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Short term field investigations of groundwater resources in Waipa River Catchment - January to April 2015

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Short term field investigation of groundwater resources in the Waipa River Catchment: January – April 2015

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DISCLAIMER

Use of Data:

Date that GNS Science can use associated data: May 2015

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CONTENTS

FIGURES

TABLES

APPENDICES

APPENDIX FIGURES

APPENDIX TABLES

ENCLOSURES

EXECUTIVE SUMMARY

A greater understanding of water resources within the Waipa River Catchment (Waipa Catchment) is required for a number of current initiatives: Vision and Strategy for the Waikato River (Te Ture Whaimana o Te Awa o Waikato), the National Policy Statement for Freshwater Management, and the Healthy Rivers Project. As such, Waikato Regional Council (WRC) has commissioned GNS Science (GNS) to carry out a short term field investigation in the Waipa Catchment, which is detailed in this report. This investigation was undertaken over the summer of 2014/15 and aims to inform the development of a Waipa Catchment flow and nitrogen transport model, which is being undertaken by GNS under a separate contract. This project will also contribute to a greater understanding of the groundwater system in the Waipa Catchment and will contribute information to the Healthy Rivers Project.

The field investigation was designed to include groundwater level surveying, water sampling for chemistry, water sampling for age dating, and limited hydraulic testing. An initial field investigation design was presented to WRC on the 12th December 2014, and agreed upon. In this report, metadata from the field investigations and a collation of the collected site details, data and analysis (where available) are presented. Recommendations are included for future enhancement of the understanding of groundwater resources within the catchment. It is expected that additional field investigations will be undertaken within the Waipa Catchment in the next two years to further supplement the flow and transport models, and the Healthy Rivers Project. For this reason, a collation of site specific information (i.e., land owner contact details and notes on site access) and well information has been collated and is presented. This metadata is expected to reduce the time needed for obtaining well access in future investigations.

The following field investigations were performed in the Waipa Catchment during the period January–April 2015:

- collection of 48 water samples for analysis of chemistry by Hill Laboratories;
- collection of nine water samples for analysis of Tritium, CFC and SF6 by the GNS Science Water Dating Laboratory;
- recording of 27 static water levels, of which 22 were measured 14th–23rd April;
- nine hydraulic tests undertaken; and
- nine new hydraulic properties derived.

1.0 INTRODUCTION

A greater understanding of water resources within the Waipa River Catchment (Waipa Catchment) is required for a number of current initiatives: Vision and Strategy for the Waikato River (Te Ture Whaimana o Te Awa o Waikato), the National Policy Statement for Freshwater Management, and the Healthy Rivers Project. As such, Waikato Regional Council (WRC) has commissioned GNS Science (GNS) to carry out a short term field investigation in the Waipa Catchment as detailed in this report, aiming to improve the bank of knowledge underlying Healthy Rivers policy options.

The primary reason for undertaking these initiatives are concerns regarding the potential for water quality deterioration due to land use changes such as intensification and deforestation. The Waipa River is the largest tributary of the Waikato River, and the Waipa Catchment (Figure 1.1) constitutes approximately 22% of the total Waikato River catchment area (Waikato Regional Council, 2012). Therefore, water resources in the Waipa Catchment are likely to have an important influence on the health of the Waikato River. Due to lag times between land use changes and effects on water quality, appropriate management and policy development requires a fit-for-purpose groundwater flow and transport model. These models will assist to inform sustainable water management of the catchment and related requirements under these initiatives, for instance linking nutrient impacts to sources to enable appropriate mitigation procedures to be put in place (Waikato Regional Council, 2014).

A recent review of information for the Waipa Catchment provided a number of recommendations for data collection (Rawlinson, 2014). The short term field investigation of groundwater resources in the Waipa Catchment over the summer of 2014/15 presented in this report aims to address a few of the recommendations in Rawlinson (2014); to inform the development of a Waipa River Catchment flow and nitrogen transport model (being undertaken by GNS under a separate contract); and will contribute to other work being undertaken within the Healthy Rivers Project. The geology displayed in the figures throughout this report is that described in Rawlinson (2014).

The field investigation was designed to include groundwater level surveying, water sampling for chemistry, water sampling for age dating, and limited hydraulic testing. An initial field investigation design was presented to WRC on the 12th December 2014, and agreed upon. In this report, metadata from the field investigations and a collation of the collected site details, data and analysis (where available) are presented. Recommendations are included for future enhancement of the understanding of groundwater resources in the catchment. It is expected that additional field investigations will be undertaken within the Waipa Catchment in the next two years to further supplement the flow and transport models, and the Healthy Rivers Project. For this reason, a collation of site specific information (i.e., land owner contact details and notes on site access) and well information has been collated and is presented. This metadata is expected to reduce the time needed for obtaining well access in future investigations.

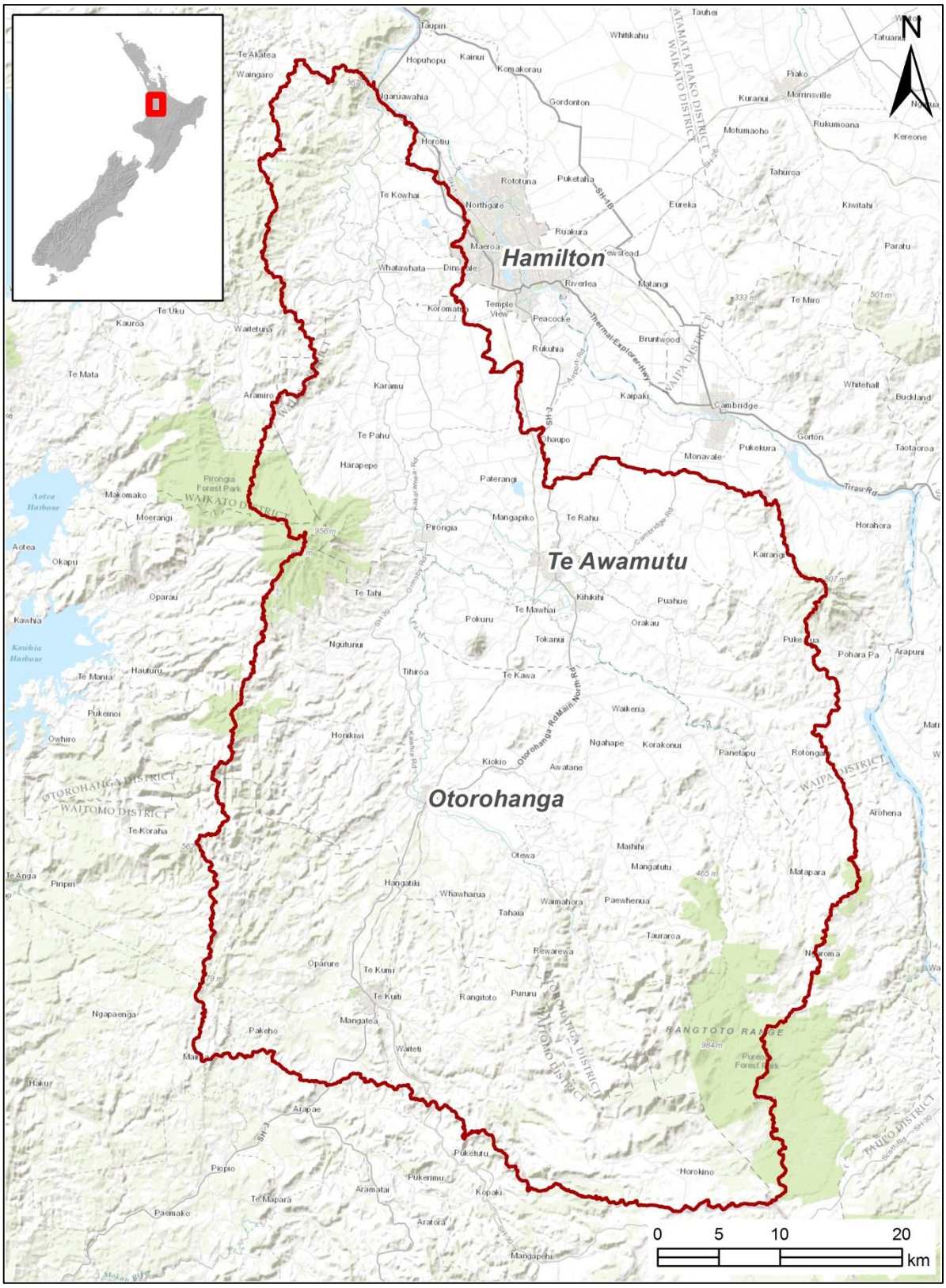

Figure 1.1 Topographic map showing the Waipa Catchment study area boundary (red line).

2.0 MILESTONE 1: PROJECT PLAN 12/12/2014

To provide context to the field investigations detailed in this report, a somewhat revised version of the project plan agreed with WRC on the 12th December 2014 is presented in this section. The below plan was designed to address information gaps within the Waipa Catchment for the development of a steady state flow and nitrogen transport model (identified in Rawlinson (2014)) and is correspondingly split into sections based on specific model requirements (specified in the section titles).

The plan considered that the dominant purpose of these models is to inform the design of mitigation procedures addressing landuse impacts on the health of the Waikato River. The initial plan was idealised, and final planning differed due to conditions associated with data and access. It was considered that there were approximately 50 water samples able to be taken and analysed for chemistry and up to 10 samples for age dating. During data collection, all sites were to have photos taken of them and GPS locations stored, in order for this information to be provided to WRC.

2.1 WATER BALANCE

Steady state water balance components will be supplied by a separate Healthy Rivers funded project being undertaken by GNS within a separate contract.

2.2 GROUNDWATER-SURFACE WATER INTERACTION

"Simultaneous" (ideally within an hour, or within one day if there is no rainfall) and spot surface water gauging measurements has been coordinated by WRC externally to the work detailed in this report, although GNS staff supplied some guidance for this. Due to the strongly linked nature of the surface water and groundwater in the area, surface water gaugings provide crucial input data for modelling. As the existing gauging measurements are insufficient to characterise any groundwater-surface water interaction (Rawlinson, 2014), it was recommended that the contractor perform sufficient gauging measurements so that at least the main branches of the tributaries have flow measurements. It was also recommended that where-ever possible, to reduce the range of model non-uniqueness, these gauging measurements should be taken simultaneously at a number of sites (at least two) for each tributary and along the main river segments, so that the groundwater – surface water flux can be measured explicitly between those sites. Spot gauging site selection was discussed on 13/01/2015 with WRC and GNS staff to address both the above requirements as well as water balance requirements, including a collation of WRC in-house knowledge and a review of historical spot gauging measurements.

2.3 BOUNDARY CONDITIONS

The discharge across the north-eastern boundary should be quantified by performing high resolution groundwater level sampling within ~5 km either side of the boundary (Figure 2.1). Wells need to be suitably chosen such that this discharge can be quantified for all layers within the conceptual model.

In select locations (area with the highest expected flux), on either side of the boundary, water sampling for chemistry and age dating analysis should also be undertaken. These will be used for verification of flow paths and will also be chosen to quantify all layers within the conceptual model.

Partway through the field investigations, it was agreed that WRC would undertake this aspect of the field programme by performing water level transects across the boundary (Hadfield, 2015b). During the collection of these transects it was determined that the accuracy that would be obtained would not be sufficient to progress considerably from our current knowledge (Hadfield, 2015a).

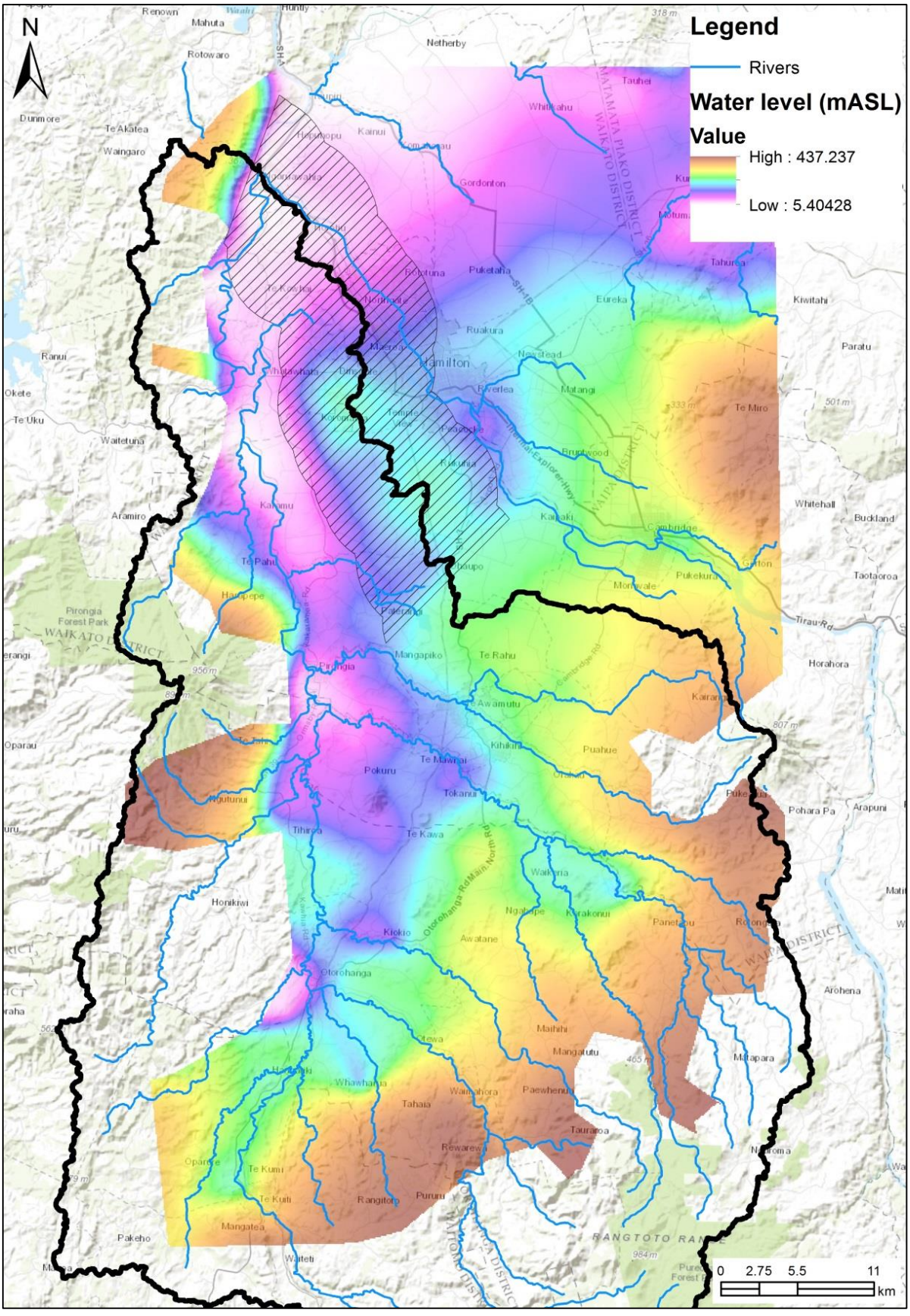

Figure 2.1 The hatched area displays the where it would be advantageous to quantify discharge across the boundary. The Waipa Catchment boundary is shown by the black line. Figure modified from Rawlinson (2014).

2.4 CONCEPTUAL MODEL BUILDING

For the development of a conceptual flow model, the following factors need to be assessed:

- flow between geological units and vertically within the Tauranga group sediments;
- the number of layers suitable for modelling within the Tauranga group sediments, which will be based on the identified flow regime and identified characteristics (e.g., chemistry, water age); and
- the character (e.g., hydraulic properties) of all layers.

High resolution water level surveying should be undertaken in the Alexander Group, the Pakaumanu Group, and within Tauranga Group sediments in the northwest of the catchment between the Waipa Fault and greywacke outcrop.

Water samples for chemistry analysis should be taken:

- from each lesser important geological unit (basement, Te Kuiti Group, Miocene sediments, Pakaumanu Group, and Alexander Group);
- in depth profiles within the Tauranga Group sediments along transects perpendicular to the boundary with the Pakaumanu Group southeastern range recharge area and the Alexander group western recharge area; and
- in depth profiles within the Tauranga Group running parallel to the Waipa River.

Samples for age dating should be taken close to existing sites with age estimates but at different depths (e.g., one current sample is at 6.7 m deep, further samples should be taken at e.g., 30 m and 100 m).

Hydraulic testing should be undertaken in the same wells used for the chemistry analysis and tritium analysis (where possible). A dense grid of hydraulic tests should be undertaken (where site selection allows), preferably close to the existing pump test data with transmissivity values of 30–50 m^2/day (to assess heterogeneity properties). Prior to site selection, all existing wells will be assessed to find those suitable based on well construction, lithological logs and screen information.

2.5 ADDITIONAL CALIBRATION DATA

A piezometric survey should be undertaken: additional to the four high resolution areas already identified, a survey should be designed to provide better coverage over the entire catchment. Only bores with lithological logs and well screen placement details should be used.

3.0 WELL SELECTION AND SITE INFORMATION GATHERING

All wells in the Waipa Catchment within the WRC database (Bevan Jenkins, 16/12/2014) are depicted in Figure 3.1. A pre-selection of wells for site visits was performed based on the well having the following:

- a lithological log
- screen depth information
- installed in the last 10 years
- casing/bore diameter of at least 100 mm

Lithological log and screen depth information are crucial factors for data interpretation. The well having a completion date in the last 10 years was chosen as a requirement to assist with making the well easier to find (the owner name in the WRC database more likely to be correct and owner more likely to have information regarding their bore than older records) as well as the well and pump construction expected to be easier to deal with. The casing/bore diameter was chosen to allow for either slug testing to be performed with the existing GNS slug equipment or that the bores would likely have pumps installed large enough to perform a pump test, as well as allowing for sufficient space for equipment to be placed down the well. Further details regarding the suitability of a well for measurements could only be ascertained through site visits and discussions with owners. A data request to WRC was sent and the landowner contact details received (name and address) for this selection of wells (Sharon Fitzpatrick, 18/12/2015).

Using these wells and the requirements discussed in Section 2.0, twelve groups (N = 99) were selected for possible site visits to investigate their utility for water sampling, water level surveying and hydraulic testing (Figure 3.2). Site visits were performed where owners were able to be contacted, were aware of a bore on their property, and were agreeable to groundwater investigations being performed on their well.

Site visits were time consuming and well identification complicated as approximately >75% of wells had incorrect GPS coordinates in the WRC database. Some wells had inaccuracies >50 m, whereas other wells were on the order of 300–3000 m. In addition, land owner and location names recorded for some bores in the database were incorrect following the sale or subdivision of properties. This is due to the fact that WRC treat consents for well construction as the lowest priority in respect to compliance checking and therefore accept the supplied drillers location information (updating this information only if it becomes available); there is also no linked update to the well database for owner changes or well abandonment (Hadfield, 2015a).

As a result, GNS was given numerous contact details of landowners that did not possess a bore on their property. Door-knocking on neighbour's properties sometimes helped to find such bores with inaccurate coordinates. Nevertheless, occasionally a pre-selected bore was not located in the field or the landowner did not allow site visits. In some such cases, replacement wells were sampled nearby that may not meet all the above mentioned pre-selection requirements. As wells have no on-site identifiers, a combination of discussions with current and previous land owners, comparisons of coordinates of the actual bore location with the ones in the WRC database, interrogation of nearby well details, and contact with drillers has been undertaken to judge whether the well sought is most probably the one found in the field. With this method, it is not always possible to be completely certain that the well found in the field matches the details in the database and it is noted in the collected

information when there are particular concerns that the field site well may belong to a different database well descriptor. For future reference, Appendix 1 includes a collation of sites for which contact details for the well were obtained, but the well was not sampled for some reason (e.g., the owners were contacted but permission for a site visit was not obtained or the well could not be located).

The following information was collated for sites that were investigated for their utility for water sampling, water level surveying and hydraulic testing:

- Identifier
- Located_key (WRC database reference)
- Address
- Contact Name
- Location name
- Home phone number
- Mobile phone number
- Owner email address if they have requested the results
- Pump details
- Details of access to survey the water level
- Water level
- Water sampling date
- Slug test suitability
- Pump test suitability
- Comment regarding if the bore sought is definitely the correct bore or if there is some ambiguity to this (due to sometimes large location coordinate errors)
- General comments
- NZTM E (new coordinate from GPS)
- NZTM N (new coordinate from GPS)
- Altitude (new coordinate from GPS, large uncertainty)
- Completion date
- Bore depth
- Bore diameter
- Casing diameter
- Screen interval start
- Screen interval end

A summary of this information is presented in Appendix 1, including relevant site photos. The full data set is available on the attached CD, in the excel spreedsheet "Wellsites_Appendix1.xls". Any other relevant information is included in the folder "Sampled_sites", in subfolders with the WRC database identifier well site key (located_key) as their name.

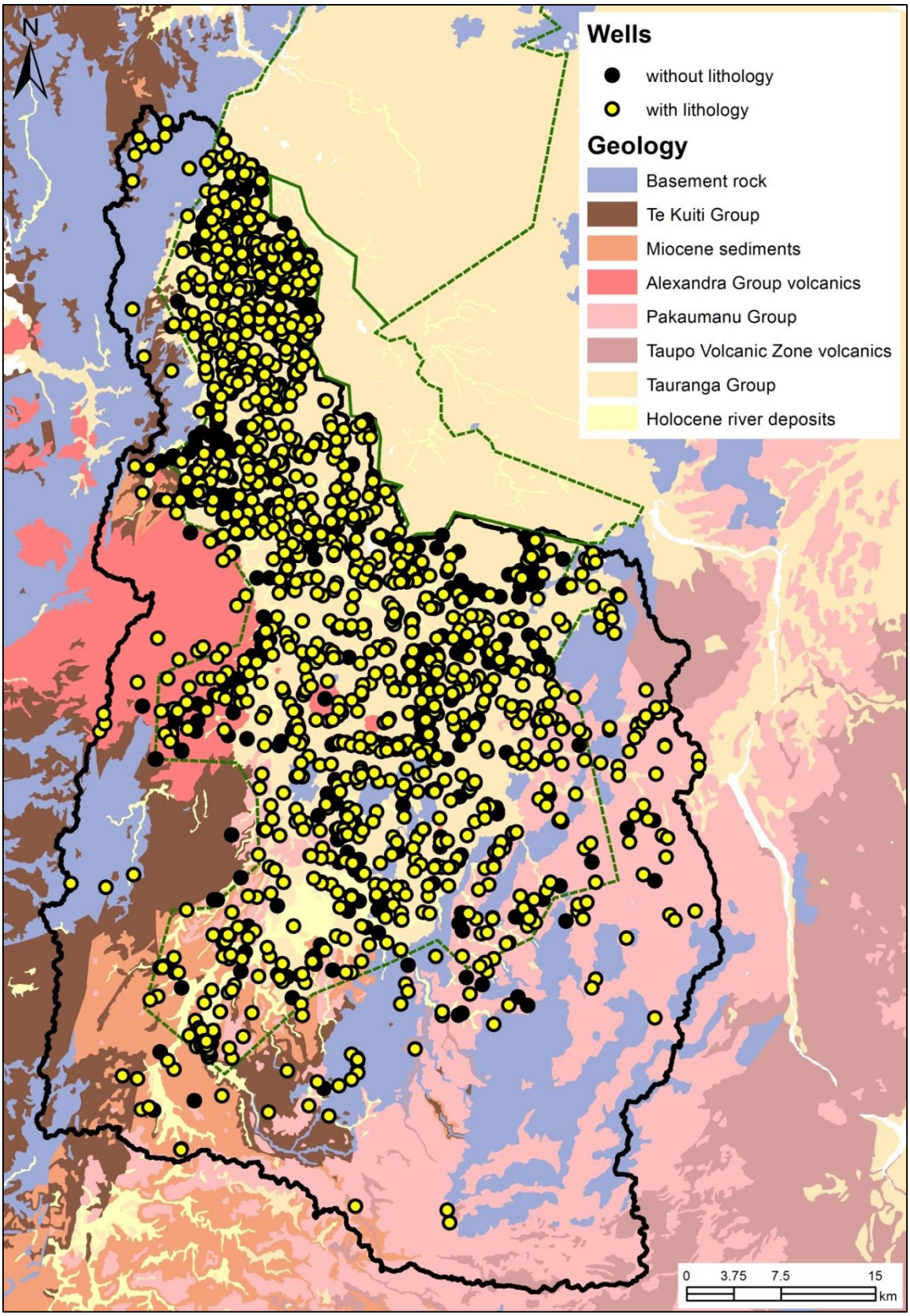

Figure 3.1 All wells in the Waipa Catchment (boundary shown by the black line) that are recorded in the WRC database (Waikato Regional Council, 2015). The green line shows the Waikato Regional Council delineated aquifers based on DEM/topographic maps. North of the 'Waipa' aquifer is the 'Hamilton Basin – West' and the 'Hamilton Basin – North'. It has to be noted that not all of these wells are useful for data collection (some do not exist anymore, some collapsed and have been replaced by another bore nearby and several are not being used at all). Figure from Rawlinson (2014).

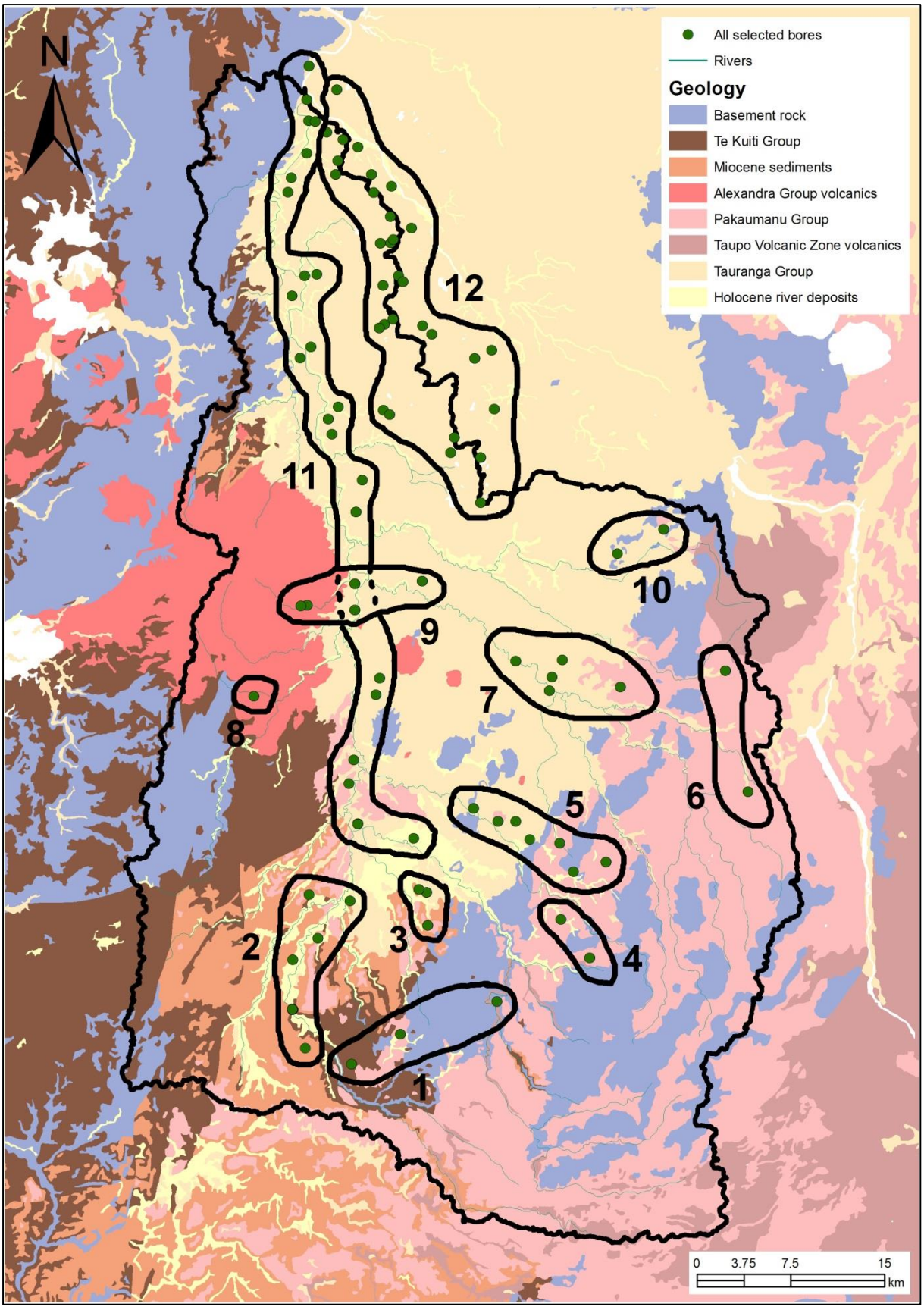

Figure 3.2 All pre-selected bores (N = 99) and their groups in the Waipa Catchment (boundary shown by the black line) that were chosen for possible site visits. Selection criteria are discussed in the text.

4.0 WATER CHEMISTRY SAMPLING

4.1 METHOD

Water chemistry sampling was guided by the New Zealand national protocol for state of the environment groundwater sampling (national protocol; Daughney et al., 2006). Due to the sampling being undertaken in summer, with many pumps operating regularly and owner's being conscious of water use and their power bill, the following method was used to aim to be in accordance with the national protocol whilst minimising disturbance to land owners:

1. Discussion with the land owner regarding how long the pump had been pumping for immediately before the site visit and over recent weeks.
2. Time to purge estimated (to the required three times the purge volume).
3. Detection of the most suitable sampling point as close as possible to the bore (compromises had to be made depending on the land owner's willingness to detach pipes that connect the pump and storage tanks and depending on the difficulty to access sampling points).
4. Following 1, 2 and 3, the following was performed:
    a. If the site was considered to be purged, additional purging was undertaken for 15–30 minutes, with pH, conductivity and temperature being measured every 5 minutes (or other time intervals that were feasible under the specific circumstances in the field). When the differences between the measurements were within the national protocol limits, the site was considered to be purged and was sampled.
    b. If the site was considered to be partially purged, additional purging was undertaken to purge the remaining volume, with pH, conductivity and temperature being measured every 5 minutes (or other time intervals that were feasible under the specific circumstances in the field). When the differences between the measurements were within the national protocol limits, the site was considered as purged and was sampled.
    c. If the site was not purged (i.e., the bore pump was not running at all on the day the sampling was undertaken), the pump was forced to run (either by opening a tap, flicking a power switch, manipulating a float switch in a storage tank or by emptying a pressure tank). Only after the bore was purged three times and when the differences between the measurements after each purge volume were within the national protocol limits, the site was considered purged and was sampled.
5. In all three cases, notes were taken on the process and a groundwater sampling sheet was filled in. These sheets are available on the attached CD/Sampled_sites, included in subfolders and documents with the well site key (located_key) as a file name identifier.

