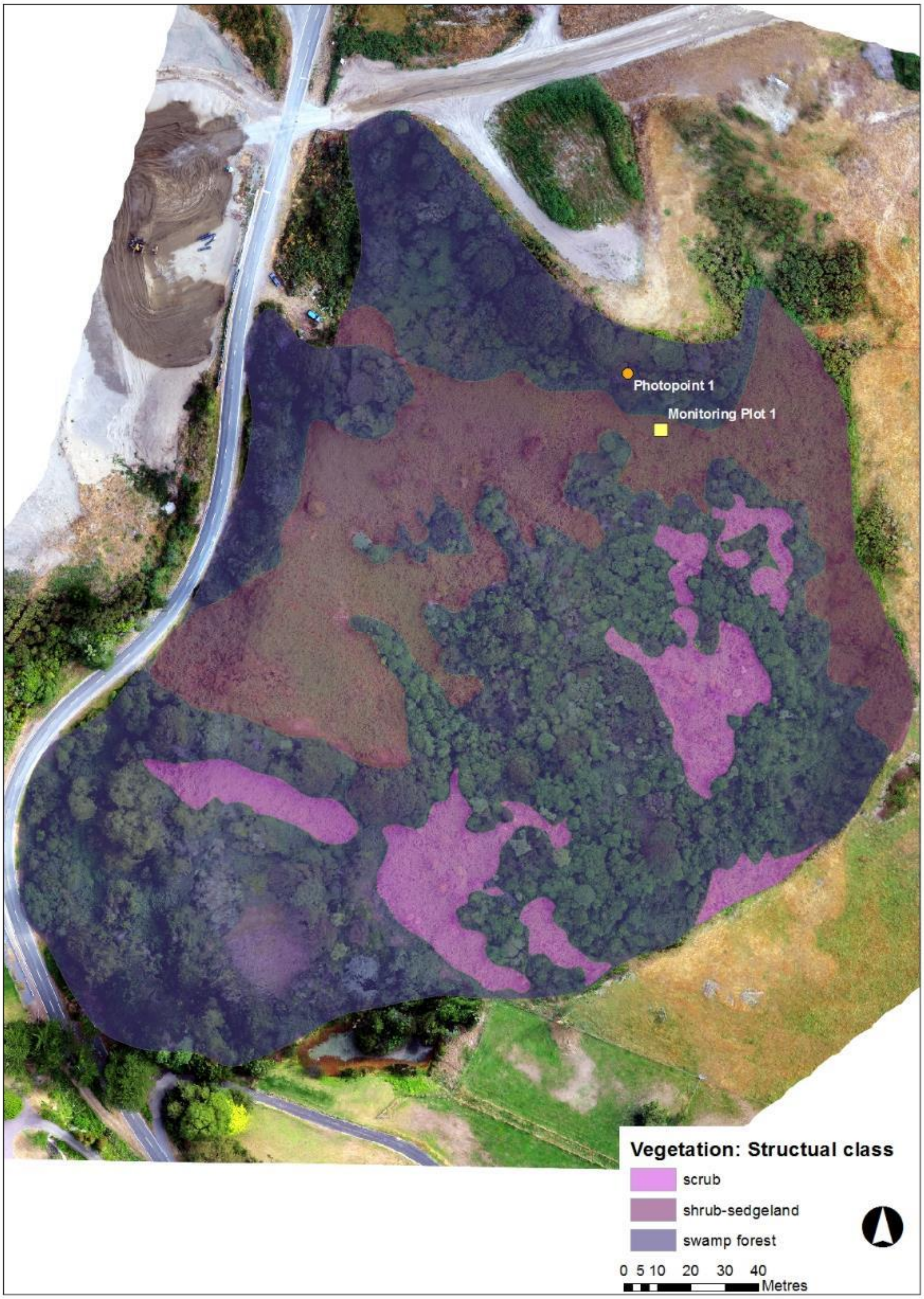



*Figure 23. Local wetland vegetation communities at Ngarara Wetland over the March 2015 aerial photograph.*

### 3.11.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.11.4 Wetland fauna

Tui and Kereru were observed in the 2014/15 survey. Fernbird have been recorded previously in the wider area.

### 3.11.5 Piezometer records

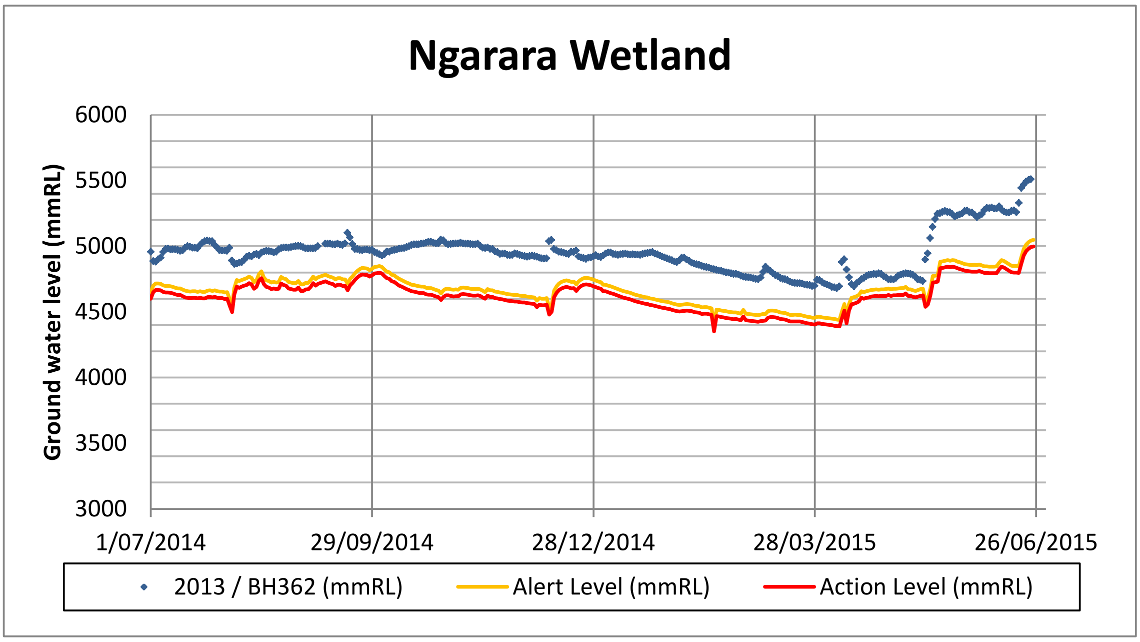



*Figure 24: Shallow groundwater levels for Ngarara wetland during the 2014/15 reporting period.*

## 3.12 Otaihanga Southern Wetland

### 3.12.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 3.

Table 12 summarises the plot vegetation species presence and cover data.

Plot 1 is a sedgeland with a dominance of *Carex secta* and the weed beggars tick; Plot 2 is a sedgeland dominated by *Carex virgata*.

It was noted that plot 2 appeared unnaturally dry and there was evidence of wetland plant dieback.

*Table 12. Summary vegetation plot statistics (Otaihanga South Wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 110% | 95% |
| Proportion of canopy exotic | 64% | 16% |
| % cover canopy native | 36% | 84% |
| Total cover other tiers (%) | 7% | 34% |
| Proportion of lower tiers exotic | 0% | 0% |
| Proportion of lower tiers native | 100% | 100% |
| Total no. spp | 5 | 10 |
| No. exotic spp | 1 | 1 |
| No. native spp | 4 | 9 |
| % native | 90% | 90% |

### 3.12.2 Vegetation community map

The resultant map is presented as Figure 25.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.


*Figure 25. Local wetland vegetation communities at Otaihanga South Wetland (March 2015 aerial photograph).*

### 3.12.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.12.4 Wetland fauna

No fauna were recorded in the 2014/15 survey.

### 3.12.5 Piezometer records

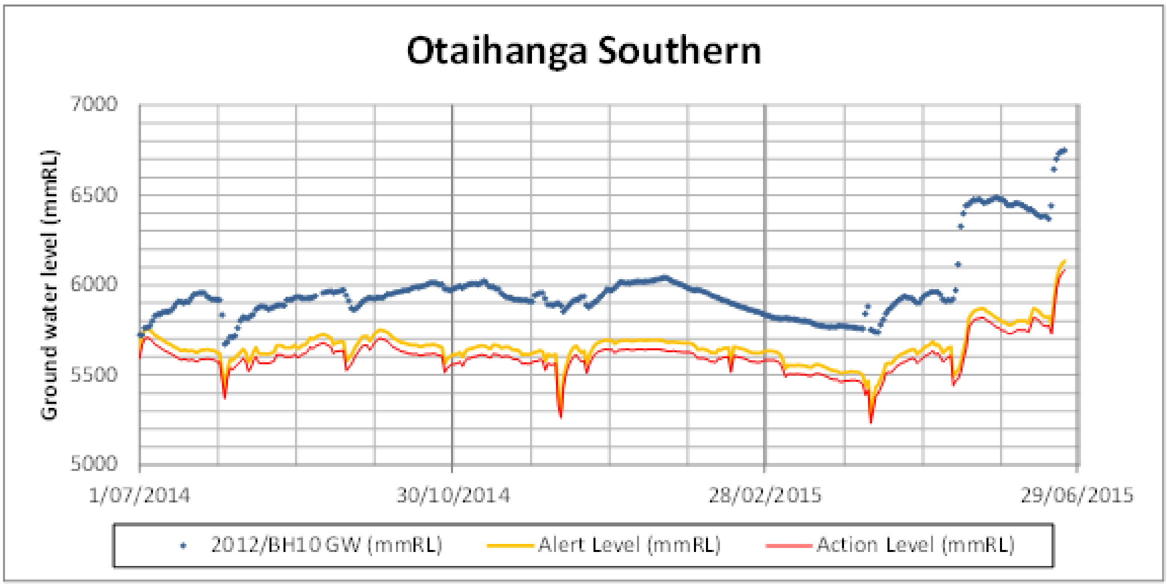



*Figure 26: Shallow groundwater levels for Otaihanga wetland site BH 10 during the 2014/15 reporting period.*

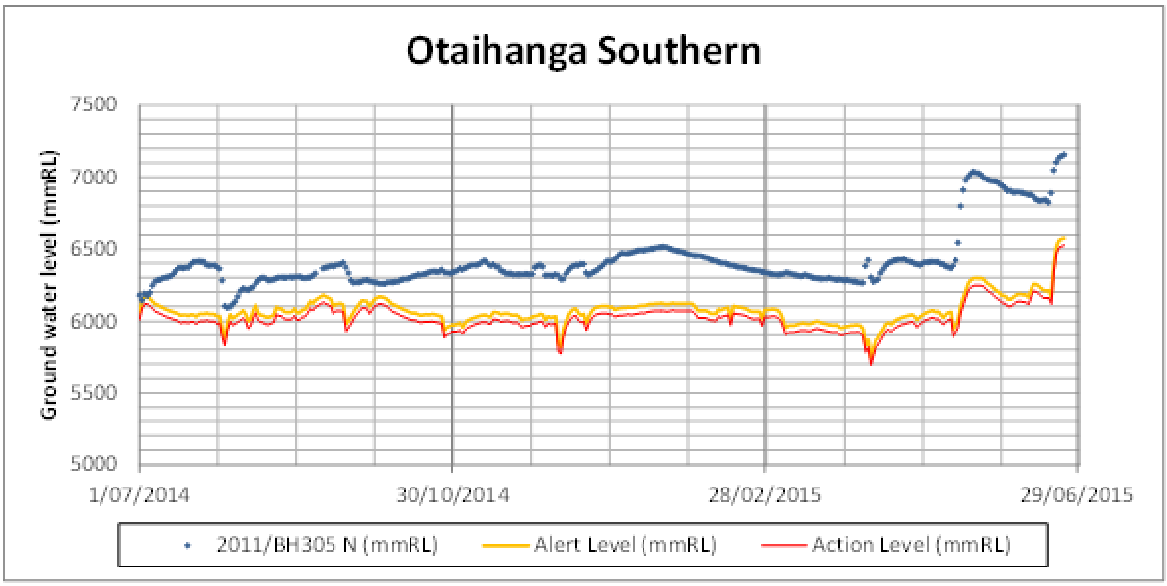



*Figure 27: Shallow groundwater levels for Otaihanga wetland site BH 305N during the 2014/15 reporting period.*

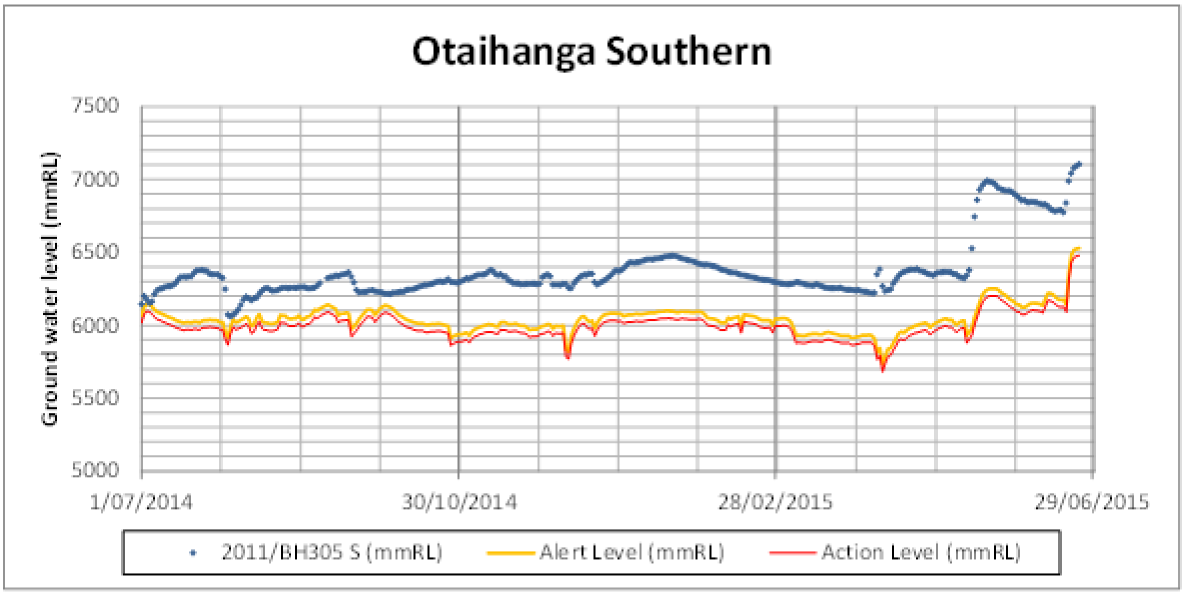



*Figure 28: Shallow groundwater levels for Otaihanga wetland site BH 305S during the 2014/15 reporting period.*

## 3.13 Crown Hill Manuka Bush Wetland

### 3.13.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

Table 13 summarises the plot vegetation species presence and cover data.

Plot 1 is a kanuka swamp forest with pukatea; Plot 2 is a manuka swamp.

*Table 13. Summary vegetation plot statistics (Crown Hill Manuka Bush Wetland).*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 100% | 74% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 31% | 40% |
| Proportion of lower tiers exotic | 0% | 0% |
| Proportion of lower tiers native | 100% | 100% |
| Total no. spp | 7 | 9 |
| No. exotic spp | 0 | 0 |
| No. native spp | 7 | 9 |
| % native | 10% | 100% |

### 3.13.2 Vegetation community map

The resultant map is presented as Figure 29.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

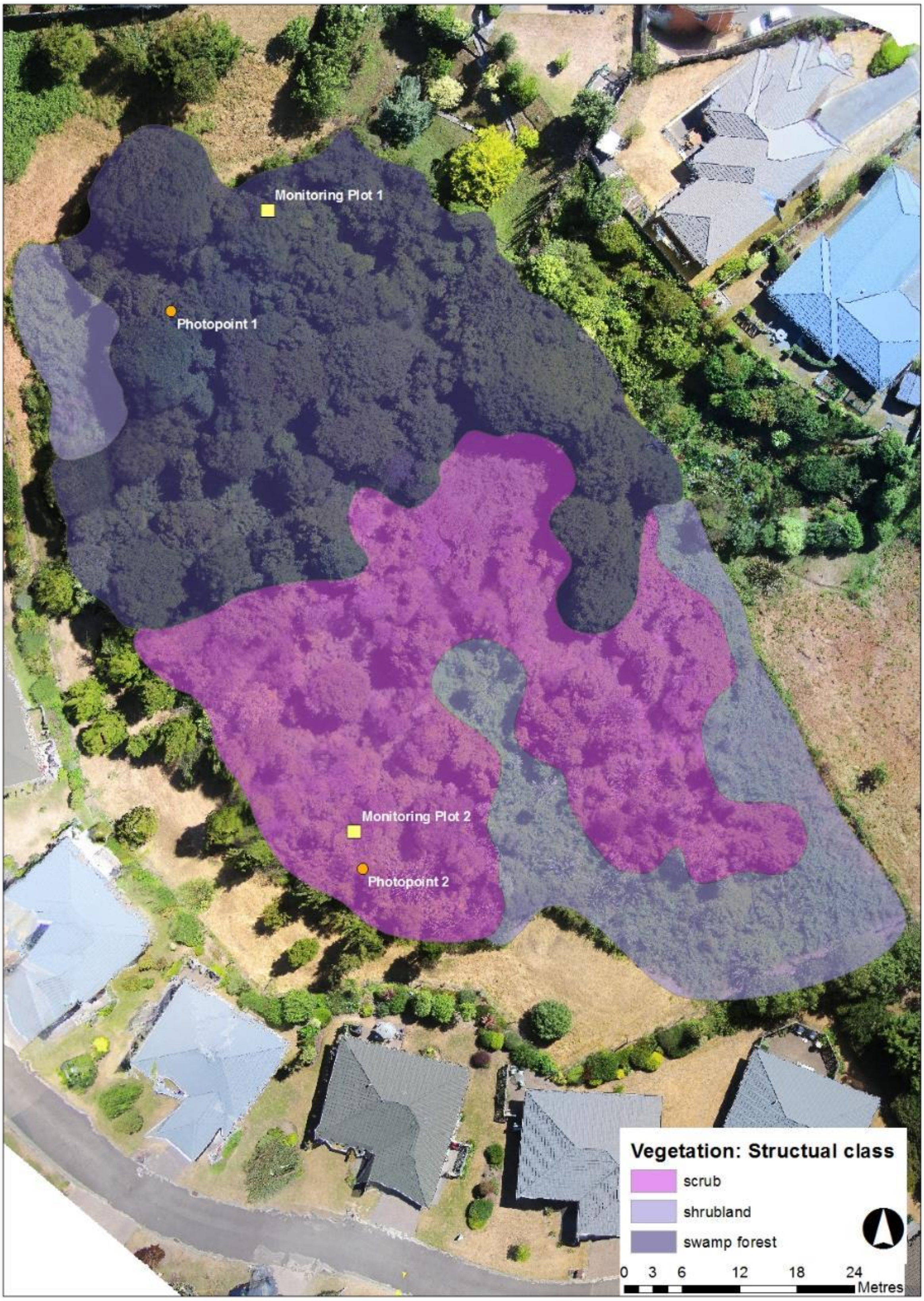



*Figure 29. Local wetland vegetation communities at Crown Hill Manuka Bush Wetland (March 2015 aerial photograph).*

### 3.13.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.13.4 Wetland fauna

During the 2014/15 survey only common exotic birds were recorded (e.g. sparrow, starling).

### 3.13.5 Piezometer records

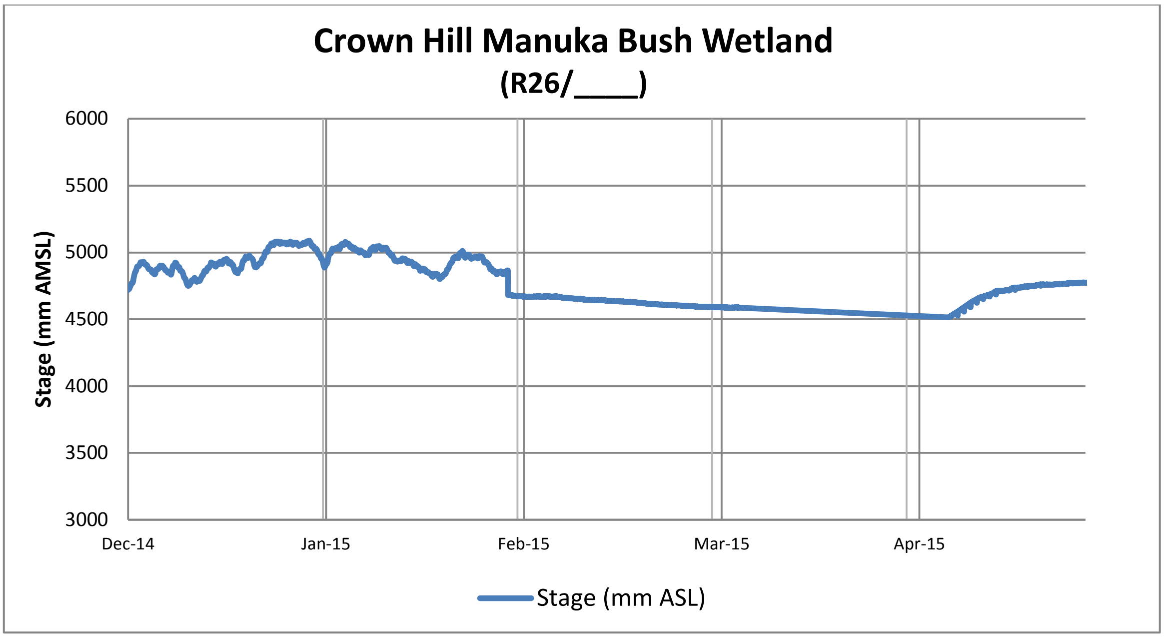



*Figure 30: Shallow groundwater levels for Crown Hill Manuka Bush wetland during the 2014/15 reporting period.*

## 3.14 Poplar Ave Wetland

### 3.14.1 Vegetation communities

Raw data for vegetation communities can be found in Appendix 1.

Table 14 summarises the plot vegetation species presence and cover data.

Plot 1 is a manuka-*Machaerina* wetland; Plot 2 is a reedland (*Isolepis*), moss field with a thin scattering of manuka.

*Table 14. Summary vegetation plot statistics (Poplar Ave Wetland)*

| Parameters | Plot 1 (Southern) | Plot 2 (northern) |
|---|---|---|
| Total % cover canopy | 60% | 5% |
| Proportion of canopy exotic | 0% | 0% |
| % cover canopy native | 100% | 100% |
| Total cover other tiers (%) | 5% | 107% |
| Proportion of lower tiers exotic | 60% | 15% |
| Proportion of lower tiers native | 40% | 85% |
| Total no. spp | 8 | 6 |
| No. exotic spp | 2 | 1 |
| No. native spp | 6 | 5 |
| % native | 75% | 83% |

### 3.14.2 Vegetation community map

The resultant map is presented as Figure 31.

The community boundaries are indicative only. They change seasonally to a small degree but were hydrology is stable the boundaries should also be relatively stable.

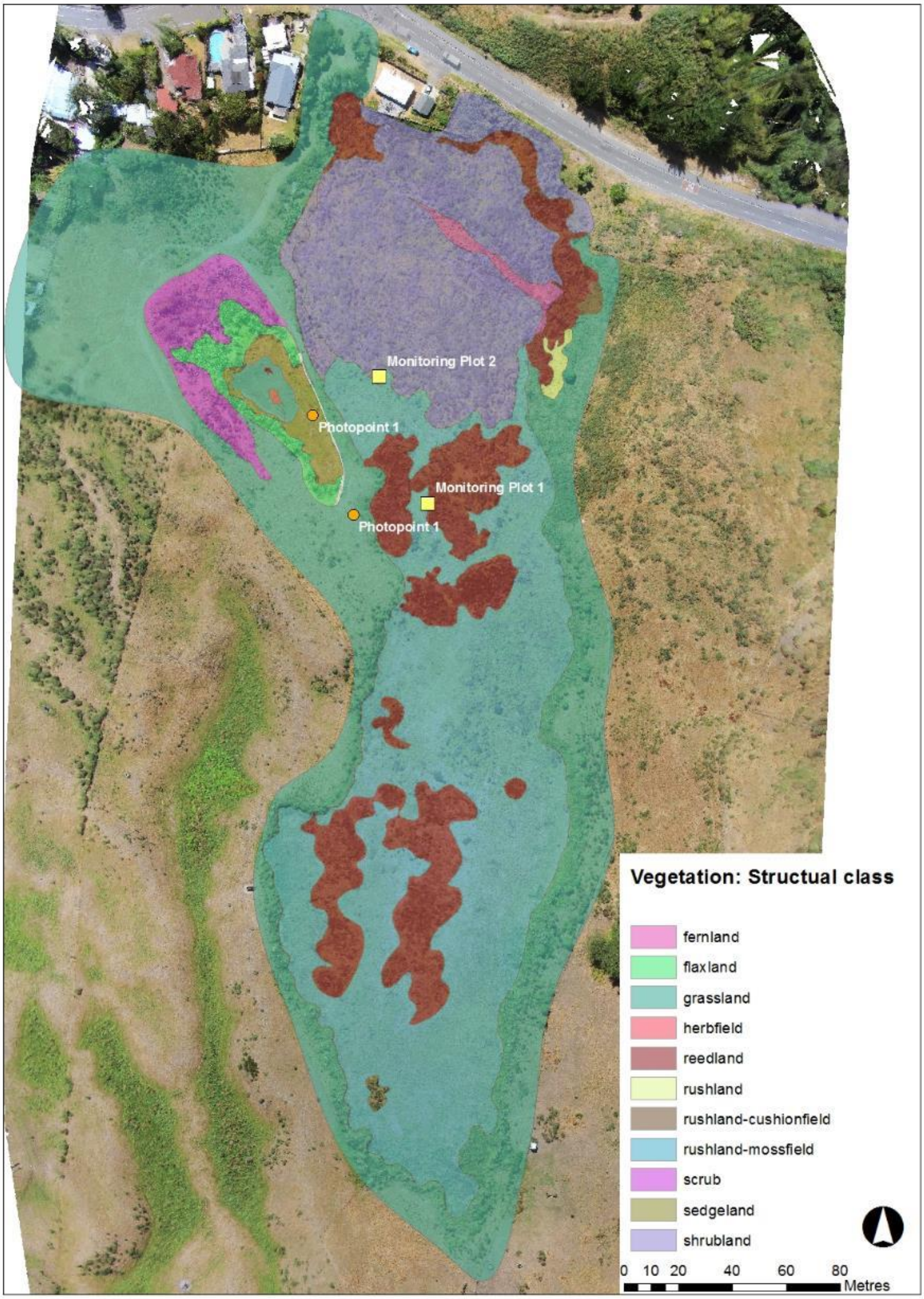



*Figure 31: Local wetland vegetation communities at Poplar Ave Wetland (March 2015 aerial photograph).*

### 3.14.3 Wetland photo points

Appendix 2 shows the photos from the photo points and these shots form one of the assessment factors for recognising wetland assemblage change.

### 3.14.4 Wetland fauna

During the 2014/15 survey skylark (an introduced species) were observed; this is not a wetland species.

### 3.14.5 Piezometer records

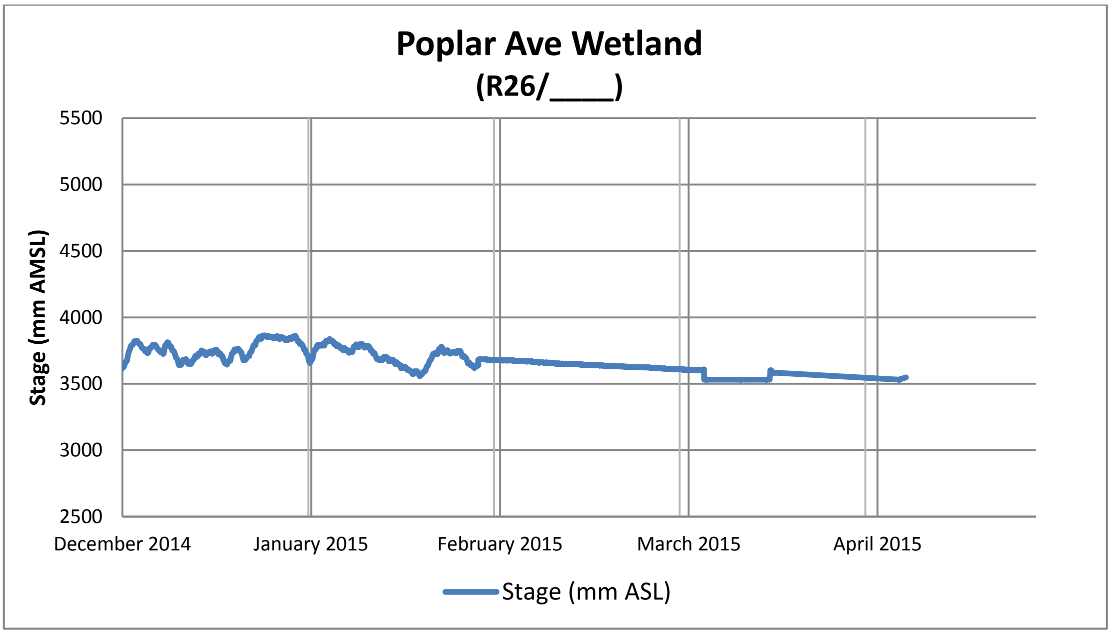



*Figure 32: Shallow groundwater levels for Poplar Ave wetland during the monitoring period of December 2014 to April 2015*

# 4. Wetland classes

For each monitoring period the wetland classification (Johnson & Gerbeaux, 2004) is assessed and reported in the table below. It compares the wetland classifications from the wetland BMP with the classification determined for the monitoring site following the 2014/15 surveys.

| **Wetland name** | **BMP Wetland class** | **2014/15 classification** | **Description** |
|---|---|---|---|
| Nationally or Regionally Significant Wetland | | | |
| Muaupoko Swamp forest | Fen | Fen | Forest (upper section) with lower wetland dominated by shrubland (swamp Coprosma) with areas of sedgeland. |
| Nga Manu wetland | Fen | Fen | Predominantly forest with small, scattered areas of sedgeland dominated by *Carex secta* and *Carex virgata* and areas of shrubland and open water. |
| Te Hapua Swamp complex A | Swamp | Swamp | Tussockland (flaxland) with areas of reedland dominated by raupo. Occasional areas of shrubland. |
| Te Hapua Swamp complex D | Fen | Fen | Tussockland (flaxland) with areas of reedland dominated by raupo. |
| Te Harakeke / Kawakahi wetland | Swamp | Fen | Tussockland (flaxland) with areas of reedland dominated by raupo. |
| Locally significant or information poor wetlands | | | |
| El rancho (Weggery) wetland | Fen | Fen | Shrubland with small, scattered areas of sedgeland dominated by *Carex secta* and *Carex virgata* and occasional rushland dominated by *Baumea.* |
| Peka Peka Rd swamp | Swamp | Swamp | Tussockland (flaxland) with areas of reedland dominated by raupo. Occasional areas of shrubland dominated by swamp Coprosma. |
| Tini bush wetland | Fen | Fen | Forest with small, scattered areas of sedgeland dominated by *Carex secta* and *Carex virgata.* |
| Ngarara bush wetland | Fen | Fen | Forest. Small fragment of kohekohe forest and a very small area of swamp forest |
| Ngarara Road wetland | Fen | Fen | Shrubland with small, scattered areas of sedgeland dominated by *Carex secta* and *Carex virgata.* |

| Wetland name | BMP Wetland class | 2014/15 classification | Description |
|---|---|---|---|
| Otaihanga Southern Wetland | Fen | Fen | Sedgeland dominated by *Carex secta* and *Carex virgata* with small areas of Baumea rushland. |
| Crown hill manuka bush wetland | Fen | Fen | Shrubland with small, scattered areas of sedgeland and flaxland. |
| Poplar Ave wetland | Fen | Fen | Shrubland dominated by manuka with sedgelands and rushlands. |

# 5. Summary

The initial wetland condition, pressure and indicator values have now been collected as well as the photographs of assemblages and condition in the 2014-2015 summer. Vegetation plots are now established along with records of species and proportional cover. The aerial photography is now complete and overlain by a vegetation boundaries map. This will assist into the future through an ability to repeat such an aerial survey if and where wetland conditions are considered to be in decline based on the plot monitoring.

An overall decline of water levels was observed in most piezometer monitoring sites during the summer months (January-March), with levels increasing again from April.

# 6. References


Atkinson, I. A. E. (1985). Derivation of vegetation mapping units for an ecological survey of Tongariro National Park North Island, New Zealand. *New Zealand Journal of Botany*, *23*, 361–378.

Clarkson, B. R., Sorrell, B. K., Reeves, P. N., Champion, P. D., Partridge, T. R., & Clarkson, B. D. (2004). *Handbook for monitoring wetland condition: Coordinated monitoring of New Zealand wetlands*. Wellington: Ministry for the Environment.

Johnson, P., & Gerbeaux, P. (2004). *Wetland types in New Zealand*. Wellington: Department of Conservation.

# Appendix 1 Raw data sheets

## Muaupoko Swamp Forest

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 10.02.15 |
| **Wetland name:** | Muaupoko Swamp forest | **Personal:** | TR, PE |
| **Region:** | Kapiti Coast | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | rail runs along NW side of forest, road along SE. | 4 | 3.67 |
| | Water table depth | | 3 | |
| | Dryland plant invasion | Some blackberry | 4 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 4 |
| | Degree of sedimentation/erosion | Some farmed surrounds | 4 | |
| | Nutrient levels | | 4 | |
| | Von Post index | | 3 | |
| Change in ecosystem intactness | Loss in area of original wetland | reduced from original shape | 4 | 4 |
| | Connectivity barriers | | 4 | |
| Change in browsing, predation & harvesting | Damage by domestic or feral animals | | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| regimes | Introduced predator impacts on wildlife | Some predator control | 3 | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | | 5 | 5 |
| | Introduced plant understorey cover | | 5 | |
| | | | **Total wetland condition index /25** | **20.67** |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types**: pukatea, nikau with lots of *Freycinetia banksii*

**Native fauna:** Kereru

**Other comments:** Bait line runs through this area.

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 4 | |
| Water quality within the catchment | 4 | |
| Animal access | 3 | Surrounded by residential houses. Cats likely present. |
| Key undesirable species | 3 | Some willow. |
| % catchment in introduced vegetation | 2 | Mainly pasture and pine. |
| Other landuse threats | | |
| Total wetland pressure index /30 | 16 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Muaupoko Swamp Forest

| WETLAND PLOT SHEET | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Muaupoko | **Date:** | 10.02.2015 | **Plot no:** | 1 |
| **Plot size:** | 2m x 2m | **Elevation:** | 15m a.s.l | **Northing:** | 5470568 |
| **Personal:** | Pat, Tess | **Structure:** | Coastal swamp forest | **Easting** | 1770775 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Rhopalostylis sapida* | *60* | *7* | *Geniostoma ligustrifolium* | *1* | *2* | *Epiphytic Microsorum scandens* | *1* | *0.7* |
| *Laurelia novae-zelandiae* | *5* | *8* | *Melicytus ramiflorus* | *1* | *2.2* | | | |
| *Ripogonum scandens* | *2* | *7* | *Asplenium bulbiferum* | *2* | *0.6* | | | |
| *Freycinetia banksii* | *40* | *6* | *Dicksonia squarrosa* | *5* | *1.2* | | | |
| | | | *Dysoxylum spectabile* | *1* | *0.4* | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Dacrycarpus dacrydioides*

**Fauna seen:** none

**Comments:** soggy underfoot but no surface water.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| Total /20 | | 20 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high. [3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 6 |

## Plot 2: Muaupoko Swamp Forest

| WETLAND PLOT SHEET | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Muaupoko | **Date:** | 10.02.2015 | **Plot no:** | 2 |
| **Plot size:** | 2m x 2m | **Elevation:** | 15m a.s.l | **Northing:** | 5470601 |
| **Personal:** | Pat, Tess | **Structure:** | Coastal swamp forest | **Easting** | 1770715 |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Sysygium maire* | 40 | 6 | *Coprosma lucida* | 1 | 0.6 | | | |
| *Myoporum laetum* | 50 | 7 | *Dysoxylum spectabile* | 2 | 0.4 | | | |
| *Geniostoma ligustrifolium* | 40 | 5 | *Rhopalostylis sapida* | 0.3 | 0.1 | | | |
| | | | *Piper excelsum* | 2 | 0.7 | | | |
| | | | *Asplenium bulbiferum* | 40 | 1 | | | |
| | | | *Ripogonum scandens* | 1 | 0.1 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Coprosma robusta Coprosma grandifolia Schefflera digitata*

**Fauna seen:** none.

**Comments:** Lots of Kohekohe, nikau, *Dicksonia squarrosa* and *Parsonsia capsularis*

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |

| | | | |
|---|---|---|---|
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| Total /20 | | 20 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high [3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 4 |

## Nga Manu Wetland

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 12.02.15 |
| **Wetland name:** | Nga Manu | **Personal:** | TR, TP |
| **Region:** | Kapiti Coast | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Some drainage channels/culverting/ constructed ponds can be found within the nature reserve | 5 | 3 |
| | Water table depth | 0.0 (surface water) | 0 | |
| | Dryland plant invasion | Blackberry | 4 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 3.67 |
| | Degree of sedimentation/erosion | low = nature reserve | 5 | |
| | Nutrient levels | | n/a | |
| | Von Post index | 8 | 1 | |
| Change in ecosystem intactness | Loss in area of original wetland | Originally part of a bigger complex | 4 | 4 |
| | Connectivity barriers | Surounded by road and farmlands | 4 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Fenced. Possum control | 5 | 5 |
| | Introduced predator impacts on wildlife | Predator control | 5 | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of | Introduced plant canopy cover | Some climbing weed species (yet controlled) | 5 | 4.5 |

| | | | | |
|---|---|---|---|---|
| native plants | Introduced plant understorey cover | Blackberry | 4 | |
| | | | **Total wetland condition index /25** | 20.17 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main vegetation types:** *Phormium tenax, Carex secta, Coprosma grandifolia, Coprosma rigida*

**Native fauna:** Tui, Kereru, large amount of waterfowl

**Other comments:** diverse and high bird life (nature reserve). Large degree of management.

| **Pressure** | **Score[2]** | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 1 | Some drainage channels, constructed ponds |
| Water quality within the catchment | 3 | Farmland surrounds |
| Animal access | 1 | intensive trapping |
| Key undesirable species | 3 | Willow, large amounts of Blackberry, Bidens are found in the surrounding area. |
| % catchment in introduced vegetation | 4 | Mostly farmland/residential |
| Other landuse threats | 0 | |
| **Total wetland pressure index /30** | 12 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Nga Manu (north)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Nga Manu | **Date:** | 12.02.2015 | **Plot no:** | 1 |
| **Plot size:** | 2m x 2m | **Elevation:** | 15m a.s.l | **Northing:** | 5474506 |
| **Personal:** | TR, TP | **Structure:** | Carex sedgeland | **Easting** | 1773506 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species1 (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Carex lessonia* | 5 | 4.5 | *Muehlenbeckia australis* | 5 | 1.8 | *Rubus fruticosus* | 1 | 0.7 |
| *Phormium tenax* | 2 | 2.4 | *Carex virgata* | 60 | 1.8 | *Juncus pallidus* | 2 | 0.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Typha oreintalis* | 5 | 2.3 | *Pteridium esculentum* | 15 | 2 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** some mistletoe seen in Manuka (planted).

**Fauna seen:** Tui abundant

**Comments:** ground soggy but no surface water.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 1 | 4 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| **Total /20** | | 19 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

## Plot 2: Nga Manu (south)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Nga Manu | **Date:** | 12.02.2015 | **Plot no:** | 2 |
| **Plot size:** | 2m x 2m | **Elevation:** | 10m a.s.l | **Northing:** | 5474372 |
| **Personal:** | TR, TP | **Structure:** | Manuka – broadleaved / flax | **Easting** | 1773492 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Carex lessoniana* | 2 | 1.7 | *Rubus australis* | 1 | 0.2 | *Hisiopteris incisa* | 2 | 0.7 |
| *Phormium tenax* | 25 | 2.4 | *Pseudopanax arboreus* | 2 | 1.4 | *Coprosma lucida.* | 2 | 0.8 |
| *Geniostoma ligustrifolium* | 10 | 2.5 | *Rubus fruticosus* | 5 | 1.3 | *Blechnum minus* | 2 | 0.8 |
| *Leptospermum scoparium* | 10 | 5 | *Piper excelsum* | 5 | 1.6 | | | |
| *Coprosma grandifolia* | 15 | 3 | *Myrsine australis* | 5 | 0.7 | | | |
| *Coprosma rigida* | 10 | 3 | *Coprosma tenuicaulis* | 2 | 1.7 | | | |
| | | | *Melicytus ramifllorus* | 1 | 0.4 | | | |

[1] % = % cover: total Canopy % cover = 100%;  H = maximum height in m;  indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Cordyline australis*

**Fauna seen:** Tui abundant, fantail.

**Comments**: 10m east of track,  Drainage ditch nearby

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 5 | 4 | |
| Total species: % number introduced spp | 5 | 4 | |
| Total species: overall stress/dieback | 0 | 5 | |
| | **Total /20** | 18 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 6 |

# Te Haupua Complex A

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 11.02.15 |
| **Wetland name:** | Te Haupua Complex A | **Personal:** | TR, TP |
| **Region:** | Kapiti Coast, Wellington | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Drained farmland surrounding. | 4 | 3.67 |
| | Water table depth | None for a metre...... | 3 | |
| | Dryland plant invasion | Pasture grass species | 4 | |
| Change in physico-chemical parameters | Fire damage | nil | 5 | 3.75 |
| | Degree of sedimentation/erosion | none visible | 5 | |
| | Nutrient levels | farmland surrounds | 4 | |
| | Von Post index | Sandy peat soils (9) | 1 | |
| Change in ecosystem intactness | Loss in area of original wetland | was once part of a larger complex | 4 | 4 |
| | Connectivity barriers | road, farming, devolpment has fragmented wetland | 4 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Rabbits | 3 | 3.33 |
| | Introduced predator impacts on wildlife | Trapping carried out | 2 | |
| | Harvesting levels | None | 5 | |
| Change in dominance of | Introduced plant canopy cover | some woody weeds (gorse, blackberry) | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| native plants | Introduced plant understorey cover | Lotus, hydropiper, forget me not. | 4 | |
| | | | **Total wetland condition index /25** | 18.75 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** I*soplepis, Carex secta*, pasture grasses

**Native fauna:** none

**Other comments:** Majority of wetland planted. Boardwalk running through. Both weed and pest mammals controlled.

| **Pressure** | **Score[2]** | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 4 | Majority of the catchment in forestry, farming or residential. |
| Water quality within the catchment | 3 | |
| Animal access | 3 | Fenced, some predator control. |
| Key undesirable species | 4 | Willow in catchment. |
| % catchment in introduced vegetation | 4 | Mostly farmed. |
| Other landuse threats | 0 | Development, Reclamation |
| **Total wetland pressure index /30** | 18 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Te Haupua Complex A (south)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te Haupua Complex A | **Date:** | 11.02.2015 | **Plot no:** | 1 |
| **Plot size:** | 2m x 2m | **Elevation:** | 10m a.s.l | **Northing:** | 5479213 |
| **Personal:** | TR, TP | **Structure:** | Juncus-carex – sedgeland, herbfield | **Easting** | 1774728 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species1 (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Juncus pallidus* | 2 | 1.7 | | | | *Bidens frondosa* | 1 | 0.3 |
| *Juncus australis* | 1 | 0.7 | | | | *Persicaria hydropiper* | 4 | 0.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Isolepis prolifera* | 60 | 0.4 | | | | *Galium propinqum* | 5 | 0.3 |
| *Carex secta* | 10 | 1.5 | | | | *Myosotis arvensis* | 20 | 0.2 |
| | | | | | | *Agrostis stolonifera* | 1 | 0.3 |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Isolepis,* forget me not, *Carex virgata, Austroderia toetoe, Cyprus australi*s

**Fauna seen:** Pukeko

**Comments:** Plot to the west of boardwalk, adjacent to the Waimeha river, by Cabbage tree.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 0 | |
| Understorey: % cover introduced spp[3] | 30 | 3 | |
| Total species: % number introduced spp | 30 | 3 | |
| Total species: overall stress/dieback | 0 | 0 | |
| | **Total /20** | **6** | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high. [3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | 0 | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 9 |

## Plot 2: Te Haupua Complex A (south)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te Haupua Complex A | **Date:** | 11.02.2015 | **Plot no:** | 2 |
| **Plot size:** | 2m x 2m | **Elevation:** | 10m a.s.l | **Northing:** | 5479378 |
| **Personal:** | TR, TP | **Structure:** | Juncus-carex rush-sedgeland | **Easting** | 1774778 |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species1 (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Carex virgata* | 1 | 0.8 | *Agrostis stolonifera* | 2 | 0.5 | | | |
| *Juncus pallidus* | 2 | 0.7 | *Galium propinqum* | 1 | 0.7 | | | |
| *Holcus lanatus* | 5 | 1 | *Isolepis prolifera* | 10 | 0.5 | | | |
| *Juncus sarophorus* | 15 | 1.2 | *Carex lessoniana* | 15 | 0.6 | | | |
| *Bidens frondosa* | 10 | 0.7 | *Juncus australis* | 40 | 0.3 | | | |
| *Lotus pedunculatis* | 10 | | | | | | | |
| *Phormium tenax* | 1 | 2 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** flax, raupo.

**Fauna seen:** none

**Comments:** Appears to be particularly dry (no groundcover suggests, normally quite wet).

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 25 | 3 | |
| Understorey: % cover introduced spp[3] | 3 | 4 | |
| Total species: % number introduced spp | 28 | 3 | |
| Total species: overall stress/dieback | 0 | 5 | |
| Total /20 | | 15 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

# Te Haupua Complex D (Pateke Lagoon)

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 12.02.15 |
| **Wetland name:** | Te Haupua Complex D | **Personal:** | TR, TP |
| **Region:** | Kapiti Coast, Wellington | **# of Plots sampled:** | 2 |

| **Classification: I System** | **IA Subsystem** | **II Wetland Class** | **IIA Wetland Form** |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| **Indicator** | **Indicator components** | **Specify and Comment** | **Score 0– 5[1]** | **Mean score** |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | | 5 | 4.5 |
| | Water table depth | | Not encountered, 0.5 EOH (collapsing) | |
| | Dryland plant invasion | Blackberry, Yorkshire fog | 4 | |
| Change in physico-chemical parameters | Fire damage | | 5 | 4.67 |
| | Degree of sedimentation/erosion | | 5 | |
| | Nutrient levels | | Unknown | |
| | Von Post index | | 4 | |
| Change in ecosystem intactness | Loss in area of original wetland | | 3? | 3 |
| | Connectivity barriers | | 3 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | | 4 | 4 |
| | Introduced predator impacts on wildlife | | 3 | |
| | Harvesting levels | | 5 | |
| Change in dominance of | Introduced plant canopy cover | | 5 | 4.5 |

| | | | | |
|---|---|---|---|---|
| native plants | Introduced plant understorey cover | | 4 | |
| **Total wetland condition index /25** | | | | 20.67 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** Harakeke, raupo, *Carex lessoniana,* Blackberry

**Native fauna:** Swamp harrier, Pukeko, Royal Spoonbill had been seen by owner

**Other comments:** Wetland has been restored.

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 4 | Majority of the catchment in forestry, farming or residential. |
| Water quality within the catchment | 3 | Some of the catchment farmed. |
| Animal access | 3 | Fenced, some predator control. |
| Key undesirable species | 4 | Willow in catchment. |
| % catchment in introduced vegetation | 4 | |
| Other landuse threats | 2 | M2PP motorway construction. |
| **Total wetland pressure index /30** | 20 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Te Haupua Complex D (Pateke Lagoon) (north)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te Haupua Complex D | **Date:** | 12.02.2015 | **Plot no:** | 1 |
| **Plot size:** | 2m x 2m | **Elevation:** | 10m a.s.l | **Northing:** | 5479221 |
| **Personal:** | TR, TP | **Structure:** | Juncus-carex rush-sedgeland | **Easting** | 1775818 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species1 (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Juncus pallidis* | 2 | 1.7 | *Pteridium esculentum* | 5 | 1.3 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Phormium tenax* | 5 | 2 | *Holcus lanatus* | 10 | 0.8 | | | |
| *Typha orientalis* | 2 | 2 | *Rubus fruticosus* | 2 | 0.7 | | | |
| *Carex germinata* | 80 | 1.5 | | | | | | |
| *Carex lessoniana* | | | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Dicksonia squarrosa, Muehenbeckia complexa, convolvulus* , Ragwort, Blackwood

**Fauna seen:** Swamp Harrier.

**Comments:** Plot located North of house between pine shelter belt and tree group containing *Dicksonia squarrosa* and Blackwood,

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 12 | 4 | |
| Total species: % number introduced spp | 12 | 4 | |
| Total species: overall stress/dieback | n/a | 4 | blackberry dieback |
| **Total /20** | | | |

[2] 5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3] Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | Not for a metre | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

## Plot 2: Te Haupua Complex D (Pateke Lagoon) (south)

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te Haupua Complex D | **Date:** | 12.02.2015 | **Plot no:** | 2 |
| **Plot size:** | 2m x 2m | **Elevation:** | 10m a.s.l | **Northing:** | 5479476 |
| **Personal:** | TR, TP | **Structure:** | Juncus-carex rush-sedgeland | **Easting** | 1775876 |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species1 (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Carex virgata* | 35 | 1.4 | | | | | | |
| *Carex lessoniana* | 70 | 1 | | | | | | |
| | | | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** Ink weed to the north of plot, *Muehlenbeckia australis* to the east. Bracken to the west. Bidens and Raupo also nearby.

**Fauna seen:** Pukeko

**Comments:**

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| **Total /20** | | 20 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high. [3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

# Te Harakeke - Wetland Record Sheet

| | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 26.2.15 |
| **Wetland name:** | Te Harakeke | **Time:** | 12.57 |
| **Region:** | Kapiti Coast | **Personal:** | Tess, Tony |
| **Altitude:** | 5 | **# of Plots sampled:** | 2 |

| **Classification: I System** | **IA Subsystem** | **II Wetland Class** | **IIA Wetland Form** |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| **Indicator** | **Indicator components** | **Specify and Comment** | **Score 0– 5[1]** | **Mean score** |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | drainage, fragmentation from nearby oxidation ponds, residential development and roads have altered original flows of wetland | 3 | 3 |
| | Water table depth | Previous studies | n/a | |
| | Dryland plant invasion | Some blackberry and convolvulus encroching into wetland. | 3 | |
| Change in physico-chemical parameters | Fire damage | nil | 5 | 4 |
| | Degree of sedimentation/erosion | nil | 5 | |
| | Nutrient levels | n/a | n/a | |
| | Von Post index | high (score of 7) | 2 | |
| Change in ecosystem intactness | Loss in area of original wetland | Originally part of a wider dune complex | 4 | 3.5 |
| | Connectivity barriers | Housing on one side of wetland and M2PP on other. . | 3 | |
| Change in browsing, predation & harvesting | Damage by domestic or feral animals | Stock has been fenced | 4 | 4.333333333 |
| | Introduced predator impacts on wildlife | predator control as part of QEII covernent | 4 | |

| | | | | |
|---|---|---|---|---|
| regimes | | and GW KNE programme | | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | Blackberry/Conolvulus | 3 | 4 |
| | Introduced plant understorey cover | none | 5 | |
| **Total wetland condition index** /25 | | | | 18.83333333 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** Differs throughout wetland, ranging from carex sedgeland, raupo rushland, and manuka semi-swamp.

**Native fauna:** tui, fantail, grey warbler:

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 2 | A reduction in flood pulsing |
| Water quality within the catchment | n/a | No water seen… |
| Animal access | 1 | Fenced |
| Key undesirable species | 2 | Willow, Bidens, elder are all found within region |
| % catchment in introduced vegetation | 2 | Blackberry, convolvulus found in catchment. |
| Other landuse threats | 0 | |
| **Total wetland pressure index** /30 | 7 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Te Harakeke

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te harakeke | **Date:** | 26.2.2015 | **Plot no:** | 1 |
| **Plot size:** | 2m x 2m | **Altitude::** | | **Northing** | 5475012 |
| **Personal:** | Tess R, Tony P (Boffa Miskell) | **Structure:** | Sedgeland | **Easting** | 1772191 |

| **Canopy** (bird's eye view) | **Subcanopy** | **Groundcover** |
|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Species**[1] (or Substrate) | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |
| *Carex lessoniana* | *50* | *1.7* | | | | | | |
| *Pteridium esculentum* | 10 | 1.8 | | | | | | |
| *Calystegia sepium* | 30 | 1.7 | | | | | | |
| *Rubus fruticosus* | 10 | 1.6 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** On higher *hummocks and banks- cabbage trees, Melicytus ramiflorus, Manuka,* Coprosma tenufolium

**Comments:** Plot is accessed through wire frame gate. To the left. In the middle of two prominent cabbage trees (see phots)

| **Indicator** (use plot data only) | **%** | **Score 0–5**[2] | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 40 | 3 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 40 | 3 | |
| Total species: overall stress/dieback | n/a | 5 | |
| **Total** /20 | | 16 | |

[2] 5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high
[3] Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | 0 | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

## Plot 2: Te Harakeke

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Te harakeke | **Date:** | 26.2.2015 | **Plot no:** | 2 |
| **Plot size:** | 2m x 2m | **Altitude::** | 10m a.s.l | **Northing** | 5474486 |
| **Personal:** | TR, TP | **Structure:** | Typha rushland | **Easting** | 1771925 |

| **Canopy** (bird's eye view) | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species**[1] (or Substrate) | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Typha orientalis* | *25* | *2.2* | *Bidens frondosa* | 5 | 0.6 | | | |
| *Juncus pallidus* | 25 | | *Willowweed* | 20 | 0.5 | | | |
| *Holcus lanatus* | 15 | | *Isolepis prolifera* | 5 | 0.2 | | | |
| | | | *Chickweed* | 2 | 0.5 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Carex umbellata* (plot is behind a pocket of this), lots of bidens to the left. Manuka on the left also.

**Comments:** Plot is found to the right of manuka tree

| **Indicator** (use plot data only) | **%** | **Score 0–5**[2] | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 15 | 4 | |
| Understorey: % cover introduced spp[3] | 27 | 3 | |
| Total species: % number introduced spp | 42 | 3 | |
| Total species: overall stress/dieback | n/a | 2 | Some Raupo (*Typha oreintalis*) dieback in areas of Yorkshire Fog (*Holcus lanatus*) establishment |
| **Total** /20 | 12 | | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high
[3]Add subcanopy and groundcover % cover for introduced species

**Field measurements:**

| | | | |
|---|---|---|---|
| Water table cm | **0** | Water conductivity uS (if present) | **n/a** |
| Water pH (if present) | **n/a** | Von Post peat decomposition index | **7** |

# El Rancho Wetland

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | M2PP | **Date:** | 9.10.15 |
| **Wetland name:** | El Rancho | **Time:** | 12.47 |
| **Region:** | Kapiti Coast | **Personal:** | Tess + Pat |
| **Altitude:** | 3 | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0–51 | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Drains cut through interior of the wetland | 3 | 3 |
| | Water table depth | Altered though drainage | 2 | |
| | Dryland plant invasion | Blackberry, gorse and herbaceous weeds invading | 4 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 4 |
| | Degree of sedimentation/erosion | Nil | 5 | |
| | Nutrient levels | Nil | 5 | |
| | Von Post index | High decomposition | 1 | |
| Change in ecosystem intactness | Loss in area of original wetland | Some historic loss through past development. | 4 | 3 |
| | Connectivity barriers | Low | 2 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Pugging seen within interior of wetland. Little browse by stock. | 3 | 4 |
| | Introduced predator impacts on wildlife | Low - near residential housing. No control | 4 | |

| | | | | |
|---|---|---|---|---|
| | Harvesting levels | Nill | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | Nil | 4 | 4 |
| | Introduced plant understorey cover | Some blackberry, gorse and herbaceous weeds. | 4 | |
| | | | **Total wetland condition index /25** | 18.00 |

1 Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** Both plots in main wetland were within a regenerating manuka wetland.

**Native fauna**: None seen

**Other comments:** Very dry with pugging seen (although this could now be historical).

| **Pressure** | **Score[2]** | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 2 | Water tables look reduced. |
| Water quality within the catchment | 1 | El Rancho grazing some rubbish dumping and residental pollution |
| Animal access | 1 | fenced |
| Key undesirable species | 3 | Catchment contains numerous weed species (close to weedy Waikanae river corridor) |
| % catchment in introduced vegetation | 4 | Highly modify catchment of pasture with blackberry and gorse. |
| Other landuse threats | 4 | Gas pipeline. |
| **Total wetland pressure index /30** | 15 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: El Rancho Wetland

| **WETLAND PLOT SHEET 1.** | | | |
|---|---|---|---|
| **Wetland name:** | El Rancho | **Conditions** | Sunny, calm |
| **Plot no:** | 1 | **X coordinates (m):** | 1,770,890.714 |
| **Date:** | 9/02/2015 | **Y coordinates (m):** | 5,473,235.161 |
| **Time:** | 12.46am | **Structure:** | Shrubland |

| **Personal:** | Tess, Pat | **Composition:** | Manuka swamp |
|---|---|---|---|

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |
| *Leptospermum scoparium* | 70 | 5 | | | | *Viola philicorlus* | 55 | 0.1 |
| | | | | | | *Schenous musculanus* | 10 | 0.05 |
| | | | | | | *Galium propinquum* | 5 | 0.1 |
| | | | | | | *Ranunculus glabrifolius* | 1 | 0.05 |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type**: Gorse, blackberry, tree fern seedlings starting to pop up in light gaps.

**Fauna seen**:

**Comments:** dense uniform canopy of manuka helps to deter weed introductions. Some blackberry is surviving beneth canopy, yet not spreading.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 5 | 4 | |
| Total species: % number introduced spp | 1 | 4 | |
| Total species: overall stress/dieback | 20 | 4 | Manuka is starting to thin out. Suggest canopy photos on next monitoring visit to compare. |
| **Total /20** | | 17 | |

[2] 5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high [3] Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

## Plot 1: El Rancho Wetland

| WETLAND PLOT SHEET 1. | | | |
|---|---|---|---|
| **Wetland name:** | El Rancho | **Conditions** | Sunny, calm |
| **Plot no:** | 2 | **X coordinates (m):** | 1,770,901.668 |
| **Date:** | 9/02/2015 | **Y coordinates (m):** | 5,473,223.784 |
| **Time:** | 12.46am | **Structure:** | Shrubland |
| **Personal:** | Tess, Pat | **Composition:** | Manuka swamp |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |
| *Leptospermum scoparium* | 60 | 4 | *Coprosma pro X rob* | 1 | 0.7 | *Taraxacum officinale* | 1 | 0.1 |
| | | | *Coprosma tenuicaulis* | 2 | 1.3 | *Dichondra repens* | 2 | 0.05 |
| | | | *Cyathea medularis* | 1 | 0.2 | *Schoenus maschalinus* | 3 | 0.05 |
| | | | *Blechnum minus* | 2 | 0.3 | *Lotus pendunculatus* | 2 | 0.05 |
| | | | *Melicytus ramiflorus* | 1 | 0.2 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** R*ubus fruticosus, Darex dissita,* foxglove, *Geneostima ligustrifolium*

**Fauna seen**:

**Comments:** Dryer than plot 2.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 3 | 4 | herbaceous weeds |
| Total species: % number introduced spp | 3 | 4 | |

| | | | |
|---|---|---|---|
| Total species: overall stress/dieback | n/a | 4 | Manuka appears to be thinning. |
| | **Total /20** | 17 | |
| [2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high<br>[3]Add subcanopy and groundcover % cover for introduced species | | | |
| | | | |

| | | | |
|---|---|---|---|
| **Field measurements:** | | | |
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

## Peka Peka Rd Wetland

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti Water Supply | **Wetland name:** | Peka Peka Rd Wetland |
| **Date:** | 11/02/2015 | **Region:** | Kapiti Coast, Wellington |
| **Time:** | 11.15am | **Altitude:** | 14m |
| **Personal:** | TR, TP | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Surrounding farmland drained, some impact of road to the north. | 4 | 4 |
| | Water table depth | 20cm below surface | 4 | |
| | Dryland plant invasion | Blackberry on margins, 1 poisoned willow | 4 | |
| Change in physico-chemical parameters | Fire damage | nil | 5 | 3.75 |
| | Degree of sedimentation/erosion | Surrounding farmland | 4 | |
| | Nutrient levels | Surrounding farmland | 4 | |
| | Von Post index | scored high (7) | 2 | |
| Change in ecosystem intactness | Loss in area of original wetland | originally part of a bigger wetland complex | 3 | 3.5 |
| | Connectivity barriers | Road, pasture | 4 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | No sign of browse | 5 | 4.33 |
| | Introduced predator impacts on wildlife | Cats, rats, stoats | 3 | |
| | Harvesting levels | nil | 5 | |
| Change in dominance of | Introduced plant canopy cover | Blackberry, willows 15% | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| native plants | Introduced plant understorey cover | Some herbaceous weeds present. | 4 | |
| | | | **Total wetland condition index /25** | 19.58 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** *Austroderia toetoe,* Raupo, *Coprosma tenuiculis, Comprosma ridgia, Carex secta, Phormium tenax*

**Native fauna:** Grey warbler, fantail

**Other comments:** Access > enter wetland at fenceline then walk south under tree canopy, plot is 5m in from the end of this row of trees/willows

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 2 | Most of catchment in drained farmland, forestry. |
| Water quality within the catchment | 2 | Runoff from farming. |
| Animal access | 3 | Fenced |
| Key undesirable species | 1 | Willow within catchment (and wetland) |
| % catchment in introduced vegetation | 4 | Kapiti Coast developed into farmland/forestry and residential |
| Other landuse threats | 3 | Development occurring to the east of the wetland. |
| **Total wetland pressure index /30** | 15 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Peka Peka Road (north)

| **WETLAND PLOT SHEET 1** | | | |
|---|---|---|---|
| **Wetland name:** | Peka Peka | **Conditions** | Sunny, calm |
| **Plot no:** | 1 | **X coordinates (m):** | 1773808 |
| **Date:** | 11/02/2015 | **Y coordinates (m):** | 5477103 |
| **Time:** | | **Structure:** | Raupo, sedgeland |
| **Personal:** | Tess R, Tony P | **Composition:** | Raupo Carex |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| Species[1] (or Substrate) | % | H(m) | Species | % | H(m) | Species | % | H(m) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Austrideria toetoe* | 10 | 2.5 | *Carex secta* | 10 | 1.7 | Sphagnum moss | 5 | 0.05 |
| *Typha oreintalis* | 15 | 2.2 | *Juncus pallidus* | 2 | 1.7 | | | |
| *Coprosma propinqua* | 20 | 2 | *Dicksonia squarrosa* | 10 | 1.4 | | | |
| | | | *Blechnum minus* | 3 | 0.8 | | | |
| | | | *Hypolepis distans* | 3 | 0.8 | | | |
| | | | *Phormium tenax* | 2 | 1.5 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** willow, blackberry

**Fauna seen:**

**Comments:** Plot is at the edge of the willows from the northern boundary.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| Total /20 | | 20 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm (in relation to soil surface)** | 30cm | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 9 |

## Plot 2: Peka Peka Road (south)

| **WETLAND PLOT SHEET 2.** |
|---|

| **Wetland name:** | Peka Peka Road | **Conditions** | Sunny, calm |
|---|---|---|---|
| **Plot no:** | 2 | **X coordinates (m):** | 1774481 |
| **Date:** | 11/02/2015 | **Y coordinates (m):** | 5476995 |
| **Time:** | | **Structure:** | Shrubland/sedgeland |
| **Personal:** | | **Composition:** | Comprosma/Flax/Isolepis |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Phormium tenax* | 2 | 1.6 | *Isolepis prolifera* | 80 | 0.2 | *Taraxacum officinale* | 1 | 0.4 |
| *Coprosma propinqua* | 1 | 1.8 | *Carex secta* | 1 | 0.3 | *Holcus lanatus* | 1 | 0.1 |
| *Typha orientalis* | 2 | 1.7 | *Leptospermum scoparium* | 1 | 0.7 | *Agrostis stolonifera* | 1 | 0.2 |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** Sphagnum, *Juncus pallidus*

**Fauna seen:**

**Comments:**

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 3 | 4 | |
| Total species: % number introduced spp | 3 | 4 | |
| Total species: overall stress/dieback | 0 | 5 | |
| **Total /20** | | 18 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm (in relation to soil surface)** | 14 | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 8 |

## Tini Bush

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 10.02.2015 |
| **Wetland name:** | Tini Bush | **Time:** | 11.05 |
| **Region:** | Kapiti Coast | **Personal:** | TR, PE |
| **Altitude:** | 19 | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | road and rail run through either end. | 4 | 4 |
| | Water table depth | n/a | | |
| | Dryland plant invasion | kohekohe seedlings | 4 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 4 |
| | Degree of sedimentation/erosion | Soroundings farmed | 4 | |
| | Nutrient levels | Soroundings farmed | 4 | |
| | Von Post index | 5 | 3 | |
| Change in ecosystem intactness | Loss in area of original wetland | Originally part of a bigger wetland complex | 2 | 2.5 |
| | Connectivity barriers | Farm drains present. | 3 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Fenced. Some baitlines. | 5 | 4.67 |
| | Introduced predator impacts on wildlife | | 4 | |
| | Harvesting levels | | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | | 5 | 4.5 |
| | Introduced plant | Limited to forest | 4 | |

| | | | | |
|---|---|---|---|---|
| | understorey cover | edges | | |
| | | | **Total wetland condition index /25** | 19.67 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** pukatea-kahikatea swamp forest

**Native fauna:** Tui

**Other comments:** Some pest control work

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 3 | |
| Water quality within the catchment | 3 | |
| Animal access | 1 | |
| Key undesirable species | 4 | |
| % catchment in introduced vegetation | 4 | |
| Other landuse threats | | |
| Total wetland pressure index /30 | 15 | |
| [2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none | | |

## Plot 1: Tini Bush

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | | **Date:** | | **Plot no:** | 1 |
| **Plot size (2m x 2m default):** | | **Altitude::** | | **GPS/GR: xxx** | |
| **Personal:** | | **Structure:** | | **Composition:** | |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |
| *Laurelia novae-* | 40 | 25 | *Coprosma grandifolia* | 1 | 0.6 | *Laurelia novae-zelandiae* | 1 | 0.1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *zelandiae* | | | | | | seedlings | | |
| | | | *Freycinetia banksii* | 40 | 0.5 | | | |
| | | | *Dicksonia squarrosa* | 1 | 0.3 | | | |
| | | | *Geniostoma ligustrifolium* | 2 | 0.4 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Cyathia medullaris,* pigeonwood, Nikau, *Dacrycarpus dacrydioides*, *Coprosma tenufolium*

**Comments:**

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 0 | 5 | |
| Total /20 | | 20 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high [3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | below ground level | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 5 |

## Plot 2: Tini Bush

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Tini Bush | **Date:** | 10.2.15 | **Plot no:** | 2 |
| **Plot size** | (2m x 2m default): | **Altitude::** | 11m | **Northing** | 5471425 |
| **Personal:** | TR, PE | **Structure:** | Coastal swamp forest | **Easting** | 1771511 |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Cordyline australis* | *10* | *3.5* | *Laurelia novae-zelandiae* | 2 | 2 | *Deperia petersenii* | | |
| *Cyathea medullaris* | 40 | 3.5 | *Coprosma grandifolia* | 1 | 0.7 | *Pyrrosia eleagnifolia* | | |
| *Coprosma robusta* | 5 | 2 | *Carex virgata* | 1 | 1.2 | *Lemna disperma* | | |
| *Genistoma ligustrifolium* | 2 | 1.7 | *Blechnum minus* | 1 | 0.5 | *Achillea millefolium* | | |
| *Melicytus ramiflorus* | 1 | 1 | *Parsonsia heterophylla* | 1 | 1.5 | *Juncos effusus* | | |
| | | | *Dacrycarpus dacrydioides* | 1 | 0.4 | | | |
| | | | *Rubus fruticosus* | 1 | 0.6 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type**: *Paesia scaberula , Hypolepis ambigua, Carex secta, Piper excelsum. Rubus fruticosus* on the sides

**Fauna seen**: none

**Comments:** Set on side of wetland. Some Yorkshire fog, gully fern

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 1 | 4 | Blackberry |
| Total species: % number introduced spp | 1 | 4 | |
| Total species: overall stress/dieback | 0 | 5 | |
| **Total /20** | | 18 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high. [3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 5 |

## Ngarara Bush

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti Water Supply | **Wetland name:** | Ngarara Bush |
| **Date:** | 26/02/2015 | **Region:** | Kapiti Coast, Wellington |
| **Time:** | 2.30pm | **Altitude:** | 14 m |
| **Personal:** | Tess R and Tony P | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Some Cut and fill around house/driveway. | 4 | 3. 67 |
| | Water table depth | Get Piezo reading. | 4 | |
| | Dryland plant invasion | Yes kohekohe pasture grasses and some solanum weed. | 3 | |
| Change in physico-chemical parameters | Fire damage | nil | 5 | 3.75 |
| | Degree of sedimentation/erosion | almost none, some off farmland surrounding property | 4 | |
| | Nutrient levels | almost none, some off farmland surrounding property | 4 | |
| | Von Post index | High | 2 | |
| Change in ecosystem | Loss in area of original wetland | would have been part of larger wetland complex | 2 | 2.5 |

| | | | | |
|---|---|---|---|---|
| intactness | Connectivity barriers | Driveway, road will have some effect on connectivity | 3 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Possums | 4 | 4 |
| | Introduced predator impacts on wildlife | Some cats, possums, rats, mustaileds, presummed present. No trapping | 4 | |
| | Harvesting levels | Nil | 4 | |
| Change in dominance of native plants | Introduced plant canopy cover | Some climbing pest plants | 4 | 4 |
| | Introduced plant understorey cover | pasture grasses, exotic herbs | 4 | |
| | | | **Total wetland condition index /25** | 17.92 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** pukatea, kahikatea, Semi-swamp forest, with kohekohe on margins.

