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POVERTY BAY MANAGED AQUIFER RECHARGE

Pilot Trial - Kaiaponi Site and Source Water Option

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REPORT

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List of Abbreviations and Units

Abbreviation/Unit	Name
DBP	Disinfection by-product
FwAG	Freshwater Advisory Group
g	Grams
g/m^3	Grams per cubic metre
GDC	Gisborne District Council
Golder	Golder Associates (NZ) Limited
GRS	Groundwater Replenishment Scheme
ha	Hectare
HAAs	Halogenated acetic acids
HANs	Haloacetonitriles
km	Kilometre
L/s	Litres per second
m	Metre
m bgl	Metres below ground level
m^2/day	Metres squared per day
m^3/day	Cubic metres per day
MAR	Managed Aquifer Recharge
NTU	Nephelometric Turbidity Units
RL	Relative level
THMs	Trihalomethanes
µS/cm	Micro Siemens per centimetre – measure of electrical conductance
WTP	Water Treatment Plant
XRD	X-Ray Diffraction

1.0 INTRODUCTION

1.1 Background

The Gisborne District Council (GDC) has identified long term water availability in the Poverty Bay area as being a potentially limiting factor in future regional development. Irrigation for horticultural purposes is one of the main uses of water across the Poverty Bay Flats. A substantial proportion of the water used for irrigation is derived from groundwater. Reviews of groundwater levels in the Poverty Bay Flats area have identified declining groundwater level trends as an environmental and water supply reliability issue. These trends are linked to increasing groundwater abstraction for irrigation purposes.

The GDC is investigating water management options in the Poverty Bay region with the aim of improving water security for all users against a background of declining groundwater level trends in response to increased demand and predicted future climate change.

One option under investigation is the use of Managed Aquifer Recharge (MAR), to replenish and sustain groundwater yields from aquifers beneath the Poverty Bay Flats. Golder Associates (NZ) Limited (Golder) was commissioned by GDC to undertake a pre-feasibility assessment for a MAR program.

The key outcomes of the Stage 1A (Golder 2014a) pre-feasibility assessment of the Poverty Bay MAR project, were:

- The Makauri Aquifer is prospective candidate for a MAR pilot project due to its relatively high usage, declining groundwater level trends, broad extent and good transmissivity.
- The combination of treated water that is potentially available outside the irrigation season and existing infrastructure (e.g., Gisborne water supply reservoirs and delivery systems) provides an opportunity for a successful groundwater replenishment scheme (GRS).
- A system of direct water injection through bores is a clear option for Makauri Aquifer groundwater replenishment and was recommended for further design and a pilot trial.

Following further investigations and modelling during Stage 1B of the pre-feasibility assessment (Golder 2014b), it was concluded that MAR, using excess water taken during high winter flow periods has the potential to replenish the Makauri Aquifer beneath the Poverty Bay Flats to support sustainable groundwater use.

GDC is now seeking to proceed with a pilot injection trial to the Makauri Aquifer (the “Pilot Trial”). Golder has been commissioned by GDC to assist with technical support for the MAR Pilot Trial. Golder has completed a technical report[1] to support the assessment of environmental effects for the Pilot Trial and submitted this report to GDC.

The primary option for the Pilot Trial is an injection bore located at the Waipaoa Augmentation Plant on Bushmere Road with two potential source water options:

- Direct injection using water from the Waingake Water Treatment Plant into the Makauri Aquifer; or
- Direct injection using water from the Waipaoa River through the Waipaoa Augmentation Plant.

This report considers a third option which involves utilizing water sourced from the Waipaoa River via an infiltration gallery at Kaiaponi Farms and the construction of an alternative injection bore site for the trial.

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[1] Golder 2015. Poverty Bay Managed Aquifer Recharge. Pilot Trial – hydrogeology and water quality. Report to Gisborne District Council from Golder Associates (NZ) Limited. Golder report 1415771-006. August 2015.

1.2 Source Water Options

The primary finding from the MAR pre-feasibility assessments (Stages 1A and 1B) was that a Pilot Trial is required to demonstrate the viability of a GRS focused on the Makauri Aquifer to improve the security of future water supply in the Poverty Bay area. The primary option and initial technical assessment was based on the direct injection of water from the Waingake Water Treatment Plant into the Makauri Aquifer.

During development of the Pilot Trial, an alternative source water option was identified. This option entails using water sourced from the Waipaoa River and treated in the Waipaoa Augmentation Plant for injection.

In order to provide additional MAR site options, in November 2015 the Kaiaponi infiltration gallery beneath the Waipaoa River was identified as an alternative option for source water supply for a MAR Pilot Project. This gallery provides water to a distribution pipe network, which services Kaiaponi Farms. As this is a private water supply system, the use of water from the Kaiaponi infiltration gallery would require the construction of an injection bore close to the existing Kaiaponi water distribution network.

1.3 Scope of Work

The scope of work presented in this report is to assess the effects of taking water from the Waipaoa River at the Kaiaponi infiltration gallery for injection to a bore located nearby. Specifically, Golder has:

- Assessed potential Kaiaponi injection bore locations in terms of lithology, and expected depth of drilling, bore construction and local aquifer properties. Provided GDC with advice regarding the most technically feasible final location.
- Provided advice on the any potential source water treatment required prior to injection.
- Assessed potential effects of the trial injection on groundwater levels in the aquifer and in nearby bores.
- Assessed the applicability of the existing geochemical modelling results from the Waipaoa Augmentation Plant to the Kaiaponi site.
- Advised GDC on new monitoring requirements and application of the current monitoring program to the Kaiaponi site.

2.0 KAIAPONI SITE MAR SCENARIO

2.1 Location

The proposed location for the alternative injection bore at Kaiaponi (Kaiaoni site) is within the Kaiponi Farm property with access to the Kaiaponi water supply pipe line. There are several location options within the property and Golder has recommended a position (Figure 1, 2028430E, 5714960N (NZTM)) which is approximately 1.6 km north of the Waipaoa Augmentation Plant. The position of the potential Kaiaponi injection bore (Figure 1) has been selected based on:

- Reasonable proximity to the Kaiaponi water supply pipe line. This water source is potentially available during the entire irrigation off-season (May to October) and therefore constitutes a reliable supply for a trial.
- Location of the bore site along the western edge of the Kaiaponi Farms property. The greatest intensity of seasonal groundwater abstraction from the Makauri Aquifer, as well as the greatest observed drawdown effects on the aquifer, is approximately 1.3 km to the east – northeast of the Kaiaponi property. As the proximity of the Kaiaponi site to the area of greatest stress on the aquifer may mask some groundwater level responses to the trial, the preferred on-site injection bore location is therefore toward the western side of the Kaiaponi Farms property.

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2. Map image: LINZ NZTopo Series, CC-BY-3.0-NZ.
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TITLE LOCATION PLAN

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The final position of the Kaiaponi injection bore may alter due to local lithological characteristics, access to land and power on the property. If the Kaiaponi site is chosen for the Pilot Trial, the location of the injection bore would be finalised after drilling of a pilot hole is been completed.

2.2 Kaiaponi Source Water

Waipaoa River water sourced through the Waipaoa Augmentation Plant has already been considered as an alternative source water supply (Golder 2015). Kaiaponi infiltration gallery is located approximately 1.6 km north of the Waipaoa Augmentation Plant site and approximately 5 km upstream of its intake. The gallery is screened between 2 m and 5 m below the base of the river in the underlying gravels (per comms. Dennis Crone).

Kaiaponi Farms can abstract up to 50 L/s and 4,000 m^3/day for irrigation. The water distribution pipeline is predominantly 150 mm in diameter and can provide a flow rate between 25 L/s and 10 L/s.

GDC holds a resource consent to take up to 13,392 m^3/day from the Waipaoa River at the Waipaoa Augmentation Plant. If Kaiaponi becomes the preferred water source option for the Pilot Trial, then GDC would apply for a new consent to take additional water at the Kaiaponi abstraction point. GDC would apply for a 'B' permit for abstraction during the higher flow period (irrigation off-season).

The GDC has established a minimum river flow of 600 L/s at the Matawhero Bridge and 1.3 m^3/s at the Kanakanaia Bridge. Water take restrictions may be applied if the flows drop below these rates. Flows below these rates have not been observed to date and restrictions have never been enforced (GDC 2008). For category "B" water permits water restrictions apply when the Waipaoa River flow at Kanakanaia Bridge drops below 4 m^3/s.

2.3 Injection Bore Conceptual Design

As the Makauri Aquifer deepens from north to south, an injection bore at Kaiaponi would potentially be shallower than the planned bore at the Waipaoa Augmentation Plant site. The closest bore to the Kaiaponi site with an available geological log (GPE034) shows a 4 m thick layer of Makauri Aquifer gravel from 66 m to 70 m bgl. Many of the other Makauri Aquifer bores close to or on the Kaiaponi property are between 67 m deep and 76 m deep. Allowance will be made in the project budget for a deeper bore, appropriate for the Wapaoa Augmentation Plant site, but it may be that a 70 m deep bore will be sufficient.

2.4 Operational Injection Water Quality Management

2.4.1 Suspended sediment

The Kaiaponi water supply system is used for the purpose of providing irrigation water for the farm. Consequently, the system is not linked to the Gisborne drinking water supply system and the water is not treated to a potable water supply standard.

Physical clogging of injection bores is a common risk factor requiring management in MAR projects internationally, and therefore needs to be carefully managed for the planned Pilot Trial. Filters are in place on the Kaiaponi irrigation system to manage the suspended solids concentrations in the supply pipeline, reducing the risk of the irrigation sprinklers becoming clogged. Sampling results have indicated that the suspended solids concentrations in both the water arriving at the first Kaiaponi filter bank and the outflow from this filter bank are close to or below the detection limit of the analysis (1 g/m^3). The river bank adjacent to the intake gallery is efficiently reducing the suspended solids load in the water from the river. Suspended solids concentrations in the intake water from the gallery and the outflow water from the existing filter bank would be monitored during the trial. At this stage, no additional filtering for suspended sediment is recommended. If the sediment concentrations in the supply water increase during the trial:

- An additional filter system could be installed on the water delivery line from the existing filter bank to the injection bore.
- Injection could be halted until the suspended sediment concentrations decrease again to acceptable levels or while the additional filter system is installed.

2.4.2 Bacterial contaminants

The results of initial water quality testing carried out on water sourced from the Kaiaponi infiltration gallery in early 2016 has shown relatively low levels of the bacterial indicator *E.coli* (concentrations from below the detection limit of 1 colony forming unit (cfu) per 100 ml up to 5 cfu). As the Kaiaponi water supply system is not used to supply potable water, there is no treatment system installed to remove pathogens, and no need for such a system to be installed.

Golder is recommending chlorine treatment of the source water for part of the trial period in order to get as much information as possible from the trial (refer Section 2.4.3). Golder does not however consider that there is a requirement for additional treatment of the supply water to protect the aquifer and groundwater users from bacterial contamination. Several factors have been taken into account in reaching this conclusion:

- Groundwater from the Makauri Aquifer is predominantly used for irrigation and there is a Gisborne City potable treated water supply for domestic supply in the area.
- The concentrations of faecal contamination indicators (e.g., *E.coli*) detected to date have been low.
- Indicators of faecal contamination (e.g., *E.coli*) have a short half-life in reduced geochemical environments similar to that of the Makauri Aquifer.
- Groundwater movement within the aquifer will be limited to within the injection bubble and therefore managed as discussed in Golder (2015).

Monitoring and management of the trial is planned to take into account the possibility that *E.coli* concentrations in the source water may increase. If the E-coli concentrations detected in the supply water increase to unacceptable levels during the trial:

- A water treatment system could be installed on the water delivery line from the existing filter bank to the injection bore.
- Injection could be halted until the E. coli concentrations decrease again to acceptable levels or while the additional filter system is installed.

Biological clogging of the injection bore is also a risk requiring management. Biological growth in water bores is commonly managed through the use of approved commercially available products approved by regulatory authorities that do not cause significant geochemical reactions affecting the local groundwater quality.

2.4.3 Recommendations

One objective of this Pilot Trial is to gain as much information as possible about the characteristics and behaviour of the aquifer when a MAR project is developed. Golder therefore recommends that a Pilot Trial at the Kaiaponi site be divided into two phases. Each phase would involve injecting approximately half the source water volume (50,000 m^3).

1) Phase 1 involves injecting filtered water without biological treatment to the aquifer, with careful monitoring and triggers to ensure safe operation. This phase is planned to provide critical information needed to confirm the attenuation rates of bacteria introduced to the conditions within the Makauri Aquifer.

2) Phase 2 involves injecting filtered water that has been chlorinated to provide a proof of concept for MAR sites using treated water. This will provide important information helping establish how this treatment approach might be progressed in the future and monitoring will allow assessment of geochemical responses in the aquifer.

A two-phase trial is recommended, as the results of the trial need to be scaled-up for planning of a wider groundwater replenishment scheme. Source water treatment is not expected to be required at all future groundwater replenishment scheme sites, especially where local groundwater is not used for drinking water supply or irrigation of sensitive horticultural crops. Some possible future MAR sites may however require treatment of injection water due to their proximity to identified drinking water sources or sensitive crops, or due to variations in source water quality. The division of the Pilot Trial into two phases as described above enables the aquifer behaviour under both treated and untreated scenarios to be confirmed.

A number of Pilot Trial management measures with respect to water quality are proposed by Golder (refer Section 6.0). These measures are proposed to ensure the quality of Makauri Aquifer groundwater available to users is not reduced as a result of the trial and includes recommended trigger conditions for applying treatment for the management of bacteria in the injection water.

3.0 EFFECTS ON GROUNDWATER LEVELS AND FLOWS

3.1 Hydrogeology

3.1.1 Introduction

The aquifer system beneath Poverty Bay Flats consists of a series of sand and gravel units within Quaternary age sediments infilling a sedimentary basin to the west and northwest of Gisborne City (Golder 2015). Five main aquifers have been identified from surface mapping and drilling. These include three shallow aquifers which are hydraulically linked to surface water bodies and two deeper aquifers. These aquifers are used extensively for irrigation and commercial purposes, and domestic supply.