Chemistry analysis was performed by Hill Laboratories, Hamilton, New Zealand. The analysis undertaken was the 'WRCgw' profile, which includes the following analyses: pH, total alkalinity, free carbon dioxide, total hardness, electrical conductivity, approx. total dissolved salts, total boron, total calcium, total copper, total iron, total magnesium, total manganese, total potassium, total sodium, total zinc, chloride, total ammoniacal-n, nitrate-n, and sulphate. In addition, the following parameters were also analysed: dissolved iron, dissolved manganese, dissolved reactive phosphorus, and reactive silica.

An example results sheet is displayed in Appendix 2 that includes the methods used to conduct these analyses.

4.2 SAMPLED WELLS

In total, 48 wells were sampled for water chemistry (Figure 4.1) during January—April 2015. The results of analysis were received and entered into the WRC database. A summary table of these results is displayed in Appendix 2 and is available on the attached CD, in the excel spreadsheet “WaterChemistry_results.xlsx”.

Figure 4.2 displays the results of electrical conductivity (EC) results in the Waipa Catchment. EC is an indicator of the total dissolved solids in groundwater. Figure 4.3 displays the results of nitrate–nitrogen sampling results in the Waipa Catchment. Nitrogen reducing conditions are indicated by the concentrations of ammoniacal-nitrogen, iron and manganese, and Figure 4.4 displays these three analytes together for comparison.

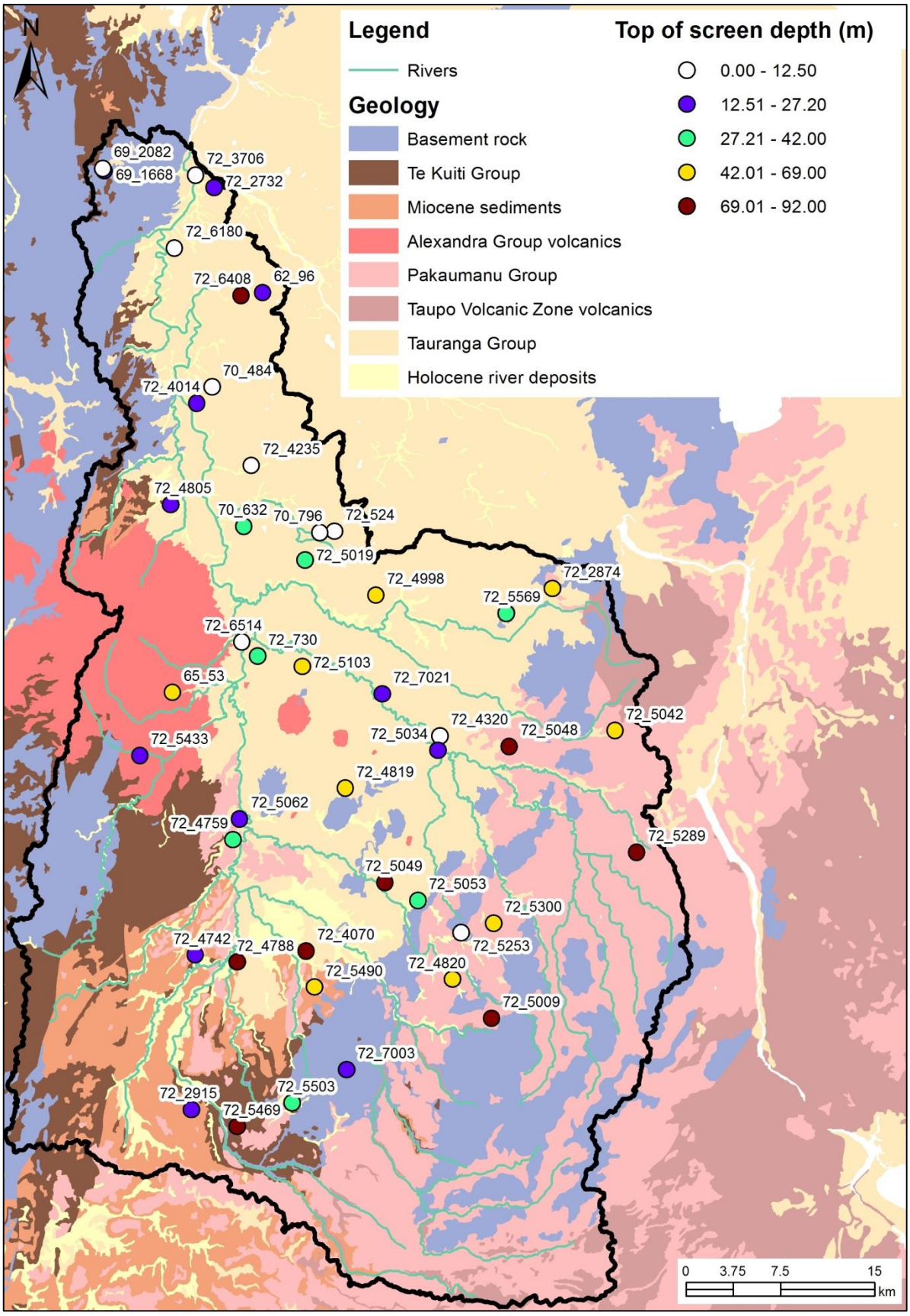

Figure 4.1 Location of wells that were sampled for water chemistry (N =48) in the Waipa Catchment (boundary shown by the black line), colour-coded by depth of the top of the screen.

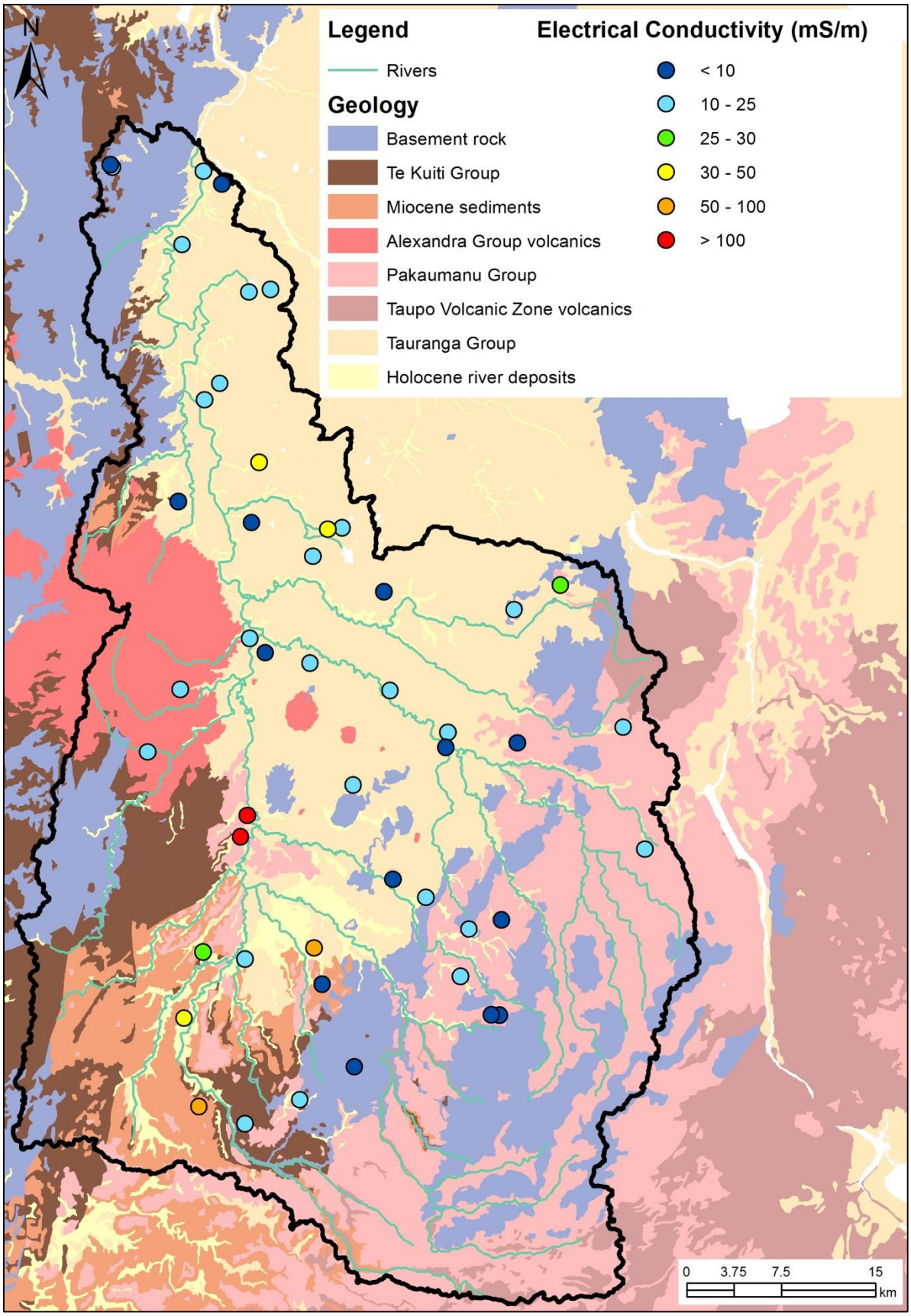

Figure 4.2 Electrical conductivity measurements from collected water samples. The Waipa Catchment is shown by the black line.

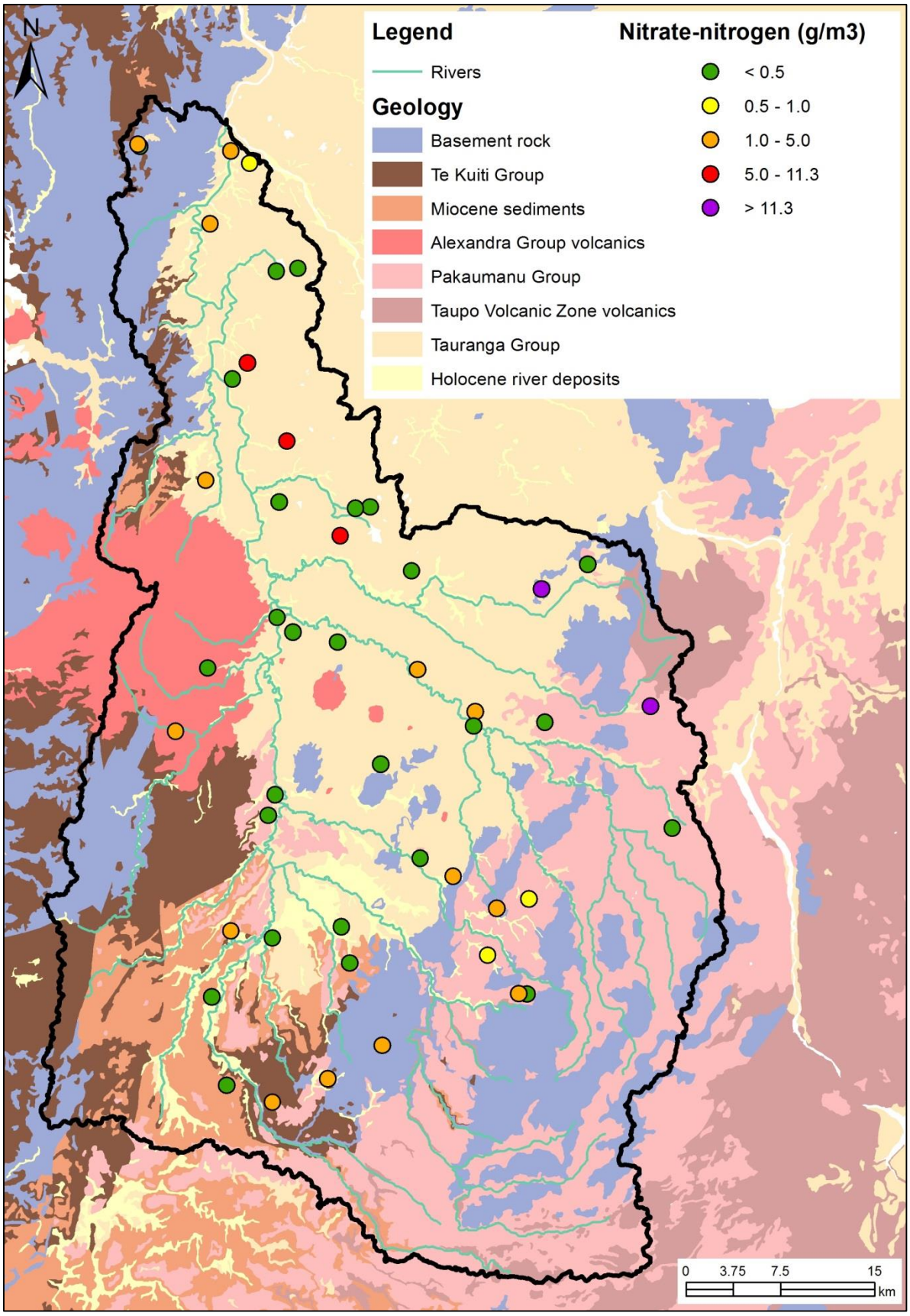

Figure 4.3 Nitrate-nitrogen measurements from collected water samples. The Waipa Catchment is shown by the black line.

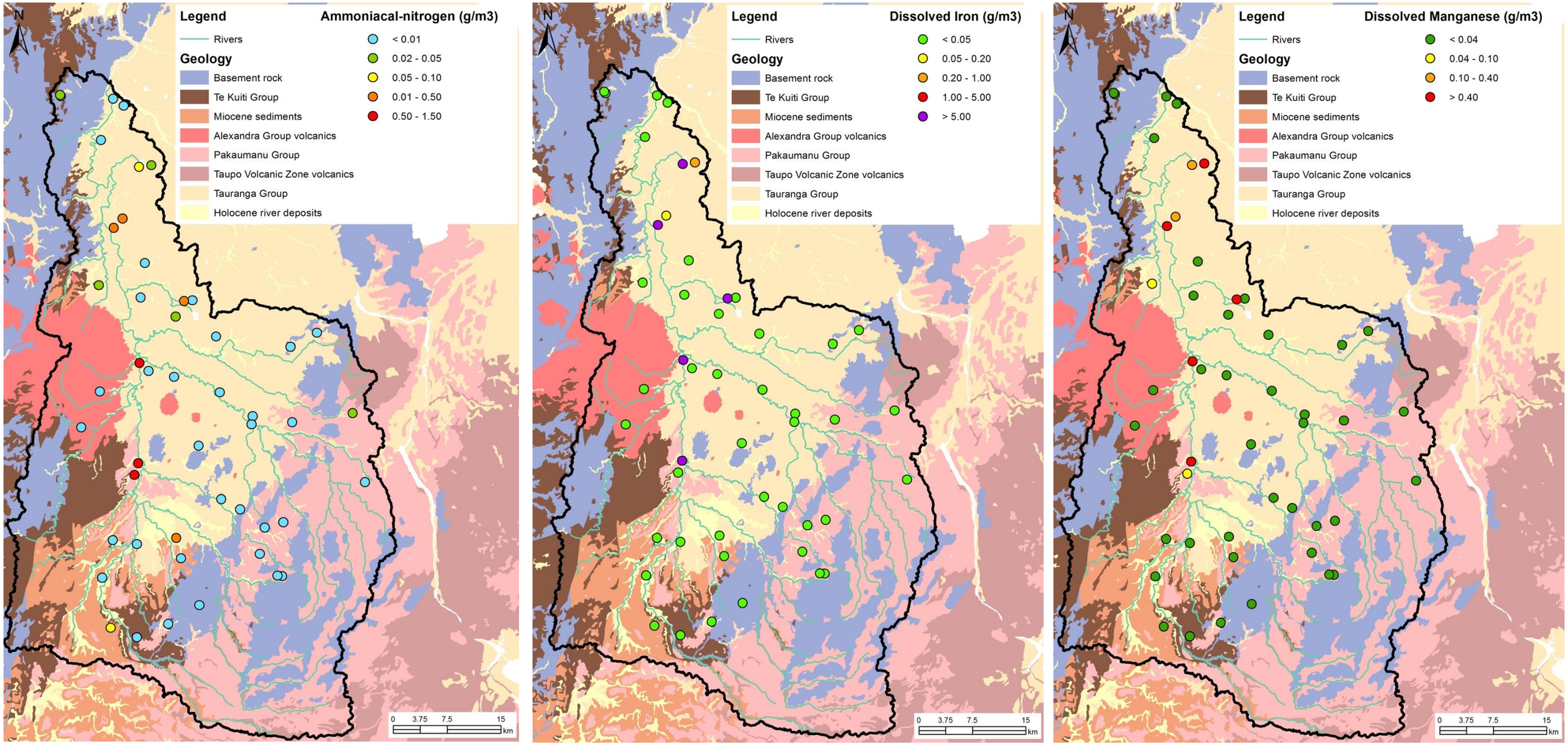

Figure 4.4 Measurements from collected water samples for: left) ammoniacal-nitrogen, centre) dissolved iron, right) dissolved manganese. The Waipa Catchment is shown by the black line.

5.0 AGE DATING SAMPLING

5.1 METHOD

For the purpose of age dating; water samples were collected for the analysis of tritium, clorofluorocarbon (CFC), and sulphur hexafluoride (SF6). Sampling was undertaken in accordance with the GNS Science Water Dating Laboratory (WDL) protocol. Purging was undertaken as described in Section 4.1.

5.2 SAMPLED WELLS

The previously available data on mean resident times (MRT) are displayed in Figure 5.1. In total, nine new wells were sampled for water age dating (Figure 5.2). Eight samples were sent to the GNS Science Water Dating Laboratory for analysis on 20/02/15 and one sample on the 02/03/15. At the time of reporting, the results of analysis were not yet available.

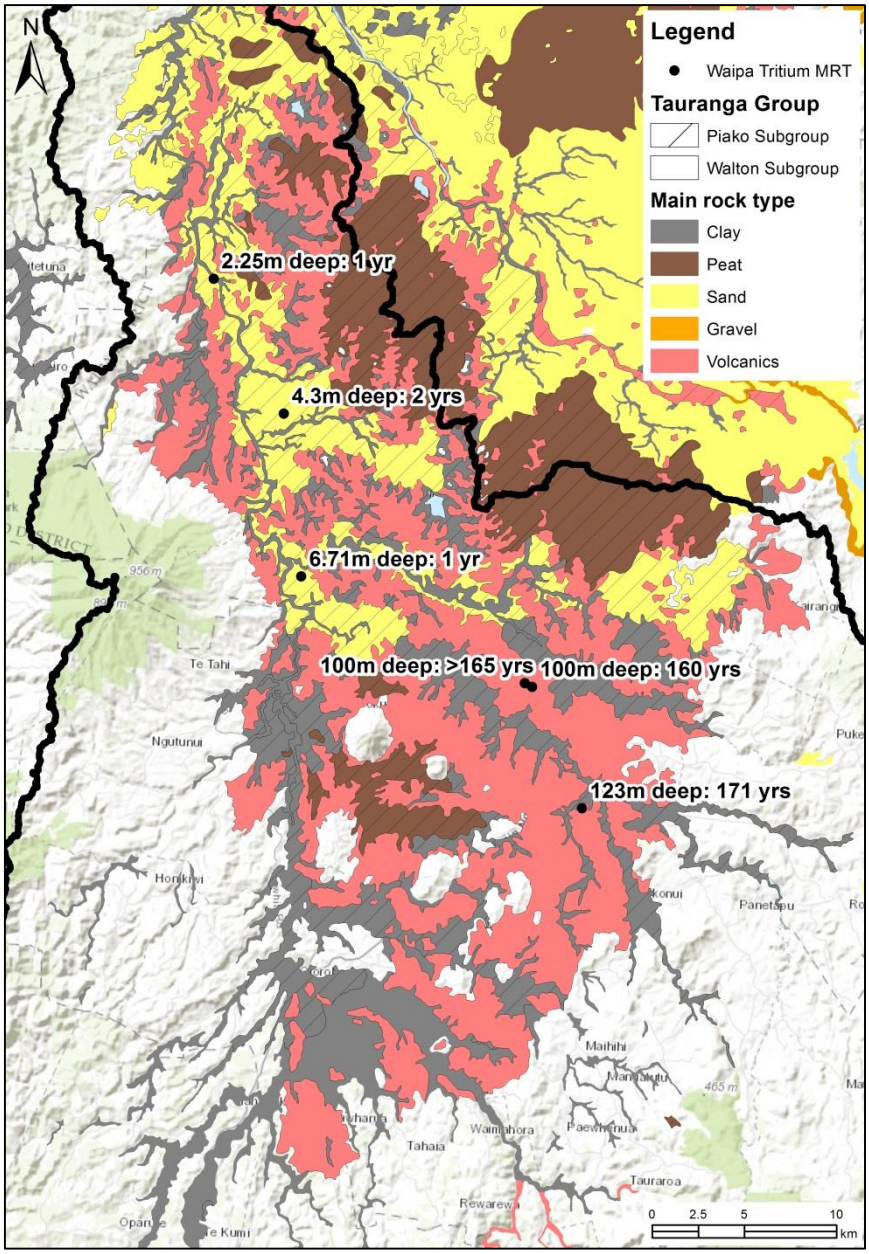

Figure 5.1 Available age estimates from tritium mean residence times (MRT) in the Waipa Catchment (black line). Figure from Rawlinson (2014).

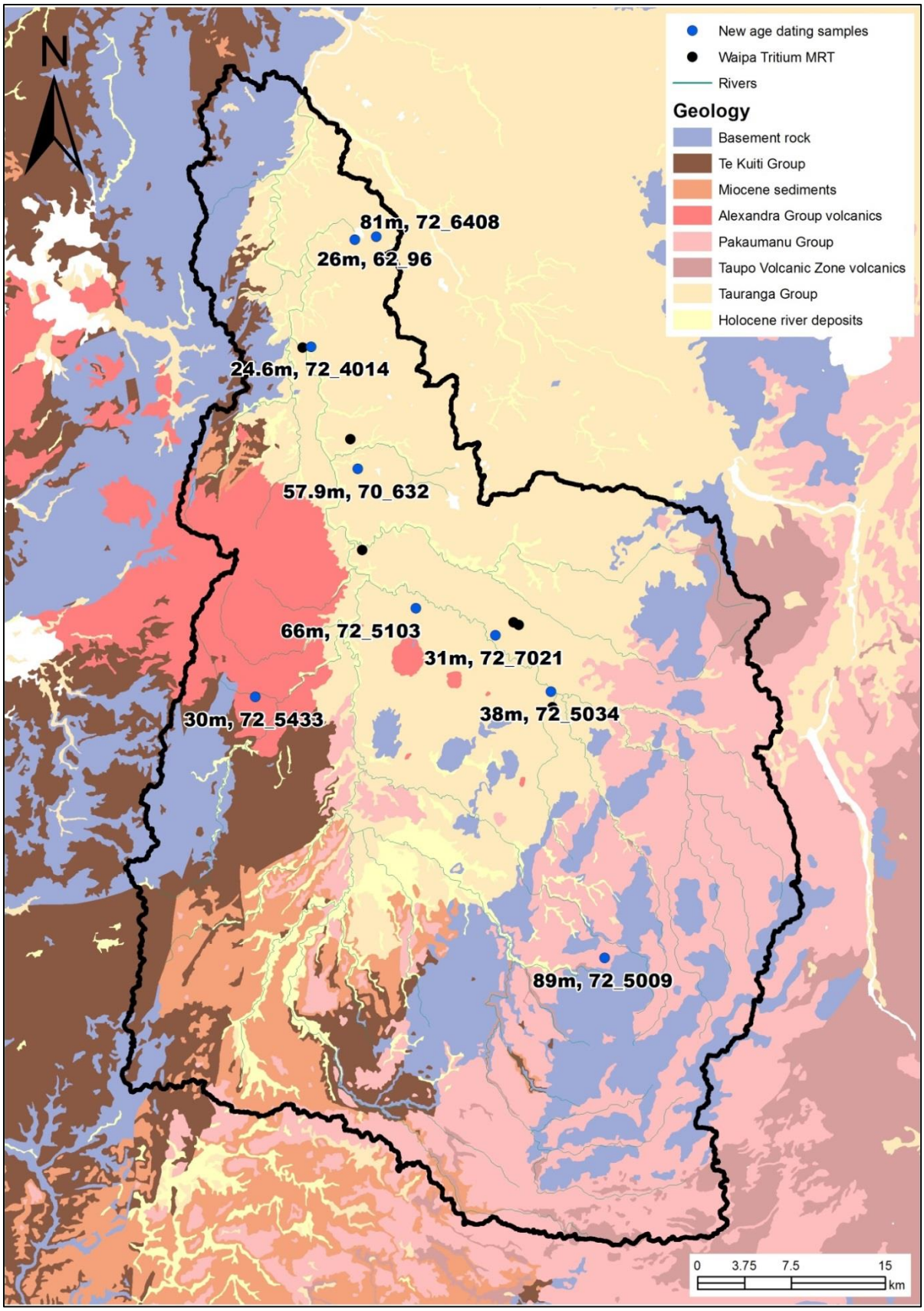

Figure 5.2 Well sites sampled for age dating (labelled by depth to the top of the screen and well location key) and existing wells with age interpretations (Figure 5.1).

6.0 WATER LEVEL SURVEYING

6.1 METHOD

Water level indicators were used to measure water levels in wells where it was possible to obtain access to the well shaft. Access to the water level was obtained through lowering the water level indicator (WLI) down an existing gap, hole or pipe between the bore pump and the bore casing, or by partly lifting up and securing the pump above the top of the casing to create such a gap. The number of water levels able to be measured was severely limited by the majority of well shafts being inaccessible. All but two of the visited bores had pumps installed and most of these pump installations were designed in such a way that the top of the bore casing was closed off, therefore, preventing access to the water table. Even if there was access down the shaft, the accessibility to the water level was often restricted by cables, pipes or submersible pumps inside the bore casings. Additionally, due to dry conditions in January, the majority of wells were often pumping and obtaining a static water level was difficult to ensure. Heavy rainfall in February and March further complicated the collection of a catchment-wide static water level survey.

Therefore, following all site visits and identification of locations where water levels could be collected, a 10 day water level survey was completed from 14th – 23rd of April 2015 in order to measure as many static water levels as possible within a short time frame.

Owners were contacted prior to site visits to try arrange for pumps to be turned off for a number of hours or alternatively to find out at which time of the day the pump is most likely to be off for a couple of hours prior to the visit. Discussions with land owners on their pump use were carried out to decide on the measuring period required to determine whether the water level was static or dynamic: if the land owners were certain that the pump had not been going for the last couple of days, then an initial 15 minute measuring period was used; however, if the owner wasn't sure when the pump had been on last, at least a 30 minute measuring period was used. If within the 30 minute measuring period, the water level continued to rise, the site was revisited a few hours later and measured again over a one hour period (and this procedure repeated if the water level was still rising and there was sufficient time in the day for another later visit). In such a case, the water levels were considered to be static if the depth to the water table did not change more than 10 mm over the period of one hour (this was only necessary for four sites). In some cases, static water levels were unable to be obtained, but these water levels have still been recorded with a note that they are dynamic levels.

All water levels were measured at the same point as the measurement of ground level to top of casing (or to the top of the plastic pipe leading down the shaft of the bore). Subsequently, all water levels are reported as metres below ground level (m BGL) after correcting for the collar height or the height between the ground level and the top of the pipe. Real Time Kinetic GPS equipment (RTK) was used to obtain ground level heights with high accuracy where possible and used to convert water levels to metres above mean sea level (AMSL).

6.2 MEASURED WELLS

In total, static water levels were measured in 27 wells, with 22 of these recorded during 14th – 23rd of April 2015. An additional nine wells had dynamic water levels measured. RTK heights were obtained for 28 of these wells with accuracies for the majority of less than 1 cm. One additional static water level from 2005 is included because it is assumed to not be held in the WRC database, as it was provided with the pump test data obtained from Waitomo District Council that was not in the WRC database (see Section 7.0). All recorded water levels are displayed in Figure 6.1. A summary table of these results is displayed in Table 6.1 and is available on the attached CD, in the excel spreadsheet "Static WL survey.xls".

Table 6.1 Measured water levels in meters below ground level (WL mBGL) and meters above mean sea level (WL AMSL). Location coordinates are provided for those with RTK measurements, as well as the associated RTK height uncertainty.