**Native fauna:** Tui, Kereru, fantail (near Nga Manu)

**Other comments:** Currently very dry (cracked earth in places). Kohekohe on surrounding higher points

| **Pressure** | **Score[2]** | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 4 | Most of the Catchment is in drained farmland, |
| Water quality within the catchment | 3 | mostly farmed |
| Animal access | 4 | No impediment to access, no control carried out. |
| Key undesirable species | 2 | |
| % catchment in introduced vegetation | 4 | Farmed and forested with pockets of native bush. |
| Other landuse threats | | |
| **Total wetland pressure index /30** | 17 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Ngarara Bush (north)

| **WETLAND PLOT SHEET 1.** | | | |
|---|---|---|---|
| **Wetland name:** | Ngarara Bush | **Conditions** | Sunny, calm |

| Plot no: | 1 | X coordinates (m): | 1773006 |
|---|---|---|---|
| Date: | 26/02/2015 | Y coordinates (m): | 5474765 |
| Time: | 2.30pm | Structure: | Pukatea-kahikatea swamp forest |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| Species1 (or Substrate) | % | H(m) | Species | % | H(m) | Species | % | H(m) |
| *Melicytus ramiflorus* | 40 | 3.5 | *Dysoxylum spectiabile* | 25 | 1.4 | *Muehlenbeckia australis* | 1 | 0.1 |
| *Dacrycarpus dacrydioides* | 5 | 3.5 | *Geniostoma ligustrifolium* | 2 | 1 | | | |
| | | | *Histiopteris incisa* | 5 | 0.7 | | | |
| | | | *Hedycarya arborea* | 1 | 0.4 | | | |
| | | | *Laurelia novae-zelandiae* | 1 | 0.2 | | | |
| | | | *Parsonsia capsularis* | 2 | 0.4 | | | |
| | | | *Beilschmiedia tawa* | 1 | 0.2 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** Laurelia novae-zelandiae, Hinau on margins, coastal kohekohe forest on higher terrace

**Fauna seen:** Tui

**Comments:** Plot corners - mahoe x2 kahikatea, kohekohe. See photos for ref.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | n/a | 4 | some canopy dieback |
| **Total /20** | | | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 5 |

## Plot 2: Ngarara Bush (South)

| WETLAND PLOT SHEET 2. | | | |
|---|---|---|---|
| **Wetland name:** | Ngarara Bush | **Conditions** | Sunny, calm |
| **Plot no:** | 2 | **Easting** | 1773829 |
| **Date:** | 26.06.2011 | **Northing** | 5475040 |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Melicytus ramiflorus* | 15 | 4.5 | *Histiopteris incisa* | 30 | 1.8 | *Digitalis purpurea* | 20 | 0.4 |
| | | | *Geniostoma ligustrifolium* | 5 | 0.6 | *Dacrycarpus dacrydioides* | 1 | 0.1 |
| | | | *Laurelia novae-zelandiae* | 8 | 0.8 | *Cyathea sp* | 1 | 0.1 |
| | | | *Dysoxylum spectabile* | 1 | 0.2 | *Rubus fruticosus* | 2 | 0.6 |
| | | | *Hedycarya arborea* | 4 | 0.5 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** Two large kaihiatea to the north. Large mamaku surrounding.

**Fauna seen:** none.

**Comments:** Plot corner is Melicytus ramiflorus marked then from that 90 degrees west and south for 2m. See pics for ref.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 22 | 4 | |

| | | | |
|---|---|---|---|
| Total species: % number introduced spp | 22 | 4 | |
| Total species: overall stress/dieback | 10 | 4 | Some Hisinc dieback. |
| **Total /20** | | 17 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

## Ngarara Road

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti Water Supply | **Wetland name:** | Ngarara Road Wetland |
| **Date:** | 12/02/2015 | **Region:** | Kapiti Coast, Wellington |
| **Time:** | 2.53pm | **Elevation (**m.a.s.l) | 10 m.a.s.l |
| **Personal:** | Tess + Pat | **# of Plots sampled:** | 1 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Possible impact by local borefields | 4 | 2.67 |
| | Water table depth | Below surface | 3 | |
| | Dryland plant invasion | High - blackberry is the dominant plant | 1 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 4.25 |
| | Degree of sedimentation/erosion | Nil | 5 | |
| | Nutrient levels | Stock and peat changes with lack of water | 4 | |
| | Von Post index | Moderate (6) | 3 | |
| Change in ecosystem intactness | Loss in area of original wetland | Historical extent diminished most likely due to bore use and farming. M2PP motorway construction has also reduced size | 2 | 2.50 |
| | Connectivity barriers | Close to Nga Manu. Large areas of blackberry with surrounding farmland. | 3 | |
| Change in browsing, predation & harvesting | Damage by domestic or feral animals | Wetland exterior reasonably fenced. Some sheep and cattle grazing on outside | 4 | 4.00 |

| | | | | |
|---|---|---|---|---|
| regimes | | edges, yet interior protected by thick blackberry. | | |
| | Introduced predator impacts on wildlife | With fernbird being observed in area this is presumed to be low to moderate. Close to Waikanae. | 3 | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | Blackberry and Gorse cover is increasing | 2 | 2.00 |
| | Introduced plant understorey cover | Pasture weeds, Beggars' tick, Blackberry and gorse encroaching. | 2 | |
| | | | **Total wetland condition index /25** | 15.42 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types**: Sedgeland (Carex secta, Carex virgata and Cyperus ustulatus) with blackberry and ferns. Some manuka in wetter areas, kanuka on raised mounds and wetland edges,

**Native fauna:** Tui, Kereru (close to Nga Manu)

**Other comments:** Monitoring focused on native sedgeland in wetland interior. Based on a review of historic photos, sedgeland and manuka were dominant habitat types. However, blackberry and gorse invasion in wetland edges and interior has resulted in rapid loss of these communities and blackberry the dominant vegetation community. Restricted sampling to 1 plot. Changed hydrology observed in dryland species invasion (rapid). 2013/14 notes – increased extent of blackberry observed through wetland. Very dry site conditions at time of survey and groundwater low

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 3 | Farm drainage, bore extraction |
| Water quality within the catchment | 2 | Run off from surrounding farms |
| Animal access | 2 | Predator pests presummed, fenced |
| Key undesirable species | 4 | Blackberry now dominante vegetation in wetter interior |
| % catchment in introduced vegetation | 4 | Majority of catchment in farming. Nga Manu found nearby |

| | | |
|---|---|---|
| Other landuse threats | 3 | Bore extraction, farming, motorway construction, subdivision introducing garden weed species. |
| **Total wetland pressure index /30** | 18 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Ngarara Road

| WETLAND PLOT SHEET 1 | | | |
|---|---|---|---|
| **Wetland name:** | Ngarara Road | **Conditions** | Sunny, calm |
| **Plot no:** | 1 | **Easting** | 1773006 |
| **Date:** | 10/02/2015 | **Northing** | 5474765 |
| **Time:** | 10.40am | **Structure:** | shrub/sedge |
| **Personal:** | Tess, Pat | **Composition:** | blackberry/carex |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| Carex virgata | 50 | 1.5 | | | | Agrostis stolonifera | 2 | 0.4 |
| Carex secta | 5 | 1.7 | | | | | | |
| Cyprus ustulatus | 5 | 1.5 | | | | | | |
| Rubus fruticosus | 60 | 2.2 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** Dominated by blackberry, on raised margins grazed kanuka broadleaved shrub present. Gorse also entering from margins

**Fauna seen:**

**Comments:** Take machete and insect repellent with next time. Enter between Kanuka and lancewood on Northern bank. Pasture grass encroachment suggest continued decline in water table.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 60 | 2 | Blackberry cover more than doubled |

| | | | |
|---|---|---|---|
| | | | since last summer survey. |
| Understorey: % cover introduced spp[3] | 2 | 4 | pasture grass invasion suggests permanently lowered water table. |
| Total species: % number introduced spp | 62 | 2 | |
| Total species: overall stress/dieback | n/a | 4 | Sedges reduced in extent. |
| **Total /20** | | 12 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

# Otaihanaga South Wetland

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | M2PP | **Wetland name:** | Otaihanga South |
| **Date:** | 9/10/2015 | **Region:** | Kapiti Coast, Wellington |
| **Time:** | 2.53pm | **Altitude:** | 8 m.a.s.l |
| **Personal:** | Tess + Pat | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0– 5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Drainage, blockage, landfill | 1 | 2.00 |
| | Water table depth | artificially totally flooded | 0 | |
| | Dryland plant invasion | due to flooding dryland species are absent | 5 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 3.67 |
| | Degree of sedimentation/erosion | Some sedimentation drift off motorway noticed on leaves and in water film. | 2 | |
| | Nutrient levels | | | |
| | Von Post index | Strongly decomposed | 4 | |
| Change in ecosystem intactness | Loss in area of original wetland | M2PP construction has resulted in a large amount of original wetland to be lost. | 2 | 2.00 |
| | Connectivity barriers | Current loss of connectivity through road construction. | 2 | |
| Change in browsing, | Damage by domestic or feral animals | Canadian geese | 4 | 4.00 |

| | | | | |
|---|---|---|---|---|
| predation & harvesting regimes | Introduced predator impacts on wildlife | Moderate (cats and rats), residential zone, landfill, sewer nearby. | 3 | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | High, Blackberry, Gorse, Pampas, and beggars' tick all increasing dramatically. | 1 | 2.50 |
| | Introduced plant understorey cover | low, due to dense canopy. | 4 | |
| | | | **Total wetland condition index /25** | 14.17 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types:** *Carex secta, Carex virgata* sedgeland with thining scattered manuka. Mostly overtopped with beggars' tick (Bidens frondosa)

**Native fauna:** none seen within wetland

**Other comments:** Very dry

| Pressure | Score[2] | Specify and Comment |
|---|---|---|
| Modifications to catchment hydrology | 4 | Motorway construction has temporarily blocked flow connectivity of this wetland. |
| Water quality within the catchment | 4 | Leachate for adjacent landfill/sewage plant and farming has potentially effected water quality. |
| Animal access | 4 | Area fenced, no predator control. |
| Key undesirable species | 4 | Bidens frondosa is now dominating this wetland. Blackberry, Gorse, fireweed, inkweed and other weeds found in nearby wetlands. |
| % catchment in introduced vegetation | 4 | Almost entire catchment in landfill, farming and plantation pine. |
| Other landuse threats | 4 | Road construction has severed water flow, leading to drying out of wetland/dieback of native wetland species. |
| **Total wetland pressure index /30** | 24 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Otaihanga South Wetland

| WETLAND PLOT SHEET 1. | | | |
|---|---|---|---|
| **Wetland name:** | Otaihanga South | **Conditions** | Sunny, calm |
| **Plot no:** | 1 | **Easting** | 1770147 |
| **Date:** | 9/02/2015 | **Northing** | 5471252 |
| **Time:** | 3.20am | **Structure:** | Sedgeland |
| **Personal:** | Tess, Pat | **Composition:** | Carex |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Carex secta* | 30 | 1.7 | *Hypolepis ambigua* | 5 | 0.6 | *Sphagnum moss* | 2 | 0.02 |
| *Carex virgata* | 10 | 1.5 | | | | | | |
| *Bidens frondosa* | 70 | 1.8 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Cordyline australis, Austroderia fulvida, Leptospermum scoparium, Carex secta, Rubus fruticosus, Ulex europanous, Pinus radiata seedlings, Isolepis proliferata, Hypolepis distans.*

**Fauna seen:**

**Comments:** Bidens frondosa, Ulex europanous and Rubus fruticosus are increasing with the unusually dry conditions. Wilding pine also removed from area. Continued loss of sphagnum and manuka. Even deep pools have dried out.

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 70 | 2 | Bidens frondosa now dominates canopy |
| Understorey: % cover introduced spp[3] | 2 | 4 | Bidens seedlings |
| Total species: % number introduced spp | 70 | 2 | |
| Total species: overall stress/dieback | n/a | 4 | Starting to see dieback of Manuka in surrounding wetland |

| Total /20 | | 12 | |
|---|---|---|---|

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

## Plot 2: Otaihanga South Wetland

| **WETLAND PLOT SHEET 2.** | | | |
|---|---|---|---|
| **Wetland name:** | Otaihanga South | **Conditions** | Sunny, calm |
| **Plot no:** | 2 (cabbage tree) | **Easting** | 1770103 |
| **Date:** | 10/02/2015 | **Northing** | 5471212 |
| **Time:** | 9.20am | **Structure:** | Sedgeland |
| **Personal:** | Tess, Pat | **Composition:** | Carex |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H(m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Bidens frondosa* | 15 | 1.7 | *Hypolepis ambigua* | 10 | 1 | *Sphagnum moss* | 10 | 0.02 |
| *Carex secta* | 10 | 1.7 | *Isolepis prolifera* | 5 | 0.2 | *Hydrocotyle novae-zeelandiae* | 2 | 0.02 |
| *Carex virgata* | 60 | 1.3 | *Juncus pallidus* | 2 | 0.4 | | | |
| *Austroderia fulvida* | 10 | 1.3 | *Blechnum minus* | 5 | 0.3 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Hypolepis ambigua, Leptospermum scoparium, coprosma robusta, rubus fruticosus*

**Fauna seen:** none

**Comments:** Unnaturally dry. Wetland plant dieback/dryland plant encroachment noticable.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 15 | 4 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 15 | 4 | |
| Total species: overall stress/dieback | n/a | 4 | Some manuka dieback |
| **Total /20** | | 17 | |

5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

## Crown Hill, Manuka Bush Wetland

| WETLAND RECORD SHEET | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 10.2.15 |
| **Wetland name:** | Crown hill/manuka bush | **Time:** | 3.05 |
| **Region:** | Kapiti Coast | **Personal:** | Pat Tess |
| **Altitude:** | 19 | **# of Plots sampled:** | 2 |

| Classification: I System | IA Subsystem | II Wetland Class | IIA Wetland Form |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| Indicator | Indicator components | Specify and Comment | Score 0–5[1] | Mean score |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | Situated within residential area, with houses either side. | 2 | 2.5 |
| | Water table depth | n/a | | |
| | Dryland plant invasion | Some perenials and blackberry invading. | 3 | |
| Change in physico-chemical parameters | Fire damage | Nil | 5 | 4 |
| | Degree of sedimentation/erosion | | 5 | |
| | Nutrient levels | n/a | | |
| | Von Post index | Scored 7 | 2 | |
| Change in ecosystem intactness | Loss in area of original wetland | Due to topography of site and surrounds, this was likely part of a bigger wetland complex | 2 | 2 |
| | Connectivity barriers | Housing segments wetland on two sides. | 2 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | area fenced, possible possum damage | 4 | 3.67 |
| | Introduced predator impacts on wildlife | Very close to residential area, most likely high cat population. No predator control. | 2 | |

| | | | | |
|---|---|---|---|---|
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | Nil | 5 | 4.5 |
| | Introduced plant understorey cover | Some blackberry and tradescantia and pasture grasses on edge | 4 | |
| **Total wetland condition index /25** | | | | 16.67 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetationetation types:** pukatea-kahikatea Semi-swamp forest, some large Hinau present.

**Fauna:** Sparrow, starling.

**Other comments:** Small piece of relict vegetation. Margins have been planted with large specimen trees (Kahikatea, Rimu).

| **Pressure** | **Score**[2] | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 4 | Small area of wetland within built-up residential zone. |
| Water quality within the catchment | 2 | Nearby GW monitoring sites read water quality as good or, fair. |
| Animal access | 3 | pest animals associated with residental areas (cats, rats etc) |
| Key undesirable species | 2 | Blackberry, Willow. |
| % catchment in introduced vegetation | 4 | Most of catchment, residentail or farming. |
| Other landuse threats | 1 | Development, dumping of garden waste |
| Total wetland pressure index /30 | 16 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1 Crown Hill Manuka Bush

| **WETLAND PLOT SHEET** | | | |
|---|---|---|---|
| **Wetland name:** | Crown hill | **Plot no:** | 1 |
| **Personal:** | Tess and Pat | **Date:** | 10.2.2015 |
| **Northing**<br>**Easting** | 5470433<br>1769125 | **Composition:** | Laurelia novae-zelandiae, Kunzea, semi-swamp forest |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H(m)** | **Species** | **%** | **H(m)** |
| *Coprosma tenuicaulis* | *10* | *2* | *Hypolepis ambigua* | 15 | 0.8 | *Laurelia novae-zelandiae* seedlings | 1 | 0.1 |
| *Kunzea robusta* | 90 | 6 | *Carex virgata* | 15 | 0.7 | | | |
| *Muehlenbeckia complexa* | 1 | 4 | | | | | | |
| *Leptospermum scoparium* | 1 | 3 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Histoptera incisa, Cordyline australis, Myrsine australis, Melicope ternata*

**Comments:** Very dry, some garden waste / lawn clippings have been dumped nearby

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 1 | 4 | Some dieback in seedlings, carex |
| Total /20 | | 19 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |

| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |
|---|---|---|---|

## Plot 2 Crown Hill Manuka Bush:

| **WETLAND PLOT SHEET** | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Crown hill | **Date:** | 10.2.15 | **Plot no:** | 2 |
| **Plot size** | (2m x 2m default): | **Altitude::** | 13 m.a.s.l | **Northing** | 5470433 |
| **Personal:** | Pat Tess | **Structure:** | Manuka Swamp forest | **Easting** | 1769125 |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H** | **Species** | **%** | **H** | **Species** | **%** | **H** |
| *Leptospermum scoparium* | *30* | *5* | *Phormium tenax* | 1.00 | 2 | *Carex geminata* | 2 | 0.6 |
| *Myrisine australis* | 35 | 3.5 | *Coprosma tenufolium* | 5.00 | 2 | *Laurelia novae-zelandiae seedlings* | 2 | 0.01 |
| *Kunzea robusta* | 5 | 2.5 | *Histiopteris incisa* | 30.00 | 2 | | | |
| *Muehlenbeckia astonii* | 4 | 2 | | | | | | |

[1] % = % cover: total Canopy % cover = 100%;  H = maximum height in m;  indicate introduced species by *

**Additional species in vicinity in same vegetation type**: Aspobl, Carex virgata, kaihikatea, asp pol blackberry on the margins. Bidens present.

**Comments:** Margins look planted - kaihikatea and rim, vines thick, fern land in centre thick

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 0 | 5 | |
| Total species: % number introduced spp | 0 | 5 | |
| Total species: overall stress/dieback | 1 | 4 | |

| Total /20 | | 19 | |
|---|---|---|---|

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | b |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 7 |

## Poplar Ave Wetland

| **WETLAND RECORD SHEET** | | | |
|---|---|---|---|
| **Project:** | Kapiti water supply | **Date:** | 11.2.15 |
| **Wetland name:** | Poplar ave | **Time:** | 9.41 |
| **Region:** | Kapiti Coast | **Personal:** | Tess tony |
| **Altitude:** | 19m elevation | **# of Plots sampled:** | 2 |

| **Classification: I System** | **IA Subsystem** | **II Wetland Class** | **IIA Wetland Form** |
|---|---|---|---|
| Palustrine | Permanent | Fen | Basin |

| **Indicator** | **Indicator components** | **Specify and Comment** | **Score 0– 5[1]** | **Mean score** |
|---|---|---|---|---|
| Change in hydrological integrity | Impact of manmade structures | M2PP construction,, farmland, urban housing | 4 | 3.67 |
| | Water table depth | n/a | 3 | |
| | Dryland plant invasion | pasture grasses | 4 | |
| Change in physico-chemical parameters | Fire damage | nil | 5 | 4 |
| | Degree of sedimentation/erosion | Historical from farming | 4 | |
| | Nutrient levels | n/a | n/a | |
| | Von Post index | Scored a 4 | 3 | |

| | | | | |
|---|---|---|---|---|
| Change in ecosystem intactness | Loss in area of original wetland | some historical loss | 4 | 3 |
| | Connectivity barriers | Road running through northern end severing wetland from greater complex. | 2 | |
| Change in browsing, predation & harvesting regimes | Damage by domestic or feral animals | Cats from houses, hedgehogs, | 5 | 4.33 |
| | Introduced predator impacts on wildlife | Predator control/bait stations is being carried out. | 3 | |
| | Harvesting levels | Nil | 5 | |
| Change in dominance of native plants | Introduced plant canopy cover | Some blackberry invasion | 4 | 4 |
| | Introduced plant understorey cover | pasture grass encroaching in some areas | 4 | |
| Total wetland condition index /25 | | | | 19 |

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

**Main Vegetation types**: Isolepis pro, hollan, with Manuka on edge

**Native fauna:** Pukeko

**Other comments**: Within QE Regional Park - well maintained by volunteers and park staff.

| **Pressure** | **Score**[2] | **Specify and Comment** |
|---|---|---|
| Modifications to catchment hydrology | 2 | Farming, roads, residential development. |
| Water quality within the catchment | 2 | Farming surrounds. |
| Animal access | 2 | Well fenced. Some predator control |
| Key undesirable species | 3 | In nearby Raumati Manuka wetland, willow, blackberry, alder/ |
| % catchment in introduced vegetation | 4 | Mostly farmed/forested/residential |
| Other landuse threats | 1 | Local bores, M2PP construction. |
| Total wetland pressure index /30 | 14 | |

[2]Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

## Plot 1: Poplar Ave Wetland

| WETLAND PLOT SHEET | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Poplar Ave | **Date:** | 19.02.2015 | **Plot no:** | 1 |
| **Plot size:** | 2mx2m | **Altitude:** | 14 masl | **Structure:** | Rushland |
| **Personal:** | Tess. R, Tony, P | **Northing**<br>**Easting** | 5466148<br>1766852 | **Composition:** | Baumea/ Isolepis/ sphagnum |

| **Canopy (bird's eye view)** | | | **Subcanopy** | | | **Groundcover** | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **H (m)** | **Species** | **%** | **H (m)** | **Species** | **%** | **H (m)** |
| *Leptospermum scoparium* | *35* | *2* | *Holcus lanatus* | 1 | 0.5 | | | |
| *Phormium tenax* | 2 | 1.2 | *Lotus penduculata* | 2 | 0.4 | | | |
| *Machaerina teretifolia* | 20 | 1.6 | *Dichondra repens* | 1 | 0.1 | | | |
| *Histiopteris incisa* | 3 | 0.6 | *Carex virgatum* | 1 | 0.3 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** *Rorippa palustris*

**fauna seen:** pukeko swallow, thrush, skylark

**Comments:** Rubbish in plot

| **Indicator (use plot data only)** | **%** | **Score 0–5[2]** | **Specify & Comment** |
|---|---|---|---|
| Canopy: % cover introduced species[2] | | 5 | |
| Understorey: % cover introduced spp[3] | | 3 | |
| Total species: % number introduced spp | | 4 | |
| Total species: overall stress/dieback | | 5 | |
| **Total** /20 | | 17 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high. [3]Add subcanopy and groundcover % cover for introduced species

| Field measurements: | | | |
|---|---|---|---|
| Water table cm | **n/a** | Water conductivity uS (if present) | **n/a** |
| Water pH (if present) | **n/a** | Von Post peat decomposition index | |

## Plot 2: Poplar Ave Wetland

| WETLAND PLOT SHEET | | | | | |
|---|---|---|---|---|---|
| **Wetland name:** | Poplar Ave | **Date:** | 19.02.2015 | **Plot no:** | 2 |
| **Plot size:** | 2mx2m | **Altitude:** | 12 masl | **Structure:** | Shrubland - sedgeland |
| **Personal:** | Tess, Tony | **Northing**<br>**Easting** | 5466195<br>1766834 | **Composition:** | Manuka/baumea/ isolepis |

| Canopy (bird's eye view) | | | Subcanopy | | | Groundcover | | |
|---|---|---|---|---|---|---|---|---|
| **Species[1] (or Substrate)** | **%** | **h(m)** | **Species** | **%** | **h(m)** | **Spp** | **%** | **h(m)** |
| *Leptospermum scoparium* | *5* | *1.5* | *Holcus lanatua* | 15 | 0.8 | *Spagmum moss* | 30 | 0.01 |
| | | | *Isolepis prolifera* | 60 | 0.4 | *Hydrocotyle novae-zeelandiae* | 1 | 0.05 |
| | | | *Machaerina rubiginosa* | 1 | 0.9 | | | |

[1] % = % cover: total Canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

**Additional species in vicinity in same vegetation type:** 30% dead yorkshire fog/ Isolepis steam cover

**Fauna Seen**: Nursery Spider webs blue copper butterfly, white butterfly.

**Comments:** Edge of plot baumea and Manuka.

| Indicator (use plot data only) | % | Score 0–5[2] | Specify & Comment |
|---|---|---|---|
| Canopy: % cover introduced species | 0 | 5 | |
| Understorey: % cover introduced spp[3] | 15 | 4 | |
| Total species: % number introduced spp | 15 | 4 | |
| Total species: overall stress/dieback | 0 | 5 | |

| | | |
|---|---|---|
| **Total /20** | 18 | |

[2]5=0%: none, 4=1– 24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; v. high

[3]Add subcanopy and groundcover % cover for introduced species

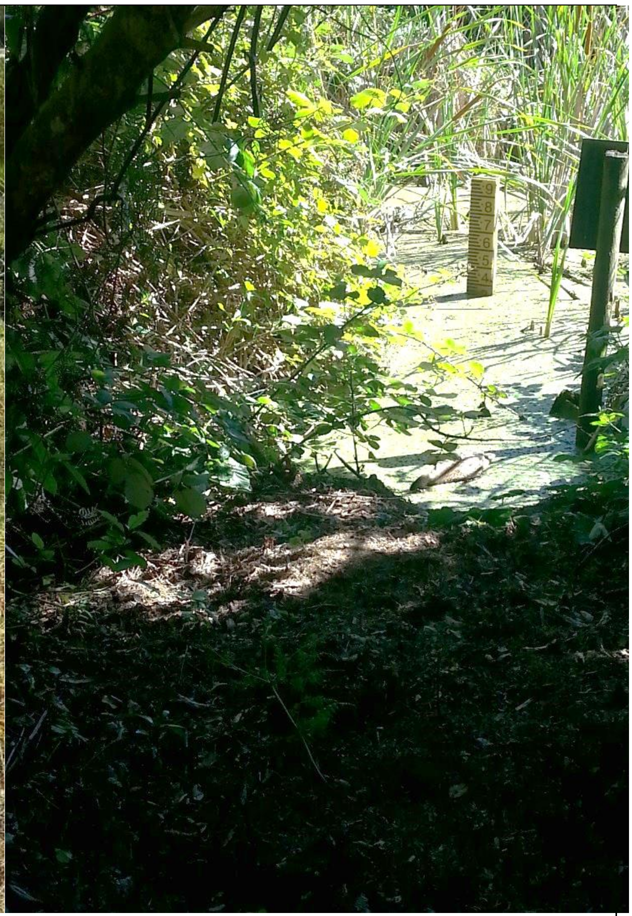
| **Field measurements:** | | | |
|---|---|---|---|
| **Water table cm** | n/a | **Water conductivity uS (if present)** | n/a |
| **Water pH (if present)** | n/a | **Von Post peat decomposition index** | 4 |

# Appendix 2: Photo points.

## Muaupoko Swamp Forest

| | |
|---|---|
|  |  |
| *Photo 1: Muaupoko Swamp Forest Photopoint 1 (east).* | *Photo 2: Muaupoko Swamp forest photopoint 2 (west)* |

Nga Manu Wetland

|  |  |
| --- | --- |
| *Photo 3: Nga Manu photooint 1 (north). Looking south towards viewing area along pond shoreline.* | *Photo 4 Nga Manu photopoint 2 (south). Looking south towards waterlevel/pond edge from piezometer.* |

Te Hapua Swamp Complex A

*Photo 5 Te Hapua swamp complex A, Looking north plot 1 (pink pegs) can be seen in upper left of the picture.*

*Photo 6: Te Hapua swamp complex A photopoint 2, looking NE towards monitoring plot 2 between cabbage tree and pittosporum*

*Photo 7 Te Hapua swamp complex A photopoint 1, Looking NE towards house.*

*Photo 8 Te Hapua swamp complex A photopoint 1, taken from corner of front garden looking NW towards pond edge.*

Te Harakeke

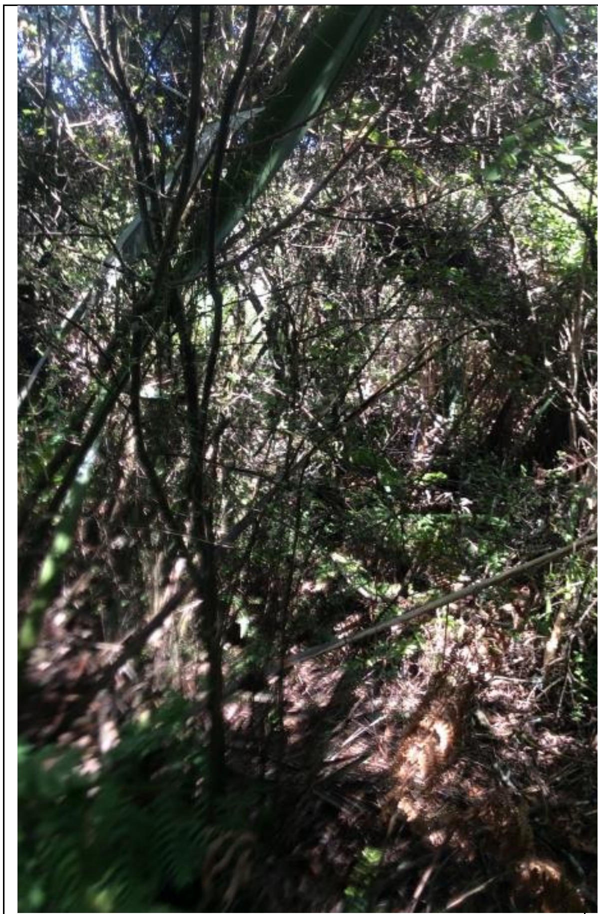
|  |  |
|---|---|
| *Photo 9:Te Harakeke photopoint 1 (south). Looking from marked fencepost on top of null South* | *Photo 10 Te Harakeke photopoint 2 (north). Looking from top of null north towards macrocarpa in background.* |

El Rancho Wetland

*Photo 11: El Rancho Wetland photopoint 1. Looking from M2PP expressway road West into Manuka stand.*


*Photo 12 El Rancho wetland photopoint 2. Looking from expressway north into Manuka stand.*

Peka Peka Rd Swamp

| | |
|---|---|
|  |  |
| *Photo 13:Peka Peka Road Swamp photopoint 1 (north), looking south.* | *Photo 14 Peka Peka Road Swamp photopoint 2 (south). Looking Northeast at edge of wetland under willow tree.* |

Tini Bush Wetland

Photo 15 Tini Bush photopoint 1 (south) Looking north from southern edge of swamp forest (can see permanent monitoring plot in background.

Photo 16: Tini Bush photopoint 2 (north) looking Southwest from under trees, across ditch.

## Ngarara Bush wetland

*Photo 17 Ngarara Bush Photopoint 1, Looking Southeast from Post alongside driveway.*

*Photo 18 Ngarara Bush Photopoint 2, looking Northeast from bank in front of house.*

Ngarara Wetland

*Photo 19 Ngarara Rd wetland, photopoint Looking from northern bank Southeast into the wetland.*

Otaihanga Southern Wetland

*Photo 20: Otaihanga Southern wetland Photopoint 1, looking from cycleway looking West into northern end of wetland*

*Photo 21Otaihanga Southern Wetland Photopoint 2, looking from cycleway southwest into the southern end of wetland.*

Crown Hill Manuka Bush Wetland

| | |
|---|---|
|  |  |
| *Photo 22: Crown Hill Manuka Bush wetland photopoint 1 (north) Looking from stake northwest to the outer edge of bush.* | *Photo 23 Crown Hill Manuka bush photopoint 2 (south) Looking northeast towards monitoring plot 2.* |

## Poplar Ave Wetland

*Photo 24 Poplar Ave photopoint 1 looking eastwards across wetland.*

*Photo 25 Poplar Ave photopoint 2 looking northward along edge of pond.*

Appendix F

# Small Coastal Streams Baseline Monitoring Annual Report 2014/15

# Small Coastal Streams Baseline Aquatic Monitoring Annual Report

A report on 2014/2015 aquatic data collection for water permit
WGN130103 [33250]
Prepared for Kapiti Coast District Council
10th July 2015

## Document Quality Assurance

| **Bibliographic reference for citation:**<br>Boffa Miskell Limited 2015. *Small Coastal Streams Baseline Aquatic Monitoring Annual Report: A report on 2014/2015 aquatic data collection for water permit WGN130103 [33250]*. Report prepared by Boffa Miskell Limited for Kapiti Coast District Council. | | |
|---|---|---|
| Prepared by: | Tessa Roberts<br>Ecologist<br>Boffa Miskell Limited | |
| Reviewed by: | Dr Vaughan Keesing<br>Senior Ecologist, Senior Principal<br>Boffa Miskell Limited | |
| Status: Final | Revision / version: C | Issue date: 10 July 2015 |




Template revision: 20150331 0000

File ref: W14039_Baseline_SmallStreams_2015_VC_20150714 .docx


*Cover photograph:* Lower Muaupoko Stream monitoring site, © Boffa Miskell, 2014

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6.0 References 21

# Appendices

Appendix 1: Rainfall and River Flows

Appendix 2: Cross Sectional Depth Measurements (cm)

Appendix 3: Raw Water Quality Data

Appendix 4: Site Photographs

Appendix 5: Monthly Small Coastal Streams Data Reports (December – April)

# 1.0 Introduction

## 1.1 Background

Resource consent condition 33 of Consent WGN130103 [33250] for the River Recharge with Groundwater Project (RRwGW Project) requires a baseline monitoring programme of small coastal streams to be carried out, following the methods approved in the Small Coastal Streams (SCS) Baseline Monitoring Plan (BMP) (Boffa Miskell Ltd, 2014b).

That plan, certified by Greater Wellington Regional Council (GWRC), requires the collection of continuous[1] shallow ground water depth adjacent to each monitored stream, continuous instream water depth (by pressure inducer), instream continuous temperature, and instream continuous dissolved oxygen. Also required are monthly cross sectional water depth measurements, and a measure of conductivity. An initial assessment of the macroinvertebrate and fish biota, is also required to determine if an assemblage exists that would be sensitive to changes in water depth and water quality.

Full details of the consent conditions and the parameters and requirements for monitoring can be found in the Boffa Miskell (BML) report "Small coastal Streams Baseline Aquatic Monitoring Plan" dated 21st May 2014 (prepared for KCDC).

## 1.2 Scope

This report outlines the 2014-2015 season of data collection for the baseline monitoring programme for small coastal streams. Monthly data reports for more detailed data presentation are presented in Appendix 5. Recommendations for amendments to the monitoring programme are made.

.

[1] Where "continuous" means a recorded reading every 15 minutes.

# 2.0 Methodology

## 2.1 Monitoring Locations

The monitoring locations have been determined in the SCS BMP and consist of seven sites (refer to Figure 1 for locations and Appendix 4 for site photographs):

- Kowhai Stream;
- Hadfield Stream;
- Paetawa Drain;
- Ngarara Stream;
- Kakariki Stream;
- Lower Muaupoko Stream;
- Upper Muaupoko Stream.

The reasoning behind each location of these streams can be found in the scoping document characterising small coastal streams (Boffa Miskell Ltd, 2014a) and specific monitoring locations are described in full in the SCS BMP (Boffa Miskell Ltd, 2014b). The upper Kakariki site was later removed due to a general absence in surface water and a lack of landowner permission for continued access. At each site, a piezometer has been installed near to the stream bank and this position marks the location of the instream measures of the three water depth cross section transects (one measure taken 25m upstream, one at the piezometer, and one 25m downstream of piezometer). Biota surveys were also undertaken in December 2014 centred on these piezometer locations.

## 2.2 Monitoring Methods

The SCS BMP (Boffa Miskell Ltd, 2014b) provides the detail, but in summary the following parameters are required to be measured at each site for the period 1 December 2014 to 1 May 2015:

1. Ground water piezometer and logger (measurements every 15 minutes):
    - Depth to groundwater (as both a depth below ground surface and a reduced level);
2. Instream logger (continuously i.e. every 15 minutes):
    - Depth of stream (by pressure inducer);
    - Temperature (°C);
    - Dissolved Oxygen (DO as mg/L);
3. Instream manual measures (monthly):
    - Depths at three cross sections;
    - Conductivity;
4. Instream biota measures (potentially once):
    - Fish;
    - Macroinvertebrates.

Once a month the monitoring sites were visited, instream depth and conductivity measurements taken and the data loggers serviced. Where the data logger is not telemetered, the data is downloaded (two sites are currently telemetered: Upper Muaupoko and Kowhai) and manually entered into Water Outlook (Councils data management and reporting system).

Also included in Appendix 1 is the rainfall and Waikanae River flows (as recorded by GWRC at the Waikanae water treatment plant) to provide context.

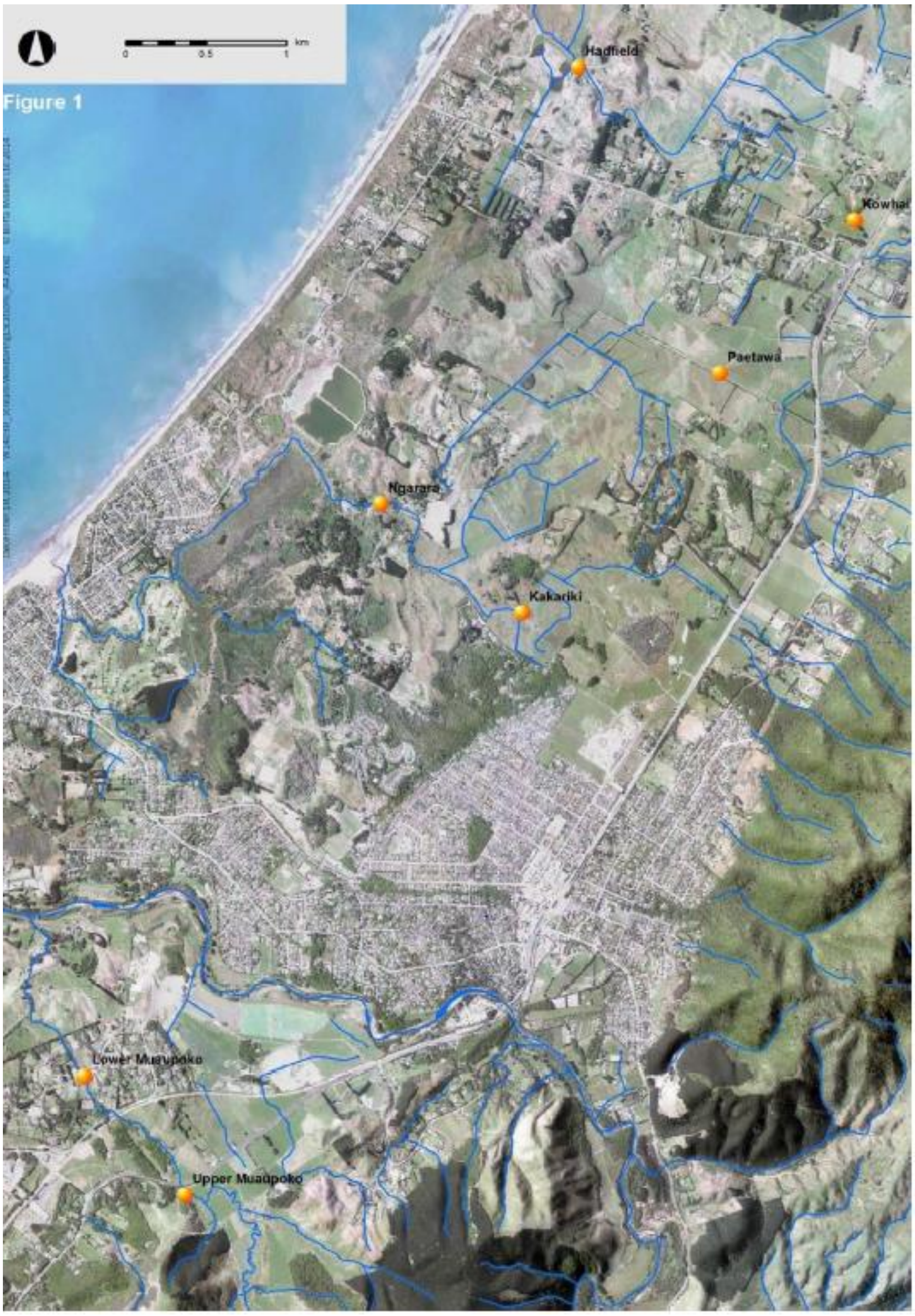


*Figure 1: Map showing locations of small coastal stream monitoring sites.*

# 3.0 Results

Attached as appendices are the complied cross sectional (Appendix 2) and water quality (Appendix 3) data. The monthly reports (December – April) for the small coastal streams monitoring are compiled into Appendix 5. These detail the monthly data collection (cross sectional measurements and conductivity readings), as well as data logger readings for both instream and groundwater measures in that month. The December report (Appendix 5) also contains the initial assessment of the macroinvertebrate and fish biota, which is summarised below (Section 3.2).

## 3.1 Piezometer and Instream Logger Data

Below (Sections 3.1.1 to 3.1.7) are a compilation of graphs (Figure 2 to Figure 29) showing the data collected for each "continuously" measured parameter (groundwater level (mm), instream water level (mm), temperature (°C) and dissolved oxygen mg/L)), by the small streams data loggers at each monitoring site during the period of December 2014 to May 2015.

### 3.1.1 Kowhai Stream

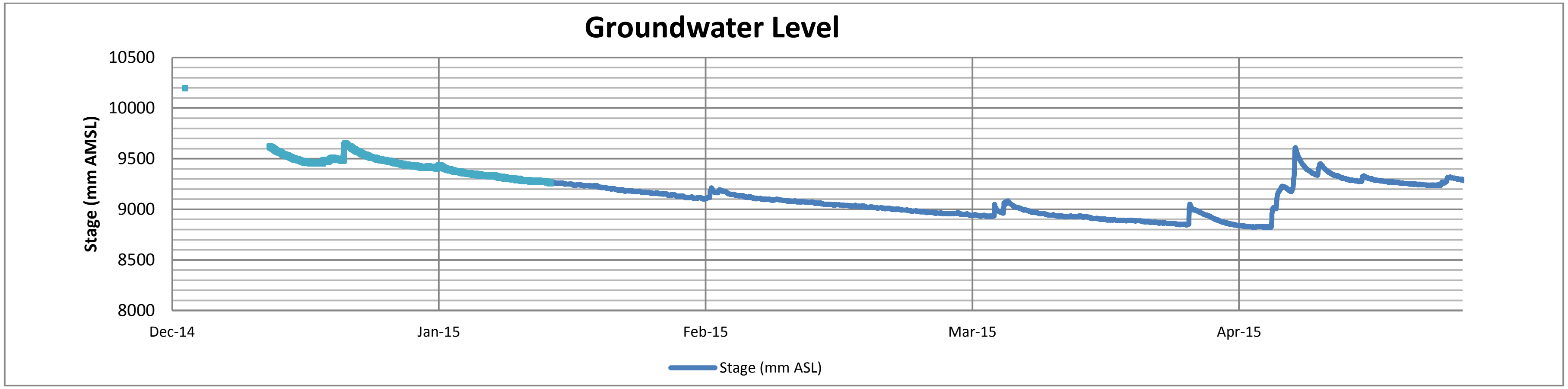


*Figure 2: Groundwater level in the Kowhai Stream for the monitoring period of December 2014 to May 2015.*

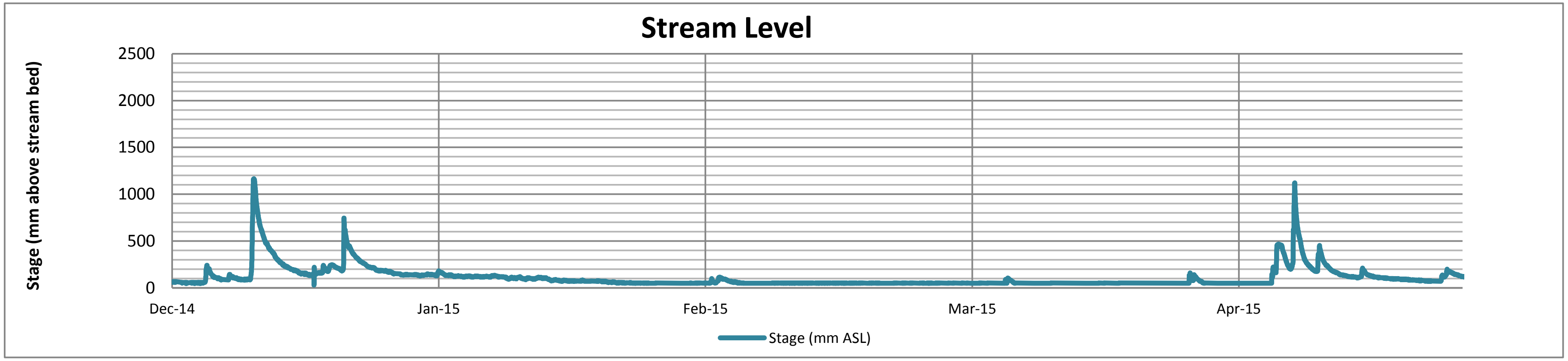


*Figure 3: Stream level in the Kowhai Stream for the monitoring period of December 2014 to May 2015.*

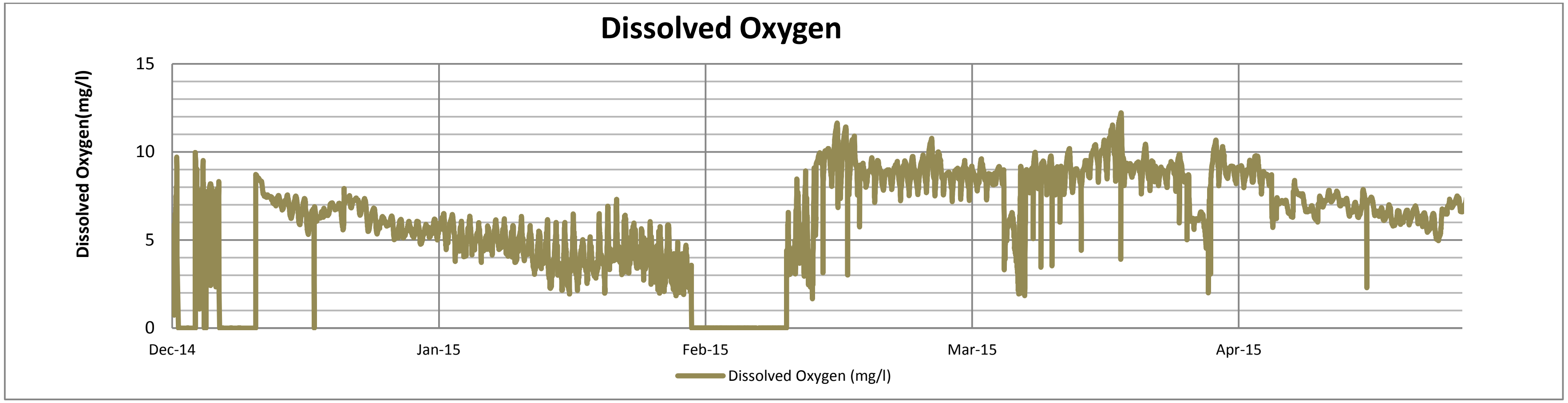


*Figure 4: Dissolved oxygen measures in the Kowhai Stream for the monitoring period of December 2014 to May 2015.*

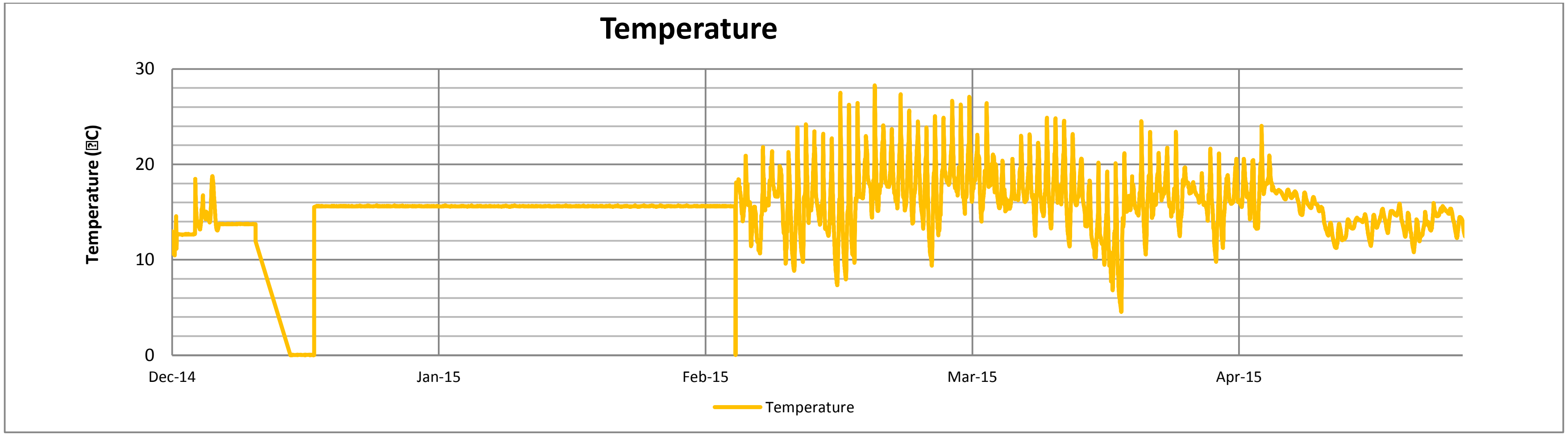


*Figure 5: Temperature measures in the Kowhai Stream for the monitoring period of December 2014 to May 2015.*

### 3.1.2 Hadfield Stream

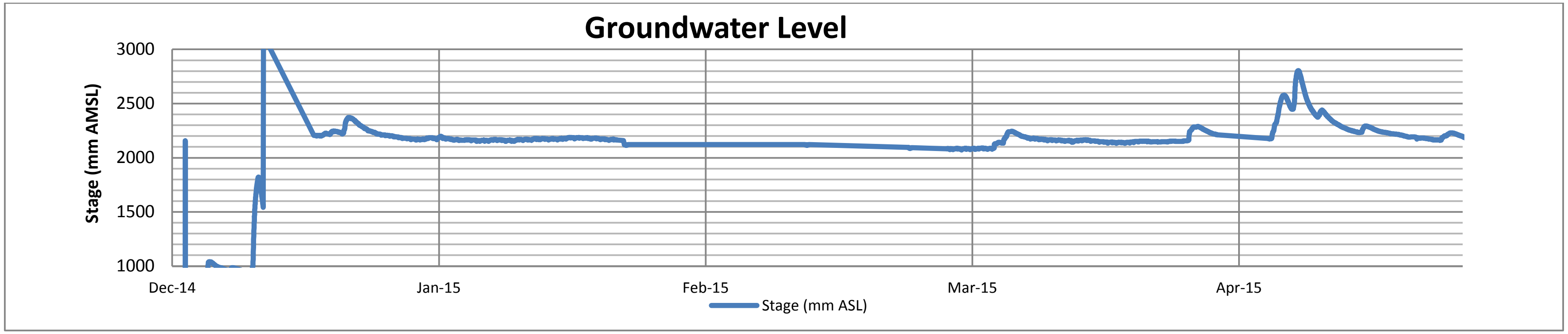


*Figure 6: Groundwater level in the Hadfield Stream for the monitoring period of December 2014 to May 2015*

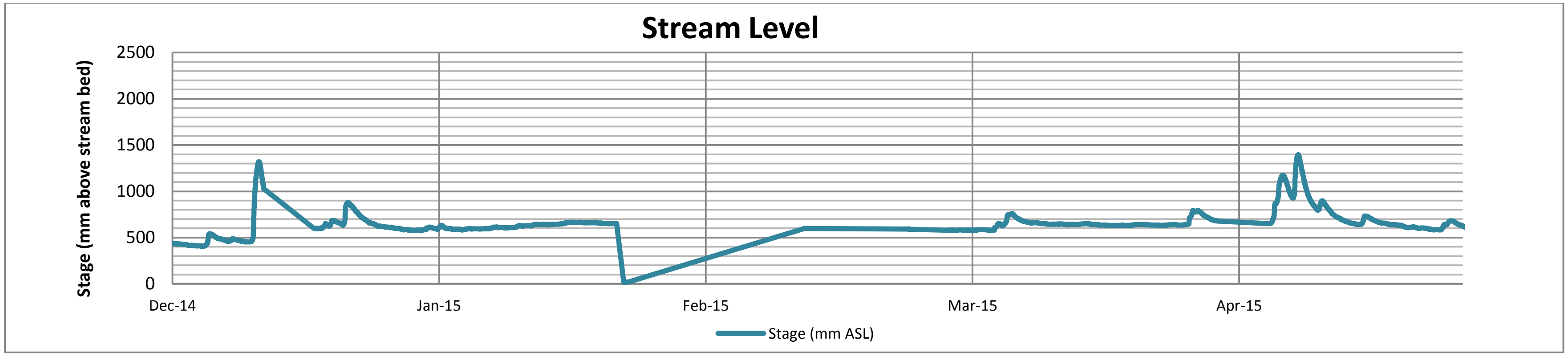


*Figure 7: Stream level in the Hadfield Stream for the monitoring period of December 2014 to May 2015*

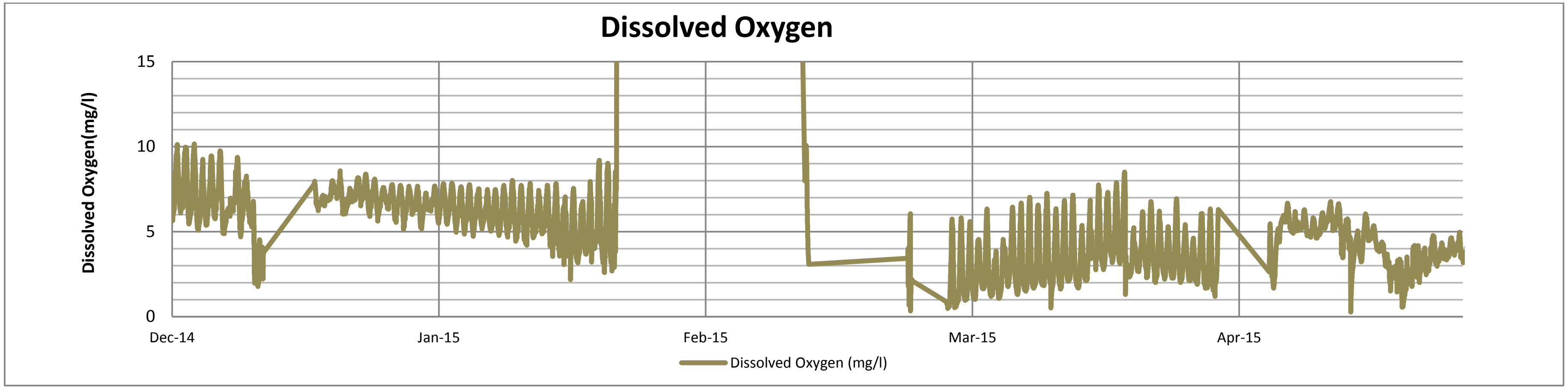


*Figure 8: Dissolved oxygen measurements in the Hadfield Stream for the monitoring period of December 2014 to May 2015*

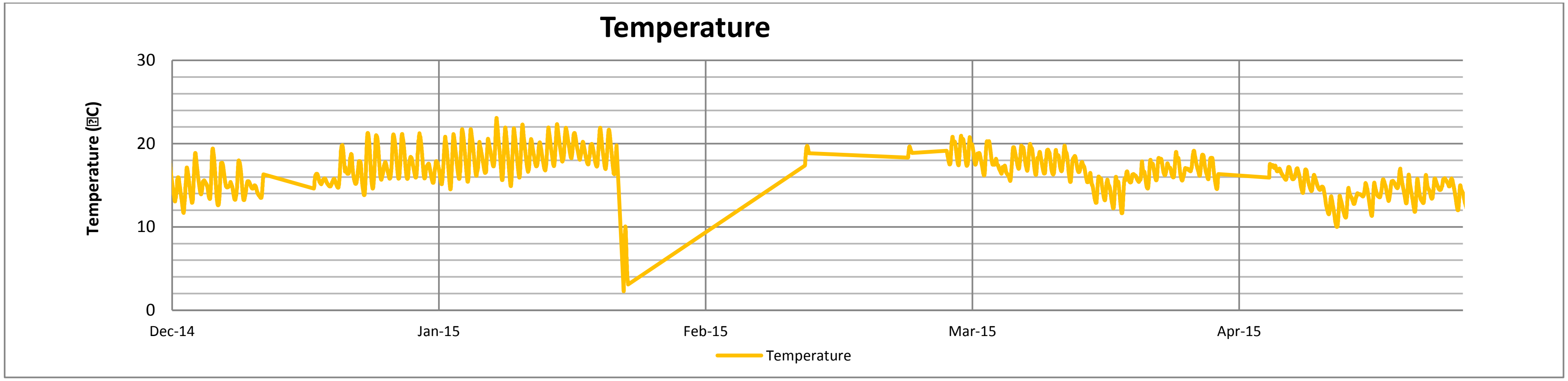


*Figure 9: Temperature measurements in the Hadfield Stream for the monitoring period of December 2014 to May 2015*

### 3.1.3 Paetawa

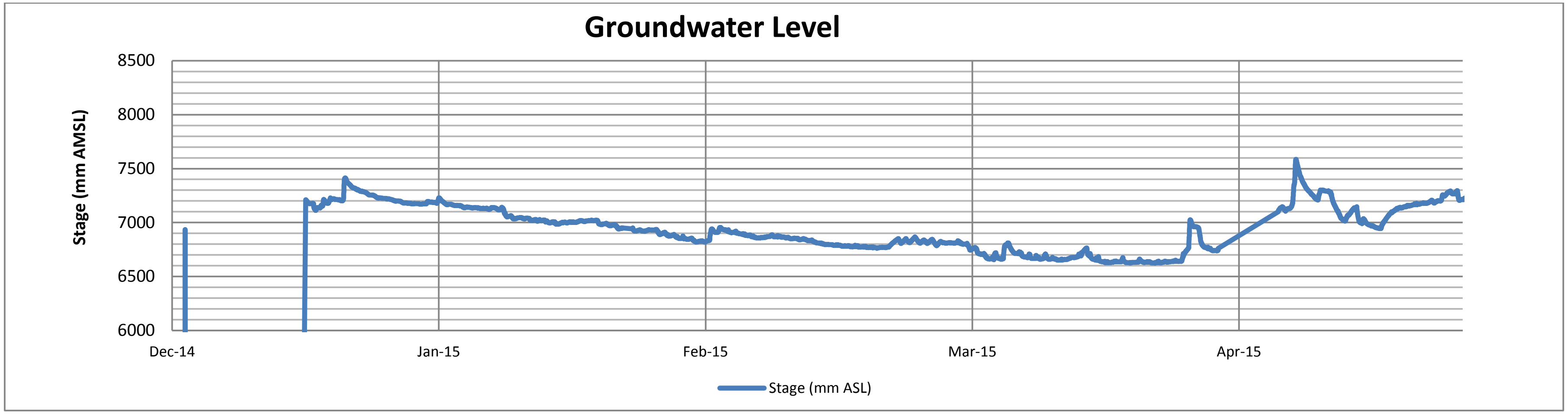


*Figure 10: Groundwater level in the Paetawa Drive Stream for the monitoring period of December 2014 to May 2015*

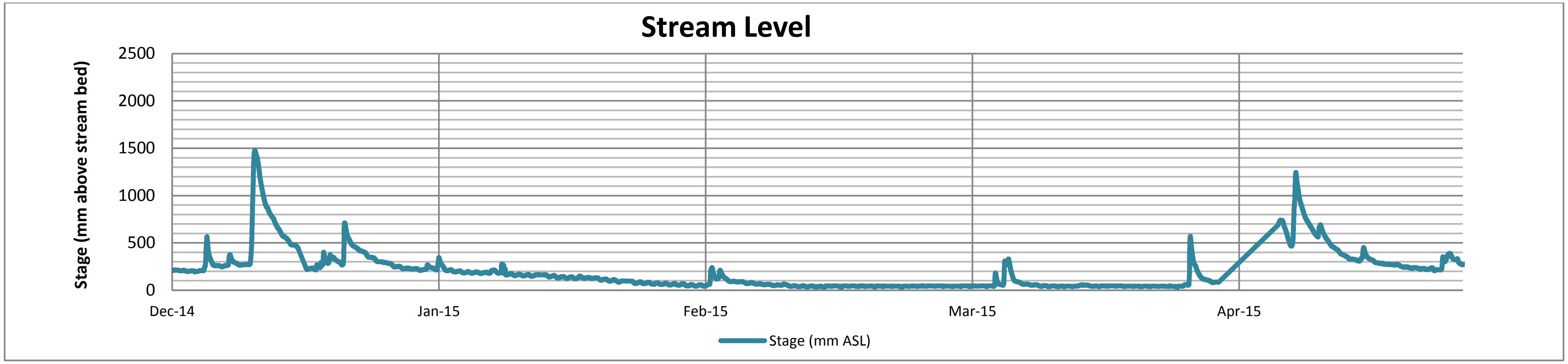


*Figure 11: Stream level in the Paetawa Drive Stream for the monitoring period of December 2014 to May 2015*

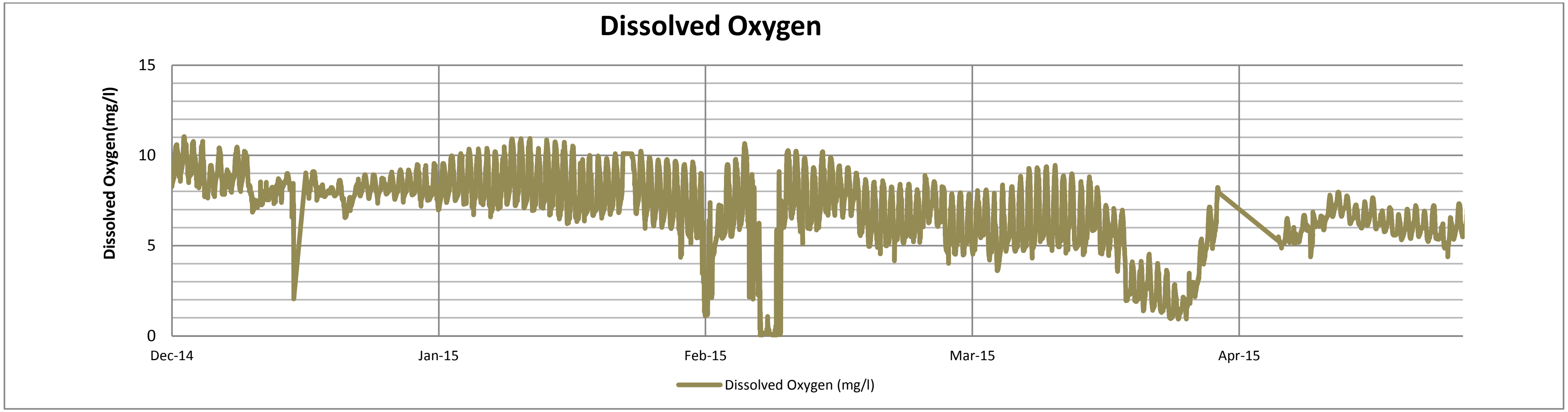


*Figure 12: Dissolved Oxygen in the Paetawa Drive Stream for the monitoring period of December 2014 to May 2015*

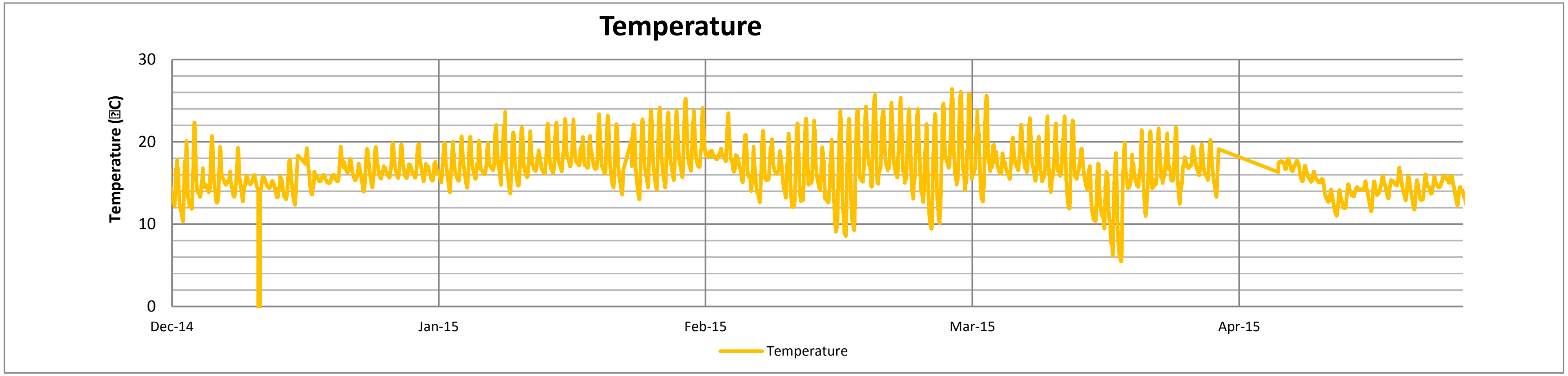


*Figure 13: Temperature measures in the Paetawa Drive Stream for the monitoring period of December 2014 to May 2015*

### 3.1.4 Kakariki

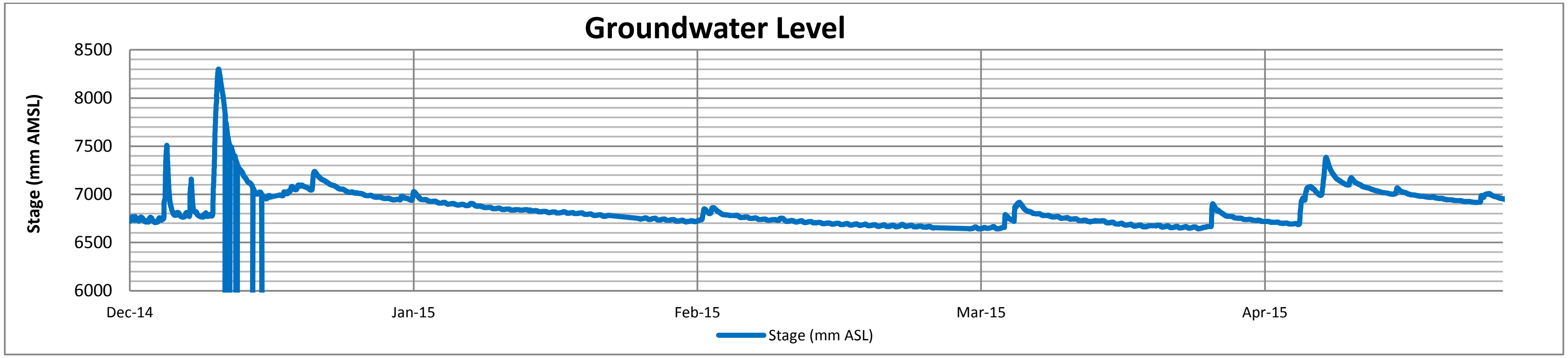


*Figure 14: Groundwater level in the Kakariki Stream for the monitoring period of December 2014 to May 2015*

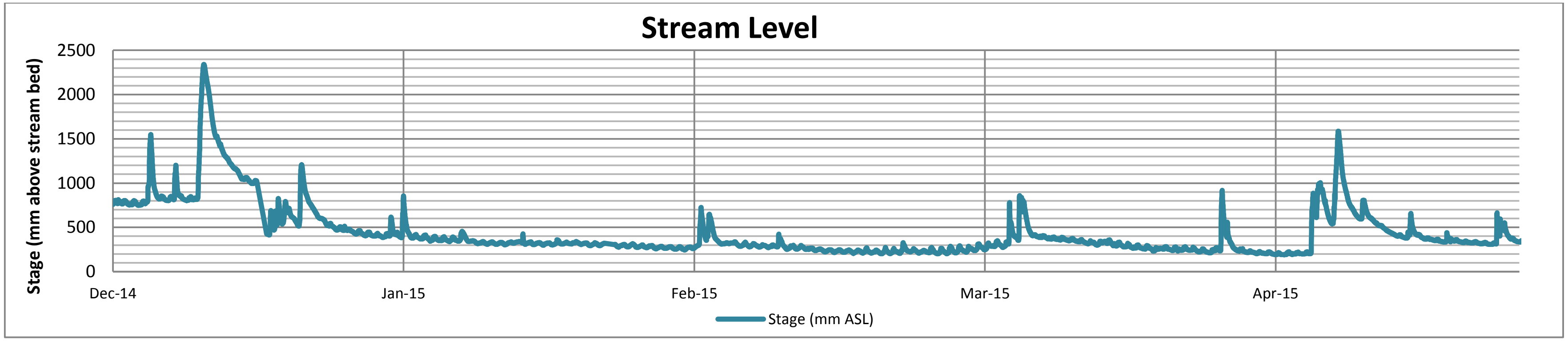


*Figure 15: Stream level in the Kakariki Stream for the monitoring period of December 2014 to May 2015*

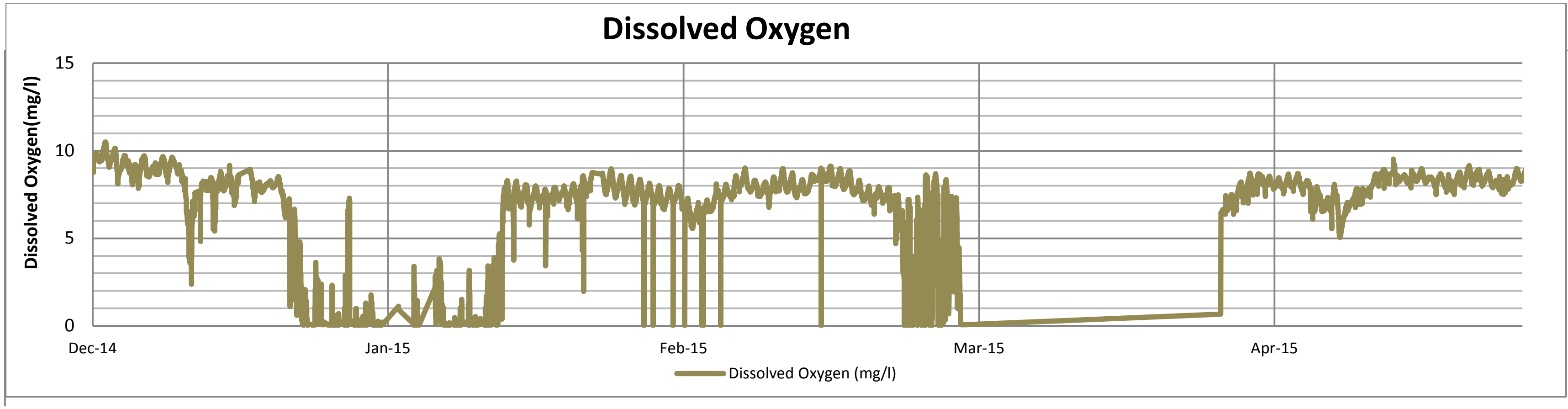


*Figure 16: Dissolved oxygen in the Kakariki Stream for the monitoring period of December 2014 to May 2015*