Toward the coast, the geological interpretation indicates the aquifers will be predominantly sandy rather than a continuation of the gravel deposits. The gravel aquifers may therefore not have a strong hydraulic connection to the ocean. There is a thick low permeability sediment layer from a former estuary which acts to restrict the hydraulic connection between the shallow aquifers and the deeper aquifers, over the southern half of the basin. In the northern areas, the deeper aquifers are closer to the surface and the main area of groundwater recharge to the Makauri Aquifer is considered to be north of Ormond (Golder 2014a).

3.1.2 Local lithology in the Makauri Aquifer

Most logs from bores in the vicinity of the Kaiaponi site show a similar lithological sequence to that from bore GPD115 as outlined in Golder (2015), however the Makauri Aquifer is shallower as discussed in Section 2.3. There are some bores tapping shallow (up to 10 m) or intermediate depth sands (20-45 m) for domestic supplies. The lithological logs for bores within two kilometres of the Kaiaponi site are listed in Appendix A.

Geological logs from bores close to the Kaiaponi site generally show:

- A shallow sandy or gravelly aquifer to a depth of up to 45 m bgl.
- A clay/silt layer between 45 m to 65 m bgl forming a confining layer overlying the Makauri Aquifer.
- A gravel or sand unit constituting the Makauri Aquifer at a depth of approximately 65 m to 76 m bgl.

In the Kaiaponi area the Makauri Aquifer is expected to be between 4 and 6 m thick.

3.1.3 Makauri Aquifer hydraulic properties

The aquifer properties will determine the hydraulic aquifer response, determine the injection bore design and potential injection rates.

Interpolation of pumping test analysis results for the Makauri Aquifer indicates transmissivity ranges from 500 m^2/day to 1,500 m^2/day across 80 % of the aquifer (Golder 2014b). Pumping test results are available for seven bores completed in the Makauri Aquifer within 1.5 km of the potential injection bore at Kaiaponi (Table 1). The transmissivity result from the nearest test performed to the Waipaoa Augmentation site was 456 m^2/day from bore GPD115. A similar transmissivity may apply to the Makauri Aquifer in the area of the potential Kaiaponi injection bore. This is, however, expected to be a conservatively low estimate as the results from most of the pumping tests performed in the Kaiaponi site area were greater (Table 1). Therefore the expected higher local aquifer transmissivity should enable increased water injection rates at the Kaiaponi site.

The storativity from the pumping test carried out on bore GPD135 (Table 1) has been used for initial projections of aquifer responses to the trial.

A 72 hour constant rate pumping test and a stepped flow rate test are planned to be undertaken on the injection bore used for the Pilot Trial. These tests would provide more specific information on the aquifer hydraulic properties at the trial site. Following the pumping tests, the projected groundwater level responses to the planned injection trial (Section 3.3) will be re-modelled to increase certainty for operational trial management purposes.

Table 1: Results of pumping tests performed on Makauri Aquifer bores near the Kaiaponi site.

Bore No.	Bore depth (m)	Depth to aquifer (m bgl)	Screen from (m bgl)	Screen to (m bgl)	Aquifer thickness (m)	Aquifer transmissivity (m²/day)	Aquifer storativity (-)
GPD135	71	70.4	-	-	5.8	424	0.00027
GPF109	82.3	-	76.8	79.3	-	1,620	-
GPF147	85.4	-	72	85	-	2,326	-
GPD089	85.3	80.7	-	-	4.5	1,155	0.00031
GPF111	79.2	67.1	72.8	76.8	12.1	1,839	0.0012
GPE034	70	66.1	67	70	-	1,280	0.0011
GPD007	70.1	-	-	-	-	383	-

Note: N/A – not available.

3.1.4 Baseline groundwater pressures

Recorded static water levels used in this report are sourced from the GDC database and have been sourced from various times and sources. The accuracy of the surrounding static water levels will be updated with additional baseline monitoring of nearby bores (Section 5.1). Groundwater levels are generally 5 m to 6 m bgl, however, records from one bore indicate shallower groundwater levels (GPF064, Table 4). It is unclear if this shallower groundwater level is due to the bore being positioned on lower topography, in another aquifer with higher groundwater levels or if the static water level was inaccurately recorded.

GDC monitors groundwater levels at the nearby bore GPE034 on a weekly basis as part of site background monitoring. In addition there is a group of monitoring bores (Ferry Road bores) with automated level record systems located one kilometre north of the preferred injection bore site on Kaiaponi Farm (Table 2).

The baseline groundwater level monitoring will be used to refine the local projected effects on groundwater levels before proceeding with the trial.

Table 2: Ferry Road monitoring bores.

Bore number	GDC database code	Bore depth (m)	Aquifer
GPE032	Hika01	12	Shallow Fluvial
GPE040	Hika02	27.5	Waipaoa
GPE041	Hika03	55	Makauri
GPE059	Hika05	89.4	Makauri

3.2 Groundwater Use

3.2.1 Nearby bores

There are 123 bores on the GDC bore database within 2 km of the proposed injection site (Figure 2). Of these bores, 55 % or 68 bores are of unknown depth or less than 25 m deep. Due to the presence of the thick confining bed overlying the Makauri Aquifer, these shallow bores are unlikely to be impacted by the proposed MAR injection trial. To confirm the effect of the aquitard a shallow bore screened in the overlying unconfined aquifer will be included in the monitoring program. Recommended monitoring bores are discussed in Section 5.1.

There are 44 bores with depths between 50 m to 90 m deep within 2 km of the secondary option Kaiaponi injection site (Appendix A). A conservative assumption can be made that these bores are potentially screened in the Makauri Aquifer.

3.2.2 Nearby consented groundwater takes

There are 24 consented groundwater takes from the Makauri Aquifer within a 2 km radius of the secondary option Kaiaponi injection site (Figure 3, Appendix A, Table B3). Fifteen of these are consented takes are also considered to be tapping the Makauri Aquifer. None of these Makauri Aquifer groundwater takes are within one kilometre of the Kaiaponi option preferred site. These groundwater take consents are permitted for irrigation purposes.

3.3 Effects on Groundwater Levels

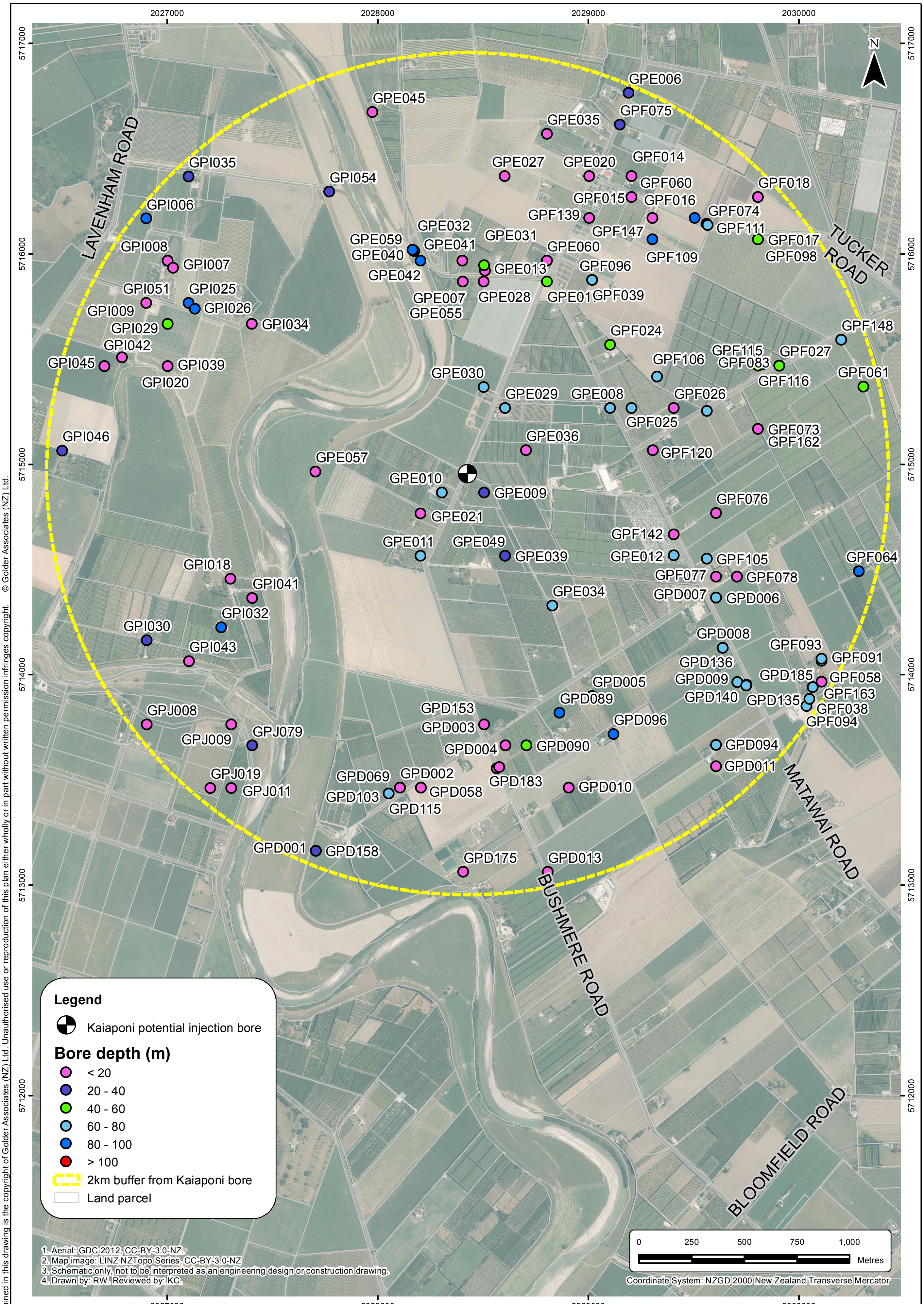
During the injection phase of the trial, groundwater levels in the Makauri Aquifer will rise in the area around the trial site. For the Kaiaponi site the water is planned to be injected during the irrigation off-season May to October period, which is typically a period of groundwater level rise or recovery.

Due to the presence of the identified thick confining bed overlying the Makauri Aquifer at this location, it is expected that the trial will have less than minor impact on the surrounding bores completed in the shallow aquifer. However, to confirm this assumption monitoring of one of the shallow bores, closest to the trial site, will be carried out prior to the commencement of the trial, to establish baseline conditions, and also throughout the trial (Section 5.1).

Groundwater level responses to the proposed injection trial at Kaiaponi site have been calculated using the same method as presented for the Waipaoa Augmentation Plant site (Theis equation) at the same rate (1,000 m^3/day) over 100 days pumping. The modelled long term injection rate (1,000 m^3/day) is slightly above the average long term expected rate of 10 L/s. The trial could involve short term injections of up to 15 L/s, dependent upon the local aquifer conditions and bore construction. However, the trial will maintain a maximum annual injection volume of 100,000 m^3.

The same range of hydraulic parameters as used in the Golder (2015) report for the Waipaoa Augmentation Plant site have been used in calculating the projected change in groundwater levels. The transmissivity may be slightly higher at the Kaiaponi site (Table 1) however the lower range is a conservative estimate. These are:

- Transmissivity between 450 and 750 m^2/day.
- Storativity between 0.0002 and 0.0005.



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TITLE

BORE LOCATIONS

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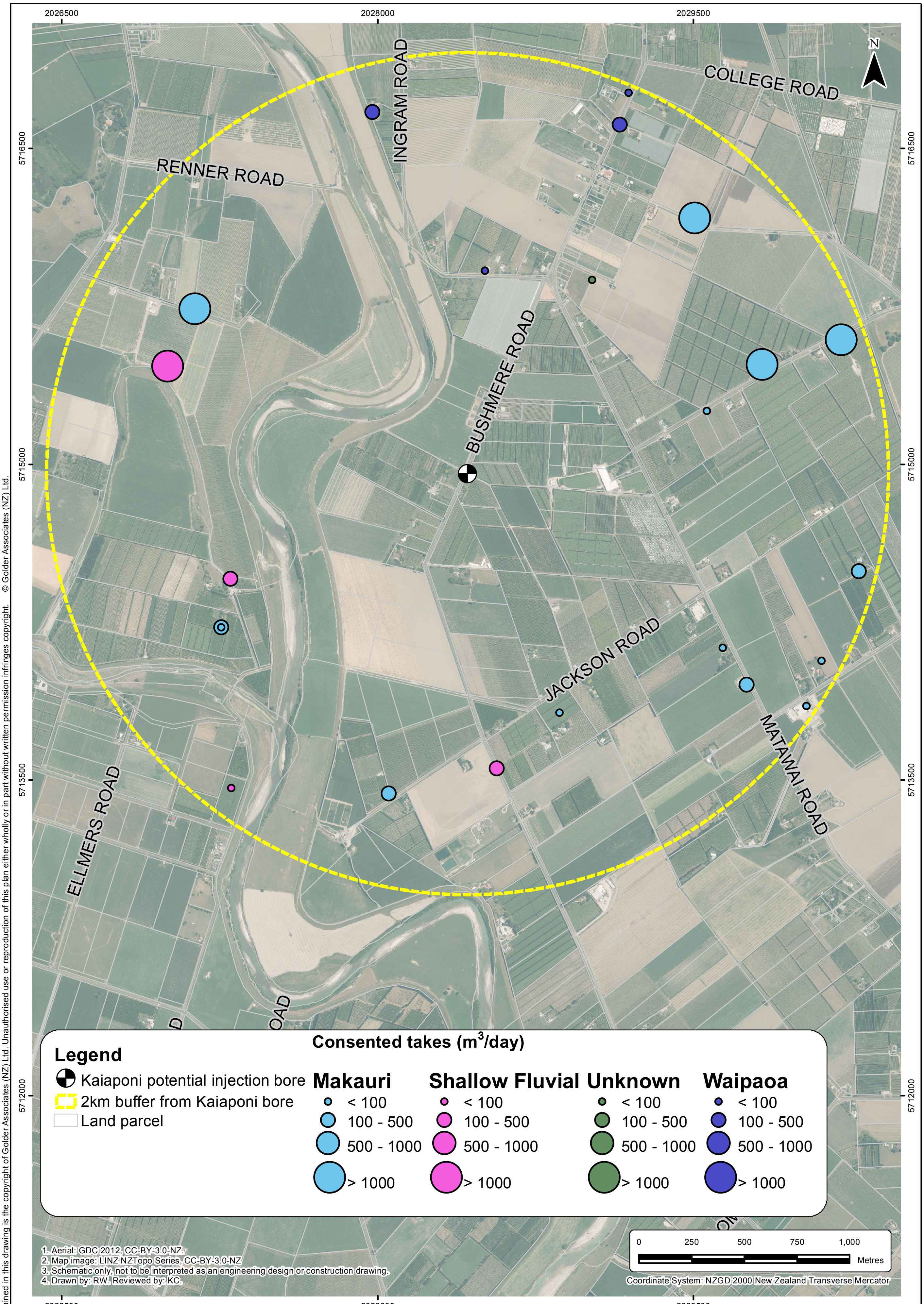

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TITLE NEARBY CONSENTED GROUNDWATER TAKES

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The calculated groundwater level responses, based on the aquifer parameter ranges presented above, are summarised in Table 3 and Table 4. Most bores have static water levels between 4.5 m and 6.5 m bgl. There are two bores reported as tapping the Makauri Aquifer with static water levels approximately 1.5 m to 2 m bgl which are greater than 1 km from proposed injection site. These two bores will be investigated further and water levels measured if the Kaiaponi site is to be used. The trial is not expected to cause water levels in nearby Makauri Aquifer bores to rise above ground level. The water is planned to be injected into the aquifer under gravitational pressure which will limit artesian conditions in the Makauri Aquifer.