Located Key	WL mBGL	Date	Time	Static?	NZTM N (RTK)	NZTM E (RTK)	mASL (RTK)	± m	WL AMSL
72_5469	49.219	14/04/2015	13:00	Yes	5751658.538	1792959.434	251.3685	0.01	202.15
72_4805	4.863	14/04/2015	18:10	Yes	5801126.255	1787588.371	37.6708	0.005	32.81
62_96	8.49	14/04/2015	17:05	Yes	5818013.813	1794889.029	32.3208	0.006	23.83
72_5019	13.497	15/04/2015	6:25	Yes	5796761.563	1798282.849	55.7313	0.011	42.23
72_7107	6.3	15/04/2015	11:40	Yes	5760039.124	1788114.437	42.7793	0.01	36.48
72_7003	4.419	15/04/2015	8:33	Yes	5756190.88	1801655.442	350.55	0.009	346.13
72_5062	10.74	15/04/2015	12:56	Yes	5776132.719	1793122.467	30.9807	0.01	20.24
74_372	2.162	16/04/2015	10:47	Yes	5778713.925	1800849.876	38.9418	0.005	36.78
72_4320	4.781	14/04/2015	15:40	Yes	5782781.696	1809022.539	41.0382	0.008	36.26
72_7021	12.854	16/04/2015	13:31	Yes	5786117.966	1804440.777	41.7514	0.007	28.90
69_2082	4.528	15/04/2015	16:25	Yes	5827883.81	1782160.559	103.8157	5.268	99.29
72_730	11.073	15/04/2015	8:30	Yes	5789098.635	1794518.401	48.5446	0.007	37.47
70_632	11.642	10/04/2015	9:09	Yes	5799435.095	1793412.679	40.4997	0.007	28.86
70_796	6.393	15/04/2015	17:36	Yes	5798940.394	1799479.832	37.173	0.009	30.78
72_6180	6.893	14/04/2015	17:50	Yes	5821556.764	1787878.448	20.8865	0.01	13.99
72_3706	7.122	16/04/2015	15:40	Yes	5827362.545	1789540.584	17.3835	0.006	10.26
72_6514	8.262	16/04/2015	16:50	Yes	5790243.834	1793280.395	27.7858	0.007	19.52
72_4014	9.425	16/04/2015	14:40	Yes	5809209.429	1789689.784	24.3224	0.006	14.90
72_5042	42.213	17/04/2015	14:30	Yes	5783216.708	1822966.897	240.0431	0.005	197.83
72_4998	17.108	18/03/2015	12:05	Yes	5793968.494	1803944.231	74.1773	0.009	57.07
72_5569	4.537	5/03/2015	11:15	Yes	5792554.098	1814275.062	65.7478	0.006	61.21
72_4236	5.268	1/04/2015	13:45	Yes	N/A	N/A	N/A	N/A	N/A
72_4742	16.145	24/02/2015	15:29	Yes	N/A	N/A	N/A	N/A	N/A
72_2915	13.418	13/05/2005	15:00	Yes	N/A	N/A	N/A	N/A	N/A
72_4759	19.04	23/04/2015	12:29	Yes	N/A	N/A	N/A	N/A	N/A
72_5503	6.13	23/04/2015	7:50	Yes	N/A	N/A	N/A	N/A	N/A
72_5300	11.887	22/04/2015	8:27	Yes	N/A	N/A	N/A	N/A	N/A
72_5009	19.091	24/04/2015	7:45	No	N/A	N/A	N/A	N/A	N/A
72_4235	5.445	1/04/2015	14:30	No	N/A	N/A	N/A	N/A	N/A
72_5433	15.516	15/04/2015	14:22	Almost	5781195.369	1785189.709	98.9592	0.038	83.44
72_4819	7.798	16/04/2015	9:16	No	5778606.384	1801520.904	44.6616	0.005	36.86
72_5049	20.551	16/04/2015	12:21	No	5771108.055	1804684.937	67.694	0.01	47.14
72_5103	25.138	15/04/2015	9:07	No	5788284.973	1798074.543	47.3443	0.004	22.21
72_5490	22.406	17/04/2015	12:22	No	5762756.978	1799074.473	84.6666	0.008	62.26
72_5289	24.805	17/04/2015	15:05	No	5773533.156	1824714.703	135.8178	0.007	111.01
72_4788	49.168	15/04/2015	4:05	No	5764749.639	1792938.902	63.8488	0.007	14.68

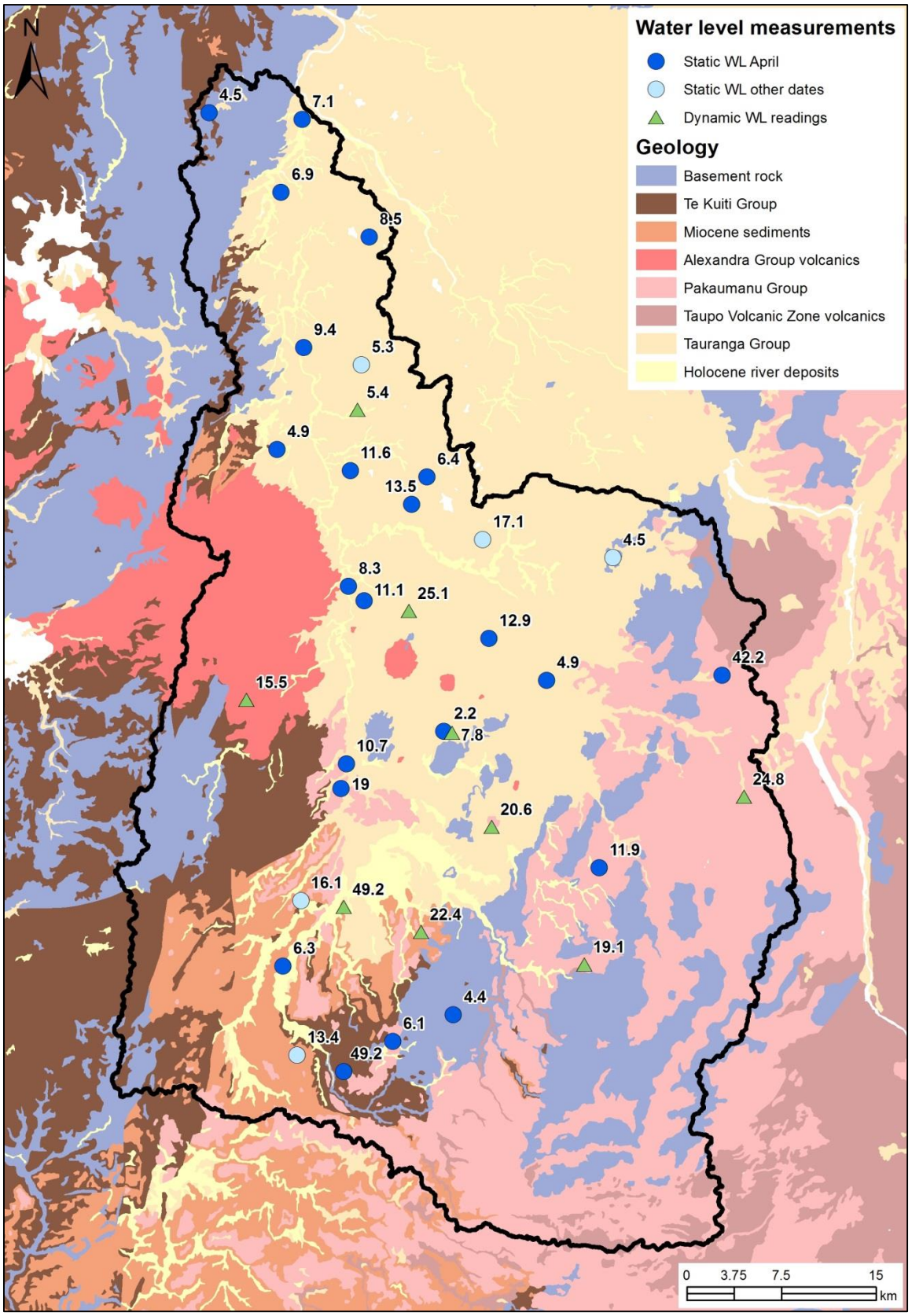

Figure 6.1 All bores where water levels (WL) have been recorded. The feature labels are the recorded water level in metres below ground level (mBGL).

7.0 HYDRAULIC TESTING

7.1 METHOD

The number of hydraulic tests that were conducted was severely limited by two factors: the majority of well shafts being inaccessible; and, due to summer conditions, the majority of wells were often already pumping and obtaining permission from land owners to turn the pumps off for a long enough period was difficult to obtain. Many owners stated that pumps would be unable to be turned off for significant periods of time until June.

Owners that were permissible to their pumps being turned off were contacted prior to testing to arrange for pumps to be turned off at approximately 6–7 pm in the evening and left off overnight to allow for ~14 hour recovery time. The installed pumps were used for the pumping and recovery tests. Details for each hydraulic test are provided in Appendix 3, along with graphs of both the manual and automatic water level data collected during testing, and the manual data provided in tables. The full data set is available on the attached CD in the folder 'Hydraulic_testing', with all relevant information included in subfolders and documents with the well site key (located_key) as a file name identifier.

The hydraulic tests performed were all single well tests and as such only the recovery data has been analysed. As per the findings of Halford et al. (2006), all tests have been analysed using the confined Cooper and Jacob (1946) method: this is considered the best analytical method for single well tests and for unconfined aquifers provides the same result (within uncertainties) as using an unconfined analytical method. The analysis had been carried out using Aqtesolv Professional version 4.5 aquifer test analysis software to provide estimates of transmissivities (T). Unconfined aquifer T-values have a greater uncertainty than those from confined aquifers, with a bias towards over-estimation (Halford et al., 2006). To convert from transmissivity (T) to hydraulic conductivity (K), where $T = Kb$: for confined aquifers, when T>50 m^2/d the saturated aquifer thickness has been used as b and when T<10 m^2/d the screen length has been used as b; while for unconfined aquifers the aquifer thickness has always been used as b (Halford et al., 2006). Analysis of each test is provided in Appendix 3, with the results presented in Section 7.2.

7.2 TESTED WELLS

In total, nine wells were hydraulically tested (Figure 7.1) during the period February-April 2015. Eight of these test results have been analysed to obtain transmissivity and hydraulic conductivity values; one of these tests was not able to be analysed due to pump and aquifer conditions (details are provided in Appendix 3). Additionally, a step drawdown test coordinated by Waitomo District Council (DC) in 2005 for well 72_2915 was interpreted to provide a transmissivity value, and was included in this report. Details of pump test setup and the results of analysis are presented in Table 7.1 and are available on the attached CD, in the excel spreadsheet "HydraulicTesting_results.xls". All transmissivity values available for the Waipa Catchment are displayed in Figure 7.2.

Table 7.1 Summary of location, construction, pump test information, and hydraulic properties for wells hydraulically tested in this study, and for the Waitomo DC well (72_2915).

Located_key	Pump rate (L/sec)	Pump duration (min)	Max drawdown (m)	Screen Top (m BGL)	Screen Bottom (m BGL)	Screen lithology	b (m)	T (m^2/day)	K (m/day)	K (m/sec)
70_632	0.63	240	7	32.3	57.9	Silt & Sands	25.6	2.38	0.09	1.1×10^{-6}
72_4014	1.155	90	0.17	19	24.6	Gravels	15.32	57.34	3.74	4.3×10^{-5}
72_4759	0.18	180	9.2	32.5	90	Clay & Mudstone	57.5	0.56	0.01	2.1×10^{-6}
72_5503	2.45	50	24.34	24	42	Greywacke	18	3.29	0.18	2.1×10^{-6}
72_5300	2.04	160	6.3	58	88	Pumice, Sands, Rhyolite, Peat wood, clay	64.6	21.53	0.33	3.9×10^{-6}
72_6180	0.24	90	0.489	8.4	11.2	Sands	3.1	120.4	38.84	4.5×10^{-4}
72_5569	1.577	360	14.175	35	41	Sands & Pumice	35.71	1.363	0.038	4.4×10^{-7}
72_5009	2.17	50	15.02	76.5	89	Rhyolite & Pumice	12.5	2.79	0.22	2.6×10^{-6}
72_2915	2, 5, 10	360	3.358	14.4	28.4	Limestone, Mudstone	15.32	296.7	16.18	1.9×10^{-4}

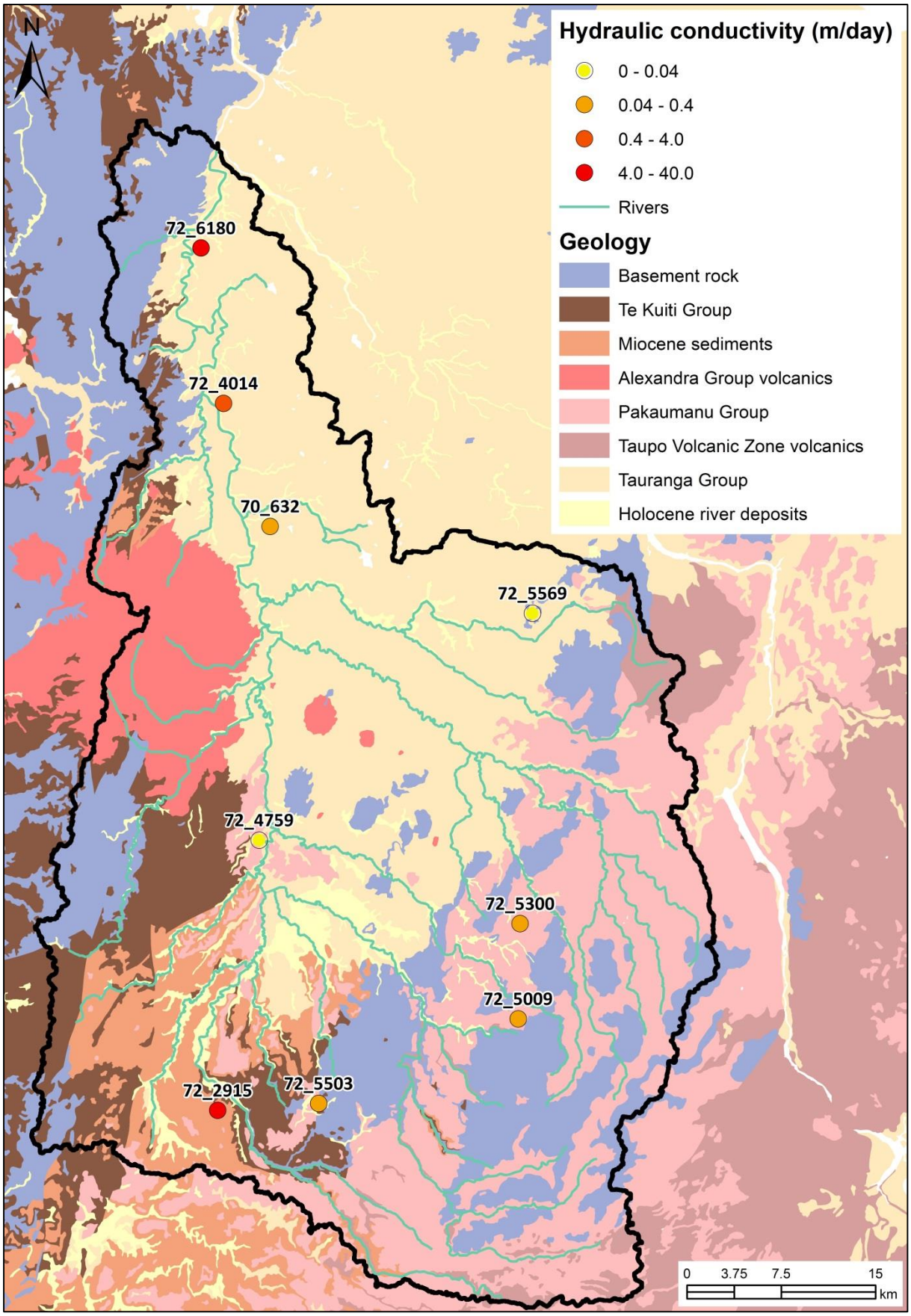

Figure 7.1 Map of the nine sites where hydraulic properties were obtained from analysis of pump tests in the Waipa Catchment (black line). All pump tests were performed by GNS, except for site 72_2915.

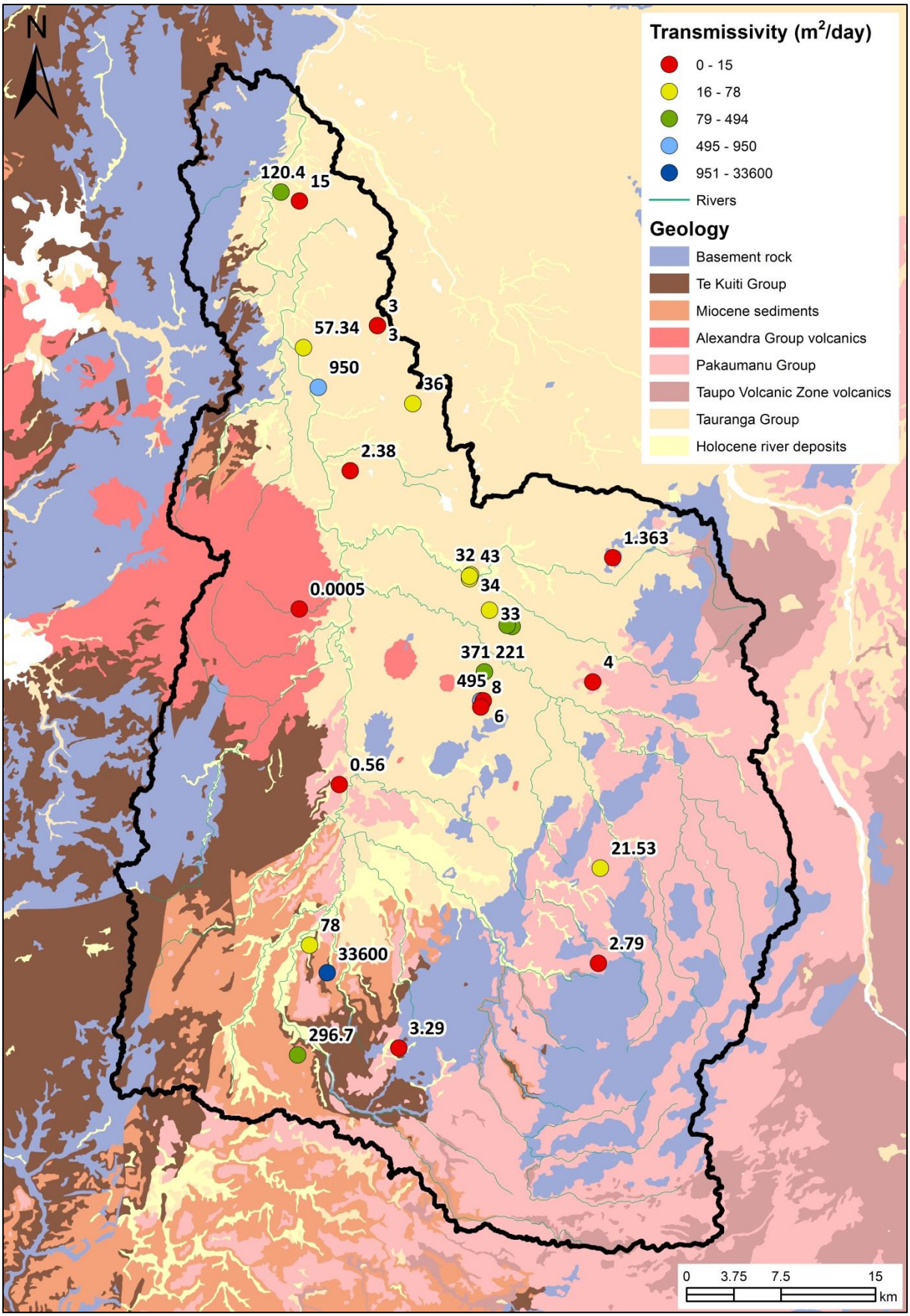

Figure 7.2 All transmissivity estimates available to date from pump tests in the Waipa Catchment (black line). Data includes new hydraulic property estimates as well as the previously available estimates.

8.0 RECOMMENDATIONS FOR FUTURE FIELDWORK INVESTIGATIONS

The short term field investigation of groundwater resources in the Waipa Catchment over the summer of 2014/15 presented in this report aimed to inform the development of a Waipa River Catchment flow and nitrogen transport model. Further recommendations required to achieve the required information are presented below.

During the duration of this work, it was identified that there are some locations that have additional data that did not appear to be recorded in the WRC database (not supplied in the Waipa Catchment data request performed by Rawlinson (2014)):

- Pump test data from local councils (e.g., well 72_2915).
- Time series water level data from State of Environment (SOE) sampling: water level surveying is required by the SOE protocol (Daughney et al., 2006).
- Time series water level data from farm monitoring (e.g., well 72_5345).

Prior to performing flow modelling for the Waipa Catchment, which is being undertaken by GNS under a separate contract, it should be determined by WRC whether the above data can be obtained and if any other such data exists that should be obtained.

It was also determined that the WRC database GPS coordinates are often inaccurate, at times significantly. As such, a GPS survey of all wells relevant to modelling should be considered. This is not so crucial for a regional flow model, but could be significant for groundwater-surface water interaction studies.

Data collection was complicated by field work being performed during the summer period, when pumping rates were high and land owners were conscious of their water use. It is recommended to carry out a winter piezometric survey as well as winter hydraulic testing to be able to collect additional data.

Preliminary flow modelling should investigate flux, no flow, and a constant head boundary across the north-eastern boundary to determine if a change in the model boundary type there has a large impact and is worth investigating further. If required, for determining discharge of the water table aquifer across this boundary, shallow piezometers could be installed at the location of primary interest or GPR surveying used to image the water table.

As there are seasonal variations expected in nitrogen levels, with higher values expected in summer than winter (Hanson, 2002), it is advised to perform additional water sampling for chemistry analysis in winter. This will be of particular use at those wells that show elevated levels of nitrogen.

Additionally, for nutrient transport purposes the following should be considered: fieldwork associated with porosity estimates, identification of denitrification areas, and soil and paleosoil sampling and classification. A combination of resistivity and GPR surveying could be used for estimating water content and porosity. Such surveying could also be useful when undertaken alongside an area with vertical sampling of age dating, chemistry and hydraulic properties, to further assess the Tauranga Group conceptual model layers.

After the collection and review of gauging measurements (being undertaken in a separate Healthy Rivers Project contract), consideration should be made as to the use of radon samples to identify groundwater inflow to surface waters in any high interest areas. These could be used in conjunction with the gauging measurements to guide the placement of fibre optic cable for use of Distributed Temperature Sensing to locate groundwater-surface interaction, and potentially identify fluxes.

9.0 CONCLUSIONS

The short term field investigation of groundwater resources in the Waipa Catchment over the summer of 2014/15 presented in this report aimed to inform the development of a Waipa River Catchment flow and nitrogen transport model; and to contribute information to the Healthy Rivers Project.

The following field investigations were performed in the Waipa Catchment during the period January–April 2015:

- collection of 48 water samples for analysis of chemistry by Hill Laboratories;
- collection of nine water samples for analysis of Tritium, CFC and SF6 by the GNS Science Water Dating Laboratory;
- recording of 27 static water levels, of which 22 were measured 14th–23rd April;
- nine hydraulic tests undertaken; and
- nine new hydraulic properties derived.

Further recommendations towards this end are presented in Section 8.0.

10.0 ACKNOWLEDGEMENTS

We would like to thank Abigail Lovett and Stewart Cameron for their helpful review comments. We would also like to thank Waikato Regional Council for the use of an additional small-diameter water level indicator.

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APPENDICES

APPENDIX 1: SITE INFORMATION

Information in this Appendix includes details obtained from desktop investigations and site visits of bores. Within the site details table for each bore: “Lithological log” refers to the lithological log details held in the WRC database corresponding to the screened interval; while “geology” is an interpretation and assignation of this described lithology to the main geological units in the area described by Rawlinson (2014). Further information for all sites can be obtained from the attached CD, in the excel spreadsheet “Wellsites_Appendix1.xls” and in the folder “Sampled_sites”, in subfolders with the WRC database identifier well site key (located_key) as their name.

A1.1 SITES INVESTIGATED BUT NO MEASUREMENTS PERFORMED

Table A 1.1 Sites investigated but no measurements performed, with a comment regarding why no measurements were taken at the site.

Located key	Problem	Comment
72_5035	Permission	Four bores on the property. Owners are not happy with anyone visiting the property to get a water sample.
72_3846	Permission	Owners are not happy with anyone visiting the property to get a water sample.
72_5463	Location	Owner’s report that there is no bore on the property. This bore might be on a neighbour’s property but this was not followed up.
72_2689	Location	Site visit performed but could not locate the bore. Two bores on church farm land found but not able to confirm that these bores are the ones mentioned in the WRC database.
72_4119	Location	
72_5727	Contact	Owner was happy to let us take a water sample but he was not around at the time so a replacement bore was sampled instead.
72_4297	Pump not suitable	Main farm bore, very large complicated pump installed without the possibility to get a water sample.
72_5345	Wrong bore	Monitoring bore with electronic water level equipment installed, not the bore we intended to sample.
1198435	Wrong bore	Bore next to Waikeria Rd in shed, old surface pump installed, not the bore we intended to sample.
72_4382	Wrong bore	Bore on top of the hill with submersible pump installed, never running, not the bore we intended to sample.
72_4782	Contact	Owner eventually got in touch with us and was happy for us to go get a sample. However, an alternative bore was already sampled earlier that week.
72_5066	Contact	Pretty sure this is the correct bore, but owners were away so alternative bore was sampled nearby.

Located key	Problem	Comment
72_4587	Access to water table	A very deep bore at the Te Awamutu Treatment Station, this bore has no pump installed and has not been used in years; too difficult to purge and sample.
70_589	Location and access	Waipa District bore to supply township with water, not able to obtain exact bore address.
70_598	Sprinkler system	Pump feeds water straight through a sprinkler and filtration system. Not useful for gas sampling.
62_70	Wrong bore	Unsure if correct bore, could be on neighbour's property instead. Collinson's have a bore on their property but they said it is substantially deeper than the one we were trying to find.
70_1004	Access	Site visit performed but not able to collect a sample since there is a manhole on the opposite side of where the water enters the storage tank.
72_1670	Access	No one remembers where this bore is located.
72_7172	Pump	Site visit performed but bore pump was not drawing water.

A1.2 SITES WITH WATER LEVEL MEASUREMENTS ONLY

72_4236

Table A 1.2 72_4236 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1793907	5804076	39 (GPS)	Most likely, but could also be 72_4235	Surface pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
8.2	5.2	8.2	Tauranga Group	Sand and silt
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	5.268 m BGL (static, 01/04/15)	Not completed	No	Yes, possible

Access comments: Drive to 1276 Kakaramea Rd. Bore is behind owner's house next to a tree. No four wheel drive is necessary.

Pump comments: Surface pump that is hardly ever running, thus water table static.

Figure A 1.1 Location of well 72_4236; image from Google Earth (2014).

Figure A 1.2 Well 72_4236.

74_372

Table A 1.3 74_372 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1800849.88	5778713.93	38.94 (RTK)	Yes	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
108	-	-	Tauranga Group	Sand, pumice, silt, clay, blue brown rock
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	2.162 m BGL (static, 16/04/15)	Not completed	No	No, no access

Access comments: Drive to cowshed at 655 Puketarata Rd. Bore is on paddock where two farm tracks intersect about 500 m northwest of the cowshed. Four wheel drive is not necessary.

Pump comments: Submersible pump that is in use only once a week. Water level assumed to be static.

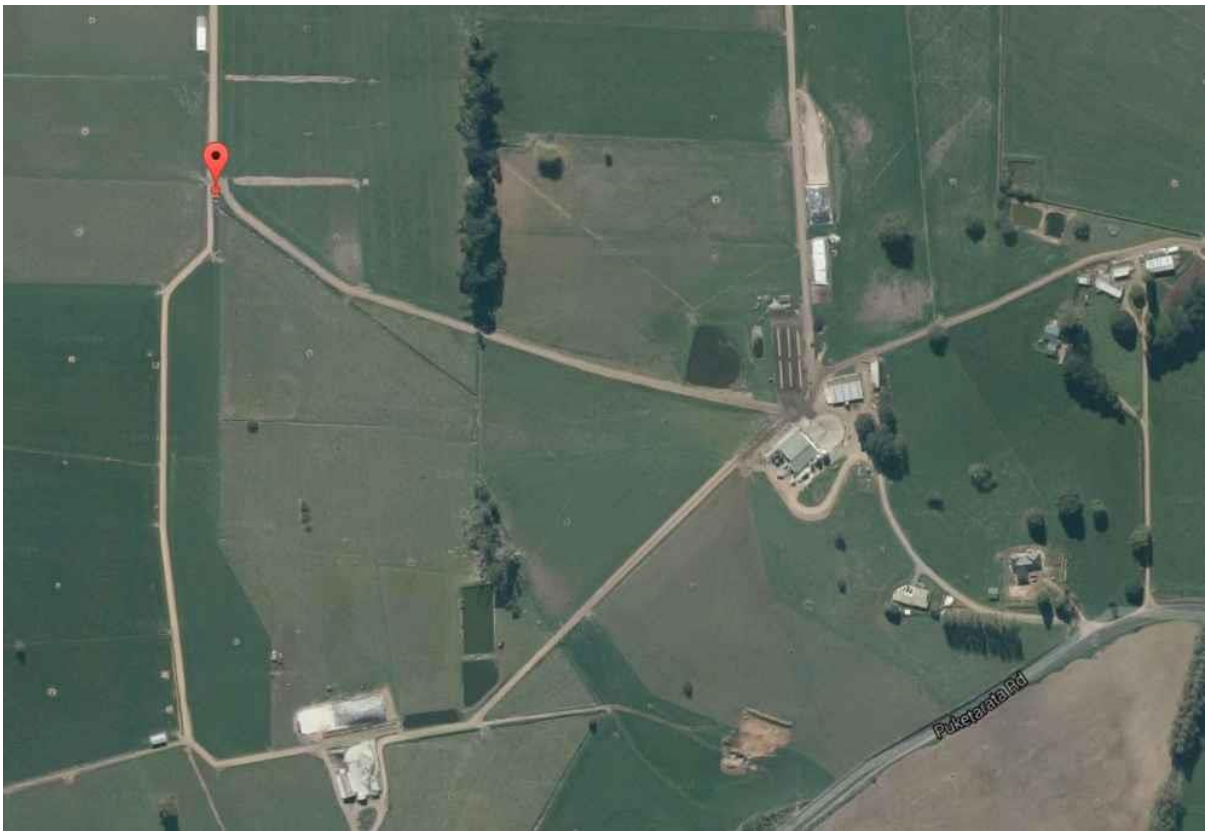


Figure A 1.3 Location of well 74_372; image from Google Earth (2014).

Figure A 1.4 Well 74_372.

A1.3 SITES WITH JUST WATER CHEMISTRY SAMPLING PERFORMED

70_484

Table A 1.4 70_484 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1790868	5810513	33 (GPS)	Most likely, but WRC coordinates are off by 200 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
6.4	4.8	6.4	Tauranga Group	Clay
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 11/03/15	No	No, no access

Access comments: Bore is 150 m west of Kakaramea and Koromatua junction near a pump shed on a paddock just south of Koromatua Rd. Access through a gate about 200 m west of Kakaramea and Koromatua junction. Four wheel drive is recommended.

Pump comments: Submersible pump that is hidden underneath timber that feeds into storage tank at cowshed a few hundred metres away.

Sampling comments: A tap in the pump shed at 3 m distance from the bore can be opened to run the pump for water quality sampling purposes. Assumed to be well purged prior to sampling.