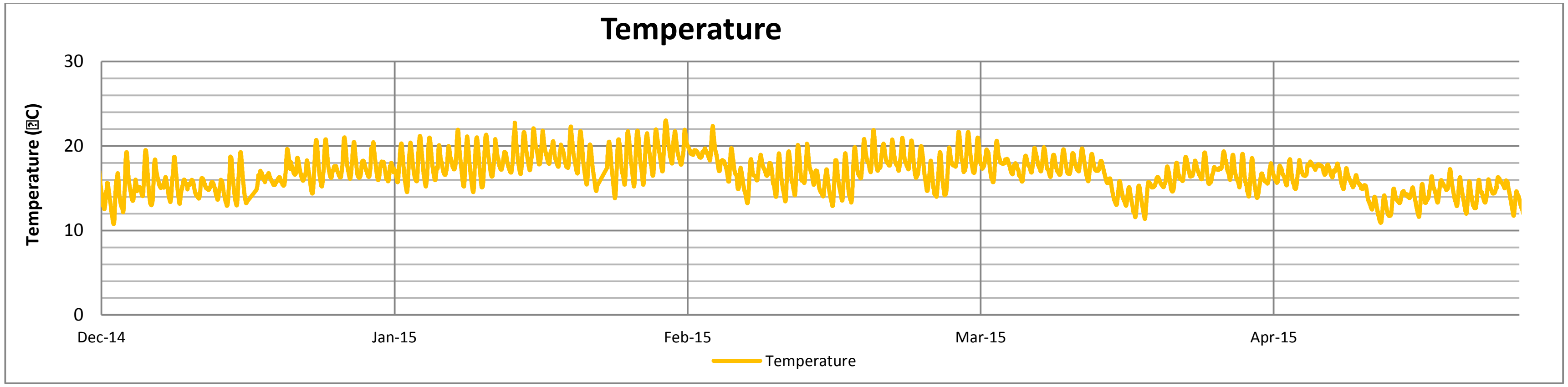


*Figure 17: Temperature measures in the Kakariki Stream for the monitoring period of December 2014 to May 2015*

### 3.1.5 Ngarara

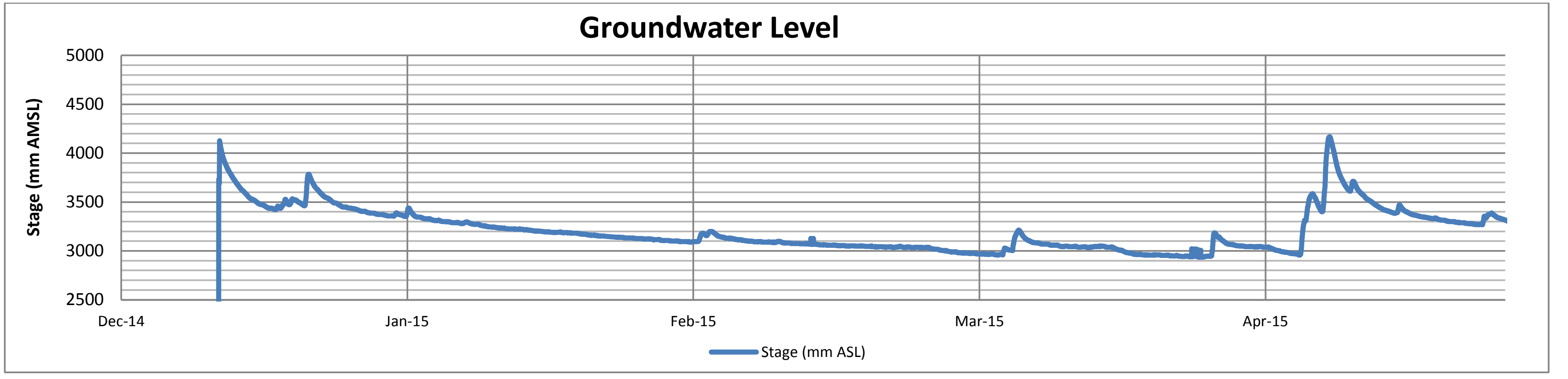


*Figure 18: Groundwater level in the Ngarara Stream for the monitoring period of December 2014 to May 2015*

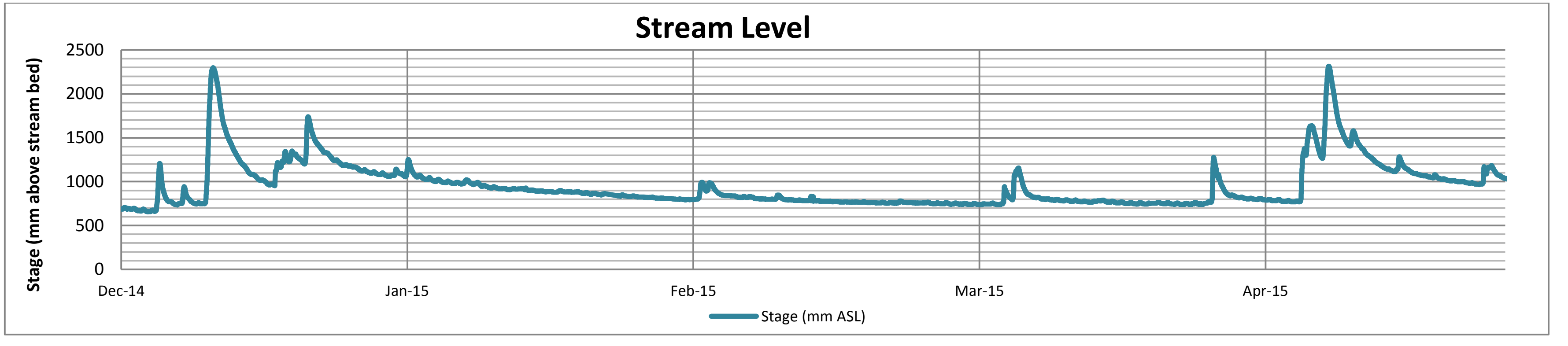


*Figure 19: Stream level in the Ngarara Stream for the monitoring period of December 2014 to May 2015*

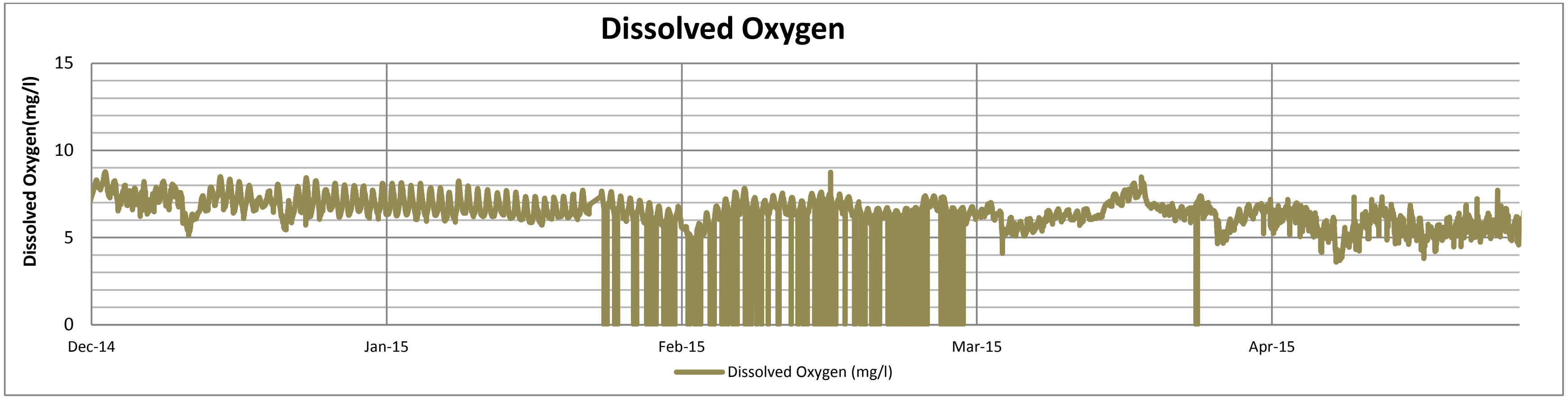


*Figure 20: Dissolved oxygen measures in the Ngarara Stream for the monitoring period of December 2014 to May 2015*

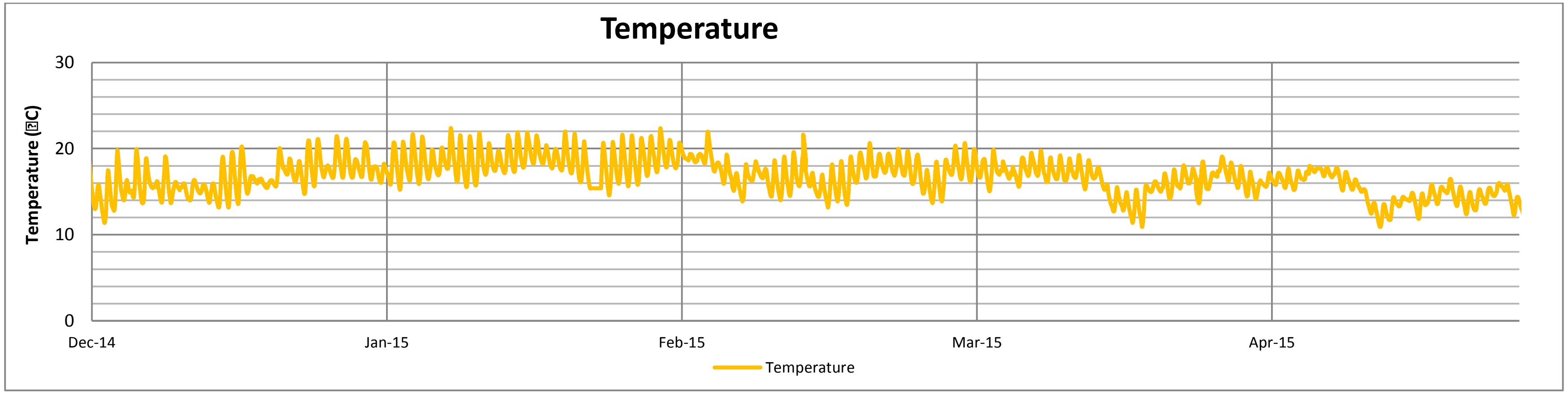


*Figure 21: Temperature measures in the Ngarara Stream for the monitoring period of December 2014 to May 2015*

### 3.1.6 Lower Muaupoko

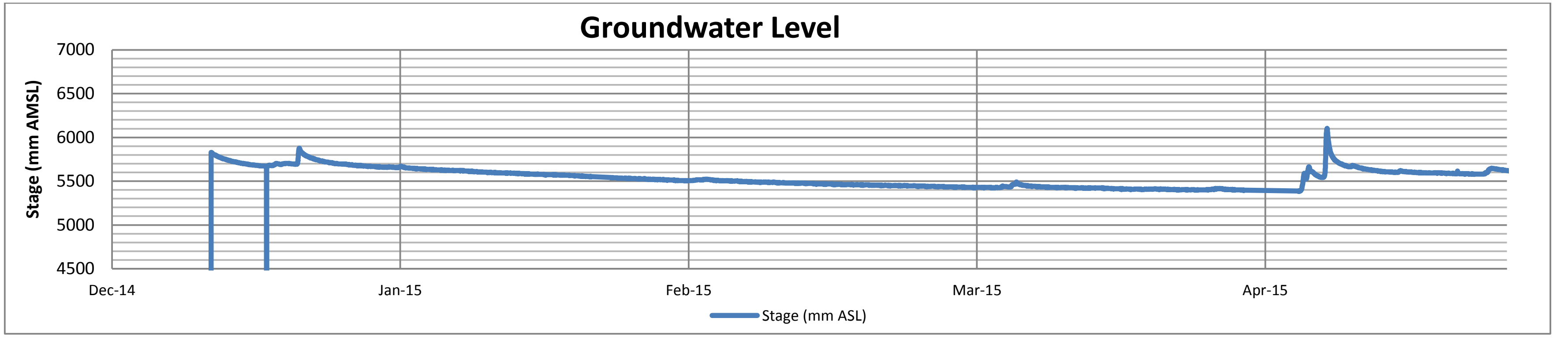


*Figure 22: Groundwater level in the Lower Muaupoko Stream for the monitoring period of December 2014 to May 2015*

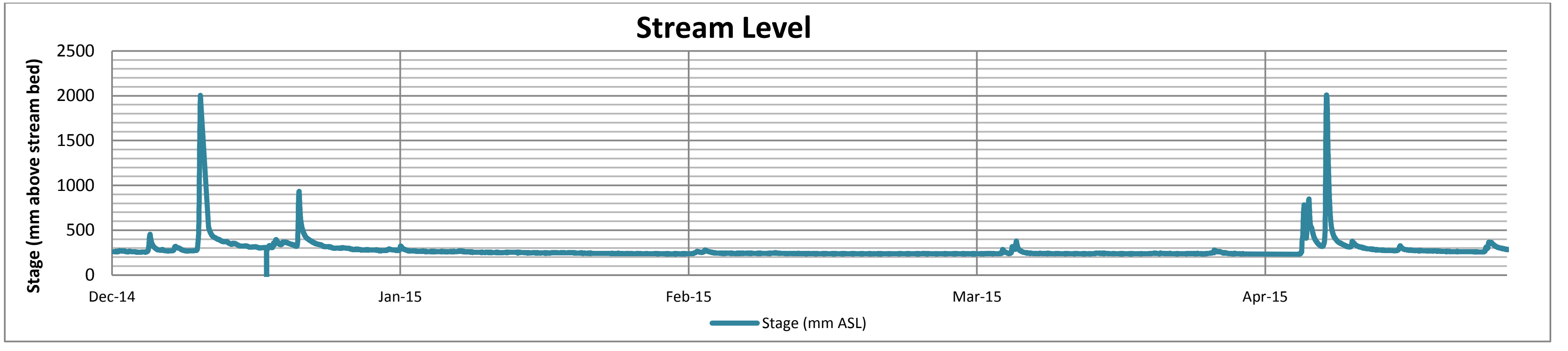


*Figure 23: Stream level in the Lower Muaupoko Stream for the monitoring period of December 2014 to May 2015*

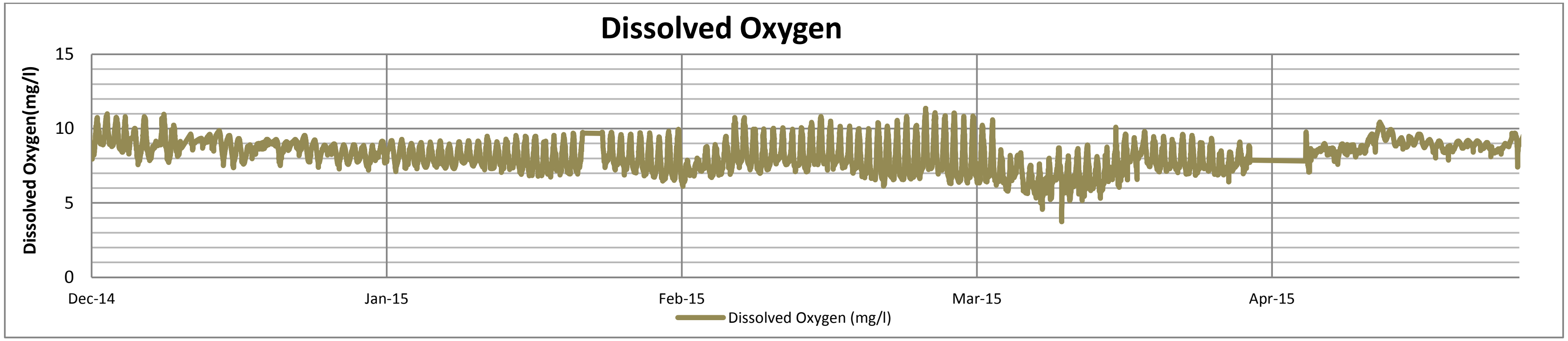


*Figure 24: Dissolved oxygen measures in the Lower Muaupoko Stream for the monitoring period of December 2014 to May 2015*

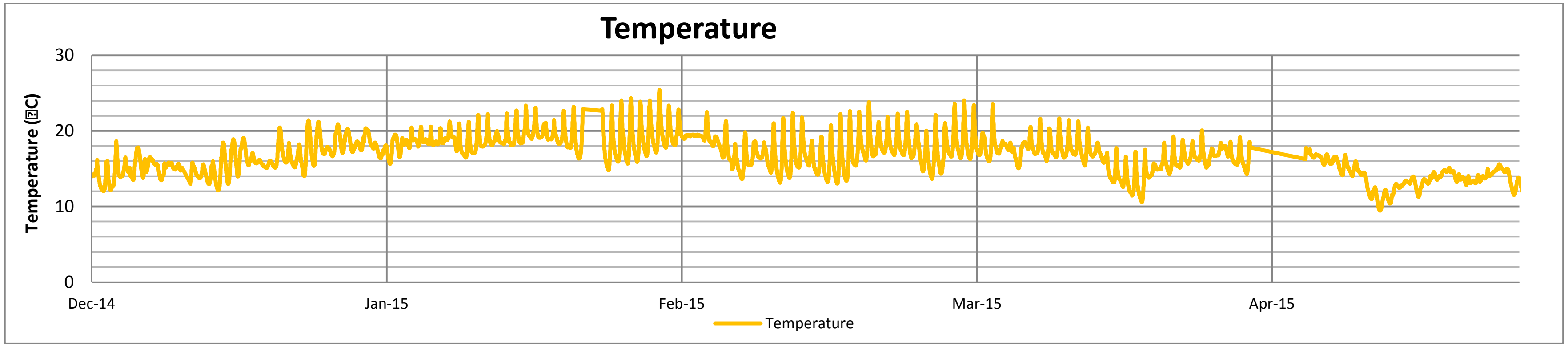


*Figure 25: Temperature measures in the Lower Muaupoko Stream for the monitoring period of December 2014 to May 2015*

### 3.1.7 Upper Muaupoko

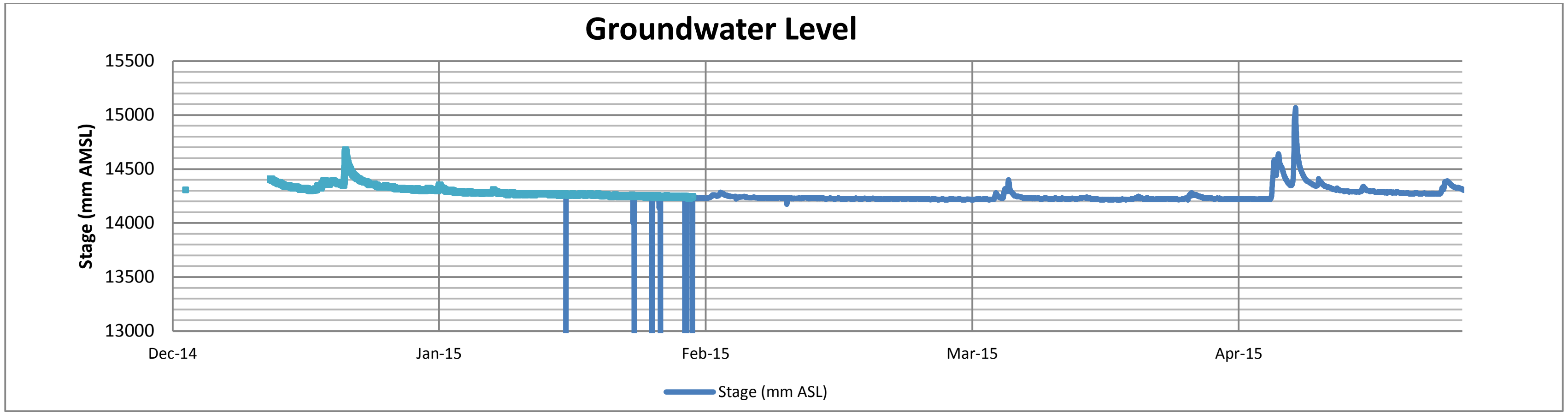


*Figure 26: Groundwater level in the Upper Muaupoko Stream for the monitoring period of December 2014 to May 2015.*

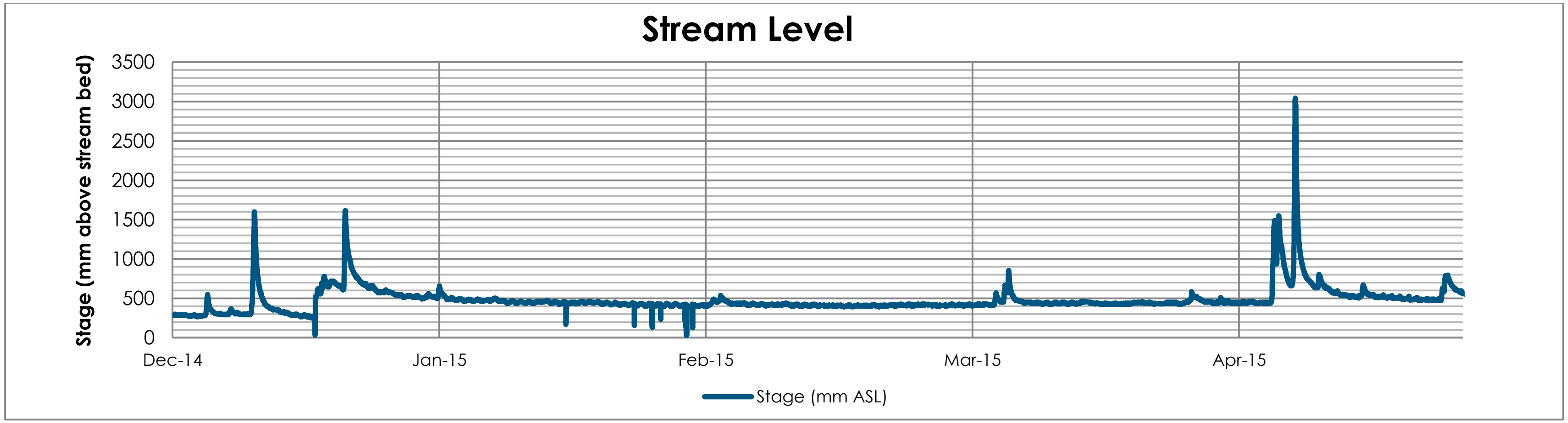


*Figure 27: Stream level in the Upper Muaupoko Stream for the monitoring period of December 2014 to May 2015.*

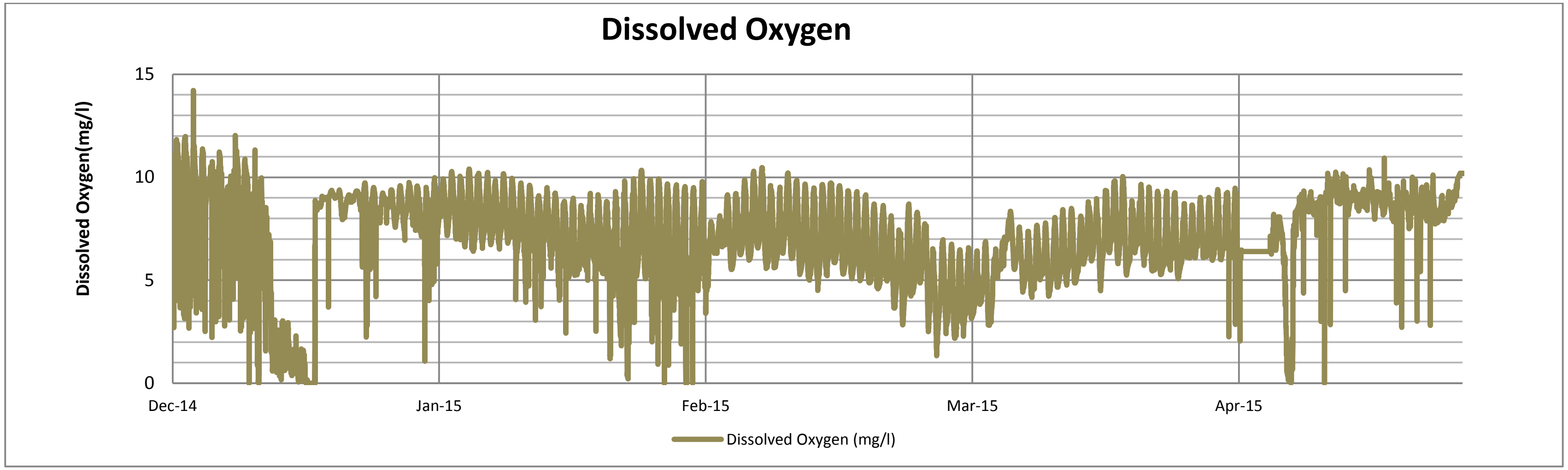


*Figure 28: Dissolved oxygen measures in the Upper Muaupoko Stream for the monitoring period of December 2014 to May 2015.*

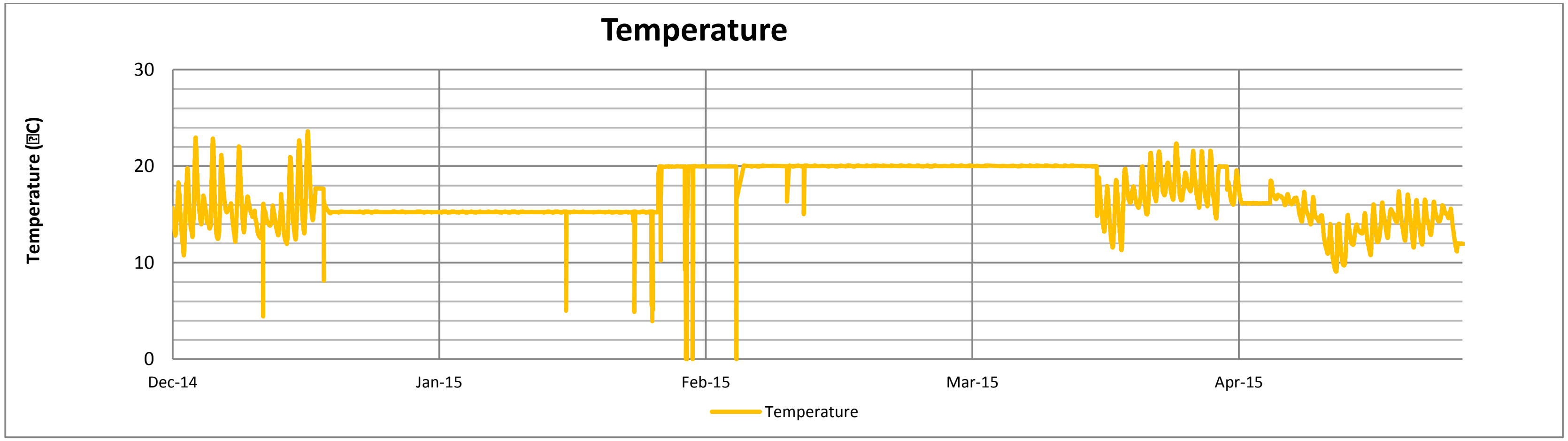


*Figure 29: Temperature measures in the Upper Muaupoko Stream for the monitoring period of December 2014 to May 2015.*

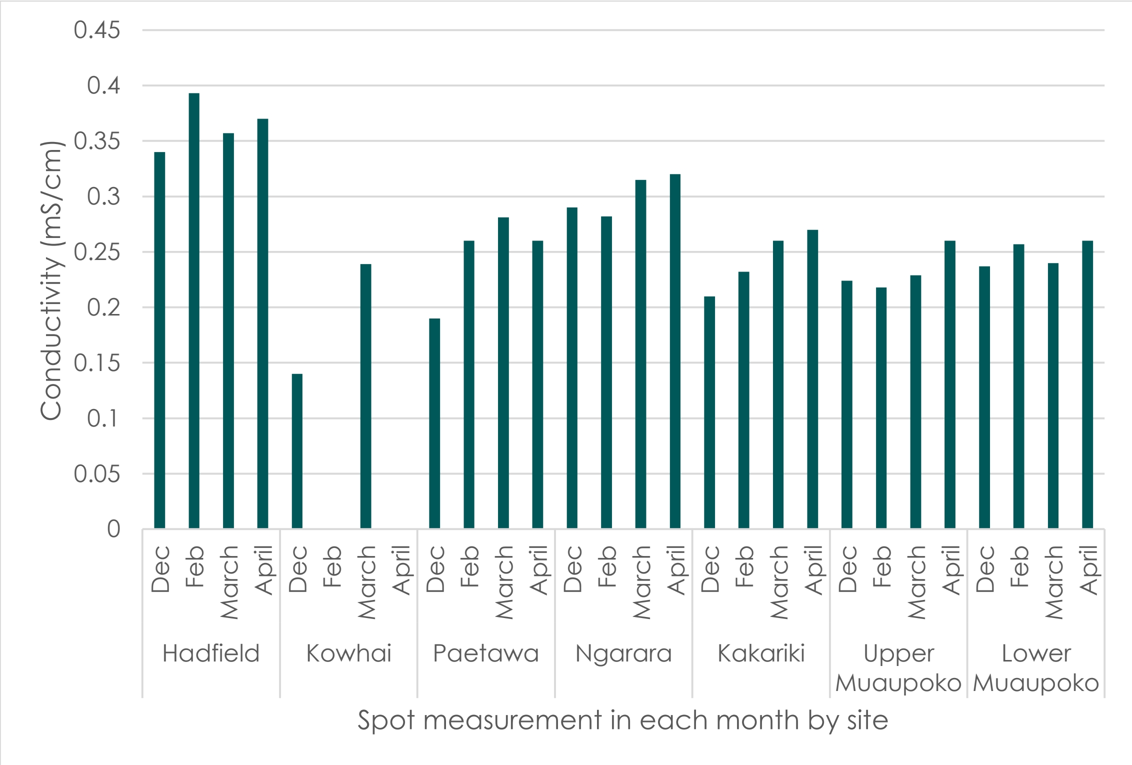


*Figure 30: Spot conductivity measures for the monitoring period of December 2014 to May 2015.*

A summary of the in-stream water conductivity (mS/cm) measures are presented in Figure 30. This summary graph, shows that apart from some missed measures in the Kowhai stream (where surface water was absent), conductivity is highest in the Hadfield Stream and generally between 0.2 and 0.3 mS/cm in the other measure sites.

## 3.2 Summary of Biotic Measures

Measures of local fish and aquatic macroinvertebrates were undertaken at each monitoring site in early December 2014 in order to determine the level of sensitive taxa present which might make reasonable indicators for reduced water levels. A summary of the macroinvertebrate survey data is presented in Table 1, and a summary of the fish survey data is presented in Table 2. Refer to the December report in Appendix 5 for the full data set.

*Table 1. Aquatic macroinvertebrate summary data.*

| Metric | Hadfield | Kakariki | Lower Muaupoko | Ngarara | Paetawa | Kowhai | Upper Muaupoko |
|---|---|---|---|---|---|---|---|
| **Total abundance** | 478 | 854 | 1005 | 672 | 3093 | 302 | 1778 |
| **Number of taxa (richness)** | 9 | 9 | 24 | 11 | 13 | 7 | 26 |
| **Number of EPT taxa** | 1 | 1 | 8 | 0 | 1 | 0 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **EPT abundance** | 5 | 2 | 42 | 0 | 12 | 0 | 123 |
| **MCI score** | 63.3 | 92.9 | 91.7 | 74.4 | 78.5 | 62.9 | 87.7 |
| **QMCI** | 2.9 | 4.6 | 4.4 | 4.4 | 4.2 | 2.7 | 4.6 |

Low and very low QMCI's (Quantitative macroinvertebrate community indices) show the benthic macroinvertebrate communities at all of the sites are dominated by robust taxa. Low MCI scores show a general absence of sensitive taxa such as mayfly and stonefly. The presence of few Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) (known as EPT) taxa emphasise the lack of sensitive taxa. Only the Muaupoko had a reasonable representation of EPT taxa, but these too were the more tolerant EPT taxa. The species richness for all but the Muaupoko communities was very low (where the expectation is >20 taxa). Abundances were however, "typical" for such low land streams in all communities but that of the Kowhai and this may represent the fact that that stream was periodically surface dry through the monitoring period.

With regard to fish species present, three "At Risk" (Goodman et.al. 2014) taxa were found (long fin eel, Inanga and Redfin bully). Only one territorial, sensitive, species was noted: banded kokopu, of which only two individuals were recorded in the Kakariki stream. There were no fish surveyed in the Kowhai stream due to an absence of water at the time of survey. Most fish taxa recorded are robust, and or highly mobile.

*Table 2. Fish EFM survey summary data.*

| SPECIES | Hadfield | Kowhai | Ngarara | Kakariki | Lower Muaupoko | Upper Muaupoko | Paetawa |
|---|---|---|---|---|---|---|---|
| Common bully | 53 | | | | 4 | | |
| Redfin Bully | | | | | 3 | 2 | |
| Inanga | 54 | | 2 | 134 | 38 | 5 | 62 |
| Banded kokopu | | | | 2 | | | |
| Shortfin eel | 3 | | 1 | 1 | | 6 | |
| Longfin eel | 4 | | 3 | 2 | 1 | 7 | 6 |
| UnID eel | 3 | | 1 | 2 | 2 | 7 | |
| Elver | | | | 6 | 2 | 16 | 4 |
| Black flounder | 2 | | | | | | |
| TOTAL ABUNDANCE | 120 | 0 | 7 | 149 | 52 | 43 | 73 |
| FISH TAXA | 5 | 0 | 3 | 4 | 4 | 4 | 2 |

# 4.0 Discussion

Establishment of the loggers and probes and success in attaining uninterrupted and good data had “teething” problems and the data of this first year for the SCS has minor issues of data “drop outs” and missed periods. Given that the baseline data set is for three years and that the recordings are over 5 months of the year at 15 minute intervals these initial data gaps are of no consequence in being able to look at the longer (three year) patterns to eventually determine normal state “trigger” alert levels.

When comparing the shallow groundwater level changes with the instream water depth changes it is observable that there are roughly parallel responses of groundwater level and instream water depth to rain. Sometimes the stream water depth increase response is ahead of the increase in groundwater level (responding first to rain fall) and at other times the change is at a similar time.

The declines in water depth are however less in-sync. More detailed analysis is needed in clarifying the relationship between groundwater level change and instream water level. This analysis will be carried out by hydrologists and hydrogeologists once the 3 year baseline monitoring period is complete.

Dissolved oxygen fluctuates daily and the magnitude of that fluctuation can be large but was typically between 6 and 10 mg/L. There is no obvious monthly trend. There is no clear correlation with temperature or change in stream water depth. Temperature generally rises to a “peak” around February and drops away towards April ranging generally between 10-20 degrees Celsius. Conductivity was highest in Hadfield stream but otherwise relatively low and common in between 0.2 and 0.3 mS/cm at the other monitoring sites.

There are no especially sensitive fish or macroinvertebrate communities present in the measured small coastal streams, and although there are three “*At Risk*” fish taxa surveyed, only inanga are common and all three species are not overly sensitive to water depth. They are also mobile and generally able to avoid unsuitable habitat conditions. With respect to the aquatic macroinvertebrate taxa present, the communities are populated with robust taxa and there are none that will provide a useful in-stream water condition indication via regular or even infrequent macroinvertebrate monitoring.

# 5.0 Summary

Despite some data gaps due to equipment failure, the data collected from the small coastal streams between 1 December 2014 and 1 May 2015 is adequate in providing the first of three years of baseline monitoring measures of relevant instream habitat parameters and potentially associated ground water levels.

Regular surveys of fish are unlikely to allow recognition of habitat quality reduction and repeated monitoring of fish at the sites is more likely to have an adverse effect than the factors being monitored for (i.e. the continued stressing of fish). Banded kokopu are the most likely to reflect changes and only two were caught (in the Kakariki), redfin bully may be sensitive (but we consider that unlikely) but only five were caught: 3 from the lower Muaupoko and 2 from the upper). The BMP stated (Section 4.5.2): "*The capture of specific fish species will determine if continued monitoring will produce a sensitive measure of water level change and will be continued. The presence of giant kokopu, red fin bully or banded kokopu represent both territorial (likely to persist in that location) and depth sensitive fish. In the absence of these species fish monitoring at those location will be discontinued*". We consider the numbers captured too low to provide a good measure and the numbers sufficiently low that resampling would be a greater potential risk than the possible stream depth changes that might be related to ground water changes.

Therefore, and in concert with the BMP (Section 4.5.2) we recommend no further fish monitoring for the remainder of the SCS baseline monitoring period, or as a trigger for effects.

We also recommend that no further aquatic macroinvertebrate "baseline" monitoring be undertaken for the purposes of providing a trigger to establish low flow stresses to the community at large. Again, (as per the BMP section 4.4.1) this is because the communities present are not generally sensitive to water depth or habitat quality changes. We do note that the Upper and Lower Muaupoko communities were the best of those sampled, but even they are relatively robust and in terms of monitoring for effects of water depth change are unlikely to supply indicative macroinvertebrate community indices.

In December 2014 monthly data report, we recommend that the temperature and DO monitoring be continued. With the total season's data set, we now suggest that there is limited value in measuring instream DO as it already fluctuates between low and good oxygen levels daily, meaning the development of a meaningful trigger will be unlikely and not reflect a bore water extraction effect. However, given its importance as a measure of aquatic health, measuring of DO is recommended in the next monitoring period, where it is to be reassessed as a meaningful indicator of hydrological changes.

The best measures of potential effect will be the measures of stream water depth and shallow groundwater levels. Development of evidence of the connection between the streams surface water and groundwater should be priority for the baseline monitoring period. Temperature as a possible indicator of water depth related stress may still be a viable indicator and should continue to be pursued. These should both continue to be monitored in the next seasonal monitoring period.

# 6.0 References

Boffa Miskell Ltd. (2014a). Characterisation of small coastal streams: identifying monitoring locations (Report No. W13118_20140307). Kapiti Coast District Council.

Boffa Miskell Ltd. (2014b). Small coastal streams baseline monitoring plan (Report No. W13118). Kapiti Coast District Council.

Goodman, J; Dunn, N; Ravenscroft, P; Allibone, R; Boubee, J; David, B; Griffiths, M; Ling, N; Hitchmough, R; and Rolfe, J. 2014. Conservation Status of NZ freshwater fish, 2013. Department of Conservation, NZ threat classification series.

# Appendix 1: Rainfall and River Flows

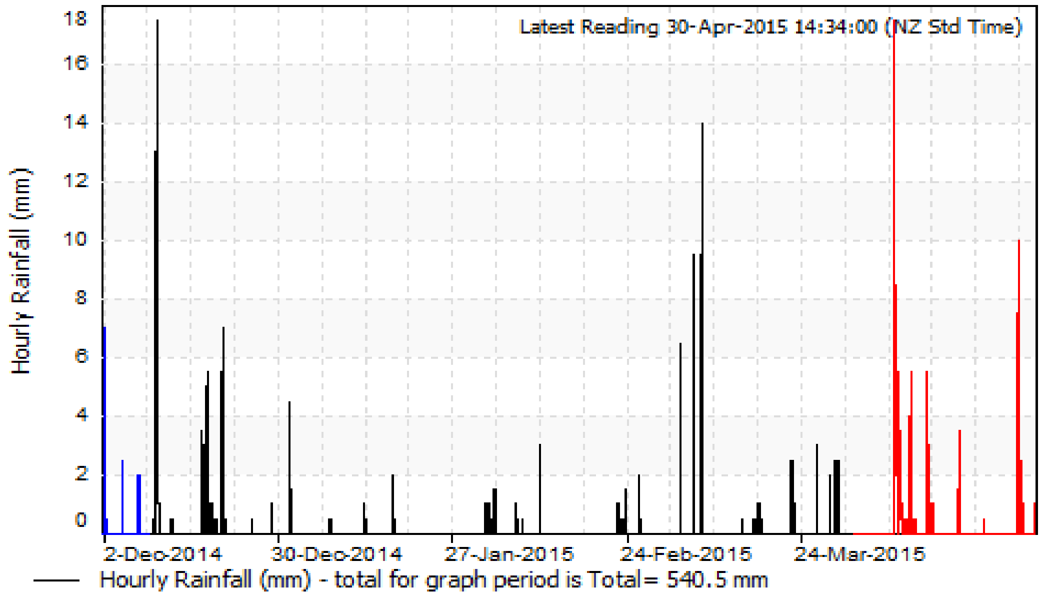


*Figure 31: Showing Rainfall as measured at the Waikanae Water Treatment Plant in Waikanae, for the monitoring period of Dec 2014 to May 2015*

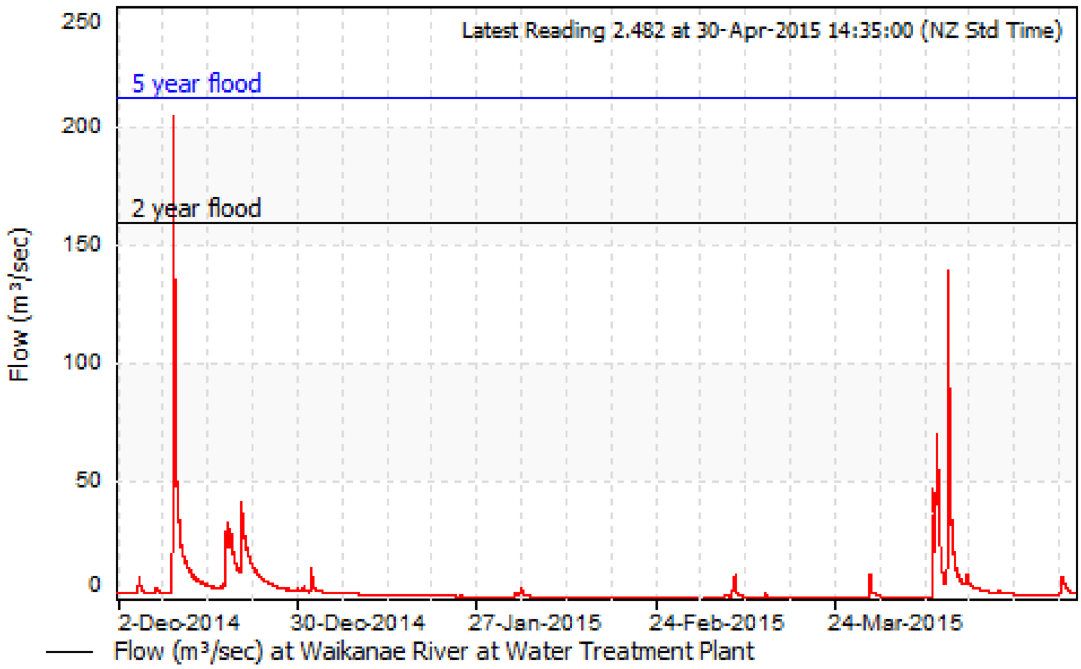


*Figure 32: Showing flow in the Waikanae River, as measured from the Waikanae Treatment Plant, Waikanae*

# Appendix 2: Cross Sectional Depth Measurements (cm)

| Site | Hadfield | | | | Kowhai | | | | Paetawa | | | | Ngarara | | | | Kakariki | | | | Upper Muaupoko | | | | Lower Muaupoko | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April |
| Wetted width A | 250 | 225 | 185 | 272 | 190 | 0 | 118 | - | 137 | 130 | 170 | 160 | 207 | 265 | 240 | 260 | 155 | 163 | 156 | 140 | 189 | 243 | 192 | 183 | 230 | 188 | 205 | 170 |
| Xsect A 1 | 17 | 6 | 11 | 8 | 1 | | 6 | | 12 | 3 | 61 | 24 | 13.2 | 38 | 37 | 7 | 1 | 19 | 10 | 2 | 1.5 | 3 | 18 | 4 | 6.8 | 15 | 8 | 14 |
| Xsect A 2 | 45 | 18 | 12 | 28 | 2.1 | | 9 | | 9 | 3.5 | 58 | 23.5 | 19.9 | 74 | 39 | 13 | 5.5 | 22 | 17 | 2 | 14 | 5 | 21 | 4.5 | 14 | 15 | 14 | 15 |
| Xsect A 3 | 45 | 24 | 15 | 47 | 2.4 | | 13 | | 8 | 6 | 61 | 21 | 17.5 | 75 | 43 | 19 | 14 | 22 | 34 | 4 | 15 | 9.5 | 24 | 4.5 | 7.6 | 15 | 15.5 | 19 |
| Xsect A 4 | 40.5 | 41 | 19 | 59 | 2.6 | | 15 | | 10 | 8.5 | 49.5 | 23* | 17.5 | 78 | 46 | 24 | 22 | 20 | 30 | 7 | 11 | 18 | 13 | 9 | 14 | 20 | 14 | 19 |
| Xsect A 5 | 38 | 48 | 24 | 45 | 2 | | 17 | | 14 | 9.5 | 54 | 17 | 33 | 81 | 50 | 28 | 27 | 21 | 44 | 12 | 9 | 23 | 17 | 11 | 12 | 5 | 18 | 16 |
| Xsect A 6 | 38 | 65 | 38 | 48 | 2.7 | | 18 | | 16 | 5 | 52 | 12.5 | 34.5 | 74 | 53 | 31 | 29 | 17 | 41 | 18 | 7 | 17 | 23 | 13 | 13 | 21 | 12 | 17.5 |
| Xsect A 7 | 37 | 72 | 50 | 59 | 2.1 | | 17.5 | | 18 | 6 | 47 | 14 | 28.4 | 59 | 56 | 30 | 25 | 10 | 45 | 21 | 9 | 9 | 26 | 17 | 8 | 20 | 17.5 | 20 |
| Xsect A 8 | 33.5 | 69 | 53 | *59 | 1.2 | | 14 | | 18 | 10 | 47.5 | 13 | 21.2 | 51 | 54 | 30 | 26 | 6 | 37 | 22 | 11 | 23 | 30 | 19 | 4.5 | 19 | 17 | 17.5 |
| Xsect A 9 | 23 | 62 | 51 | 69 | 0.4 | | 12 | | 15 | 8.5 | 49 | 10 | 17.2 | 37 | 51 | 33 | 22 | 3 | 37 | 21 | 8.5 | 21 | 30 | 20 | 1.3 | 17 | 18 | 16 |
| Xsect A 10 | 8 | 20 | 46 | 73 | 0.2 | | 10 | | 11 | 4 | 47.5 | 8 | 4.7 | 5 | 50 | 38 | 14 | 1 | 24 | 16 | 6 | 4 | 31 | 23* | 1 | 12 | 19.5 | 20 |
| Xsect A 11 | | | 31 | 71 | | | 4 | | | | 46 | 6 | | | 51 | 45 | | | 16 | 3 | | | 20 | 24 | | | 23 | 12 |
| Xsect A 12 | | | 34 | 81 | | | | | | | 44 | 3 | | | 57 | 35 | | | | 8 | | | 20 | 24 | | | 23.5 | 14.5 |
| Xsect A 13 | | | 30 | 90 | | | | | | | 41 | 1 | | | 58 | 36 | | | | 13 | | | 17 | 17 | | | 17 | 12 |
| Xsect A 14 | | | 17 | 85 | | | | | | | 36 | 4 | | | 56 | 42 | | | | 15 | | | 12 | 9 | | | 18 | 9 |
| Xsect A 15 | | | 12 | 87 | | | | | | | 34 | 3 | | | 56 | 47 | | | | 15 | | | 10 | 10 | | | 19 | 6 |
| Xsect A 16 | | | 7 | 72 | | | | | | | 25.5 | | | | 54 | 48 | | | | | | | 6 | 12 | | | 17 | 2 |
| Xsect A 17 | | | | 65 | | | | | | | | | | | 54 | 47 | | | | | | | 6 | 23 | | | 15 | |
| Xsect A 18 | | | | 43 | | | | | | | | | | | 44 | 41 | | | | | | | | 13 | | | 10 | |
| Xsect A 19 | | | | 45 | | | | | | | | | | | 49 | 40 | | | | | | | | | | | | |
| Xsect A 20 | | | | 45 | | | | | | | | | | | 44 | 40 | | | | | | | | | | | | |
| Xsect A 21 | | | | 22 | | | | | | | | | | | 40 | 38 | | | | | | | | | | | | |

| Site | Hadfield | | | | Kowhai | | | | Paetawa | | | | Ngarara | | | | Kakariki | | | | Upper Muaupoko | | | | Lower Muaupoko | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April |
| Xsect A 22 | | | | 5 | | | | | | | | | | | 19 | 36 | | | | | | | | | | | | |
| Xsect A 23 | | | | | | | | | | | | | | | | 34 | | | | | | | | | | | | |
| Xsect A 24 | | | | | | | | | | | | | | | | 27 | | | | | | | | | | | | |
| Xsect A 25 | | | | | | | | | | | | | | | | 20 | | | | | | | | | | | | |
| Xsect A 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Wetted width B** | 250 | 243 | 173 | 240 | 170 | 0 | 127 | | 86 | 105 | 210 | 150 | 276 | 240 | 222 | 230 | 125 | 140 | 70 | 100 | 180 | 160 | 164 | 85 | 180 | 245 | 160 | 200 |
| Xsect B 1 | 13 | 19 | 17 | 10 | 3.1 | | 2 | | 1.5 | 2 | 25 | 23 | 38 | 30 | 33 | 16 | 6 | 2 | 30 | 14 | 3 | 1 | 2 | 5 | 3 | 6 | 5 | 7 |
| Xsect B 2 | 34.5 | 28 | 23 | 22 | 4 | | 7 | | 3 | 7 | 36 | 25 | 50 | 46 | 79 | 65 | 11 | 3 | 35 | 15 | 9 | 1.5 | 4 | 8 | 6 | 6.5 | 6 | 9 |
| Xsect B 3 | 42.5 | 32 | 24 | 37 | 8.1 | | 11 | | 6 | 12 | 57 | 28 | 53 | 52 | 80 | 63 | 18 | 9 | 32 | 12 | 6 | 2 | 9 | 7 | 6 | 8 | 8 | 8 |
| Xsect B 4 | 48 | 27 | 27 | 47 | 11 | | 12 | | 9 | 12 | 57 | 29 | 64 | 56 | 81 | 64 | 27 | 15 | 34 | 8 | 8.5 | 4 | 11 | 15 | 7 | 11 | 8.5 | 9 |
| Xsect B 5 | 47 | 26 | 35 | 52 | 12 | | 12.5 | | 19 | 9 | 67 | 30 | 65 | 58 | 78 | 50 | 24 | 18 | 31 | | 9 | 4 | 14 | 17 | 4 | 14 | 10 | 10 |
| Xsect B 6 | 47 | 26 | 39 | 54 | 10 | | 13 | | 19 | 8 | 70 | 32 | 49 | 55 | 79 | 55 | 23 | 14 | 28 | | 9 | 7.5 | 16 | 20 | 5 | 16 | 9 | 12 |
| Xsect B 7 | 38 | 21 | 44 | 55 | 7.1 | | 12.5 | | 19 | 5 | 73 | 33 | 51 | 55 | 82 | 54 | 22 | 13 | | | 7.9 | 8 | 16.5 | 18 | 5 | 17 | 8 | 12 |
| Xsect B 8 | 33.5 | 20 | 41 | 56 | 3.4 | | 11 | | 18 | 5 | 76 | 31 | 45 | 53 | 82 | 55 | 17 | 9 | | | 11 | 12 | 18 | 21 | 5.5 | 19 | 8 | 13 |
| Xsect B 9 | 29 | 18 | 39 | 53 | 0.2 | | 9 | | 9 | 4 | 75 | 29 | 33 | 41 | 81 | 51 | 17 | 5 | | | 8 | 10 | 17 | | 5 | 20 | 6 | 15 |
| Xsect B 10 | 4 | 7 | 35 | 53 | 0.3 | | 8.5 | | 5 | 2 | 79 | 27 | 16 | 37 | 86 | 40 | 15 | 2 | | | 5 | 10 | 15 | | 3 | 13 | 4 | 16 |
| Xsect B 11 | | | 21 | 53 | | | 7 | | | | 79 | 24 | | | 88 | 43 | | | | | | | 12 | | | | 3.5 | 16.5 |
| Xsect B 12 | | | 20 | 52.5 | | | 5 | | | | 76 | 22 | | | 91 | 34 | | | | | | | 12 | | | | 2.5 | 18 |
| Xsect B 13 | | | 12 | 53 | | | | | | | 74 | 18 | | | 101 | 25 | | | | | | | 7.5 | | | | 2 | 20 |
| Xsect B 14 | | | 8 | 54 | | | | | | | 65 | 12 | | | 81 | 28 | | | | | | | 6 | | | | 2 | 22 |
| Xsect B 15 | | | 5 | 53 | | | | | | | 62 | | | | 71 | 15 | | | | | | | | | | | | 19.5 |
| Xsect B 16 | | | | 56 | | | | | | | 59 | | | | 66 | 14 | | | | | | | | | | | | 23 |
| Xsect B 17 | | | | 55 | | | | | | | 30 | | | | 68 | 22 | | | | | | | | | | | | 22 |
| Xsect B 18 | | | | 55 | | | | | | | 26 | | | | 66 | 18 | | | | | | | | | | | | 22 |
| Xsect B 19 | | | | 50 | | | | | | | 21.5 | | | | 42.5 | 10 | | | | | | | | | | | | 6 |

| Site | Hadfield | | | | Kowhai | | | | Paetawa | | | | Ngarara | | | | Kakariki | | | | Upper Muaupoko | | | | Lower Muaupoko | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April | Dec | Feb | March | April |
| Xsect B 20 | | | | 36 | | | | | | | 20 | | | | 36 | 13 | | | | | | | | | | | | |
| Xsect B 21 | | | | 23 | | | | | | | | | | | | 8 | | | | | | | | | | | | |
| Xsect B 22 | | | | 17 | | | | | | | | | | | | | | | | | | | | | | | | |
| Xsect B 23 | | | | 9 | | | | | | | | | | | | | | | | | | | | | | | | |
| Xsect B 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Wetted width C** | 220 | 205 | 225 | 235 | 87 | 0 | 70 | | 120 | 108 | 210 | 130 | 300 | 257 | 217 | 220 | 200 | 124 | 152 | 80 | 168 | 81 | 93 | 81 | 130 | 136 | 185 | 130 |
| Xsect C 1 | 10 | 25 | 6 | 36 | 5 | | 7 | | 10 | 2 | 38 | 6 | 9 | 13 | 60 | 20 | 4.5 | 3 | 5 | 2 | 8 | 2 | 8 | 3 | 7 | 1 | 3 | 6 |
| Xsect C 2 | 21.5 | 26 | 18 | 34.5 | 4.1 | | 8 | | 19 | 8.5 | 46 | 16 | 25 | 21 | 68 | 24 | 11 | 7 | 7 | 10 | 29 | 5.5 | 12 | 8 | 17 | 6 | 8.5 | 6 |
| Xsect C 3 | 27 | 28 | 16 | 37 | 6 | | 8 | | 24 | 11 | 51 | 26 | 38 | 39 | 68 | 28 | 16 | 12 | 13 | 18 | 27 | 5 | 23 | 9.5 | 18 | 6.5 | 18 | 7 |
| Xsect C 4 | 29 | 23 | 30 | 42 | 10 | | 9 | | 24 | 11 | 57 | 30 | 50 | 49 | 79 | 30 | 17 | 16 | 18 | 24 | 24 | 10 | 27 | 13 | 15 | 6.5 | 20.5 | 7 |
| Xsect C 5 | 33.3 | 22 | 28 | 41 | 12 | | 9 | | 23 | 10 | 59 | 30 | 57 | 64 | 73 | 38 | 36 | 17 | 22 | 25 | 22 | 14 | 27 | 16 | 13 | 7.5 | 23.5 | 5.5 |
| Xsect C 6 | 36 | 20 | 28 | 53 | 13 | | 2 | | 21 | 9 | 60 | 27 | 52 | 64 | 83 | 41 | 43 | 22 | 38 | 23 | 18 | 16 | 23 | 16 | 11 | 7 | 25 | 6 |
| Xsect C 7 | 34.7 | 24 | 27.5 | 54.5 | 13 | | | | 18 | 8 | 60 | 23 | 47 | 50 | 92 | 42 | 35 | 18 | 38 | 22 | 18 | 20 | 13 | 16 | 7 | 4.5 | 23.5 | 5.5 |
| Xsect C 8 | 35 | 15 | 40 | 53.5 | 11 | | | | 16 | 7 | 59.5 | 19 | 39 | 40 | 88 | 43 | 24 | 20 | 30 | 19 | 13 | 19 | 6 | 13 | 4 | 3.5 | 22 | 5 |
| Xsect C 9 | 34 | 13 | 43 | 50 | 7.6 | | | | 13 | 6 | 58 | 18 | 39.5 | 28 | 85 | 45 | 19 | 23 | 26 | 14 | 4 | 15 | | | 2 | 2.8 | 18 | 5 |
| Xsect C 10 | 37 | 8 | 39 | 49 | 4.5 | | | | 8 | 2 | 57 | 13 | 30 | | 82 | 49 | 5 | 16 | 23 | | 2 | 10 | | | 2 | 1 | 18 | 3 |
| Xsect C 11 | | | 40 | 48 | | | | | | | 57 | | | | 78 | 57 | | | 22 | | | | | | | | 19.5 | 2 |
| Xsect C 12 | | | 35 | 49 | | | | | | | 54 | | | | 74 | 58 | | | 13 | | | | | | | | 20 | 2 |
| Xsect C 13 | | | 30 | 47.5 | | | | | | | 50 | | | | 79.5 | 59 | | | 6 | | | | | | | | 21 | |
| Xsect C 14 | | | 23 | 48 | | | | | | | 47.5 | | | | 74 | 49 | | | | | | | | | | | 20 | |
| Xsect C 15 | | | 27 | 48 | | | | | | | 45.5 | | | | 73 | 51 | | | | | | | | | | | 18 | |
| Xsect C 16 | | | 32 | 50 | | | | | | | 42 | | | | 72 | 44 | | | | | | | | | | | 10 | |
| Xsect C 17 | | | 28 | 49.5 | | | | | | | 48 | | | | 70 | 38 | | | | | | | | | | | | |
| Xsect C 18 | | | 20 | 46 | | | | | | | 43 | | | | 57 | 30 | | | | | | | | | | | | |
| Xsect C 19 | | | 16 | 47 | | | | | | | 43 | | | | 46 | 28 | | | | | | | | | | | | |

Appendix 2: Cross Sectional Depth Measurements (cm)

| Site | Hadfield | | | | Kowhai | | | | Paetawa | | | | Ngarara | | | | Kakariki | | | | Upper Muaupoko | | | | Lower Muaupoko | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** |
| Xsect C 20 | | | 6 | 50 | | | | | | | 43 | | | | 14 | 22 | | | | | | | | | | | | |
| Xsect C 21 | | | | 53 | | | | | | | | | | | | 18 | | | | | | | | | | | | |
| Xsect C 22 | | | | 26 | | | | | | | | | | | | 14 | | | | | | | | | | | | |
| Xsect C 23 | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | |

# Appendix 3: Raw Water Quality Data

| Site | Hadfield | | | | Kowhai | | | | Paetawa | | | | Ngarara | | | | Kakariki | | | | Upper Muaupoko | | | | Lower Muaupoko | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** | **Dec** | **Feb** | **March** | **April** |
| **Temp** | 14.03 | | 15.72 | | 15.71 | | 15.42 | | 15.63 | | 17.25 | | 15.82 | | 15.77 | | 14.86 | | 16.41 | | 17.42 | | 14.62 | | 15.66 | | 15.33 | |
| **pH** | 10.7 | 7.87 | 6.96 | | 10 | | 6.83 | | 7.35 | 8.12 | 6.37 | | 10.1 | 7.31 | 6.88 | | 7.2 | 7.52 | 7.25 | | 7.9 | 7.37 | 6.55 | | 7.73 | 7.96 | 7.41 | |
| **mS/cm** | 0.34 | 0.393 | 0.357 | 0.37 | 0.14 | | 0.239 | | 0.19 | 0.26 | 0.281 | 0.26 | 0.29 | 0.282 | 0.315 | 0.32 | 0.21 | 0.232 | 0.26 | 0.27 | 0.224 | 0.218 | 0.229 | 0.26 | 0.237 | 0.257 | 0.24 | 0.26 |
| **mg/L DO** | 19.77 | | 8.33 | | 15.9 | | 17 | | 10.46 | | 11.25 | | 29 | | 9.59 | | 10.9 | | 19.68 | | 12.9 | | 13.4 | | 13.86 | | 19.58 | |
| **% DO** | 198.5 | | 86.7 | | 165.9 | | 175.7 | | 108.6 | | 120.7 | | 218 | | 99.9 | | 109.7 | | 207.6 | | 134.2 | | 136.2 | | 140.3 | | 202.1 | |
| **g/l TDS** | 0.24 | | 0.232 | | 0.09 | | 0.155 | | 0.12 | | 0.183 | | 0.19 | | 0.205 | | 0.14 | | 0.169 | | 0.145 | | 0.149 | | 0.54 | | 0.156 | |
| **NTU** | 0.45 | | 12.1 | | 19.1 | | 1.2 | | 102 | | 5.4 | | 5.6 | | 8.6 | | 4 | | 9.6 | | 2.9 | | 3.1 | | 2.5 | | 1.9 | |

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*Figure 33: Showing the small coastal stream sampling site of the Kowhai Stream.*

*Figure 34: Showing the small coastal stream sampling site of the Hadfield Stream.*

*Figure 35: Showing the small coastal stream sampling site of the Paetawa Stream.*

*Figure 36: Showing the small coastal stream sampling site of the Ngarara Stream.*

*Figure 37: Showing the small coastal stream sampling site of the Kakariki Stream.*

*Figure 38: Showing the small coastal stream sampling site of the Upper Muaupoko Stream.*

*Figure 39: Showing the small coastal stream sampling site of the Lower Muaupoko Stream.*

# Appendix 5: Monthly Small Coastal Streams Data Reports (December – April)

# Small Coastal Streams Baseline Aquatic Monitoring & Monthly Data Report – December 2014

Kapiti Water Supply: RRwGW Scheme
Prepared for Kapiti Coast District Council
15 Sept 2015

# Document Quality Assurance

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*Cover photograph:* Electric fishing, Muaupoko stream, © Boffa Miskell Ltd, 2015

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# 1.0 Introduction

## 1.1 Background

Resource consent condition 33 of Consent WGN130103 [33250] for the River Recharge with Groundwater Project (RRwGW Project) requires a baseline monitoring programme of small coastal streams to be carried out, following the methods approved in the Small Coastal Streams Baseline Monitoring Plan (Boffa Miskell Ltd, 2014b).

The purpose of this baseline monitoring is to gather information to develop an on-going monitoring regime for the small coastal streams and to set on-going 'alert', 'ensure these streams are protected from adverse environmental effects associated with Kapiti action' and 'cease' triggers for small coastal streams in the Small Coastal Streams On-going Mitigation Plan. The information gathered during the baseline monitoring could inform the development of management trigger levels and cease abstraction compliance limits, and to inform any mitigation and/or adaptive management to Coast District Council's groundwater take from wells within the Waikanae Borefield.

Monitoring following the Small Coastal Streams Baseline Monitoring Plan (Streams BMP) was carried out in early December (1st and 5th) 2014. However, a delay in processing macroinvertebrate samples has meant the full dataset of baseline monitoring for December 2014 was not available, until February 2015.

This report also contains, in Appendix 7, summaries of the logged data for the December 2014 period for shallow ground water piezometer level, stream pressure induced depth, dissolved oxygen and temperature.

## 1.2 Conditions of Consent

The parameters to be monitored are set out in some detail in consent condition 33 b of consent WGN130103 [33250]: The detail of baseline monitoring (methods, site numbers and locations, frequency of sampling, reporting) is set out in the Streams BMP

The Streams BMP shall include but not be limited to the following:

- The installation of water level recorders (including shallow groundwater level piezometers) at agreed locations on the small coastal streams;
- Monitoring of the stream surface water levels;
- Monitoring of fish communities;
- Monitoring of water quality (e.g. water temperature and dissolved oxygen), macroinvertebrates, may be required. This will be determined by the Wellington Regional Council following the completion of the stream characterisation survey, in consultation with the consent holder;
- The monitoring of ecological components should be linked (e.g. at the same site) with the hydrological monitoring, where appropriate as determined by the Wellington Regional Council, in consultation with the consent holder

## 1.3 Report Aim & Objectives

This, the biological report (in support of the water depth and aspects of habitat quality) assesses if valued and depth sensitive aquatic fish and macroinvertebrate species were present at the monitoring locations. The Streams BMP and consent conditions aim to establish, by the process undertaken herein, where such species existed, the value of ongoing monitoring of those taxa; and to use those taxa in terms of presence / absence or a relative baseline abundance, as effects triggers.

This report aims to outline the small coastal streams baseline monitoring completed thus far, and assess and make recommendations as to the value of future fish and macroinvertebrate monitoring as part of the small coastal streams monitoring.

This report also details the cross sections undertaken which describe the monitoring sites in terms of stream depth profiles as at early December 2014.

Monitoring results for shallow groundwater levels, stream surface water levels, instream water temperature and dissolved oxygen are also recent are included in the updated report.

Lastly GWRC data is presented in graph form of the December 2014 rain fall and river flows.

# 2.0 Methodology

## 2.1 Survey Period

The sampling for cross sections, electric fishing and water quality data occurred on the 1st December 2014 and the 5th December 2014 (Paetawa, Kakariki and upper Muaupoko sites). Additional fish netting and macroinvertebrate samples were taken on the 16th December 2014. The physical habitat survey period was before the heavy rain and flow period around the 10th of December (2014) (see Figure 1 and Figure 2 below).

The fish netting and macroinvertebrate sampling occurred after the heavier rain period, although there were still light falls about the collection time. The collection period was sufficiently after the higher flow event as to not affect the macroinvertebrate sampling result.

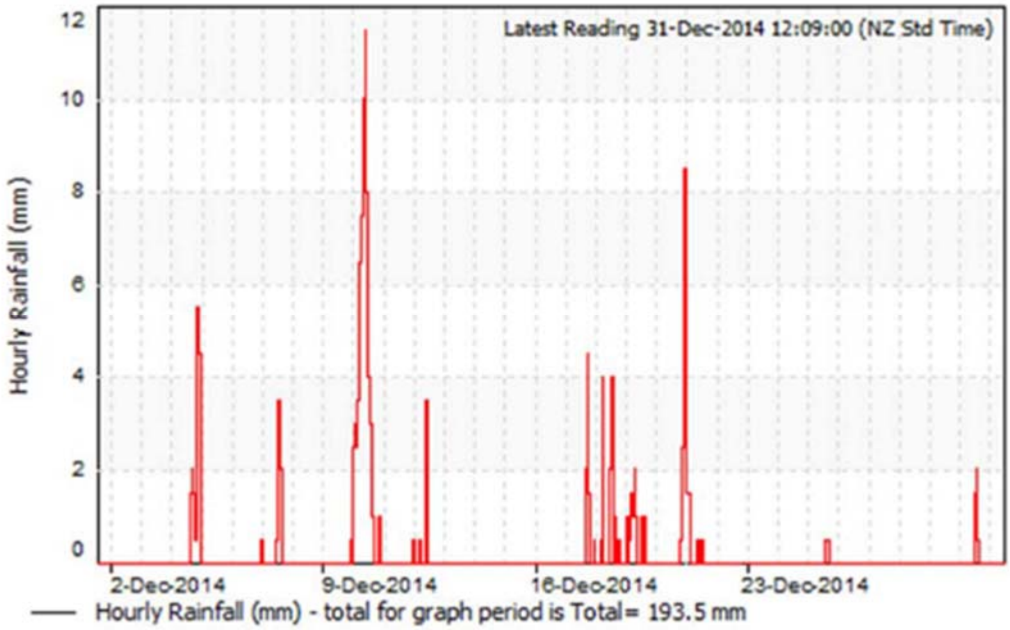


*Figure 1 GWRC data: Rain gauge at WWTP (Waikanae River), records through December 2014.*

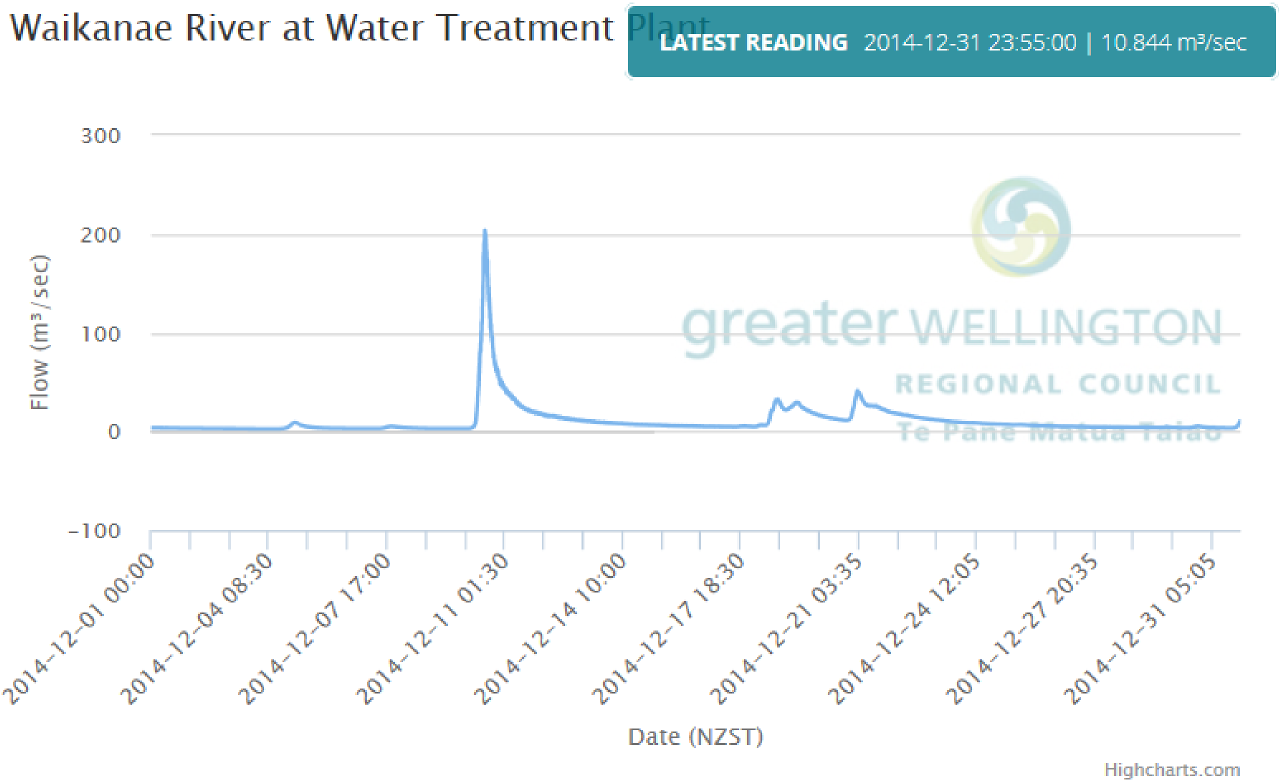


*Figure 2 GWRC flow record from the Waikanae River (at the WWTP) for December*

## 2.2 Sampling Locations

The Kapiti Coast small coastal streams (SCS) included in the baseline monitoring programme were selected through a characterisation survey completed in March 2014 (Boffa Miskell Ltd, 2014a). Site characteristics and the selection process are further detailed in that report. Figure 2-3 is a map of locations of all survey sites. Note that since that characterization survey and site selection, further changes have been made and certified through Greater Wellington Regional Council. Those changes are minor shifts in the position for monitoring and one major change being the removal of the Upper Kakariki site, due to a lack of surface water and also lack of landowner permission for continued access.