Table 3: Projected groundwater level increase from water injection at 1,000 m^3/day for 100 days.

Distance from injection bore (m)	Projected groundwater level rise (m)
10	1.6-2.7
100	1.2-2.0
300	0.9-1.4
500	0.8-1.3
1,000	0.6-1.1
1,200	0.6-1.0
1,500	0.6-0.8
2,000	0.5-0.7

As stated in Golder (2015), the results from the pumping tests performed on the injection bore will be used to refine the projected water level responses of the aquifer to the planned injection trial. This process will enable the final planning of injection rates and the water level monitoring systems for the nearest monitoring bores

3.4 Groundwater Level Summary

The Kaiaponi site option could potentially be used in a very similar manner to the Augmentation Plant site for an injection bore to inject up to 100,000 m^3 of water over a period from May to October at a rate of up to 15 L/s. During construction the screened section of the proposed injection bore will be carefully sealed off from the upper aquifers. The source water will be supplied to the site via the Kaiaponi water pipeline.

Based on our preliminary assessment using information available from nearby sites on the aquifer hydraulic properties, the proposed Poverty Bay MAR Pilot Project is not considered to have a significant effect on any surrounding bore users or on the aquifer.

The Pilot Project will be carefully monitored and data gathered will be analysed during the trial so that the hydraulic responses in the aquifer can be applied to the design of any future GRS (Section 5.1).

Table 4: Projected effects on bores with known groundwater levels.

Bore No.	Aquifer	Ground elevation	Bore depth	Baseline Water level(2)	Water level	Distance from Kaiaponi injection bore site	Aquifer transmissivity	Projected water level rise	Projected final water level
		(m RL)	(m)	(m bgl)	(m RL)	(m)	(m^2/day)	(m)	(m bgl)
GPE034(1)	Makauri	10.3	70	5.85	4.5	749	1,280	1.2	4.7
GPF162	Makauri	9.0	76	5.9	3.1	1,172		1	4.9
GPD007	Makauri	8.5	70.1	5.5	3.0	1,321	383	1	4.5
GPI032	Makauri	12.4	81.3	6.04	6.4	1,383		0.9	5.1
GPI026	Makauri	13.1	83	6.24	6.8	1,512		0.8	5.4
GPD115	Makauri	10.9	75.1	5.48	5.4	1,572	456	0.8	4.7
GPF074	Makauri	11.2	36.5	5.27	5.9	1,637	2,312	0.8	4.5
GPD135	Makauri	7.9	71	4.6	3.3	1,666	424	0.8	3.8
GPF064	Makauri	7.8	85.4	1.5	6.3	1,915		0.7	0.8

Note: (1) Currently monitored by GDC. (2) As recorded in the GDC database from a variety of sources.

4.0 WATER QUALITY

4.1 Groundwater Quality

A geochemical assessment of the effects on aquifer water quality from injecting water from the Waipaoa Augmentation Plant into the Makauri Aquifer has been undertaken (Golder 2015). This assessment was undertaken based on water quality data obtained from sampling bore GPD115, which is monitored by GDC.

The Kaiaponi site is located approximately 1.6 km from bore GPD115. The water quality data from this monitored bore is considered appropriate to be used for a geochemical analysis of the Kaiaponi site as it is still relatively close to the site and the quality of water sampled from other monitored sites nearer to Kaiaponi is similar or better. On this basis using the water quality data from GPD115 is a conservative approach to a water mixing assessment.

There are four additional GDC water quality monitoring sites within 2 km of the Kaiaponi site. These are:

- GPF106: Closest groundwater monitoring site, located approximately 1.1 km to the northeast.
- GPI032: Located 1.3 km to the southwest.
- GPI026: Located 1.5 km to the northwest.
- GPD096: Located 2 km to the southeast.

The distribution of key water quality parameters in the Makauri Aquifer has been presented in the MAR feasibility study report (Golder 2014b). The maps presented in Appendix C of the feasibility report (Golder 2014b) show water quality in most of the four additional monitoring bores (listed above) is consistent with that sampled from bore GPD115. The iron levels in GPI032 are slightly higher than in GPD115.

Golder consider that the groundwater quality results near Kaiaponi site are similar to that used in the Golder (2015) assessment of geochemical effects for Waipaoa Augmentation Plant site.

4.2 Source Water Quality

4.2.1 Introduction

This section provides an assessment of water quality at the Kaiaponi Farms (Kaiaponi) infiltration gallery, a possible alternate injection water source for the MAR Pilot Trial. The previous water quality assessment completed for the MAR Pilot Trial(Golder 2015) concluded that treated water from the Waipaoa Augmentation Plant was generally suitable for injection into the Makauri Aquifer. Therefore, this current assessment compares water quality at the Kaiaponi infiltration gallery to the Waipaoa Augmentation Plant (i.e., a baseline water quality for this assessment). It is determined that if water available from the Kaiaponi infiltration gallery is of similar or better quality than water from the Waipaoa Augmentation Plant, then it would also be a viable source of injection water for the MAR Pilot Trial.

In the approximately 5 km reach of Waipaoa River between the Kaiaponi infiltration gallery and the Waipaoa Augmentation Plant the adjacent land use may generally be described as agricultural and rural residential. Numerous small, and presumably ephemeral, surface water drainage channels enter Waipaoa River in this reach. The largest surface water inflow to the Waipaoa River in this reach is from Whakaahu Stream, a tributary from a hill catchment that flows through the small settlement of Patutahi and enters Waipaoa River from the west, approximately 2.4 km upstream of the Waipaoa Augmentation Plant. Water quality information for Whakaahu Stream was not reviewed for this assessment, but it is possible that this tributary could influence Waipaoa River water quality at certain times of the year through possible stormwater runoff from residential sources or sediment transported from the hilly catchment, particularly during heavy precipitation events.

4.2.2 Available information

To prepare this assessment, Golder reviewed water quality monitoring data provided by GDC for the two potential injection water sources. The samples were collected by GDC in 2014 and 2015 and included:

- Water quality samples for annual chemical screening at the Waipaoa Augmentation Plant:
    - raw Waipaoa River water collected from the Waipaoa Augmentation Plant on 17 January, 2014; and
    - potable water collected from the Waipaoa Augmentation Plant on 16 January, 2014.
- Water quality samples collected on 16 November, 2015 from the infiltration gallery at Kaiaponi Farms:
    - at the infiltration gallery prior to the screen filter (labelled ‘Meter’ on laboratory reports); and
    - after the screen filter and prior to the distribution system (labelled ‘Arkal’ on laboratory reports).

Water quality data for select parameters are summarized in Table 5 and full laboratory reports for all four samples are provided in Appendix B.

4.2.3 Water quality results

Raw water quality from the sample taken at the Kaiaponi infiltration gallery in November 2015 was similar to the samples from Waipaoa Augmentation Plant; both have an alkaline pH (7.8 and 8.1, respectively), similar electrical conductivity values (~550 µS/cm), are characterized as calcium-bicarbonate type waters (Ca-HCO_3), and are classified as ‘very hard’ water according to the elevated concentrations of calcium and magnesium (230 g $CaCO_3$/m$^{3).}$ The major ion composition of the raw waters is evaluated in Figure 4 with the use of a Durov diagram. Relative concentrations of the major cations (i.e., calcium, magnesium, potassium, and sodium) are shown in the triangle to the left of the diagram, while the major anions (i.e., chloride, bicarbonate, and sulfate) are shown in the triangle in the upper portion. The close alignment of all Waipaoa River data points in both triangles means the relative abundance of all major ions is very similar for all samples, an indication that the waters originated from the same source or spent significant time in contact with the same types of minerals (e.g., limestone based on the calcium-bicarbonate water type).

The comparison of total dissolved solids (TDS) concentrations in the right portion of the Durov diagram shows that the Kaiaponi infiltration gallery raw water had a slightly lower TDS concentration (380 g/m^3) compared to the Waipaoa Augmentation Plant (463 g/m^3); both are substantially lower than regional groundwater (890 g/m^3), which is included for comparison (data from Golder 2015). The small difference in TDS between the two locations on the Waipaoa River represents slightly higher alkalinity and chloride concentrations at the downstream location.

Table 5: Summary of Gisborne City water quality from the Waipaoa Augmentation Plant.

Parameter	**Units**	**Kaiaponi infiltration gallery (pre-screen)**	**Kaiaponi infiltration gallery (post-screen)**	**Waipaoa augmentation plant (raw)**	**Waipaoa augmentation plant (potable)**
Sample date	-	16/11/2015	16/11/2015	16/1/2014	17/1/2014
Fluid parameters					
pH	s.u.	7.8	7.6	8.1	7.9
Turbidity	NTU	-	-	1.96	0.27
Electrical Conductivity	µS/cm	565	591	549	548
Total Dissolved Solids	g/m^3	380	400	*464 (calculated)*	*444 (calculated)*
Total Alkalinity	g $CaCO_3$/m^3	184	196	187	170
Bicarbonate	g/m^3 at 25°C	220	240	230	210
Hardness	g $CaCO_3$/m^3	230	250	230	230
Major ions					
Calcium	g/m^3	79	86	78	77
Chloride	g/m^3	10.4	10.6	19	19
Magnesium	g/m^3	8.3	8.6	9.3	9.1
Potassium	g/m^3	3.4	3.5	3.2	3.1
Sodium	g/m^3	27	27	29	27
Sulfate	g/m^3	96	98	95	99
Nutrients					
Total Ammoniacal-N	g/m^3	0.022	0.016	<0.010	<0.010
Nitrate-N	g/m^3	0.086	0.093	<0.002	<0.002
Nitrite-N	g/m^3	<0.002	0.002	<0.002	< 0.002
Dissolved Reactive Phosphorus	g/m^3	0.010	0.008	<0.004	<0.004
Organic carbon					
Absorbance at 254 nm	AU cm^{-1}	-	-	0.053	0.029
Dissolved Organic Carbon	g/m^3	1.1	3.6	-	-
Total Organic Carbon	g/m^3	2.3	3.9	-	-
Metals (dissolved)					
Aluminum	g/m^3	<0.003	<0.003	0.021	0.169
Iron	g/m^3	<0.02	<0.02	<0.02	< 0.02
Manganese	g/m^3	0.083	0.059	<0.0005	0.002

Notes: Results are shown for select parameters. All results are included in raw laboratory reports attached as Appendix B. - not tested.

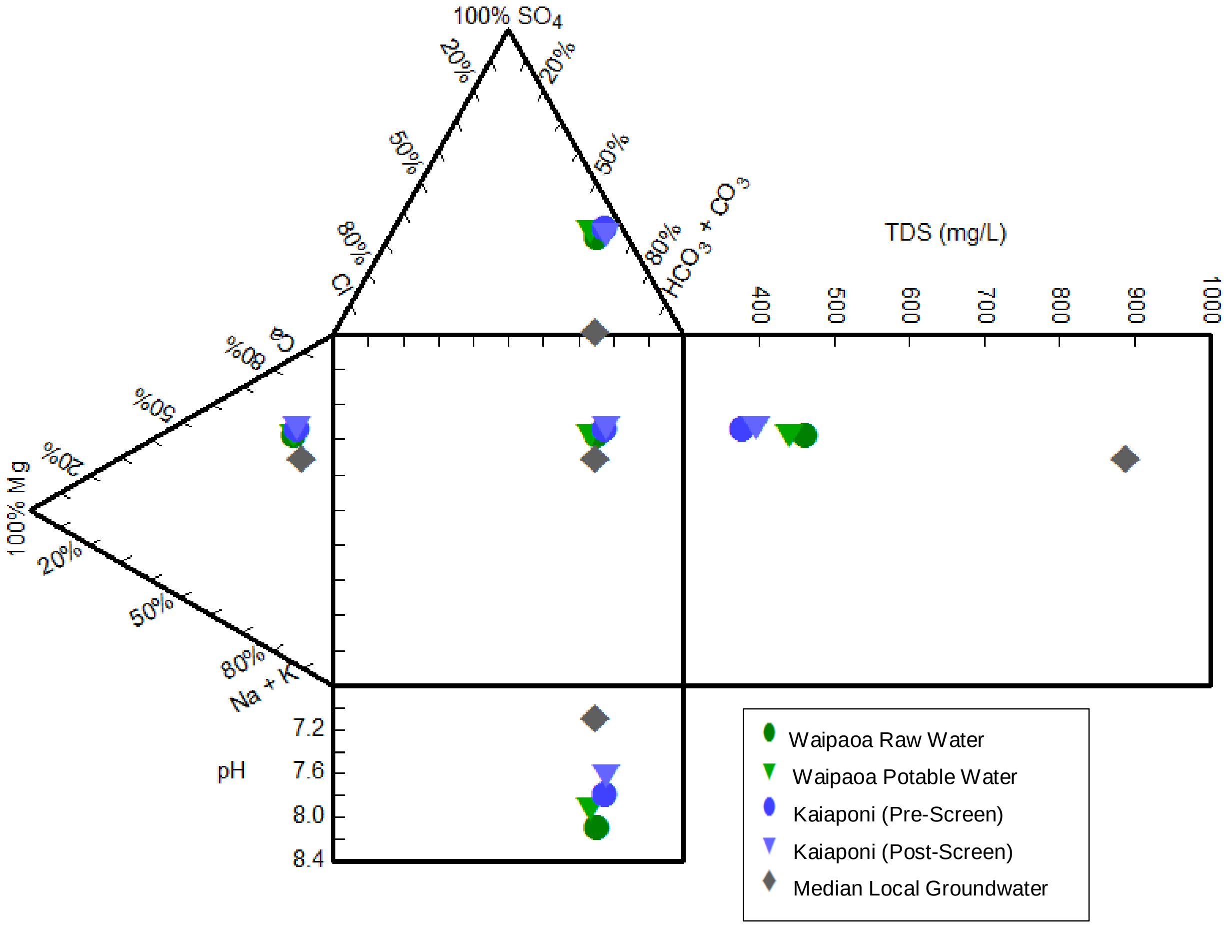

Figure 4: Durov diagram of raw and treated water from possible Waipaoa River sources. Median local groundwater from Golder (2015) is shown for comparison.