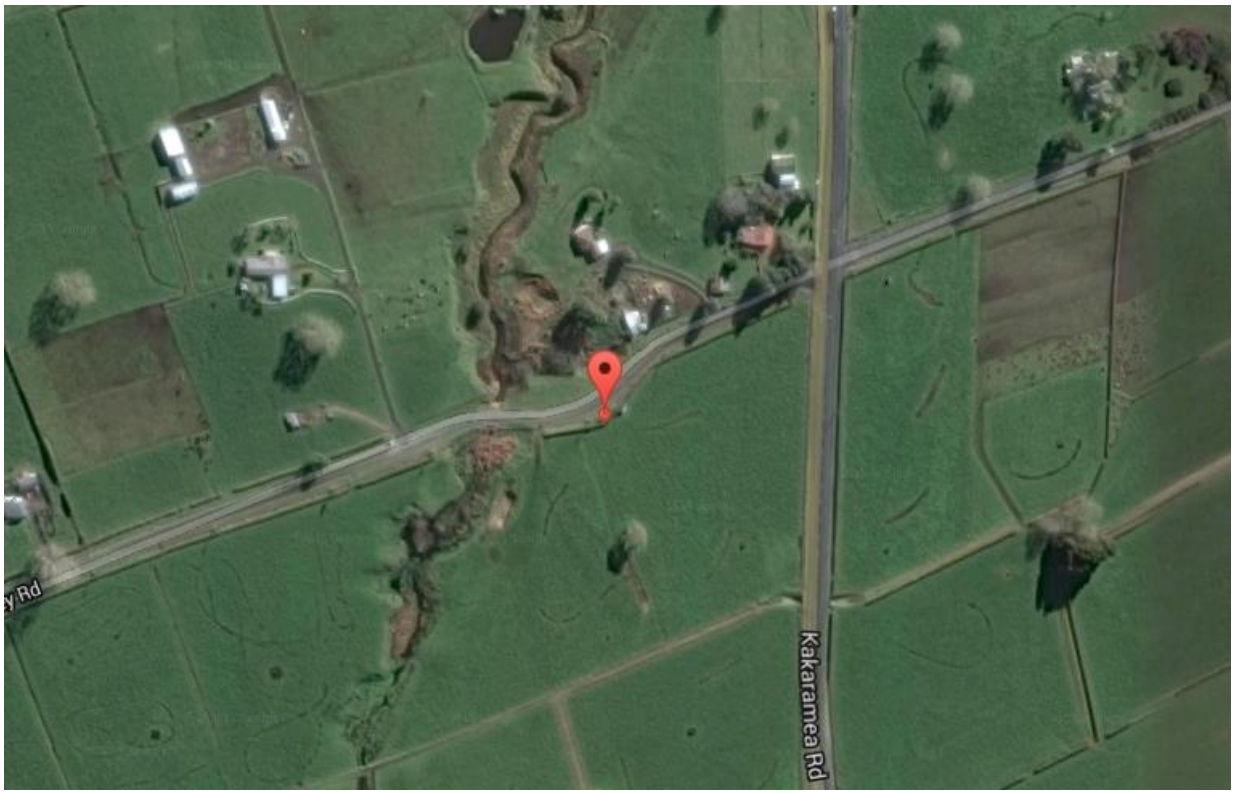


Figure A 1.5 Location of well 70_484; image from Google Earth (2014).

Figure A 1.6 Well 70_484.

72_2874

Table A 1.5 72_2874 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1817954	5794514	27 (GPS)	Yes, but WRC coordinates 150 m off	Submersible pump, pump rate 500 gallons/hour (~1900 L/h) according to owner
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
78	66	78	Basement rock	Greywacke
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 21/01/15	No	Maybe in winter

Access comments: Bore on paddock about 30 m next to shed just next to Norwegian Rd. Walking distance from road so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into storage tank near owner's property.

Sampling comments: The pipe was detached before it goes into the shed for water quality sampling purposes. Assumed to be well purged prior to sampling.

Additional comments: There is a second bore located in the shed that also feeds water into the storage tank, but it is older and was not sampled. A hole would have to be drilled into the top of the pump cap if a pump test needs to be completed.

Figure A 1.7 Location of well 72_2874; image from Google Earth (2014).

Figure A 1.8 Well 72_2874.

72_4070

Table A 1.6 72_4070 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1798414	5765642	91 (GPS)	Yes, but WRC coordinates 90 m off	Submersible pump, pump rate ~ 8700 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
108.5	92	108.5	Te Kuiti Group	Siltstone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 10/02/15	No	No, no access

Access comments: Bore on farm land a long way up a paddock. Access through Tauporae Farm at 497 Mangawhero Rd. Four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete tank nearby.

Sampling comments: Water quality sample taken where water feeds into concrete tank. Assumed to be well purged prior to sampling. Pump cannot be forced to run unless farm workers turn on the wash down hoses in the cowshed. Difficult bore to sample since float switch cannot be bypassed. Alistair Hogg is very interested in water quality results.

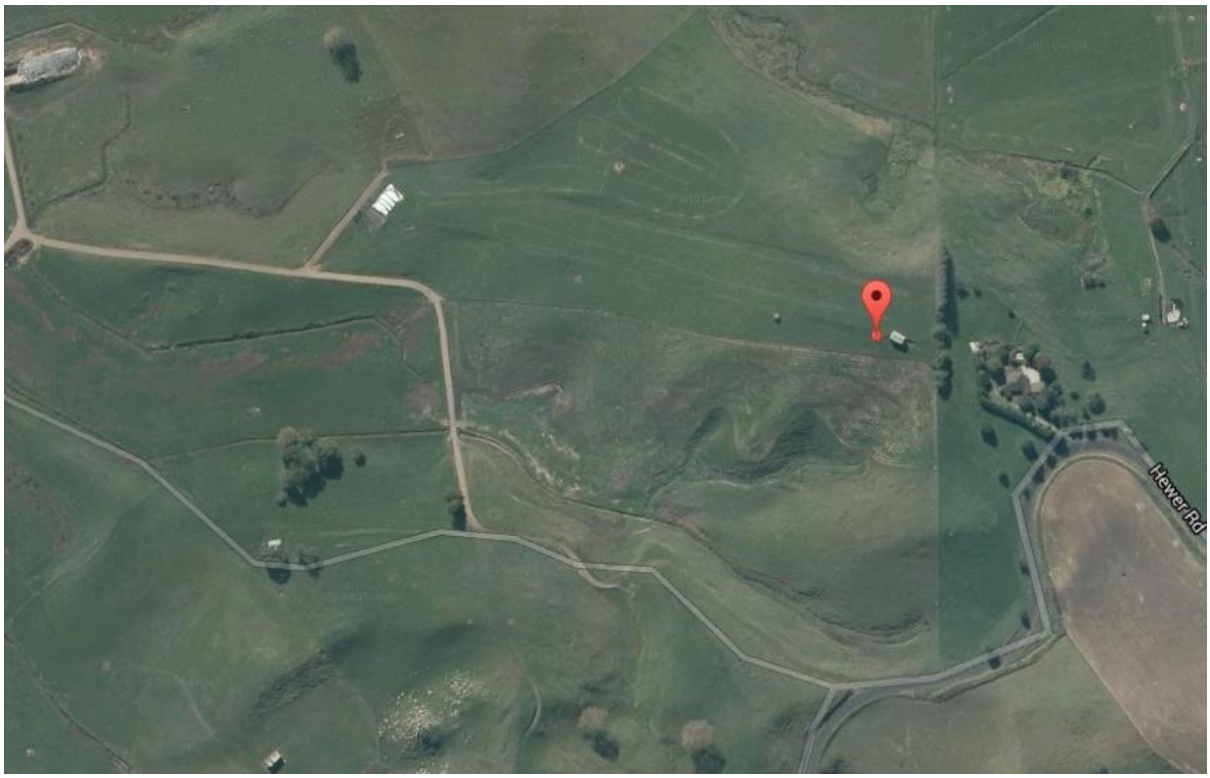


Figure A 1.9 Location of well 72_4070; image from Google Earth (2014).

Figure A 1.10 Well 72_4070.

72_4820

Table A 1.7 72_4820 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1810045	5763401	150 (GPS)	Yes, but WRC coordinates off by 340 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
90	65	90	Pakaumanu Group	Rhyolite
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 28/01/15	No	No, no access

Access comments: Bore is near farm sheds at 1310 Maihiihi Rd. Gravel road, no four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete storage tank nearby. Pump hidden under massive concrete tub that cannot be moved making access to the bore very difficult.

Sampling comments: Water quality sample was taken where it enters the concrete tank 5 m next to the bore. Assumed to be well purged prior to sampling.

Figure A 1.11 Location of well 72_4820; image from Google Earth (2014).

Figure A 1.12 Well 72_4820.

72_5048

Table A 1.8 72_5048 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1814568	5781944	117 (GPS)	Yes, but WRC coordinates off by 80 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
133	91.5	133	Pakaumanu Group	Pumice, gravels and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 04/02/15	No	No, no access

Access comments: Bore is 500–600 m south of 17 Mellsop Rd next to the cowshed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into a concrete storage tank 5 m next to bore.

Sampling comments: Water quality sample taken where water enters the concrete header tank. Assumed to be well purged prior to sampling. Difficult sampling as manhole is opposite to where the water feeds into the concrete tank.

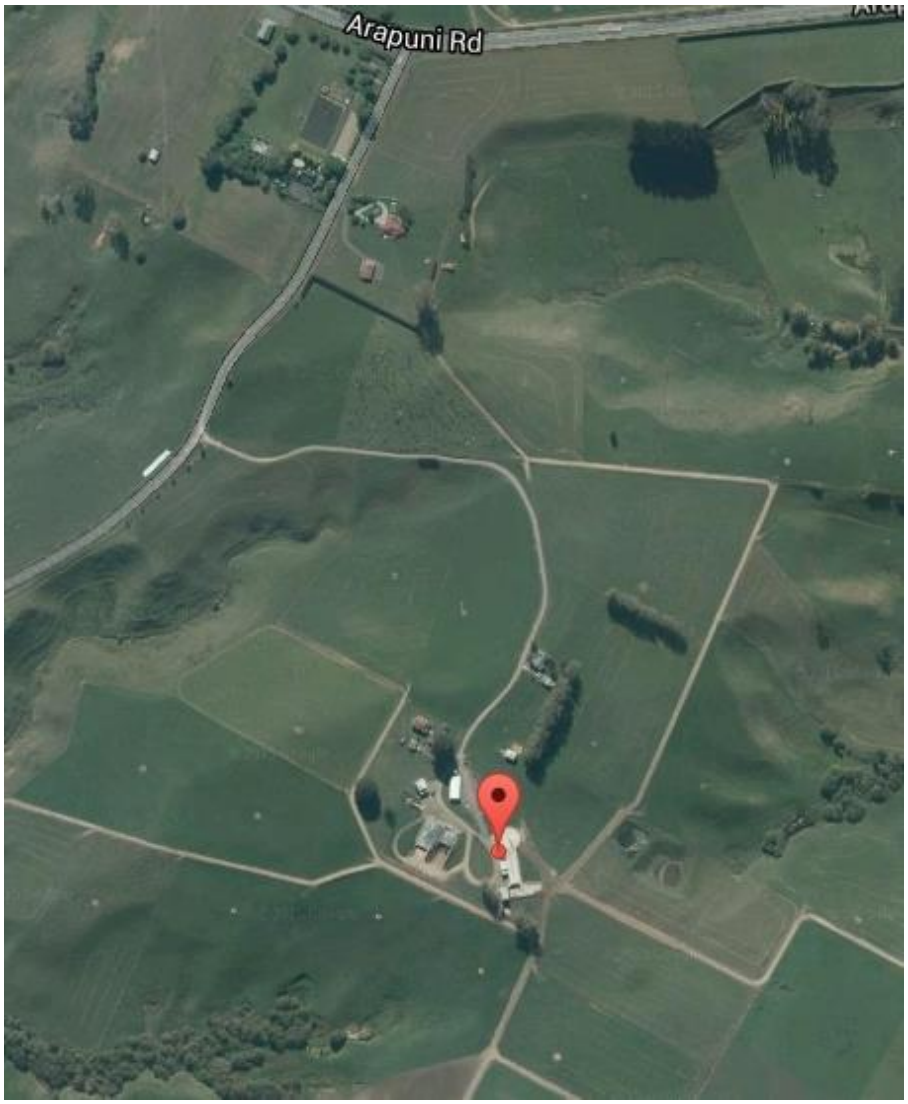


Figure A 1.13 Location of well 72_5048; image from Google Earth (2014).

Figure A 1.14 Well 72_5048.

72_5053

Table A 1.9 72_5053 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1807299	5769671	-	Yes, but WRC coordinates 80 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
65	41	54	Tauranga Group	Pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Maybe with small WLI	-	Done, 21/01/15	No	No, no access

Access comments: Bore is on paddock next to cowshed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into a plastic storage tank next to the cowshed.

Sampling comments: Water quality sample was taken where pipe feeds water into the plastic storage tank next to the cowshed. Assumed to be well purged prior to sampling.

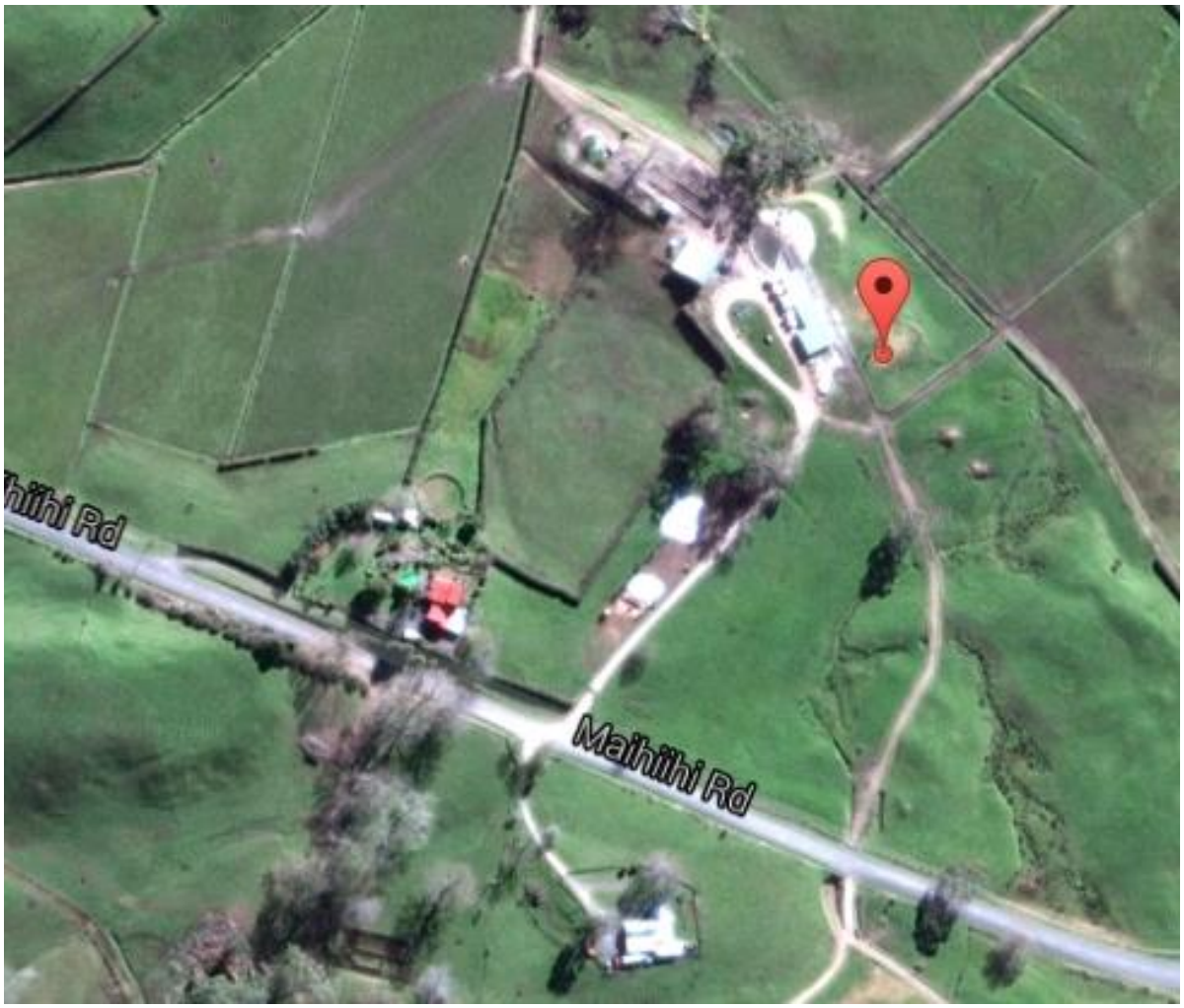


Figure A 1.15 Location of well 72_5053; image from Google Earth (2014).

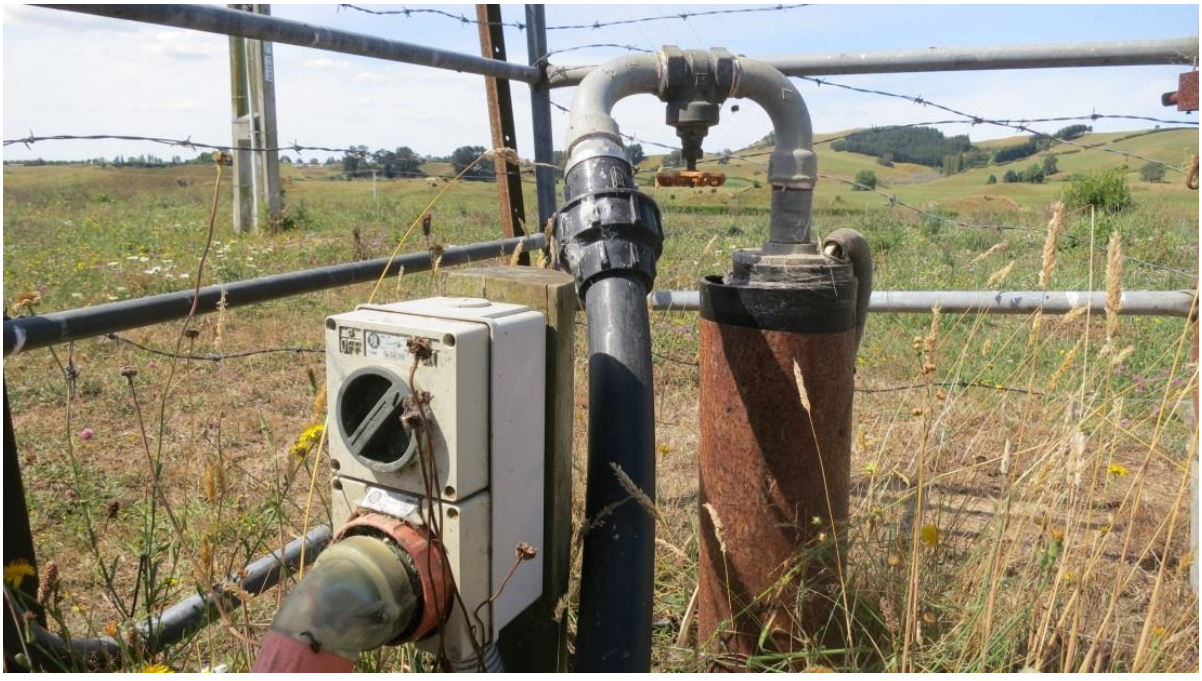


Figure A 1.16 Well 72_5053.

72_524

Table A 1.10 72_524 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1800630	5799042	43 (GPS)	Yes, but WRC coordinates 950 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
59	39	59	Tauranga Group	Sand and pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	-	Done, 18/03/15	No	No, no access

Access comments: Bore is just next to road 160 m south of Lake and Ryburn Rd intersection near a pump shed. Walking distance from road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water through pressure tank and then to farm.

Sampling comments: Water quality sample was taken by opening tap right at the pressure tank in the pump shed. Bore is pumped every day for the farm. Assumed to be well purged prior to sampling. Bore is under a steel cover that is difficult to take off.

Additional comments: There is another open bore (70_796) at 369 Ryburn Rd that could be easily used for pump testing.

Figure A 1.17 Location of well 72_524; image from Google Earth (2014).

Figure A 1.18 Well 72_524.

72_5253

Table A 1.11 72_5253 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1810750.7	5767132.1	144 (GPS)	Yes, but WRC coordinates 60 m off	Submersible pump, pump rate ~ 920 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
10	6.5	10	Basement rock	Blue weathered siltstone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Maybe	-	Done, 28/01/15	No	Maybe

Access comments: Bore is on paddock roughly 100 m north of shed.

Pump comments: Submersible that pumps water into concrete storage tank next to shed.

Sampling comments: Water quality sample was taken where pipe feeds water into concrete storage tank. Assumed to be well purged prior to sampling.

Figure A 1.19 Location of well 72_5253; image from Google Earth (2014).

Figure A 1.20 Well 72_5253.

65_53

Table A 1.12 65_53 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1787752	5786201	133 (GPS)	Yes, but WRC coordinates 60 m off	Submersible pump, pump rate ~ 2880 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
85.3	61.87	85.3	Alexandra Group volcanics	Basalt and rhyolite
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 01/04/15	No	No, no access

Access comments: Bore is behind house near a small shed. Drive up driveway to 275 Mangati Rd and walk 50 m to bore. No four wheel drive is needed. Bore is hidden under heavy concrete tub so no easy access to it.

Pump comments: Submersible that pumps water through a pressure tank to house.

Sampling comments: Water quality sample was taken after detaching a tap just next to the bore and after 25 minutes of purging. Only 1.8 purge volumes were completed, but parameters stayed constant for 15 minutes so assumed the well to be sufficiently purged prior to sampling.

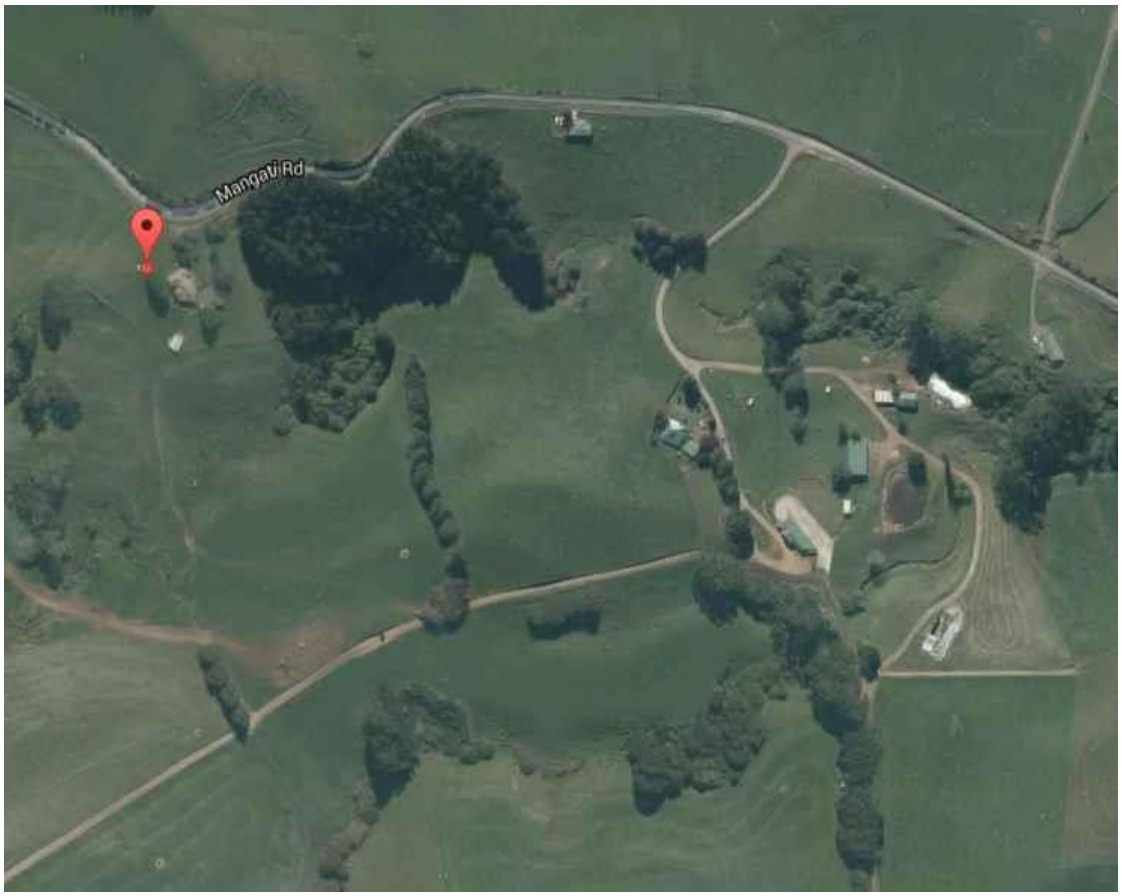


Figure A 1.21 Location of well 65_53; image from Google Earth (2014).

Figure A 1.22 Well 65_53.

69_1668

Table A 1.13 69_1668 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1782297	5827696	138 (GPS)	Most likely, but could also be 69_2082	Surface pump, pump rate ~ 757 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
32.5	21	32.5	Basement rock	Greywacke
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 10/04/15	No	No, no access

Access comments: Bore is at the bottom of a paddock below the property at 94B Wilton Collieries Rd, just next to where the old train tracks used to be. A car could possibly be driven along the gravel track near the old train tracks to get easier access to the bore. Four wheel drive is recommended.

Pump comments: Bore is inside a pump shed and an old surface pump feeds the water into a storage tank on top of the hill at about 110 m distance.

Sampling comments: Water quality sample was taken after detaching the pipe that feeds the water into the storage tank on top of the hill. To force the pump to run another smaller pipe that exits the smaller storage tank has to be lowered in order to drain water. Then the pump switch in the pump shed has to be turned on.

Figure A 1.23 Location of well 69_1668; image from Google Earth (2014).

Figure A 1.24 69_1668 site details.

72_7799

Table A 1.14 72_7799 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1812521	5760349	-	No idea	Surface pump, pump rate ~ 400 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
Unknown	unknown	unknown	Pakaumanu Group	unknown
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 23/01/15	No	No, no access

Access comments: Bore is on steep hill just south of the property at 680 Tauraroa Valley Rd. Very steep drive up paddock. Four wheel drive necessary.

Pump comments: Old surface pump that pumps water into concrete storage tank just next to pump shed.

Sampling comments: Pump was going at arrival and parameters stayed constant for 15 minutes so assumed the bore to be well purged prior to sampling.

Additional comments: Thought this bore was 72_5009, but realised that it could not be after later looking at the WRC database. It is likely that it does not exist in the WRC database and therefore WRC assigned it the number “72_7799”. Water quality data for this bore is probably not useful since all other bores in this region have no information on screen intervals in the WRC database.

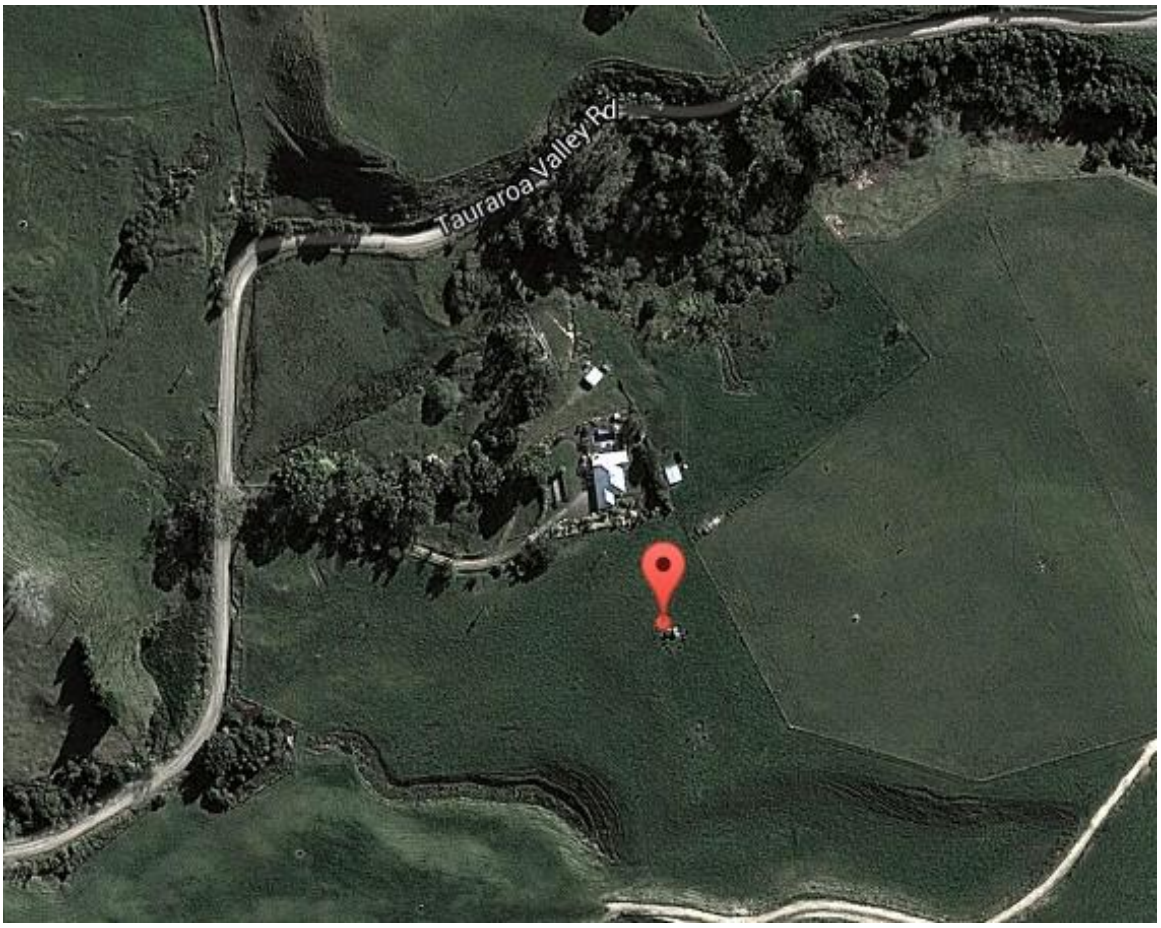


Figure A 1.25 Location of well 72_7799; image from Google Earth (2014).

Figure A 1.26 Well 72_7799.

A1.4 SITES WITH WATER CHEMISTRY SAMPLING AND WATER LEVEL MEASUREMENTS

72_4742

Table A 1.15 72_4742 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1789610	5765310	61 (GPS)	Yes, but WRC coordinates 130 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
32	19.5	32	Miocene sediments	Limestone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	16.145 m BGL (static, 24/02/15)	Done 24/02/15	No	Possible

Access comments: Bore is on a small hill just south of 507 Haurua Rd. Access is over a paddock so four wheel drive is recommended.

Pump comments: Strong submersible pump attached to pressure tank that feeds water into concrete storage tank on farm.

Sampling comments: Water quality sample was taken right at the bore by unscrewing a tap. Assumed to be well purged prior to sampling.

Additional comments: Big gap to get equipment down the bore. Really fast recovery of water table.

Figure A 1.27 Location of well 72_4742; image from Google Earth (2014).

Figure A 1.28 Well 72_4742.