The SCS monitoring sites are (Figure 3):

- Lower Muaupoko
- Upper Muaupoko
- Ngarara
- Kakariki
- Paetawa
- Hadfield
- Kowhai

## 2.3 Depth of Cross Sections

At each site a 50m study reach, including the installed piezometers, were set out and GPS marked. The wetted width and depth profile measurements were taken at three cross sectional transects at the start, middle and end of the 50m survey length, with each transect representing the channel forms present in a 50m reach. The central cross section is at and in line with the installed piezometer, then one up stream and one downstream 25m.

Across each transect the wetted width was recorded and then divided into ten equal sections where measures of depth (of clear water above the substrate) were taken.

## 2.4 Water Quality Sampling

A hand held U-50 Multiparameter Water Quality Meter was used to measure Total Dissolved Solids (TDS), Nephelometric Turbidity Units (NTU), dissolved oxygen, pH, and temperature. Five measures were taken at each site from the middle of the channel at roughly 10m spacing's along the 50m transect (before any other in-stream monitoring commences) with the resulting average recorded.

## 2.5 Backpack Electrofishing

Backpack Electrofishing (EFM) was carried out as appropriate to the stream channel (depth velocity and clarity). The Hadfield and Ngarara were too deep to fish using EFM and the method was abandoned after two 5m runs at each site.

Electrofishing followed the New Zealand Freshwater Fish Sampling Protocols (Joy, David, & Lake, 2013). Fishing was carried out by at least two NIWA certified operators using a Kainga

300 backpack electrofishing machine (EFM). The machine was set to a minimum voltage (1-2V) in order to reduce fish fatalities.

Fishing was carried out with multiple passes over the 50m survey reach that was further sectioned into 10 sampling runs of 5m. Each fish seen was captured using either a handheld net or the stop net downstream and transferred into a bucket to be processed. The fish caught were then identified and measured (nose to distal end of caudal fin), and returned downstream.

## 2.6 Fyke Netting & Gee Minnow Traps

Deeper and slower flowing streams that were unable to be successfully sampled using an EFM, were fished using baited fyke nets and Gee minnow traps. One to three fyke nets and five Gee minnow traps were set within the slower flowing, deeper survey site of Hadfield. Nets were also set in the Paetawa (in addition to the EFM survey). Three fyke nets were installed in the Ngarara (it being partially EFM surveyed). These nets were set in the afternoon of 16 December 2014 and processed the following morning. The fishing was sufficiently after the higher flow events caused by the 10th December rain fall so as to not affect the probability of catch. Fish species caught were recorded as they were identified, counted and measured.

## 2.7 Macroinvertebrate Surveys

Communities were sampled using the Ministry for the Environment (MfE) sampling protocol 'C1' hard bottom or 'C2' soft bottom, as was appropriate to each site. This involved the use of a 0.5mm kick net, using the national standard kick-sampling protocol described by (Stark, Boothroyd, Harding, Maxted, & Scarsbrook, 2001), and pooling 10 sub-samples from each site ensuring 1m2 of habitat was sampled. Species were identified to the lowest possible taxa (sufficient for MCI allocation) and abundances were recorded as quantitative sampling.

Samples were forwarded to a laboratory (Ryder Consulting) for identification. Species were identified to Macroinvertebrate Community Index (MCI level) and abundance records were full count (Method P3).

The results for each site's three replicates were averaged to give mean values and confidence intervals, and pooled to give total taxa counts and abundances for the site.

The following six invertebrate indices were calculated for each replicate at each site and averaged. These biotic indices use the tolerances of New Zealand macroinvertebrate taxa to assess water quality and the health of aquatic habitats.

- Taxa Richness;
- EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa;
- EPT abundance;
- Macroinvertebrate Community Index (MCI); and
- Quantitative MCI (QMCI).

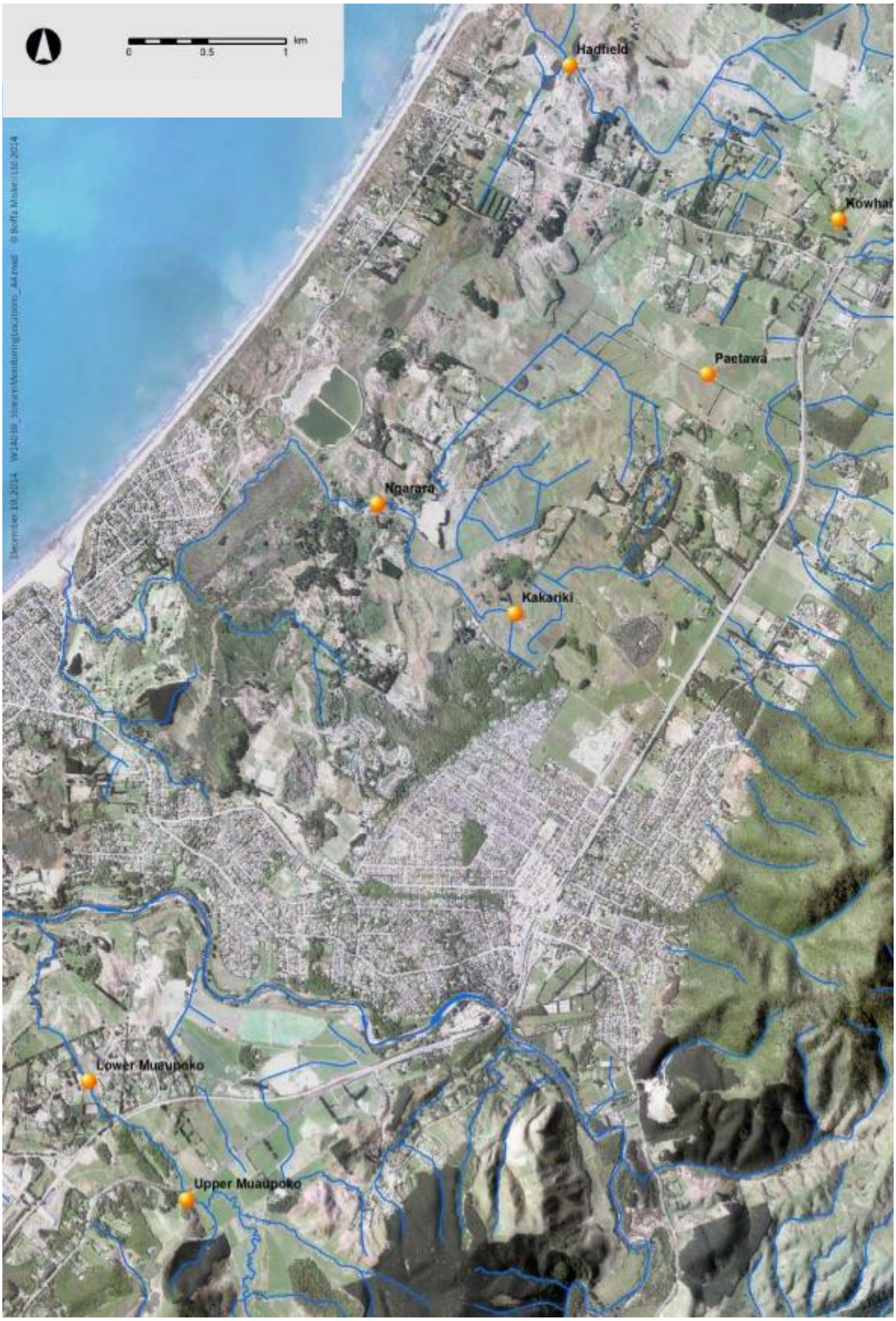

*Figure 3 Survey sites for the Kapiti Coast Small Coastal Streams baseline monitoring programme. Note the Upper Kakariki survey site was abandoned due to limitations of access*

# 3.0 Results

## 3.1 Water Quality Measures

Tabled below (Table 1) are the water quality results, averaged from five measurements for each survey site. While only spot measures they help describe the aquatic habitat at the time of survey. At all sites dissolved oxygen (DO) is high (good), while pH is notably alkaline, especially so at three of the sites (Hadfield, Kowhai and Ngarara) which have higher than the recommended "normal" upper pH of 9 (ANZECC, 2000).

*Table 1: Average water quality from five measurements for the small streams survey sites (1-5th December 2014).Note: Values of pH are uncharacteristically high and we question the measure.*

| Site | Temp (°C) | pH | ORP V | Conductivity mS/cm | DO mg/L | DO % | TDS mg/L | NTU |
|---|---|---|---|---|---|---|---|---|
| Hadfield | 14.03 | 10.7 | 263.00 | 0.34 | 19.77 | 198.50 | 0.24 | 0.45 |
| Kowhai | 15.71 | 10.0 | 260.00 | 0.14 | 15.90 | 165.90 | 0.09 | 19.10 |
| Paetawa | 15.63 | 7.35 | 20.00 | 0.19 | 10.46 | 108.60 | 0.12 | 102.00 |
| Ngarara | 15.82 | 10.1 | 185.00 | 0.29 | 29.00 | 218.00 | 0.19 | 5.60 |
| Kakariki | 14.86 | 7.20 | 148.00 | 0.21 | 10.90 | 109.70 | 0.14 | 4.00 |
| Lower Muaupoko | 15.66 | 7.73 | 307.00 | 0.237 | 13.86 | 140.30 | 0.54 | 2.50 |
| Upper Muaupoko | 17.42 | 7.9 | 218.00 | 0.224 | 12.90 | 134.20 | 0.145 | 2.90 |

## 3.2 Cross-sectional Depth

Below (Figure 3 to Figure 9) are the three depth profiles for each survey reach at ten points along each cross-section across the waterway, displayed as line graphs. Note that the widths of the stream vary and the graph only illustrates the 10 measures, not the wetted width. T0 is 25m up stream of the piezo, T25 is at the Piezometer and T50 is 25m downstream of the piezometer.

Raw data for these results can be found in Appendix 1 Table 4.

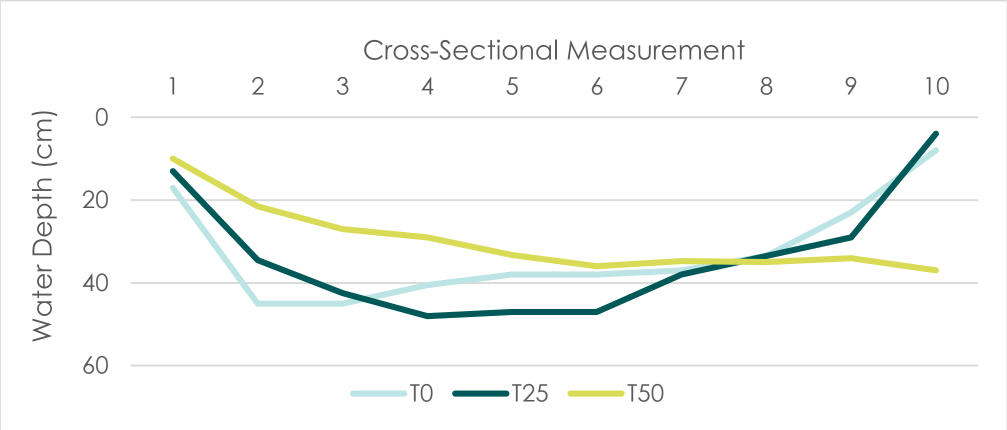

*Figure 3. Depth profile of the Hadfield stream survey reach at 25m intervals (transect 0m = T0, transect 25m = T25, transect 50m = T50).*

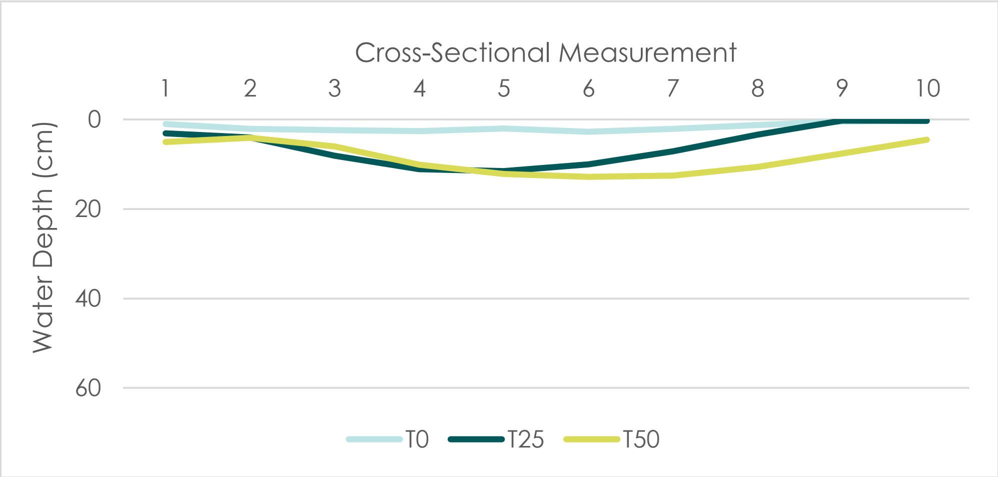

*Figure 4: Depth profile of the Kowhai stream survey reach at 25m intervals (transect 0m= T0, transect 25m= T25, transect 50m = T50)*

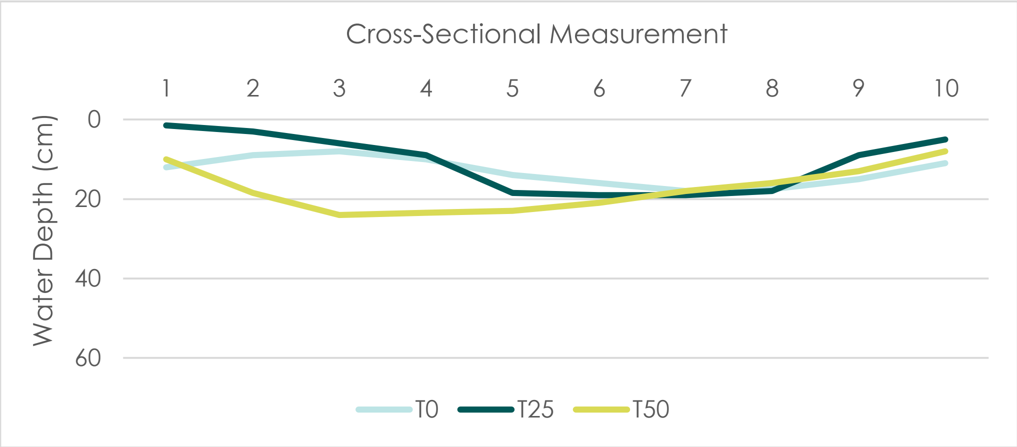

*Figure 5: Depth profile of the Paetawa stream survey reach at 25m intervals (transect 0m = T0, transect 25m = T25, transect 50m = T50)*

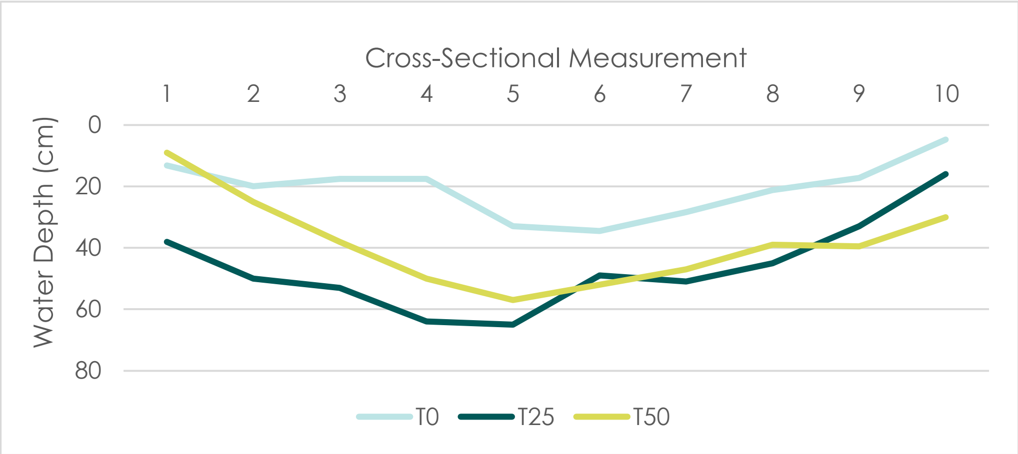

*Figure 6: Depth profile of the Ngarara stream survey reach at 25m intervals (transect 0m= T0, transect 25m = T25, transect 50m = T50). Note y-axis finishes at 80m*

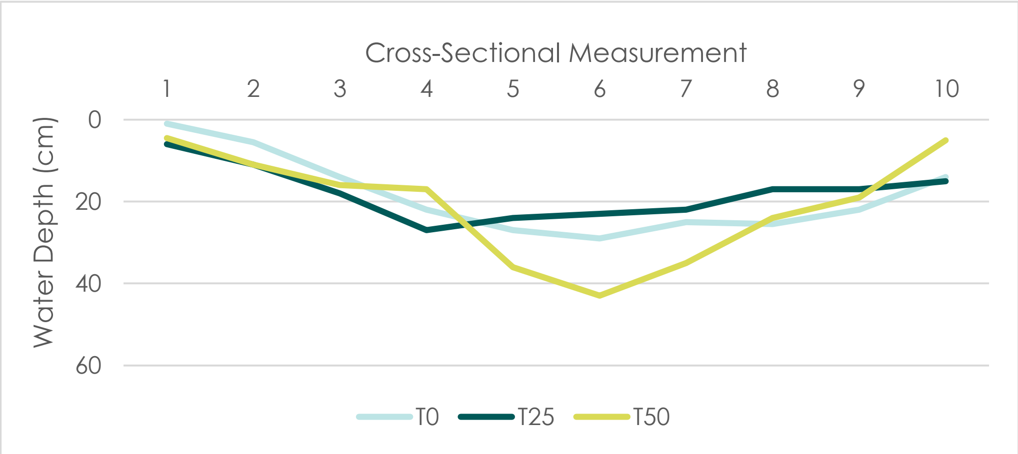

*Figure 7: Depth profile of the Kakariki stream survey reach at 25m intervals (transect 0m= T0, transect 25m = T25, transect 50m = T50).*

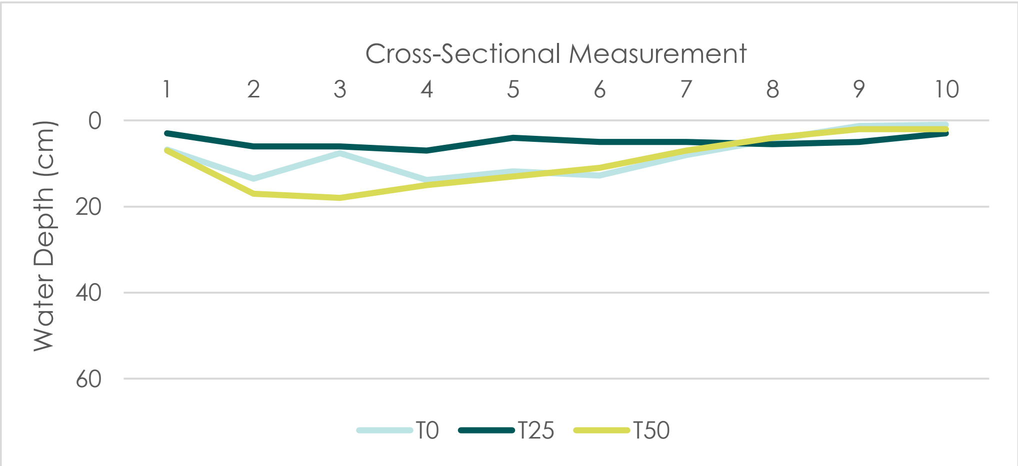

*Figure 8: Depth profile of the Upper Muaupoko stream survey reach at 25m intervals (transect 0m= T0, transect 25m= T25, transect 50m = T50*

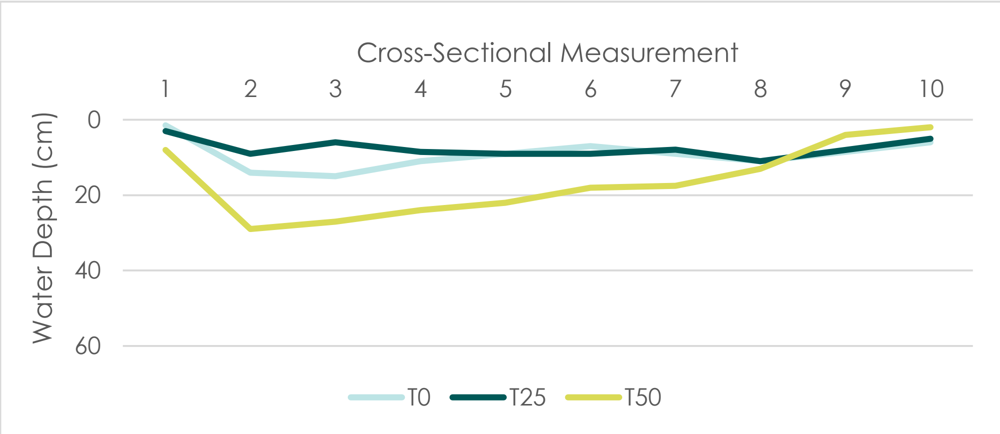


*Figure 9: Depth profile of the Lower Muaupoko stream survey reach at 25m intervals (transect 0m= T0, transect 25m= T25, transect 50m = T50).*

## 3.3 Fish Results

The freshwater fish communities recorded through all fishing methods (Table 2 and Figure 10) show low to fair numbers of common bully, inanga and eel over the 50m reaches. Black flounder, red fin bully and koura were few. There were 2 banded kokopu caught in the Hadfield Stream.

In comparing the fish communities recorded at each site, the Kakariki contained the greatest abundance of fish (Table 2), with the majority of these being inanga. The Hadfield returned 5 taxa and included the semi-marine wander black flounder. The Kakariki and the Muaupoko contained four species. The Kowhai held no fish as it had little surface water at survey (<3 cm). The Paetawa and Ngarara sites only recorded eel and inanga.

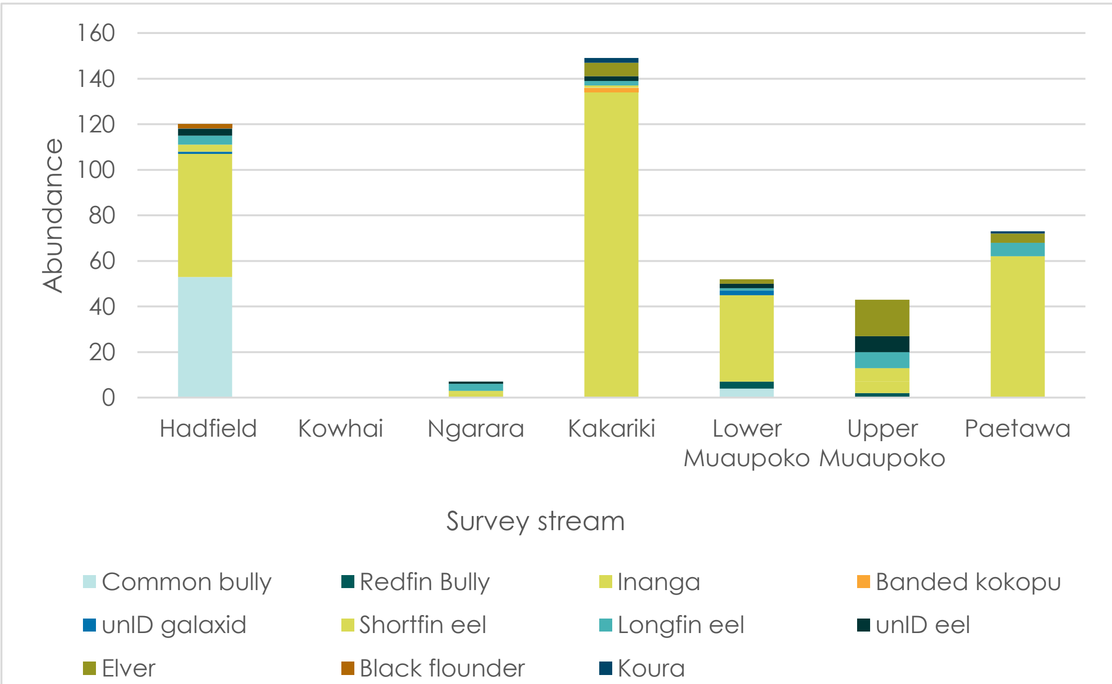


*Figure 10: Abundance and diversity of freshwater fish recorded in each survey reach (all methods)*

*Table 2: Fish community species diversity and abundance at each sample reach.*

| SPECIES | Hadfield | Kowhai | Ngarara | Kakariki | Lower Muaupoko | Upper Muaupoko | Paetawa |
|---|---|---|---|---|---|---|---|
| **Common bully** | 53 | | | | 4 | | |
| **Redfin Bully** | | | | | 3 | 2 | |
| **Inanga** | 54 | | 2 | 134 | 38 | 5 | 62 |
| **Banded kokopu** | | | | 2 | | | |
| **Shortfin eel** | 3 | | 1 | 1 | | 6 | |
| **Longfin eel** | 4 | | 3 | 2 | 1 | 7 | 6 |
| **UnID eel** | 3 | | 1 | 2 | 2 | 7 | |
| **Elver** | | | | 6 | 2 | 16 | 4 |
| **Black flounder** | 2 | | | | | | |
| **Koura** | | | | 2 | | | 1 |
| **TOTAL ABUNDANCE** | **120** | **0** | **7** | **149** | **52** | **43** | **73** |
| **FISH TAXA** | **5** | **0** | **3** | **4** | **4** | **4** | **2** |

## 3.4 Freshwater Macroinvertebrates

A total of 38 taxa (a taxonomic group at either the order (in capitals) or family (lower case)) and 8182 individuals were recognised from all of the sites from 10 “main groups”. Diptera (true flies) were the largest group with 12 taxa, followed by caddisfly (7), and crustacean (4). Most other main groups were represented by 1 or 2 taxa.

In terms of percentage abundance, the communities in general were numerically dominated by 6 taxa (Figure 11). The proportional composition of the total sampled community was dominated by: Paracalliope (freshwater Amphipod - 56% of all individuals caught), followed by Potamopyrgus (freshwater snail) (16%); Elimidae beetles (7%); Ostracods (7%), and the common true flies: Orthocladiinae (6%) and Chrinomus (2%). All other taxa (32) were less than 1% of the total catch (8182 individuals).

These data represent a typical soft bottomed, macrophyte rich, fauna suggestive of high organic matter and “challenging” water quality periods. The density of taxa from a sample area averaged 7m$^{-2}$ should be considered low.

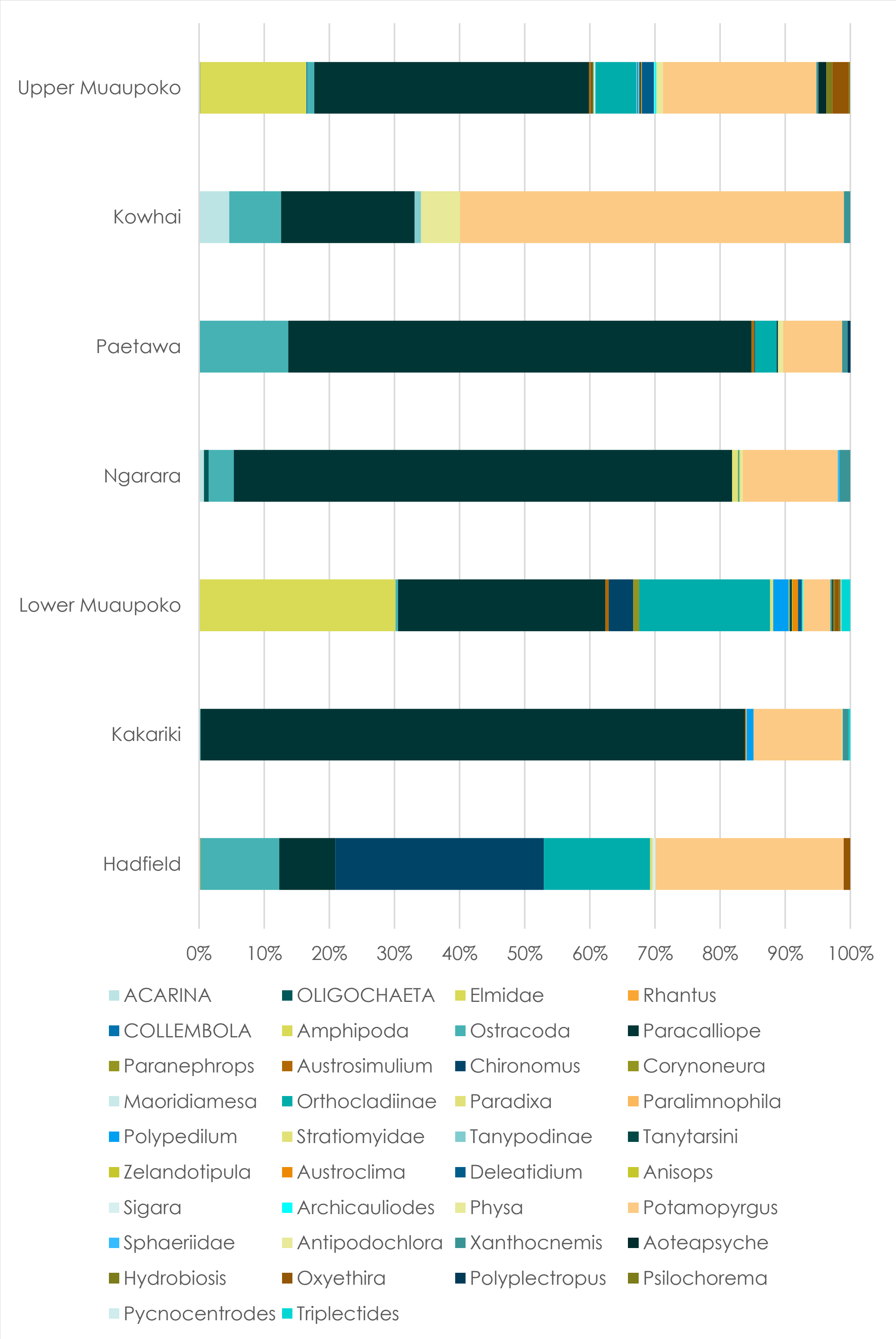


*Figure 11: Showing percentage abundance of taxa within each study site*

### 3.4.1 Specific Sites

The results of the kick net sampling for each site are summarised in Table 3, each parameter is then discussed below.

*Table 3: Summary invertebrate metrics complied from the raw data from each site's kick samples.*

| Metric | Hadfield | Kakariki | Lower Muaupoko | Ngarara | Paetawa | Kowhai | Upper Muaupoko |
|---|---|---|---|---|---|---|---|
| **Total abundance** | 478 | 854 | 1005 | 672 | 3093 | 302 | 1778 |
| **Number of taxa (richness)** | 9 | 9 | 24 | 11 | 13 | 7 | 26 |
| **Number of EPT taxa** | 1 | 1 | 8 | 0 | 1 | 0 | 7 |
| **EPT abundance** | 5 | 2 | 42 | 0 | 12 | 0 | 123 |
| **MCI score** | 63.3 | 92.9 | 91.7 | 74.4 | 78.5 | 62.9 | 87.7 |
| **QMCI** | 2.9 | 4.6 | 4.4 | 4.4 | 4.2 | 2.7 | 4.6 |

### 3.4.2 Species Richness

The Hadfield and Kowhai stream had low taxa richness (national kick sample median 14 per sample (Quinn & Hickey 1990)).

The Muaupoko (lower and upper) had a "relatively" high taxa richness, and the highest of all of the sampled streams.

The lower Muaupoko was the only stream to record mayfly (Deleatidium, and Austroclima) and had most of the recorded "higher sensitivity" caddisfly.

This trend is shown clearly in the number of EPT taxa, where most sites had 1 or none. Where one was recorded it was normally Oxyethira, a poor quality indicator species (MCI score 2).

### 3.4.3 Ephemeroptera, Plecoptera and Trichoptera

Ephemeroptera, Plecoptera, and Trichoptera (EPT), are three insect orders commonly used to indicate water health. In the small coastal streams sites EPT taxa (9) in total comprised 42 individuals or ~0.5% of the total catch.

%EPT proposed National Guideline (MfE) suggests those communities with <25% EPT taxa are in "poor" condition and those with 25-50% in fair condition (LAWA 20141). There are obviously caveats to this simple approach, but in terms of this metric most of the sites rank as "poor" and the best sites rank as "fair" (Muaupoko sites).

### 3.4.4 Macroinvertebrate Community Index

It is generally accepted that a Macroinvertebrate Community Index (MCI) score < 80 reflects a severe degradation of the water habitat, and a poor condition; and 80-99 a "fair" condition and moderately degraded (Stark & Maxted 2007, Wright-Stow & Winterbourn 2010 etc). Other than the Muaupoko, all the streams sampled can be said to be in “poor” and severely degraded” conditions at the locations of the samples.

The Muaupoko sites are classified as moderately degraded, “fair” condition.

### 3.4.5 Quantitative Macroinvertebrate Community Index

An arguably better index, the Quantitative Macroinvertebrate Community Index (QMCI) accounts for the proportional abundance of the various sensitivity scoring individuals sampled. A QMCI score < 4 reflects a severely degraded habitat (poor) and 4-4.9 a moderately degraded habitat (fair). This index raises several sites above poor to “fair” (moderately degraded) (Table 5). The Hadfield at both sites however, is clearly classified as very poor condition (and had limited surface water).

# 4.0 Analysis

The primary purpose of the SCS baseline monitoring to date was to identify fish or macroinvertebrate taxa (or communities) that are “valued” and sensitive to water depth issues (i.e. increasingly shallow water).

## 4.1 Fish

Valued fish, in terms of those with a “threat classification” (Goodman et al., 2014), include:

- Long fin eel (At Risk)
- Red fin bully (At Risk)
- Inanga (At Risk).

Fish sensitive to substantive decreases in water depth (and lowered dissolved oxygen) are those fish that are territorial, grow to large size and occupy the middle water column (are not adapted to variable water presence). These species on the Kapiti Coast included giant kokopu and banded kokopu.

Bully, being benthic dwelling, typically manage very shallow depths, and are somewhat tolerant of lowered dissolved oxygen (DO).

Eel are also tolerant of lower DO and become mobile at worsening conditions, but are capable of persisting in low water depths through burrowing and through partial air breathing.

Banded kokopu adults typically seek out deeper pool habitat (Baker & Smith, 2007) and are more typical at higher altitudes than found on the Kapiti Coast. Nevertheless, banded kokopu are found in the Paetawa, Kakariki and Hadfield streams although those found here are typically small (40-70mm) and are likely to be mobile and not territorially established in any one area.

Eel are the most significant predator and limit Galaxid habitat occupation. Bully, however, (especially common bully) co-habitat well.

Inanga are the most numerically common species in these streams and that is a factor of proximity to the sea and season of monitoring. “Whitebait” season on the Kapiti Coast is typically at its peak in December and inanga are frequent and highly mobile at this time. Worsening water conditions will see inanga move up or downstream to better habitat as these fishes are not territorial as are giant kokopu and banded kokopu.

It is our opinion that, in the general absence of territorial adult giant kokopu, banded kokopu (or short jaw kokopu), there are no especially water depth sensitive (or DO sensitive) fish species at the SCS monitoring sites. Eel and inanga and common bully numerically dominate the communities and these fish are either highly mobile, escaping habitats that reduce in quality, as well as being most tolerant of lowering DO and water depth.

Given the fish community present and the ability to successful monitor relevant and meaningful changes in such communities that relate to a factor such as water depth, we do not recommend that fish at the monitoring sites be an ongoing monitoring parameter for either baseline monitoring or ongoing monitoring.

## 4.2 Sensitive Macroinvertebrate Taxa

For soft bottomed stream communities only the two diptera (*Paralimnophila* and *Polypedilum*); and two Caddisfly (*Polyplectropus* and *Psilochorema*) have MCI sensitivity scores > 7. In terms of a hard bottom stream fauna (as is found in the Muaupoko) the mayfly (Deleatidium and *Austroclima*) are also “sensitive” taxa.

There were only a few sensitive taxa present at any one site. Both fly taxa were present at the Kakariki site (totalling 10 individuals of 854 sampled) and, in addition to the two flys, the Caddisfly and Mayfly in the Muaupoko (upper: 3 fly individuals and 14 mayfly, and lower: 24 *Polypedium*, 36 Mayfly and 3 caddis).

The numbers of individuals sampled suggest that these “sensitive” taxa may not be part of the resilient, always present, community, but are transitory taxa. In regard to the Lower Muaupoko, the “best site”, the “sensitive” taxa make up 44 of the total of 1778 individuals or 2.5% of the assemblages total abundance.

Neither the Kakariki nor Upper Muaupoko, that is the sites with greater presence of sensitive taxa, have abundances of those taxa that suggest a reliable population is present and which may be resampled with any frequency to provide an indication of habitat quality. The general results indicating poor quality and severe degradation support that conclusion. Over sampling may remove such small populations of taxa.

Given the above, we believe there are no aquatic macroinvertebrate taxa present that will provide any useful stream water condition indication via regular or even infrequent macroinvertebrate monitoring.

# 5.0 Conclusion

There are no especially sensitive fish or macroinvertebrate communities present and though there are three “at Risk” fish taxa, only inanga are common and all three are not overly water depth sensitive and mobile, generally avoiding unsuitable habitat conditions.

Regular surveys of fish are unlikely to allow recognition of habitat quality reduction and repeated monitoring of fish at the sites is more likely to have an adverse effect than the factors being monitored for.

We recommend no further fish monitoring for the remainder of the SCS baseline monitoring period.

In a similar vein, and unsurprising given the quality of the aquatic habitat, we conclude that there are no aquatic macroinvertebrate taxa present that will provide any useful in-stream water condition indication via regular or even infrequent macroinvertebrate monitoring.

We therefore recommend that no further aquatic “baseline” monitoring be undertaken for the purposes of providing a trigger to establish low flow stresses to the community at large.

We recommend that the temperature and DO monitoring be continued as these are the best and most effective indicators of low water depth aquatic habitat stress in these small coastal streams.

# 6.0 References


Baker, C. F., & Smith, J. P. (2007). Habitat use by banded kokopu (Galaxias fasciatus) and giant kokopu (G. argenteus) co-occurring in streams draining the Hakarimata Range, New Zealand. New Zealand Journal of Marine and Freshwater Research, 41(1), 25–33.

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Quinn, J.M. & Hickey, C.W. (1990) Characterisation and classification of benthic invertebrate communities in 88 New Zealand rivers in relation to environmental factors, New Zealand Journal of Marine and Freshwater Research, 24:3, 387-409

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# Appendix 1: Cross-sectional depth profiles raw data

*Table 4: Wetted width and depth of survey reaches at each transect reach.*

| Site | Transect | wetted width (cm) | Cross–section measurement (depth, cm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Hadfield** | **T0** | 250 | 17 | 45 | 45 | 40.5 | 38 | 38 | 37 | 33.5 | 23 | 8 |
| | **T25** | 250 | 13 | 34.5 | 42.5 | 48 | 47 | 47 | 38 | 33.5 | 29 | 4 |
| | **T50** | 220 | 10 | 21.5 | 27 | 29 | 33.3 | 36 | 34.7 | 35 | 34 | 37 |
| **Kowhai** | **T0** | 190 | 1 | 2.1 | 2.4 | 2.6 | 2 | 2.7 | 2.1 | 1.2 | 0.4 | 0.2 |
| | **T25** | 170 | 3.1 | 4 | 8.1 | 11.1 | 11.5 | 10 | 7.1 | 3.4 | 0.2 | 0.3 |
| | **T50** | 87 | 5 | 4.1 | 6 | 10.1 | 12.2 | 12.8 | 12.5 | 10.6 | 7.6 | 4.5 |
| **Paetawa** | **T0** | 137 | 12 | 9 | 8 | 10 | 14 | 16 | 18 | 17.5 | 15 | 11 |
| | **T25** | 86 | 1.5 | 3 | 6 | 9 | 18.5 | 19 | 19 | 18 | 9 | 5 |
| | **T50** | 120 | 10 | 18.5 | 24 | 23.5 | 23 | 21 | 18 | 16 | 13 | 8 |
| **Ngarara** | **T0** | 207 | 13.2 | 19.9 | 17.5 | 17.5 | 33 | 34.5 | 28.4 | 21.2 | 17.2 | 4.7 |
| | **T25** | 276 | 38 | 50 | 53 | 64 | 65 | 49 | 51 | 45 | 33 | 16 |
| | **T50** | 300 | 9 | 25 | 38 | 50 | 57 | 52 | 47 | 39 | 39.5 | 30 |
| **Kakariki** | **T0** | 155 | 1 | 5.5 | 14 | 22 | 27 | 29 | 25 | 25.5 | 22 | 14 |
| | **T25** | 125 | 6 | 11 | 18 | 27 | 24 | 23 | 22 | 17 | 17 | 15 |
| | **T50** | 200 | 4.5 | 11 | 16 | 17 | 36 | 43 | 35 | 24 | 19 | 5 |
| **Lower Muaupoko** | **T0** | 230 | 6.8 | 13.5 | 7.6 | 13.8 | 11.8 | 12.8 | 8 | 4.5 | 1.3 | 1 |
| | **T25** | 180 | 3 | 6 | 6 | 7 | 4 | 5 | 5 | 5.5 | 5 | 3 |
| | **T50** | 130 | 7 | 17 | 18 | 15 | 13 | 11 | 7 | 4 | 2 | 2 |
| **Upper Muaupoko** | **T0** | 189 | 1.5 | 14 | 15 | 11 | 9 | 7 | 9 | 11 | 8.5 | 6 |
| | **T25** | 180 | 3 | 9 | 6 | 8.5 | 9 | 9 | 7.9 | 11 | 8 | 5 |
| | **T50** | 168 | 8 | 29 | 27 | 24 | 22 | 18 | 17.5 | 13 | 4 | 2 |

# Appendix 2: Macroinvertebrate samples raw data

Raw data: Total counts for each taxa sampled from 10 pooled kick net samples surveying 1m$^2$. Yellow depicts the most sensitive taxa (highest MCI scores)

| | Hadfield | Kakariki | Lower Muaupoko | Ngarara | Paetawa | Kowhai | Upper Muaupoko |
|---|---|---|---|---|---|---|---|
| ACARINA | | | 1 | 5 | | 14 | |
| OLIGOCHAETA | | | | 5 | 3 | | 3 |
| Elmidae | | | 302 | | | | 290 |
| Rhantus | 1 | | | | | | |
| COLLEMBOLA | | | | | | | 2 |
| Amphipoda | | | | | 1 | | |
| Ostracoda | 58 | 2 | 4 | 26 | 420 | 24 | 20 |
| Paracalliope | 41 | 714 | 320 | 514 | 2200 | 62 | 750 |
| Paranephrops | | | | | 1 | | |
| Austrosimulium | | 1 | 5 | | 12 | | 7 |
| Chironomus | 153 | | 38 | | 3 | | 2 |
| Corynoneura | | | 9 | | | | 3 |
| Maoridiamesa | | | | | | | 5 |
| Orthocladiinae | 78 | | 202 | | 102 | | 112 |
| Paradixa | 2 | | 5 | 6 | | | |
| Paralimnophila | | 1 | | | | | 1 |
| Polypedilum | | 9 | 24 | 1 | | | 4 |
| Stratiomyidae | | | 1 | | | | |
| Tanypodinae | | | | | | 3 | 3 |
| Tanytarsini | | | 4 | | 7 | | 4 |
| Zelandotipula | | | 1 | | | | |
| Austroclima | | | 8 | | | | 3 |
| Deleatidium | | | 6 | | | | 33 |
| Anisops | | | | 1 | | | |
| Sigara | 2 | | | | | | 1 |
| Archicauliodes | | | 2 | | | | 6 |
| Physa | | | | 3 | 25 | 18 | 17 |
| Potamopyrgus | 138 | 116 | 42 | 98 | 280 | 178 | 419 |
| Sphaeriidae | | | | 2 | | | |
| Antipodochlora | | 1 | | | | | |
| Xanthocnemis | | 8 | 3 | 11 | 27 | 3 | 6 |
| Aoteapsyche | | | 1 | | | | 21 |
| Hydrobiosis | | | 3 | | | | 17 |
| Oxyethira | 5 | | 6 | | | | 45 |
| Polyplectropus | | | | | 12 | | |
| Psilochorema | | | 3 | | | | 3 |
| Pycnocentrodes | | | 1 | | | | 1 |
| Triplectides | | 2 | 14 | | | | |

# Appendix 3: Fish scientific names

| Scientific name | Common name |
| --- | --- |
| *Gobiomorphus cotidianus* | Common bully |
| *Gobiomorphus huttoni* | Redfin Bully |
| *Galaxias maculatus* | Inanga |
| *Galaxias fasciatus* | Banded kokopu |
| *Galaxid spp* | UnID galaxid |
| *Anguilla australis* | Shortfin eel |
| *Anguilla dieffenbachii* | Longfin eel |
| *Anguilla spp* | UnID eel |
| *Anguilla spp* | Elver |
| *Rhombosolea retiaria* | Black flounder |
| *Paranephrops planifrons* | Koura |

# Appendix 4: Electric fishing raw data

## Hadfield

| Run | Species | Length (mm) | Length (mm) | Length (mm) |
|---|---|---|---|---|
| 1 | Common bully | 35 | 30 | 43 |
| | Flounder | P | | |
| 2 | Inanga | 54 | 41 | |
| 3 | Inanga | 50 | 51 | |
| 4 | Common bully | 52 | | |
| | Inanga | 50 | | |
| 5 | UnID eel | 19 | | |
| 6 | UnID eel | 16 | | |
| | Shortfin eel | 22 | | |
| 7 | Inanga | 55 | 40 | |
| | Common bully | 30 | | |
| 8 | UnID galaxid | 10 | | |
| | UnID eel | 10 | 8 | |
| 9 | Longfin eel | 44 | | |
| 10 | Common bully | 42 | | |
| | Flounder | 15.5 | | |

## Kowhai

| |
|---|
| No Fish |

## Paetawa

| Run | Species | Length (mm) | Length (mm) |
|---|---|---|---|
| 1 | Inanga | 60 | |
| | Elver | 240 | |
| 2 | No Fish | | |
| 3 | No Fish | | |
| 4 | Inanga | 60 | 60 |
| | Elver | 120 | 100 |
| 5 | No Fish | | |
| 6 | Elver | 200 | |
| 7 | No Fish | | |
| 8 | No Fish | | |
| 9 | No Fish | | |
| 10 | Longfin eel | 1000 | |

## Ngarara

| Run | Species | Length (mm) |
|---|---|---|
| 1 | Inanga | 50 |
| | UnID eel | 90 |
| | Shortfin eel | 90 |
| | Inanga | 55 |

* fishing was stopped on first run due to stream being too deep to safely, and effectively, electric fish. Fyke netting was carried out on this monitoring reach instead.

## Kakariki

| Run | Species | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | inanga | 70 | 60 | 60 | 50 | 40 | 40 | 40 | 40 | 40 | 40 |
| | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | | 50 | 60 | | | | | | | | |
| | UnID eel | P | | | | | | | | | |
| | Elver | 100 | 120 | | | | | | | | |
| 2 | Inanga | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | | 40 | 40 | 80 | 60 | 50 | 50 | 50 | 60 | 50 | 60 |
| | | 50 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | | 40 | 40 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 3 | Longfin eel | 180 | | | | | | | | | |
| | Inanga | 90 | 50 | 50 | 40 | 40 | 50 | 60 | 60 | 40 | 50 |
| | | 70 | 70 | 50 | 40 | 50 | 50 | 40 | 50 | 40 | 50 |
| | | 60 | 60 | 50 | | | | | | | |
| 4 | Inanga | 40 | 50 | 50 | 50 | 40 | 50 | 40 | 50 | 40 | 50 |
| | | 40 | 50 | 60 | | | | | | | |
| 5 | Inanga | 50 | 50 | 50 | | | | | | | |
| | Koura | 80 | 60 | | | | | | | | |
| | Banded kokopu | 40 | 70 | | | | | | | | |
| 6 | Inanga | 40 | 40 | | | | | | | | |
| | Elver | 100 | | | | | | | | | |
| 7 | UnID eel | 220 | | | | | | | | | |
| | Elver | 140 | 100 | 90 | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8** | Inanga | 70 | 60 | 50 | | | | | | | |
| **9** | Shortfin eel | 400 | | | | | | | | | |
| | Inanga | 50 | 50 | 60 | 50 | | | | | | |
| **10** | Inanga | 40 | 50 | 50 | 50 | 40 | 90 | 50 | 50 | | |
| | Longfin eel | 250 | | | | | | | | | |

## Lower Muaupoko

| **Run** | **Species** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** | **Length (mm)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | inanga | 5 | | | 5 | | 6.5 | | | | | |
| **2** | inanga | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | |
| | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 65 | 60 | 50 | |
| **3** | inanga | 55 | | | | | | | | | | |
| | common bully | 50 | | | | | | | | | | |
| **4** | inanga | 60 | | | | | | | | | | |
| | common bully | 60 | | | | | 35 | | | | | |
| | unID eel | 220 | | | | | | | | | | |
| **5** | no fish | | | | | | | | | | | |
| **6** | inanga | 10 | | | | | | | | | | |
| **7** | elver | 120 | | | | | | | | | | |
| | redfin bully | 90 | | | | | 75 | | | | | |
| | unID galaxid | 30 | | | | | | | | | | |
| **8** | inanga | 50 | | | | | | | | | | |
| **9** | inanga | 50 | | 50 | 40 | | 70 | | 60 | 50 | | |
| | unID galaxid | 40 | | | | | | | | | | |
| **10** | inanga | 55 | | 60 | | 50 | | 50 | | 95 | | |
| | unID eel | 300 | | | | | | | | | | |
| | elver | 90 | | | | | | | | | | |
| | longfin eel | 270 | | | | | | | | | | |
| | redfin bully | 60 | | | | | | | | | | |
| | | **Notes: Shrimp common in inland runs** | | | | | | | | | | |

## Upper Muaupoko

| Run | SPP | Length (mm) | Length (mm) | Length (mm) | Length (mm) |
|---|---|---|---|---|---|
| **1** | shortfin eel | 280 | | | |
| | elvers | 180 | 180 | 100 | 100 |
| | unID eel | 280 | 280 | | |
| | Longfin eel | 260 | 220 | | |
| | redfin bully | 70 | | | |
| **2** | Longfin eel | 140 | | | |
| | elver | 100 | 120 | 130 | |
| | inanga | 40 | | | |
| **3** | inanga | 50 | | | |
| | elver | 100 | | | |
| **4** | Longfin eel | 400 | | | |
| | shortfin eel | 280 | | | |
| **5** | shortfin eel | 100 | | | |
| | Longfin eel | 240 | | | |
| | elver | 120 | 120 | | |
| **6** | shortfin eel | 190 | | | |
| | Longfin eel | 220 | | | |
| | elver | 180 | | | |
| **7** | shortfin eel | 270 | | | |
| | elver | 120 | | | |
| | unID eel | 140 | | | |
| **8** | unID eel | 400 | 300 | 250 | 250 |
| **9** | elver | 100 | 90 | | |
| | Longfin eel | 220 | | | |
| **10** | shortfin eel | 280 | | | |
| | inanga | 70 | 60 | 80 | |
| | elvers | 180 | 240 | | |

# Appendix 5: Fish netting and trapping raw data

| METHOD | SPECIES | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) | Length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hadfield** | | | | | | | | | | | | | | | |
| Fyke 1 | Shortfin eel | 500 | 400 | | | | | | | | | | | | |
| Minnow 1 | No fish | | | | | | | | | | | | | | |
| Minnow 2 | Common bully | 15 | 40 | 20 | 25 | 35 | | | | | | | | | |
| | Inanga | 30 | | | | | | | | | | | | | |
| Minnow 3 | Common bully | 45 | 15 | 30 | 20 | 15 | 15 | 25 | 30 | 15 | 40 | 40 | | | |
| | Inanga | 55 | 80 | 70 | 90 | 100 | 100 | 70 | 80 | 70 | 70 | 60 | 80 | 80 | 15 |
| Minnow 4 | Inanga | 60 | 50 | 60 | 70 | 80 | 80 | 100 | | | | | | | |
| | longfin eel | 280 | 250 | 270 | | | | | | | | | | | |
| | Dead inanga | 40 | 60 | 100 | 110 | 40 | 60 | 50 | 40 | 50 | 50 | 80 | 80 | 90 | |
| | | 60 | 60 | 50 | 60 | 40 | 50 | 70 | 60 | 60 | 50 | 50 | 60 | | |
| Minnow 5 | Shrimp | 40 | 40 | 50 | | | | | | | | | | | |
| | Common bully | 12 | 25 | 10 | 10 | 15 | 12 | | 15 | 15 | 10 | 20 | 15 | 15 | |
| | | 15 | 15 | 25 | 12 | 12 | 15 | 15 | 20 | 30 | 15 | 10 | 15 | 15 | |
| | | 10 | 20 | 12 | 15 | 15 | 20 | | | | | | | | |
| | Inanga | 70 | | | | | | | | | | | | | |
| **Paetawa** | | | | | | | | | | | | | | | |
| Fyke 1 | Longfin eel | 1000 | 800 | 700 | 900 | | | | | | | | | | |
| Minnow 1 | Inanga | 90 | 90 | 80 | 70 | 60 | 90 | 70 | 60 | 70 | 50 | 50 | 60 | 50 | |
| | | 70 | 40 | 60 | 50 | 70 | 40 | 60 | 50 | 70 | 80 | 100 | 70 | 60 | 100 |
| | elver | 180 | | | | | | | | | | | | | |
| Minnow 2 | Koura | 90 | | | | | | | | | | | | | |
| | Inanga | 60 | 100 | 90 | 80 | 50 | 40 | 60 | 70 | 50 | 50 | 60 | 50 | 70 | 40 |
| | | 70 | 80 | 100 | 70 | 60 | 100 | 50 | 60 | 50 | | | | | |
| Minnow 3 | No fish | | | | | | | | | | | | | | |
| Minnow 4 | Inanga | 60 | 50 | | | | | | | | | | | | |
| Minnow 5 | Inanga | 80 | 70 | 70 | 60 | 50 | 50 | | | | | | | | |
| **Ngarara** | | | | | | | | | | | | | | | |
| Fyke 1 | longfin eel | 1100 | 800 | 700 | | | | | | | | | | | |
| Fyke 2 | No fish | | | | | | | | | | | | | | |
| Fyke 3 | No fish | | | | | | | | | | | | | | |

# Appendix 6: Site photos

## Hadfield

*Photo 1: Lower Hadfield showing long exotic grass on the true right of the stream and mown grass reserve on the true*

*Photo 2: Piezometer installed in the Hadfield stream, with stream flowing from box culvert in background.*

## Kowhai

*Photo 3: Muddy bottom, steep dug sides and low flow at the Kowhai Stream*

*Photo 4: Electric fishing was possible at points, where pools of water has formed*

## Paetawa

*Photo 5: Piezometer located in the construction zone for MacKays to Peka Peka motorway*

*Photo 6: Paetawa stream with muddy bottom and long exotic grass growing on the banks.*

## Ngarara

*Photo 7: Showing the deep, meandering Ngarara stream, with overgrown banks*

*Photo 8: Ngarara stream with muddy bottom and long grasses growing on the banks.*

## Kakariki

*Photo 9: Long pasture grasses growing on banks of survey reach.*

*Photo 10: Adjacent to the piezometer installed before T-junction of stream*

## Lower Muaupoko

*Photo 11: Shallow runs with a hard gravel stream bed*

*Photo 12: Riparian shading of survey reach by native restoration planting:*

## Upper Muaupoko

*Photo 13: Installation of piezometer and sharp bend/deep pool at downstream end of survey reach*

*Photo 14: 1Upstream of survey reach, showing filamentous algae present, where stock have direct access to reach.*

# Appendix 7: Summary data of logged in-stream and Piezometer parameters (Dec 2014)

## Hadfield

Measurements taken from the Hadfield stream piezometer for the month of December, show some gaps in data. Some early data was manually read. The piezometer logger was not fully operational until Dec. As a result there remain some data gaps in the data base for early December.

See table and graphs below summarising collected data at the Hadfield for the month of December.

*Table 5: Summary of December measurements in the Hadfield Stream*

| Hadfield_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 2224.47 | 644.37 | 6.87 | 17.07 |
| Median | 2207.00 | 614.00 | 6.90 | 16.66 |
| Standard Deviation | 53.58 | 74.32 | 0.85 | 1.78 |
| Minimum | 2163.00 | 575.00 | -0.01 | 13.80 |
| Maximum | 2372.00 | 879.00 | 8.58 | 21.29 |
| No. of measures | 1395.00 | 1395.00 | 1395.00 | 1395.00 |

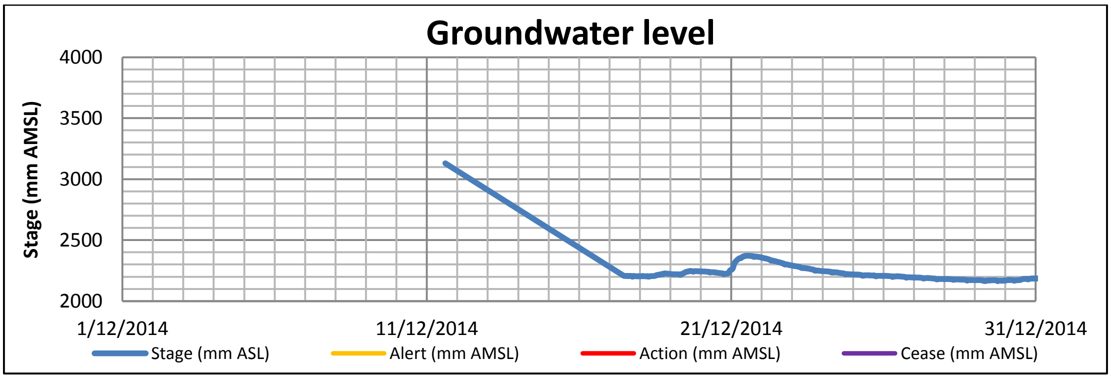


*Figure 12: Showing level of groundwater recorded at the Hadfield Stream for the month of December.*

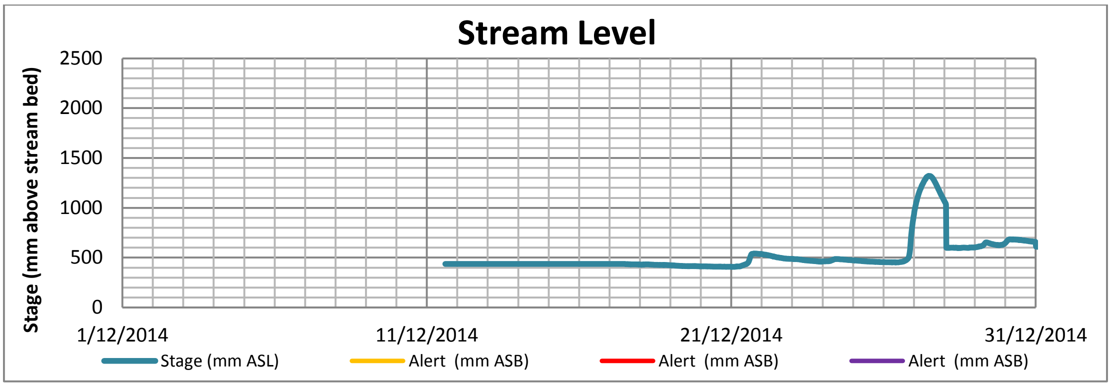


*Figure 13: Showing level of stream water recorded in the Hadfield Stream for the month of December.*

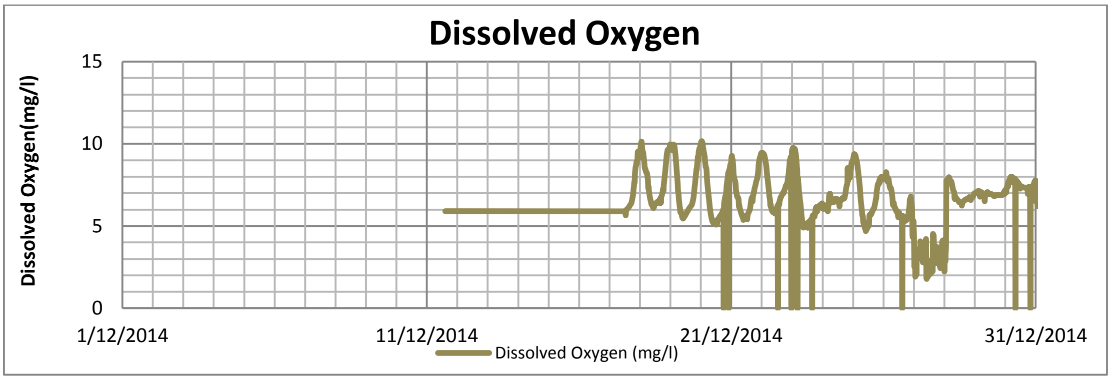


*Figure 14: Showing dissolved oxygen measures recorded in the Hadfield Stream for the month of December.*

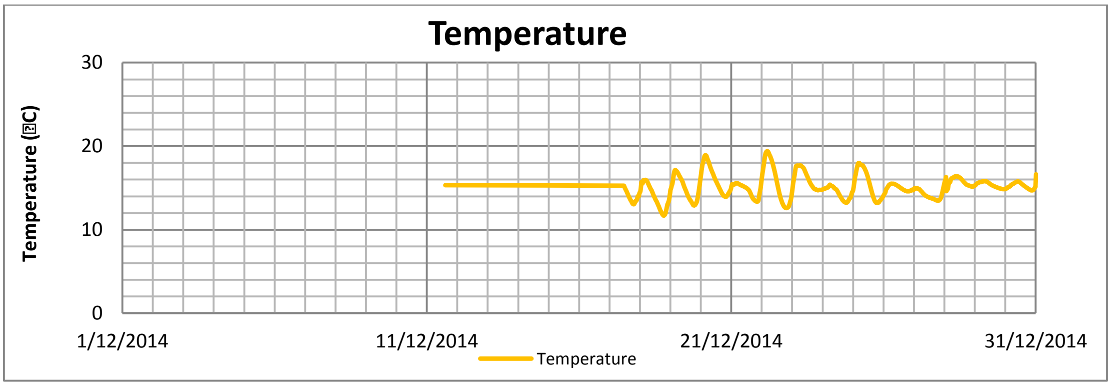


*Figure 15: Showing temperature measures recorded in the Hadfield Stream for the month of December.*

## Kowhai

Measurements taken from the Kowhai stream piezometer for the month of December, show some gaps in data. The stream levels appear to be full and correct, however the groundwater level is unnaturally stable (only one measurement value record). The Dissolved Oxygen levels and temperature levels appear to have dropped out at points (this could possibly be explained in the stream completely drying out over this time.

See table and graphs below summarising collected data at the Kowhai for the month of December.

*Table 6: Summary of December measurements in the Kowhai Stream. Note groundwater depth contains false data*

| Kowhai_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 9273.0 | 163.6 | 5.4 | 14.2 |
| Median | 9273.0 | 138.0 | 5.6 | 15.6 |
| Standard Deviation | 0.0 | 104.4 | 1.6 | 4.1 |
| Minimum | 9273.0 | 51.8 | 0.0 | 0.0 |
| Maximum | 9273.0 | 1158.7 | 9.2 | 18.7 |
| No. of measures | 2158.0 | 2158.0 | 2158.0 | 2158.0 |

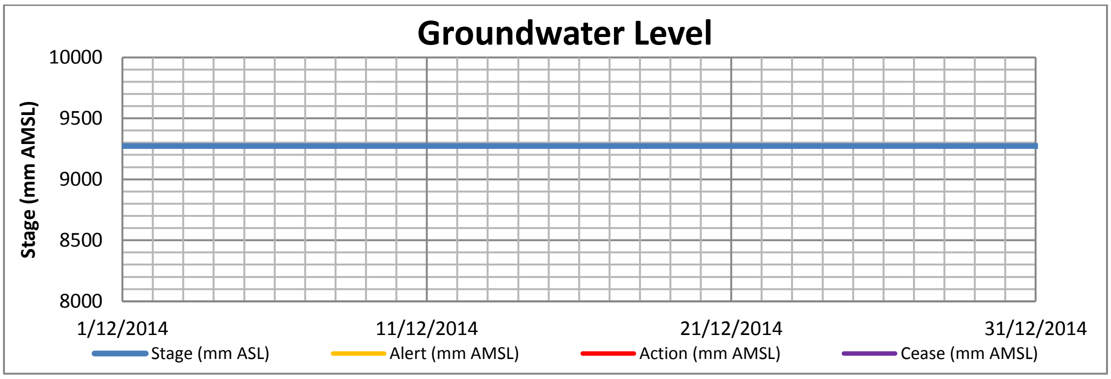


*Figure 16: Showing level of groundwater recorded in the Kowhai Stream for the month of December.*

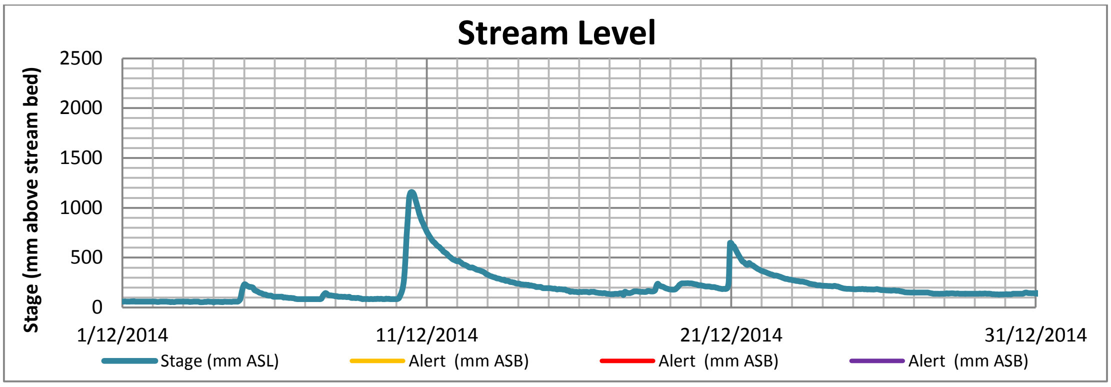


*Figure 17: Showing level of stream water recorded in the Kowhai Stream for the month of December.*

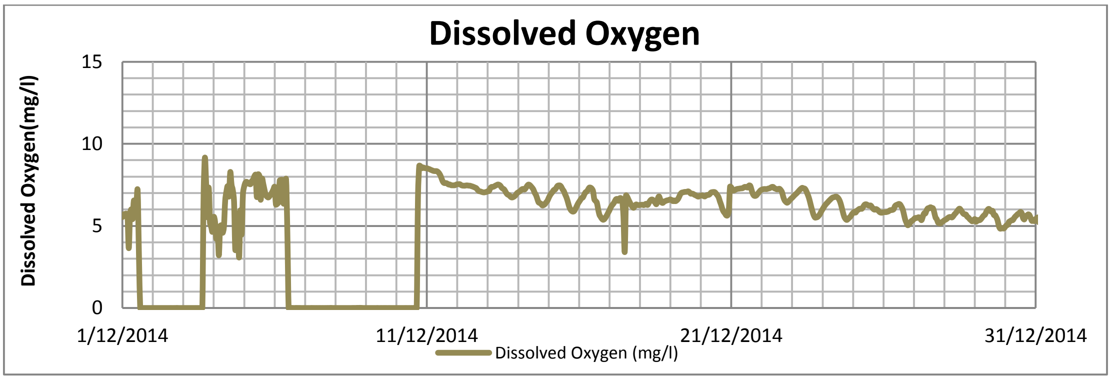


*Figure 18: Showing dissolved oxygen measures recorded in the Kowhai Stream for the month of December.*

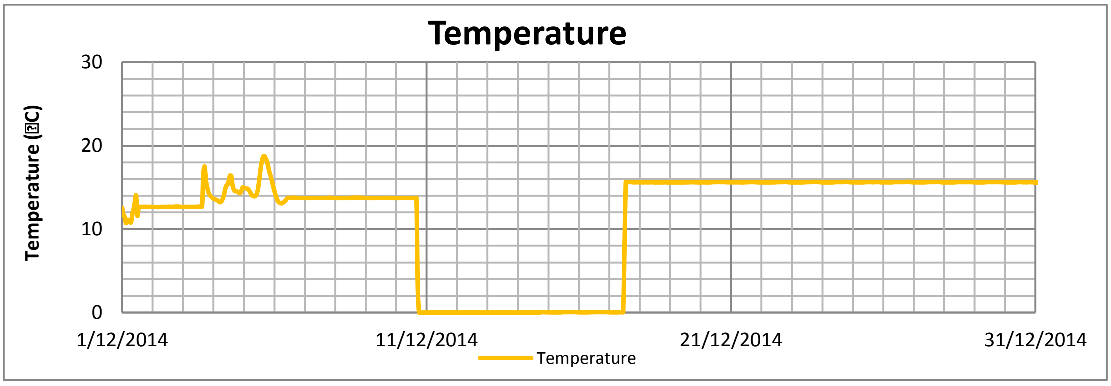


*Figure 19: Showing temperature measures recorded in the Kowhai Stream for the month of December.*

## Paetawa

Measurements taken from the Paetawa stream piezometer for the month of December, show some gaps in data. The stream level measurements appear to be full and correct, however the groundwater level measurements show false readings for the entire month. The Dissolved Oxygen levels and temperature levels appear to have dropped out at points.