Nitrogen (as ammoniacal-N and nitrate) and phosphorous (as dissolved reactive phosphorus) were detected in water at the Kaiaponi infiltration gallery. The presence of nutrients at low concentrations is consistent with the Waipaoa River's agricultural catchment.

Organic carbon was detected in raw water at the Kaiaponi infiltration gallery (2.3 g/m^3), of which approximately half was dissolved (1.1 g/m^3). Organic carbon was detected in the post-screening sample at a higher concentration (3.9 g/m^3) and was mostly dissolved, consistent with the treatment at this location being limited to a screen for removal of suspended particles. As described previously in Golder (2015), most metals measured in the raw Waipaoa River Augmentation Plant water occurred at only very low or non-detectable concentrations. Aluminium, iron and manganese were selected for analysis in samples of Kaiaponi infiltration gallery water as they could contribute to metal oxide formation if present in injection water at appreciable concentrations. Concentrations of all three metals were generally low; aluminium and iron occurred as fine-grained suspended particulates (i.e., metals were not detectable in the dissolved fraction) and manganese occurred at a low concentration (0.083 g/m^3).

The samples of Kaiaponi infiltration gallery water were also submitted for analysis of a range of common pesticides and their derivatives. The results of this analysis are included in Appendix B and show that none of the pesticides tested were detected at concentrations exceeding laboratory detection limits.

Golder consider that the source water quality results are similar to that used in the Golder (2015) assessment of geochemical effects. Given the presence of nutrients and organic carbon the use of disinfection treatments at the Kaiaponi site would need to be managed similar to that proposed for the Waipaoa Augmentation Plant site (Golder 2015).

4.2.4 Water quality summary

As there were no substantial differences in water quality between the upstream (Kaiaponi) and downstream (Waipaoa Augmentation Plant) samples (other than chloride, which was higher at the Waipaoa Augmentation Plant), inflows from tributaries are expected to have only minor effects on Waipaoa River water quality during normal flow conditions.

Small differences in water quality were observed between the raw and filtered samples at the Kaiaponi infiltration gallery and the Waipaoa Augmentation Plant (i.e., pre- and post-treatment by filtration, settling, and disinfection by ultra-violet light and chlorine addition). However, as these treatment methods are not directly comparable, and additional treatment could be used if the Kaiaponi infiltration gallery was selected as the source of injection water for the MAR Pilot Trial, this assessment was primarily based on the results of the raw water quality analyses. In addition, this geochemical assessment is based on the results of one sampling event carried out in November 2015. There may be seasonal, land use and flow dependent changes to the Kaiaponi infiltration gallery water quality that will be assessed through further source water testing. This additional testing of the Waipaoa River water will be used to facilitate the design parameters for any water treatment system.

4.3 Conclusion

Based on the water quality information reviewed by Golder, the Waipaoa River water quality at the Kaiaponi infiltration gallery was of good quality and similar to raw water samples collected downstream at the Waipaoa Augmentation Plant. The water is alkaline and a calcium-bicarbonate type water, consistent with the limestone-bearing catchment.

Using river water obtained from the Kaiaponi infiltration gallery for the MAR Pilot Trial would be mostly similar to the Waipaoa Augmentation Plant. Therefore, the geochemical assessment presented in Golder (2015), which used a simple geochemical model to characterize the mixing of treated water from the Waipaoa Augmentation Plant with Makauri Aquifer groundwater, is considered an appropriate analogue for water sourced from the Kaiaponi infiltration gallery. The water quality from these two sources is nearly identical (Table 4).

Water pumped from the Kaiaponi intake gallery and treated using filters to remove suspended solids would be suitable for injection to the Makauri Aquifer during the Pilot Trial. The risk of physical clogging of the injection bore would be managed through removal of suspended solids by the filter system. The risk of chemical clogging, which could occur due to metal oxide formation at or around a well screen, would be similar to the risk described in Golder (2015). As described in Section 2.4, the risk of biological clogging, which could be caused by bacterial growth, will be managed by active monitoring and possible chemical addition, if required.

5.0 MONITORING

5.1 Water Level and Flow Monitoring

The flow of water into the injection bore will be monitored at the bore head works at Kaiaponi using the same methods as the primary site as outlined in Golder 2015.

Alternative groundwater level monitoring sites to those established for the Augmentation Plant site are proposed to be established if the Kaiaponi site is used. The sites would be monitored for the duration of the MAR Pilot Trial. In the same way as the Augmentation site, the Kaiaponi site water levels in the nearby standpipe piezometer installed during drilling will be monitored throughout the injection and recovery.

There are eight bores on or near the Kaiaponi Property tapping the Makauri Aquifer which are, therefore potential water level monitoring bore sites in the Makauri Aquifer (Table 6). In addition there are intermediate depth bores and shallow bores to select according to site access and proximity. These bores are all within one kilometre of the Kaiaponi preferred injection well site. The closest bores would be established as water quality monitoring sites in various directions from the potential injection site. More monitoring bores in the direction of the abstraction bores is recommended. Access and suitability of the bores is currently under investigation by GDC.

One or two of the closest bores in the shallow aquifer and at least two bores in the intermediate depth range will be selected for water level monitoring. Responses in the shallow aquifer are not expected to occur but this will be confirmed through monitoring of groundwater levels. A transducer may be used to take frequent regular automatic level readings.

Table 6: Potential bores for monitoring close or on Kaiaponi Property.

Bore number	Bore depth	Easting (m NZTM)	Northing (m NZTM)	Aquifer
GPE007	Unknown	2028406	5715867	Shallow bores
GPF120	Unknown	2029308	5715066	
GPE039	Unknown	2028607	5714564	
GPF026	3.3	2029408	5715266	
GPE021	7.6	2028206	5714764	
GPF142	9	2029408	5714665	
GPE057	12.9	2027705	5714964	Intermediate depth bores (Waipaoa Aquifer)
GPE036	15.2	2028707	5715065	
GPE028	16	2028506	5715867	
GPE031	17	2028512	5715918	
GPE009	24	2028507	5714865	
GPE049	28	2028607	5714564	
GPE013	40.8	2028508	5715944	
GPF024	42.7	2029107	5715567	
GPE017	45	2028806	5715867	
GPE008	67	2029107	5715266	Makauri Aquifer Bores
GPE030	68	2028506	5715366	
GPE034*	70	2028831	5714327	
GPE029	72	2028606	5715266	
GPF025	73	2029208	5715266	
GPE011	73.1	2028206	5714564	
GPE010	73.8	2028306	5714865	
GPF106*	76	2029328	5715415	

Note: * Currently monitored by GDC.

5.2 Water Quality Monitoring

Water quality monitoring will be carried out at the Kaiaponi Site consistent with the methods proposed in Golder (2015).

Additional water quality monitoring bores will be identified during site surveys carried out in early 2016. Bore GPF106 is currently monitored for water quality regularly by GDC and is located 1 km to the east of the potential injection site. Water quality sampling will be carried out on a selected shallow bore prior to commencement of injection and subsequently resampled if the water level monitoring data indicate a change inconsistent with natural recovery rates or background use.

There is potential variability in the source water quality at the Kaiaponi site. Additional testing of the Waipaoa River water throughout seasonal changes will be used to facilitate the design parameters for any water treatment system. An initial program for Kaiaponi source water quality monitoring parameters and monitoring frequency is provided in Appendix C.

6.0 WATER QUALITY MANAGEMENT MEASURES

Water from the Makauri Aquifer is primarily used for horticultural irrigation purposes. For some of the horticultural crops, it is critical that bacterial concentrations in the irrigation water remain low, in order to meet relevant food hygiene standards.

Under Phase 2 of the trial, the injected water will be treated to maintain the bacterial counts in the injected water at a very low level. It is expected that *E.coli* concentrations in the injected water during this phase of the trial would be below the laboratory detection limit.

Under Phase 1 of the trial, the injected water would not be treated to manage bacterial loads. As the nearest bores used for water supply are substantially more than 100 m from the area where the injection bore is planned, the trigger conditions are proposed to protect the quality of groundwater at a distance of 100 m from the injection bore. Golder recommends the following water quality triggers be adopted for the trial:

1) The *E.coli* concentration in the injected water should initially not exceed 100 cfu, which is considered to be a conservatively low concentration for the protection of water quality in the aquifer.

2) The *E.coli* data from the planned nearby monitoring bore (10 m away) shall be used to calculate an attenuation rate for bacteria in the aquifer. This attenuation rate shall be used to confirm that *E.coli* concentrations in the groundwater will decrease to below the detection limit within a radius of 100 m from the injection bore.

3) Once the attenuation rate for *E.coli* has been confirmed, the initial trigger concentration may be adjusted to enable the attenuation rate to tested under a range of injection concentrations and recharge rates.

If the monitoring of water levels or groundwater quality shows potential for adverse effects, the injection rate can be reduced through the flow control system or Phase 1 of the trial can be brought to a close if necessary. In the latter case, the second phase of the trial will be advanced and the chlorination system installed earlier than initially planned.

7.0 CONCLUSIONS

The proposed Poverty Bay MAR Pilot Trial involves injecting up to 100,000 m^3 of treated water to the Makauri Aquifer through a specifically designed injection bore. Based on our assessment of the aquifer and geochemical conditions, performing the proposed Pilot Trial on an injection bore at Kaiaponi would not result in significant effects on surrounding bore users or the aquifer.

A Pilot Trial planned for Kaiaponi would be divided into two phases, the first using filtered water and the second using filtered and treated water. Both phases would be carefully monitored to confirm the lack of effects on the aquifer water quality. Management measures have been proposed for the trial to protect the quality of groundwater for nearby users.

Should any biological growth occur in the injection bore, leading to reduced bore efficiency, this would be managed through the use of commercially available products approved by regulatory authorities.

8.0 LIMITATIONS

Your attention is drawn to the document, “Report Limitations”, as attached in Appendix D. The statements presented in that document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks to which this report relates which are associated with this project. The document is not intended to exclude or otherwise limit the obligations necessarily imposed by law on Golder Associates (NZ) Limited, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

9.0 REFERENCES

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APPENDIX A

Groundwater Data Summary

Table A1: Lithological logs for bores within 2 km of proposed injection site.

Bore no.	Start depth m	End depth m	Lithology
GPD005	0	65	Surface clay then silt
	65	71	Gravel and sand
GPD007	0	61	Blue pug
	61	69.2	Gravel
GPD008	0	5.4	Surface clay and pumice layers
	5.4	65.5	Grey silt with some timber
	65.5	69.5	Sand and gravel
	69.5	70.1	Blue silt
GPD089	0	80.7	Brown clay then blue and grey silt layers and some timber at 45.8
	80.7	85.3	Gravels
GPE012	0	65	Surface clay then silts
	65	68	Gravel
GPE013	0	4.6	Surface clay then pumice
	4.6	36.5	Grey silt
	36.5	41.4	Sands and gravel
	41.4	45.8	Silt
GPE034	0	3	Brown silt
	3	66.1	Grey silt timber and shells
	66.1	70	Sands and gravels
GPE059	0	4.2	Firmish brown clay
	4.2	6.4	Silty brown clay changing to very silty sandy brown clay
	6.4	8	Coarse blue sand cohesive
	8	16.8	Blue gravel changing to more sandy gravel from about 11.3 sands are relatively coarse
	16.8	29	Sandy gravel with some rotten wood vegetation and small bands of clay interspersed. Gravel also has small amount of alluvial argelitepapa type material
	29	41.1	Greasy grey clay
	41.1	44.3	Less greasy softer grey clay
	44.3	45	Fine blue gravel
	45	47.2	Coarse blue sand cohesive
	47.2	55.8	Bluegrey clay partly silty
	55.8	57	Fine blue gravel little water loss stays open
	57	59.1	Coarse blue gravellittle water loss stays open
	59.1	66.9	Grey greasy clay becoming very firm last 3.7
	66.9	67.4	Coarse blue gravelwater loss at 67m
	67.4	68.9	Very tight conglomerate type gravel with small water loss stays open

Bore no.	Start depth m	End depth m	Lithology
	68.9	69.8	Tight gravel rapid loss at 69.2 and 69.5 does not stay open past 68.9
	69.8	71.2	Tight gravel partly cohesive then finer and loose for last 0.6 approx.
	71.2	82.4	Greasy grey blue clay. Very firm towards base
	82.4	82.6	Blue gravel
	82.6	84.7	Blue sandstone coarse
	84.7	85.6	Tight blue gravel stays open
	85.6	87.2	Blue gravel easier partly running. Some water loss
	87.2	89.4	Greasy grey clay
GPF024	0	33.5	Surface clay then grey silt
	33.5	39.6	Pumice then sand
	39.6	42.7	Gravel
GPF105	0	61	Blue pug interpreted
	61	69.2	Gravel
GPF106	0	3.7	Brown silt
	3.7	27.4	Grey silt
	27.4	33.5	Sands
	33.5	54.9	Grey silt
	54.9	61	Sand
	61	64	Pumice
	64	71.6	Sands
	71.6	74.7	Small gravel
	74.7	77.7	Various gravels
GPF109	0	3	Brown silt
	3	35	Grey silt
	35	38.1	Sands
	38.1	41.2	Gravels
	41.2	57.9	Grey silt
	57.9	67.1	Sands
	67.1	91.4	Various sands silts and gravels and some timber
GPI032	0	10.6	Brown then grey silt
	10.6	15.2	Sands
	15.2	41.1	Grey silt
	41.1	42.6	Sand and gravel
	42.6	77.7	Grey silt
	77.7	81.1	Sands and gravel

Table A2: Bores within 2 km of Kaiaponi Site with depth between 50 and 90 m.