72_6514

Table A 1.16 72_6514 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1793280.40	5790243.83	27.79 (RTK)	Yes, but WRC coordinates 130 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
18.22	9.1	18.22	Tauranga Group	Silt, Sands, Gravel
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, pump can be lifted up	8.262 m BGL (static, 16/04/15) 7.929 m BGL (static, 04/03/15)	Done, 04/03/15	No	Maybe

Access comments: Bore is just next to house on Linwood Downs Farm Ltd. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible pump that feeds water through a treatment system and then into a plastic storage tank next to it.

Sampling comments: Water quality sample was taken right at the bore by detaching pipe. Assumed to be well purged prior to sampling.

Additional comments: Pump can be lifted up in order to put equipment down the bore.

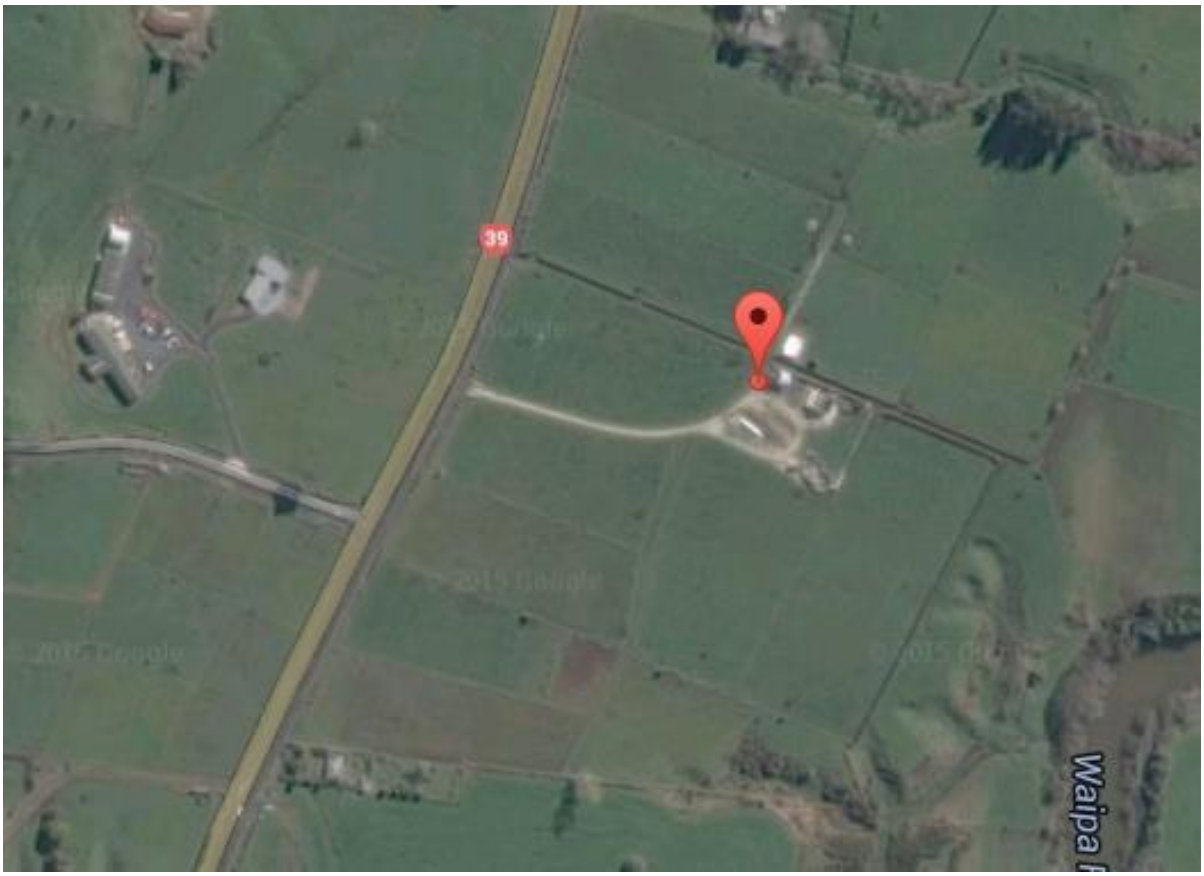


Figure A 1.29 Location of well 72_6514; image from Google Earth (2014).

Figure A 1.30 Well 72_6514.

72_4998

Table A 1.17 72_4998 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1803944.23	5793968.49	74.18 (RTK)	Yes, but WRC coordinates 115 m off	Submersible pump, pump rate ~ 1393 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
59.3	56.3	59.3	Tauranga Group	Pumice and clay
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	17.108 m BGL (static, 18/03/15)	Done, 18/03/15	No	Maybe

Access comments: Bore is next to garden at 37 Ngaroto Rd. Easy access from road, so no four wheel drive is necessary.

Pump comments: Submersible pump that feeds water into house and also through a pipe onto driveway.

Sampling comments: Water quality sample was taken about 10 m distance from bore at the open ending of the pipe on their driveway. Assumed to be well purged prior to sampling.

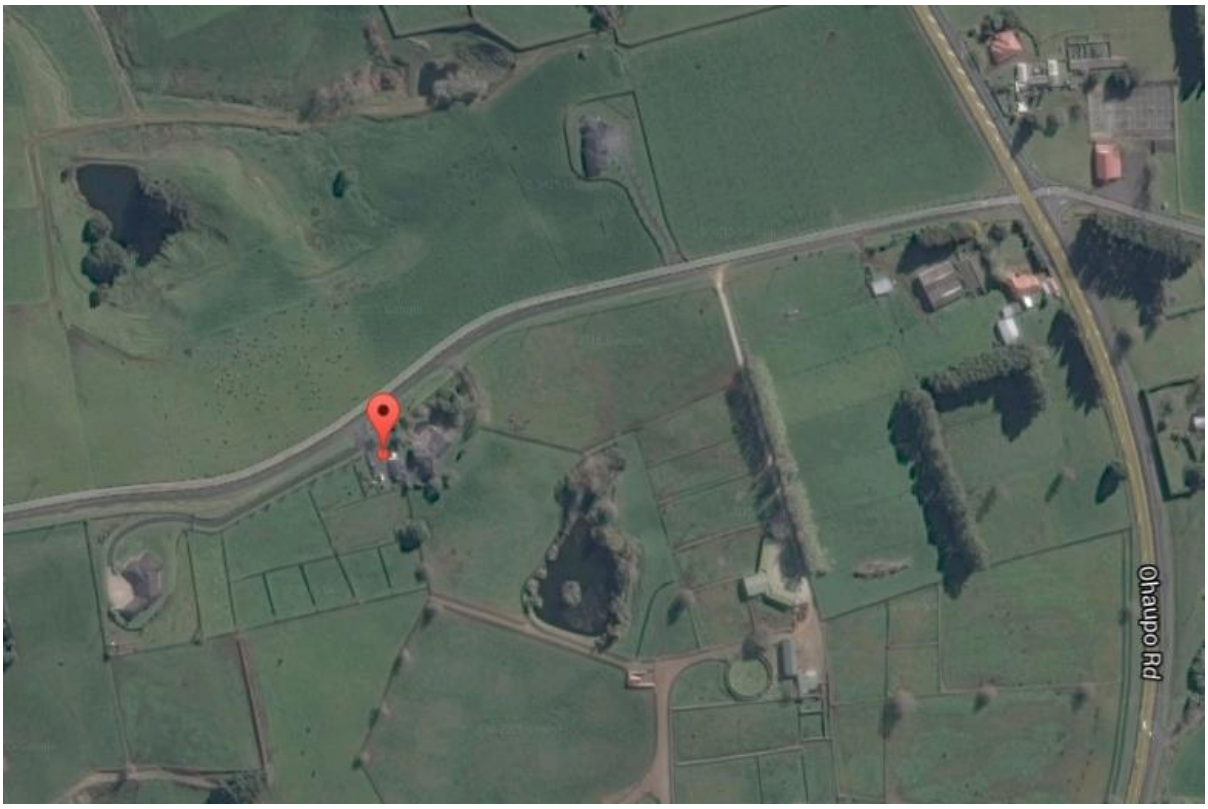


Figure A 1.31 Location of well 72_4998; image from Google Earth (2014).

Figure A 1.32 Well 72_4998.

72_3706

Table A 1.18 72_3706 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1789540.58	5827362.55	17.38 (RTK)	Yes, but WRC coordinates 150 m off	Surface pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
8	6	8	Tauranga Group	Sands and silt
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	7.122 m BGL (static, 16/04/15) 7.013 m BGL (static, 11/03/15)	Done, 11/03/15	No	Maybe

Access comments: Bore is next to driveway in little shed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible pump that feeds water to storage tank but also to a tap at 5 m distance from bore.

Sampling comments: Water quality sample was taken at about 5 m distance from bore at a tap. Assumed to be well purged prior to sampling.

Figure A 1.33 Location of well 72_3706; image from Google Earth (2014).

Figure A 1.34 Well 72_3706.

72_5469

Table A 1.19 72_5469 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1792959.43	5751658.54	251.37 (RTK)	Yes, but WRC coordinates 20 m off	Submersible pump, pump rate ~ 3600 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
126	71.5	126	Pakaumanu Group	Ignimbrite
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	49.219 m BGL (static, 14/04/15)	Done, 17/02/15	No	No, no access

Access comments: Drive to the end of Tate Rd southwest of Te Kuiti and go up driveway in the middle. Bore is next to shed on the right 60 m up the driveway. Access to concrete storage tank is steep terrain across a paddock. Four wheel drive necessary.

Pump comments: Submersible pump that feeds into a concrete tank about 500 m northeast of bore on top of a hill.

Sampling comments: Water quality sample taken where water feeds into concrete tank on top of the hill. Assumed to be well purged prior to sampling. Float switch in header tank can be lifted out in order to force the pump to run.

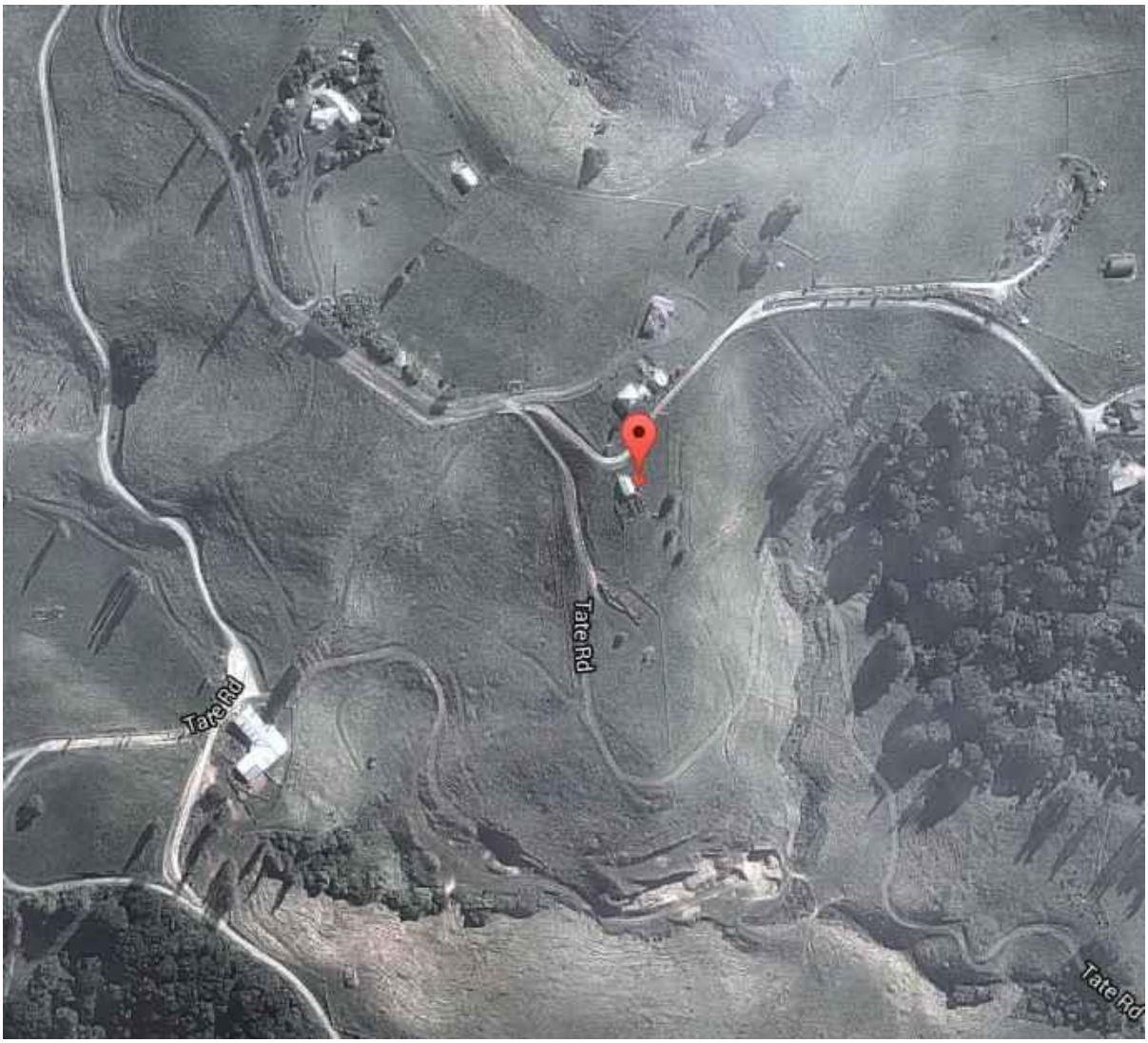


Figure A 1.35 Location of well 72_5469; image from Google Earth (2014).

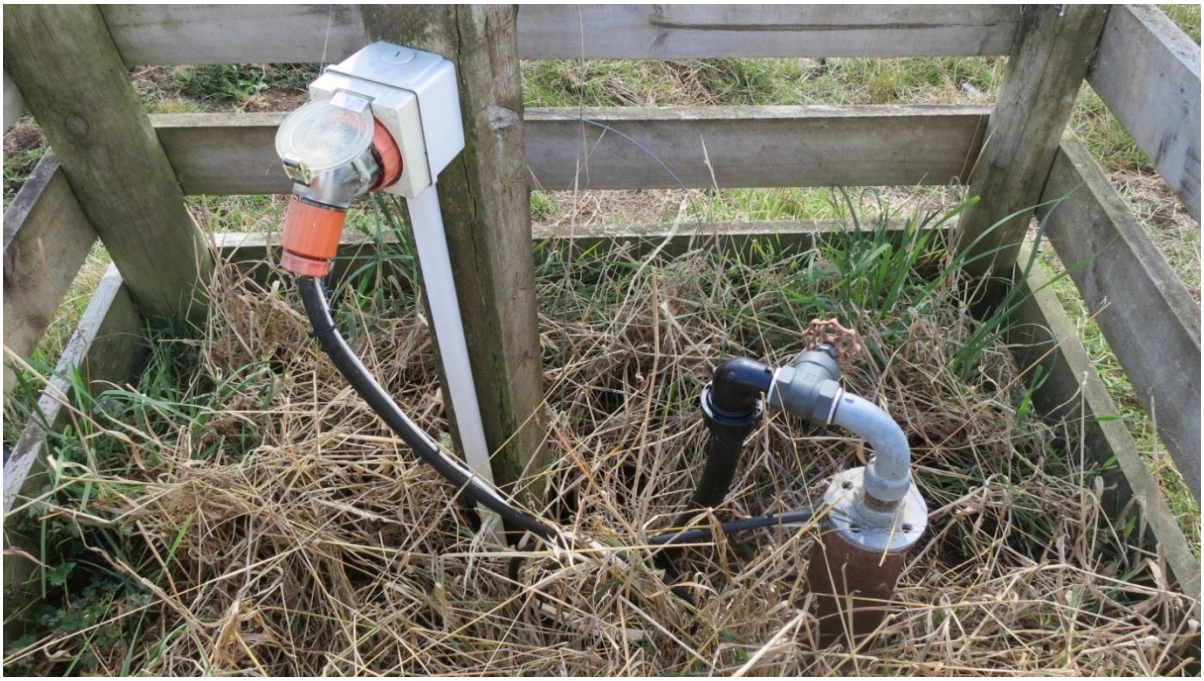


Figure A 1.36 Well 72_5469.

72_4320

Table A 1.20 72_4320 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1809022.54	5782781.70	41.04 (RTK)	Most likely, but coordinates from WRC are off by 800 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
15	12.5	15	Tauranga Group	Gravels with sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	4.781 m BGL (static, 14/04/15)	Done, 29/01/15	No	Maybe

Access comments: Bore just next to shed at the driveway at 290 Tiki Rd, Te Awamutu. No four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete tank nearby.

Sampling comments: Water quality sample taken where water feeds into concrete storage tank. Assumed to be well purged prior to sampling.

Additional comments: Small pipe that may be used for water level measurements going down bore shaft. Owner confirmed that this is most likely the correct bore. But since coordinates in the WRC database do not make sense it could also be 72_4369.

Figure A 1.37 Location of well 72_4320; image from Google Earth (2014).

Figure A 1.38 Well 72_4320.

72_4805

Table A 1.21 72_4805 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1787588.37	5801126.26	37.67 (RTK)	Yes, but WRC coordinates off by 80 m	Submersible pump, pump rate ~ 700 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
29	23	29	Tauranga Group	Pumice and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, but need to remove cover	4.863 m BGL (static, 14/04/15)	Done, 12/03/15	No	Possible

Access comments: Bore is in garden of 741 Te Pahu Rd, easy access. No four wheel drive is necessary.

Pump comments: Submersible that pumps water through treatment system. Pump hidden under a big cover in the middle of the garden.

Sampling comments: Water quality sample taken right at bore after detaching pipe. Assumed to be well purged prior to sampling.

Additional comments: Owner was very keen on getting water sampling done since he wants to supply the data when he sells the property.

Figure A 1.39 Location of well 72_4805; image from Google Earth (2014).

Figure A 1.40 Well 72_4805.

72_5019

Table A 1.22 72_5019 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1798282.85	5796761.56	55.73 (RTK)	Yes, but WRC coordinates off by 100 m	Submersible pump, pump rate ~ 3320 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
50	31.5	50	Tauranga Group	Pumice and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	13.497 m BGL (static, 15/04/15)	Done, 18/03/15	No	No, owner cautious of water use

Access comments: Bore is on paddock near shed behind main house. Gravel road, No four wheel drive is necessary.

Pump comments: Submersible that pumps water through a pressure cylinder into concrete storage tank nearby.

Sampling comments: Water quality sample taken at pressure tank after draining it for two hours. Assumed to be well purged prior to sampling.

Additional comments: Owner is very cautious regarding wasting water and the power bill. Screen depth in WRC database does not match notes received from driller (supplied by the owner). WRC database states screen from 31.5–50 m but driller notes say screen from 32.5–41 m.

Figure A 1.41 Location of well 72_5019; image from Google Earth (2014).

Figure A 1.42 Well 72_5019.

72_5042

Table A 1.23 72_5042 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1822966.90	5783216.71	240.04 (RTK)	Yes, but WRC coordinates off by 60 m	Submersible pump, pump rate ~ 660 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
106	69	106	Pakaumanu Group	Clay and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	42.213 m BGL (static, 17/04/15)	Done, 18/03/15	No	No, no access

Access comments: Bore is half way between main house and shed. Gravel road, No four wheel drive is necessary.

Pump comments: Submersible that pumps water into a concrete storage tank. Pump rate is roughly 660 L/h.

Sampling comments: Water quality sample taken right at the bore after detaching the pipe. Only one purge completed before sampling since it was too time consuming due to the low flow rate, but pump was running earlier the same day and parameters (pH, conductivity, temperature) stayed constant after one hour so it should be well purged.

Figure A 1.43 Location of well 72_5042; image from Google Earth (2014).

Figure A 1.44 Well 72_5042.

72_5062

Table A 1.24 72_5062 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1793122.47	5776132.72	30.98 (RTK)	Yes, but WRC coordinates 80 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
24	18	24	Tauranga Group	Gravels
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	10.74 m BGL (static, 15/04/15)	Done, 26/02/15	No	No, no access

Access comments: Bore is just next to cowshed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water through a pipe into drainage channel.

Sampling comments: Water quality sample was taken where the pipe drains water into a channel. Farmer turned pump on six hours before our arrival to purge the bore. Assumed to be well purged prior to sampling.

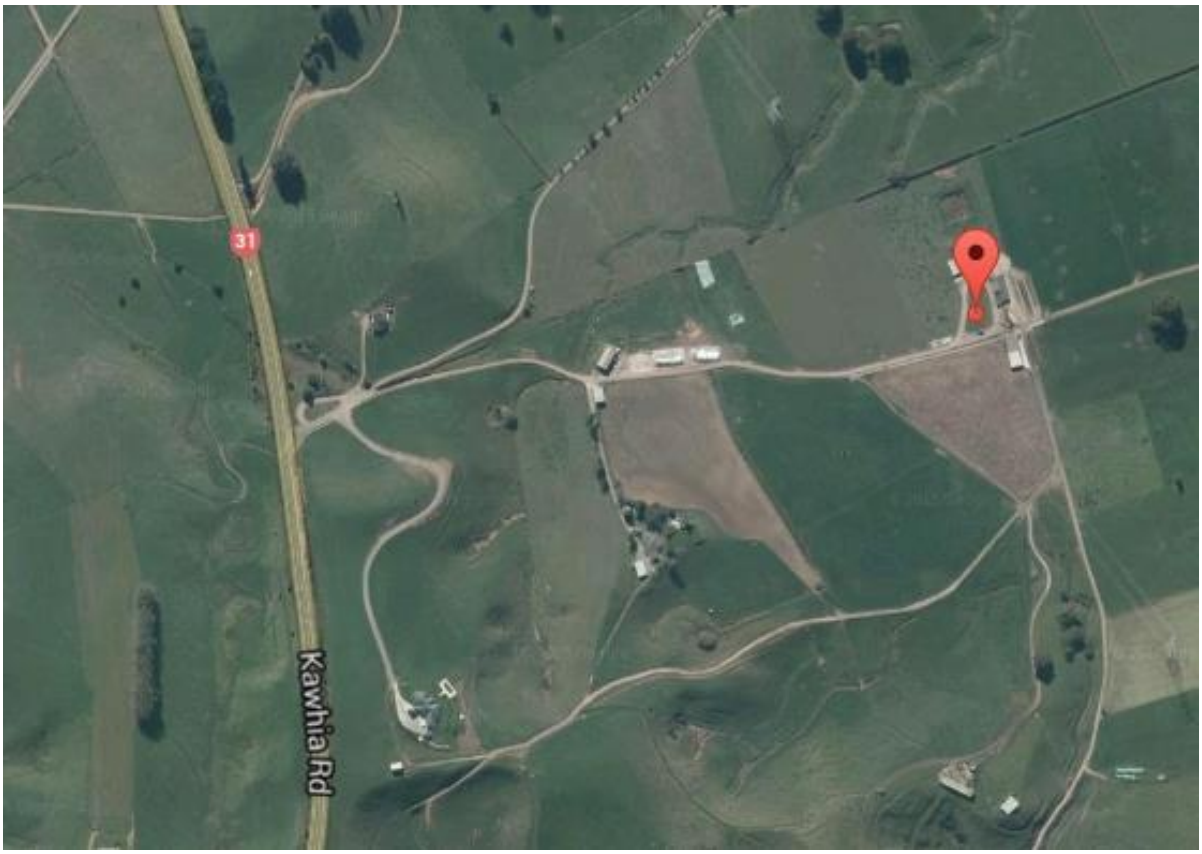


Figure A 1.45 Location of well 72_5062; image from Google Earth (2014).

Figure A 1.46 Well 72_5062.

72_7003

Table A 1.25 72_7003 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1801655.44	5756190.88	350.55 (RTK)	Probably not, WRC coordinates are 3000 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
31	18	31	Tauranga Group or Pakaumanu Group	Gravel, sands, pumice and clay
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	4.419 m BGL (static, 15/04/15)	Done, 26/02/15	No	No, no access

Access comments: Bore is on paddock east of 85 Thompson Rd. Steep terrain, so four wheel drive is necessary.

Pump comments: Submersible that pumps water into a concrete storage tank about 5 m from the bore.

Sampling comments: Water quality sample was taken right at the bore after detaching the pipe. Assumed to be well purged prior to sampling.

Location comments: This is most likely not the bore 72_7003. The WRC coordinates given for 72_7003 indicate a location on the Waipa River, which is not possible. The farm manager of Rata Ridge Ltd (Ian Buchanan) mentioned that this is the only bore he knows of at Thompson Rd, but did not know any details regarding the bore. Rex Brown Drilling told us that they did not drill this particular bore. We were not successful in finding out the drilling company name or any other details for this bore prior to completion of this report.

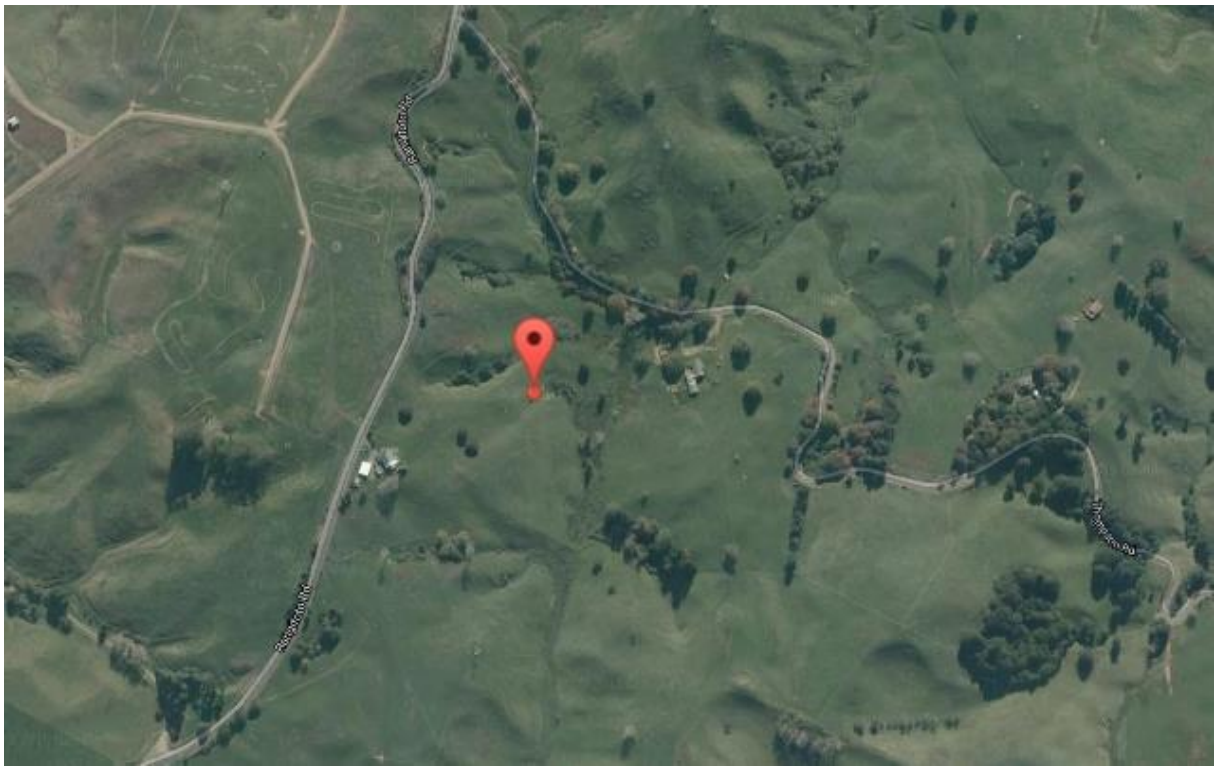


Figure A 1.47 Location of well 72_7003; image from Google Earth (2014).

Figure A 1.48 Well 72_7003.

72_7107

Table A 1.26 72_7107 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1788114.44	5760039.12	42.78 (RTK)	Yes, but WRC coordinates are 60 m off	Submersible pump, pump rate ~ 4320 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
65	51.6	58.1	Miocene sediments	Fracture Limestone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	6.3 m BGL (static, 15/04/15)	Done, 17/02/15	No	No, no access

Access comments: Bore is on paddock 60 m west of cowshed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into plastic storage tank next to the cowshed.

Sampling comments: Water quality sample was taken where the pipe feeds water into a plastic storage tank. Assumed to be well purged prior to sampling. Float switch can easily be forced down in order to start the pump running. Bore hidden under wooden box.

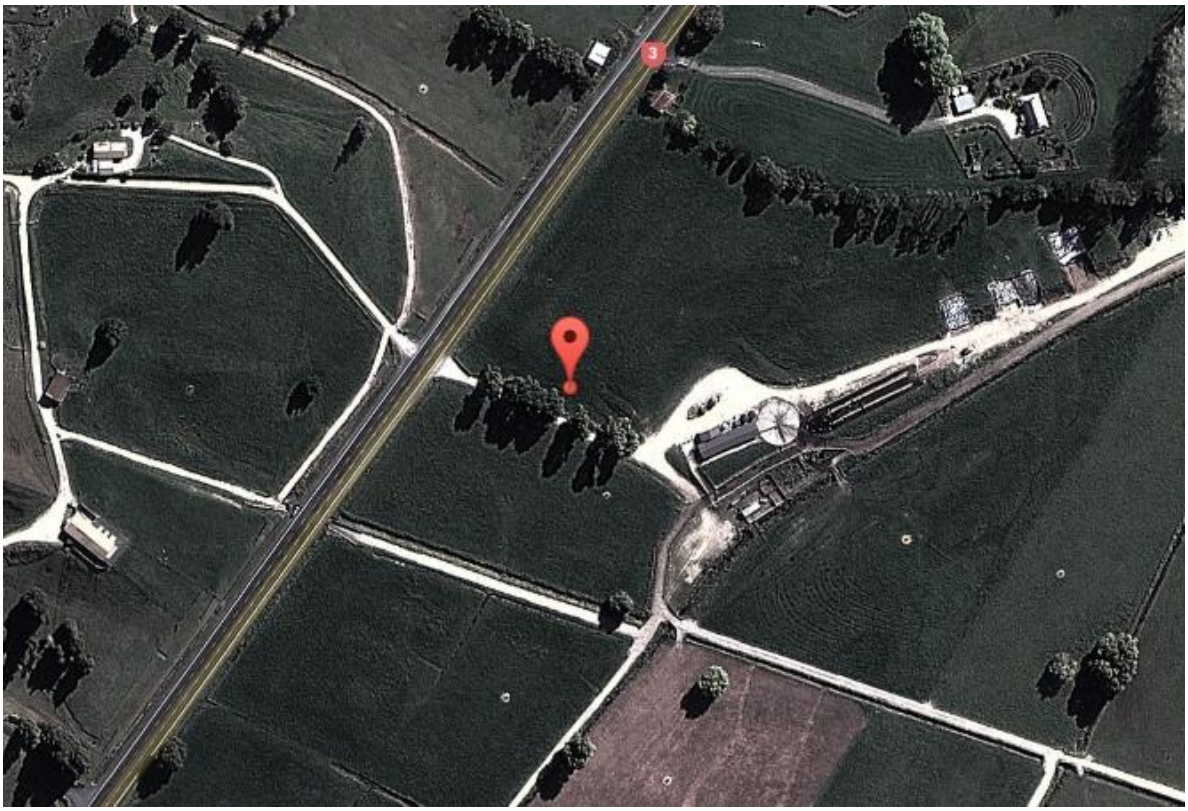


Figure A 1.49 Location of well 72_7107; image from Google Earth (2014).