See table and graphs below summarising collected data at the Paetawa for the month of December.

*Table 7: Summary of December measurements in the Paetawa Stream. Note groundwater depth contains false data*

| Paetawa_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 470.0 | 377.5 | 8.2 | 15.6 |
| Median | 12.0 | 281.0 | 8.3 | 15.6 |
| Standard Deviation | 521.2 | 245.4 | 1.4 | 2.0 |
| Minimum | 11.7 | 194.0 | -0.1 | -3.0 |
| Maximum | 1978.0 | 1478.0 | 11.0 | 22.4 |
| No. of measures | 2890.0 | 2890.0 | 2889.0 | 2890.0 |

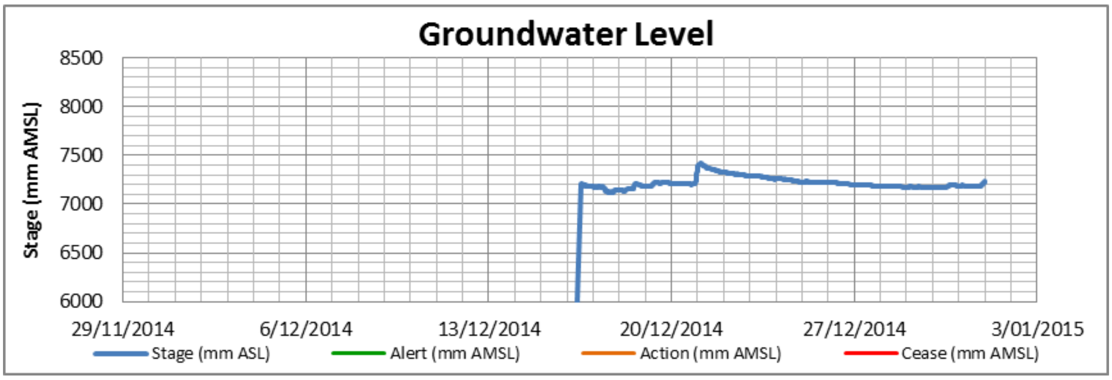


*Figure 20: Showing level of groundwater recorded in the Paetawa Stream for the month of December.*

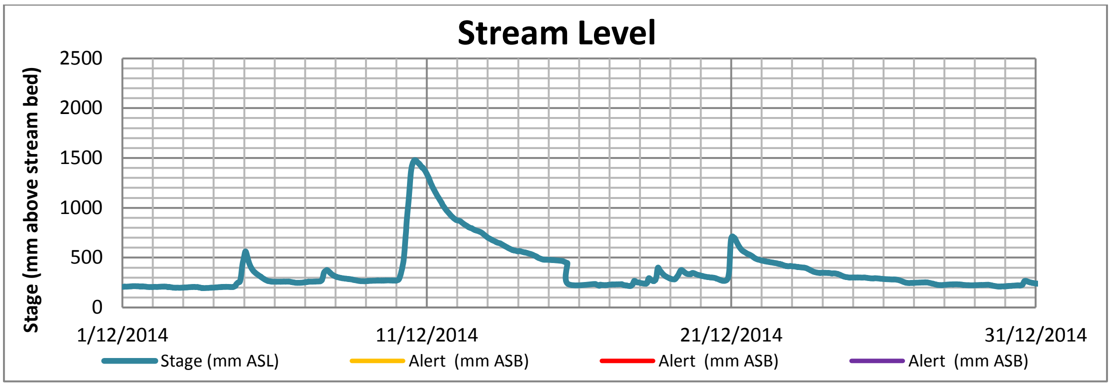


*Figure 21: Showing level of stream water recorded in the Paetawa Stream for the month of December.*

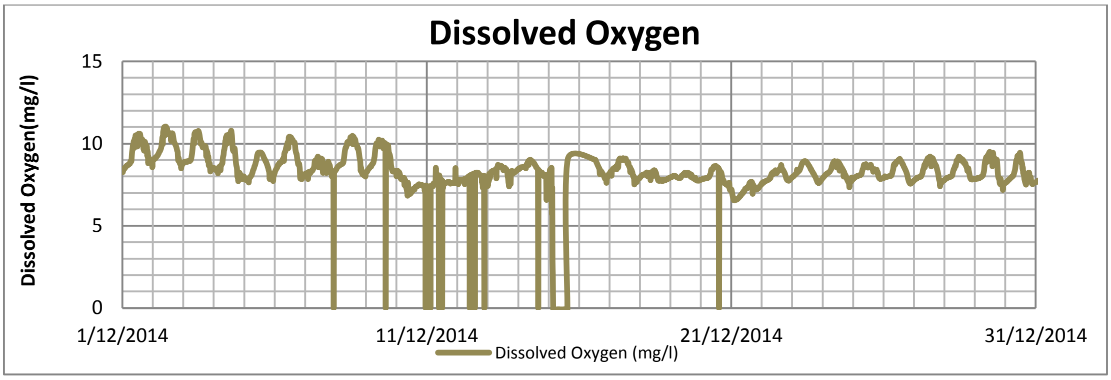


*Figure 22: Showing dissolved oxygen measures recorded in the Paetawa Stream for the month of December.*

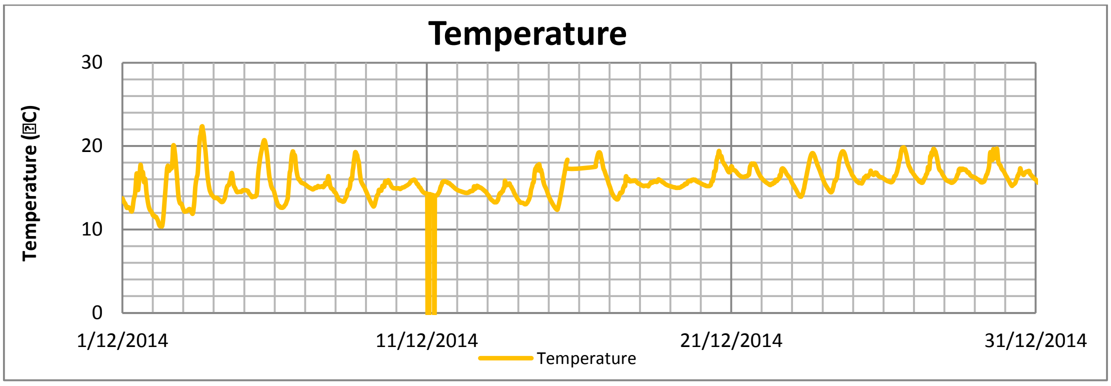


*Figure 23: Showing temperature measures recorded in the Paetawa Stream for the month of December.*

## Ngarara

Measurements taken from the Ngarara stream piezometer for the month of December, show some gaps in data. The deeper piezometer measuring groundwater was not installed at this site until the 11th of Dec, measurement successfully record from this point for groundwater. The stream level and temperature measurements appear to be full and correct. The Dissolved Oxygen levels and temperature levels appear to have dropped out at points.

See table and graphs below summarising collected data at the Ngarara for the month of December.

*Table 8: Summary of December measurements in the Ngarara Stream*

| Ngarara_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 1116.3 | 604.2 | 7.0 | 16.5 |
| Median | 1105.0 | 12.0 | 7.2 | 16.3 |
| Standard Deviation | 332.9 | 745.8 | 1.4 | 1.9 |
| Minimum | 657.0 | 11.9 | 0.0 | 11.4 |
| Maximum | 2298.0 | 2798.0 | 8.8 | 21.4 |
| No. of measures | 2978.0 | 2387.0 | 2978.0 | 2978.0 |

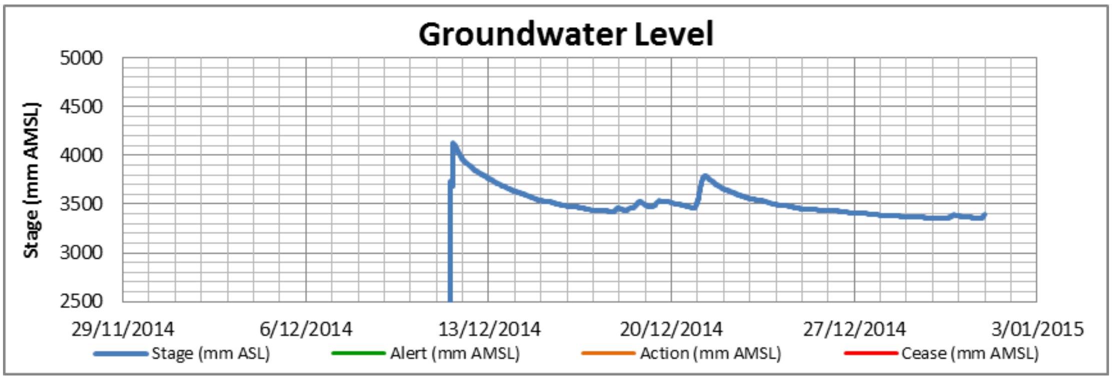


*Figure 24: Showing level of groundwater recorded in the Ngarara Stream for the month of December.*

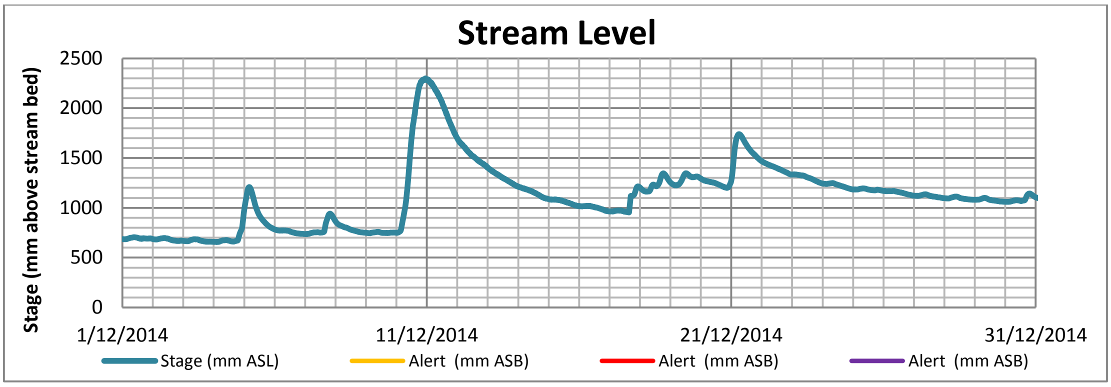


*Figure 25: Showing level of stream water recorded in the Ngarara Stream for the month of December (Note there was a large rain event on the 10th that is seen as a peak in stream level).*

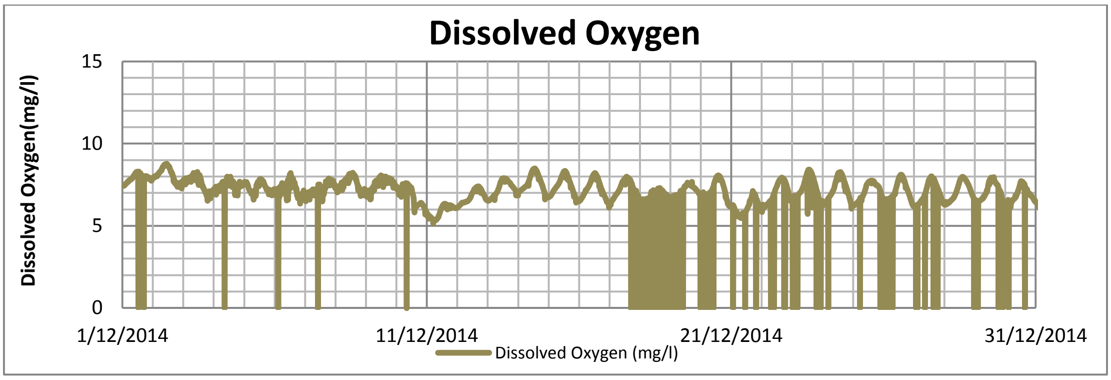


*Figure 26: Showing dissolved oxygen measures recorded in the Ngarara Stream for the month of December.*

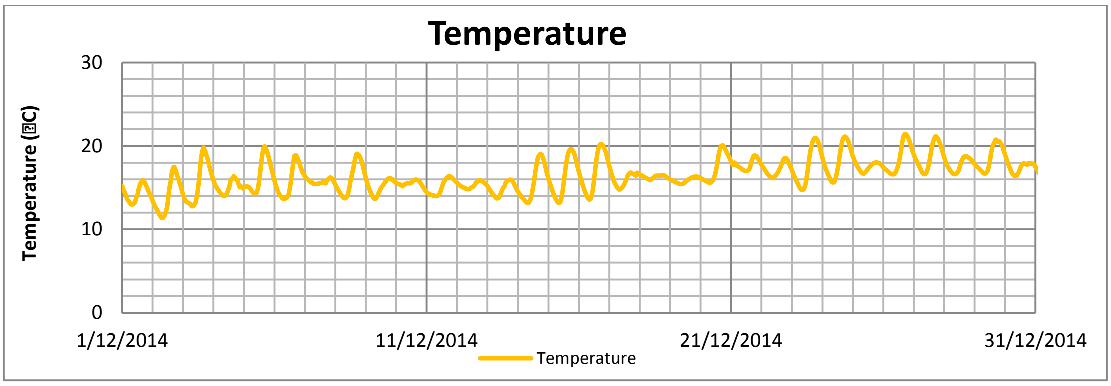


*Figure 27: Showing temperature measures recorded in the Ngarara stream for the month of December.*

## Kakariki

Measurements taken from the Kakariki stream piezometer for the month of December, show large gaps in data. Measurements for groundwater and stream level were unusually sporadic until recording stopped on the 16th of December. Both the dissolved oxygen levels and temperature levels appear to have dropped out at points to unnaturally read zero and stop reading from the 8th of December.

See table and graphs below summarising collected data at the Kakariki for the month of December.

*Table 9: Summary of December measurements in the Kakariki Stream*

| Kakariki_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 886.7 | 555.4 | 5.7 | 16.1 |
| Median | 753.0 | 475.0 | 7.9 | 16.1 |
| Standard Deviation | 325.4 | 292.6 | 3.9 | 2.0 |
| Minimum | 652.2 | 248.0 | -0.1 | 3.0 |
| Maximum | 2341.0 | 1841.0 | 10.5 | 21.0 |
| No. of measures | 2854.0 | 2854.0 | 2854.0 | 2854.0 |

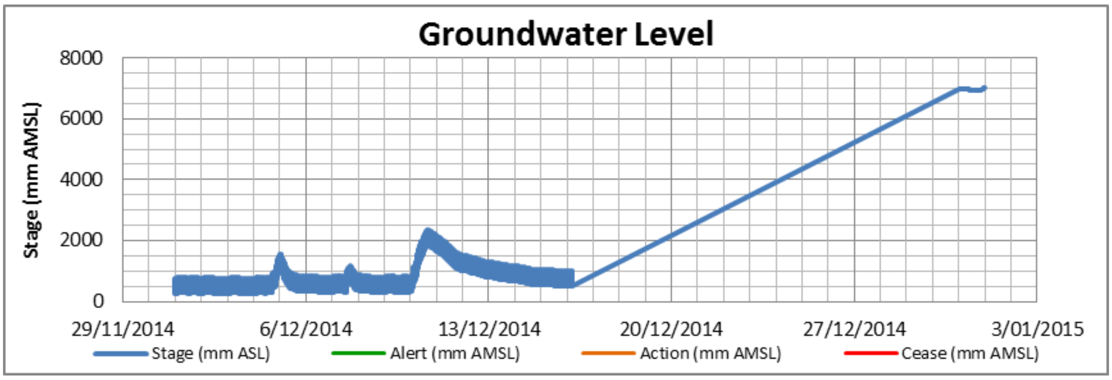


*Figure 28: Showing level of groundwater recorded in the Kakariki Stream for the month of December (Note the different y-axis to other groundwater graphs).*

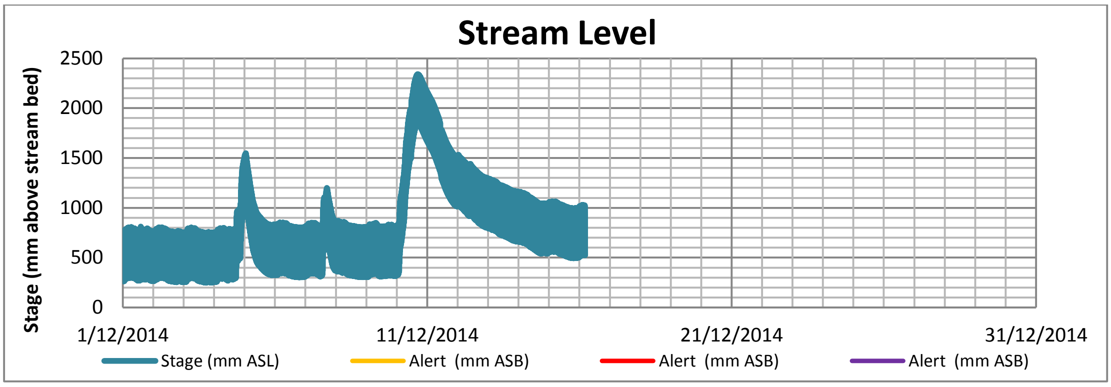


*Figure 29: Showing level of stream water recorded in the Kakariki Stream for the month of December.*

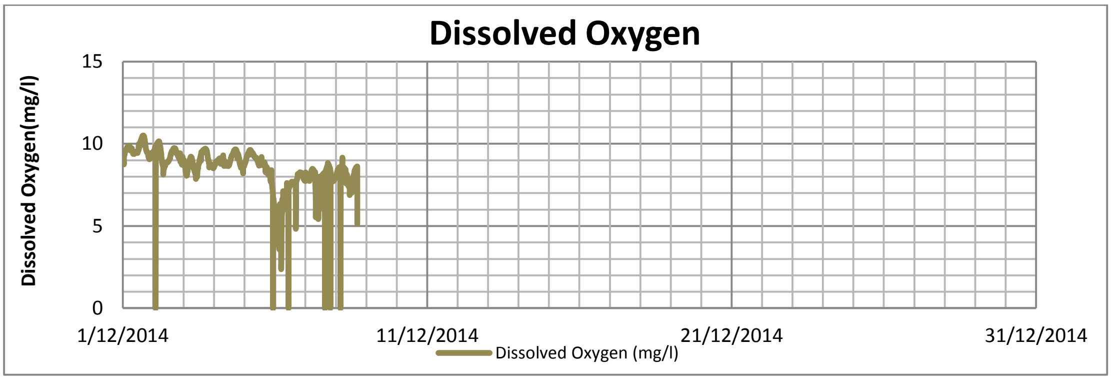


*Figure 30: Showing dissolved oxygen measures recorded in the Kakariki Stream for the month of December.*

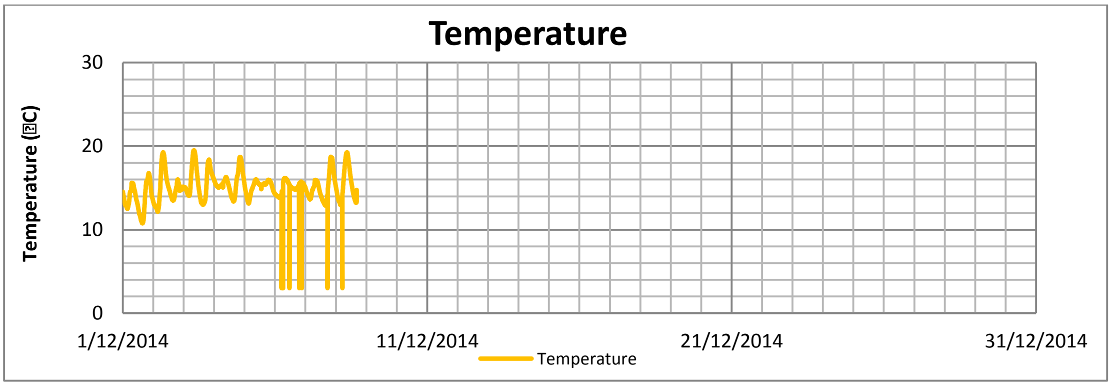


*Figure 31: Showing temperature measures recorded in the Kakariki Stream for the month of December.*

## Lower Muaupoko

Measurements taken from the Lower Muaupoko stream piezometer for the month of December, show some gaps in data. The deeper piezometer measuring groundwater did not successfully record any true data. The stream level and temperature measurements appear to be full and correct. The Dissolved Oxygen levels and temperature levels appear to have dropped out at points.

See table and graphs below summarising collected data at the Lower Muaupoko for the month of December.

*Table 10: Summary of December measurements in the Lower Muaupoko Stream (Note groundwater depth contains false data)*

| Lower Muaupoko_Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 3717.0 | 324.0 | 8.8 | 16.2 |
| Median | 12.4 | 301.0 | 8.9 | 15.8 |
| Standard Deviation | 2303.3 | 111.3 | 0.8 | 2.0 |
| Minimum | -5386.0 | -988.0 | 0.0 | 12.1 |
| Maximum | 5875.0 | 2006.0 | 11.0 | 21.3 |
| No. of measures | 2895.0 | 2896.0 | 2896.0 | 2896.0 |

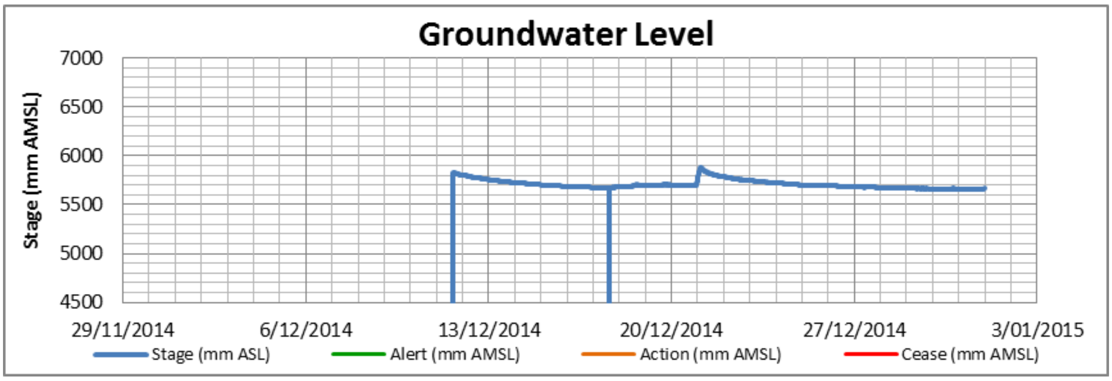


*Figure 32: Showing level of groundwater recorded in the Lower Muaupoko Stream for the month of December.*

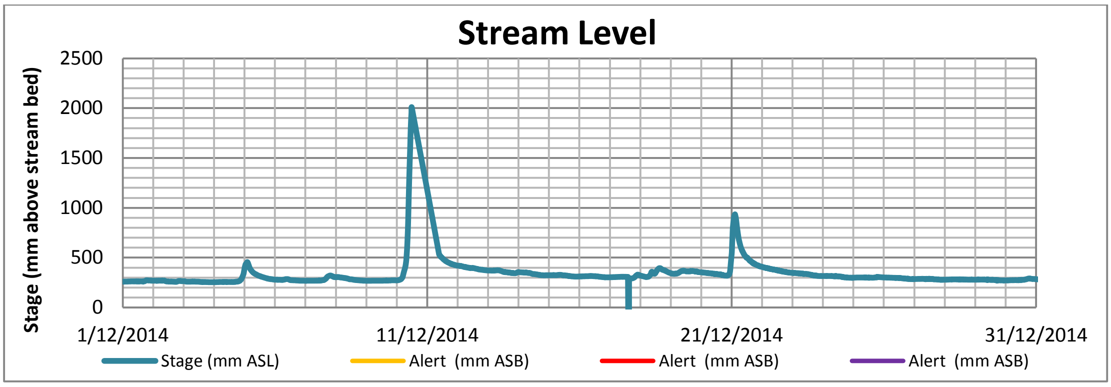


*Figure 33: Showing level of stream water recorded in the Lower Muaupoko Stream for the month of December.*

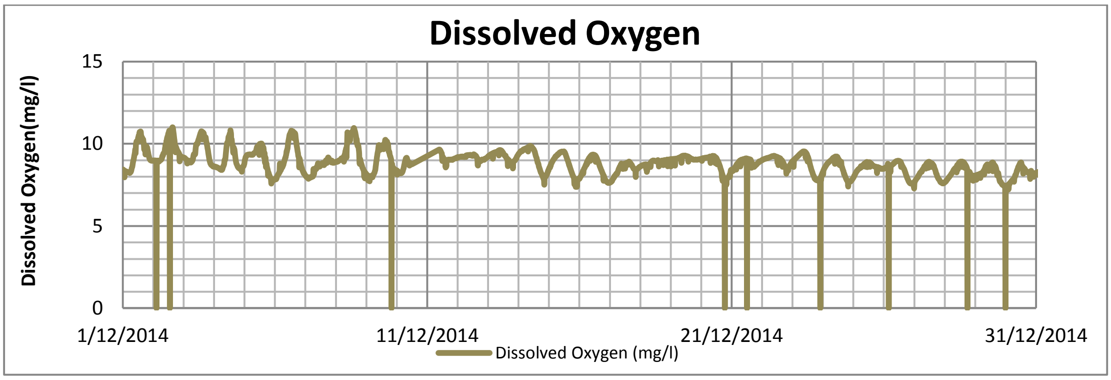


*Figure 34: Showing dissolved oxygen measures recorded in the Lower Muaupoko Stream for the month of December.*

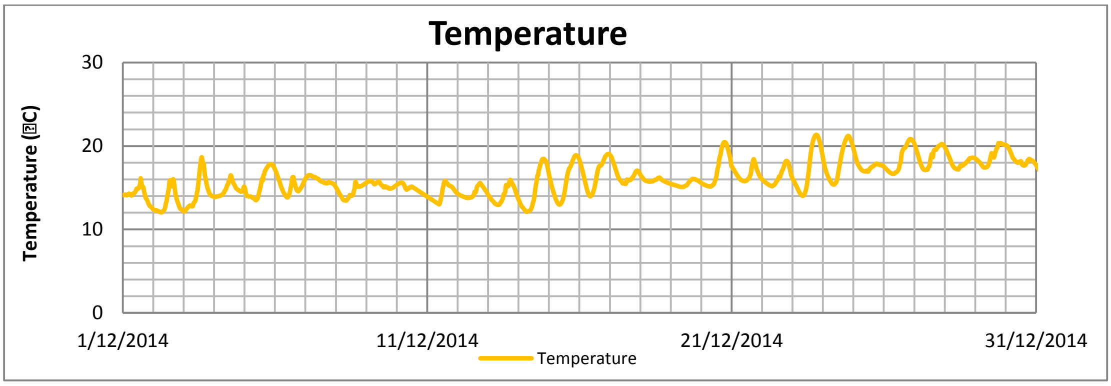


*Figure 35: Showing temperature measures recorded in the Lower Muaupoko Stream for the month of December.*

## Upper Muaupoko

Measurements taken from the Upper Muaupoko stream piezometer for the month of December, show some gaps in data. The stream levels appear to be full and correct, however the groundwater level is unnaturally stable (only one measurement value record). The Dissolved Oxygen levels and temperature levels recorded appear to be true until the 19th of December where temperature appears to record falsely as a stable value.

See table and graphs below summarising collected data at the Upper Muaupoko for the month of December.

*Table 11: Summary of December measurements in the Upper Muaupoko Stream (Note groundwater depth contains false data)*

| Upper Muaupoko _Dec14 | *Groundwater depth (mm)* | *Stream depth (mm)* | *DO (mg)* | *Temp (°C)* |
|---|---|---|---|---|
| Mean | 14274.0 | 510.5 | 7.9 | 15.4 |
| Median | 14274.0 | 524.0 | 8.3 | 15.3 |
| Standard Deviation | 0.0 | 133.7 | 2.1 | 1.2 |
| Minimum | 14274.0 | 30.0 | 0.0 | 10.9 |
| Maximum | 14274.0 | 1591.5 | 11.8 | 23.5 |
| No. of measures | 2160.0 | 2160.0 | 2160.0 | 2160.0 |

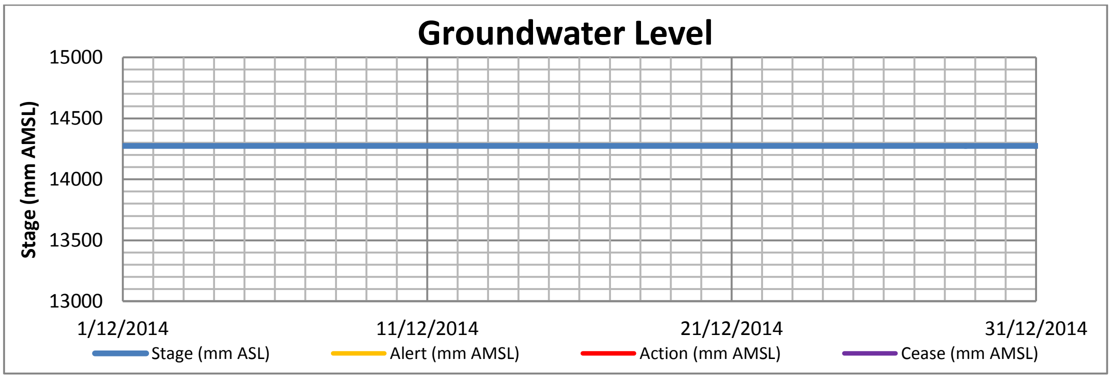


*Figure 36: Showing level of groundwater recorded in the Upper Muaupoko Stream for the month of December.*

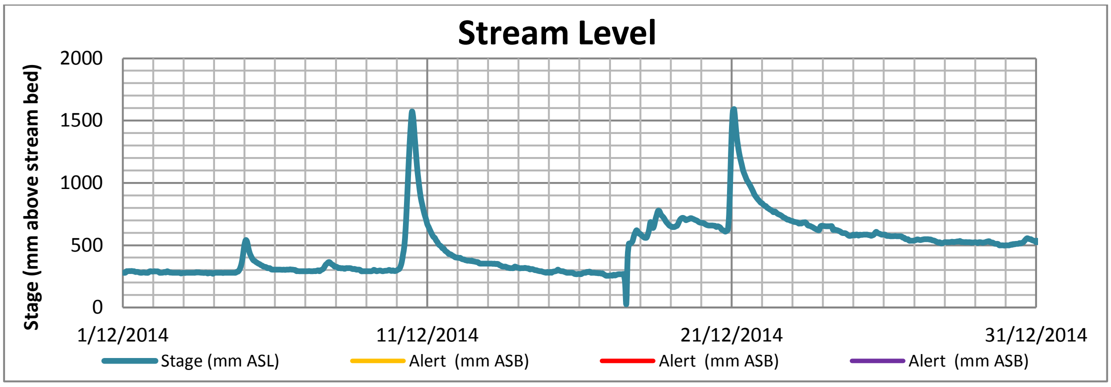


*Figure 37: Showing level of stream water recorded in the Upper Muaupoko Stream for the month of December.*

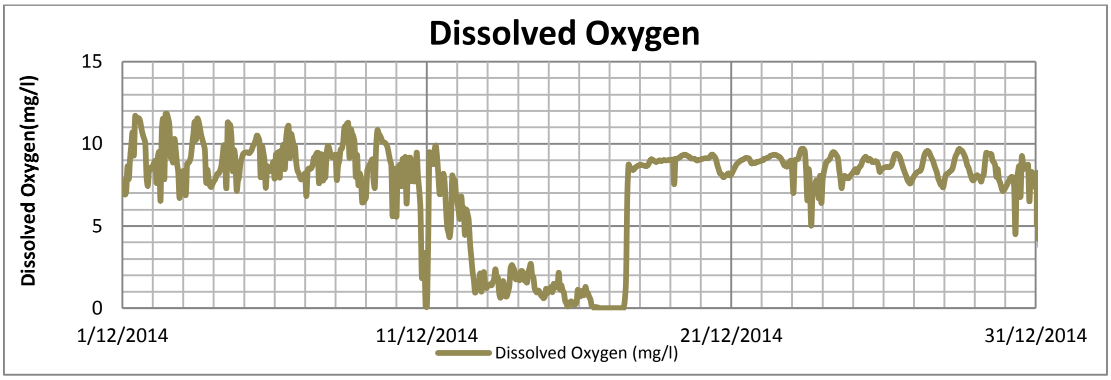


*Figure 38: Showing dissolved oxygen measures recorded in the Upper Muaupoko Stream for the month of December.*

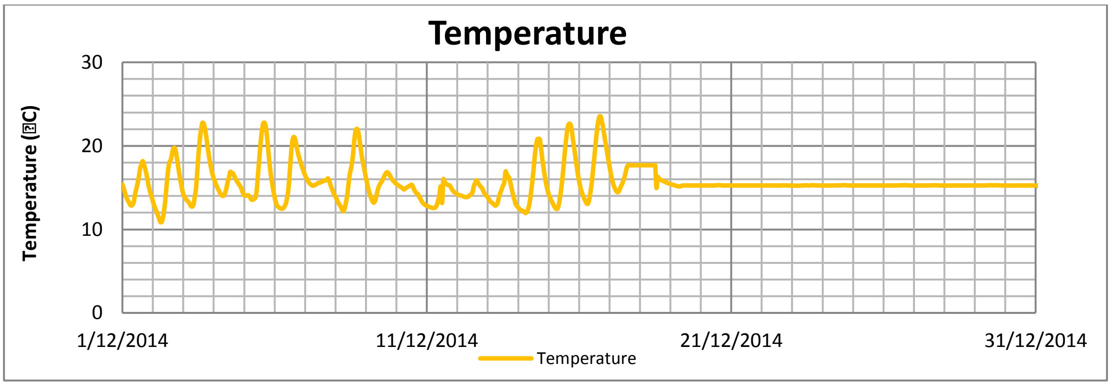


*Figure 39: Showing temperature measures recorded in the Upper Muaupoko Stream for the month of December.*

# Small Coastal Streams Monthly Data: Report - January 2015

Kapiti Water Supply: RRwGW Scheme
Prepared for Kapiti Coast District Council

14 April 2015

## Document Quality Assurance

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*Cover photograph:* Waikanae River © Boffa Miskell, 2015

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# 1 INTRODUCTION

Monthly reports are required by the Small Coastal Streams (SCS) Baseline Aquatic Monitoring Plan (BMP 27th May 2014) to establish the collection of the data for the SCS monitoring programme during the baseline period.

Data are collected from the following sites:

1. Kowhai Stream
2. Hadfield Stream
3. Paetawa Stream
4. Kakariki Stream
5. Ngarara stream
6. Upper Muaupoko Stream
7. Lower Muaupoko Stream

As required by the BMP the following parameters are collected:

- Piezometer water level,
- in-stream water level (depth),
- in-stream dissolved oxygen level,
- in-stream temperature,
- monthly conductivity measure, and
- monthly in-stream cross sectional depth profiles.

The following reports on the second month of data collection (January 2015). Rather than attach all of the data for each logger, a summary of the statistics is presented here. The monthly conductivity recordings for this month's baseline monitoring is limited to one site due to equipment failure (see Section 2.8).

These summary results include the Telemetered site data whose graphic format is different from the other sites as they are generated directly from water outlook.

Appendix 1 presents the rain fall and Waikanae River flows as collected by GWRC at the Waikanae Waste Water Treatment Plant monitoring station, as an indication of rain fall and general river flow patterns through the monitoring month.

# 2 RESULTS

## 2.1 Kowhai

Table 7 is a set of January 2015 summary statistics for the Kowhai Stream (a Telemetered site). The four figures that follow the table summarise the logged data for in-stream depth (Figure 25), groundwater depth (Figure 26), and in-stream dissolved oxygen (Figure 27). The temperature probe has been shut down at present as its operation disrupted the DO probe and the DO data is the more important data to gather in terms of tracking biotic stress in these small streams.

*Table 1: Summary statistics for the Kowhai– January 2015*

| | *Groundwater depth (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 9273.00 | 175.27 | 5.80 | 15.59 |
| *Median* | 9114.00 | 50.00 | 0.01 | 15.63 |
| *Standard Deviation* | 62.63 | 24.06 | 2.17 | 0.02 |
| *Minimum* | 9102.00 | 50.00 | 0.00 | 15.56 |
| *Maximum* | 9273.00 | 175.83 | 6.93 | 15.67 |
| *Count* | 2233.00 | 2233.00 | 1963.00 | 2233.00 |

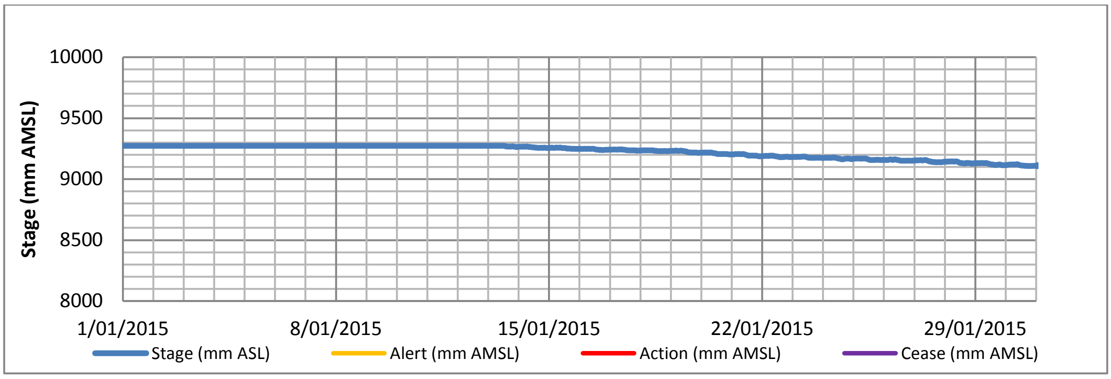



*Figure 1: Groundwater depth in the Kowhai Stream in January 2015 Note Y-axis starts at 8000 mm AMSL.*

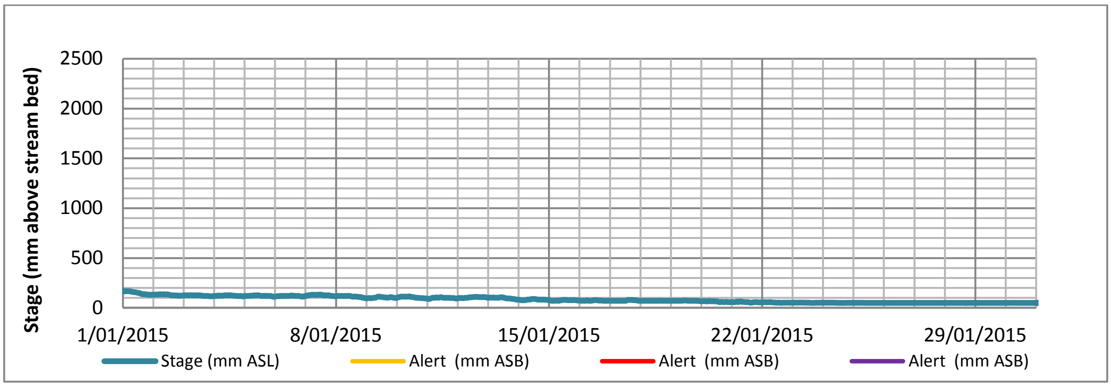



*Figure 2: In-stream depth in the Kowhai Stream in January 2015*

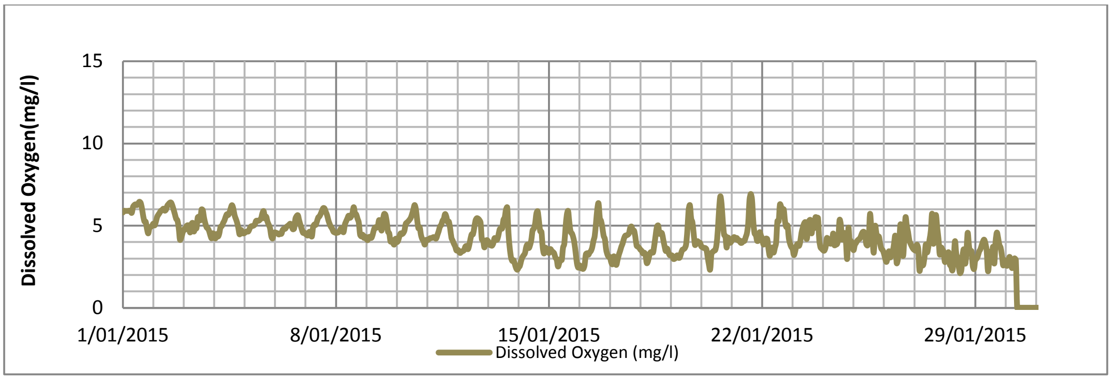



*Figure 3: In-stream dissolved oxygen in the Kowhai Stream in January 2015*

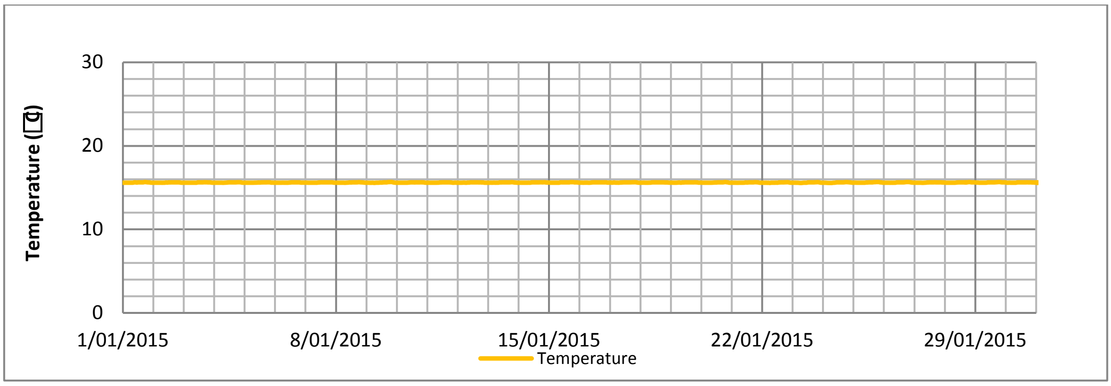



*Figure 4: Water temperature in the Kowhai Stream in January 2015*

## 2.2 Hadfield

Table 1 is a set of January 2015 summary statistics for the Hadfield (lower). The four figures that follow the table summarise the logged data for in-stream depth (Figure 1), groundwater depth (Figure 2), in-stream dissolved oxygen (Figure 3) and water temperature (Figure 4). There was an instrument failure on the 22$^{nd}$ at this site resulting in a week's lost data (from the 22$^{nd}$ to the 31$^{st}$)

*Table 2: Summary statistics for Hadfield - January 2015*

| | *Groundwater depth (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 2170.80 | 627.87 | 5.75 | 18.79 |
| *Median* | 2170.00 | 629.00 | 5.76 | 18.77 |
| *Standard Deviation* | 8.62 | 26.31 | 1.40 | 1.78 |
| *Minimum* | 2150.00 | 584.00 | -0.01 | 14.51 |
| *Maximum* | 2198.00 | 667.00 | 9.20 | 23.09 |
| *Count* | 1984.00 | 1984.00 | 1984.00 | 1984.00 |

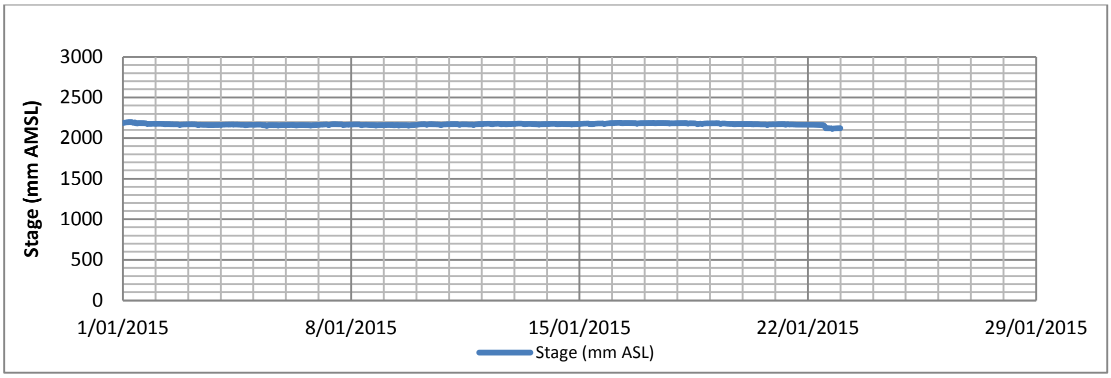



*Figure 5: Groundwater depth in the Hadfield Stream in January 2015*

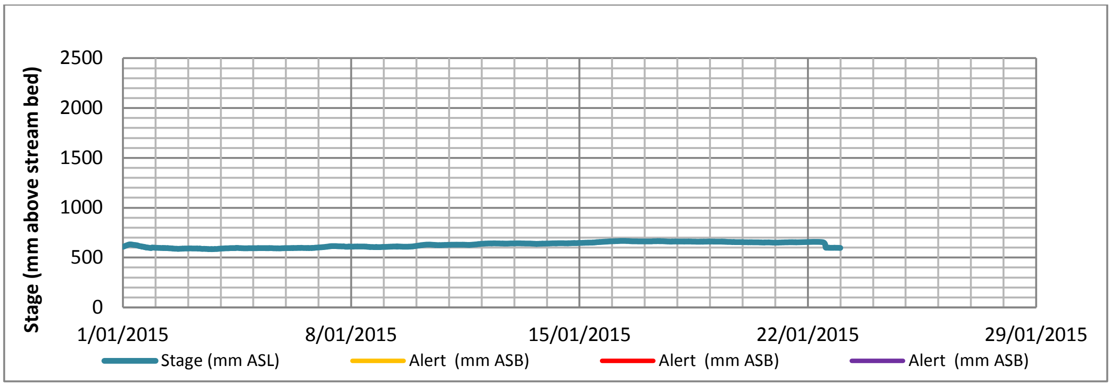



*Figure 6: In-stream depth in the Hadfield Stream in January 2015*

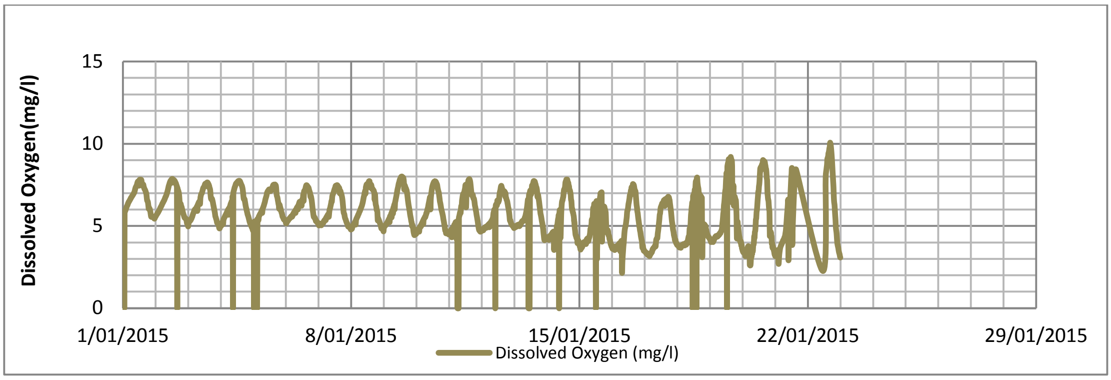



*Figure 7: In-stream dissolved oxygen in the Hadfield Stream in January 2015*

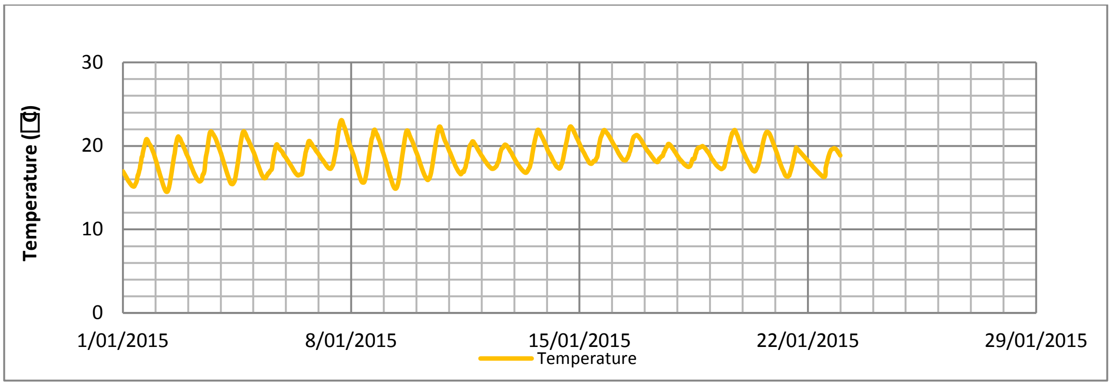



*Figure 8: Water temperature in the Hadfield Stream in January 2015*

## 2.3 Paetawa

Table 6 is a set of January 2015 summary statistics for the Paetawa. The four figures that follow the table summarise the logged data for in-stream depth (Figure 21), groundwater depth (Figure 22), in-stream dissolved oxygen (Figure 23) and water temperature (Figure 24).

*Table 3: Summary statistics for the Paetawa – January 2015*

| | *Groundwater depth (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 6993.96 | 125.50 | 8.12 | 18.15 |
| *Median* | 7002.00 | 130.00 | 7.90 | 17.48 |
| *Standard Deviation* | 92.32 | 50.35 | 1.57 | 2.41 |
| *Minimum* | 6819.00 | 42.00 | -0.01 | 12.99 |
| *Maximum* | 7157.00 | 278.00 | 10.94 | 25.24 |
| *Count* | 2653.00 | 2653.00 | 2653.00 | 2653.00 |

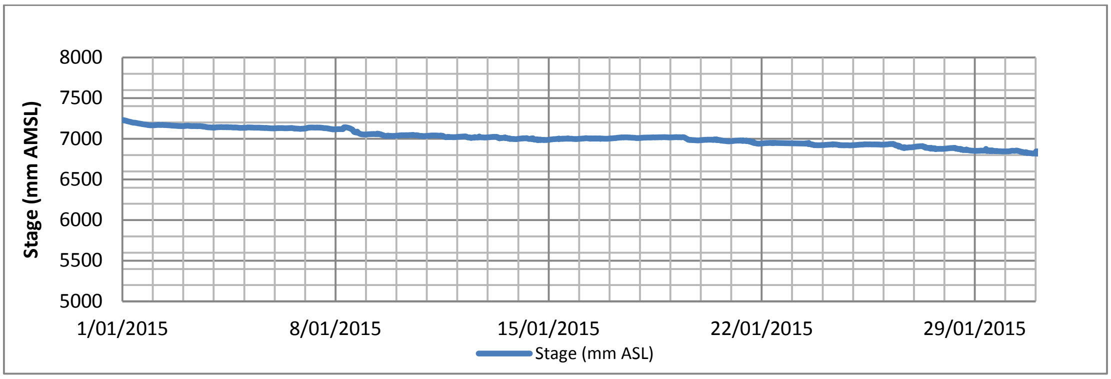



*Figure 9: In-stream depth in the Paetawa Stream in January 2015 Note Y-axis starts at 5000 mm AMSL.*

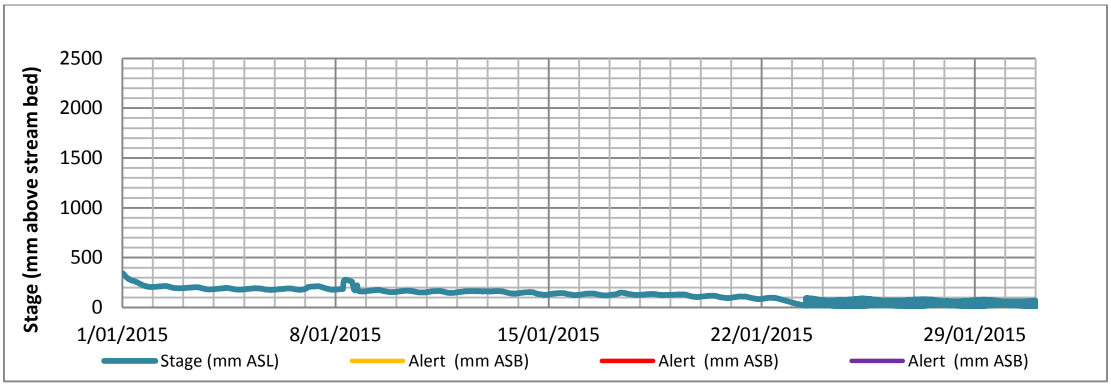



*Figure 10: Groundwater depth in the Paetawa Stream in January 2015*

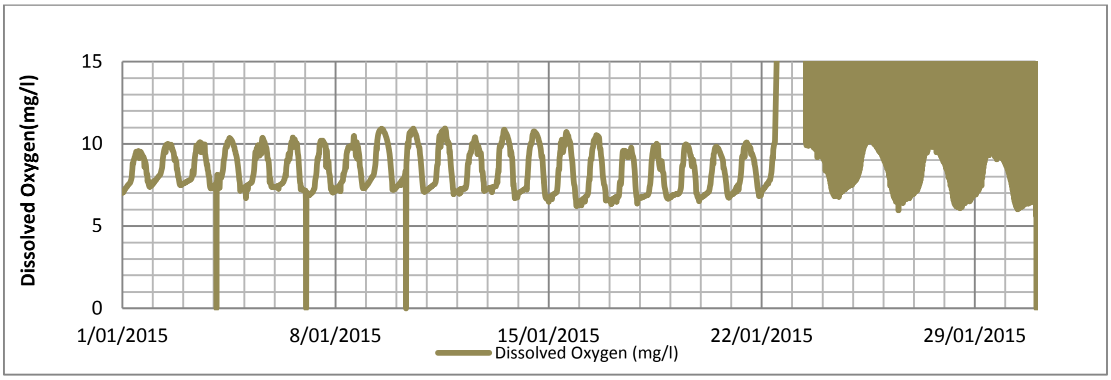



*Figure 11: Dissolved oxygen in the Paetawa Stream in January 2015*

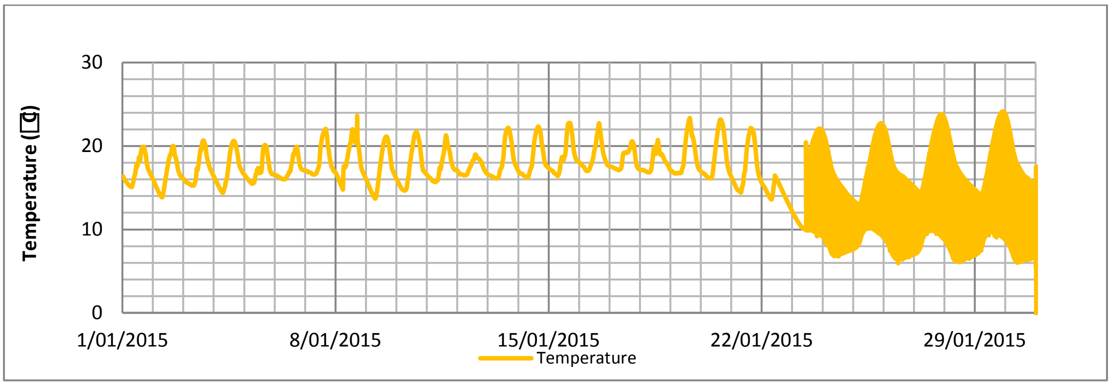



*Figure 12: Temperature in the Paetawa Stream in January 2015*

## 2.4 Kakariki

Table 5 is a set of January 2015 summary statistics over the Kakariki Stream. The four figures the table summarise the logged data for in-stream depth (Figure 17), groundwater depth (Figure 18), in-stream dissolved oxygen (Figure 19) and water temperature (Figure 20).

*Table 4: Summary statistics for the Kakariki – January 2015*

| | Groundwater depth (mm) | Stream depth (mm) | Dissolved Oxygen (mg/L) | Temperature (°C) |
|---|---|---|---|---|
| *Mean* | 6821.81 | 325.41 | 4.67 | 18.50 |
| *Median* | 6817.00 | 319.00 | 7.12 | 18.41 |
| *Standard Deviation* | 68.50 | 52.45 | 3.61 | 1.87 |
| *Minimum* | 6715.00 | 245.00 | -0.12 | 13.80 |
| *Maximum* | 7029.00 | 828.00 | 8.96 | 23.01 |
| *Count* | 2874.00 | 2874.00 | 2874.00 | 2874.00 |

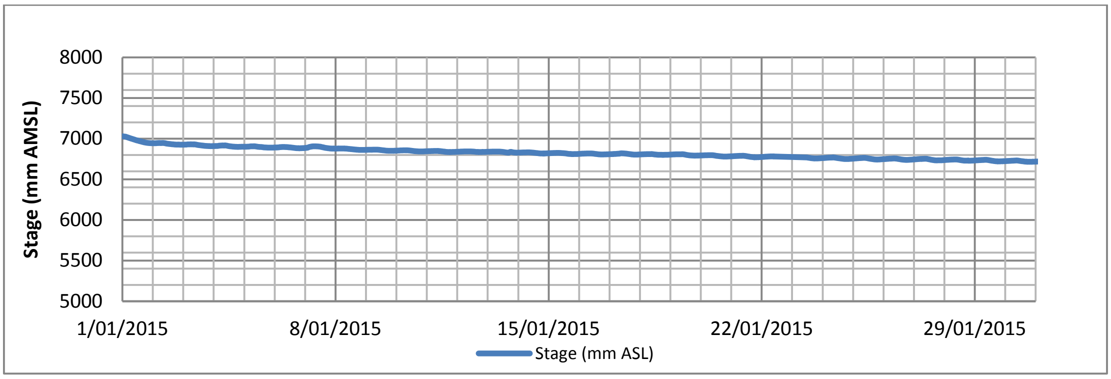



*Figure 13: In-stream depth in the Kakariki Stream in January 2015. Note Y-axis starts at 5000 mm AMSL.*

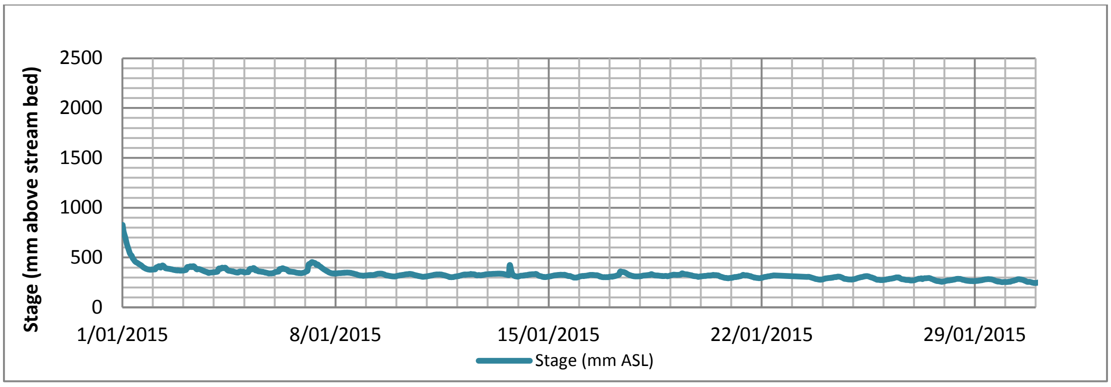



*Figure 14: Groundwater depth in the Kakariki Stream in January 2015*

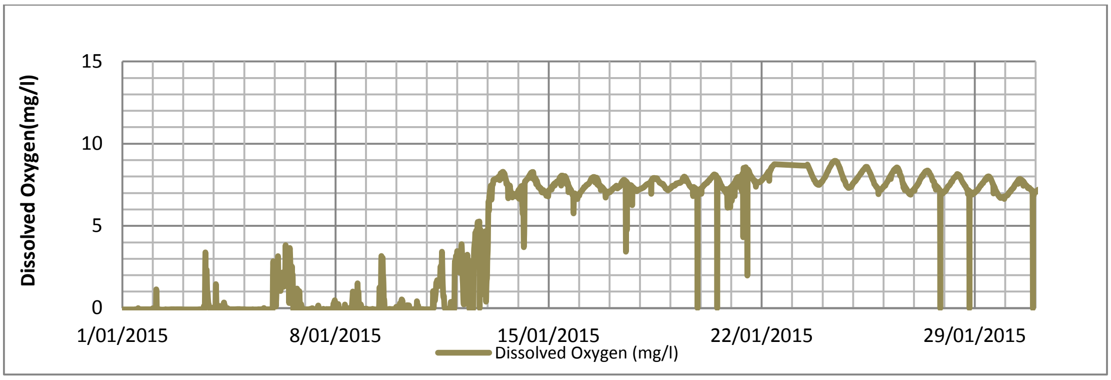



*Figure 15: Dissolved oxygen in the Kakariki Stream in January 2015*

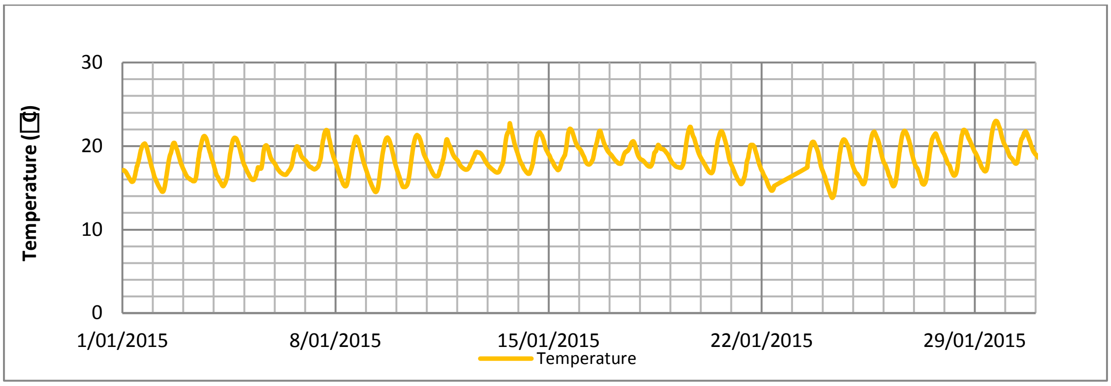



*Figure 16: Temperature in the Kakariki Stream in January 2015*

## 2.5 Ngarara

Table 2 is a set of January 2015 summary statistics for the Ngarara. The four figures that follow the table summarise the logged data for in-stream depth (Figure 5), groundwater depth (Figure 6), in-stream dissolved oxygen (Figure 7) and water temperature (Figure 8).

*Table 5: Summary statistics for the Ngarara – January 2015*

| | *Groundwater depth (mm)* | *Stream depth (mm)* | *Dissolved oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 3203.47 | 902.48 | 6.38 | 18.71 |
| *Median* | 3471.00 | 1181.00 | 6.96 | 16.85 |
| *Standard Deviation* | 138.28 | 170.06 | 1.51 | 1.77 |
| *Minimum* | 3351.00 | 954.00 | -0.01 | 13.17 |
| *Maximum* | 4064.00 | 1849.00 | 8.49 | 21.44 |
| *Count* | 1984.00 | 1984.00 | 1984.00 | 1984.00 |

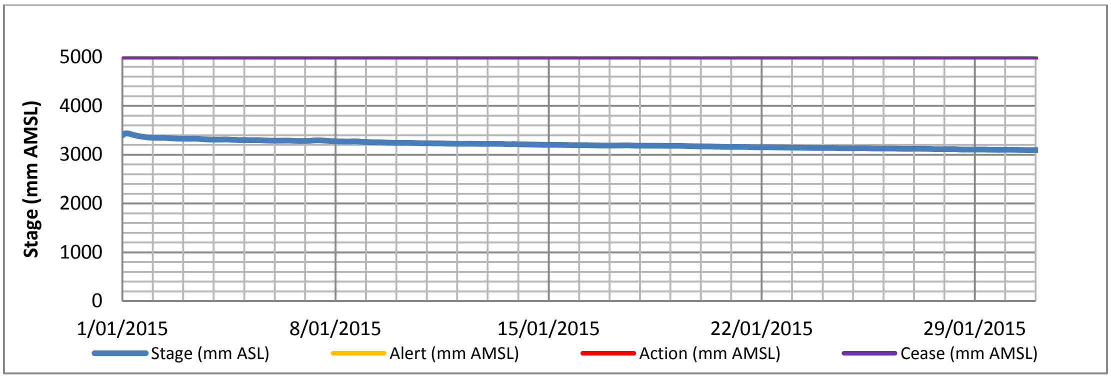



*Figure 17: In-stream depth in the Ngarara Stream in January 2015*

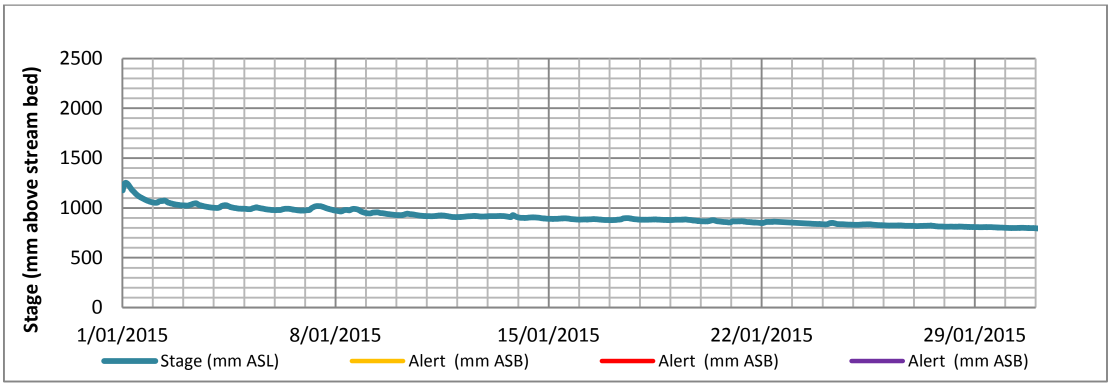



*Figure 18: Groundwater depth in the Ngarara Stream in January 2015*

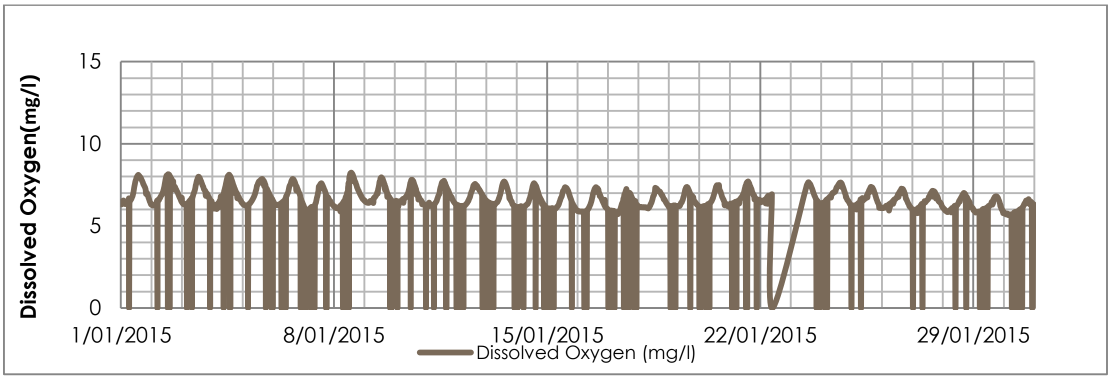



*Figure 19: Dissolved oxygen in the Ngarara Stream in January 2015*

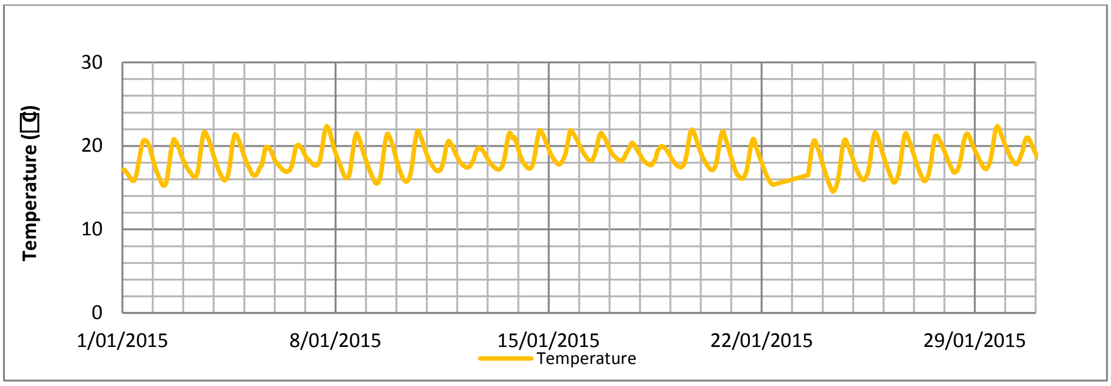



*Figure 20: Temperature in the Ngarara Stream in January 2015*

## 2.6 Upper Muaupoko

Table 4 is a set of January 2015 summary statistics for the Upper Muaupoko. The four figures that follow the table summarise the logged data for in-stream depth (Figure 13), groundwater depth (Figure 14), in-stream dissolved oxygen (Figure 15) and water temperature (Figure 16). Note: only one measurement a day was taken from this telemetered logger.