Bore number	Bore depth (m)	Location	Easting (NZTM)	Northing (NZTM)	Elevation (m RL)
GPF116	51		2029808	5715467	9.4
GPF098	54.8	Tuckers Rd Waerenga-A-Hika	2029808	5716068	10.7
GPI029	54.9		2027003	5715665	12.2
GPE041	55	Over Stopbank Ferry Rd	2028171	5716015	13.7
GPD090	58	Bushmere Road	2028708	5713663	10.2
GPF148	63	114 Harper Rd	2030203	5715590	9.0
GPF115	65	(Wp03) Harper Rd,Makauri	2029829	5715473	9.7
GPE008	67	S Hway 2	2029107	5715266	9.9
GPE012	68	S Hway 2 B/W Jackson & Harper Roads	2029409	5714565	8.9
GPE030	68	Bushmere Rd	2028506	5715366	12.7
GPF038	70	8 O'grady Rd	2030038	5713849	7.3
GPF163	70	23 Ogrady Road	2030068	5713939	7.4
GPE034	70	(Pt) Jackson Rd	2028831	5714327	10.3
GPD007	70.1	(Pt) 9 Jackson Rd	2029609	5714365	8.5
GPD008	70.1	(Wp98) 475 Matawai Rd S.H.2	2029641	5714126	8.4
GPF105	71	Shw.2 Hika Nr Jackson Rd	2029566	5714549	8.9
GPD005	71	Jackson Rd Waerenga-A-Hika	2029020	5713897	8.9
GPD009	71.6	Shwd Waerenga-A-Hika	2029710	5713964	8.0
GPF091	71.9	23 O'grady Rd	2030110	5714065	7.4
GPE029	72	Bushmere Road	2028606	5715266	12.6
GPF094	72.2	O'grady Rd Waerenga-A-Hika	2030053	5713884	7.3
GPF025	73	S Hway 2 B/W Ferry And Harper Roads	2029208	5715266	10.1
GPE011	73.1	Bushmere Road	2028206	5714564	12.5
GPE010	73.8	Bushmere Rd	2028306	5714865	13.0
GPF093	74	23 O'grady Road	2030110	5714075	7.5
GPD115	75.1	(Wp98,Pt) 54 Bolitho Rd	2028054	5713434	10.9
GPF162	76	50 Harper Road Gisborne	2029565	5715253	9.0
GPD140	76.2		2029710	5713964	8.0
GPD094	76.2	Shw.2 Waerenga-A-Hika	2029610	5713664	7.8
GPD135	76.2	(Pt) Shw.2 Nr O'Grady Rd	2029753	5713948	7.9
GPF096	76.2	(Wp98) Shw.2 Waerenga-A-Hika	2029021	5715875	12.2
GPF111	79.2	(Wp98, Pt) Tucker Rd Shw2 End	2029564	5716141	11.5
GPF074	79.2	(Pt) Tuckers Rd Shw 2 End	2029569	5716136	11.2
GPI025	81		2027103	5715765	13.4
GPI006	81	Lavenham Road	2026903	5716166	13.5
GPI032	81.3	(Wp99) 437 Kirkpatrick Rd	2027259	5714224	12.4
GPD096	81.4	Bushmere Rd Nr Jackson Rd	2029122	5713717	8.9

Bore number	Bore depth (m)	Location	Easting (NZTM)	Northing (NZTM)	Elevation (m RL)
GPF109	82.3	(Pt) 619 Tucker Rd	2029307	5716068	11.5
GPI026	83	(Pt) 47 Judd Rd	2027133	5715738	13.1
GPE042	85		2028205	5715967	15.3
GPD089	85.3	(Wp98,Pt) Jackson Rd	2028866	5713819	9.3
GPF064	85.4	(Wp98,Pt) 77 O'Grady Road	2030287	5714491	7.8
GPF147	85.4	(Wp99) Tuckers Rd ABC Blk	2029507	5716168	11.4
GPE059	89.4	Over Stopbank Ferry Rd	2028168	5716018	13.7

Table A3: Consented groundwater abstraction within 2 km.

Bore	Consent holder	Take location	Aquifer	Consented volume (m^3/day)	Consented rate (L/s)
GPF147	Leaderbrand Produce Ltd	Tucker Rd	Makauri	6,000	60
GPI032	A & K McKay	437 Kirkpatrick Rd	Makauri	110	3.8
GPD089	A B & B N Kemp P/ship	97 Jackson Rd	Makauri	100	3
GPD008	A C & P V Gayford	475 Matawai Rd	Makauri	100	3
GPD185	W Mortleman	458 Matawai Road	Makauri	180	4.5
GPF162	Anthony/Peter Thorpe	Harper Road	Makauri	74	5
GPI032	Lanark Orchard	436 Kirkpatrick Rd	Makauri	0	0
GPF115	Karaka Kiwi Farm	87 Harper Rd	Makauri	0	0
GPD115	B R & C A Baty	54 Bolitho Rd	Makauri	210	3.8
GPF064	N S & Y M Brown	77 O'Grady Rd	Makauri	285	3.3
GPF091	Haisman Family Trust	24 Ogrady Road	Makauri	20	2
GPF148	Harpers Gold Ltd	110 Harper Rd	Makauri	1,550	18.6
GPF115	Eastern Bay Orchards	86 Harper Rd	Makauri	1,100	18
GPI026	Judd Co Ltd	47 Judd Rd	Makauri	1944	30
GPF038	TBD Ltd	8 O'Grady Rd	Makauri	17.5	5
GPI018	I E Tietjen	447 Kirkpatrick Rd	Shallow Fluvial	480	5.55
GPD004	J D S & J M Dymock	99 Jackson Rd	Shallow Fluvial	114	2.25
GPI039	Judd Co Ltd	Judd Rd	Shallow Fluvial	1,620	25
GPJ011	F J Lewis & A W Hope	367 Kirkpatrick Rd	Shallow Fluvial	0	0
GPF096	Te Whanau-a-Taupara (or Corson Grain)	Hyland Rd	Unknown	0	0
GPE031	M Broad	21 Ferry Rd	Waipaoa	100	4
GPE045	M Peach	73 Ingram Rd	Waipaoa	190	4.3
GPE006	H Lardelli	Matawai Rd	Waipaoa	100	2.25
GPF075	Te Whanau-a-Taupara (or Corson Grain)	752 Matawai Rd	Waipaoa	110	5

APPENDIX B

Waipaoa Source Water – Water Quality Monitoring Results

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

R J Hill Laboratories Limited
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Hamilton 3240, New Zealand

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ANALYSIS REPORT

Client:	Golder Associates (NZ) Limited	**Lab No:**	1501663 POPv1
Contact:	Clare Houlbrooke	**Date Registered:**	17-Nov-2015
	C/- Golder Associates (NZ) Limited	**Date Reported:**	19-Nov-2015
	PO Box 19479	**Quote No:**	72840
	HAMILTON 3244	**Order No:**	
		Client Reference:	MR Trace DL
		Submitted By:	Mr B Sinclair

Sample Type: Aqueous

Sample Name:	Meter 16-Nov-2015 8:30 am	Arkal 16-Nov-2015 8:30 am			
Lab Number:	1501663.1	1501663.2			
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS					
Analytes Detected:	None	None			
Multiresidue Extra Pesticides Trace in Water samples by Liq/liq					
Analytes Detected:	None	None			
Organochlorine Pesticides Trace in water, By Liq/Liq					
Analytes Detected:	None	None			

Please refer to the detection limits table for the list of analytes screened and their detection limits.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Multiresidue Pesticides Trace in Water by Liq/liq GCMS	Liquid/liquid extraction, GPC (if required), GC-MS analysis	-	1-2
Multiresidue Extra Pesticides Trace in Water samples by Liq/liq			
Bendiocarb	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Benodanil	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Bifenthrin	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00002 g/m^3	1-2
Bromophos-ethyl	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Bupirimate	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Buprofezin	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Captafol	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.0002 g/m^3	1-2
Carboxin	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Chlorfenvinphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Chlorpropham	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Chlozolinate	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Coumaphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Cyproconazole	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Cyprodinil	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Demeton-S-methyl	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Dichlobenil	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Dichlofenthion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Dicofol	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.0002 g/m^3	1-2
Dicrotophos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Dinocap	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.0003 g/m^3	1-2
Disulfoton	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
EPN	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Esfenvalerate	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Ethion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Etrimfos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Famphur	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenamiphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenarimol	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenitrothion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenpropathrin	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fensulfothion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenthion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Fenvalerate	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Folpet	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Hexythiazox	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.0002 g/m^3	1-2
Imazalil	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.0002 g/m^3	1-2
Indoxacarb	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Iodofenphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Isazophos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Isofenphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00002 g/m^3	1-2
Leptophos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Methacrifos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Methidathion	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Methiocarb	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Mevinphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Nitrofen	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Nitrothal-isopropyl	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Oxychlordane	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00002 g/m^3	1-2
Penconazole	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Phorate	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Phosmet	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Phosphamidon	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Propetamphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00006 g/m^3	1-2
Propham	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Prothiofos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Pyrazophos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Pyrifenox	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Pyrimethanil	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Quintozene	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Sulfotep	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Tebufenpyrad	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00002 g/m^3	1-2
Tetrachlorvinphos	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2
Thiometon	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00008 g/m^3	1-2
Triadimefon	Liquid / liquid extraction, GPC (if required), GC-MS SIM analysis. Roos et al (modified).	0.00004 g/m^3	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Detection Limits

Analytes	Detection Limit
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS	
Acetochlor	0.00004 g/m^3
Alachlor	0.00004 g/m^3
Atrazine	0.00004 g/m^3
Atrazine-desethyl	0.00004 g/m^3
Atrazine-desisopropyl	0.00008 g/m^3
Azaconazole	0.00002 g/m^3
Azinphos-methyl	0.00008 g/m^3
Benalaxyl	0.00002 g/m^3
Bitertanol	0.00008 g/m^3
Bromacil	0.00004 g/m^3
Bromopropylate	0.00004 g/m^3
Butachlor	0.00004 g/m^3
Captan	0.00008 g/m^3
Carbaryl	0.00004 g/m^3
Carbofenothion	0.00004 g/m^3
Carbofuran	0.00004 g/m^3
Chlorfluazuron	0.00004 g/m^3
Chlorothalonil	0.00004 g/m^3
Chlorpyrifos	0.00004 g/m^3
Chlorpyrifos-methyl	0.00004 g/m^3
Chlortoluron	0.00008 g/m^3
Cyanazine	0.00004 g/m^3
Cyfluthrin	0.00004 g/m^3
Cyhalothrin	0.00004 g/m^3
Cypermethrin	0.00008 g/m^3
Deltamethrin (including Tralomethrin)	0.00006 g/m^3
Diazinon	0.00002 g/m^3
Dichlofluanid	0.00004 g/m^3
Dichloran	0.0002 g/m^3
Dichlorvos	0.00008 g/m^3
Difenoconazole	0.00008 g/m^3
Dimethoate	0.00008 g/m^3
Diphenylamine	0.00008 g/m^3
Diuron	0.00004 g/m^3
Fenpropimorph	0.00004 g/m^3
Fluazifop-butyl	0.00004 g/m^3
Fluometuron	0.00004 g/m^3
Flusilazole	0.00004 g/m^3
Fluvalinate	0.00004 g/m^3
Furalaxyl	0.00002 g/m^3
Haloxyfop-methyl	0.00004 g/m^3
Hexaconazole	0.00004 g/m^3
Hexazinone	0.00002 g/m^3
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	0.0002 g/m^3
Kresoxim-methyl	0.00002 g/m^3
Linuron	0.00005 g/m^3
Malathion	0.00004 g/m^3
Metalaxyl	0.00004 g/m^3
Metolachlor	0.00004 g/m^3
Metribuzin	0.00004 g/m^3
Molinate	0.00008 g/m^3
Myclobutanil	0.00004 g/m^3
Naled	0.0002 g/m^3
Norflurazon	0.00008 g/m^3
Oxadiazon	0.00004 g/m^3
Oxyfluorfen	0.00002 g/m^3
Paclobutrazol	0.00004 g/m^3
Parathion-ethyl	0.00004 g/m^3
Parathion-methyl	0.00004 g/m^3
Pendimethalin	0.00004 g/m^3
Permethrin	0.00002 g/m^3
Pirimicarb	0.00004 g/m^3
Pirimiphos-methyl	0.00004 g/m^3
Prochloraz	0.0002 g/m^3
Procymidone	0.00004 g/m^3
Prometryn	0.00002 g/m^3
Propachlor	0.00004 g/m^3
Propanil	0.0002 g/m^3
Propazine	0.00002 g/m^3
Propiconazole	0.00004 g/m^3
Pyriproxyfen	0.00004 g/m^3
Quizalofop-ethyl	0.00004 g/m^3
Simazine	0.00004 g/m^3
Simetryn	0.00004 g/m^3
Sulfentrazone	0.0002 g/m^3
TCMTB [2-(thiocyanomethylthio) benzothiazole,Busan]	0.00008 g/m^3
Tebuconazole	0.00004 g/m^3
Terbacil	0.00004 g/m^3
Terbufos	0.00004 g/m^3
Terbumeton	0.00004 g/m^3
Terbuthylazine	0.00002 g/m^3
Terbuthylazine-desethyl	0.00004 g/m^3
Terbutryn	0.00004 g/m^3
Thiabendazole	0.0002 g/m^3
Thiobencarb	0.00004 g/m^3
Tolylfluanid	0.00002 g/m^3
Triazophos	0.00004 g/m^3
Trifluralin	0.00004 g/m^3
Vinclozolin	0.00004 g/m^3
Multiresidue Extra Pesticides Trace in Water samples by Liq/liq	
Bendiocarb	0.00004 g/m^3
Benodanil	0.00008 g/m^3
Bifenthrin	0.00002 g/m^3
Bromophos-ethyl	0.00004 g/m^3
Bupirimate	0.00004 g/m^3
Buprofezin	0.00004 g/m^3
Captafol	0.0002 g/m^3
Carbofenothion	0.00004 g/m^3
Carboxin	0.00004 g/m^3
Chlorfenvinphos	0.00004 g/m^3
Chlorpropham	0.00008 g/m^3
Chlozolinate	0.00004 g/m^3
Coumaphos	0.00008 g/m^3
Cyproconazole	0.00004 g/m^3
Cyprodinil	0.00004 g/m^3
Demeton-S-methyl	0.00008 g/m^3
Dichlobenil	0.00004 g/m^3
Dichlofenthion	0.00004 g/m^3
Dicofol	0.0002 g/m^3
Dicrotophos	0.00004 g/m^3
Dinocap	0.0003 g/m^3
Disulfoton	0.00004 g/m^3
EPN	0.00004 g/m^3
Esfenvalerate	0.00004 g/m^3
Ethion	0.00004 g/m^3
Etrimfos	0.00004 g/m^3
Famphur	0.00004 g/m^3
Fenamiphos	0.00004 g/m^3
Fenarimol	0.00004 g/m^3
Fenitrothion	0.00004 g/m^3
Fenpropathrin	0.00004 g/m^3
Fensulfothion	0.00004 g/m^3
Fenthion	0.00004 g/m^3
Fenvalerate	0.00004 g/m^3
Folpet	0.00008 g/m^3
Hexythiazox	0.0002 g/m^3
Imazalil	0.0002 g/m^3
Indoxacarb	0.00004 g/m^3
Iodofenphos	0.00004 g/m^3
Isazophos	0.00004 g/m^3
Isofenphos	0.00002 g/m^3
Leptophos	0.00004 g/m^3
Methacrifos	0.00004 g/m^3
Methidathion	0.00004 g/m^3
Methiocarb	0.00004 g/m^3
Mevinphos	0.00008 g/m^3
Nitrofen	0.00008 g/m^3
Nitrothal-Isopropyl	0.00004 g/m^3
Oxychlordane	0.00002 g/m^3
Penconazole	0.00004 g/m^3
Phorate	0.00008 g/m^3
Phosmet	0.00004 g/m^3
Phosphamidon	0.00004 g/m^3
Propetamphos	0.00006 g/m^3
Propham	0.00004 g/m^3
Prothiofos	0.00004 g/m^3
Pyrazophos	0.00004 g/m^3
Pyrifenox	0.00004 g/m^3
Pyrimethanil	0.00004 g/m^3
Quintozene	0.00008 g/m^3
Sulfotep	0.00004 g/m^3
Tebufenpyrad	0.00002 g/m^3
Tetrachlorvinphos	0.00004 g/m^3
Thiometon	0.00008 g/m^3
Triadimefon	0.00004 g/m^3
Organochlorine Pesticides Trace in water, By Liq/Liq	
Aldrin	0.000005 g/m^3
alpha-BHC	0.000010 g/m^3
beta-BHC	0.000010 g/m^3
delta-BHC	0.000010 g/m^3
gamma-BHC (Lindane)	0.000010 g/m^3
cis-Chlordane	0.000005 g/m^3