Figure A 1.50 Well 72_7107.

72_730

Table A 1.27 72_730 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1794518.40	5789098.64	48.55 (RTK)	Yes, but WRC coordinates off by 130 m	Submersible pump, pump rate ~ 4300 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
48	36	48	Tauranga Group	Pumice and sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	11.073 m BGL (static, 15/04/15)	Done, 08/04/15	No	No, no access

Access comments: Bore is in paddock on eastern side of Candy Road just opposite the property at 533 Candy Rd. Bore is in a steel drum next to the pump shed. No four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete storage tank just next to pump shed.

Sampling comments: Water quality sample was taken where pipe feeds water into storage tank. Assumed to be well purged prior to sampling.

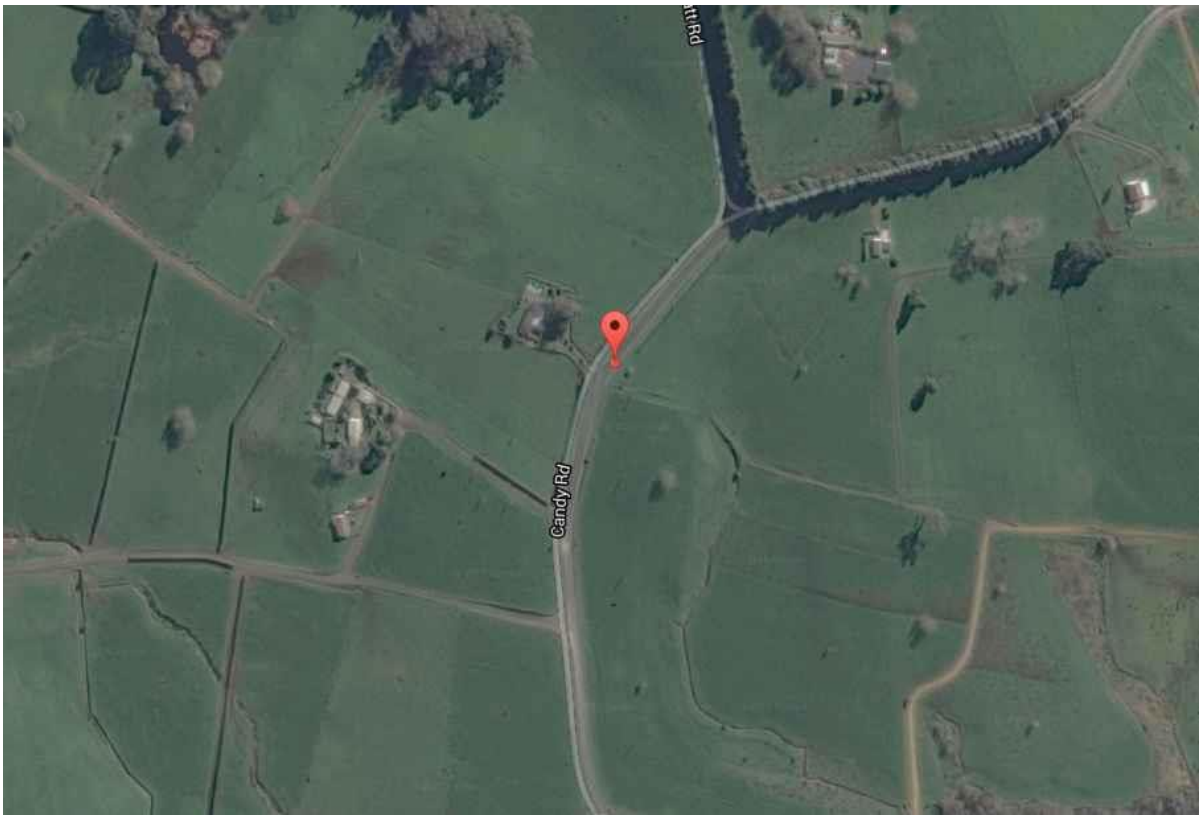


Figure A 1.51 Location of well 72_730; image from Google Earth (2014).

Figure A 1.52 Well 72_730.

69_2082

Table A 1.28 69_2082 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1782160.56	5827883.81	103.82 (RTK)	Most likely, but WRC coordinates off by 80 m	Surface pump, pump rate ~ 583 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
60	-	-	Basement rock	
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	4.528 m BGL (static, 15/04/15)	Done, 01/04/15	No	Maybe

Access comments: Bore is next to shed just past the property at 94A Wilton Collieries Rd. No four wheel drive is necessary.

Pump comments: Old surface pump that has not been in use much over the past years.

Sampling comments: Water quality sample was taken right at the bore after detaching the pipe there. Owner forced pump to run for 75 minutes before sample was taken. Assumed to be well purged prior to sampling.

Figure A 1.53 Location of well 69_2082; image from Google Earth (2014).

Figure A 1.54 Well 69_2082.

72_4235

Table A 1.29 72_4235 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1794022	5804259	38 (GPS)	Most likely, but could also be 72_4236	Surface pump, ~ 1440 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
7.3	4.3	7.3	Tauranga Group	Sand and silts
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	5.445 m BGL (dynamic, 01/04/15)	Done, 01/04/15	No	Maybe

Access comments: Bore is at 1288 Kakaramea Rd, Ohaupo. Drive up tanker track to cowshed. Bore is located on southern side of gravel track near a pump shed. No four wheel drive is necessary.

Pump comments: Surface pump that feeds water into storage tank at about 70 m distance just next to the cowshed.

Sampling comments: Pump was going at arrival and parameters stayed constant for 15 minutes so assumed the bore to be well purged prior to sampling.

Additional comments: This bore could also be 72_4236, but since both have very similar bore depth and screens it will likely not matter for interpretation.

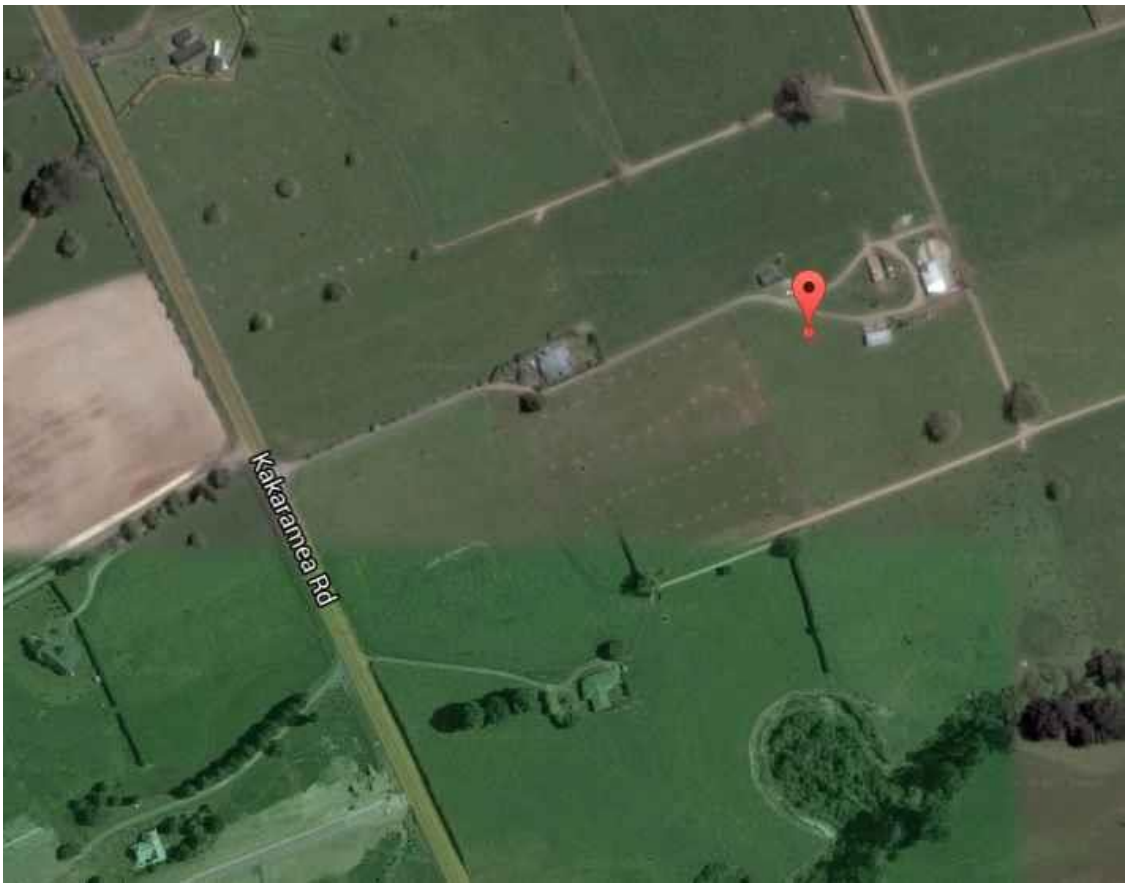


Figure A 1.55 Location of well 72_4235; image from Google Earth (2014).

Figure A 1.56 Well 72_4235.

72_5289

Table A 1.30 72_5289 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1824714.70	5773533.16	135.82 (RTK)	Yes, but WRC coordinates 100 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
138	92	138	Pakaumanu Group	Rhyolite
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	24.805 m BGL (dynamic, 17/04/15)	Done, 28/01/15	No	No, no access

Access comments: Bore is next to cowshed. Gravel road, easy but steep access. Four wheel drive is recommended if rain preceded visit or is expected.

Pump comments: Submersible that pumps water into plastic storage tank next to cowshed.

Sampling comments: Pipe was detached before entering the plastic tank to get a water quality sample. Assumed to be well purged prior to sampling.

Additional comments: Owner also has another older bore near the house, 300 m east of the cowshed.

Figure A 1.57 Location of well 72_5289; image from Google Earth (2014).

Figure A 1.58 Well 72_5289.

72_5490

Table A 1.31 72_5490 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1799074.47	5762756.98	84.67 (RTK)	Yes, but WRC coordinates 40 m off	Submersible pump, pump rate ~ 1080 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
136	52	136	Te Kuiti Group	Gravels, mudstone and silt
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	22.406 m BGL (dynamic, 17/04/15)	Done, 10/02/15	No	No, no access

Access comments: Bore is next to cowshed. Gravel road. If rain preceded visit or is expected then four wheel drive is recommended to obtain access to the plastic storage tank.

Pump comments: Submersible that pumps water into plastic storage tank about 150 m east of bore.

Sampling comments: Water quality sample taken where water feeds into plastic storage tank. Assumed to be well purged prior to sampling.

Figure A 1.59 Location of well 72_5490; image from Google Earth (2014).

Figure A 1.60 Well 72_5490.

72_5049

Table A 1.32 72_5049 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1804684.94	5771108.06	67.69 (RTK)	Yes, exact coordinates	Submersible pump, pump rate ~ 3600 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
90	73	75	Pakaumanu Group	Rhyolite
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	20.551 m BGL (dynamic, 16/04/15)	Done, 03/02/15	No	No, no access

Access comments: Bore is just next to a driveway on top of the hill near a gate. Easy access from Whibley Rd, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into a plastic storage tank next to the cowshed 280 m south of bore.

Sampling comments: Water quality sample was taken where the pipe feeds water into the plastic storage tank next to the cowshed. Assumed to be well purged prior to sampling.

Additional comments: Owner is not too fond of the Regional Council.

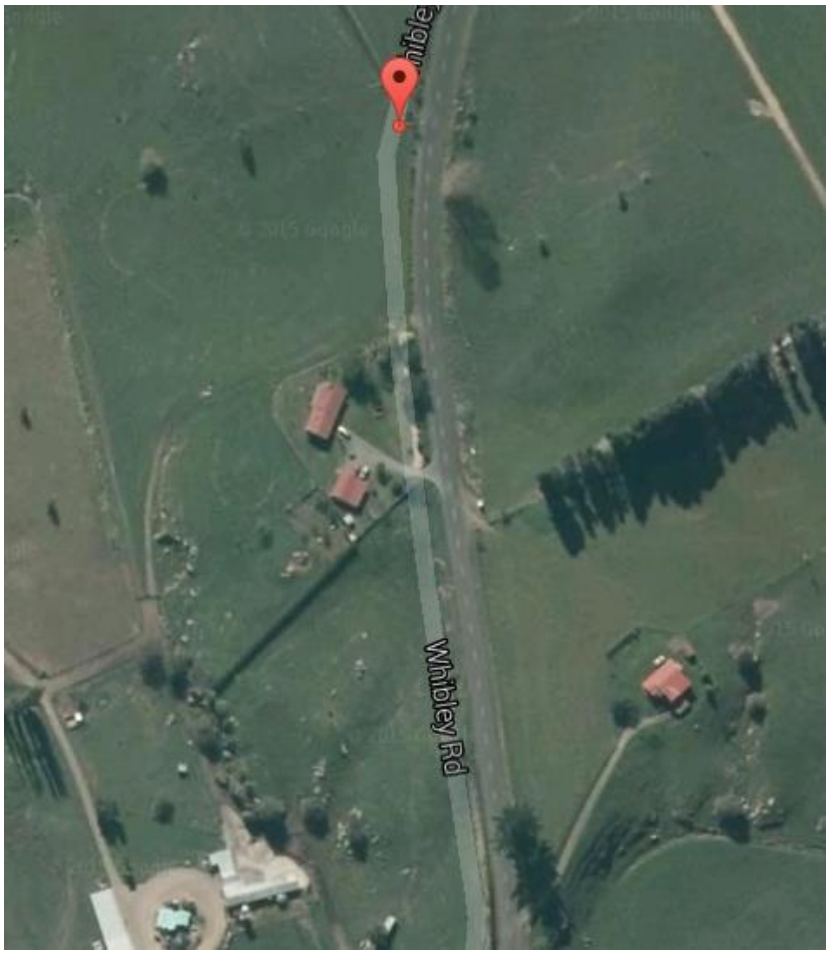


Figure A 1.61 Location of well 72_5049; image from Google Earth (2014).

Figure A 1.62 Well 72_5049.

72_4788

Table A 1.33 72_4788 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1792938.90	5764749.64	63.85 (RTK)	Yes, but WRC coordinates off by 100 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
120	90	120	Miocene sediments	fractured mudstone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Maybe with small WLI	49.168 m BGL (dynamic, 15/04/15)	Done 24/02/15	No	No, no access

Access comments: Bore is 900 m northeast from 727 Old Te Kuiti Rd on a hill on the northern side of the road. Access through a gate up a paddock. Four wheel drive is recommended.

Pump comments: Submersible that pumps water into a plastic storage near the cowshed at 727 Old Te Kuiti Rd at about 900 m distance from the bore.

Sampling comments: Water quality sample was taken where water feeds into plastic tank at 900 m distance from the bore. Assumed to be well purged prior to sampling.

Additional comments: Water level could maybe be measured with a smaller water level indicator.

Figure A 1.63 Location of well 72_4788; image from Google Earth (2014).

Figure A 1.64 Well 72_4788.

72_4819

Table A 1.34 72_4819 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1801520.90	5778606.38	44.66 (RTK)	Yes, but WRC coordinates off by 1200 m	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
58.5	52	58.5	Tauranga Group	Pumice and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	7.798 m BGL (dynamic, 16/04/15)	Done, 4/03/2015	No	No, no access

Access comments: Bore is near farm at 661 Puketarata Rd. Gravel road, No four wheel drive is necessary.

Pump comments: Submersible that pumps water through treatment device and into concrete storage tank.

Sampling comments: Water quality sample was taken just after a filter as the pipe could not be detached. Assumed to be well purged prior to sampling. Owner mentioned that the filter only takes out suspended material such as sand and gravel and does not change water chemistry. It is assumed that the filter is larger than the 45 μm filter size used for sampling and will not affect the chemistry results.

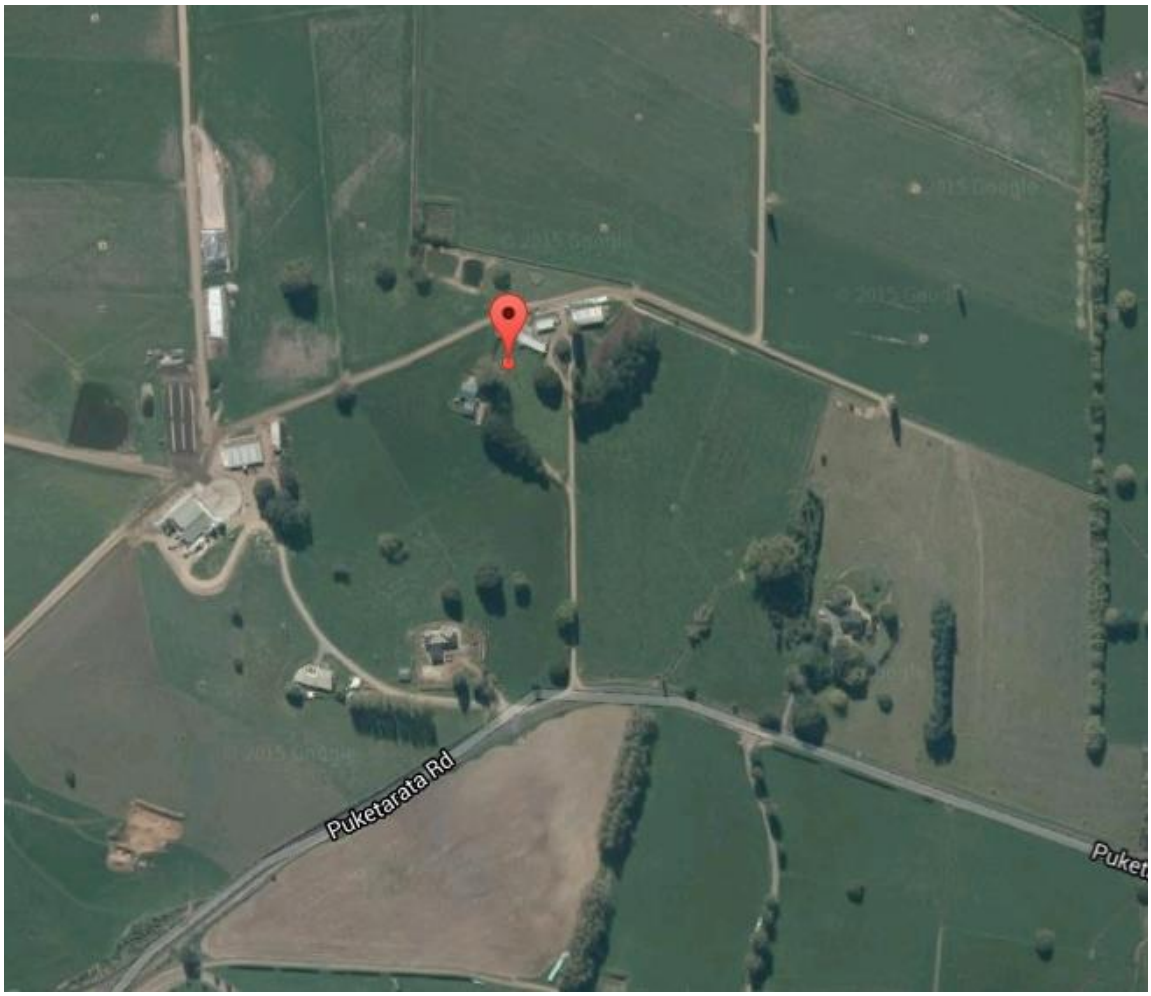


Figure A 1.65 Location of well 72_4819; image from Google Earth (2014).

Figure A 1.66 Well 72_4819.

72_2732

Table A 1.35 72_2732 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1791025	5826377	27 (GPS)	Yes, but WRC coordinates 90 m off	Submersible pump, pump rate 300 gallons/hour (~1,130 L/h) according to owner
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
35	27.2	35	Tauranga Group	Pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	10.54 m BGL (dynamic, 12/03/15)	Done, 12/03/15	No	No, owner would not allow

Access comments: Drive up gravel driveway at 75A Saulbrey Rd. Bore is 70 m southeast of house near a shed. Four wheel drive is recommended.

Pump comments: Submersible that pumps water through a pressure tank and then onto five neighbouring properties.

Sampling comments: Opened tap at pressure tank in order to drain tank and to force pump to run. Water quality sample taken at tap on pressure tank. Assumed to be well purged prior to sampling.

Additional comments: Owner is very sensitive about draining water and the power bill and is not too fond of the Regional Council.

Figure A 1.67 Location of well 72_2732; image from Google Earth (2014).

Figure A 1.68 Well 72_2732.

A1.5 SITES WITH AGE DATING AND WATER CHEMISTRY SAMPLING

72_5034

Table A 1.36 72_5034 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1808894	5781614	60 (GPS)	Yes, but WRC coordinates 90 m off	Submersible pump, pump rate ~ 3600 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
38	20	38	Tauranga Group	Pumice, gravels and sand
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	-	Done, 29/02/15	No	No, no access

Access comments: Bore is just next to driveway inside a wooden shed. Easy access, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water through a pressure cylinder into house and also to a tap inside the wooden shed.

Sampling comments: Water quality and age samples were taken at tap inside wooden shed. Assumed to be well purged prior to sampling.

Additional comments: Never knock on 422 Waikeria Road: owner gets really angry if people come unannounced.

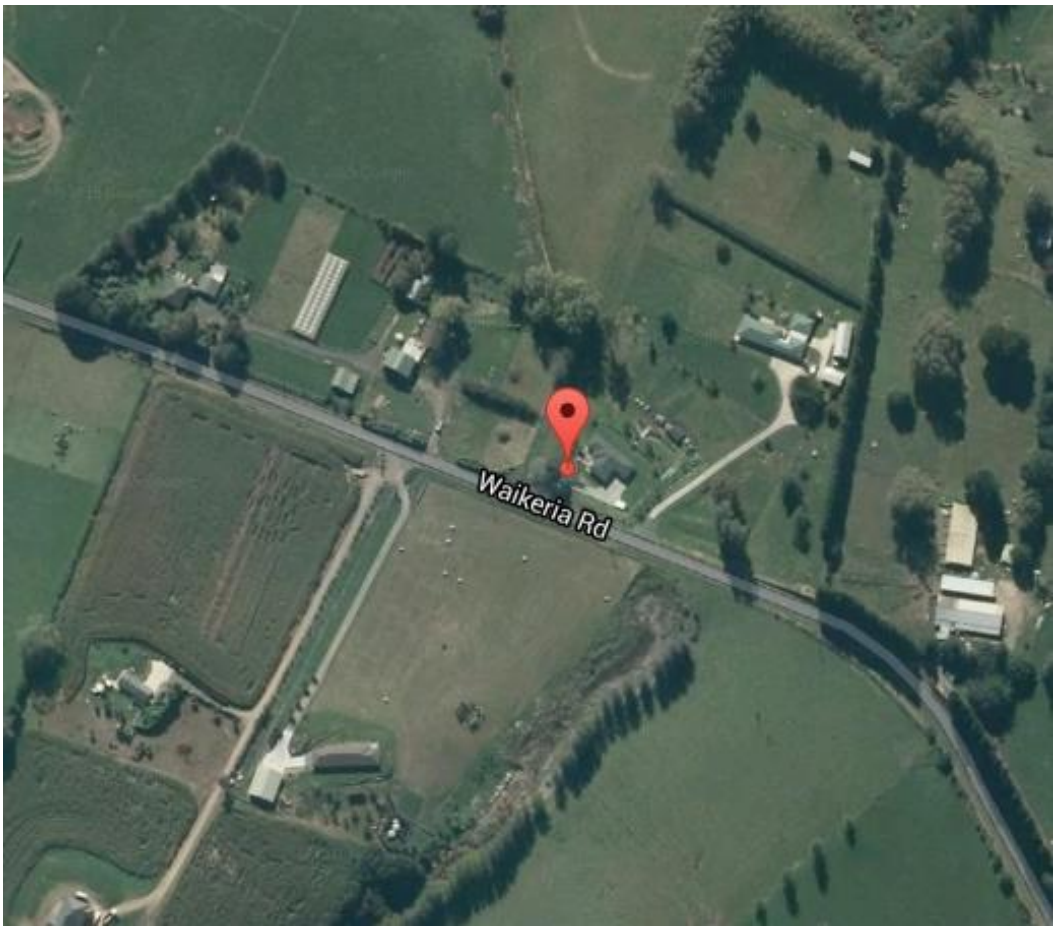


Figure A 1.69 Location of well 72_5034; image from Google Earth (2014).

Figure A 1.70 Well 72_5034.

72_5433

Table A 1.37 72_5433 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1785189.71	5781195.37	98.96 (RTK)	Yes, but WRC coordinates 90 m off	Submersible pump, pump rate ~ 3000 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
30	21.5	30	Alexandra Group volcanics	Basalt
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	15.516 m BGL (dynamic, 15/04/15)	Done, 24/02/2015	No	No, no access

Access comments: Bore is next to house at 2091 State Highway 31. Steep gravel road. Four wheel drive recommended in wet conditions.

Pump comments: Submersible pump that feeds water into concrete storage tank next to it.

Sampling comments: Water quality and age samples were taken at about 3 m distance from bore after detaching pipe. Assumed to be well purged prior to sampling. Float switch can be forced down easily to force pump to run.

Figure A 1.71 Location of well 72_5433; image from Google Earth (2014).

Figure A 1.72 Well 72_5433.

72_5103

Table A 1.38 72_5013 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1798074.54	5788284.97	47.34 (RTK)	Yes, but WRC coordinates 80 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
66	53	66	Tauranga Group	Pumice and sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	25.138 m BGL (dynamic, 15/04/15)	Done, 12/02/15	No	No, no access

Access comments: Bore is next to farm near the pond at the bottom of the hill. Gravel road, No four wheel drive is necessary.

Pump comments: Submersible pump that feeds water into concrete storage tank about 180 m northwest of bore next to the owner's house.

Sampling comments: Bore hidden inside three large tractor tyres. Water quality and age samples were taken where water enters into the concrete storage tank. Assumed to be well purged prior to sampling.

Figure A 1.73 Location of well 72_5013; image from Google Earth (2014).

Figure A 1.74 Well 72_5013.

A1.6 SITES WITH AGE DATING, WATER CHEMISTRY SAMPLING AND WATER LEVEL MEASUREMENTS

72_6408

Table A 1.39 72_6408 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1793179	5817787	62 (GPS)	Yes, but WRC coordinates 30 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
81	72	81	Tauranga Group	Pumice and sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, pump can be lifted up	29.39 m BGL (static, 12/02/15)	Done, 12/02/2015	No	Possible

Access comments: Bore is just next to house in garden. Easy access, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water through a treatment system into a concrete storage tank.

Sampling comments: Water quality and age samples were taken right at the bore after detaching pipe. Assumed to be well purged prior to sampling.

Additional comments: Owners use pump only to water the garden and to fill up the pool.

Figure A 1.75 Location of well 72_6408; image from Google Earth (2014).

Figure A 1.76 Well 72_6408.

62_96

Table A 1.40 62_96 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1794889.03	5818013.81	32.32 (RTK)	Yes, but WRC coordinates 75 m off	Surface pump, pump rate ~ 2880 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
26	22	26	Tauranga Group	Sands, clay, pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	8.49 m BGL (static, 14/04/15)	Done, 19/02/15	No	Maybe

Access comments: Bore is in shed behind house. Easy access, so no four wheel drive is necessary.

Pump comments: Surface pump that feeds water through a pressure cylinder to a tap.

Additional comments: Water quality and age samples were taken at the tap about 20 m distance from the bore. Assumed to be well purged prior to sampling.

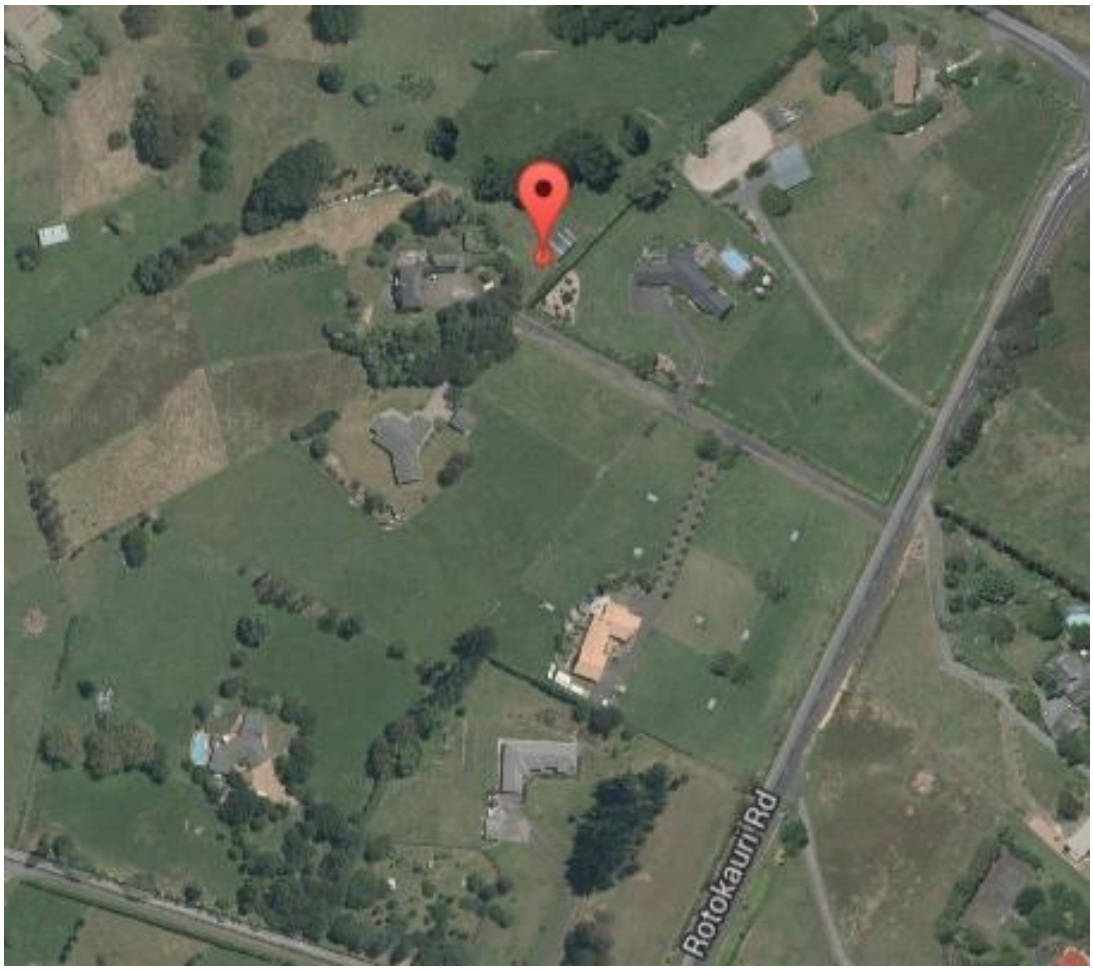


Figure A 1.77 Location of well 62_96; image from Google Earth (2014).