*Table 6: Summary statistics for the Upper Muaupoko – January 2015*

| | *Groundwater Depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 14274.00 | 649.88 | 8.27 | 15.24 |
| *Median* | 14231.00 | 413.00 | 6.83 | 19.99 |
| *Standard Deviation* | 165.09 | 30.75 | 1.82 | 2.33 |
| *Minimum* | 11086.23 | 126.56 | 0.38 | 0.99 |
| *Maximum* | 14274.00 | 649.88 | 10.34 | 20.03 |
| *Count* | 2232.00 | 2232.00 | 2232.00 | 2232.00 |

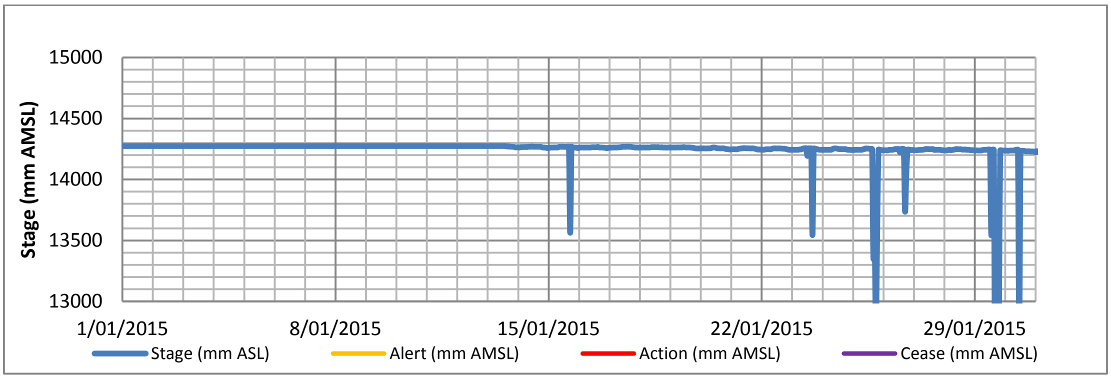



*Figure 13: Groundwater depth in the Upper Muaupoko in January 2015. Note Y-axis starts at 13000 mm AMSL.*

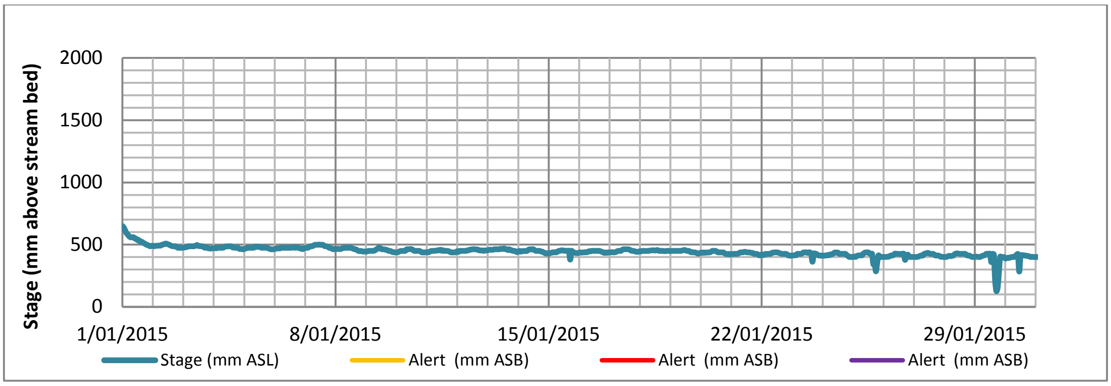



*Figure 21: In-stream depth in the Upper Muaupoko in January 2015*

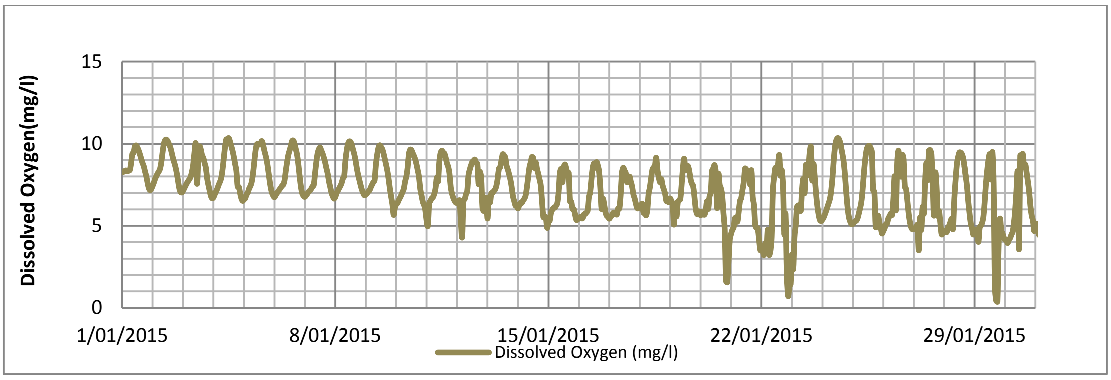



*Figure 15: Dissolved oxygen in the Upper Muaupoko in January 2015*

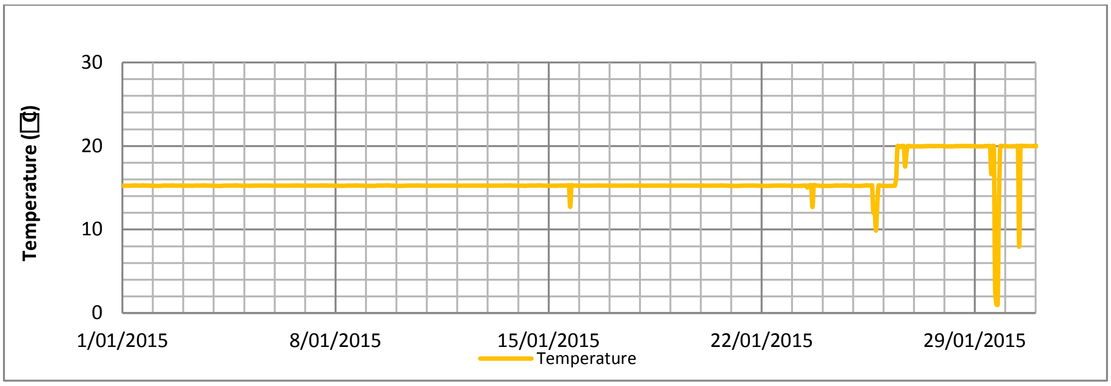



*Figure 16: Temperature in the Upper Muaupoko in January 2015*

## 2.7 Lower Muaupoko

Table 3 is a set of January 2015 summary statistics for the lower Muaupoko. The four figures that follow the table summarise the logged data for in-stream depth (Figure 9), groundwater depth (Figure 10), in-stream dissolved oxygen (Figure 11) and water temperature (Figure 12).

*Table 7: Summary statistics for the Lower Muaupoko – January 2015*

| | *Groundwater Depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 5577.80 | 250.69 | 8.04 | 18.93 |
| *Median* | 5580.00 | 249.00 | 7.85 | 18.73 |
| *Standard Deviation* | 43.53 | 11.95 | 0.85 | 1.73 |
| *Minimum* | 5504.00 | 233.00 | 0.00 | 14.79 |
| *Maximum* | 5670.00 | 325.00 | 9.95 | 25.43 |
| *Count* | 2785.00 | 2785.00 | 2785.00 | 2785.00 |

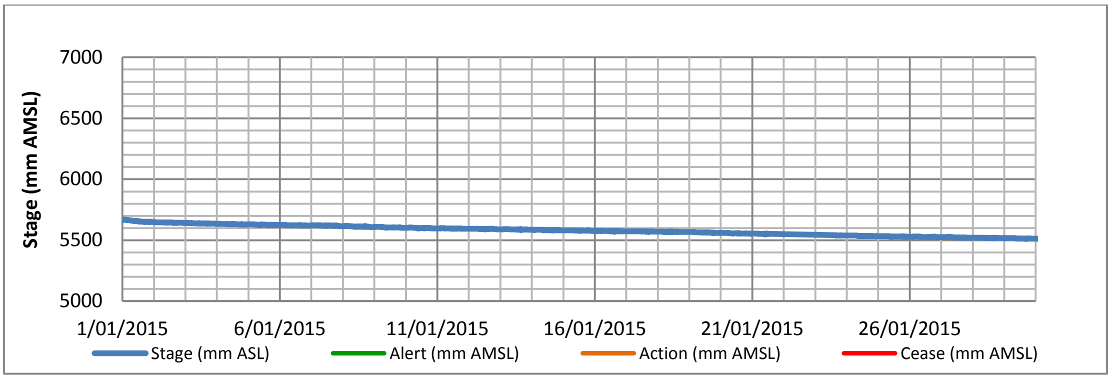



*Figure 22: Groundwater depth in the Lower Muaupoko in January 2015 Note Y-axis starts at 5000 mm AMSL.*

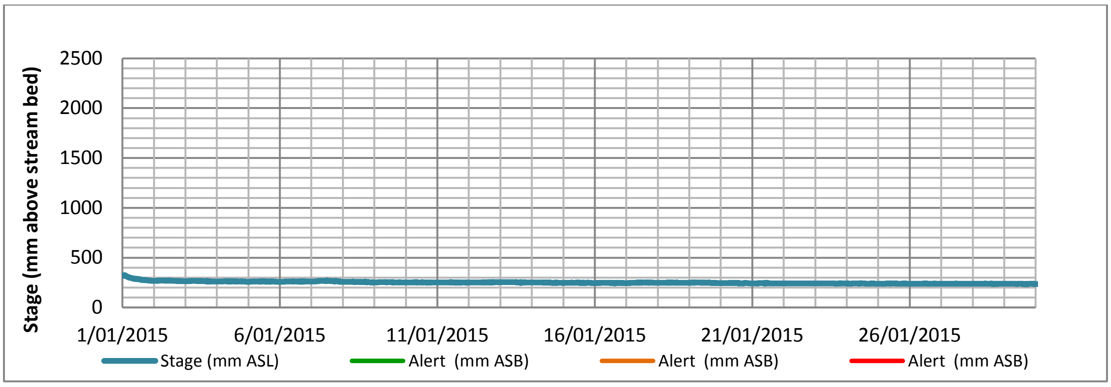



*Figure 23: In-stream depth in the Muaupoko (lower) in January 2015*

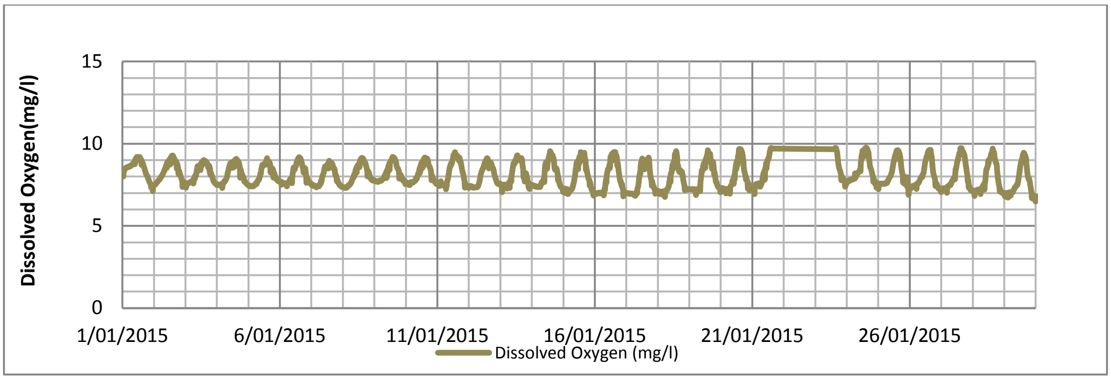



*Figure 24: Dissolved oxygen in the Lower Muaupoko in January 2015*

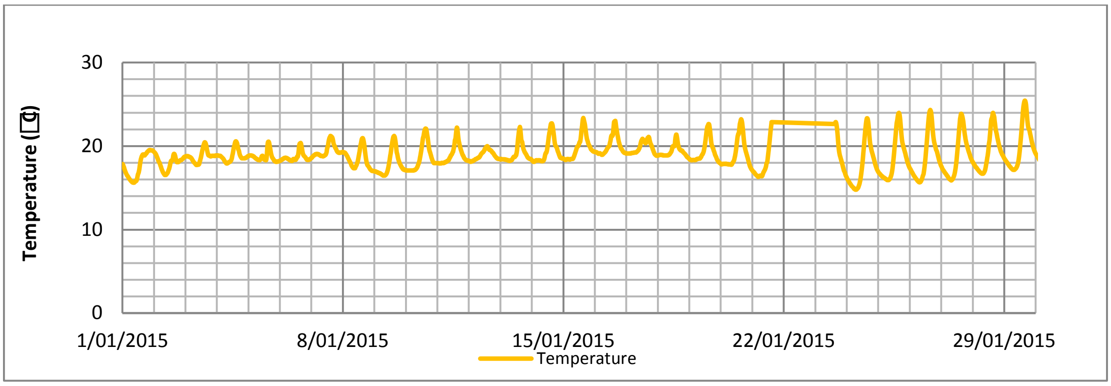



*Figure 25: Temperature in the Lower Muaupoko in January 2015*

## 2.8 Conductivity

As noted earlier, the conductivity recordings for this month's monitoring baseline has been limited to one site, the upper Muaupoko, due to repeated equipment failures. Table 8 below provides the water quality results of the January measures for conductivity averaged from five measurements for the one site.

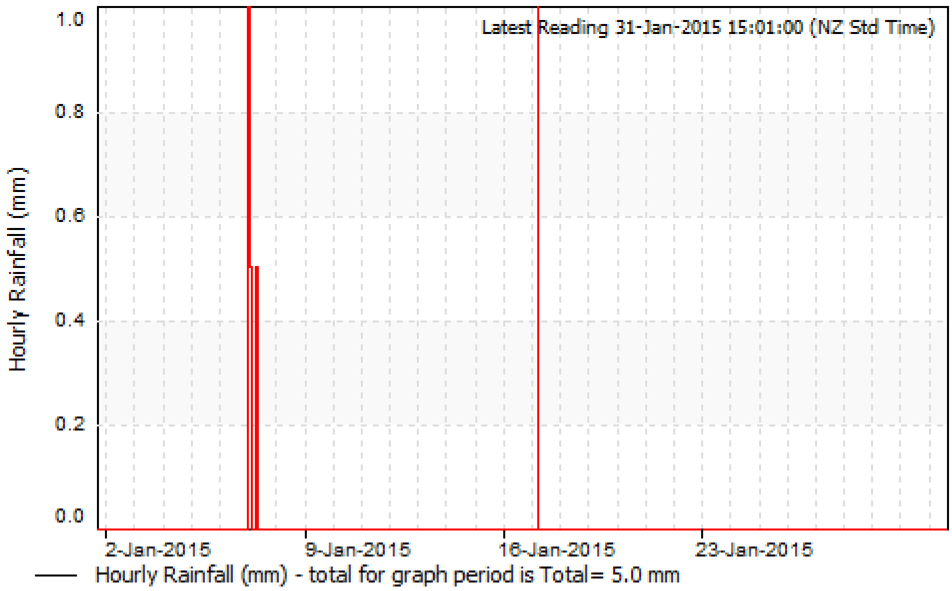
*Table 8: Average water quality from five measurements for the small streams survey reaches – January 2015.*

| Site | Conductivity (mS/cm) |
|---|---|
| Upper Muaupoko | 0.237 |

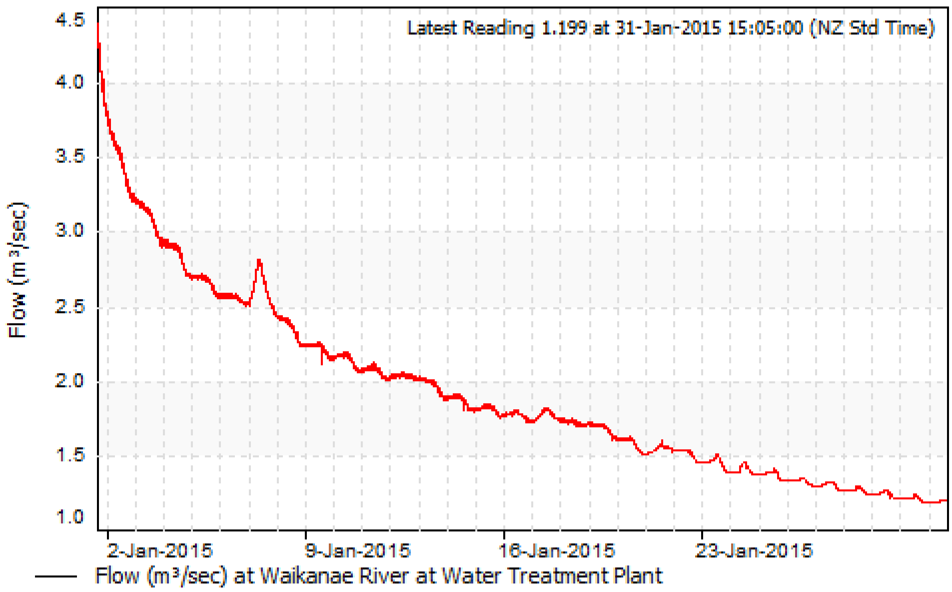
Cross sections were not completed (in error) for the January measure.

# Appendix 1: Rain fall and Waikanae River Flows

GWRC Rain fall Data for January 2015 as collected at the Waikanae waste Water treatment Plant (WWTP).



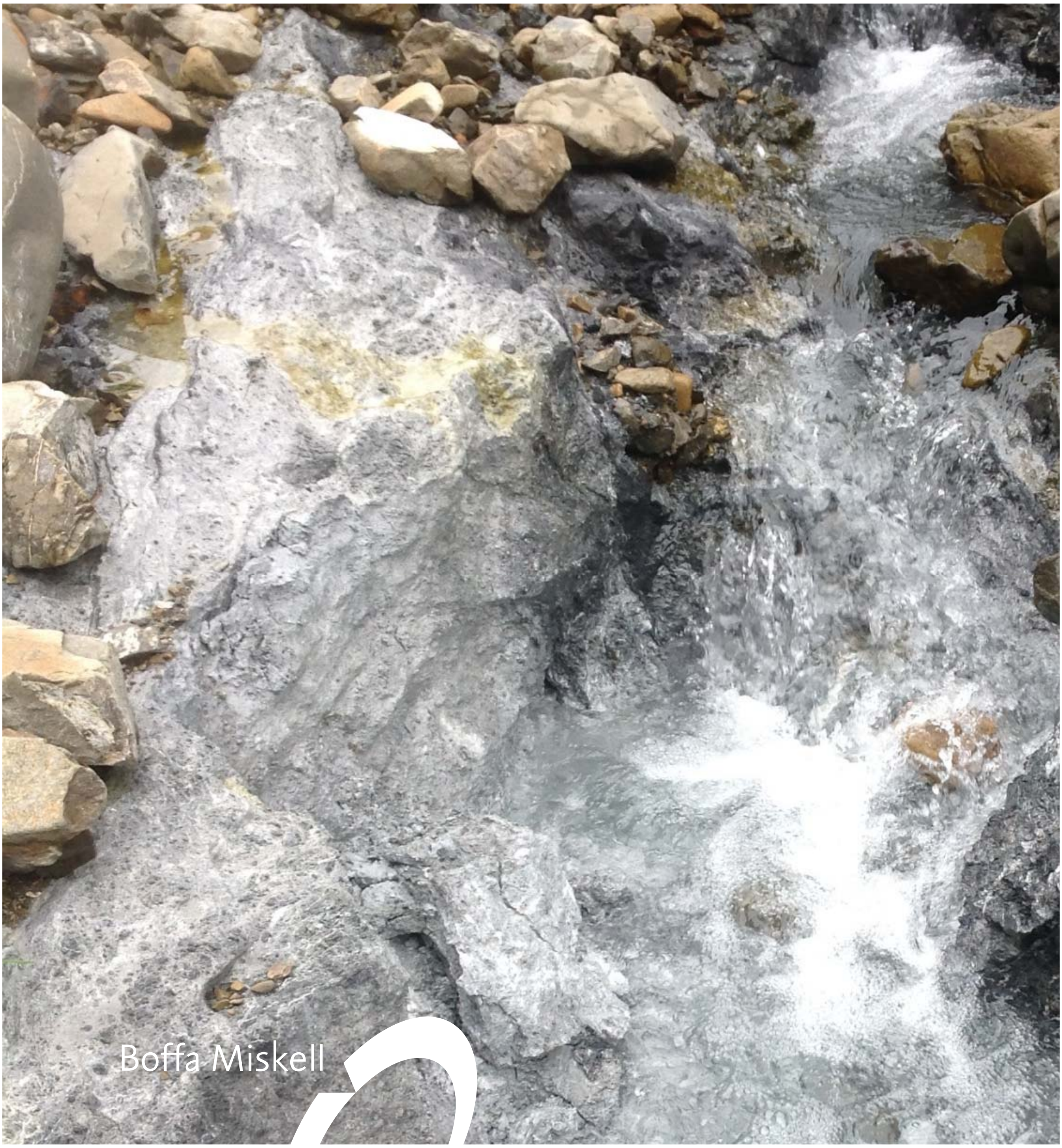

Waikanae river flow record for January 2015 at the WWTP.



# Small Coastal Stream Monthly Data Collection Report - February 2015

Kapiti Water Supply: RRwGW Scheme
Prepared for Kapiti Coast District Council

14 April 2015



# Document Quality Assurance

| **Bibliographic reference for citation:** | | |
| --- | --- | --- |
| Boffa Miskell Limited 2015. *Small Coastal Stream Monthly Data Collection Report - February 2015: Kapiti Water Supply: RRwGW Scheme*. Report prepared by Boffa Miskell Limited for Kapiti Coast District Council. | | |
| Prepared by: | Dr Vaughan Keesing<br>Senior Principal Senior Ecologist<br>Boffa Miskell Limited | |
| Reviewed by: | Dr Leigh Bull<br>Principal / Senior Ecologist<br>Boffa Miskell Limited | |
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# 1 INTRODUCTION

Monthly reports are required by the Small Coastal Streams (SCS) Baseline Aquatic Monitoring Plan (BMP 27$^{th}$ May 2014) to establish the collection of the data for the SCS monitoring programme during the baseline period.

Data are collected from the following sites:

1. Upper Muaupoko Stream
2. Lower Muaupoko Stream
3. Ngarara stream
4. Kakariki Stream
5. Paetawa Stream
6. Kowhai Stream
7. Hadfield Stream

The data collected are:

- Piezometer water level,
- in-stream water level (depth),
- in-stream dissolved oxygen level,
- in-stream temperature,
- monthly conductivity measure, and
- monthly in-stream cross sectional depth profiles

The following reports on the month of February data collection. Rather than attach all of the data for each logger, a summary of the statistics is presented here.

These summary results include the Telemetered site data who's graphic format is different from the other sites as they are generated directly from water outlook.

Appendix 1 presents the rain fall and Waikanae River flows as collected by GWRC at the Waikanae Waste Water Treatment Plant monitoring station, as an indication of rain fall and general river flow patterns through the monitoring month.

# 2 RESULTS

## 2.1 Hadfield

Table 1 is a set of January 2015 summary statistics for the Hadfield (lower). The four figures that follow the table summarise the logged data for in-stream depth (Figure 1), piezometer depth (Figure 2), in-stream dissolved oxygen (Figure 3) and water temperature (Figure 4).

*Table 1: Summary statistics for Hadfield - February 2015*

| | *Piezometer depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 2097.8 | 588.2 | 4.2 | 17.9 |
| *Standard Error* | 0.4 | 0.3 | 0.1 | 0.0 |
| *Median* | 2094.0 | 584.0 | 3.5 | 18.0 |
| *Mode* | 2091.0 | 583.0 | 1.6 | 18.4 |
| *Standard Deviation* | 16.9 | 13.4 | 2.8 | 1.4 |
| *Sample Variance* | 284.8 | 180.3 | 7.7 | 2.1 |
| *Minimum* | 2075.0 | 575.0 | 0.0 | 13.6 |
| *Maximum* | 2171.0 | 654.0 | 11.2 | 20.8 |
| *Count* | 1784.0 | 1785.0 | 1785.0 | 1785.0 |

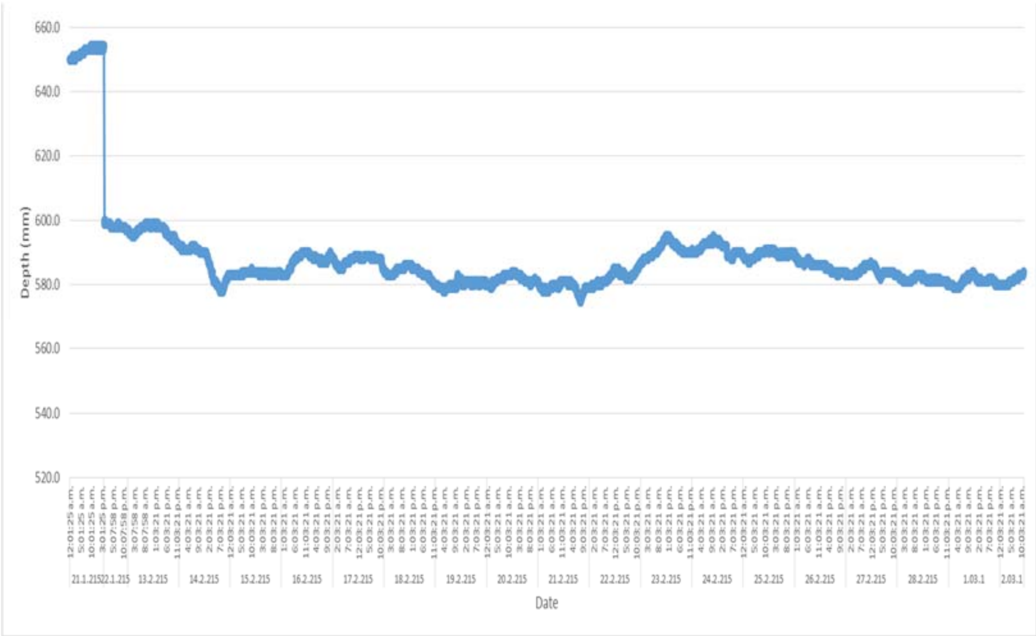



*Figure 1: In-stream depth in the Hadfield Stream in February 2015*

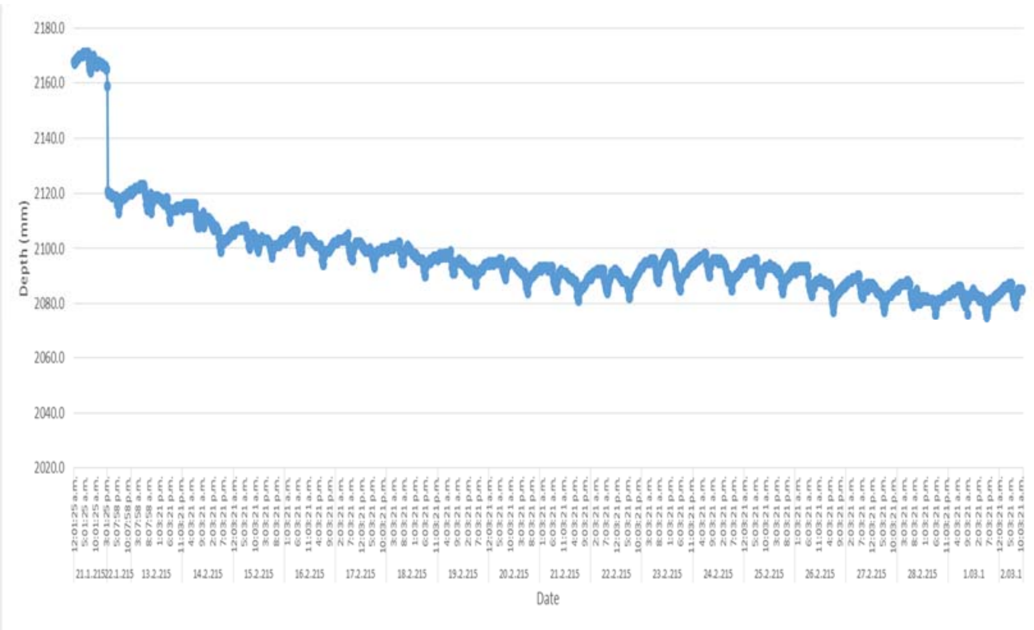



*Figure 2: Piezometer depth in the Hadfield Stream in February 2015*

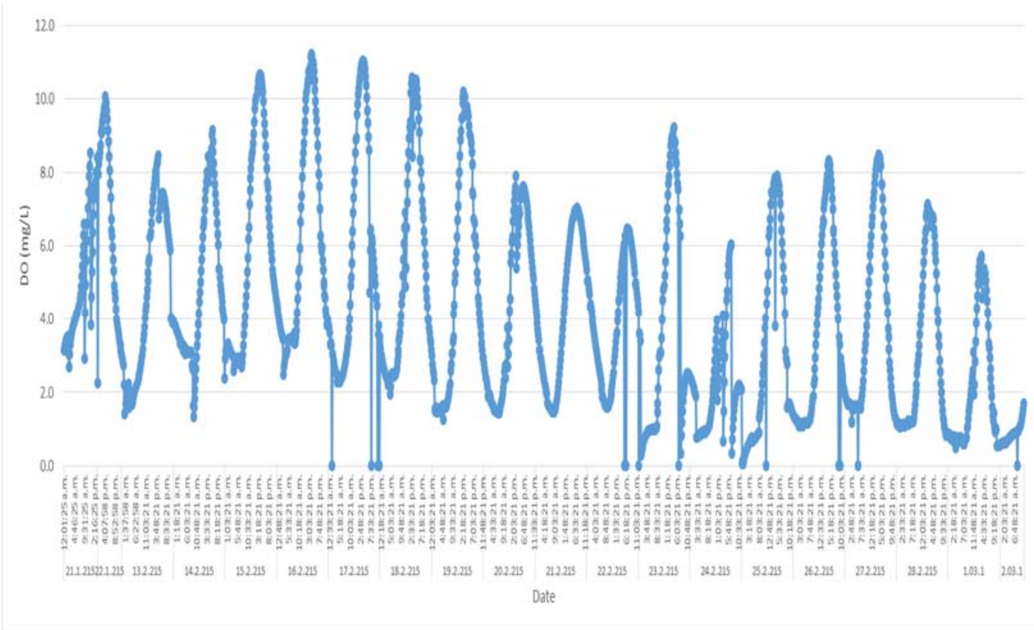



*Figure 3: In-stream dissolved oxygen in the Hadfield Stream in February 2015*

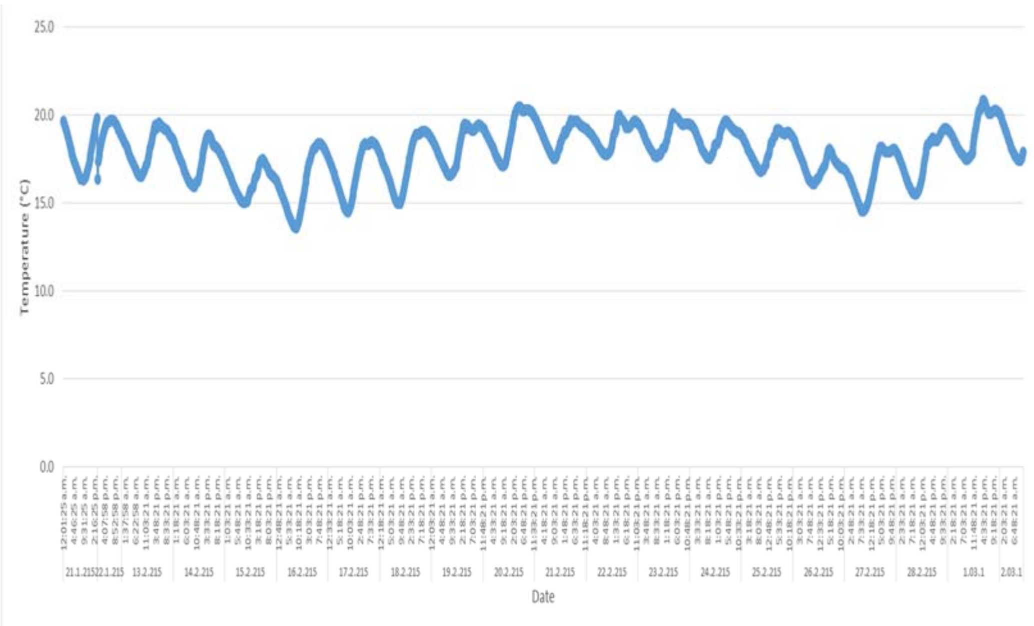



*Figure 4: Water temperature in the Hadfield Stream in February 2015*

## 2.2 Ngarara

Table 2 is a set of February 2015 summary statistics for the Ngarara. The four figures that follow the table summarise the logged data for in-stream depth (Figure 5), piezometer depth (Figure 6), in-stream dissolved oxygen ( Figure 7) and water temperature (Figure 8).

*Table 2: Summary statistics for the Ngarara – February 2015*

| | *Piezometer Depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 3078.3 | 797.3 | 6.3 | 17.5 |
| *Standard Error* | 0.8 | 0.7 | 0.0 | 0.0 |
| *Median* | 3078.0 | 791.0 | 6.5 | 17.5 |
| *Mode* | 3038.0 | 756.0 | 0.0 | 17.1 |
| *Standard Deviation* | 46.3 | 45.0 | 1.4 | 1.8 |
| *Sample Variance* | 2145.4 | 2023.8 | 1.9 | 3.3 |
| *Minimum* | 2976.0 | 742.0 | 0.0 | 13.2 |
| *Maximum* | 3199.0 | 993.0 | 8.7 | 22.4 |
| *Count* | 3658.0 | 3658.0 | 3658.0 | 3658.0 |

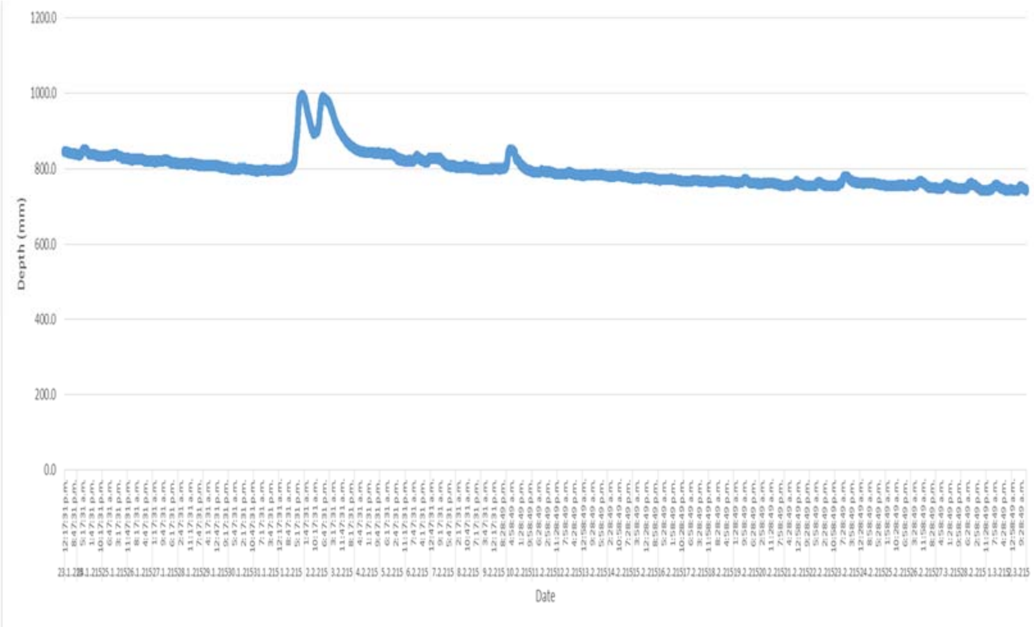



*Figure 5: In-stream depth in the Ngarara Stream in February 2015*

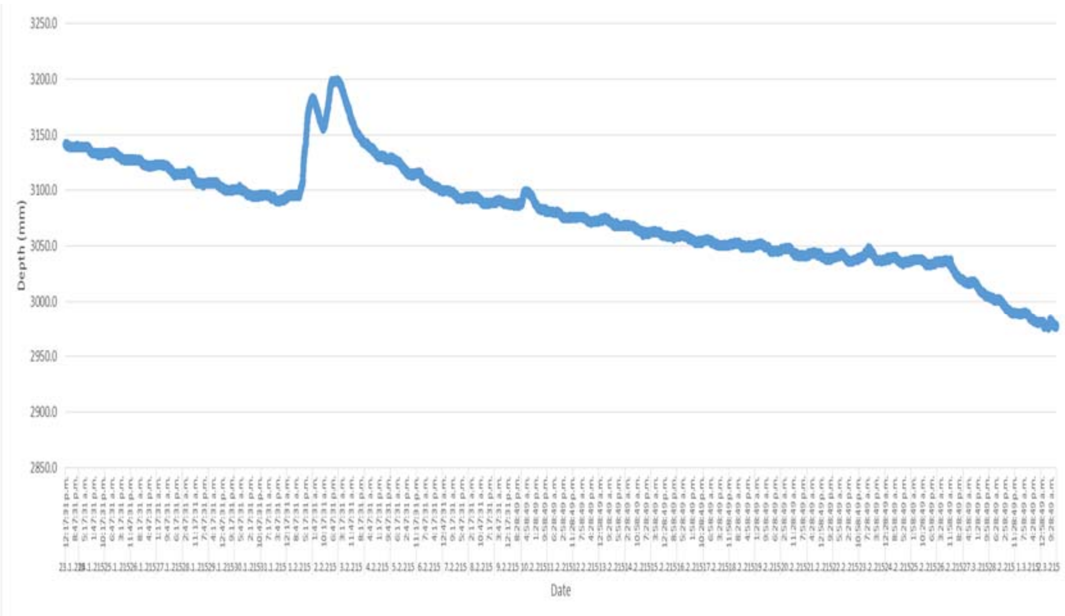



*Figure 6: Piezometer depth in the Ngarara Stream in February 2015*

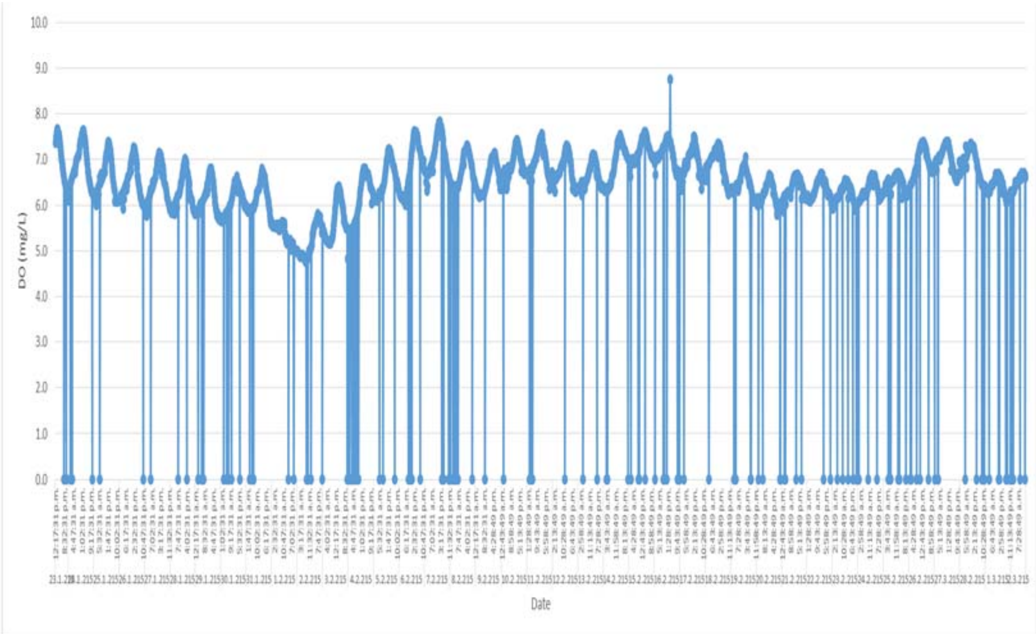



*Figure 7: Dissolved oxygen in the Ngarara Stream in February 2015*

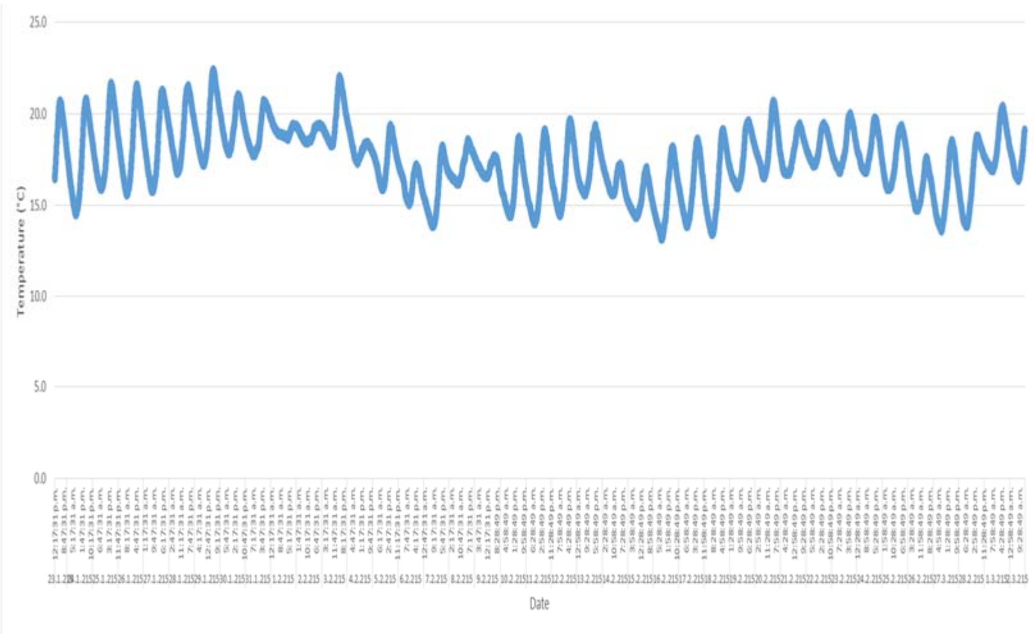



*Figure 8: Temperature in the Ngarara Stream in February 2015*

## 2.3 Lower Muaupoko

Table 3 is a set of February 2015 summary statistics for the Muaupoko (lower). The four figures that follow the table summarise the logged data for in-stream depth (Figure 9), piezometer depth (Figure 10), in-stream dissolved oxygen (Figure 11) and water temperature (Figure 12).

*Table 3: Summary statistics for the Muaupoko – February 2015*

| | *Piezometer Depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 5481.8 | 240.5 | 8.1 | 17.7 |
| *Standard Error* | 0.5 | 0.1 | 0.0 | 0.0 |
| *Median* | 5479.0 | 239.0 | 7.8 | 17.5 |
| *Mode* | 5508.0 | 238.0 | 7.3 | 19.4 |
| *Standard Deviation* | 31.3 | 5.3 | 1.1 | 2.4 |
| *Sample Variance* | 978.0 | 28.5 | 1.2 | 5.6 |
| *Minimum* | 5427.0 | 231.0 | 0.0 | 13.0 |
| *Maximum* | 5543.0 | 279.0 | 11.4 | 25.4 |
| *Count* | 3659.0 | 3659.0 | 3659.0 | 3659.0 |

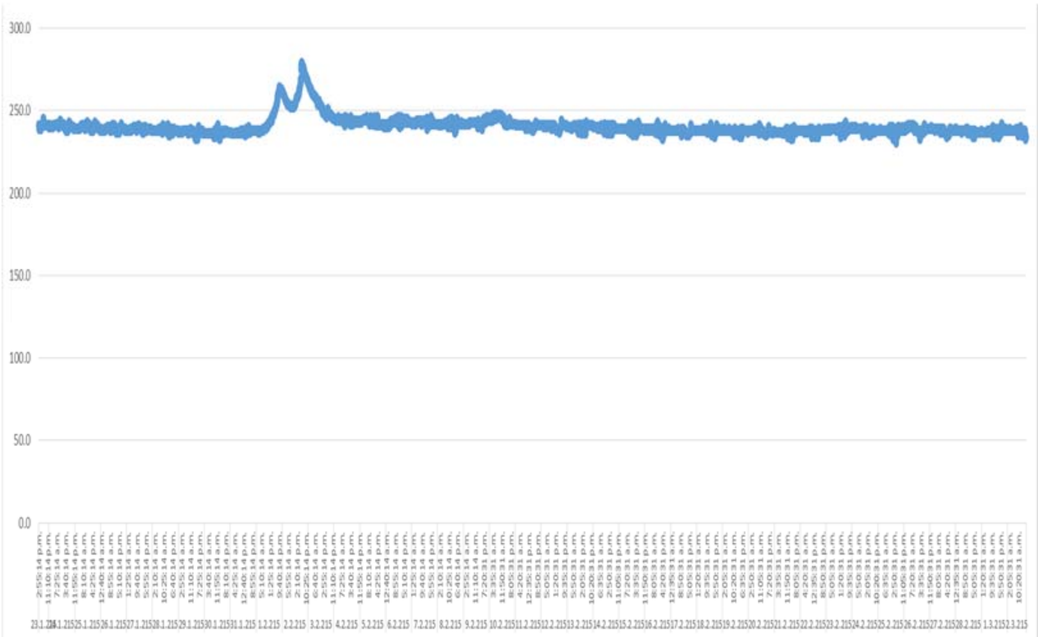



*Figure 9: In-stream depth in the Lower Muaupoko in February 2015*

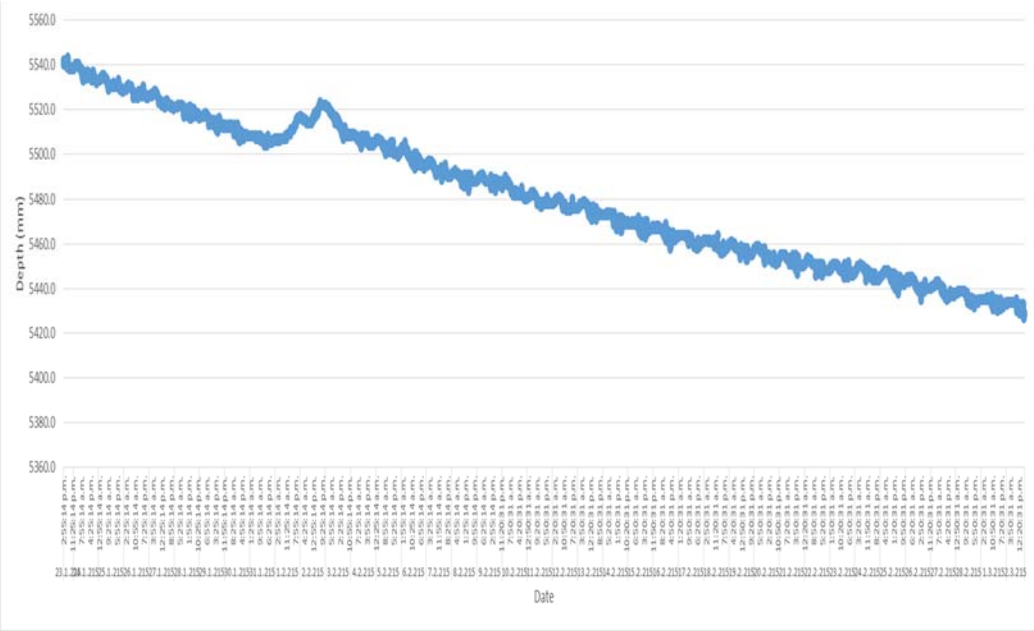



*Figure 10: Piezometer depth in the Lower Muaupoko in February 2015*

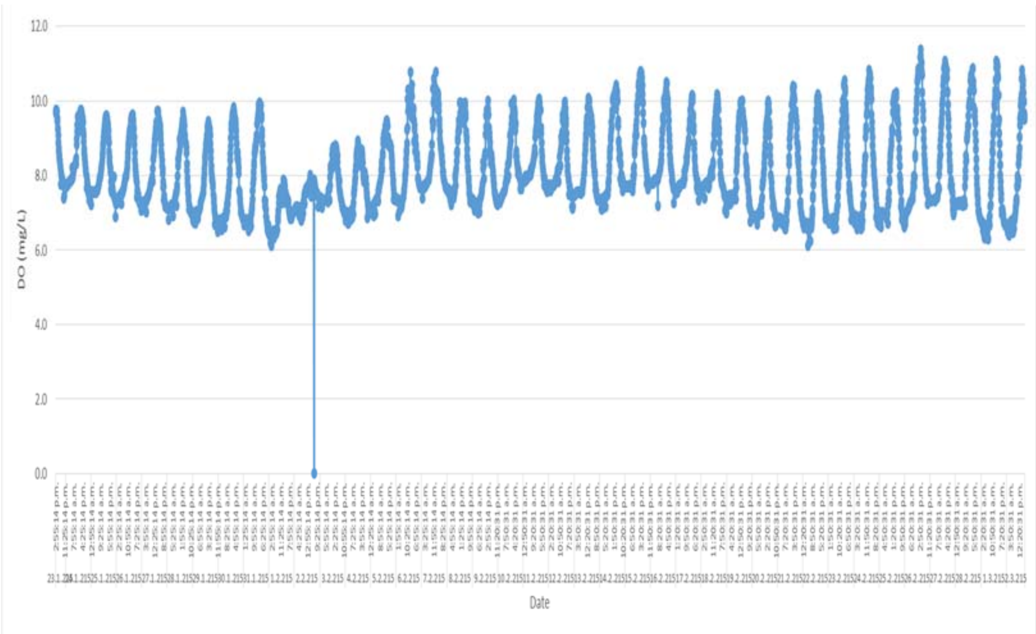



*Figure 11: Dissolved oxygen in the Lower Muaupoko in February 2015*

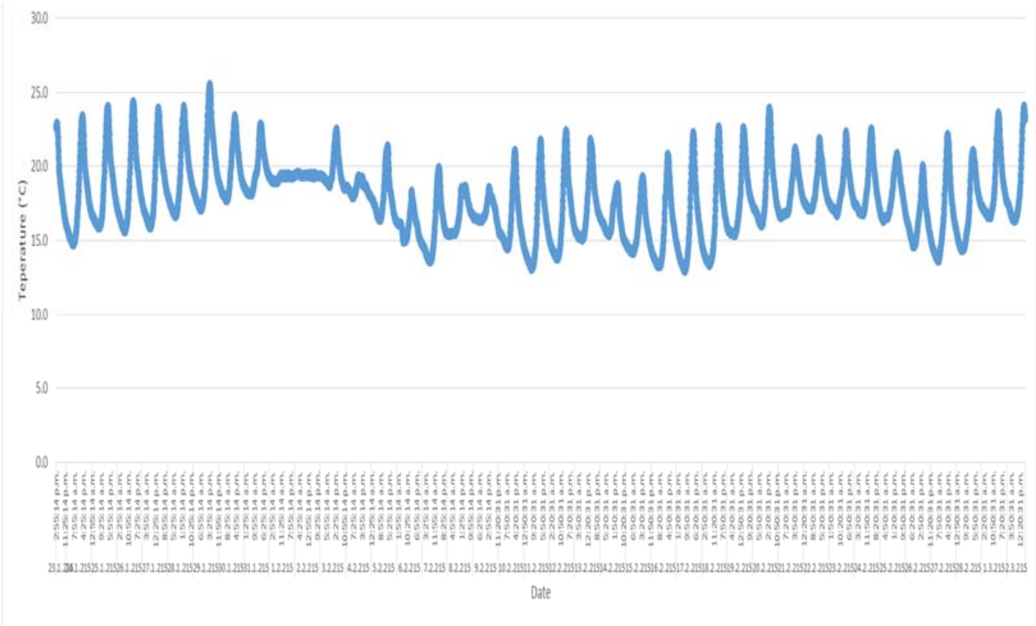


Figure 12: Temperature in the Lower Muaupoko in February 2015

## 2.4 Upper Muaupoko

Table 4 is a set of February 2015 summary statistics for the Upper Muaupoko. The four figures that follow the table summarise the logged data for in-stream depth (Figure 13), piezometer depth (Figure 14), in-stream dissolved oxygen (Figure 15) and water temperature (Figure 16).

*Table 4: Summary statistics for the Muaupoko – February 2015*

| | *Piezometer Depth (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 14217.5 | 411.8 | 5.3 | 20.0 |
| *Standard Error* | 2.4 | 0.3 | 0.0 | 0.0 |
| *Median* | 14219.0 | 413.0 | 5.3 | 20.0 |
| *Mode* | 14219.0 | 413.0 | 3.2 | 20.0 |
| *Standard Deviation* | 112.6 | 15.9 | 1.8 | 0.8 |
| *Sample Variance* | 12685.0 | 253.1 | 3.4 | 0.7 |
| *Minimum* | 11086.2 | 126.6 | 0.4 | 1.0 |
| *Maximum* | 14282.5 | 528.0 | 10.4 | 20.1 |
| *Count* | 2160.0 | 2160.0 | 2160.0 | 2160.0 |

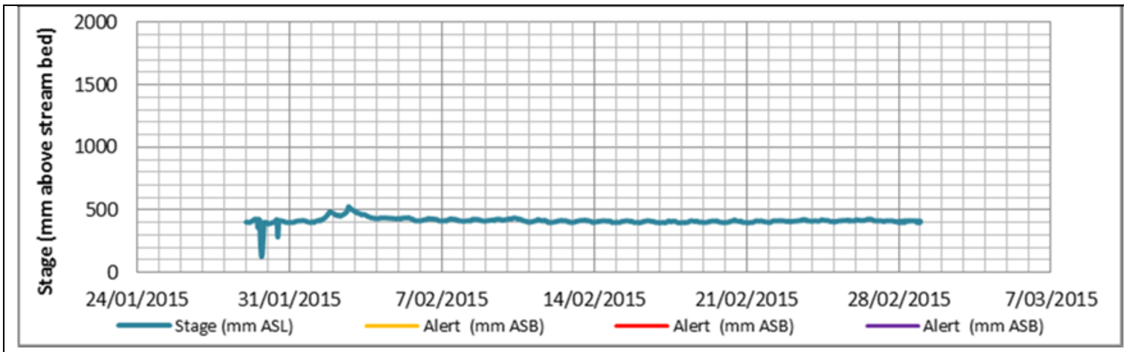



*Figure 13 : In-stream depth in the Upper Muaupoko Stream in February 2015*

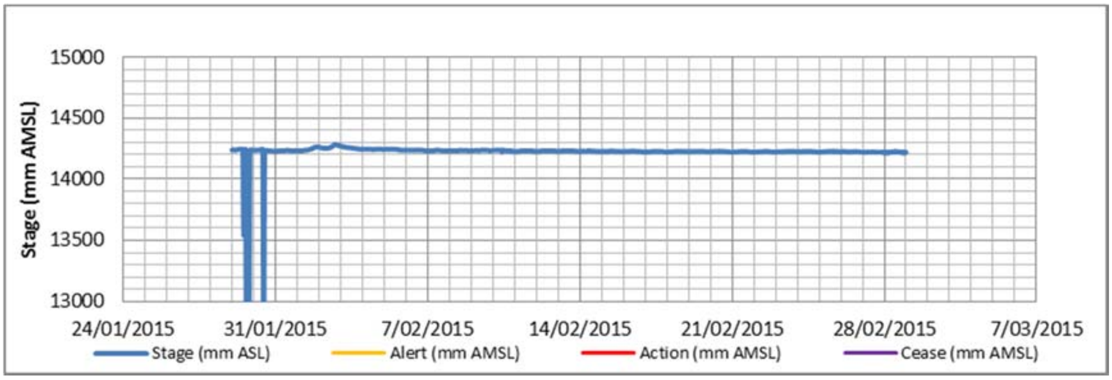



*Figure 14 : Piezometer depth in the Upper Muaupoko Stream in February 2015*

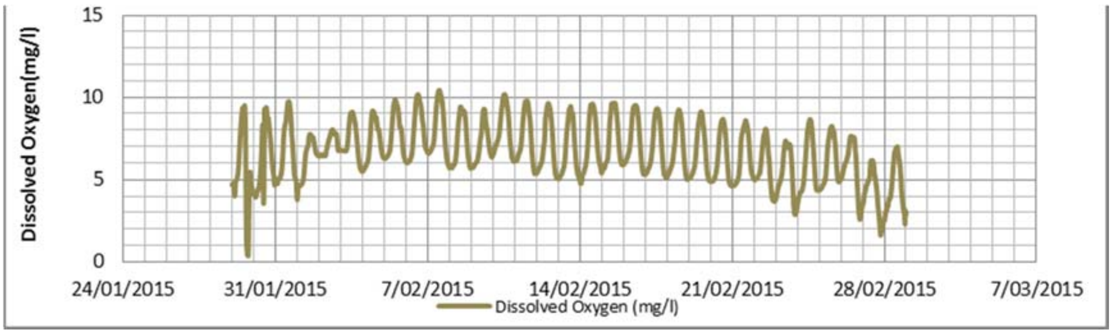



*Figure 15 : Dissolved oxygen in the Upper Muaupoko Stream in February 2015*

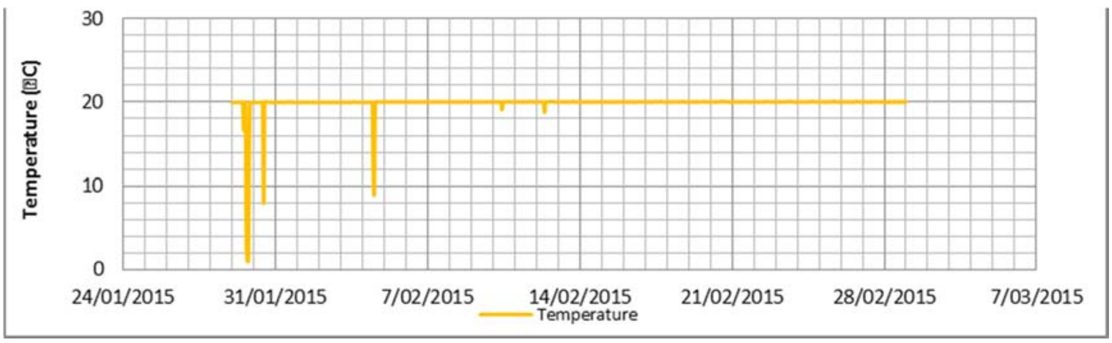



*Figure 16 : Temperature in the Upper Muaupoko Stream in February 2015*

## 2.5 Kakariki

Table 5 is a set of February 2015 summary statistics over the Kakariki Stream. The four figures the table summarise the logged data for in-stream depth (Figure 17), piezometer depth (Figure 18), in-stream dissolved oxygen (Figure 19) and water temperature (Figure 20).

*Table 5: Summary statistics for the Kakariki – February 2015*

| | *Piezometer depth (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 6717.2 | 273.1 | 6.9 | 17.7 |
| *Standard Error* | 0.8 | 1.1 | 0.0 | 0.0 |
| *Median* | 6718.0 | 264.0 | 7.6 | 17.8 |
| *Mode* | 6667.0 | 283.0 | 0.1 | 18.3 |
| *Standard Deviation* | 46.2 | 63.7 | 2.2 | 2.0 |
| *Sample Variance* | 2132.9 | 4062.4 | 4.7 | 4.2 |
| *Minimum* | 6644.0 | 202.0 | 0.0 | 12.9 |
| *Maximum* | 6862.0 | 727.0 | 9.1 | 23.0 |
| *Count* | 3662.0 | 3662.0 | 3662.0 | 3662.0 |

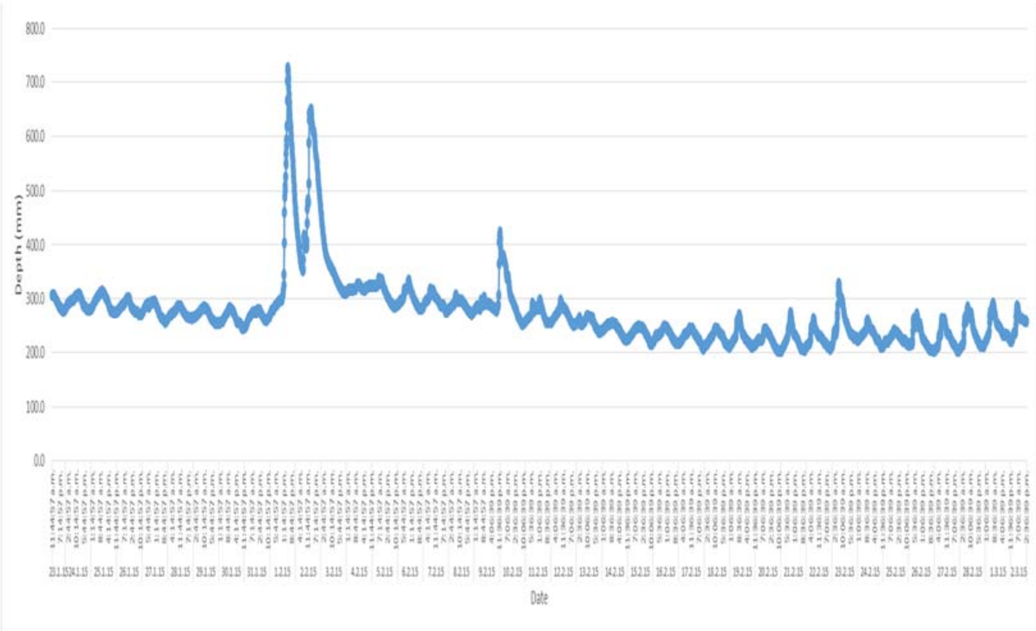



*Figure 17: In-stream depth in the Kakariki Stream in February 2015*

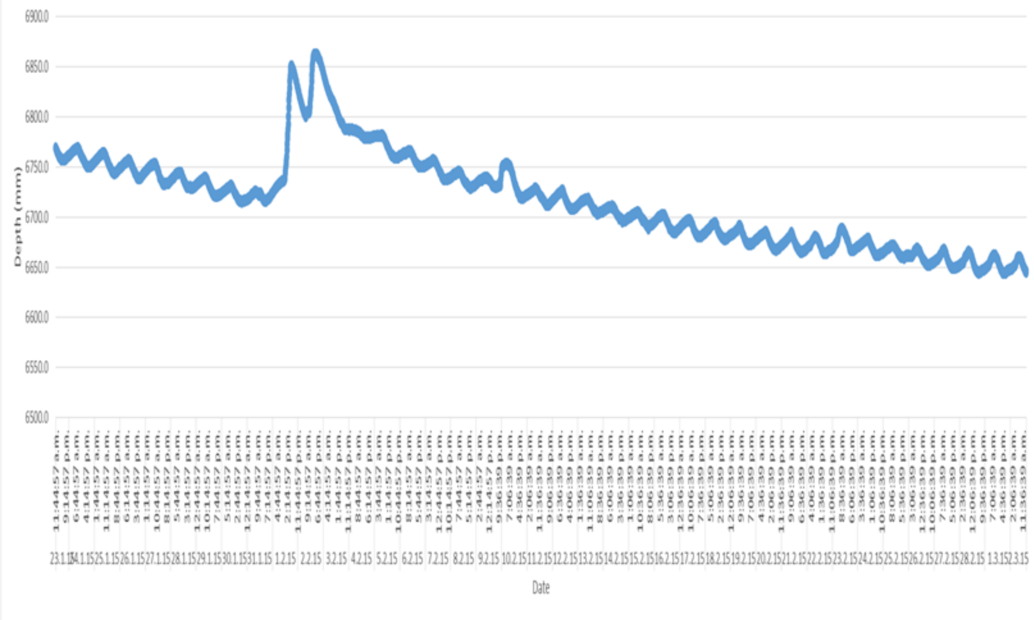



*Figure 18: Piezometer depth in the Kakariki Stream in February 2015*

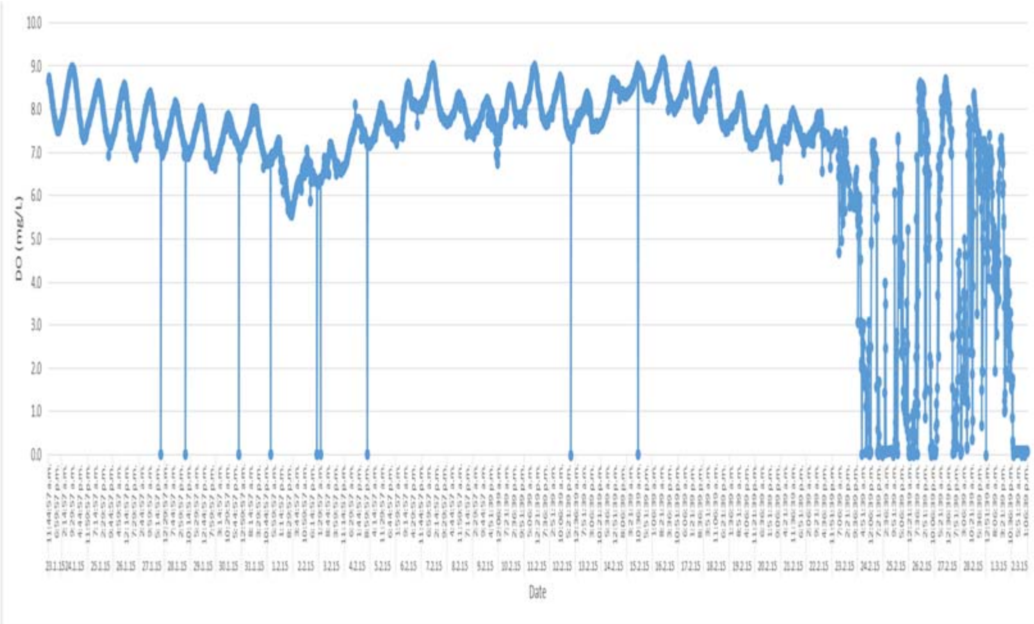



*Figure 19: Dissolved oxygen in the Kakariki Stream in February 2015*

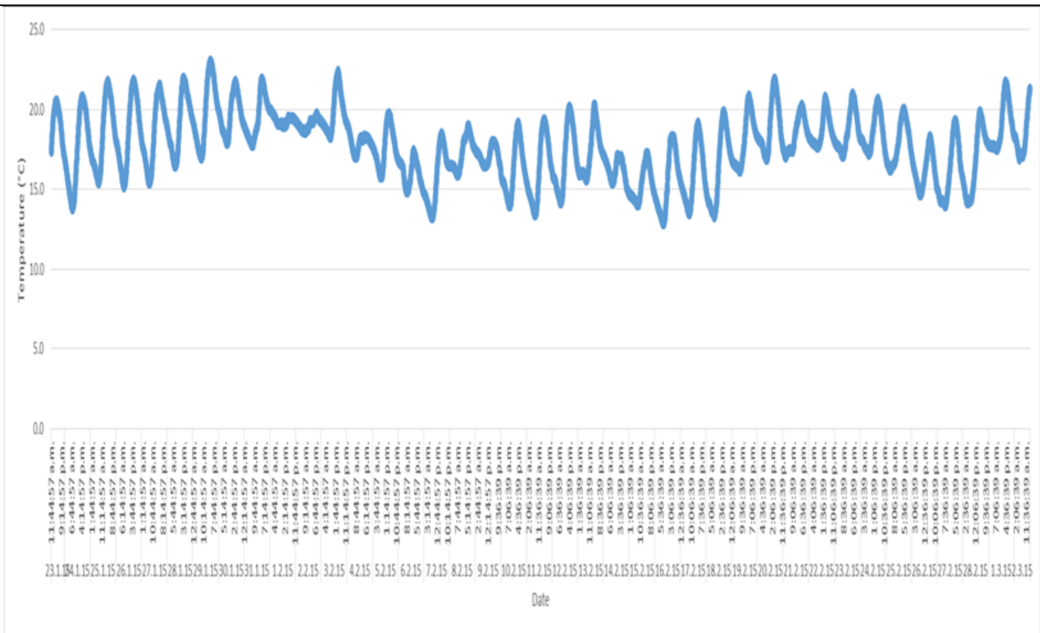


Figure 20: Temperature in the Kakariki Stream in February 2015

## 2.6 Paetawa

Table 6 is a set of February 2015 summary statistics for the Paetawa. The four figures that follow the table summarise the logged data for in-stream depth (Figure 21), piezometer depth (Figure 22), in-stream dissolved oxygen (Figure 23) and water temperature (Figure 24).