Analytes	Detection Limit
Organochlorine Pesticides Trace in water, By Liq/Liq	
trans-Chlordane	0.000005 g/m^3
2,4'-DDD	0.000010 g/m^3
Total DDT Isomers	0.00006 g/m^3
4,4'-DDD	0.000010 g/m^3
2,4'-DDE	0.000010 g/m^3
4,4'-DDE	0.000010 g/m^3
2,4'-DDT	0.000010 g/m^3
4,4'-DDT	0.000010 g/m^3
Dieldrin	0.000005 g/m^3
Endosulfan I	0.000010 g/m^3
Endosulfan II	0.000010 g/m^3
Endosulfan sulfate	0.000010 g/m^3
Endrin	0.000005 g/m^3
Endrin aldehyde	0.000005 g/m^3
Endrin ketone	0.000010 g/m^3
Heptachlor	0.000005 g/m^3
Heptachlor epoxide	0.000005 g/m^3
Hexachlorobenzene	0.00004 g/m^3
Methoxychlor	0.000005 g/m^3
Total Chlordane [(cis+trans)* 100/42]	0.00002 g/m^3

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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ANALYSIS REPORT

Client:	Golder Associates (NZ) Limited	**Lab No:**	1501991	DWPv1
Contact:	Clare Houlbrooke	**Date Registered:**	17-Nov-2015	
	C/- Golder Associates (NZ) Limited	**Date Reported:**	24-Nov-2015	
	PO Box 19479	**Quote No:**	68584	
	HAMILTON 3244	**Order No:**	23097	
		Client Reference:	Gisborne Analysis	
		Submitted By:	Mr B Sinclair	

Sample Type: Aqueous

	Sample Name:	Meter 16-Nov-2015 8:30 am	Arkal 16-Nov-2015 8:45 am	**Guideline Value**	**Maximum Acceptable Values (MAV)**
	Lab Number:	1501991.1	1501991.2		
Individual Tests					
Sum of Anions	meq/L	6.0	6.3	-	-
Sum of Cations	meq/L	5.9	6.3	-	-
pH	pH Units	7.8	7.6	7.0 - 8.5	-
Total Alkalinity	g/m^3 as $CaCO_3$	184	196	-	-
Bicarbonate	g/m^3 at 25°C	220	240	-	-
Total Hardness	g/m^3 as $CaCO_3$	230	250	< 200	-
Electrical Conductivity (EC)	mS/m	56.5	59.1	-	-
Approx Total Dissolved Salts	g/m^3	380	400	< 1000	-
Total Suspended Solids	g/m^3	< 3	3	-	-
Total Dissolved Solids (TDS)	g/m^3	380	400	-	-
Dissolved Aluminium	g/m^3	< 0.003	< 0.003	< 0.1	-
Total Aluminium	g/m^3	0.0107	0.029	< 0.1	-
Dissolved Calcium	g/m^3	79	86	-	-
Dissolved Iron	g/m^3	< 0.02	< 0.02	< 0.2	-
Total Iron	g/m^3	0.022	0.113	< 0.2	-
Dissolved Magnesium	g/m^3	8.3	8.6	-	-
Dissolved Manganese	g/m^3	0.083	0.059	< 0.04 (Staining) < 0.10 (Taste)	0.4
Total Manganese	g/m^3	0.092	0.066	< 0.04 (Staining) < 0.10 (Taste)	0.4
Dissolved Potassium	g/m^3	3.4	3.5	-	-
Dissolved Sodium	g/m^3	27	27	< 200	-
Chloride	g/m^3	10.4	10.6	< 250	-
Fluoride	g/m^3	0.17	0.17	-	1.5
Total Phosphorus	g/m^3	0.010	0.009	-	-
Total Sulphide	g/m^3	< 0.002	< 0.002	-	-
Sulphate	g/m^3	96	98	< 250	-
Dissolved Organic Carbon (DOC)	g/m^3	1.1	3.6	-	-
Total Organic Carbon (TOC)	g/m^3	2.3	3.9	-	-
Nutrient Profile					
Total Ammoniacal-N	g/m^3	0.022	0.016	< 1.2	-
Nitrite-N	g/m^3	< 0.002	0.002	-	0.06 0.91 (short term)
Nitrate-N	g/m^3	0.086	0.093	-	11.3
Nitrate-N + Nitrite-N	g/m^3	0.087	0.095	-	-
Dissolved Reactive Phosphorus	g/m^3	0.010	0.008	-	-

Note: The Guideline Values and Maximum Acceptable Values (MAV) are taken from the publication 'Drinking-water Standards for New Zealand 2005 (Revised 2008)', Ministry of Health. Copies of this publication are available from http://www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2008

The Maximum Acceptable Values (MAVs) have been defined by the Ministry of Health for parameters of health significance and should not be exceeded. The Guideline Values are the limits for aesthetic determinands that, if exceeded, may render the water unattractive to consumers.

Note that the units g/m^3 are the same as mg/L and ppm.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Nutrient Profile		0.0010 - 0.010 g/m^3	1-2
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-2
Total Phosphorus Digestion	Acid persulphate digestion.	-	1-2
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 22nd ed. 2012.	0.07 meq/L	1-2
Total cations for anion/cation balance check	Sum of cations as mEquiv/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H^+) also included in calculation if available. APHA 1030 E 22nd ed. 2012.	0.05 meq/L	1-2
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22nd ed. 2012.	1.0 g/m^3 as $CaCO_3$	1-2
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 22nd ed. 2012.	1.0 g/m^3 at 25°C	1-2
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22nd ed. 2012.	0.1 mS/m	1-2
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m^3	1-2
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m^3	1-2
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) 22nd ed. 2012.	10 g/m^3	1-2
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-2
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.003 g/m^3	1-2
Total Aluminium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.0032 g/m^3	1-2
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1-2
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1-2
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.021 g/m^3	1-2
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1-2
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1-2
Total Manganese	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m^3	1-2
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1-2
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1-2

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl$^-$ E (modified from continuous flow analysis) 22nd ed. 2012.	0.5 g/m^3	1-2
Fluoride	Direct measurement, ion selective electrode. APHA 4500-F$^-$ C 22nd ed. 2012.	0.05 g/m^3	1-2
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH$_4$-N = NH$_4$+-N + NH$_3$-N). APHA 4500-NH$_3$ F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m^3	1-2
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO$_3^-$ I 22nd ed. 2012 (modified).	0.002 g/m^3	1-2
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1-2
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO$_3^-$ I 22nd ed. 2012 (modified).	0.002 g/m^3	1-2
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m^3	1-2
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P B & E (modified from manual analysis) 22nd ed. 2012. Also modified to include the use of a reductant to eliminate interference from arsenic present in the sample. NWASCA, Water & soil Miscellaneous Publication No. 38, 1982.	0.004 g/m^3	1-2
Sulphide Distillation	Acid distillation of sample into alkaline trapping solution using Simple Distillation system. APHA 4500-S^{2-} I 22nd ed. 2012.	-	1-2
Total Sulphide	Sulphide distillation. Automated methylene blue colorimetry, discrete analyser. APHA 4500-S^{2-} I (modified) 22nd ed. 2012.	0.002 g/m^3	1-2
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m^3	1-2
Dissolved Organic Carbon (DOC)	Filtered sample, Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC. APHA 5310 C (modified) 22nd ed. 2012.	0.5 g/m^3	1-2
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC. APHA 5310 C (modified) 22nd ed. 2012.	0.5 g/m^3	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Gisborne District Council	**Lab No:**	1224687 SPv1
Contact:	Gayle Cave	**Date Registered:**	17-Jan-2014
	C/- Gisborne District Council	**Date Reported:**	29-Jan-2014
	PO Box 747	**Quote No:**	32659
	GISBORNE 4040	**Order No:**	6333
		Client Reference:	Raw Water
		Submitted By:	Judith Robertson

Sample Type: Aqueous

	Sample Name:	Waipaoa Raw				
	Lab Number:	1224687.1				
Individual Tests						
Apparent Hazen Colour	Hazen units	< 5	-	-	-	-
Turbidity	NTU	1.96	-	-	-	-
pH	pH Units	8.1	-	-	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	187	-	-	-	-
Bicarbonate	g/m^3 at 25°C	230	-	-	-	-
Electrical Conductivity (EC)	mS/m	54.9	-	-	-	-
Dissolved Bromine*	g/m^3	0.040	-	-	-	-
Total Mercury	g/m^3	< 0.00008	-	-	-	-
Total Cyanide	g/m^3	< 0.0010	-	-	-	-
Fluoride	g/m^3	0.14	-	-	-	-
Total Ammoniacal-N	g/m^3	< 0.010	-	-	-	-
Nitrite-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N + Nitrite-N	g/m^3	< 0.002	-	-	-	-
Dissolved Reactive Phosphorus	g/m^3	< 0.004	-	-	-	-
Reactive Silica	g/m^3 as SiO$_2$	9.8	-	-	-	-
Sulphate	g/m^3	95	-	-	-	-
Absorbance at 254 nm	AU cm^{-1}	0.053	-	-	-	-
Drinking water metals suite, dissolved, trace						
Total Hardness	g/m^3 as CaCO$_3$	230	-	-	-	-
Dissolved Aluminium	g/m^3	0.021	-	-	-	-
Dissolved Antimony	g/m^3	< 0.0002	-	-	-	-
Dissolved Arsenic	g/m^3	< 0.0010	-	-	-	-
Dissolved Barium	g/m^3	0.098	-	-	-	-
Dissolved Beryllium	g/m^3	< 0.00010	-	-	-	-
Dissolved Boron	g/m^3	0.132	-	-	-	-
Dissolved Cadmium	g/m^3	< 0.00005	-	-	-	-
Dissolved Calcium	g/m^3	78	-	-	-	-
Dissolved Chromium	g/m^3	< 0.0005	-	-	-	-
Dissolved Copper	g/m^3	0.0006	-	-	-	-
Dissolved Iron	g/m^3	< 0.02	-	-	-	-
Dissolved Lead	g/m^3	< 0.00010	-	-	-	-
Dissolved Lithium	g/m^3	0.022	-	-	-	-
Dissolved Magnesium	g/m^3	9.3	-	-	-	-
Dissolved Manganese	g/m^3	< 0.0005	-	-	-	-
Dissolved Mercury	g/m^3	< 0.00008	-	-	-	-
Dissolved Molybdenum	g/m^3	0.0014	-	-	-	-
Dissolved Nickel	g/m^3	0.0012	-	-	-	-