Figure A 1.78 Well 62_96.

72_7021

Table A 1.41 72_7021 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1804440.78	5786117.97	41.75 (RTK)	Yes, but WRC coordinates 30 m off	Submersible pump
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
31	25	31	Tauranga Group	Sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	12.854 m BGL (static, 16/04/15)	Done, 19/02/15	No	No, no access

Access comments: Bore is next to house at 28 Awanui Avenue. Gravel road, No four wheel drive is necessary.

Pump comments: Submersible pump that feeds water to sprinkler system and into a storage tank.

Sampling comments: Water quality and age samples were taken at about 3 m distance from bore at a tap. Assumed to be well purged prior to sampling.

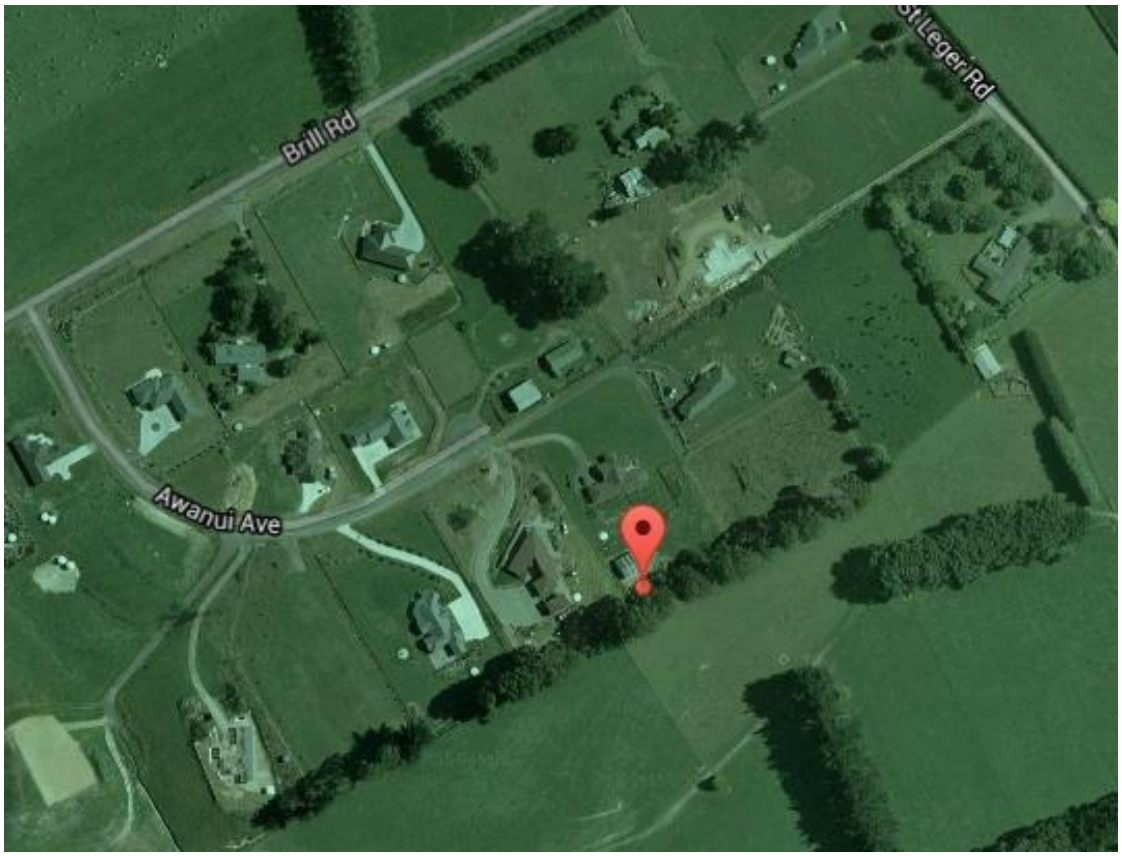


Figure A 1.79 Location of well 72_7021; image from Google Earth (2014).

Figure A 1.80 Well 72_7021.

A1.7 SITES WITH HYDRAULIC TESTING, WATER LEVEL MEASUREMENTS AND WATER CHEMISTRY SAMPLING

72_5569

Table A 1.42 72_5569 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1814275.06	5792554.10	65.74 (RTK)	Yes, exact coordinates	Submersible pump, pump rate ~ 2400 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
41	35	41	Tauranga Group	Sands and pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, pump can be shifted	4.537 m BGL (static, 05/03/15)	Done, 29/01/15	No	Completed, 05/03/15

Access comments: Bore is just next to the farm. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into a concrete storage tank nearby.

Sampling comments: Water quality sample taken where water enters the concrete storage tank. Assumed to be well purged prior to sampling.

Figure A 1.81 Location of well 72_5569; image from Google Earth (2014).

Figure A 1.82 Well 72_5569.

72_6180

Table A 1.43 72_6180 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1787878.45	5821556.76	20.89 (RTK)	Yes, but WRC coordinates 40 m off	Surface pump, pump rate ~ 864 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
20.9	8.4	11.2	Tauranga Group	Sands and gravels
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	6.838 m BGL (static, 12/03/15) 6.893 m BGL (static, 14/04/15)	Done, 12/03/15	No	Completed, 12/03/15

Access comments: Bore is just next to the farm. Gravel road, so no four wheel drive is necessary.

Pump comments: Surface pump that feeds water into a storage tank nearby.

Sampling comments: Water quality sample taken where water enters the concrete storage tank by pulling out the pipe. Assumed to be well purged prior to sampling.

Figure A 1.83 Location of well 72_6180; image from Google Earth (2014).

Figure A 1.84 Well 72_6180.

72_2915

Table A 1.44 72_2915 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1789296	5753007	184 (GPS)	Yes, but WRC coordinates 80 m off	Submersible pump that can pump up to 36,000 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
30.4	14.4	28.4	Miocene sediments	Limestone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
No	10.06 m BGL (static, 12/05/05)	Done 26/02/15	No	Completed by council in 2005

Access comments: From Te Kuiti drive south along State Highway 3 and turn onto gravel road at a picnic area 300 m north of Johnston Rd. After 150 m turn right and go through a gate, drive up paddock to top of the hill. Four wheel drive is recommended.

Pump comments: Strong pump with a pump rate of about 36,000 L/h. Pump can manually be switched on and off.

Additional comments: Bore not in use at present, but Waitomo DC turns the pump on every day for about 10 minutes to clean the bore.

Sampling comments: Water quality sample taken at tap right at the bore. Assumed to be well purged prior to sampling.

Figure A 1.85 Location of well 72_2915; image from Google Earth (2014).

Figure A 1.86 Well 72_2915.

72_4759

Table A 1.45 72_4759 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1792572	5774489	50 (GPS)	Not likely, bore sampled is 370 m north of WRC coordinates	Submersible pump, pump rate ~ 648 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
120	42	90	Miocene sediments	Mudstone
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	19.04 m BGL (static, 23/04/15)	Done, 04/03/15	No	Completed, 23/04/15

Access comments: Bore is actually at 442 Kawhia Rd, Otorohanga on a small hill just south of the property; 20 m from house so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete tank nearby.

Sampling comments: Water quality sample was taken right at the bore after detaching pipe. Assumed to be well purged prior to sampling.

Location comments: The bore located key number for this bore may be wrong. It seems that 72_4759 was another bore at 412 Kawhia Rd. This bore apparently collapsed and the owner contracted Barham United Welldrillers to drill a new bore at 422 Kawhia Rd as a replacement (which is the bore that was sampled for water chemistry and had a hydraulic test completed). The driller supplied us with the following information about this replacement bore: Depth: 90 m, Screen: 32.5 – 90 m, Casing diameter: 150 mm, Casing Depth: 32.5 m, Screen diameter: 100 mm, Static WL: 18 m. The replacement bore and the bore 72_4759 are only about 370 m apart and are at approximately the same elevation. Since we do not have any information on lithology for the replacement bore, we have used the lithological log from 72_4759 for the interpretation of the hydraulic test conducted at the replacement bore (see hydraulic testing appendices) in combination with the details supplied by the drillers (presented in the well details for 72_4759 in Appendix 3).

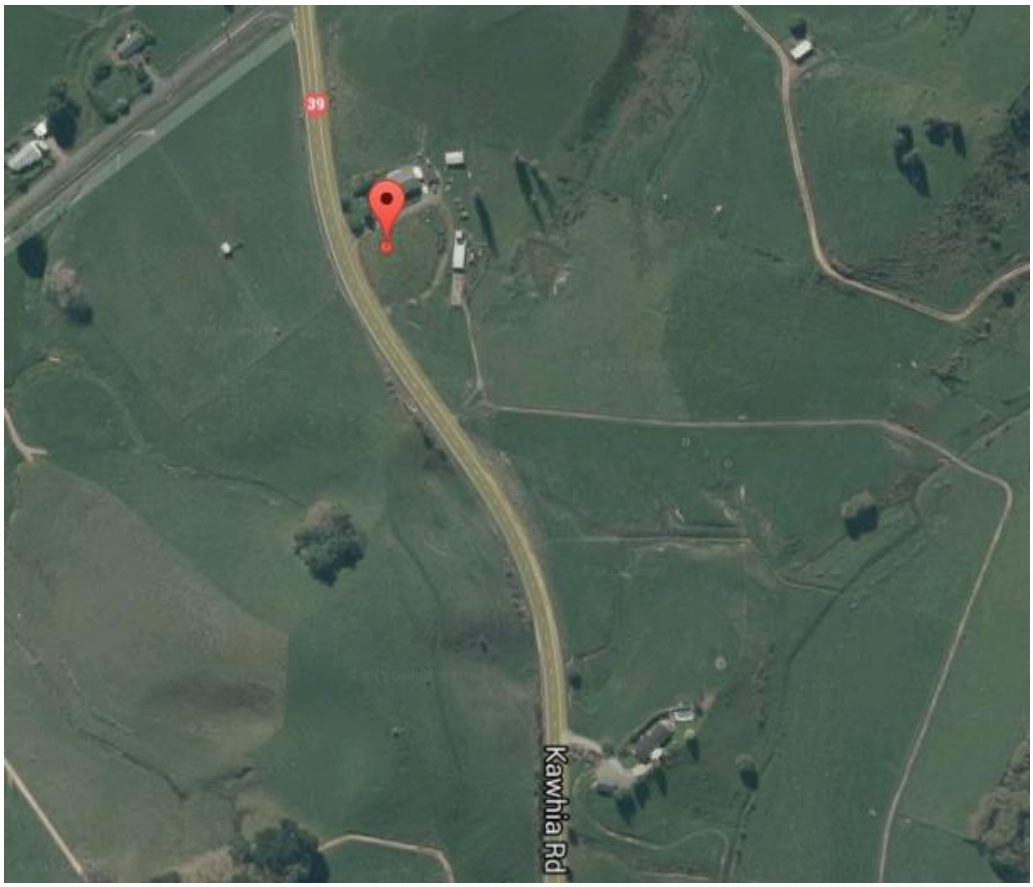


Figure A 1.87 Location of well 72_4759; image from Google Earth (2014).

Figure A 1.88 Well 72_4759.

72_5300

Table A 1.46 72_5300 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1813323	5767877	170 (GPS)	Yes, but WRC coordinates 90 m off	Submersible pump, pump rate ~ 7344 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
88	58	88	Pakaumanu Group	Rhyolite, peat and clay
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, with small WLI	11.887 m BGL (static, 22/04/15)	Done, 29/01/15	No	Completed, 22/04/15

Access comments: Bore is next to shed. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into concrete storage tank.

Sampling comments: Pipe was detached right at the bore for water quality sampling purposes. Assumed to be well purged prior to sampling.

Additional comments: Only use the small WLI to measure water level in this bore. The bore casings shifted and this may result in the larger WLI getting stuck.

Figure A 1.89 Location of well 72_5300; image from Google Earth (2014).

Figure A 1.90 Well 72_5300.

72_5503

Table A 1.47 72_5503 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1797331	5753564	244 (GPS)	Most likely, but WRC coordinates 670 m off	Submersible pump, pump rate ~ 8820 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
50	32	50	Basement rock	Fractured Greywacke
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	11.887 m BGL (static, 22/04/15)	Done, 17/02/15	No	Completed, 22/04/15

Access comments: Bore is just 100 m past the Rangitoto School on the right. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible that pumps water into plastic storage tank about 850 m west next to the cowshed.

Sampling comments: Water quality sample taken where water feeds into plastic storage tank. Assumed to be well purged prior to sampling.

Location comments: The bore located key number for this bore may be wrong. The bore we sampled for water chemistry and tested for hydraulic conductivity is about 670 m southeast of the location of 72_5503 when plotted using the coordinates of the WRC database. The drilling company (Barham United Welldrillers) supplied us with the following information for the bore that we tested: Depth: 42 m, Screen: 24 – 42 m, Casing diameter: 150 mm, Casing Depth: 26 m, Screen diameter: 100 mm, Static WL: 6.12 m. There was no other bore in this locality with similar details in the WRC database. Since we do not have any information on lithology for this bore, we used the lithological log at 72_4759 for the interpretation of the hydraulic test conducted at this bore (see hydraulic testing appendices) in combination with the details supplied by the drillers (presented in the well details for 72_4759 in Appendix 3). .

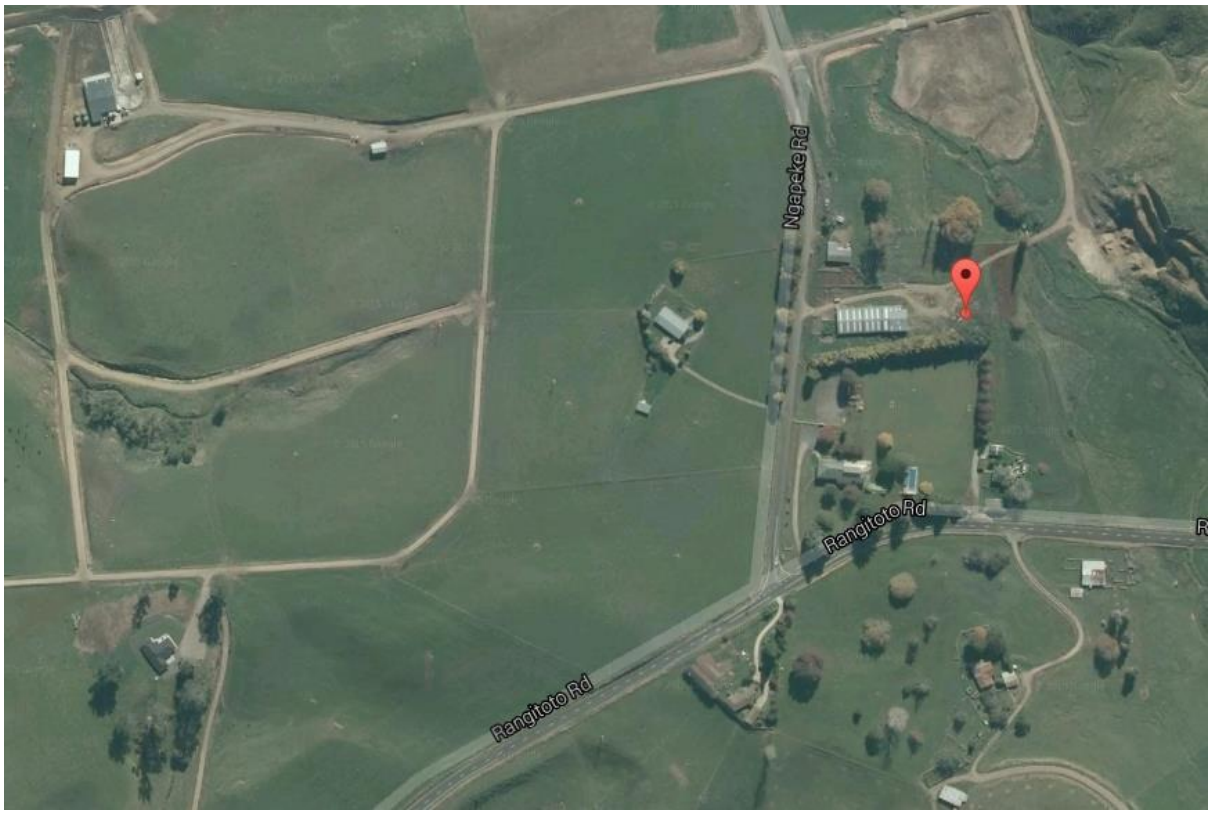


Figure A 1.91 Location of well 72_5503; image from Google Earth (2014).

Figure A 1.92 Well 72_5503.

70_796

Table A 1.48 70_796 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1799479.83	5798940.39	37.17 (RTK)	Yes, but WRC coordinates off by 190 m	Open bore, no pump installed
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
8.5	6.5	8.5	Tauranga Group	Sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	6.393 m BGL (static, 15/04/15)	Done, 10/04/15	Yes	Completed, 15/04/15

Access comments: Bore is just on the eastern side of the driveway onto the farm at 369 Ryburn Rd. No four wheel drive is necessary.

Pump comments: Open bore, no pump installed.

Sampling comments: Water quality sample taken by using the whale pump. Assumed to be well purged prior to sampling.

Additional comments: Pump test was completed using the GNS whale pump but results may not be useful since this pump was too weak (pump rate of 580 L/h) to create a drawdown.

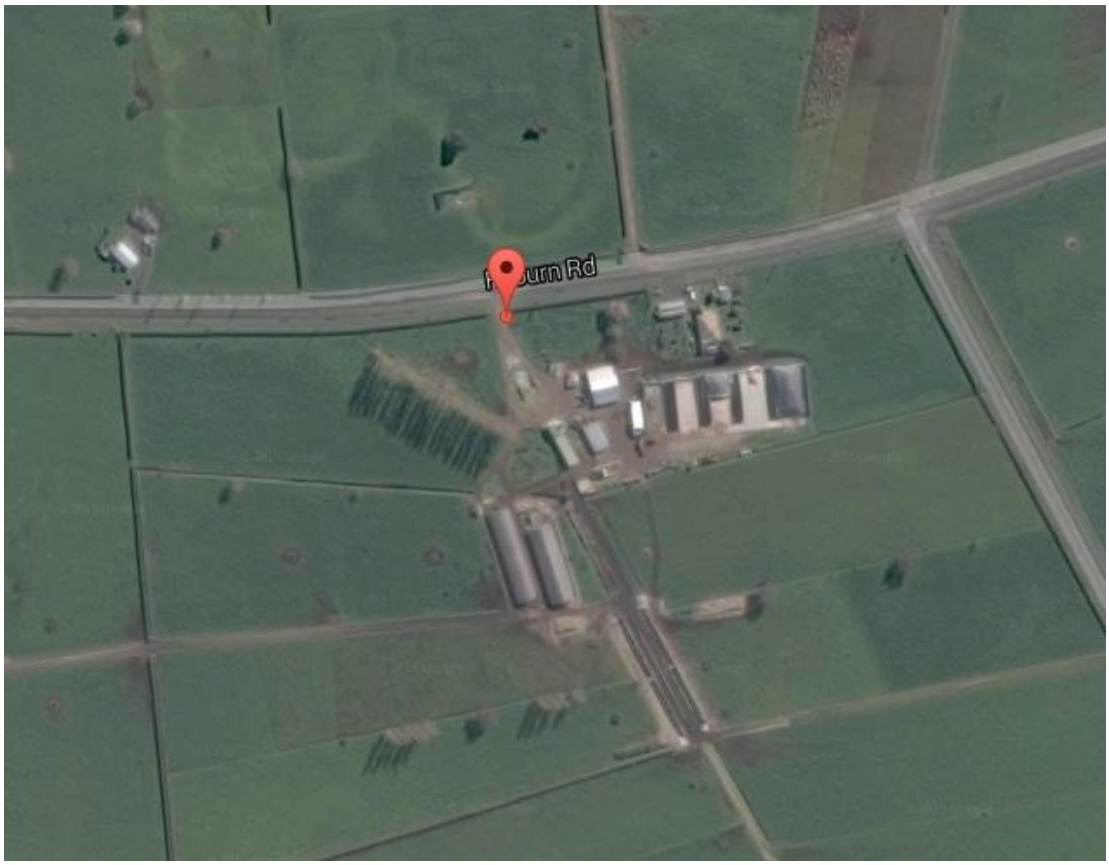


Figure A 1.93 Location of well 70_796; image from Google Earth (2014).

Figure A 1.94 Well 70_796.

A1.8 SITES WITH HYDRAULIC TESTING, AGE DATING, WATER CHEMISTRY SAMPLING AND WATER LEVEL MEASUREMENTS

70_632

Table A 1.49 70_632 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1793412.68	5799435.10	40.50 (RTK)	Yes, but WRC coordinates 40 m off	Submersible pump, pump rate ~ 2268 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
57.9	32.3	57.9	Tauranga Group	Silts and Sands
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	11.642 m BGL (static, 10/04/15)	Done, 19/02/15	No	Completed, 10/04/15

Access comments: Bore is within kiwi fruit farm. Four wheel drive is recommended.

Pump comments: Submersible pump that feeds water into a concrete storage tank next to bore.

Sampling comments: Water quality and age samples were taken where water feeds into concrete storage tank. Assumed to be well purged prior to sampling.

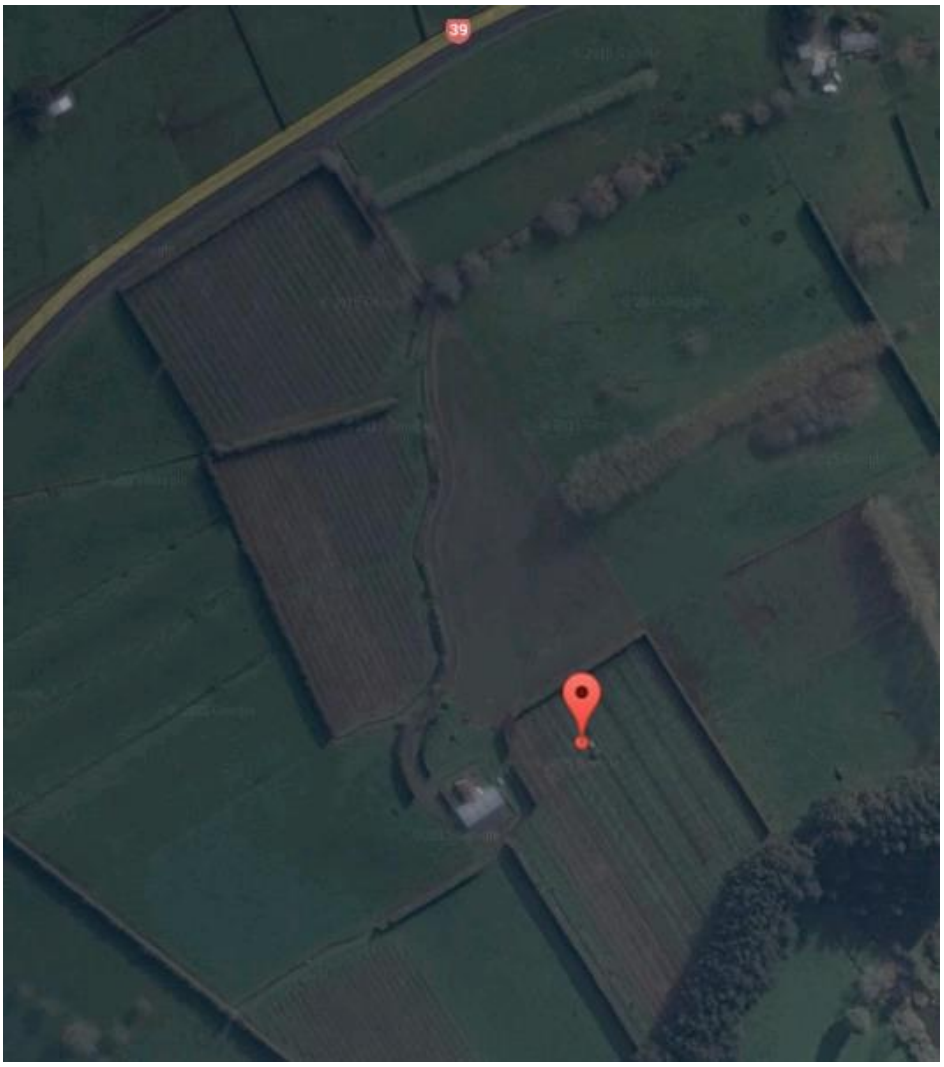


Figure A 1.95 Location of well 70_632; image from Google Earth (2014).

Figure A 1.96 Well 70_632.

72_4014

Table A 1.50 72_4014 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1789689.78	5809209.43	24.32 (RTK)	Yes, but WRC coordinates 50 m off	Submersible pump, pump rate ~ 4200 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
24.6	19	24.6	Tauranga Group	Gravels
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes, pump can be lifted	9.28 m BGL (static, 05/03/15) 9.425 m BGL (static, 16/04/15)	Done, 12/02/15	No	Completed, 05/03/15

Access comments: Bore is just next to road behind a gate. No four wheel drive is necessary.

Pump comments: Submersible pump with a pressure cylinder that feeds water into a plastic storage tank.

Sampling comments: Both water quality and age samples were taken at this bore. All samples were taken right at the bore after detaching the pipe. Assumed to be well purged prior to sampling.

Additional comments: Pump test was completed using the owner's submersible pump but the pump was too weak (pump rate of ~4200 L/h) to create a proper drawdown. Pump test data may not be useful.

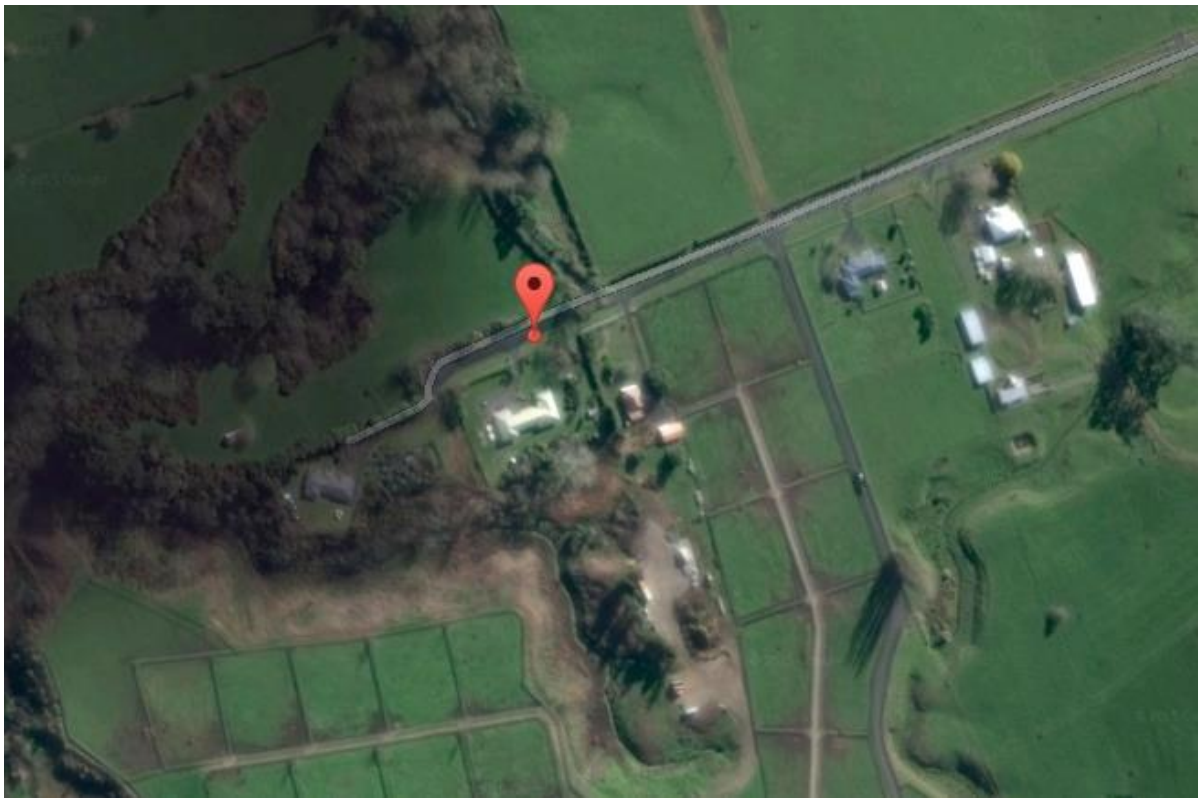


Figure A 1.97 Location of well 72_4014; image from Google Earth (2014).

Figure A 1.98 Well 72_4014.

72_5009

Table A 1.51 72_5009 site details.

NZTM E (new)	NZTM N (new)	Altitude (m ASL)	Correct Bore	Pump
1813181	5760312	279 (GPS)	Yes, but WRC coordinates 1140 m off	Submersible pump, ~ 7740 L/h
Bore Depth	**Screen_from**	**Screen_to**	**Geology**	**Lithological log**
89	76.5	89	Pakaumanu Group	Pumice
Access to WT	**Water Table**	**Water sampling**	**Slug test**	**Pump test**
Yes	19.091 m BGL (dynamic, 24/04/15)	Done, 28/01/15	No	Completed, 24/04/15

Access comments: Bore is on farm on southern side of Rauraroa Valley Rd., next to cowshed at farm. Gravel road, so no four wheel drive is necessary.

Pump comments: Submersible pump that feeds water into storage tank nearby and to a tap inside cowshed.

Sampling comments: Water quality sample taken at tap inside cowshed. Age samples were taken right at bore after detaching pipe. Assumed to be well purged prior to sampling.