*Table 6: Summary statistics for the Paetawa – February 2015*

| | Piezometer depth (mm) | Stream depth (mm) | Dissolved Oxygen (mg/L) | Temperature (°C) |
|---|---|---|---|---|
| *Mean* | 6866.0 | 66.7 | 6.6 | 17.4 |
| *Standard Error* | 0.9 | 0.7 | 0.1 | 0.1 |
| *Median* | 6864.0 | 59.0 | 6.9 | 17.4 |
| *Mode* | 6796.0 | 46.0 | 0.1 | 18.4 |
| *Standard Deviation* | 44.3 | 32.5 | 2.7 | 3.1 |
| *Sample Variance* | 1966.8 | 1058.6 | 7.5 | 9.6 |
| *Minimum* | 6780.0 | 30.0 | 0.0 | 8.5 |
| *Maximum* | 6955.0 | 239.0 | 10.7 | 25.2 |
| *Count* | 2405.0 | 2405.0 | 2405.0 | 2404.0 |

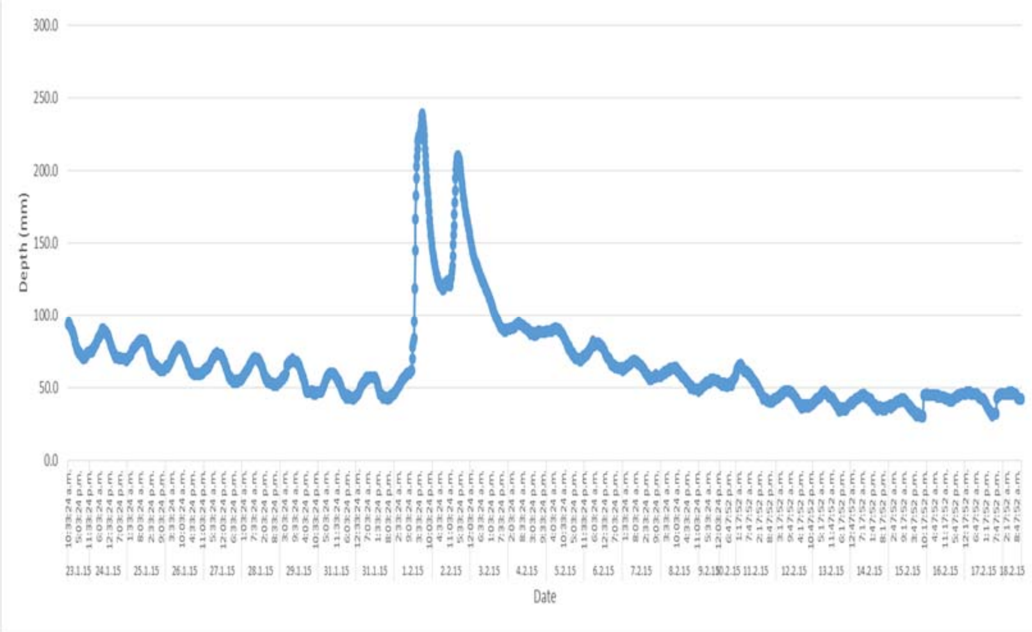



*Figure 21: In-stream depth in the Paetawa Stream in February 2015*

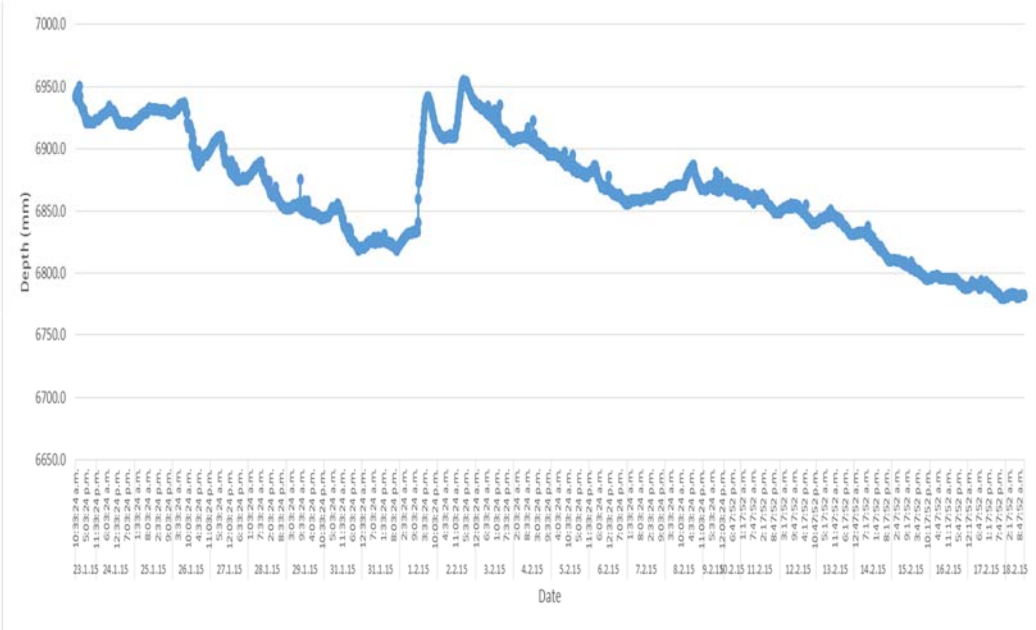



*Figure 22: Piezometer depth in the Paetawa Stream in February 2015*

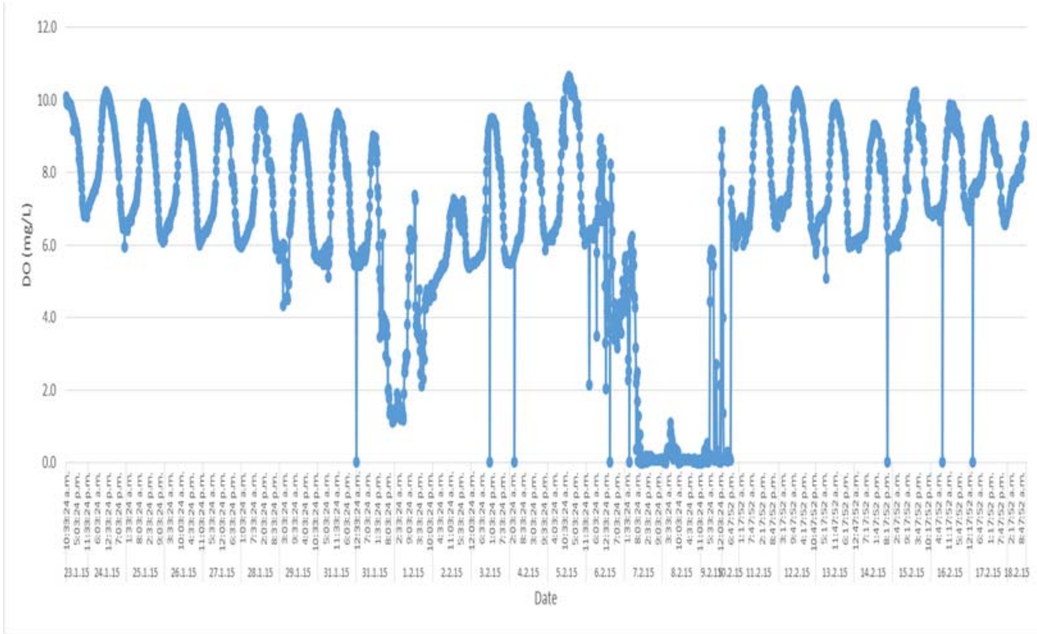



*Figure 23: Dissolved oxygen in the Paetawa Stream in February 2015*

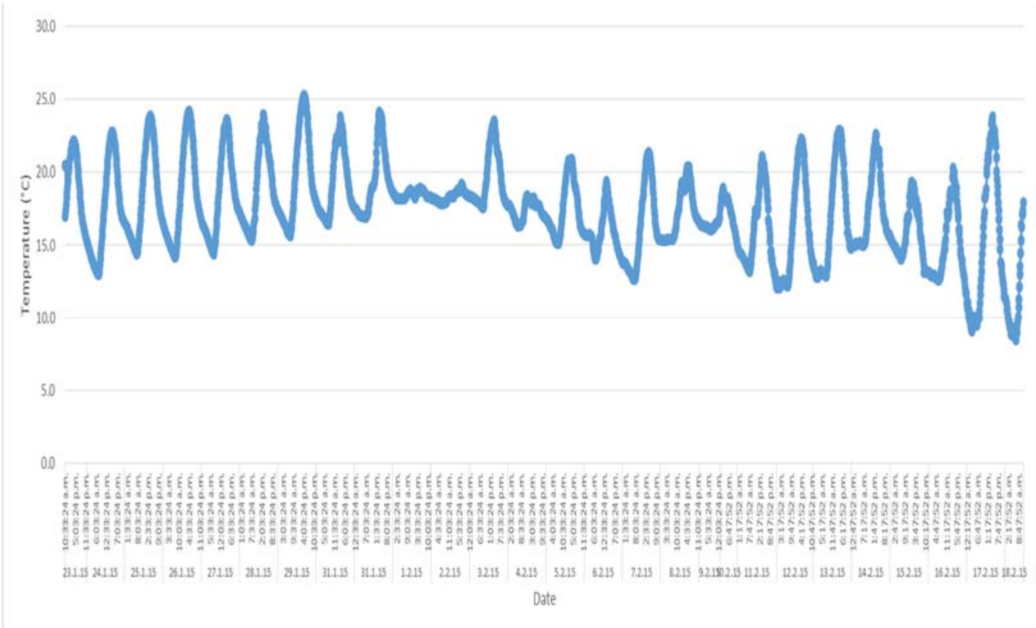



*Figure 24: Temperature in the Paetawa Stream in February 2015*

## 2.7 Kowhai

Table 7 is a set of February 2015 summary statistics for the Kowhai Stream. The four figures that follow the table summarise the logged data for in-stream depth (Figure 25), piezometer depth (Figure 26), in-stream dissolved oxygen (Figure 27) and water temperature (Figure 28).

*Table 7: Summary statistics for the* Kowhai *– February 2015*

| | *Piezometer depth (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 8994.9 | 51.1 | 7.6 | 17.2 |
| *Standard Error* | 1.3 | 0.1 | 0.1 | 0.1 |
| *Median* | 8961.0 | 50.0 | 8.7 | 17.4 |
| *Mode* | 8961.0 | 50.0 | 8.7 | 19.2 |
| *Standard Deviation* | 61.2 | 5.8 | 3.1 | 3.4 |
| *Sample Variance* | 3740.2 | 33.4 | 9.7 | 11.5 |
| *Minimum* | 8955.0 | 50.0 | 0.0 | 7.4 |
| *Maximum* | 9210.1 | 113.0 | 11.6 | 27.4 |
| *Count* | 2160.0 | 2160.0 | 2160.0 | 2160.0 |

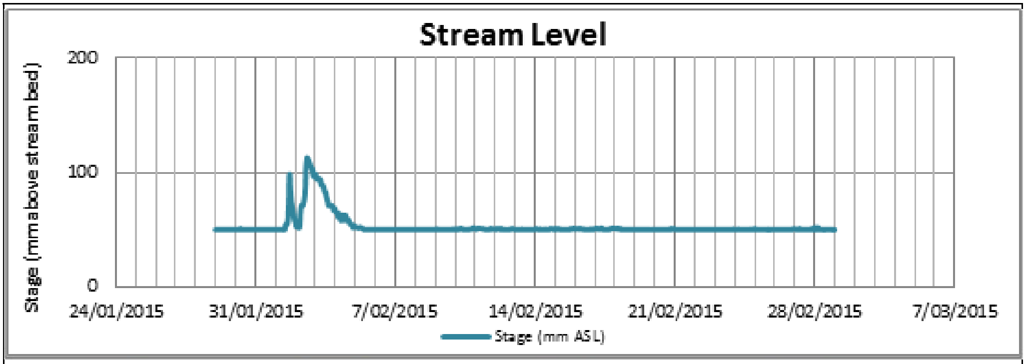


*Figure 25: Stream depth in the Kowhai Stream in February 2015*

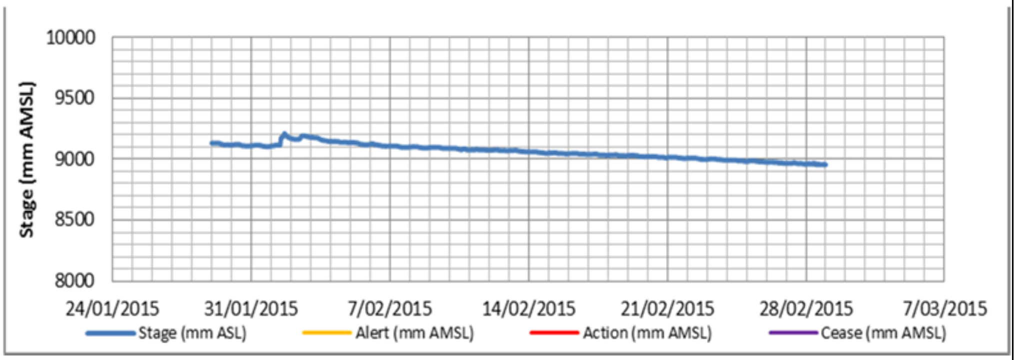


*Figure 26: Piezometer depth in the Kowhai Stream in February 2015*

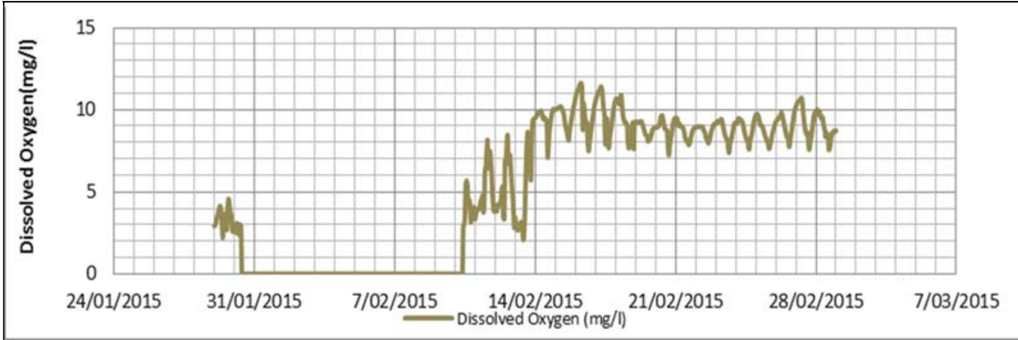



*Figure 27: Dissolved oxygen in the Kowhai Stream in February 2015*

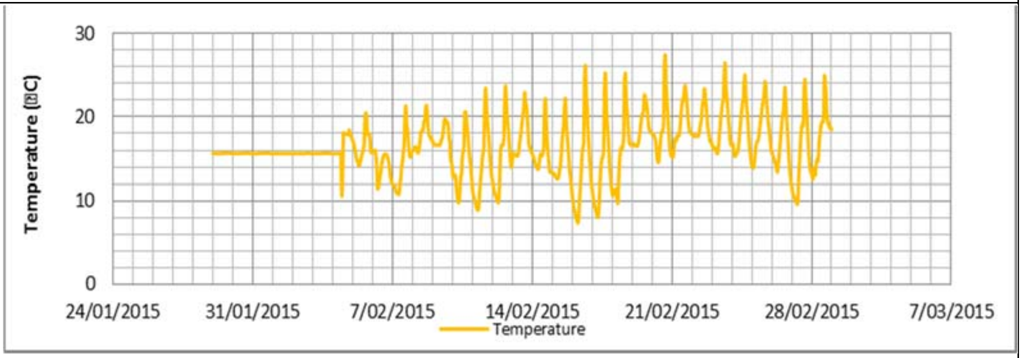



*Figure 28: Temperature in the Kowhai Stream in February 2015*

## 2.8 Conductivity & Cross sectional depth profiles

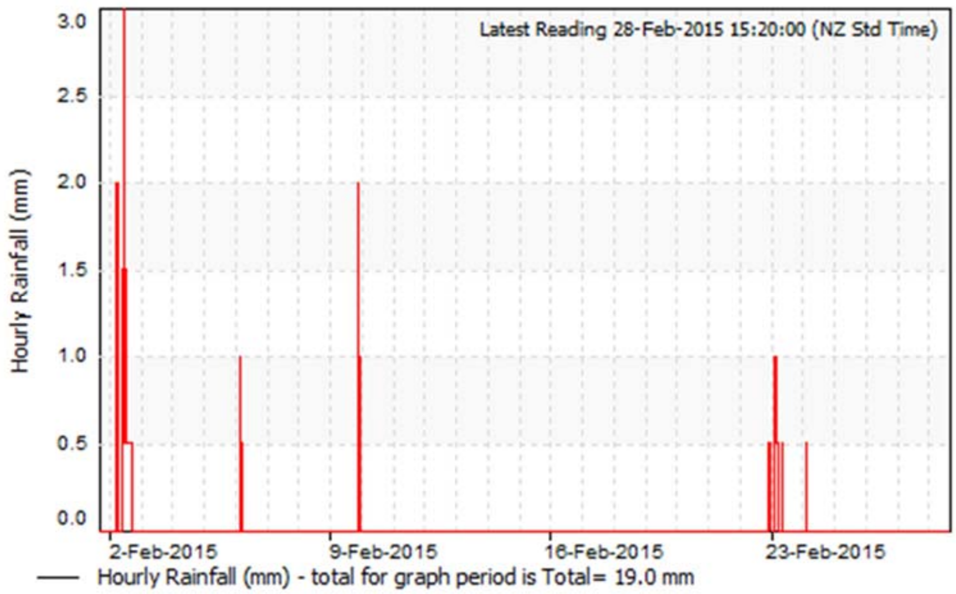
Table 8 below provides the Conductivity results of the February measures for conductivity averaged from five measurements for the one site.

*Table 8: Cross section depth measures (Xsect A, 25m up stream, Xsect B, 25m downstream). And averaged water conductivity (and pH) for the small streams survey reaches – February 2015.*

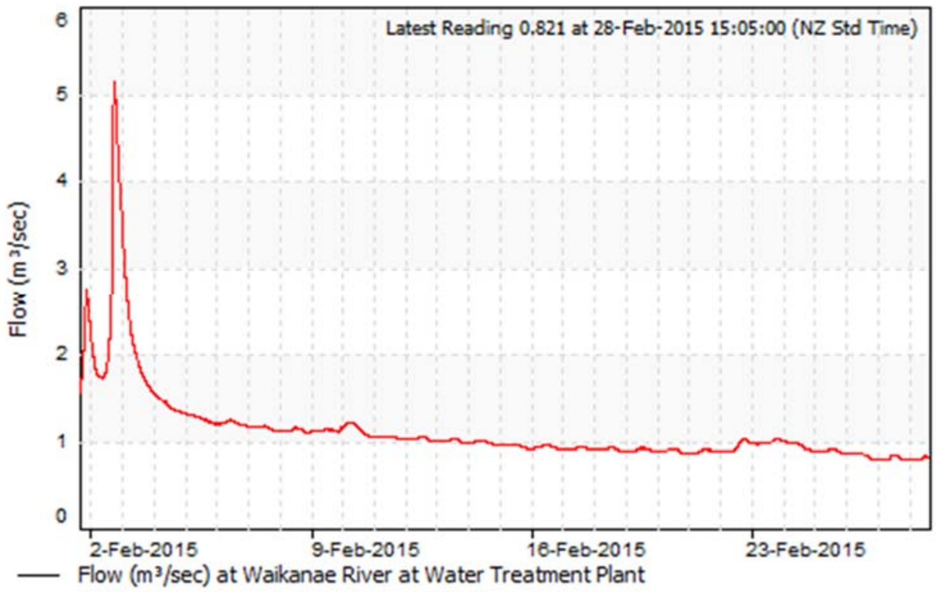
| Date | 2/03/2015 | 2/03/2015 | 2/03/2015 | 2/03/2015 | 2/03/2015 | 2/03/2015 |
|---|---|---|---|---|---|---|
| Site | Hadfield | Paetawa | Ngarara | Kakariki | Upper Muaupoko | Lower Muaupoko |
| **Wetted width @ piezo** | 225 | 130 | 265 | 163 | 243 | 188 |
| Xsect A 1 | 6 | 3 | 37.8 | 19 | 3 | 15 |
| Xsect A 2 | 18 | 3.5 | 74 | 22 | 5 | 15 |
| Xsect A 3 | 24 | 6 | 75 | 21.5 | 9.5 | 15 |
| Xsect A 4 | 41 | 8.5 | 78 | 20 | 18 | 19.5 |
| Xsect A 5 | 48 | 9.5 | 80.5 | 21 | 23 | 5 |
| Xsect A 6 | 65 | 5 | 74 | 17 | 16.5 | 21 |
| Xsect A 7 | 72 | 6 | 59 | 10 | 9 | 20 |
| Xsect A 8 | 69 | 10 | 51 | 6 | 23 | 18.5 |
| Xsect A 9 | 62 | 8.5 | 37 | 3 | 21 | 17 |
| Xsect A 10 | 20 | 4 | 5 | 1 | 4 | 12 |
| Wetted width Tran B | 243 | 105 | 240 | 140 | 160 | 245 |
| Xsect B 1 | 19 | 2 | 30 | 2 | 1 | 6 |
| Xsect B 2 | 28 | 7 | 46 | 3 | 1.5 | 6.5 |
| Xsect B 3 | 32 | 11.5 | 52 | 9 | 2 | 8 |
| Xsect B 4 | 27 | 12 | 56 | 15 | 4 | 11 |
| Xsect B 5 | 26 | 9 | 58 | 17.5 | 4 | 14 |
| Xsect B 6 | 26 | 8 | 55 | 14 | 7.5 | 16 |
| Xsect B 7 | 21 | 5 | 55 | 13 | 8 | 17 |
| Xsect B 8 | 20 | 5 | 53 | 9 | 11.5 | 18.5 |
| Xsect B 9 | 18 | 4 | 41 | 5 | 10 | 20 |
| Xsect B 10 | 7 | 2 | 37 | 2 | 10 | 13 |
| Wetted width Tran C | 205 | 108 | 257 | 124 | 81 | 136 |
| Xsect C 1 | 25 | 2 | 13 | 3 | 2 | 1 |
| Xsect C 2 | 26 | 8.5 | 21 | 7 | 5.5 | 6 |
| Xsect C 3 | 28 | 11 | 39 | 12 | 5 | 6.5 |
| Xsect C 4 | 23 | 11 | 49 | 15.5 | 10 | 6.5 |
| Xsect C 5 | 22 | 10 | 64 | 17 | 13.5 | 7.5 |
| Xsect C 6 | 20 | 9 | 64 | 21.5 | 16 | 7 |
| Xsect C 7 | 24 | 8 | 50 | 18 | 20 | 4.5 |
| Xsect C 8 | 15 | 7 | 39.5 | 20 | 19 | 3.5 |
| Xsect C 9 | 13 | 6 | 28 | 23 | 15 | 2.8 |
| Xsect C 10 | 8 | 2 | 28 | 16 | 10 | 1 |
| **Water Parameters** | | | | | | |
| Ph | 7.87 | 8.12 | 7.31 | 7.52 | 7.37 | 7.96 |
| Conductivity (mS/cm) | 0.393 | 0.26 | 0.282 | 0.232 | 0.218 | 0.257 |

# Appendix 1: Rain fall and River Flow at the WWTP

GWRC recorded rain fall at the WWTP monitoring site for February 2015




GWRC recorded River flow in the Waikanae River at the WWTP monitoring site for February 2015



# Small Coastal Streams Monthly Data: Report - March 2015

Kapiti Water Supply: RRwGW Scheme
Prepared for Kapiti Coast District Council

14 April 2015

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| Reviewed by: | Dr Vaughan Keesing<br>Senior Principal Senior Ecologist<br>Boffa Miskell Limited | |
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*Cover photograph:* Lower Hadfield/kowhai stream, Peka Peka 

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# 1 Introduction

Monthly reports are required by the Small Coastal Streams (SCS) Baseline Aquatic Monitoring Plan (BMP 27th May 2014) to establish the collection of the data for the SCS monitoring programme during the baseline period.

Data are collected from the following sites:

1. Kowhai Stream
2. Hadfield Stream
3. Paetawa Stream
4. Kakariki Stream
5. Ngarara stream
6. Upper Muaupoko Stream
7. Lower Muaupoko Stream

The parameters collected are:

- Groundwater level,
- in-stream water level (depth),
- in-stream dissolved oxygen level,
- in-stream temperature,
- monthly conductivity measure, and
- monthly in-stream cross sectional depth profiles

The following reports on the month of March data collection.  Rather than attach all of the data for each logger, graphs of the parameters and a summary of the statistics is presented here. These summary results include the Telemetered site data from the Kowhai and Upper Muaupoko Streams.

Appendix 1 presents the rain fall and Waikanae River flows as collected by Greater Wellington Regional Council at the Waikanae Waste Water Treatment Plant (WWTP) monitoring station, as an indication of rain fall and general river flow patterns through the monitoring month.

# 2 Results

## 2.1 Kowhai

Table 1is a set of March 2015 summary statistics for the Kowhai Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-1), in-stream depth (Figure 2-2), in-stream dissolved oxygen (Figure 2-3), and water temperature (Figure 2-4).

*Table 1: Summary statistics for the Kowhai Stream – March 2015*

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 8955.00 | 50.00 | 8.74 | 18.36 |
| *Median* | 8935.12 | 50.00 | 7.60 | 16.00 |
| *Standard Deviation* | 30.52 | 7.30 | 1.91 | 2.40 |
| *Minimum* | 8847.36 | 50.00 | 0.01 | 4.60 |
| *Maximum* | 9080.04 | 147.81 | 12.21 | 26.27 |
| *Count* | 2162.00 | 2162.00 | 2153.00 | 2162.00 |

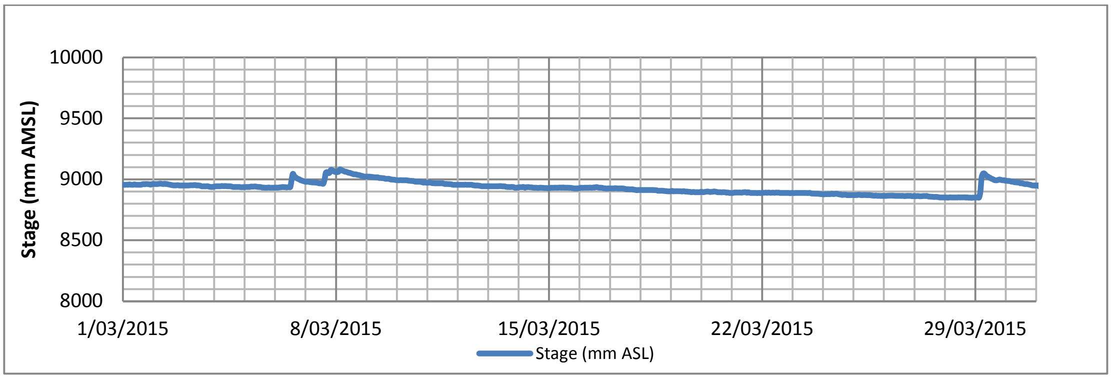


*Figure 2-1: Groundwater level next to the Kowhai Stream, measured in 15 minute intervals for the month of March 2015: Note Y-axis starts at 8000 mm AMSL.*

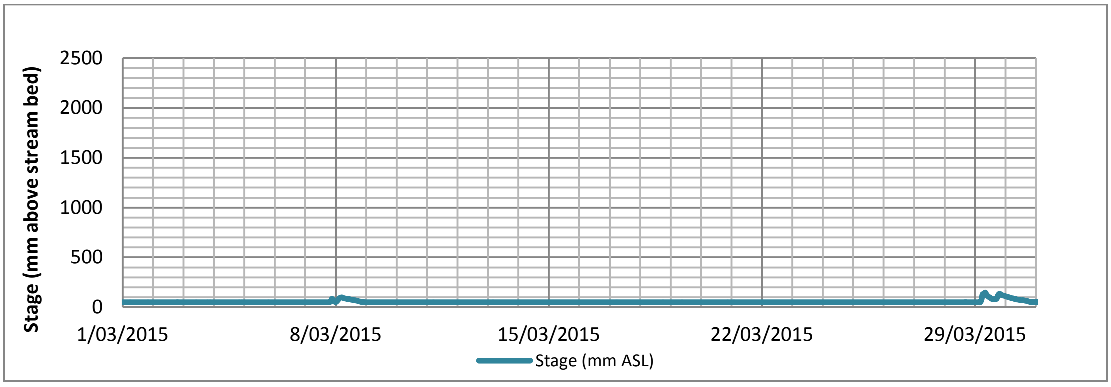


*Figure 2-2: Stream depth in the Kowhai Stream, measured in 15 minute intervals for the month of March 2015*

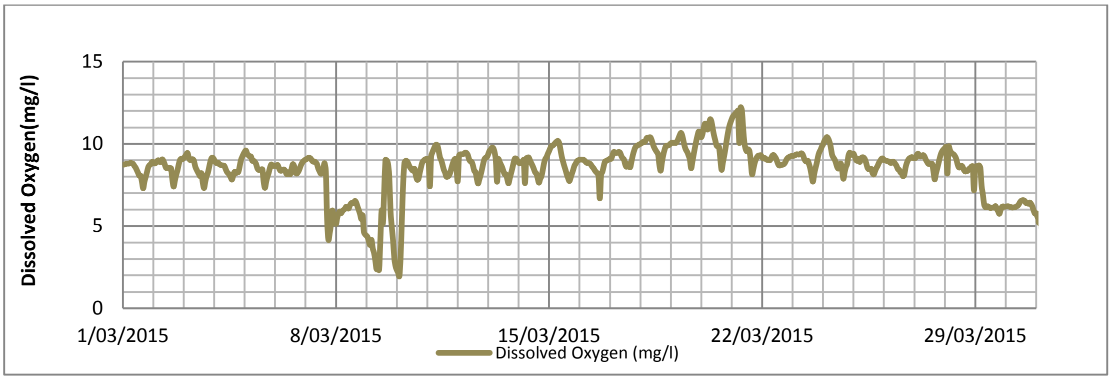


*Figure 2-3: Dissolved oxygen in the Kowhai Stream, measured in 15 minute intervals for the month of March 2015*

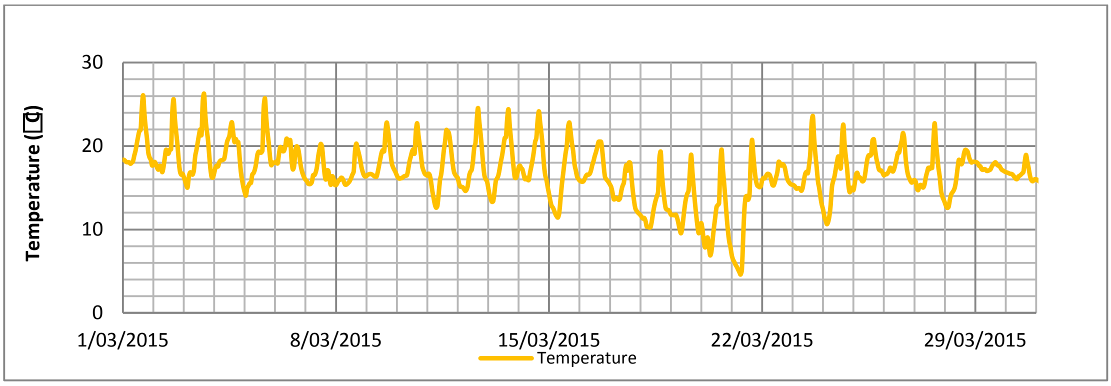


*Figure 2-4: Water temperature in the Kowhai Stream, measured every 15 minutes during March 2015*

## 2.2 Hadfield

Table 2is a set of March 2015 summary statistics for the Hadfield Stream. The four figures that follow the table summarise the logged data for groundwater level (*Figure 2-5*), in-stream depth (*Figure 2-6*), in-stream dissolved oxygen (Figure 2-7) and water temperature (Figure 2-8).

*Table 2: Summary statistics for Hadfield Stream - March 2015*

| | *Groundwater level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 2156.12 | 645.37 | 3.42 | 17.14 |
| *Median* | 2152.00 | 640.00 | 3.10 | 17.15 |
| *Standard Deviation* | 48.66 | 47.17 | 1.70 | 1.70 |
| *Minimum* | 2073.00 | 578.00 | -0.01 | 11.64 |
| *Maximum* | 2289.00 | 794.00 | 8.50 | 20.97 |
| *Count* | 2975.00 | 2975.00 | 2975.00 | 2975.00 |

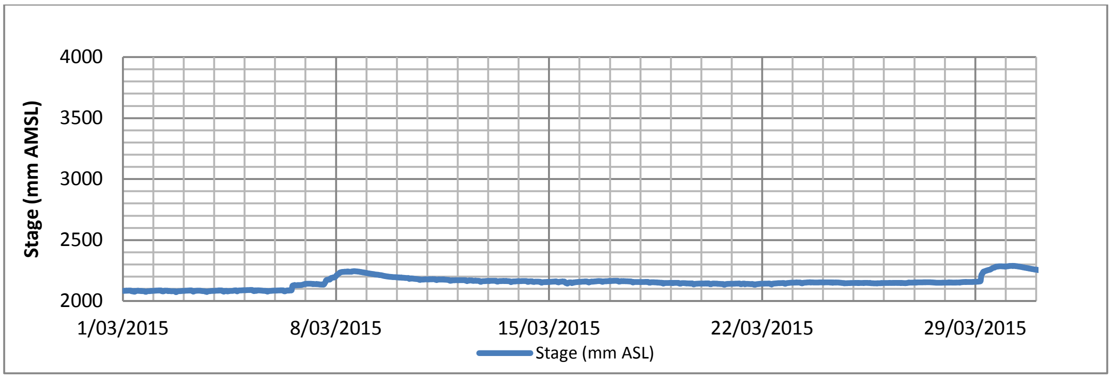


Figure 2-5: Groundwater level next to the Hadfield Stream, *measured in 15 minute intervals for the month of March 2015. Note Y-axis starts at 2000 mm AMSL.*

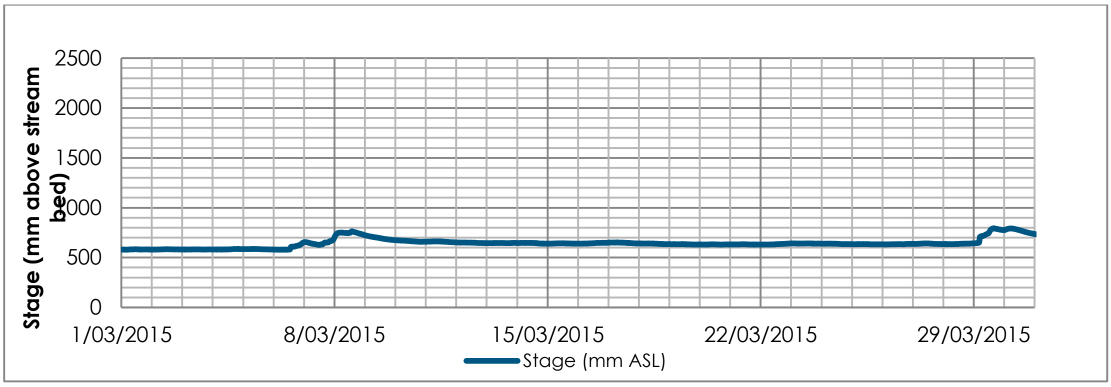


Figure 2-6: In-stream depth in the Hadfield Stream, *measured in 15 minute intervals for the month of March* 2015

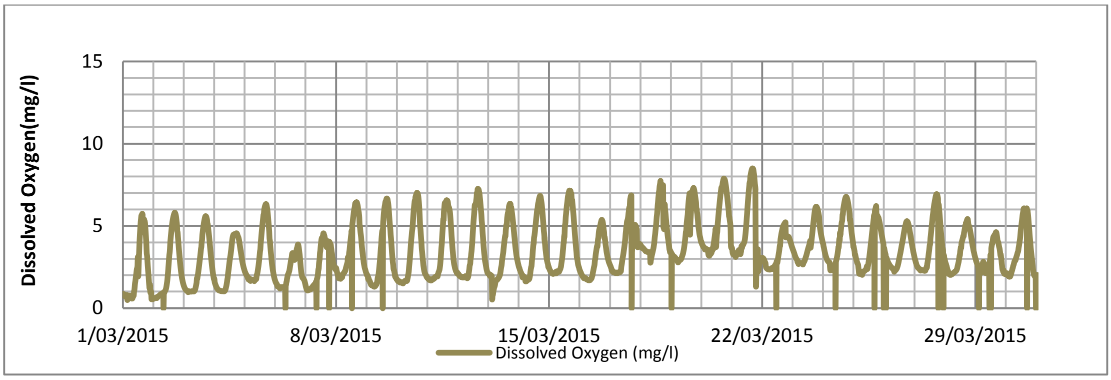


*Figure 2-7: In-stream dissolved oxygen in the Hadfield Stream, measured in 15 minute intervals for the month of March 2015*

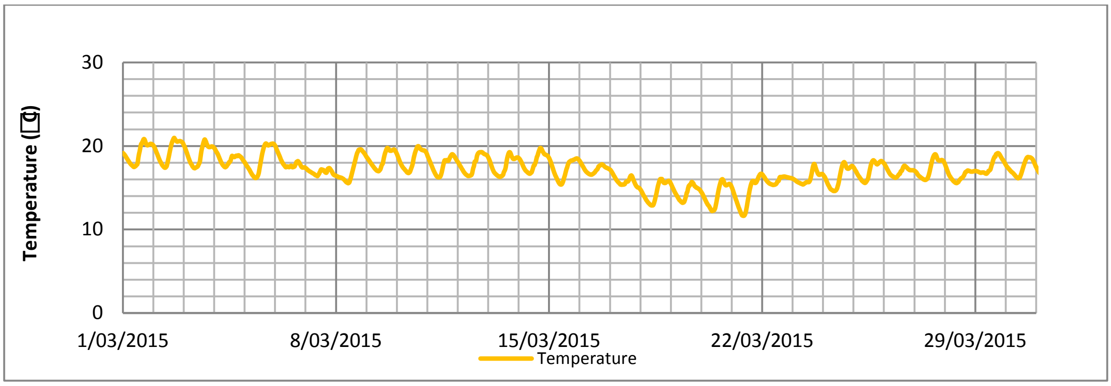


*Figure 2-8: Water temperature in the Hadfield Stream, measured every 15 minutes during March 2015*

## 2.3 Paetawa

Table 3is a set of March 2015 summary statistics for the Paetawa. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-9), in-stream depth (Figure 2-10), in-stream dissolved oxygen (Figure 2-11), and water temperature (Figure 2-12).

*Table 3: Summary statistics for the Paetawa Stream – March 2015*

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 6700.40 | 68.27 | 5.06 | 16.80 |
| *Median* | 6670.00 | 44.00 | 5.14 | 16.70 |
| *Standard Deviation* | 78.92 | 69.03 | 2.13 | 3.32 |
| *Minimum* | 6625.00 | 29.00 | -0.01 | 5.46 |
| *Maximum* | 7026.00 | 571.00 | 9.46 | 26.43 |
| *Count* | 2975.00 | 2975.00 | 2975.00 | 2975.00 |

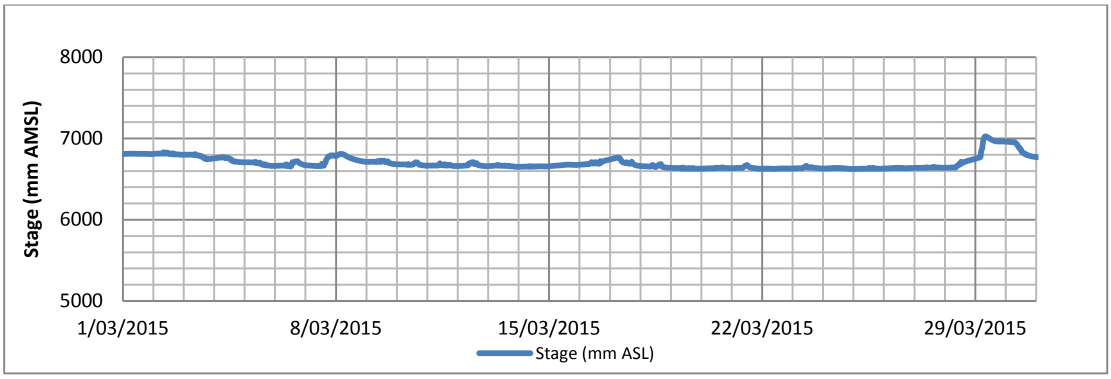


*Figure 2-9: Groundwater level next to the Paetawa Stream, measured in 15 minute intervals for the month of March 2015. Note Y-axis starts at 5000 mm AMSL.*

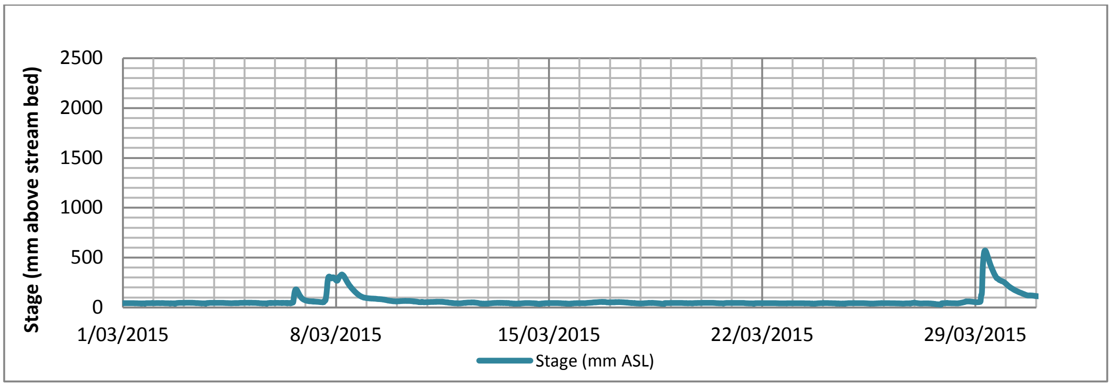


*Figure 2-10: In-stream depth in the Paetawa Stream, measured in 15 minute intervals for the month of March 2015*

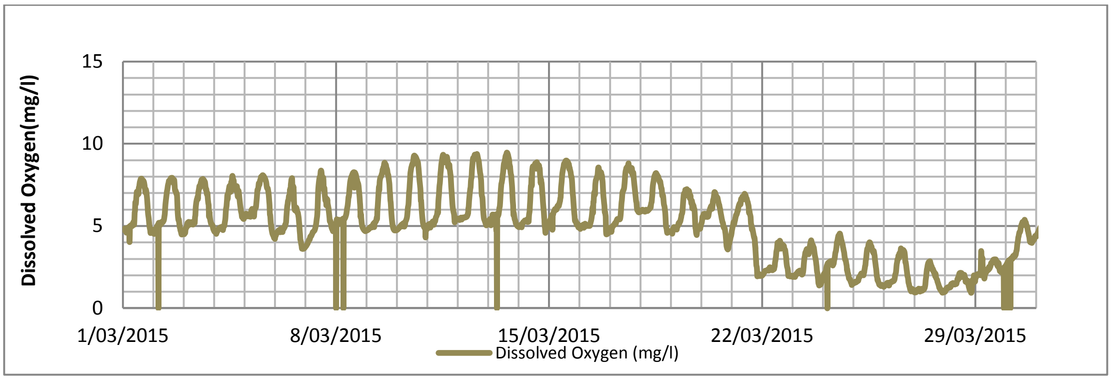


*Figure 2-11 In-stream dissolved oxygen in the Paetawa Stream, measured in 15 minute intervals for the month of March 2015*

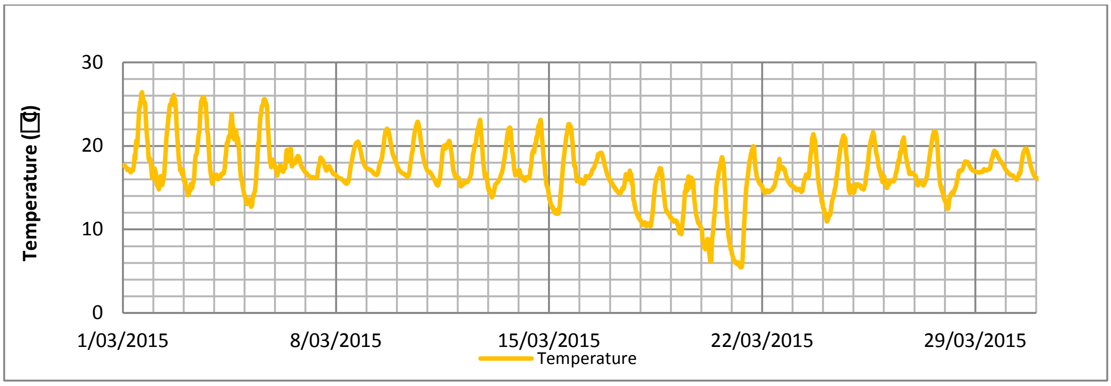


*Figure 2-12 In Stream water temperature in the Paetawa Stream, measured every 15 minutes during March 2015*

## 2.4 Kakariki

Table 4 a set of March 2015 summary statistics over the Kakariki Stream. The four figures the table summarise the logged data for groundwater level (Figure 2-13), in-stream depth (Figure 2-14), in-stream dissolved oxygen (Figure 2-15) and water temperature (Figure 2-16).

*Table 4: Summary statistics for the Kakariki Stream – March 2015*

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 6715.33 | 320.65 | 0.69 | 16.99 |
| *Median* | 6684.00 | 253.00 | 7.22 | 17.58 |
| *Standard Deviation* | 56.30 | 99.21 | 3.74 | 1.79 |
| *Minimum* | 6641.00 | 202.00 | -0.12 | 12.88 |
| *Maximum* | 6918.00 | 857.00 | 9.13 | 21.89 |
| *Count* | 2975.00 | 2975.00 | 2975.00 | 2975.00 |

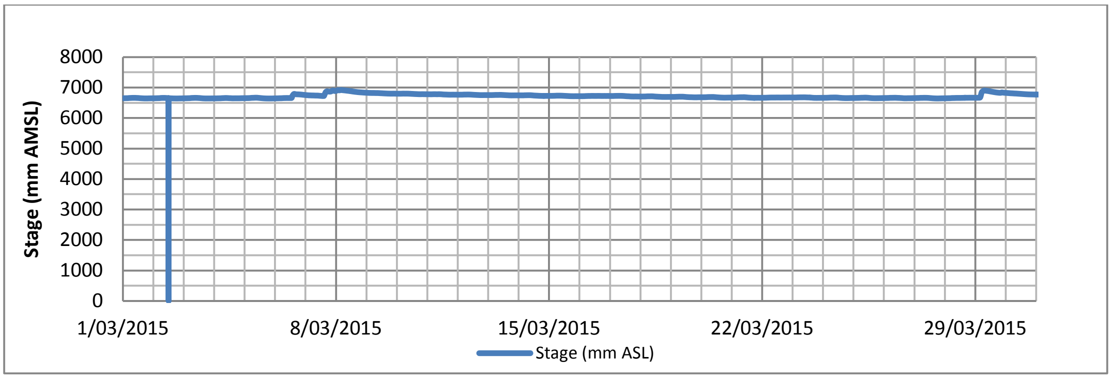


Figure 2-13: Groundwater level next to the Kakariki Stream, measured in 15 minute *intervals* for the *month* of March 2015

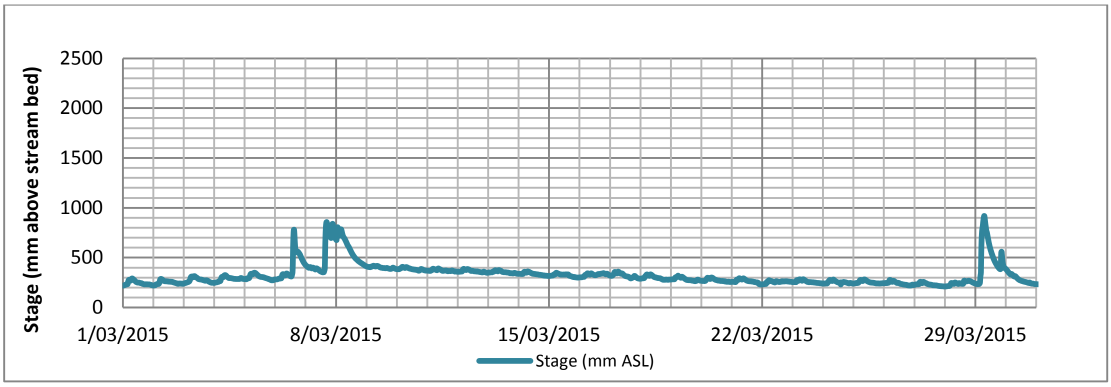


*Figure 2-14: In-stream depth in the Kakariki Stream, measured in 15 minute intervals for the month of March 2015*

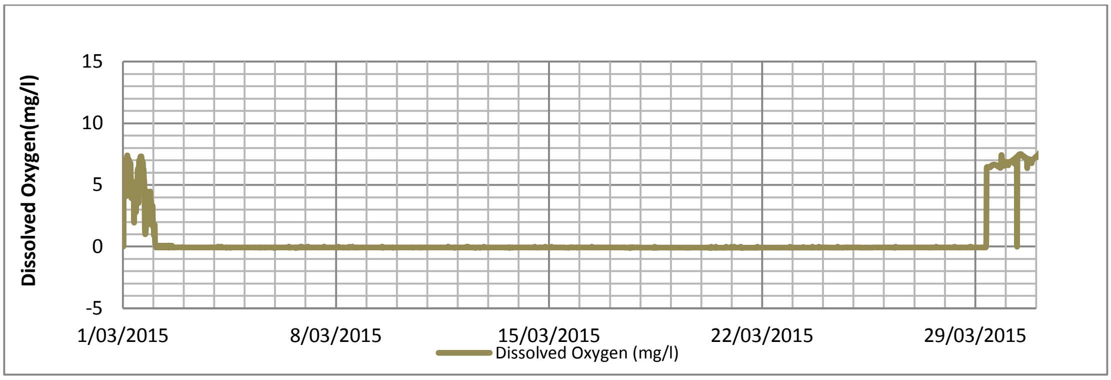


*Figure 2-15: Dissolved oxygen in the Kakariki Stream, measured in 15 minute intervals for the month of March 2015*

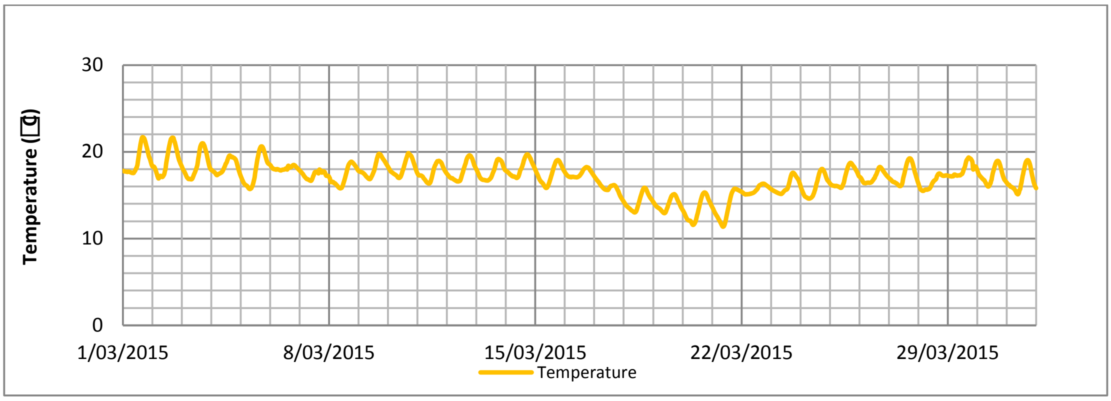


*Figure 2-16: Water temperature in the Kakariki Stream, measured every 15 minutes during March 2015*

## 2.5 Ngarara

Table 5 is a set of March 2015 summary statistics for the Ngarara Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-17), in-stream depth (Figure 2-18), in-stream dissolved oxygen (Figure 2-19) and water temperature (Figure 2-20).

Table 5: *Summary statistics for the Ngarara Stream– March 2015*

| | *Groundwater level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 3014.77 | 795.73 | 6.08 | 16.63 |
| *Median* | 3004.00 | 764.00 | 6.36 | 16.85 |
| *Standard Deviation* | 62.59 | 89.37 | 1.48 | 1.71 |
| *Minimum* | 2937.00 | 737.00 | -0.01 | 10.90 |
| *Maximum* | 3213.00 | 1277.00 | 8.48 | 20.65 |
| *Count* | 2976.00 | 2976.00 | 2976.00 | 2976.00 |

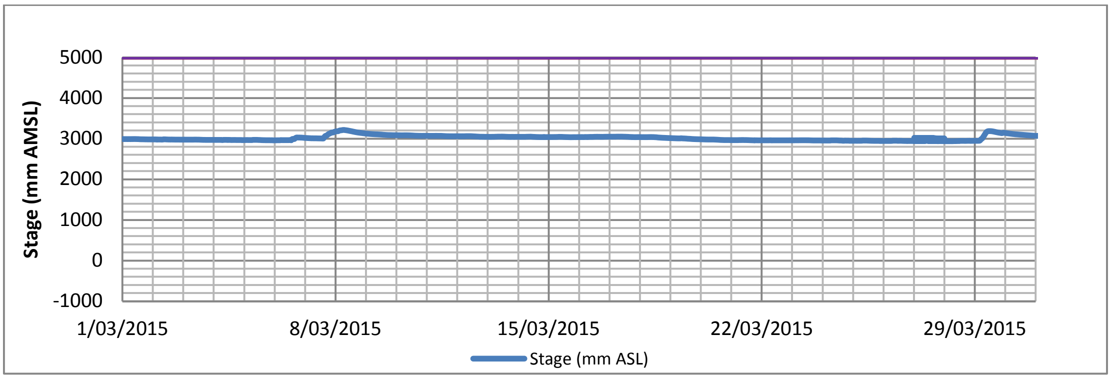


*Figure 2-17: Groundwater level* next to the *Ngarara Stream, measured in 15 minute intervals for the month of March 2015*

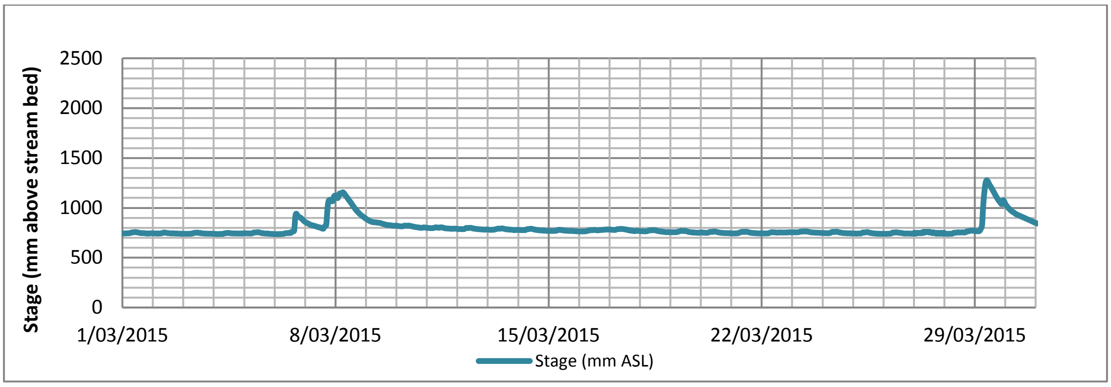


*Figure 2-18: In stream depth in the Ngarara Stream, measured in 15 minute intervals for the month of March 2015*

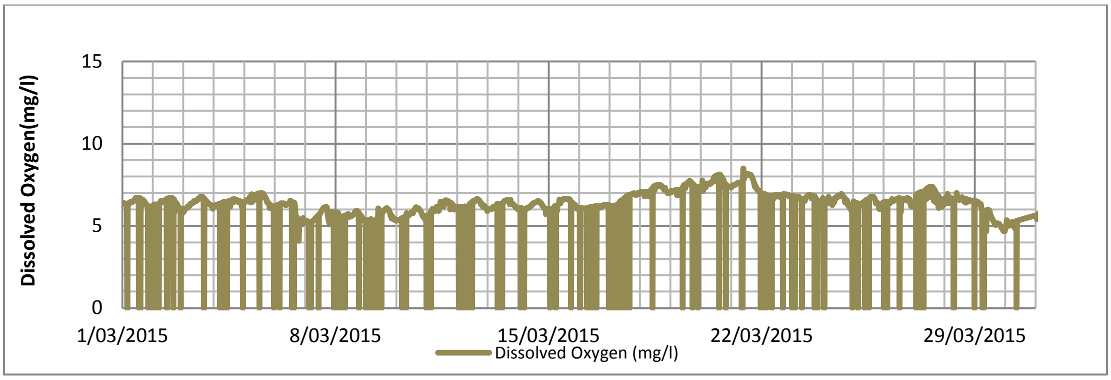


*Figure 2-19: Dissolved oxygen in the Ngarara Stream, measured in 15 minute intervals for the month of March 2015*

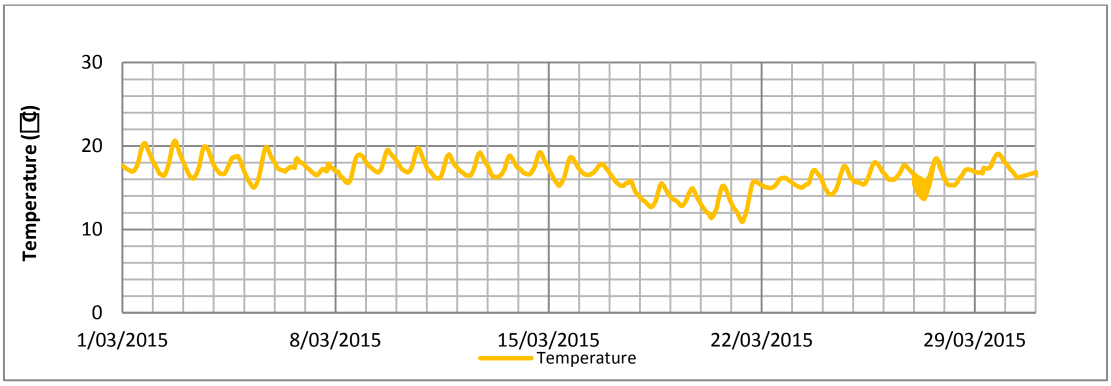


*Figure 2-20: Water temperature in the Ngarara Stream, measured every 15 minutes during March 2015*

## 2.6 Upper Muaupoko

Table 6 is a set of March 2015 summary statistics for the Upper Muaupoko Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-21), in-stream depth (Figure 2-22), in-stream dissolved oxygen (Figure 2-23), and water temperature (Figure 2-24).

*Table 6: Summary statistics for the Upper Muaupoko Stream – March 2015*

| | *Groundwater Level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 14251.78 | 472.19 | 7.29 | 17.07 |
| *Median* | 14234.07 | 450.00 | 9.14 | 16.91 |
| *Standard Deviation* | 86.61 | 113.02 | 1.25 | 3.08 |
| *Minimum* | 11086.23 | 30.00 | 6.54 | 0.99 |
| *Maximum* | 15068.00 | 2980.95 | 11.84 | 23.52 |
| *Count* | 10776.00 | 10776.00 | 10763.00 | 10776.00 |

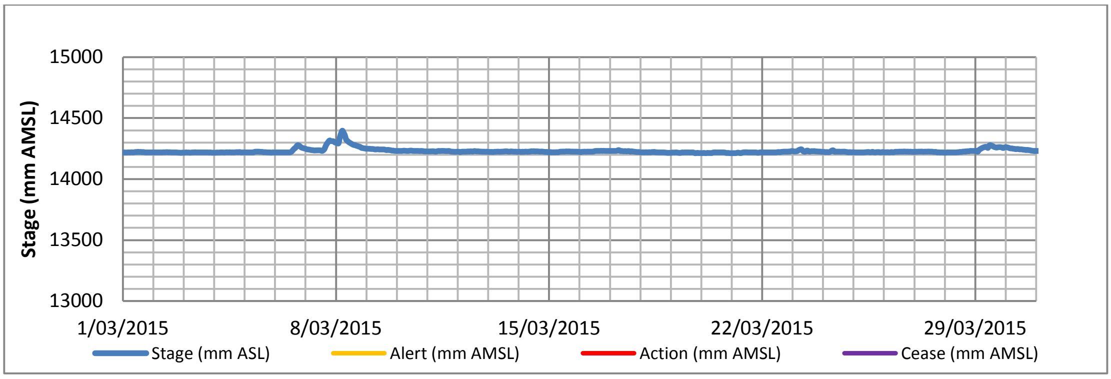


*Figure 2-21 : Groundwater level next to the Upper Muaupoko Stream, measured in 15 minute intervals for the month of March 2015*

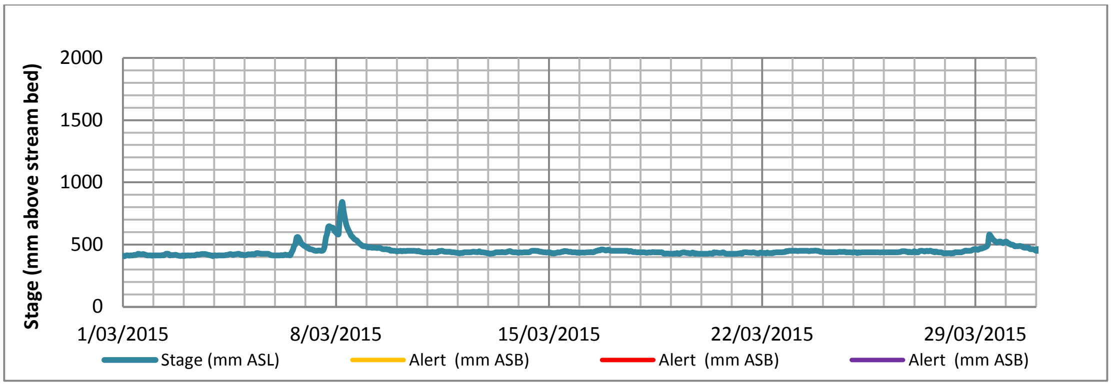


*Figure 2-22 : In-stream depth in the Upper Muaupoko Stream, measured in 15 minute intervals for the month of March 2015*

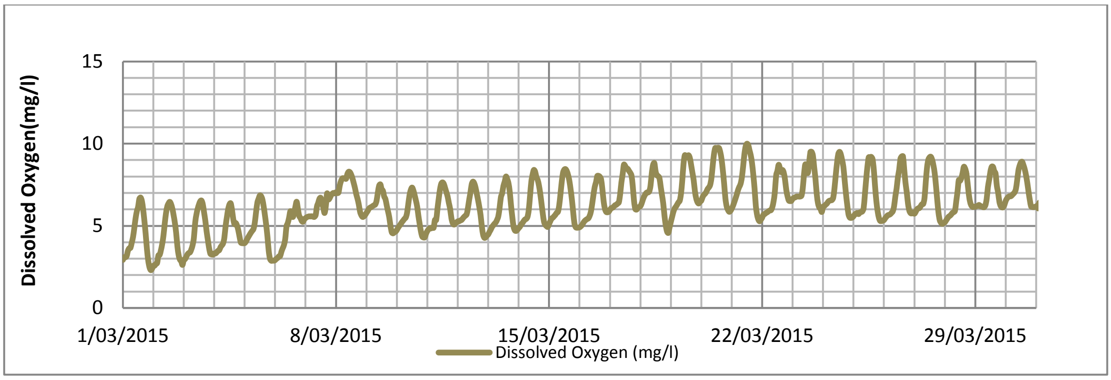


*Figure 2-23 : Dissolved oxygen in the Upper Muaupoko Stream, measured in 15 minute intervals for the month of March 2015*

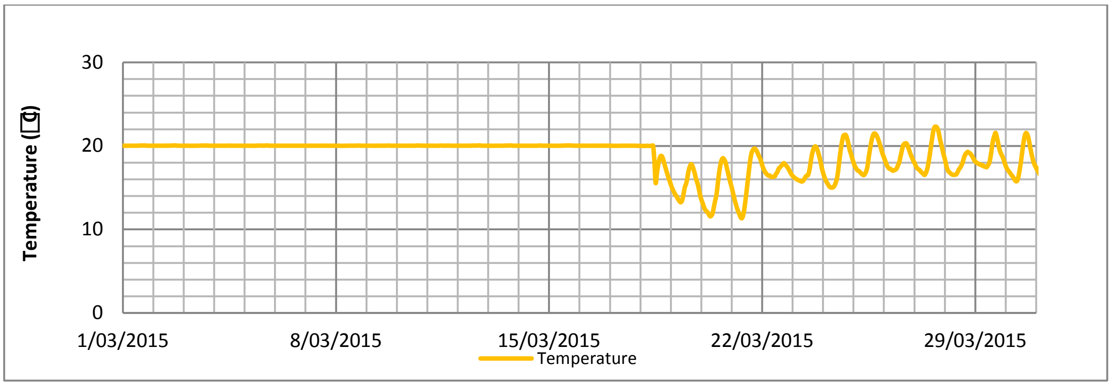


*Figure 2-2-24: Water temperature in the Upper Muaupoko Stream, measured every 15 minutes during March 2015*

## 2.7 Lower Muaupoko

Table 7is a set of March 2015 summary statistics for the lower Muaupoko Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-25), in-stream depth (Figure 2-26), in-stream dissolved oxygen (Figure 2-27) and water temperature (Figure 2-28).

*Table 7: Summary statistics for the lower Muaupoko Stream – March 2015*

| | *Groundwater Level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 5421.03 | 242.97 | 7.45 | 16.79 |
| *Median* | 5422.00 | 239.00 | 7.38 | 16.87 |
| *Standard Deviation* | 15.72 | 13.88 | 1.08 | 2.08 |
| *Minimum* | 5396.00 | 231.00 | 0.00 | 10.61 |
| *Maximum* | 5490.00 | 381.00 | 11.06 | 24.00 |
| *Count* | 2977.00 | 2977.00 | 2977.00 | 2977.00 |

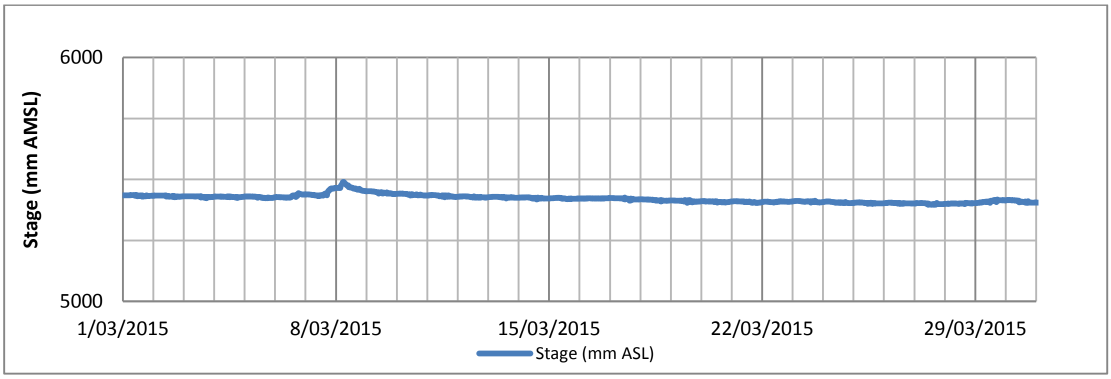


*Figure 2-25: Groundwater level* next to the *Lower Muaupoko, measured in 15 minute intervals for the month of March 2015*

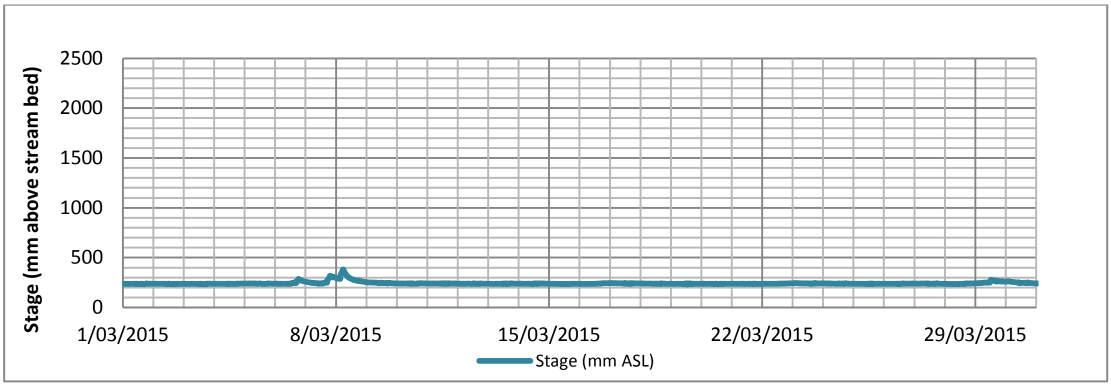


*Figure 2-26: In-stream depth in the Lower Muaupoko, measured in 15 minute intervals for the month of March 2015*

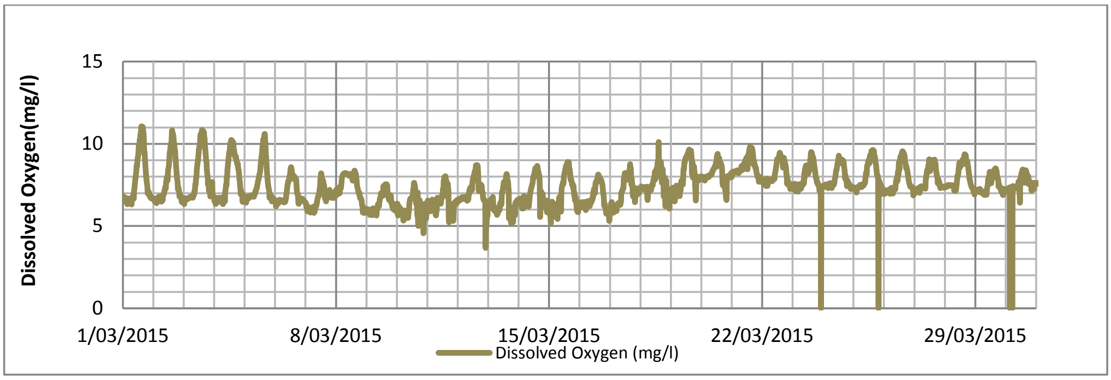


*Figure 2-27: Dissolved oxygen in the Lower Muaupoko, measured in 15 minute intervals for the month of March 2015*

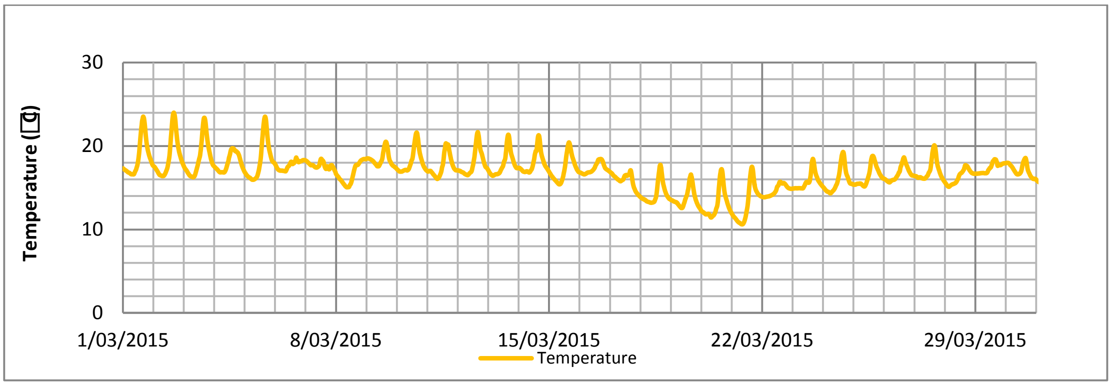


*Figure 2-28: Water temperature in the lower Muaupoko Stream, measured every 15 minutes during March 2015*

## 2.8 Conductivity

Table 8 below details the conductivity results of the March measures averaged from five measurements, at each site.