Sample Type: Aqueous

Sample Name:		Waipaoa Raw				
Lab Number:		1224687.1				
Drinking water metals suite, dissolved, trace						
Dissolved Potassium	g/m^3	3.2	-	-	-	-
Dissolved Selenium	g/m^3	< 0.0010	-	-	-	-
Dissolved Silver	g/m^3	< 0.00010	-	-	-	-
Dissolved Sodium	g/m^3	29	-	-	-	-
Dissolved Tin	g/m^3	< 0.0005	-	-	-	-
Dissolved Uranium	g/m^3	0.00045	-	-	-	-
Dissolved Zinc	g/m^3	< 0.0010	-	-	-	-
Acid Herbicides Screen in Water by LCMSMS						
Acifluorfen	g/m^3	< 0.0004	-	-	-	-
Bentazone	g/m^3	< 0.0004	-	-	-	-
Bromoxynil	g/m^3	< 0.0004	-	-	-	-
Clopyralid	g/m^3	< 0.0004	-	-	-	-
2,4-Dichlorophenoxyacetic acid (24D)	g/m^3	< 0.0004	-	-	-	-
2,4-Dichlorophenoxybutyric acid (24DB)	g/m^3	< 0.0004	-	-	-	-
Dicamba	g/m^3	< 0.0004	-	-	-	-
Dichlorprop	g/m^3	< 0.0004	-	-	-	-
Fluazifop	g/m^3	< 0.0004	-	-	-	-
Fluroxypyr	g/m^3	< 0.0004	-	-	-	-
Haloxyfop	g/m^3	< 0.0004	-	-	-	-
2-methyl-4-chlorophenoxyacetic acid (MCPA)	g/m^3	< 0.0004	-	-	-	-
2-methyl-4-chlorophenoxybutanoic acid (MCPB)	g/m^3	< 0.0004	-	-	-	-
Mecoprop	g/m^3	< 0.0004	-	-	-	-
Oryzalin	g/m^3	< 0.0004	-	-	-	-
2,3,4,6-Tetrachlorophenol (TCP)	g/m^3	< 0.0004	-	-	-	-
2,4,5-trichlorophenoxypropionic acid (245TP,Fenoprop, Silvex)	g/m^3	< 0.0004	-	-	-	-
2,4,5-Trichlorophenoxyacetic acid (245T)	g/m^3	< 0.0004	-	-	-	-
Pentachlorophenol (PCP)	g/m^3	< 0.0004	-	-	-	-
Picloram	g/m^3	< 0.0004	-	-	-	-
Quizalofop	g/m^3	< 0.0004	-	-	-	-
Triclopyr	g/m^3	< 0.0004	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m^3	< 0.02	-	-	-	-
Organochlorine/Organonitro&phosphorus Pest.s Drinking Water						
Alachlor	g/m^3	< 0.00004	-	-	-	-
Aldrin	g/m^3	< 0.000005	-	-	-	-
Atrazine	g/m^3	< 0.00004	-	-	-	-
Atrazine-desethyl	g/m^3	< 0.00004	-	-	-	-
Atrazine-desisopropyl	g/m^3	< 0.00008	-	-	-	-
Azinphos-methyl	g/m^3	< 0.00008	-	-	-	-
gamma-BHC (Lindane)	g/m^3	< 0.000010	-	-	-	-
Bromacil	g/m^3	< 0.00004	-	-	-	-
Carbofuran	g/m^3	< 0.00004	-	-	-	-
cis-Chlordane	g/m^3	< 0.000005	-	-	-	-
trans-Chlordane	g/m^3	< 0.000005	-	-	-	-
Chlorpyrifos	g/m^3	< 0.00004	-	-	-	-
Chlorpyrifos-methyl	g/m^3	< 0.00004	-	-	-	-
Chlortoluron	g/m^3	< 0.00008	-	-	-	-
Cyanazine	g/m^3	< 0.00004	-	-	-	-
2,4'-DDD	g/m^3	< 0.000010	-	-	-	-
4,4'-DDD	g/m^3	< 0.000010	-	-	-	-
2,4'-DDE	g/m^3	< 0.000010	-	-	-	-
4,4'-DDE	g/m^3	< 0.000010	-	-	-	-
2,4'-DDT	g/m^3	< 0.000010	-	-	-	-

Sample Type: Aqueous						
Sample Name:		Waipaoa Raw				
Lab Number:		1224687.1				
Organochlorine/Organonitro&phosphorus Pest.s Drinking Water						
4,4'-DDT	g/m^3	< 0.000010	-	-	-	-
Diazinon	g/m^3	< 0.00002	-	-	-	-
Dieldrin	g/m^3	< 0.000005	-	-	-	-
Dimethoate	g/m^3	< 0.00008	-	-	-	-
Diuron	g/m^3	< 0.00004	-	-	-	-
Endrin	g/m^3	< 0.000005	-	-	-	-
Endrin aldehyde	g/m^3	< 0.000005	-	-	-	-
Endrin ketone	g/m^3	< 0.000010	-	-	-	-
Heptachlor	g/m^3	< 0.000005	-	-	-	-
Heptachlor epoxide	g/m^3	< 0.000005	-	-	-	-
Hexachlorobenzene	g/m^3	< 0.00004	-	-	-	-
Hexazinone	g/m^3	< 0.00002	-	-	-	-
Malathion	g/m^3	< 0.00004	-	-	-	-
Metalaxyl	g/m^3	< 0.00004	-	-	-	-
Methoxychlor	g/m^3	< 0.000005	-	-	-	-
Metolachlor	g/m^3	< 0.00004	-	-	-	-
Metribuzin	g/m^3	< 0.00004	-	-	-	-
Molinate	g/m^3	< 0.00008	-	-	-	-
Oxadiazon	g/m^3	< 0.00004	-	-	-	-
Parathion-methyl	g/m^3	< 0.00004	-	-	-	-
Pendimethalin	g/m^3	< 0.00004	-	-	-	-
Permethrin	g/m^3	< 0.00002	-	-	-	-
Pirimiphos-methyl	g/m^3	< 0.00004	-	-	-	-
Procymidone	g/m^3	< 0.00004	-	-	-	-
Prometryn	g/m^3	< 0.00002	-	-	-	-
Propanil	g/m^3	< 0.0002	-	-	-	-
Propazine	g/m^3	< 0.00002	-	-	-	-
Pyriproxyfen	g/m^3	< 0.00004	-	-	-	-
Simazine	g/m^3	< 0.00004	-	-	-	-
Terbacil	g/m^3	< 0.00004	-	-	-	-
Terbuthylazine	g/m^3	0.00011	-	-	-	-
Terbuthylazine-desethyl	g/m^3	< 0.00004	-	-	-	-
Thiabendazole	g/m^3	< 0.0002	-	-	-	-
Total Chlordane [(cis+trans)*100/42]	g/m^3	< 0.00002	-	-	-	-
Trifluralin	g/m^3	< 0.00004	-	-	-	-
Haloethers Trace in SVOC Water Samples by GC-MS						
Bis(2-chloroethoxy) methane	g/m^3	< 0.0005	-	-	-	-
Bis(2-chloroethyl)ether	g/m^3	< 0.0005	-	-	-	-
Bis(2-chloroisopropyl)ether	g/m^3	< 0.0005	-	-	-	-
4-Bromophenyl phenyl ether	g/m^3	< 0.0005	-	-	-	-
4-Chlorophenyl phenyl ether	g/m^3	< 0.0005	-	-	-	-
Nitrogen containing compounds Trace in SVOC Water Samples, GC-MS						
3,3'-Dichlorobenzidine	g/m^3	< 0.003	-	-	-	-
2,4-Dinitrotoluene	g/m^3	< 0.0010	-	-	-	-
2,6-Dinitrotoluene	g/m^3	< 0.0010	-	-	-	-
Nitrobenzene	g/m^3	< 0.0005	-	-	-	-
N-Nitrosodi-n-propylamine	g/m^3	< 0.0010	-	-	-	-
N-Nitrosodiphenylamine	g/m^3	< 0.0010	-	-	-	-
Organochlorine Pesticides Trace in SVOC Water Samples by GC-MS						
Aldrin	g/m^3	< 0.0005	-	-	-	-
alpha-BHC	g/m^3	< 0.0005	-	-	-	-
beta-BHC	g/m^3	< 0.0005	-	-	-	-
delta-BHC	g/m^3	< 0.0005	-	-	-	-
gamma-BHC (Lindane)	g/m^3	< 0.0005	-	-	-	-
4,4'-DDD	g/m^3	< 0.0005	-	-	-	-

Sample Type: Aqueous						
Sample Name:		Waipaoa Raw				
Lab Number:		1224687.1				
Organochlorine Pesticides Trace in SVOC Water Samples by GC-MS						
4,4'-DDE	g/m^3	< 0.0005	-	-	-	-
4,4'-DDT	g/m^3	< 0.0010	-	-	-	-
Dieldrin	g/m^3	< 0.0005	-	-	-	-
Endosulfan I	g/m^3	< 0.0010	-	-	-	-
Endosulfan II	g/m^3	< 0.0010	-	-	-	-
Endosulfan sulfate	g/m^3	< 0.0010	-	-	-	-
Endrin	g/m^3	< 0.0010	-	-	-	-
Endrin ketone	g/m^3	< 0.0010	-	-	-	-
Heptachlor	g/m^3	< 0.0005	-	-	-	-
Heptachlor epoxide	g/m^3	< 0.0005	-	-	-	-
Hexachlorobenzene	g/m^3	< 0.0005	-	-	-	-
Polycyclic Aromatic Hydrocarbons Trace in SVOC Water Samples						
Acenaphthene	g/m^3	< 0.0003	-	-	-	-
Acenaphthylene	g/m^3	< 0.0003	-	-	-	-
Anthracene	g/m^3	< 0.0003	-	-	-	-
Benzo[a]anthracene	g/m^3	< 0.0003	-	-	-	-
Benzo[a]pyrene (BAP)	g/m^3	< 0.0005	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.0005	-	-	-	-
Benzo[g,h,i]perylene	g/m^3	< 0.0005	-	-	-	-
Benzo[k]fluoranthene	g/m^3	< 0.0005	-	-	-	-
2-Chloronaphthalene	g/m^3	< 0.0003	-	-	-	-
Chrysene	g/m^3	< 0.0003	-	-	-	-
Dibenzo[a,h]anthracene	g/m^3	< 0.0005	-	-	-	-
Fluoranthene	g/m^3	< 0.0003	-	-	-	-
Fluorene	g/m^3	< 0.0003	-	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.0005	-	-	-	-
2-Methylnaphthalene	g/m^3	< 0.0003	-	-	-	-
Naphthalene	g/m^3	< 0.0003	-	-	-	-
Phenanthrene	g/m^3	< 0.0003	-	-	-	-
Pyrene	g/m^3	< 0.0003	-	-	-	-
Phenols Trace (drinkingwater) in SVOC Water Samples by GC-MS						
2-Chlorophenol	g/m^3	< 0.0005	-	-	-	-
2,4-Dichlorophenol	g/m^3	< 0.0005	-	-	-	-
2,4,6-Trichlorophenol	g/m^3	< 0.0010	-	-	-	-
Phenols Trace (non-drinkingwater) in SVOC Water Samples by GC-MS						
4-Chloro-3-methylphenol	g/m^3	< 0.0010	-	-	-	-
2,4-Dimethylphenol	g/m^3	< 0.0005	-	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	g/m^3	< 0.0010	-	-	-	-
2-Methylphenol (o-Cresol)	g/m^3	< 0.0005	-	-	-	-
2-Nitrophenol	g/m^3	< 0.0010	-	-	-	-
Pentachlorophenol (PCP)	g/m^3	< 0.010	-	-	-	-
Phenol	g/m^3	< 0.0010	-	-	-	-
2,4,5-Trichlorophenol	g/m^3	< 0.0010	-	-	-	-
Plasticisers Trace (non-drinkingwater) in SVOC Water by GCMS						
Butylbenzylphthalate	g/m^3	< 0.0010	-	-	-	-
Diethylphthalate	g/m^3	< 0.0010	-	-	-	-
Dimethylphthalate	g/m^3	< 0.0010	-	-	-	-
Di-n-butylphthalate	g/m^3	< 0.0010	-	-	-	-
Di-n-octylphthalate	g/m^3	< 0.0010	-	-	-	-
Plasticisers Trace (drinkingwater) in SVOC Water Samples by GCMS						
Bis(2-ethylhexyl)phthalate	g/m^3	< 0.003	-	-	-	-
Di(2-ethylhexyl)adipate	g/m^3	< 0.0010	-	-	-	-
Other Halogenated compounds Trace (drinkingwater) in SVOC Water						
1,2-Dichlorobenzene	g/m^3	< 0.0010	-	-	-	-

Sample Type: Aqueous						
	Sample Name:	Waipaoa Raw				
	Lab Number:	1224687.1				
Other Halogenated compounds Trace (drinkingwater) in SVOC Water						
1,3-Dichlorobenzene	g/m^3	< 0.0010	-	-	-	-
1,4-Dichlorobenzene	g/m^3	< 0.0010	-	-	-	-
Other Halogenated compounds Trace (non-drinkingwater) in SVOC						
Hexachlorobutadiene	g/m^3	< 0.0010	-	-	-	-
Hexachloroethane	g/m^3	< 0.0010	-	-	-	-
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
Other SVOC Trace in SVOC Water Samples by GC-MS						
Benzyl alcohol	g/m^3	< 0.005	-	-	-	-
Carbazole	g/m^3	< 0.0005	-	-	-	-
Dibenzofuran	g/m^3	< 0.0005	-	-	-	-
Isophorone	g/m^3	< 0.0005	-	-	-	-
Tributyl Tin Trace in Water samples by GCMS						
Dibutyltin (as Sn)	g/m^3	< 0.00006	-	-	-	-
Tributyltin (as Sn)	g/m^3	< 0.00005	-	-	-	-
Triphenyltin (as Sn)	g/m^3	< 0.00004	-	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m^3	< 0.0005	-	-	-	-
Toluene	g/m^3	< 0.0010	-	-	-	-
Ethylbenzene	g/m^3	< 0.0005	-	-	-	-
m&p-Xylene	g/m^3	< 0.0005	-	-	-	-
o-Xylene	g/m^3	< 0.0005	-	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane (Methyl Bromide)	g/m^3	< 0.002	-	-	-	-
Carbon tetrachloride	g/m^3	< 0.0005	-	-	-	-
Chloroethane	g/m^3	< 0.0005	-	-	-	-
Chloromethane	g/m^3	< 0.0005	-	-	-	-
1,2-Dibromo-3-chloropropane	g/m^3	< 0.0005	-	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m^3	< 0.0004	-	-	-	-
Dibromomethane	g/m^3	< 0.0005	-	-	-	-
Dichlorodifluoromethane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloroethane	g/m^3	< 0.0005	-	-	-	-
1,2-Dichloroethane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
cis-1,2-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
trans-1,2-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
Dichloromethane (methylene chloride)	g/m^3	< 0.010	-	-	-	-
1,2-Dichloropropane	g/m^3	< 0.0005	-	-	-	-
1,3-Dichloropropane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
cis-1,3-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
trans-1,3-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
Hexachlorobutadiene	g/m^3	< 0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	g/m^3	< 0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	g/m^3	< 0.0005	-	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m^3	< 0.0005	-	-	-	-
1,1,1-Trichloroethane	g/m^3	< 0.0005	-	-	-	-
1,1,2-Trichloroethane	g/m^3	< 0.0005	-	-	-	-
Trichloroethene (trichloroethylene)	g/m^3	< 0.0005	-	-	-	-
Trichlorofluoromethane	g/m^3	< 0.0005	-	-	-	-
1,2,3-Trichloropropane	g/m^3	< 0.0005	-	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m^3	< 0.004	-	-	-	-
Vinyl chloride	g/m^3	< 0.0005	-	-	-	-
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m^3	< 0.0005	-	-	-	-