*Table 8 Averaged conductivity measurements at each site.*

| **Date** | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 |
|---|---|---|---|---|---|---|
| **Site** | Hadfield | Paetawa | Ngarara | Kakariki | Upper Muaupoko | Lower Muaupoko |
| **Conductivity (mS/cm)** | 0.374 | 0.2592 | 0.3165 | 0.2745 | 0.2596 | 0.2598 |

## 2.9 Cross sectional depth profiles

Table 9 provides the cross sectional (wetted width) depth measurements. Note that these measurements are one off and taken at the turn of the new month and may show little resemblance to the months averages as measured by the pressure inducer.

*Table 9: Cross section depth measures (Xsect A, 0m upstream, Xsect B, 25m downstream, section C, 50m downstream). And averaged water conductivity (and pH) for the small streams survey reaches – March 2015. Note: there was no water in the Kowhai at the time of sampling.*

| **Date** | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 | 02/03/2015 |
|---|---|---|---|---|---|---|
| **Site** | Hadfield | Paetawa | Ngarara | Kakariki | Upper Muaupoko | Lower Muaupoko |
| **Wetted width @ piezo** | 232 | 160 | 230 | 140 | 183 | 170 |
| **A1** | 8 | 24 | 16 | 2 | 4.5 | 14 |
| **A2** | 28 | 23.5 | 65 | 2 | 4.5 | 15 |
| **A3** | 47 | 21 | 63 | 4 | 9 | 19 |
| **A4** | 59 | 23 | 64 | 7 | 11 | 19 |
| **A5** | 45 | 17 | 50 | 12 | 13 | 16 |
| **A6** | 48 | 12.5 | 55 | 18 | 17 | 17.5 |
| **A7** | 59 | 14 | 54 | 21 | 19 | 20 |
| **A8** | 59 | 13 | 55 | 22 | 20 | 17.5 |
| **A9** | 69 | 10 | 51 | 21 | 23 | 16 |
| **A10** | 73 | 8 | 40 | 16 | 23.5 | 20 |
| **A11** | 71 | 6 | 43 | 3 | 24 | 12 |
| **A12** | 81 | 3 | 34 | 8 | 17 | 14.5 |
| **A13** | 90 | 1 | 25 | 13 | 9 | 12 |
| **A14** | 85 | 4 | 28 | | 10 | 9 |
| **A15** | 87 | 3 | 15 | | 12 | 6 |
| **A16** | 72 | | 14 | | 23 | 2 |
| **A17** | 65 | | 22 | | 13 | |
| **A18** | 43 | | 18 | | | |
| **A19** | 45 | | 10 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **A20** | 45 | | 13 | | | |
| **A21** | 22 | | 8 | | | |
| **A22** | 5 | | | | | |
| **Wetted width @B** | 240 | 150 | 220 | 80 | 85 | 200 |
| **B1** | 10 | 23 | 20 | 2 | 8 | 7 |
| **B2** | 22 | 25 | 24 | 10 | 7 | 9 |
| **B3** | 37 | 28 | 28 | 18 | 15 | 8 |
| **B4** | 47 | 29 | 30 | 24 | 17 | 9 |
| **B5** | 52 | 30 | 38 | 25 | 19.5 | 10 |
| **B6** | 54 | 32 | 41 | 23 | 18 | 12 |
| **B7** | 55 | 33 | 42 | 22 | 21 | 12 |
| **B8** | 56 | 31 | 43 | 19 | | 13 |
| **B9** | 53 | 29 | 45 | | | 15 |
| **B10** | 53 | 27 | 49 | | | 16 |
| **B11** | 53 | 24 | 57 | | | 16.5 |
| **B12** | 52.5 | 22 | 58 | | | 18 |
| **B13** | 53 | 18 | 59 | | | 20 |
| **B14** | 54 | 12 | 49 | | | 22 |
| **B15** | 53 | | 51 | | | 19.5 |
| **B16** | 56 | | 44 | | | 23 |
| **B17** | 55 | | 38 | | | 22 |
| **B18** | 55 | | 30 | | | 22 |
| **B19** | 50 | | 28 | | | 6 |
| **B20** | 36 | | 22 | | | |
| **B21** | 23 | | 18 | | | |
| **B22** | 17 | | 14 | | | |
| **B23** | 9 | | | | | |
| **Wetted width @ C** | 235 | 130 | 260 | 80 | 81 | 130 |
| **C1** | 36 | 6 | 7 | 2 | 8 | 6 |
| **C2** | 34.5 | 16 | 13 | 10 | 9.5 | 6 |
| **C3** | 37 | 26 | 19 | 18 | 13 | 7 |
| **C4** | 42 | 30 | 24 | 24 | 16 | 7 |
| **C5** | 41 | 30 | 28 | 25 | 15.5 | 5.5 |
| **C6** | 53 | 27 | 30.5 | 23 | 16 | 6 |
| **C7** | 54.5 | 23 | 30 | 22 | 13 | 5.5 |
| **C8** | 53.5 | 19 | 30 | 19 | | 5 |
| **C9** | 50 | 18 | 33 | | | 5 |
| **C10** | 49 | 13 | 38 | | | 3 |
| **C11** | 48 | | 45 | | | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **C12** | 49 | | 35 | | | 2 |
| **C13** | 47.5 | | 36 | | | |
| **C14** | 48 | | 42 | | | |
| **C15** | 48 | | 47 | | | |
| **C16** | 50 | | 48 | | | |
| **C17** | 49.5 | | 47 | | | |
| **C18** | 46 | | 41 | | | |
| **C19** | 47 | | 40 | | | |
| **C20** | 50 | | 40 | | | |
| **C21** | 53 | | 38 | | | |
| **C22** | 26 | | 36 | | | |
| **C23** | 6 | | 34 | | | |
| **C24** | | | 27 | | | |
| **C25** | | | 20 | | | |

# Appendix 1: Rain fall and River Flow at the WWTP

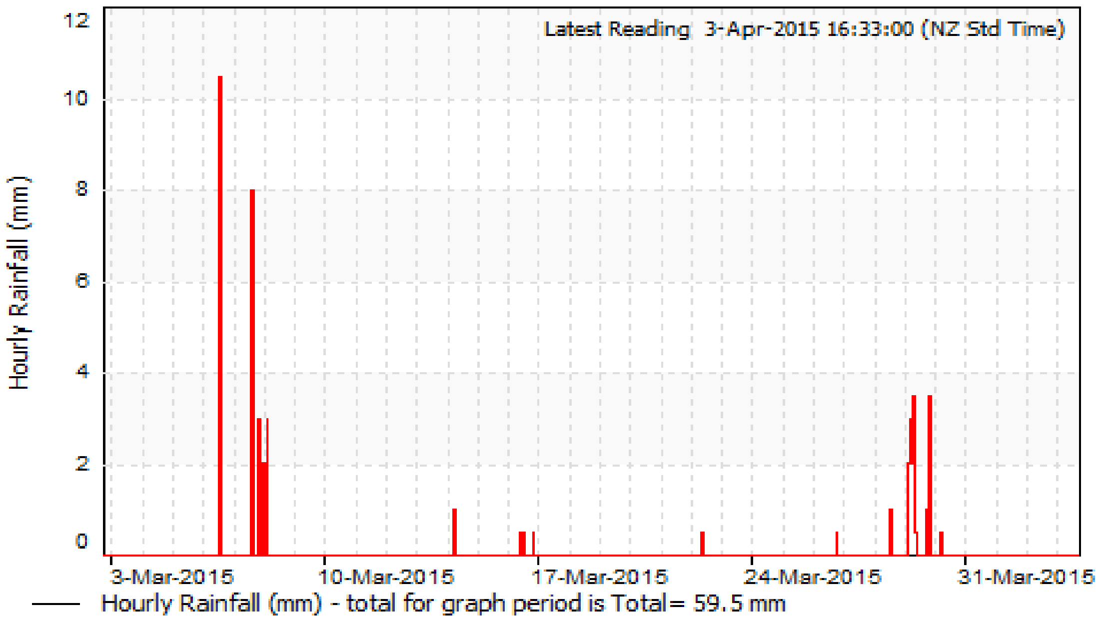


*Figure 2-29: GWRC recorded rain fall at the WWTP monitoring site for March 2015*

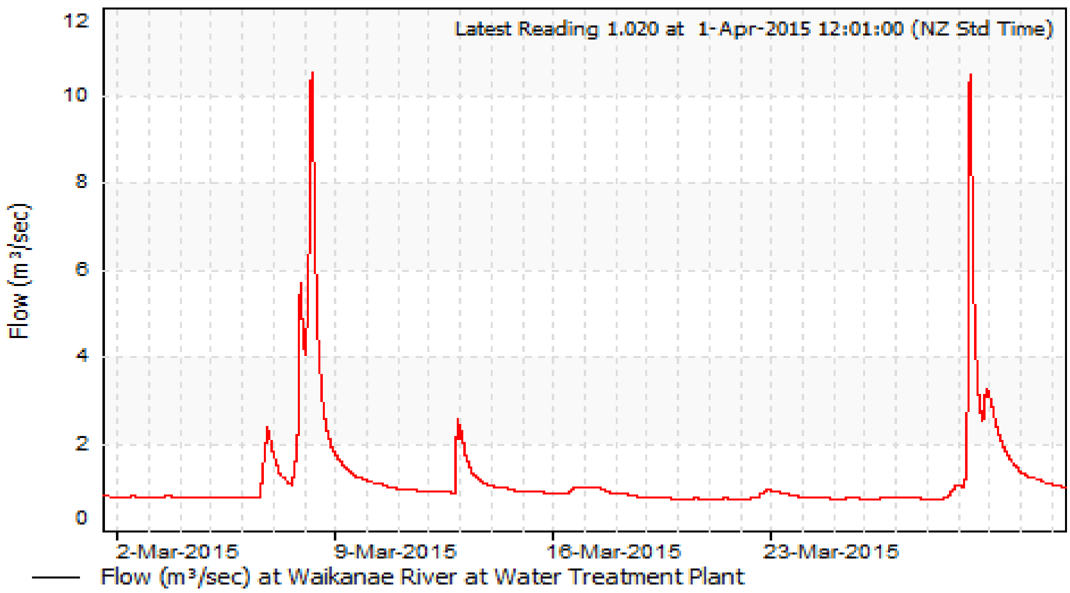


*Figure 2-30: GWRC recorded River flow in the Waikanae River at the WWTP monitoring site for March 2015*

# Small Coastal Streams Monthly Data: Report - April 2015

Kapiti Water Supply: RRwGW Scheme
Prepared for Kapiti Coast District Council

11 June 2015

# Document Quality Assurance

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| Prepared by: | Tessa Roberts<br>Ecologist<br>Boffa Miskell Limited | |
| Reviewed by: | Dr Vaughan Keesing<br>Senior Principal Senior Ecologist<br>Boffa Miskell Limited | |
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# 1 Introduction

Monthly reports are required by the Small Coastal Streams (SCS) Baseline Aquatic Monitoring Plan (BMP 27th May 2014) to establish the collection of the data for the SCS monitoring programme during the baseline period.

Data are collected from the following sites:

1. Kowhai Stream
2. Hadfield Stream
3. Paetawa Stream
4. Kakariki Stream
5. Ngarara stream
6. Upper Muaupoko Stream
7. Lower Muaupoko Stream

The data collected are:

- Groundwater level,
- in-stream water level (depth),
- in-stream dissolved oxygen level,
- in-stream temperature,
- monthly conductivity measure, and
- monthly in-stream cross sectional depth profiles

The following reports on the month of April 2015 data collection. Rather than attach all of the data for each logger, graphs of the parameters and a summary of the statistics is presented here.

These summary results include the Telemetered site data from the Kowhai and Upper Muaupoko streams.

Appendix 1 presents the rain fall and Waikanae River flows as collected by Greater Wellington Regional Council at the Waikanae Water Treatment Plant (WWTP) monitoring station, as an indication of rain fall and general river flow patterns through the monitoring month.

# 2 Results

## 2.1 Kowhai

Table 1 is a set of April 2015 summary statistics for the Kowhai Stream. The graphs show the trends for groundwater level (Figure 2-1), in-stream depth (Figure 2-2), in-stream dissolved oxygen (Figure 2-3), and water temperature (Figure 2-4).

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 8909.18 | 50.00 | 9.78 | 13.49 |
| *Median* | 9273.00 | 113.00 | 7.05 | 12.62 |
| *Standard Deviation* | 123.43 | 81.92 | 0.68 | 1.68 |
| *Minimum* | 8821.00 | 50.00 | 5.02 | 9.88 |
| *Maximum* | 9607.97 | 1081.78 | 10.65 | 23.36 |
| *Count* | 2136.00 | 2136.00 | 2136.00 | 2136.00 |

*Table 1: Summary statistics for the Kowhai Stream – April 2015*

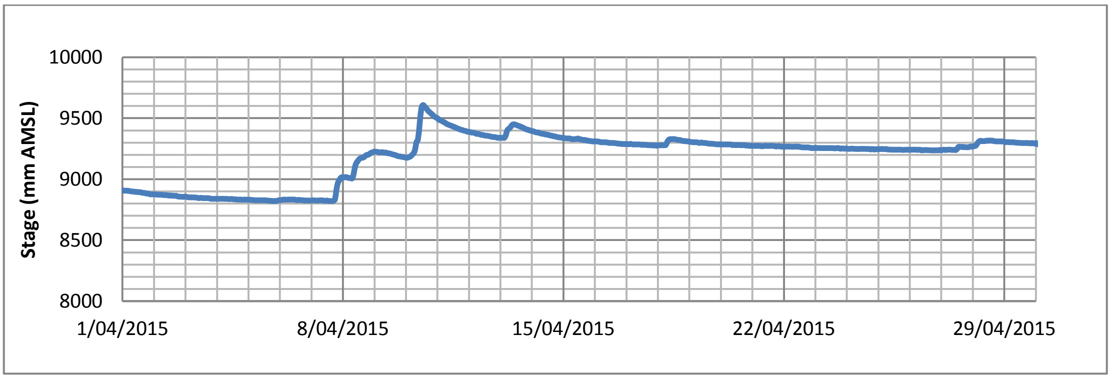


*Figure 2-1: Groundwater level next to the Kowhai Stream, measured in 15 minute intervals for the month of April 2015.* Note y axis starts at 8000.

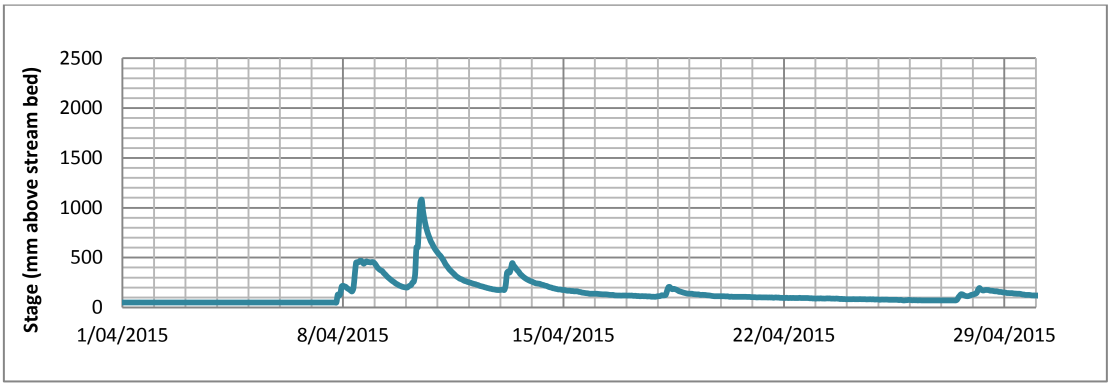


*Figure 2-2: Stream depth in the Kowhai Stream, measured in 15 minute intervals for the month of April 2015*

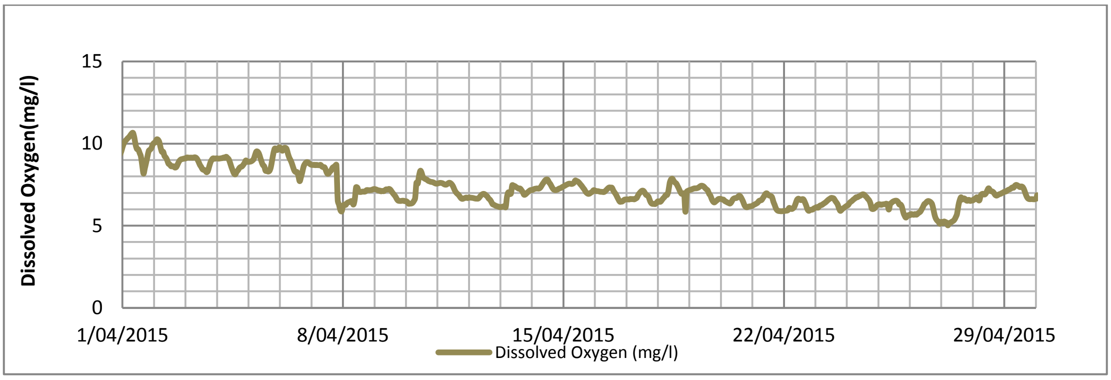


*Figure 2-3: Dissolved oxygen in the Kowhai Stream, measured in 15 minute intervals for the month of April 2015*

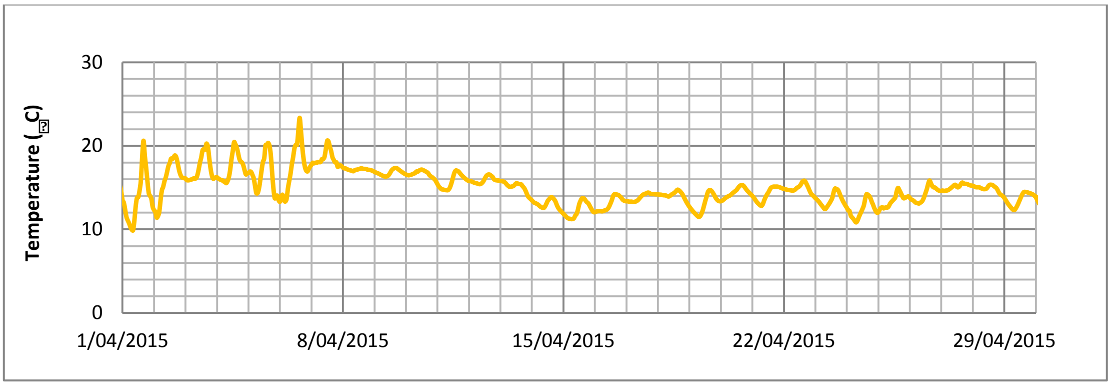


*Figure 2-4: Water temperature in the Kowhai Stream, measured every 15 minutes during April 2015*

## 2.2 Hadfield

Table 2 is a set of April 2015 summary statistics for the Hadfield Stream. The graphs summarise the logged data for groundwater level (Figure 2-5), in-stream depth (Figure 2-6), in-stream dissolved oxygen (Figure 2-7) and water temperature (Figure 2-8).

*Table 2: Summary statistics for Hadfield Stream - April 2015*

| | *Groundwater level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 2299.10 | 743.49 | 4.16 | 14.48 |
| *Median* | 2238.00 | 666.00 | 4.18 | 14.57 |
| *Standard Deviation* | 144.44 | 181.95 | 1.32 | 1.55 |
| *Minimum* | 2162.00 | 583.00 | -0.01 | 9.99 |
| *Maximum* | 2804.00 | 1396.00 | 6.77 | 17.58 |
| *Count* | 2313.00 | 2313.00 | 2313.00 | 2313.00 |

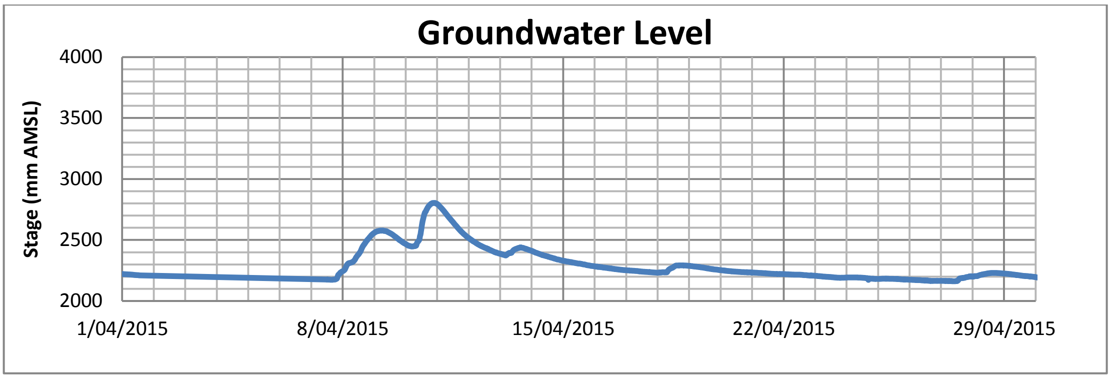


Figure 2-5: Groundwater level next to the Hadfield Stream, *measured in 15 minute intervals for the month of April 2015.* Note y axis starts at 2000.

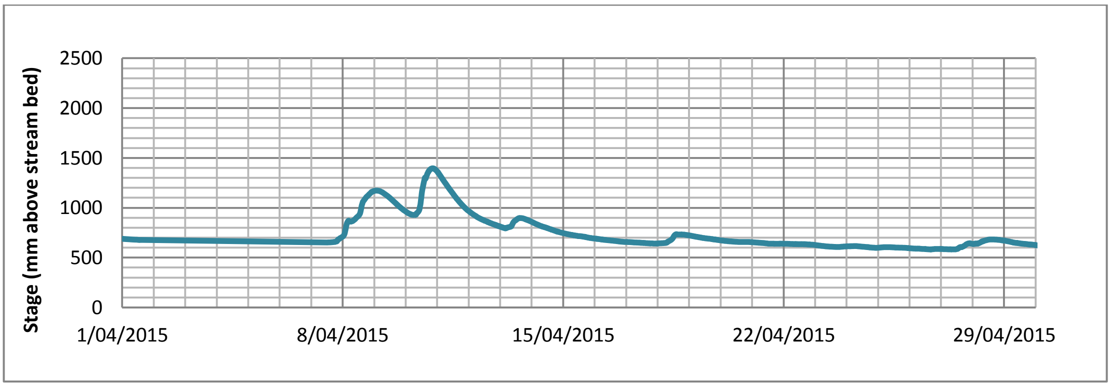


Figure 2-6: In-stream depth in the Hadfield Stream, *measured in 15 minute intervals for the month of April* 2015

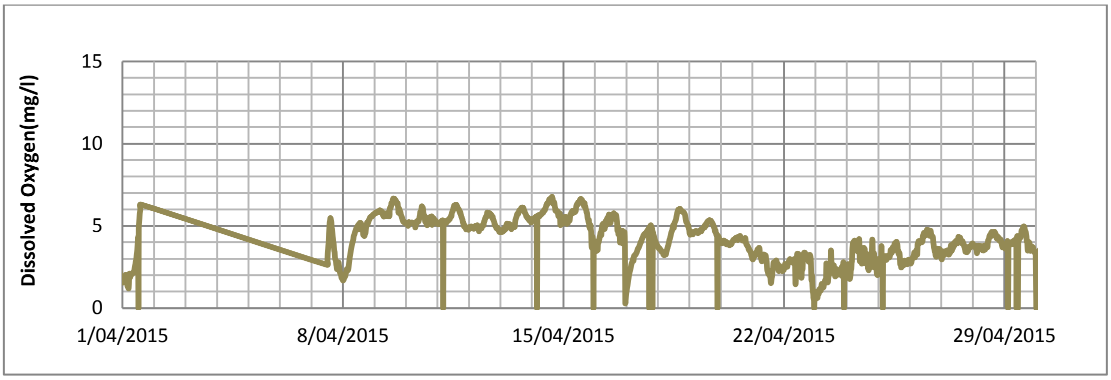


*Figure 2-7: In-stream dissolved oxygen in the Hadfield Stream, measured in 15 minute intervals for the month of April 2015*

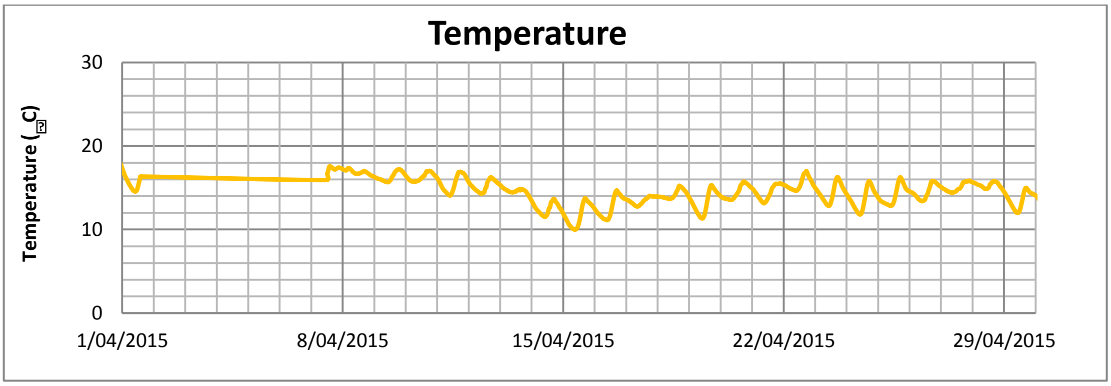


*Figure 2-8: Water temperature in the Hadfield Stream, measured every 15 minutes during April 2015*

## 2.3 Paetawa

Table 3 is a set of April 2015 summary statistics for the Paetawa. The graphs summarise the logged data for groundwater level (Figure 2-9), in-stream depth (Figure 2-10), in-stream dissolved oxygen (Figure 2-11), and water temperature (Figure 2-12).

*Table 3: Summary statistics for the Paetawa Stream – April 2015*

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 7156.24 | 395.95 | 6.21 | 14.60 |
| *Median* | 7166.00 | 324.00 | 6.16 | 14.55 |
| *Standard Deviation* | 136.46 | 209.88 | 0.72 | 1.50 |
| *Minimum* | 6739.00 | 81.00 | 4.37 | 11.02 |
| *Maximum* | 7585.00 | 1244.00 | 8.22 | 19.10 |
| *Count* | 2215.00 | 2215.00 | 2215.00 | 2215.00 |

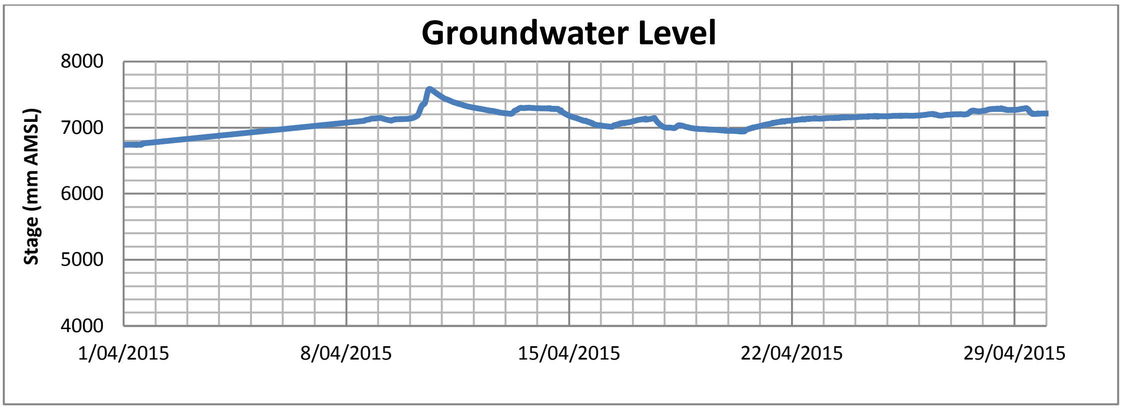


*Figure 2-9: Groundwater level* next to the *Paetawa Stream, measured in 15 minute intervals for the month of April 2015.* Note y axis starts at 4000.

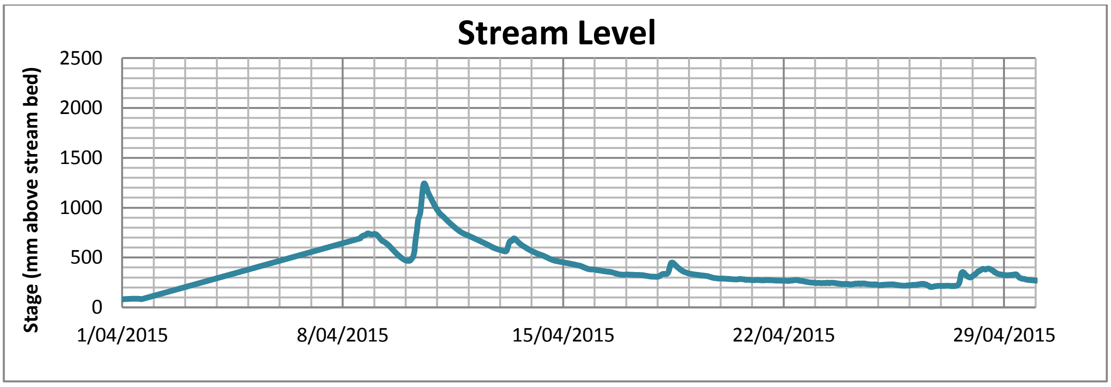


*Figure 2-10: In-stream depth in the Paetawa Stream, measured in 15 minute intervals for the month of April 2015*

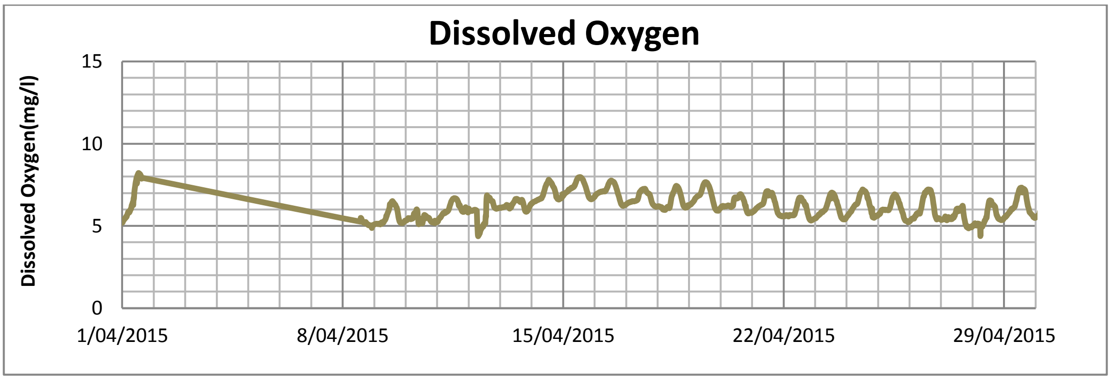


*Figure 2-11: Dissolved oxygen in the Paetawa Stream, measured in 15 minute intervals for the month of April 2015*

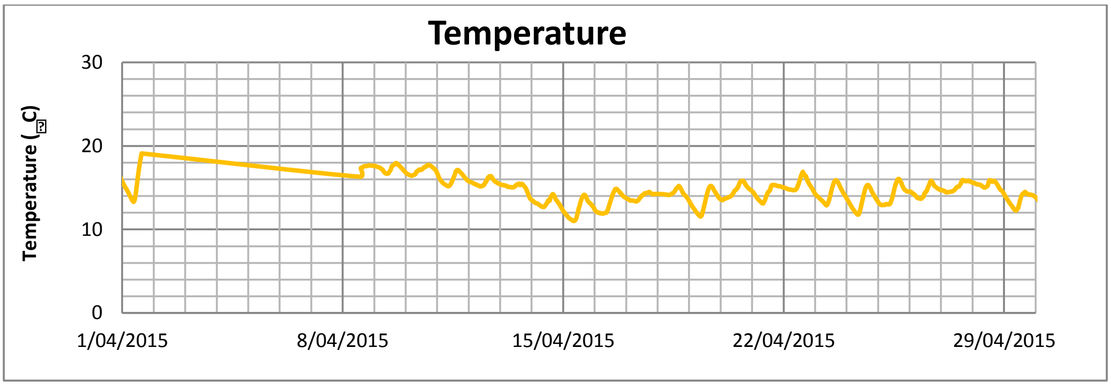


*Figure 2-12: Water temperature in the Paetawa Stream, measured every 15 minutes during April 2015*

## 2.4 Kakariki

Table 4 is a set of April 2015 summary statistics over the Kakariki Stream. The graphs summarise the logged data for groundwater level (Figure 2-13), in-stream depth (Figure 2-14), in-stream dissolved oxygen (Figure 2-15) and water temperature (Figure 2-16).

*Table 4: Summary statistics for the Kakariki Stream – April 2015*

| | *Groundwater level (mm)* | *Stream depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 6951.38 | 439.05 | 8.06 | 15.06 |
| *Median* | 6974.00 | 364.00 | 8.20 | 15.14 |
| *Standard Deviation* | 149.21 | 241.89 | 0.73 | 1.70 |
| *Minimum* | 6687.00 | 191.00 | -0.01 | 10.92 |
| *Maximum* | 7384.00 | 1587.00 | 9.52 | 18.57 |
| *Count* | 2876.00 | 2876.00 | 2876.00 | 2876.00 |

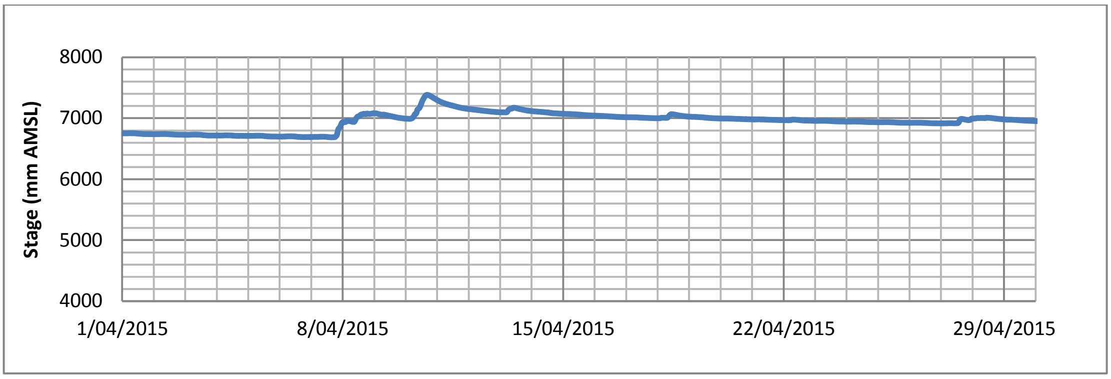


Figure 2-13: Groundwater level next to the Kakariki Stream, measured in 15 minute intervals for the month of April 2015. Note y axis starts at 4000.

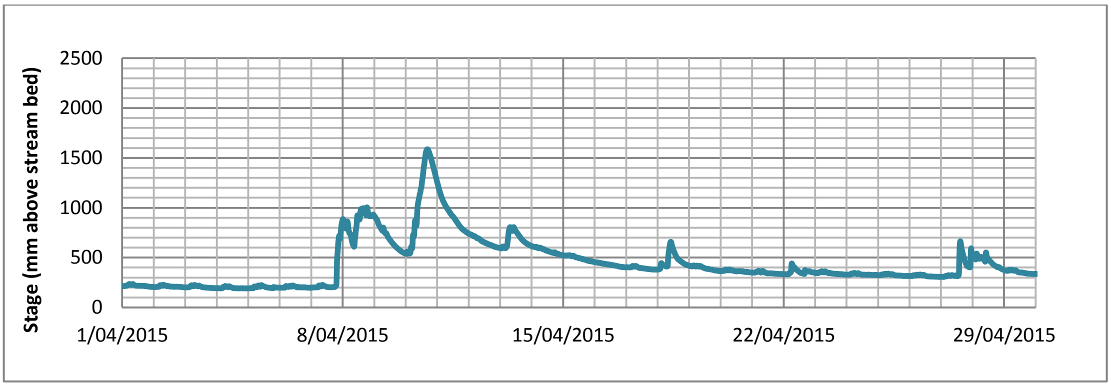


Figure 2-14*: In-stream depth in the Kakariki Stream, measured in 15 minute intervals for the month of April 2015*

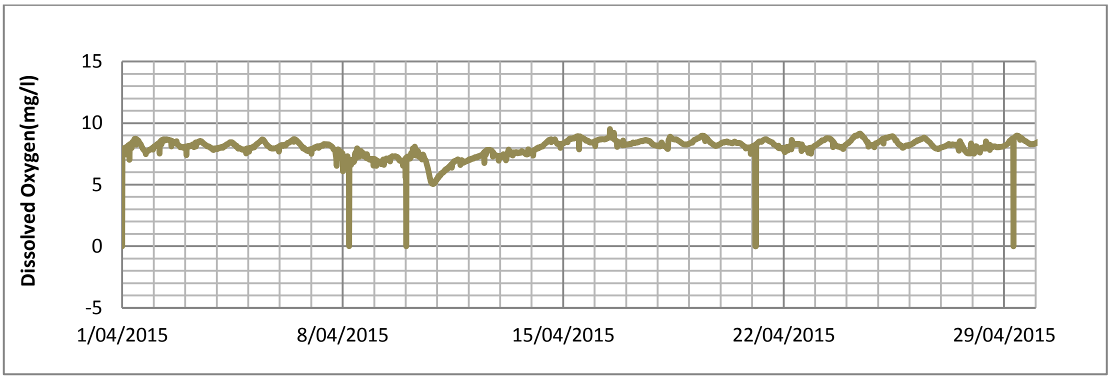


*Figure 2-15: Dissolved oxygen in the Kakariki Stream, measured in 15 minute intervals for the month of April 2015*

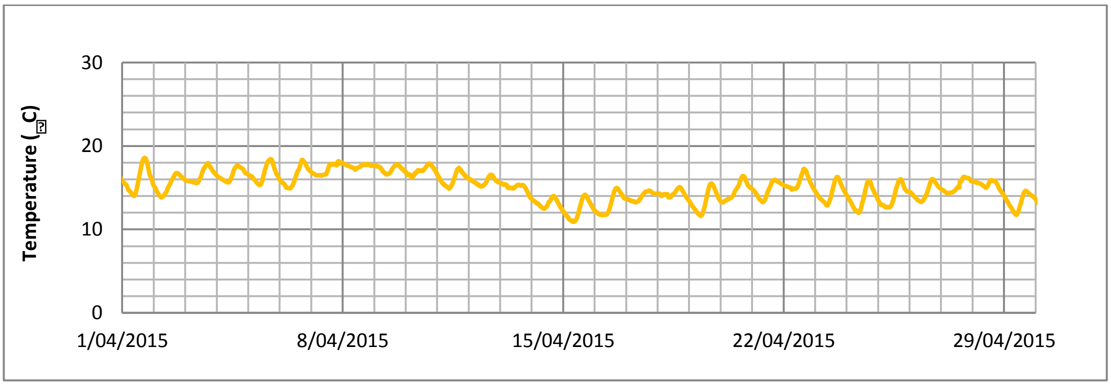


*Figure 2-16: Water temperature in the Kakariki Stream, measured every 15 minutes during April 2015*

## 2.5 Ngarara

Table 5 is a set of April 2015 summary statistics for the Ngarara Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-17), in-stream depth (Figure 2-18), in-stream dissolved oxygen (Figure 2-19) and water temperature (Figure 2-20).

*Table 5: Summary statistics for the Ngarara Stream– April 2015*

| | *Groundwater level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 3345.96 | 1133.15 | 5.76 | 15.02 |
| *Median* | 3336.00 | 1069.00 | 5.82 | 15.14 |
| *Standard Deviation* | 247.81 | 307.92 | 0.76 | 1.60 |
| *Minimum* | 2958.00 | 769.00 | -0.01 | 10.91 |
| *Maximum* | 4168.00 | 2313.00 | 7.72 | 17.98 |
| *Count* | 2876.00 | 2876.00 | 2876.00 | 2876.00 |

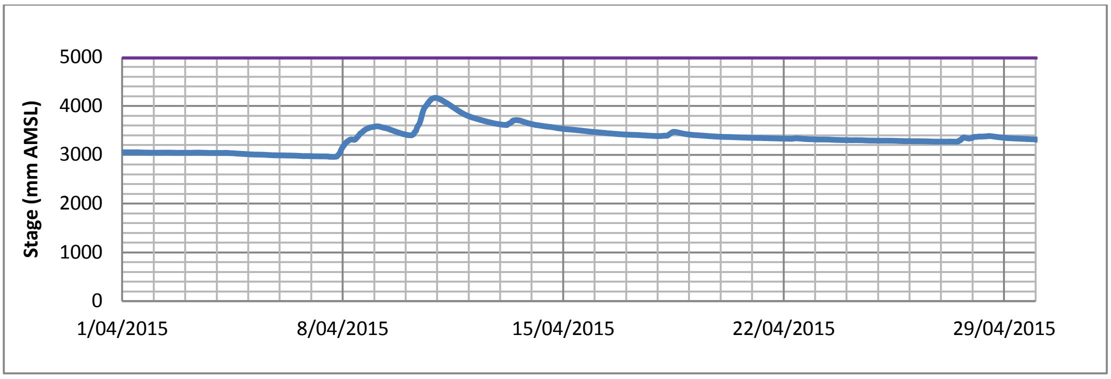


*Figure 2-17: Groundwater level next to the Ngarara Stream, measured in 15 minute intervals for the month of April 2015.*

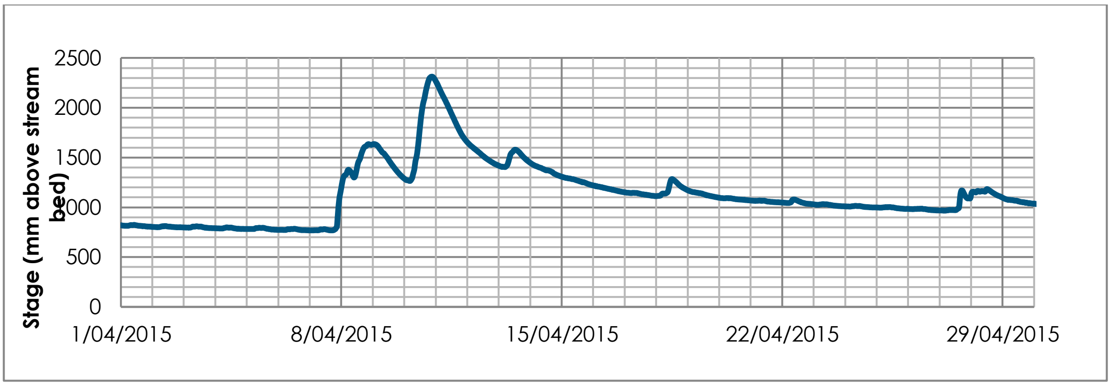


*Figure 2-18: In stream depth in the Ngarara Stream, measured in 15 minute intervals for the month of April 2015*

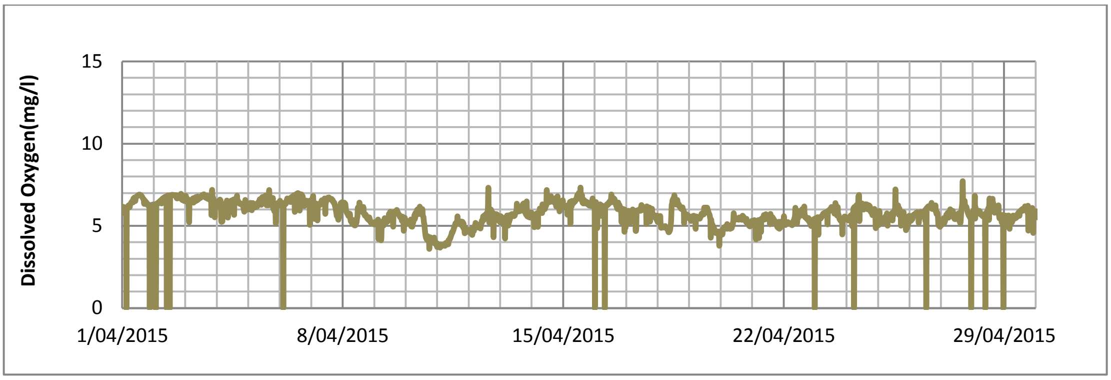


*Figure 2-19: Dissolved oxygen in the Ngarara Stream, measured in 15 minute intervals for the month of April 2015*

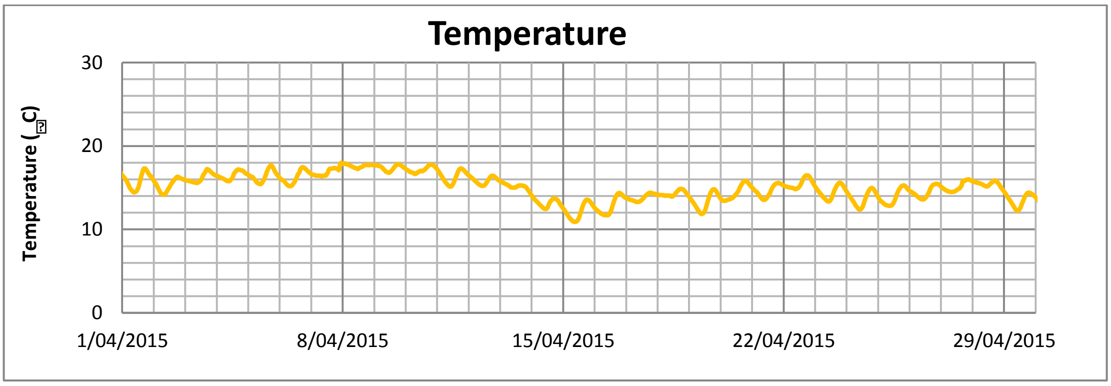


*Figure 2-20: Water temperature in the Ngarara Stream, measured every 15 minutes during April 2015*

## 2.6 Upper Muaupoko

Table 6 is a set of April 2015 summary statistics for the Upper Muaupoko Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-21), in-stream depth (Figure 2-22), in-stream dissolved oxygen (Figure 2-23), and water temperature (Figure 2-24).

*Table 6: Summary statistics for the Upper Muaupoko Stream – April 2015*

| | *Groundwater Level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 14225.00 | 445.61 | 6.11 | 17.12 |
| *Median* | 14298.00 | 548.00 | 10.18 | 11.96 |
| *Standard Deviation* | 62.48 | 165.25 | 1.39 | 1.84 |
| *Minimum* | 14219.00 | 438.00 | 0.08 | 9.08 |
| *Maximum* | 15068.00 | 2980.95 | 10.20 | 20.00 |
| *Count* | 2136.00 | 2136.00 | 2136.00 | 2136.00 |

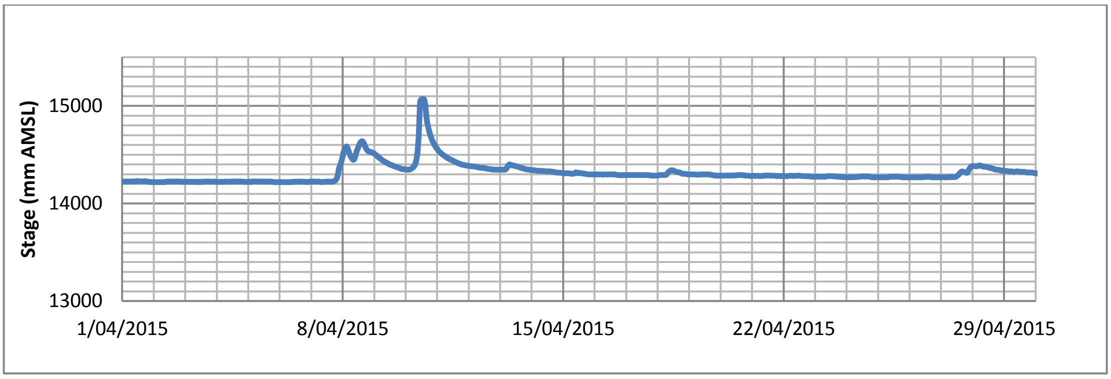


*Figure 2-21 : Groundwater level next to the Upper Muaupoko Stream, measured in 15 minute intervals for the month of April 2015. Note y axis starts at 13000.*

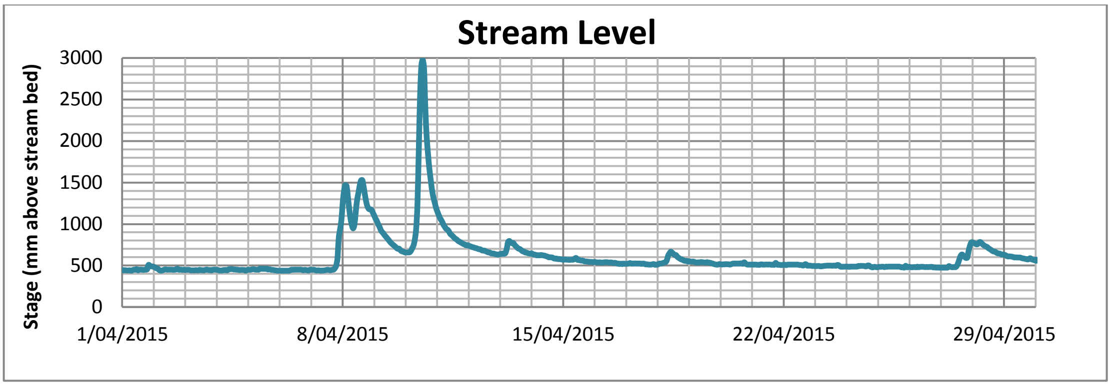


*Figure 2-22 : In-stream depth in the Upper Muaupoko Stream, measured in 15 minute intervals for the month of April 2015*

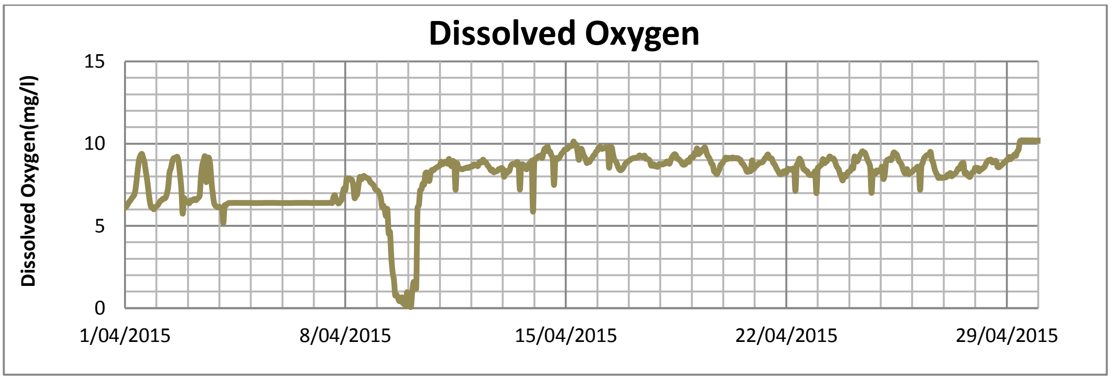


*Figure 2-23 : Dissolved oxygen in the Upper Muaupoko Stream, measured in 15 minute intervals for the month of April 2015*

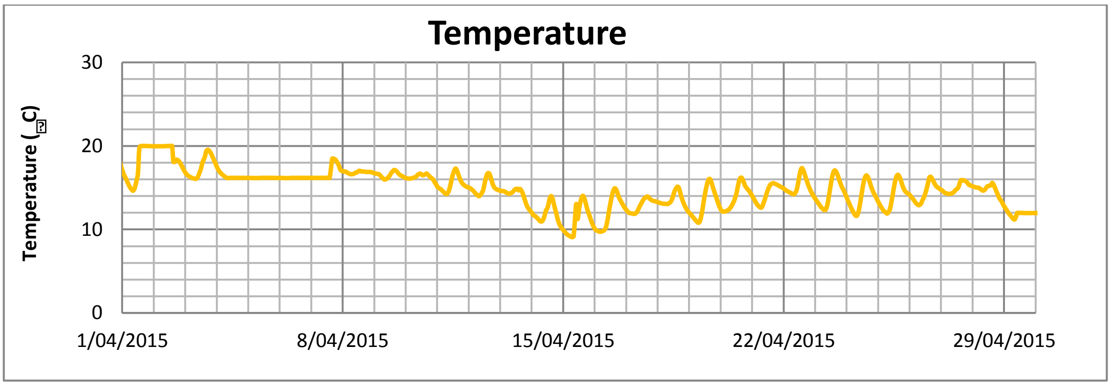


*Figure 2-24 : Water temperature in the Upper Muaupoko Stream, measured every 15 minutes during April 2015*

## 2.7 Lower Muaupoko

Table 7 is a set of April 2015 summary statistics for the Lower Muaupoko Stream. The four figures that follow the table summarise the logged data for groundwater level (Figure 2-25), in-stream depth (Figure 2-26), in-stream dissolved oxygen (Figure 2-27) and water temperature (Figure 2-28).

*Table 7: Summary statistics for the Lower Muaupoko Stream – April 2015*

| | *Groundwater Level (mm)* | *Stream Depth (mm)* | *Dissolved Oxygen (mg/L)* | *Temperature (°C)* |
|---|---|---|---|---|
| *Mean* | 5611.94 | 332.78 | 8.87 | 13.93 |
| *Median* | 5604.00 | 280.00 | 8.85 | 13.94 |
| *Standard Deviation* | 5386.00 | 232.00 | 0.00 | 9.45 |
| *Minimum* | 6103.00 | 2009.00 | 10.45 | 18.54 |
| *Maximum* | 2320.00 | 2320.00 | 2320.00 | 2320.00 |
| *Count* | 5611.94 | 332.78 | 8.87 | 13.93 |

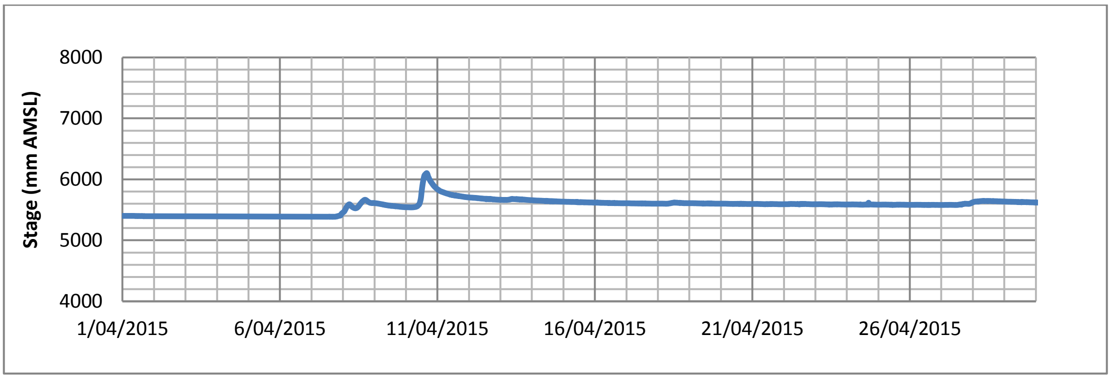


*Figure 2-25: Groundwater level next to the Lower Muaupoko Stream, measured in 15 minute intervals for the month of April 2015. Note y axis starts at 4000.*

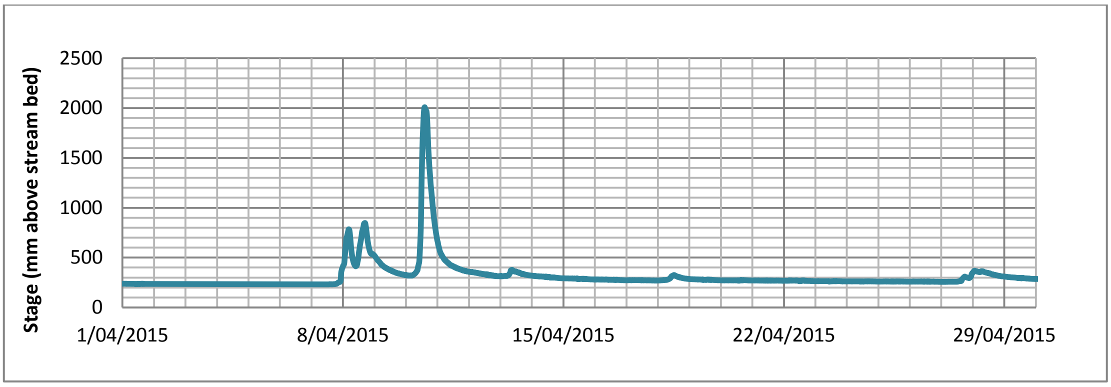


*Figure 2-26: In-stream depth in the Lower Muaupoko Stream, measured in 15 minute intervals for the month of April 2015*

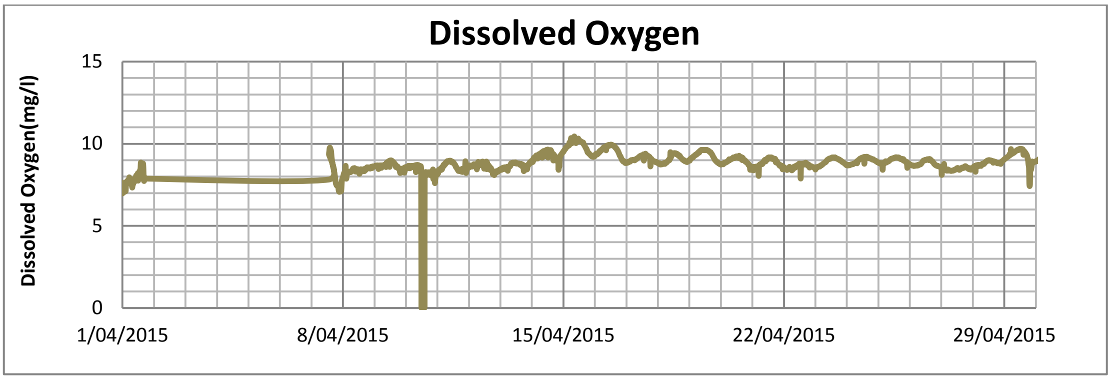


*Figure 2-27: Dissolved oxygen in the Lower Muaupoko Stream, measured in 15 minute intervals for the month of April 2015*

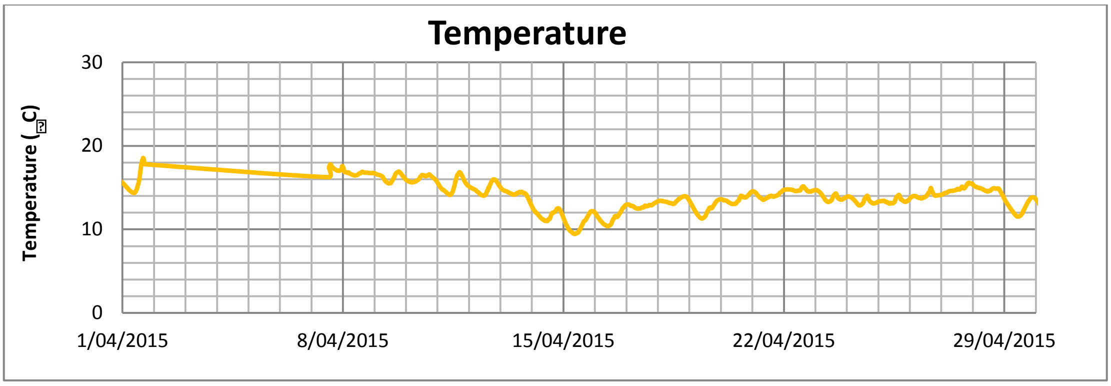


*Figure 2-28: Water temperature in the Lower Muaupoko Stream, measured every 15 minutes during April 2015*

## 2.8 Conductivity

Table 8 below provides the conductivity measurements from April, averaged from five measurements.

*Table 8: Showing the averaged April measurements of conductivity.*

| | HADFIELD | KOWHAI | PAETAWA | NGARARA | KAKARIKI | UPPER MUAUPOKO | LOWER MUAUPOKO |
|---|---|---|---|---|---|---|---|
| **CONDUCTIVITY (ms/cm)** | 0.375 | - | 0.259 | 0.32 | 0.275 | 0.26 | 0.26 |

## 2.9 Cross sectional depth profiles

*Table 9: Cross section depth measures (Cross Section A = 25m up stream, Cross section B = 25m downstream from the piezometer) for the small streams survey reaches – April 2015*

| Site | Hadfield | Kowhai | Paetawa | Ngarara | Kakariki | Upper Muaupoko | Lower Muaupoko |
|---|---|---|---|---|---|---|---|
| Wetted width @ piezo | 272 cm | | 160 | 260 | 140 | 183 | 170 |
| Cross Section A 1 | 8 | | 24 | 7 | 2 | 4 | 14 |
| Cross Section A 2 | 28 | | 23.5 | 13 | 2 | 4.5 | 15 |
| Cross Section A 3 | 47 | | 21 | 19 | 4 | 4.5 | 19 |
| Cross Section A 4 | 59 | | 23* | 24 | 7 | 9 | 19 |
| Cross Section A 5 | 45 | | 17 | 28 | 12 | 11 | 16 |
| Cross Section A 6 | 48 | | 12.5 | 31 | 18 | 13 | 17.5 |
| Cross Section A 7 | 59 | | 14 | 30 | 21 | 17 | 20 |
| Cross Section A 8 | *59 | | 13 | 30 | 22 | 19 | 17.5 |
| Cross Section A 9 | 69 | | 10 | 33 | 21 | 20 | 16 |
| Cross Section A 10 | 73 | | 8 | 38 | 16 | 23* | 20 |
| Cross Section A 11 | 71 | | 6 | 45 | 3 | 24 | 12 |
| Cross Section A 12 | 81 | | 3 | 35 | 8 | 24 | 14.5 |
| Cross Section A 13 | 90 | | 1 | 36 | 13 | 17 | 12 |
| Cross Section A 14 | 85 | | 4 | 42 | 15 | 9 | 9 |
| Cross Section A 15 | 87 | | 3 | 47 | 15 | 10 | 6 |
| Cross Section A 16 | 72 | | | 48 | | 12 | 2 |
| Cross Section A 17 | 65 | | | 47 | | 23 | |
| Cross Section A 18 | 43 | | | 41 | | 13 | |
| Cross Section A 19 | 45 | | | 40 | | | |
| Cross Section A 20 | 45 | | | 40 | | | |
| Cross Section A 21 | 22 | | | 38 | | | |
| Cross Section A 22 | 5 | | | 36 | | | |
| Cross Section A 23 | | | | 34 | | | |
| Cross Section A 24 | | | | 27 | | | |
| Cross Section A 25 | | | | 20 | | | |
| Wetted width Tran B | 240 | | 150 | 230 | 100 | 85 | 200 |
| Cross Section B 1 | 10 | | 23 | 16 | 14 | 5 | 7 |
| Cross Section B 2 | 22 | | 25 | 65 | 15 | 8 | 9 |
| Cross Section B 3 | 37 | | 28 | 63 | 12 | 7 | 8 |
| Cross Section B 4 | 47 | | 29 | 64 | 8 | 15 | 9 |
| Cross Section B 5 | 52 | | 30 | 50 | | 17 | 10 |
| Cross Section B 6 | 54 | | 32 | 55 | | 20 | 12 |
| Cross Section B 7 | 55 | | 33 | 54 | | 18 | 12 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cross Section B 8 | 56 | | 31 | 55 | | 21 | 13 |
| Cross Section B 9 | 53 | | 29 | 51 | | | 15 |
| Cross Section B 10 | 53 | | 27 | 40 | | | 16 |
| Cross Section B 11 | 53 | | 24 | 43 | | | 16.5 |
| Cross Section B 12 | 52.5 | | 22 | 34 | | | 18 |
| Cross Section B 13 | 53 | | 18 | 25 | | | 20 |
| Cross Section B 14 | 54 | | 12 | 28 | | | 22 |
| Cross Section B 15 | 53 | | | 15 | | | 19.5 |
| Cross Section B 16 | 56 | | | 14 | | | 23 |
| Cross Section B 17 | 55 | | | 22 | | | 22 |
| Cross Section B 18 | 55 | | | 18 | | | 22 |
| Cross Section B 19 | 50 | | | 10 | | | 6 |
| Cross Section B 20 | 36 | | | 13 | | | |
| Cross Section B 21 | 23 | | | 8 | | | |
| Cross Section B 22 | 17 | | | | | | |
| Cross Section B 23 | 9 | | | | | | |
| Wetted width Transect C | 235 | | 130 | 220 | 80 | 81 | 130 |
| Cross Section C 1 | 36 | | 6 | 20 | 2 | 3 | 6 |
| Cross Section C 2 | 34.5 | | 16 | 24 | 10 | 8 | 6 |
| Cross Section C 3 | 37 | | 26 | 28 | 18 | 9.5 | 7 |
| Cross Section C 4 | 42 | | 30 | 30 | 24 | 13 | 7 |
| Cross Section C 5 | 41 | | 30 | 38 | 25 | 16 | 5.5 |
| Cross Section C 6 | 53 | | 27 | 41 | 23 | 16 | 6 |
| Cross Section C 7 | 54.5 | | 23 | 42 | 22 | 16 | 5.5 |
| Cross Section C 8 | 53.5 | | 19 | 43 | 19 | 13 | 5 |
| Cross Section C 9 | 50 | | 18 | 45 | 14 | | 5 |
| Cross Section C 10 | 49 | | 13 | 49 | | | 3 |
| Cross Section C 11 | 48 | | | 57 | | | 2 |
| Cross Section C 12 | 49 | | | 58 | | | 2 |
| Cross Section C 13 | 47.5 | | | 59 | | | |
| Cross Section C 14 | 48 | | | 49 | | | |
| Cross Section C 15 | 48 | | | 51 | | | |
| Cross Section C 16 | 50 | | | 44 | | | |
| Cross Section C 17 | 49.5 | | | 38 | | | |
| Cross Section C 18 | 46 | | | 30 | | | |
| Cross Section C 19 | 47 | | | 28 | | | |
| Cross Section C 20 | 50 | | | 22 | | | |
| Cross Section C 21 | 53 | | | 18 | | | |
| Cross Section C 22 | 26 | | | 14 | | | |
| Cross Section C 23 | 6 | | | | | | |

# Appendix 1: Rain fall and River Flow at the WWTP

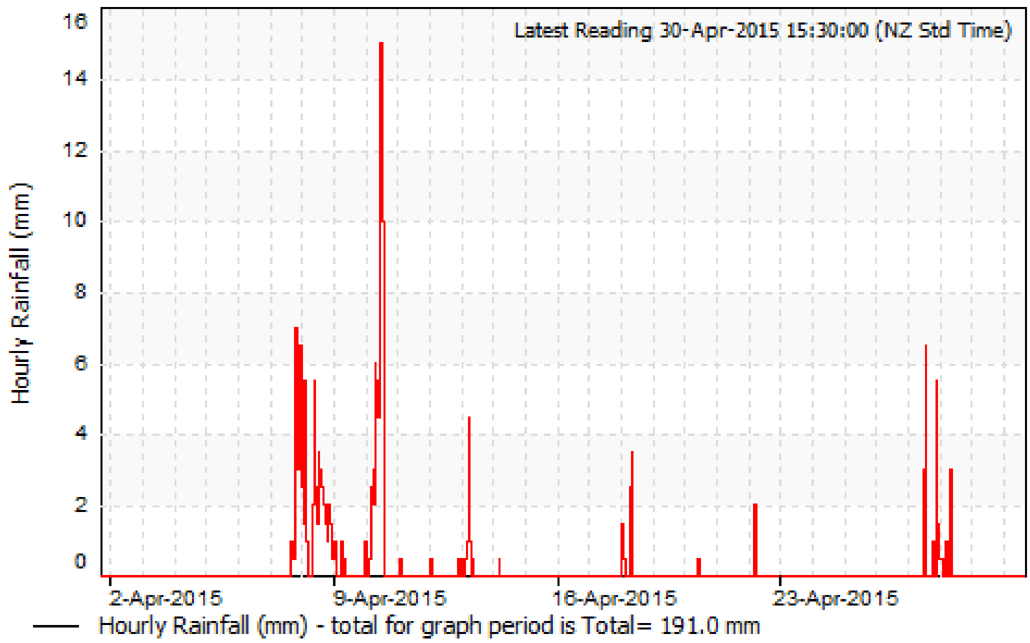


*Figure 2-29: GWRC recorded rain fall at the WWTP monitoring site for April 2015*

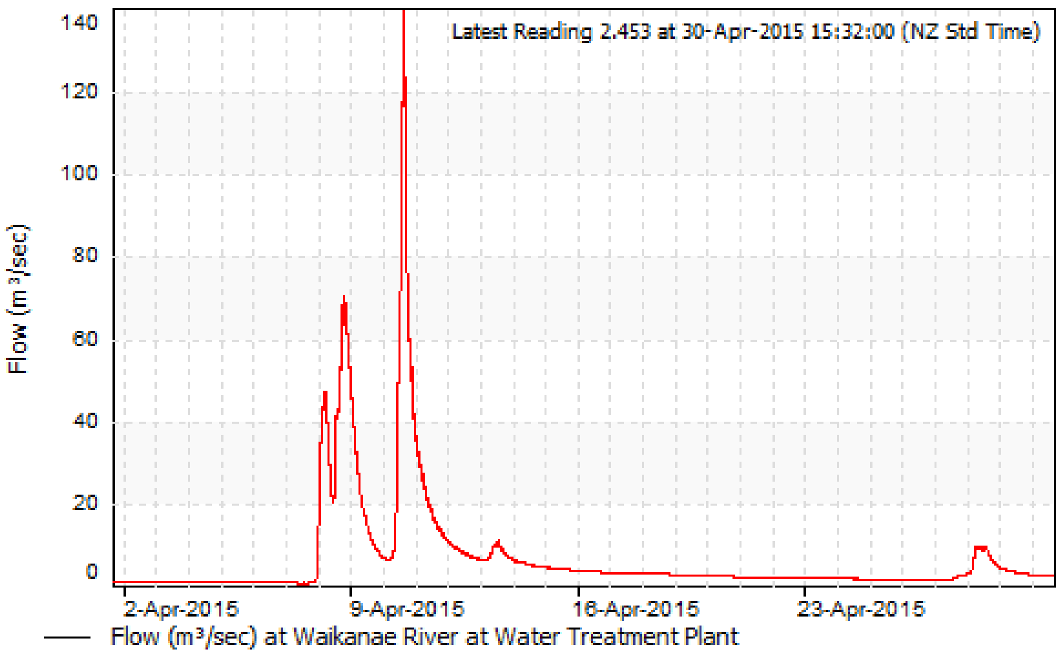


*Figure 2-30: GWRC recorded River flows at the WWTP monitoring site for April 2015*