Sample Type: Aqueous

Sample Name:		Waipaoa Raw				
Lab Number:		1224687.1				
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	-	-	-	-
2-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
4-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
1,2-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,4-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,2,3-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m^3	< 0.0005	-	-	-	-
n-Propylbenzene	g/m^3	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Styrene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m^3	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m^3	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m^3	< 0.0005	-	-	-	-
Dibromochloromethane	g/m^3	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	-	-	-	-
Naphthalene	g/m^3	< 0.0005	-	-	-	-
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	94	-	-	-	-
Toluene-d8	%	98	-	-	-	-

Analyst's Comments

Sample 1 Comment:
It has been noted that the method performance for Hexachlorocyclopentadiene for SVOC analysis is not acceptable therefore we are unable to report this compound at this present time.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Cyanide Distillation	Distillation following the addition of sulphuric acid, alkaline trapping solution. APHA 4500-CN$^-$ C (modified) 22nd ed. 2012.	-	1
Apparent Hazen Colour	Determined on original sample without filtration or centrifugation, determination by Lovibond colorimeter. APHA 2120 B 22nd ed. 2012.	5 Hazen units	1
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 22nd ed. 2012.	0.05 NTU	1

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22nd ed. 2012.	1.0 g/m^3 as $CaCO_3$	1
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 22nd ed. 2012.	1.0 g/m^3 at 25°C	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22nd ed. 2012.	0.1 mS/m	1
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1
Dissolved Bromine*	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.005 g/m^3	1
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Total Cyanide	Distillation, colorimetry. APHA 4500-CN^- C (modified) & E (modified) 22nd ed. 2012.	0.0010 g/m^3	1
Fluoride	Direct measurement, ion selective electrode. APHA 4500-F^- C 22nd ed. 2012.	0.05 g/m^3	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m^3	1
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m^3	1
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m^3	1
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m^3	1
Reactive Silica	Filtered sample. Heteropoly blue colorimetry. Discrete analyser. APHA 4500-SiO_2 F (modified from flow injection analysis) 22nd ed. 2012.	0.10 g/m^3 as SiO_2	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m^3	1
Absorbance at 254 nm	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B 22nd ed. 2012.	0.002 AU cm^{-1}	1
Acid Herbicides Screen in Water by LCMSMS	Direct injection LCMSMS	-	1
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1
Organochlorine/Organonitro&phosphorus Pest.s Drinking Water	Liquid/Liquid extraction, GPC (if required), GC-MS FS analysis	-	1
Semivolatile Organic Compounds Trace in Water by GC-MS	Liquid/Liquid extraction, GPC cleanup (if required), GC-MS FS analysis	-	1
Tributyl Tin Trace in Water samples by GCMS	Solvent extraction, ethylation, SPE cleanup, GC-MS SIM analysis	-	1
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis [KBIs:28233,2694]	-	1
Drinking water metals suite, dissolved, trace			
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m^3 as $CaCO_3$	1
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.003 g/m^3	1
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Dissolved Arsenic	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Dissolved Beryllium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Dissolved Boron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.005 g/m^3	1
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00005 g/m^3	1
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Dissolved Chromium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Dissolved Lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Dissolved Lithium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Dissolved Tin	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00002 g/m^3	1
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Gisborne District Council	**Lab No:**	1225056 DWPv1
Contact:	Gayle Cave C/- Gisborne District Council PO Box 747 GISBORNE 4040	**Date Registered:**	17-Jan-2014
		Date Reported:	23-Jan-2014
		Quote No:	35124
		Order No:	6333
		Client Reference:	Treated Potable Water
		Submitted By:	Judith Robertson

Sample Type: Aqueous

	Sample Name:	Waipaoa Potable 16-Jan-2014		**Guideline Value**	**Maximum Acceptable Values (MAV)**
	Lab Number:	1225056.1			
Individual Tests					
Turbidity	NTU	0.27	-	< 2.5	-
pH	pH Units	7.9	-	7.0 - 8.5	-
Total Alkalinity	g/m^3 as $CaCO_3$	170	-	-	-
Bicarbonate	g/m^3 at 25°C	210	-	-	-
Electrical Conductivity (EC)	mS/m	54.8	-	-	-
Bromide	g/m^3	< 0.05	-	-	-
Bromate	g/m^3	< 0.005	-	-	0.01
Total Cyanide	g/m^3	< 0.0010	-	-	0.6
Chloride	g/m^3	19.1	-	< 250	-
Chlorite	g/m^3	< 0.005	-	-	0.8
Chlorate	g/m^3	< 0.005	-	-	0.8
Fluoride	g/m^3	0.12	-	-	1.5
Total Ammoniacal-N	g/m^3	< 0.010	-	< 1.2	-
Nitrite-N	g/m^3	< 0.002	-	-	0.06 0.91 (short term)
Nitrate-N	g/m^3	< 0.002	-	-	11.3
Nitrate-N + Nitrite-N	g/m^3	0.002	-	-	-
Dissolved Reactive Phosphorus	g/m^3	< 0.004	-	-	-
Reactive Silica	g/m^3 as SiO_2	8.3	-	-	-
Sulphate	g/m^3	99	-	< 250	-
Absorbance at 254 nm	AU cm^{-1}	0.029	-	-	-
Drinking water metals suite, as received, trace					
Total Hardness	g/m^3 as $CaCO_3$	230	-	< 200	-
Aluminium	g/m^3	0.169	-	< 0.1	-
Antimony	g/m^3	< 0.0002	-	-	0.02
Arsenic	g/m^3	< 0.0010	-	-	0.01
Barium	g/m^3	0.090	-	-	0.7
Beryllium	g/m^3	< 0.00010	-	-	-
Boron	g/m^3	0.128	-	-	1.4
Cadmium	g/m^3	< 0.00005	-	-	0.004
Calcium	g/m^3	77	-	-	-
Chromium	g/m^3	< 0.0005	-	-	0.05
Copper	g/m^3	0.0007	-	< 1	2
Iron	g/m^3	< 0.02	-	< 0.2	-
Lead	g/m^3	< 0.00010	-	-	0.01
Lithium	g/m^3	0.020	-	-	-
Magnesium	g/m^3	9.1	-	-	-

Sample Type: Aqueous

Sample Name:		Waipaoa Potable 16-Jan-2014		**Guideline Value**	**Maximum Acceptable Values (MAV)**
Lab Number:		1225056.1			
Drinking water metals suite, as received, trace					
Manganese	g/m^3	0.0020	-	< 0.04 (Staining) < 0.10 (Taste)	0.4
Total Mercury	g/m^3	< 0.00008	-	-	0.007
Molybdenum	g/m^3	0.0014	-	-	0.07
Nickel	g/m^3	0.0007	-	-	0.08
Potassium	g/m^3	3.1	-	-	-
Selenium	g/m^3	< 0.0010	-	-	0.01
Silver	g/m^3	< 0.00010	-	-	-
Sodium	g/m^3	27	-	< 200	-
Tin	g/m^3	< 0.0005	-	-	-
Uranium	g/m^3	0.00042	-	-	0.02
Zinc	g/m^3	< 0.0010	-	< 1.5	-
Chlorine, Free & Combined					
Free Chlorine	g/m^3	1.20	-	0.6 - 1.0	5
Combined Chlorine	g/m^3	0.15	-	-	-
Chloramines					
Monochloramine	g/m^3	< 0.05	-	-	3
Dichloramine	g/m^3	0.09	-	-	-
Trichloramine	g/m^3	< 0.05	-	-	-

Note: The Guideline Values and Maximum Acceptable Values (MAV) are taken from the publication 'Drinking-water Standards for New Zealand 2005 (Revised 2008)', Ministry of Health. Copies of this publication are available from http://www.moh.govt.nz/moh.nsf/pagesmh/8534

The Maximum Acceptable Values (MAVs) have been defined by the Ministry of Health for parameters of health significance and should not be exceeded. The Guideline Values are the limits for aesthetic determinands that, if exceeded, may render the water unattractive to consumers.

Note that the units g/m^3 are the same as mg/L and ppm.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Cyanide Distillation	Distillation following the addition of sulphuric acid, alkaline trapping solution. APHA 4500-CN$^-$ C (modified) 22nd ed. 2012.	-	1
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 22nd ed. 2012.	0.05 NTU	1
pH	pH meter. APHA 4500-H$^+$ B 22nd ed. 2012.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22nd ed. 2012.	1.0 g/m^3 as CaCO$_3$	1
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO$_2$ D 22nd ed. 2012.	1.0 g/m^3 at 25°C	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22nd ed. 2012.	0.1 mS/m	1
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.05 g/m^3	1
Bromate	Sample analysed as received, filtered if required. Ion Chromatography. US EPA Method 300.1 Part B.	0.005 g/m^3	1
Total Cyanide	Distillation, colorimetry. APHA 4500-CN$^-$ C (modified) & E (modified) 22nd ed. 2012.	0.0010 g/m^3	1
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl$^-$ E (modified from continuous flow analysis) 22nd ed. 2012.	0.5 g/m^3	1
Chlorite	Sample analysed as received, filtered if required. Ion Chromatography. US EPA Method 300.1 Part B.	0.005 g/m^3	1

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Chlorate	Sample analysed as received, filtered if required. Ion Chromatography. US EPA Method 300.1 Part B.	0.005 g/m^3	1
Fluoride	Direct measurement, ion selective electrode. APHA 4500-F^- C 22nd ed. 2012.	0.05 g/m^3	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m^3	1
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m^3	1
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m^3	1
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m^3	1
Reactive Silica	Filtered sample. Heteropoly blue colorimetry. Discrete analyser. APHA 4500-SiO_2 F (modified from flow injection analysis) 22nd ed. 2012.	0.10 g/m^3 as SiO_2	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m^3	1
Absorbance at 254 nm	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B 22nd ed. 2012.	0.002 AU cm^{-1}	1
Chlorine, Free & Combined	DPD Colorimetric	-	1
Drinking water metals suite, as received, trace			
Total Hardness	Calculation: from Ca and Mg. APHA 2340 B 22nd ed. 2012.	1.0 g/m^3 as $CaCO_3$	1
Aluminium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.003 g/m^3	1
Antimony	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Arsenic	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1
Barium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Beryllium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Boron	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.005 g/m^3	1
Cadmium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00005 g/m^3	1
Calcium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1
Chromium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Copper	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Iron	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Lead	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1
Lithium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Magnesium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Manganese	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Molybdenum	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0002 g/m^3	1
Nickel	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Potassium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m^3	1
Selenium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1
Silver	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00010 g/m^3	1

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Sodium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m^3	1
Tin	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m^3	1
Uranium	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00002 g/m^3	1
Zinc	Analysed as received (after acid preservation, if required), ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1
Chloramines			
Monochloramine	Colorimetric. APHA 4500-Cl G 22nd ed. 2012.	0.05 g/m^3	1
Dichloramine	Colorimetric. APHA 4500-Cl G 22nd ed. 2012.	0.05 g/m^3	1
Trichloramine	Colorimetric. APHA 4500-Cl G 22nd ed. 2012.	0.05 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Client Services Manager - Environmental Division

APPENDIX C

Monitoring Program

APPENDIX C

Gisborne MAR Pilot Trial water quality monitoring

Table C1: Source water quality monitoring.

Irrigation season	Pre-trial	During trial
4-5 samples at different flow rates.	At least three intensive sampling periods linked to high flow river events. 5 samples per event, total of 15 samples.	Weekly sampling for laboratory analysis. Weekly measurements for field parameters to match laboratory sampling schedule.

Source water monitoring parameters for program set out in Table C1:

- Laboratory analysis:
    - E-coli
    - TSS and turbidity (NTU)
    - Major ions (including sulfate & carbonate)
    - NO_3-N, NO_2-N NH_4-N, Total N
    - Dissolved iron
    - Dissolved arsenic
    - pH
- Field monitoring parameters (Strict equipment calibration procedures):
    - pH, Eh and temperature
    - Electrical conductivity
    - Dissolved oxygen
    - Turbidity (NTU)

Table C2: Groundwater quality monitoring.

Irrigation season	Pre-trial	During trial
Monthly sampling Monthly measurements for field parameters to match laboratory sampling schedule.	Monthly sampling. Monthly measurements for field parameters to match laboratory sampling schedule.	Weekly maximum sampling, more intensive during initial stages of trial. Weekly measurements maximum for field parameters to match laboratory sampling schedule. More intensive during initial stages of trial.

Groundwater water monitoring parameters for program set out in Table C2:

- Laboratory analysis:
  - E-coli
  - Total suspended solids (TSS) and turbidity (NTU)
  - Major ions (including SO_4 & CO_3)
  - Nitrogen parameters (NO_3-N, NO_2-N NH_4-N, Total N)
  - Dissolved iron
  - Dissolved arsenic
  - pH
- Field monitoring parameters (Strict equipment calibration procedures):
  - pH, Eh and temperature
  - Electrical conductivity
  - Dissolved oxygen
  - Turbidity (NTU)

APPENDIX D

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Report Limitations

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