Additional comments: A pump test was completed using the owner's submersible pump. The farm manager forgot to turn the pump off the evening before the pump test and therefore the water level was not quite static at the start of the test. The pump rate increased and decreased during the test time due to the farm workers using the wash down hose in the cowshed. This variable pump rate was accounted for during hydraulic testing.

Figure A 1.99 Location of well 72_5009; image from Google Earth (2014).

Figure A 1.100 Well 72_5009.

APPENDIX 2: WATER CHEMISTRY ANALYSIS

A2.1 EXAMPLE OF WATER CHEMISTRY ANALYSIS REPORT

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT Page 1 of 2

Client:	Waikato Regional Council	Lab No:	1397460	SPv1
Contact:	Mr I Buchanan	Date Registered:	13-Mar-2015	
	C/- Waikato Regional Council	Date Reported:	23-Mar-2015	
	Private Bag 3038	Quote No:	37495	
	Waikato Mail Centre	Order No:	S1010	
	HAMILTON 3240	Client Reference:	6240	
		Submitted By:	Mr I Buchanan	

Sample Type: Aqueous

Sample Name:		W_72_6180 12-Mar-2015 2:15 pm	W_72_4805 12-Mar-2015 5:30 pm	W_72_2732		
Lab Number:		1397460.1	1397460.2	1397460.3		
Individual Tests						
Dissolved Iron	g/m³	< 0.02	< 0.02	< 0.02	-	-
Dissolved Manganese	g/m³	0.0033 #1	0.045	0.0011 #1	-	-
Dissolved Reactive Phosphorus	g/m³	0.036	< 0.004	0.008	-	-
Reactive Silica	g/m³ as SiO_2	57	84	93	-	-
Waikato Regional Council groundwater profile						
pH	pH Units	6.5	6.3	6.2	-	-
Total Alkalinity	g/m³ as $CaCO_3$	24	23	19.1	-	-
Free Carbon Dioxide	g/m³ at 25°C	16.4	23	22	-	-
Total Hardness	g/m³ as $CaCO_3$	37	13.7	7.4	-	-
Electrical Conductivity (EC)	mS/m	15.4	10.0	10.0	-	-
Approx Total Dissolved Salts	g/m³	103	67	67	-	-
Total Boron	g/m³	0.020	0.021	0.0129	-	-
Total Calcium	g/m³	7.3	2.9	1.52	-	-
Total Copper	g/m³	< 0.00053	< 0.00053	< 0.00053	-	-
Total Iron	g/m³	< 0.021	0.84	< 0.021	-	-
Total Magnesium	g/m³	4.6	1.55	0.88	-	-
Total Manganese	g/m³	0.0030 #1	0.045	0.00100 #1	-	-
Total Potassium	g/m³	6.8	5.1	4.4	-	-
Total Sodium	g/m³	11.7	12.6	16.0	-	-
Total Zinc	g/m³	0.66	0.0014	0.0069	-	-
Chloride	g/m³	12.0	12.8	14.7	-	-
Total Ammoniacal-N	g/m³	< 0.010	0.028	0.012	-	-
Nitrate-N	g/m³	4.9	1.13	0.90	-	-
Sulphate	g/m³	11.1	1.8	2.8	-	-

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

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
Waikato Regional Council groundwater profile		-	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-3
pH	pH meter. APHA 4500-H+ B 22nd ed. 2012.	0.1 pH Units	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-3
Free Carbon Dioxide	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/m³ at 25°C	1-3
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22nd ed. 2012.	0.1 mS/m	1-3
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m³	1-3
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-3
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0053 g/m³	1-3
Total Calcium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.053 g/m³	1-3
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m³	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-3
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.021 g/m³	1-3
Total Magnesium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.021 g/m³	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.0005 g/m³	1-3
Total Manganese	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m³	1-3
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.053 g/m³	1-3
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.021 g/m³	1-3
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.0011 g/m³	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m³	1-3
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/m³	1-3
Nitrate-N	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.05 g/m³	1-3
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m³	1-3
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/m³ as SiO_2	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m³	1-3

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.

This report must not be reproduced, except in full, without the written consent of the signatory.

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

A2.2 SUMMARY OF WATER CHEMISTRY ANALYSIS

Well ID	Date	Dissolved Iron (g/m^3)	Dissolved Manganese (g/m^3)	Dissolved Reactive Phosphorus (g/m^3)	Reactive Silica (g/m^3 as SiO_2)	pH (ph Units)	Total Alkalinity (g/m^3 as $CaCO_3$)	Free Carbon Dioxide (g/m^3 at 25°C)	Total Hardness (g/m^3 as $CaCO_3$)	Electrical Conductivity (mS/m)	Approx Total Dissolved Salts (g/m^3)	Total Boron (g/m^3)	Total Calcium (g/m^3)	Total Copper (g/m^3)	Total Iron (g/m^3)	Total Magnesium (g/m^3)	Total Manganese (g/m^3)	Total Potassium (g/m^3)	Total Sodium (g/m^3)	Total Zinc (g/m^3)	Chloride (g/m^3)	Total Ammoniacal-N (g/m^3)	Nitrate-N (g/m^3)	Sulphate (g/m^3)
62_96	19/02/2015	0.82	1.61	0.172	93	6.5	80	46	45	21.3	143	0.0144	7	<0.00053	2.9	6.7	1.69	5.2	24	0.008	19	0.04	<0.05	<0.5
65_53	1/04/2015	< 0.02	< 0.0005	0.052	50	7	42	8.1	36	10.8	72	0.0076	7.8	< 0.00053	< 0.021	4.1	< 0.00053	1.12	7.5	0.0022	7.3	< 0.010	0.22	1.4
69_1668	10/04/2015	< 0.02	0.0045	0.11	54	6.3	26	29	15.9	10.6	71	0.014	3.6	0.0023	0.129	1.71	0.0044	2.7	12.3	1.93	13.5	< 0.010	0.2	3.2
69_2082	1/04/2015	< 0.02	0.033	< 0.004	23	6.6	10.5	5.9	13.6	9.4	63	0.0111	1.9	0.0027	1.11	2.2	0.031	1.74	11.8	0.171	12.7	0.015	3.2	1.5
70_484	11/03/2015	0.07	0.154	0.024	58	6.2	18.8	24	60	22	147	0.0134	14.9	<0.00053	0.23	5.6	0.158	5.7	15.4	0.0019	19.2	0.187	6.4	28
70_632	19/02/2015	<0.02	<0.0005	0.048	88	6.5	22	13.7	9.6	7.8	53	0.0133	2.1	<0.00053	<0.021	1.07	<0.00053	3.1	10.7	0.0198	8	<0.010	0.08	3.2
70_796	10/04/2015	41	0.70	< 0.004	71	6	24	42	43	33.8	230	0.0134	8.6	< 0.00053	43	5.3	0.66	4.8	16.6	0.0049	16.2	0.31	< 0.05	106
72_2732	12/03/2015	<0.02	0.0011	0.008	93	6.2	19.1	22	7.4	10	67	0.0129	1.52	<0.00053	<0.021	0.88	0.001	4.4	16	0.0069	14.7	0.012	0.9	2.8
72_2874	21/01/2015	< 0.02	< 0.0005	0.055	44	7.2	108	12.4	82	25.5	171	0.021	20	< 0.00053	< 0.021	7.7	< 0.00053	1.06	22	0.0139	13.8	< 0.010	0.22	3.7
72_2915	26/02/2015	<0.02	0.0036	<0.004	16.1	7.3	310	31	340	68.1	460	0.075	123	<0.00053	0.116	7.7	0.0037	2.3	19.6	0.012	11.1	0.084	0.11	52
72_3706	11/03/2015	0.03	0.0031	0.084	72	6	18.9	39	22	14.1	94	0.0197	3.7	0.00151	0.05	3	0.0032	4.3	17.5	0.0084	17.7	<0.01	2.1	11
72_4014	12/02/2015	8.2	0.58	0.34	82	6.7	69	30	37	18.2	122	0.0101	5.8	< 0.00053	8.6	5.5	0.56	4.5	18.4	< 0.0011	14.4	0.119	< 0.05	0.5
72_4070	10/02/2015	< 0.02	< 0.0005	< 0.004	19.4	9.2	48	< 1.0	15.2	92.5	620	2.2	5.7	< 0.00053	< 0.021	0.22	< 0.00053	0.77	171	< 0.0011	240	0.193	< 0.05	< 0.5
72_4235	1/04/2015	< 0.02	0.0006	0.058	63	6.7	37	16.4	87	36.2	240	0.0199	19.6	0.0022	< 0.021	9.3	< 0.00053	28	17.7	0.0148	31	< 0.010	11.1	41
72_4320	29/01/2015	< 0.02	< 0.0005	0.116	67	6.7	46	18.2	29	13.2	89	0.0113	6.7	< 0.00053	< 0.021	3.1	< 0.00053	2.2	15.3	< 0.0011	9.5	< 0.010	1.02	2.1
72_4742	24/02/2015	<0.02	<0.0005	0.05	29	7.8	111	3.2	116	26.2	176	0.0094	43	<0.00053	<0.021	1.93	<0.00053	1.55	7.5	0.0042	9.6	<0.010	1.55	3.2
72_4759	4/03/2015	<0.02	0.088	0.023	16.2	8	92	2.1	380	259	1740	0.46	117	<0.0011	0.167	21	0.095	4	390	0.145	750	0.66	0.06	1.2
72_4788	24/02/2015	<0.02	<0.0005	0.044	20	8.2	85	1	35	20.1	135	0.058	11.4	<0.00053	<0.021	1.55	<0.00053	1.53	29	<0.0011	10.1	<0.010	0.15	3.3
72_4805	12/03/2015	<0.02	0.045	<0.004	84	6.3	23	23	13.7	10	67	0.021	2.9	<0.00053	0.84	1.55	0.045	5.1	12.6	0.0014	12.8	0.028	1.13	1.8
72_4819	4/03/2015	<0.02	<0.0005	0.042	84	7	80	14.3	50	20.3	136	0.026	12.3	<0.00053	<0.021	4.7	0.00055	3.9	24	0.0012	13.9	<0.010	0.23	3
72_4820	28/01/2015	< 0.02	< 0.0005	0.109	80	7	56	11	35	14	94	0.0153	6	< 0.00053	< 0.021	4.9	< 0.00053	2.8	13.6	0.0012	7.6	< 0.010	0.52	2.1
72_4998	18/03/2015	< 0.02	0.0015	0.136	87	6.7	19	8.1	9.9	7.5	50	0.0134	2.3	< 0.00053	< 0.021	0.98	0.00104	4	9.4	0.0053	8.8	< 0.010	0.42	3.2
72_5009	28/01/2015	< 0.02	0.0012	0.073	67	6.8	25	8.8	14.1	8	54	0.0072	2.9	< 0.00053	< 0.021	1.67	0.00108	3	8.8	0.0071	7.9	< 0.010	0.26	1.8
72_5019	18/03/2015	< 0.02	0.0092	< 0.004	30	5.7	8.6	37	20	12.3	82	0.0161	3.7	0.00152	< 0.021	2.6	0.0092	2.1	14.3	0.026	14.1	0.017	6.8	1.2
72_5034	18/02/2015	<0.02	<0.0005	0.014	89	7.1	24	3.7	10.7	7.7	52	0.0102	2.4	<0.00053	<0.021	1.15	<0.00053	3.5	9.9	0.0014	7.6	<0.010	0.09	1.9
72_5042	18/03/2015	< 0.02	0.0037	0.06	83	6	20	39	43	21.5	144	0.0165	7.8	0.00059	< 0.021	5.8	0.0038	8.3	19.5	0.03	20	0.021	12.2	1.8
72_5048	4/02/2015	< 0.02	< 0.0005	0.14	101	6.9	20	5.4	8.9	7.3	49	0.0118	2	< 0.00053	< 0.021	0.93	< 0.00053	3.7	9	< 0.0011	7.1	< 0.010	0.3	2.9
72_5049	3/02/2015	< 0.02	< 0.0005	0.125	85	7	31	6.4	15.8	9.9	67	0.02	3.6	< 0.00053	< 0.021	1.64	< 0.00053	3.2	12.9	0.0013	9.2	< 0.010	0.42	2.4

Well ID	Date	Dissolved Iron (g/m^3)	Dissolved Manganese (g/m^3)	Dissolved Reactive Phosphorus (g/m^3)	Reactive Silica (g/m^3 as SiO_2)	pH (ph Units)	Total Alkalinity (g/m^3 as $CaCO_3$)	Free Carbon Dioxide (g/m^3 at 25°C)	Total Hardness (g/m^3 as $CaCO_3$)	Electrical Conductivity (mS/m)	Approx Total Dissolved Salts (g/m^3)	Total Boron (g/m^3)	Total Calcium (g/m^3)	Total Copper (g/m^3)	Total Iron (g/m^3)	Total Magnesium (g/m^3)	Total Manganese (g/m^3)	Total Potassium (g/m^3)	Total Sodium (g/m^3)	Total Zinc (g/m^3)	Chloride (g/m^3)	Total Ammoniacal-N (g/m^3)	Nitrate-N (g/m^3)	Sulphate (g/m^3)
72_5062	26/02/2015	11.9	0.49	<0.004	52	6.5	63	36	500	327	2200	0.76	194	<0.0011	18.8	2.5	0.51	3.5	470	0.0035	990	1.2	<0.05	<0.5
72_5103	12/02/2015	< 0.02	0.0033	0.102	40	7.4	94	7.5	75	23.9	160	0.0196	11.6	< 0.00053	< 0.021	11.1	0.004	0.91	23	0.0167	18	< 0.010	0.08	3.8
72_524	18/03/2015	<0.02	0.0075	0.046	87	6.7	39	15.1	19.7	11.8	79	0.0132	3.9	<0.00053	<0.021	2.4	0.0085	4.8	14.9	0.007	11.7	<0.010	0.38	2.6
72_5253	28/01/2015	< 0.02	< 0.0005	0.083	35	6.7	30	12.8	40	14.3	96	0.0102	11.5	0.00074	< 0.021	2.8	< 0.00053	1.16	10.8	0.0019	12.8	< 0.010	2.5	8.8
72_5289	28/01/2015	< 0.02	0.031	0.2	86	6.8	49	15.4	29	12.1	81	0.0084	4.4	< 0.00053	< 0.021	4.4	0.03	1.51	12.6	0.0089	7.7	< 0.010	0.28	2.3
72_5300	29/01/2015	< 0.02	0.0009	0.15	79	7	24	5.2	14.9	8.1	54	0.0093	2.6	< 0.00053	< 0.021	2.1	< 0.00053	3.5	7.8	< 0.0011	6.9	< 0.010	0.53	2.7
72_5433	24/02/2015	<0.02	<0.0005	0.034	37	7.3	38	4.1	39	12.1	81	0.0085	8.8	<0.00053	<0.021	4.1	<0.00053	1.27	7.5	0.15	9.8	<0.010	1.64	1.5
72_5469	17/02/2015	< 0.02	0.0024	0.04	32	6.8	51	15	53	16.4	110	0.0165	11.8	< 0.00053	< 0.021	5.8	0.0024	1.07	12.2	0.24	11.8	< 0.010	1.9	6.8
72_5490	10/02/2015	< 0.02	0.0019	0.028	56	6.9	31	8.2	17	9.4	63	0.021	4	0.00093	< 0.021	1.72	0.00197	1.9	11.7	0.0017	7.3	< 0.010	0.21	4
72_5503	17/02/2015	< 0.02	< 0.0005	0.074	39	6.7	31	11.2	35	13	87	0.0123	7.9	< 0.00053	< 0.021	3.7	< 0.00053	1.35	11.4	0.0011	10.1	< 0.010	4.5	1.2
72_5569	29/01/2015	< 0.02	0.0012	0.046	94	6.2	19.5	25	51	24.7	165	0.0151	11.5	< 0.00053	< 0.021	5.5	0.00135	8.5	21	0.0108	25	< 0.010	12.8	2.7
72_6180	12/03/2015	<0.02	0.0033	0.036	57	6.5	24	16.4	37	15.4	103	0.02	7.3	<0.00053	<0.021	4.6	0.003	6.8	11.7	0.66	12	<0.010	4.9	11.1
72_6408	12/02/2015	6	0.172	0.146	93	6.6	61	28	29	19.4	130	0.014	4.3	< 0.00053	6.2	4.3	0.178	4.9	25	0.0083	25	0.045	< 0.05	< 0.5
72_6514	4/03/2015	10.4	0.84	<0.04	78	6.6	65	35	23	14.8	99	0.0148	4.4	<0.00053	25	2.8	0.87	3.4	12.2	0.0012	8.5	0.73	<0.05	<0.5
72_7003	26/02/2015	<0.02	<0.0005	0.084	37	7.3	27	2.8	24	9.3	62	0.0103	4.9	<0.00053	<0.021	2.8	<0.00053	1.01	9.2	0.009	6.4	<0.010	1.96	1.5
72_7021	18/02/2015	<0.02	<0.0005	0.104	89	6.7	34	14.7	28	13.4	90	0.0118	4.9	<0.00053	<0.021	3.8	<0.00053	4.6	13.6	0.26	10.6	<0.010	3.4	1.9
72_7107	17/02/2015	< 0.02	< 0.0005	0.008	16.9	7.8	146	4.5	154	32.5	220	0.024	51	< 0.00053	< 0.021	6.7	< 0.00053	1.16	10.1	0.079	7.5	< 0.010	0.17	15.2
72_730	8/02/2015	< 0.02	0.0014	0.004	78	6.5	18.2	11.2	7.9	7.2	48	0.0097	1.8	< 0.00053	< 0.021	0.83	0.00158	3.9	8.8	0.0078	9.3	< 0.010	0.31	1.6
72_7799	23/01/2015	<0.02	0.0015	0.074	77	7.1	17.4	2.6	8.6	6.6	45	0.0098	1.88	0.025	0.027	0.94	0.00149	4.2	7.2	0.028	5.6	<0.010	1.09	1.6
72_5053	21/01/2015	< 0.02	< 0.0005	0.22	88	7	32	6.9	24	11.9	80	0.0125	4.8	< 0.00053	< 0.021	2.9	< 0.00053	4.4	11.3	0.0026	9.5	< 0.010	1.68	4.3

APPENDIX 3: HYDRAULIC TESTING

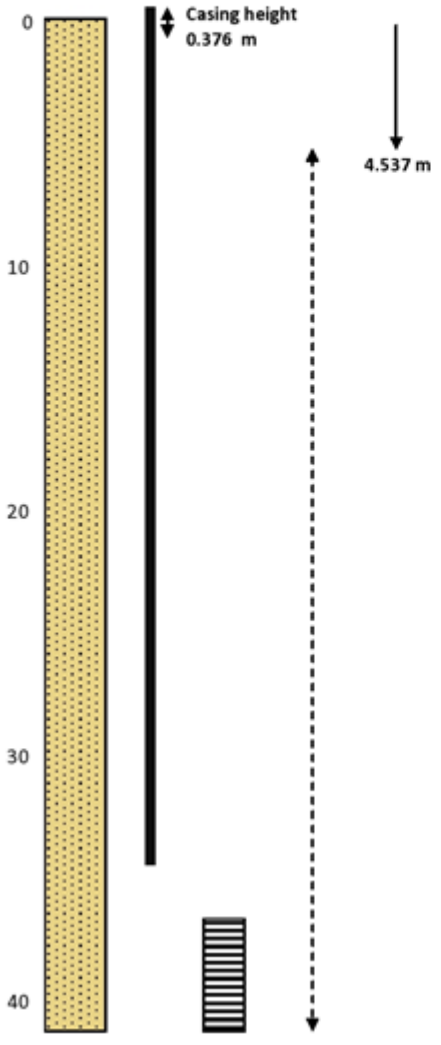
All theoretical values discussed are from Domenico and Schwartz (1990).

A3.1 HYDRAULIC TESTING DETAILS FOR WELL 72_5569

A3.1.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Saturated Thickness (m)	Data Logger Depth (m)
72_5569	5792554	1814275	41	26	100	80	35 - 41	36.463	15.452

(m)	Core Log	Casing	Screen	Saturated Thickness	Water Level	Depth (m)	Dominant	Secondary	Notes



0	41	Sands	Pumice	Good test that resulted in nice recovery data.

Pumping test comments for 72_5569: A single well test was performed with both drawdown and recovery data collected on the 05/03/2015. The installed submersible pump was not running for at least 12 hours prior to starting the hydraulic test. The pump was forced to run for 380 minutes: the pump rate dropped from 0.8 L/s initially to 0.6 L/s after about one hour. Subsequently, the pump was turned off and recovery measured for 90 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test. Data loggers were installed at 10 m below the static water level recorded at the beginning of the pump test. Within 3 minutes of pumping, the drawdown reached 10 m below the beginning water level, resulting in the data loggers not measuring water depth after 3 minutes of the start of the pump test (see drawdown and recovery plots). As such, only manual measurements were used for analysis.

A3.1.2 Data

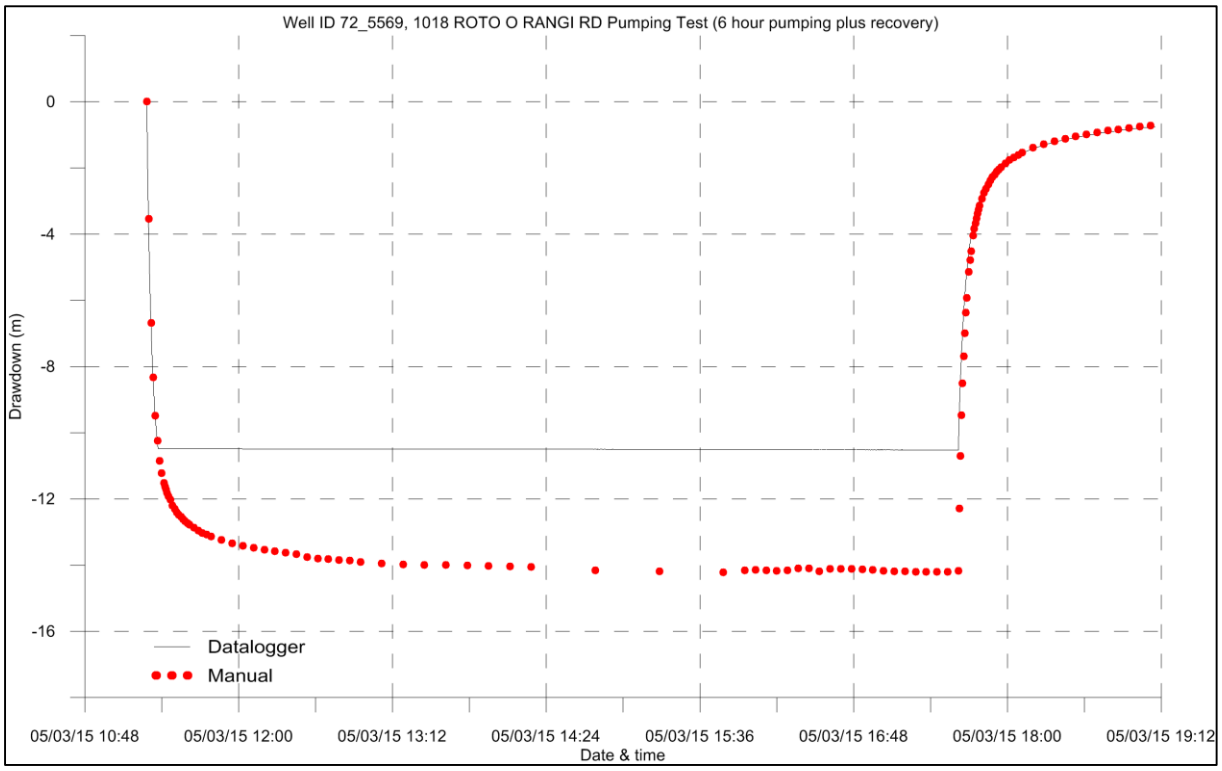


Figure A 3.1 Drawdown and recovery plot for well 72_5569.

Table A 3.1 Manual data recorded during hydraulic testing.

1018 ROTO O RANGI RD Pumping Test (6 hour pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	1018 ROTO O RANGI RD	**ID:**	72_5569
Location:	E1814275.062 N5792554.098	**Well depth:**	41 m
Elevation (gl):	65.748 m ASL	**Casing diam:**	100 mm
Date:	5/03/2015	**Casing depth:**	26 m BGL
Pump rate:	0.635 L/sec	**Elevation (MP):**	0.376 m
Screen:	35 – 41 m BGL	**SWL:**	4.537 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
05/03/2015 11:17	0		0	4.913	4.537	0.000
05/03/2015 11:18	1		1	8.450	8.074	3.537
05/03/2015 11:19	2		2	11.600	11.224	6.687
05/03/2015 11:20	3		3	13.250	12.874	8.337
05/03/2015 11:21	4		4	14.400	14.024	9.487
05/03/2015 11:22	5		5	15.160	14.784	10.247
05/03/2015 11:23	6		6	15.760	15.384	10.847
05/03/2015 11:24	7		7	16.140	15.764	11.227
05/03/2015 11:25	8		8	16.430	16.054	11.517
05/03/2015 11:25	8.5		8.5	16.530	16.154	11.617
05/03/2015 11:26	9		9	16.620	16.244	11.707
05/03/2015 11:26	9.5		9.5	16.730	16.354	11.817
05/03/2015 11:27	10		10	16.830	16.454	11.917
05/03/2015 11:28	11		11	16.930	16.554	12.017
05/03/2015 11:29	12		12	17.110	16.734	12.197
05/03/2015 11:30	13		13	17.220	16.844	12.307
05/03/2015 11:31	14		14	17.320	16.944	12.407
05/03/2015 11:32	15		15	17.390	17.014	12.477
05/03/2015 11:33	16		16	17.460	17.084	12.547
05/03/2015 11:34	17		17	17.524	17.148	12.611
05/03/2015 11:35	18		18	17.590	17.214	12.677
05/03/2015 11:36	19		19	17.642	17.266	12.729
05/03/2015 11:37	20		20	17.700	17.324	12.787
05/03/2015 11:39	22		22	17.785	17.409	12.872
05/03/2015 11:41	24		24	17.865	17.489	12.952
05/03/2015 11:43	26		26	17.941	17.565	13.028
05/03/2015 11:45	28		28	17.992	17.616	13.079
05/03/2015 11:47	30		30	18.044	17.668	13.131
05/03/2015 11:52	35		35	18.159	17.783	13.246
05/03/2015 11:57	40		40	18.252	17.876	13.339
05/03/2015 12:02	45		45	18.333	17.957	13.420
05/03/2015 12:07	50		50	18.392	18.016	13.479
05/03/2015 12:12	55		55	18.451	18.075	13.538
05/03/2015 12:17	60		60	18.499	18.123	13.586
05/03/2015 12:22	65		65	18.542	18.166	13.629
05/03/2015 12:27	70		70	18.581	18.205	13.668
05/03/2015 12:32	75		75	18.669	18.293	13.756
05/03/2015 12:37	80		80	18.715	18.339	13.802
05/03/2015 12:42	85		85	18.731	18.355	13.818
05/03/2015 12:47	90		90	18.757	18.381	13.844
05/03/2015 12:52	95		95	18.776	18.400	13.863
05/03/2015 12:57	100		100	18.821	18.445	13.908

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
05/03/2015 13:07	110		110	18.861	18.485	13.948
05/03/2015 13:17	120		120	18.891	18.515	13.978
05/03/2015 13:27	130		130	18.908	18.532	13.995
05/03/2015 13:37	140		140	18.915	18.539	14.002
05/03/2015 13:47	150		150	18.928	18.552	14.015
05/03/2015 13:57	160		160	18.937	18.561	14.024
05/03/2015 14:07	170		170	18.947	18.571	14.034
05/03/2015 14:17	180		180	18.964	18.588	14.051
05/03/2015 14:47	210		210	19.074	18.698	14.161
05/03/2015 15:17	240		240	19.095	18.719	14.182
05/03/2015 15:47	270		270	19.138	18.762	14.225
05/03/2015 15:57	280		280	19.072	18.696	14.159
05/03/2015 16:02	285		285	19.063	18.687	14.150
05/03/2015 16:07	290		290	19.071	18.695	14.158
05/03/2015 16:12	295		295	19.081	18.705	14.168
05/03/2015 16:17	300		300	19.075	18.699	14.162
05/03/2015 16:22	305		305	19.016	18.640	14.103
05/03/2015 16:27	310		310	19.015	18.639	14.102
05/03/2015 16:32	315		315	19.097	18.721	14.184
05/03/2015 16:37	320		320	19.028	18.652	14.115
05/03/2015 16:42	325		325	19.024	18.648	14.111
05/03/2015 16:47	330		330	19.029	18.653	14.116
05/03/2015 16:52	335		335	19.036	18.660	14.123
05/03/2015 16:57	340		340	19.059	18.683	14.146
05/03/2015 17:02	345		345	19.086	18.710	14.173
05/03/2015 17:07	350		350	19.100	18.724	14.187
05/03/2015 17:12	355		355	19.109	18.733	14.196
05/03/2015 17:17	360		360	19.119	18.743	14.206
05/03/2015 17:22	365		365	19.110	18.734	14.197
05/03/2015 17:27	370		370	19.116	18.740	14.203
05/03/2015 17:32	375		375	19.123	18.747	14.210
05/03/2015 17:37	380	0	380	19.088	18.712	14.175
05/03/2015 17:37		0.5	380.5	17.200	16.824	12.287
05/03/2015 17:38		1	381	15.620	15.244	10.707
05/03/2015 17:38		1.5	381.5	14.390	14.014	9.477
05/03/2015 17:39		2	382	13.426	13.050	8.513
05/03/2015 17:39		2.5	382.5	12.599	12.223	7.686
05/03/2015 17:40		3	383	11.913	11.537	7.000
05/03/2015 17:40		3.5	383.5	11.282	10.906	6.369
05/03/2015 17:41		4	384	10.844	10.468	5.931
05/03/2015 17:42		5	385	10.057	9.681	5.144
05/03/2015 17:42		5.5	385.5	9.692	9.316	4.779
05/03/2015 17:43		6	386	9.424	9.048	4.511
05/03/2015 17:44		7	387	8.957	8.581	4.044
05/03/2015 17:44		7.5	387.5	8.748	8.372	3.835
05/03/2015 17:45		8	388	8.589	8.213	3.676
05/03/2015 17:45		8.5	388.5	8.437	8.061	3.524
05/03/2015 17:46		9	389	8.290	7.914	3.377
05/03/2015 17:46		9.5	389.5	8.171	7.795	3.258
05/03/2015 17:47		10	390	8.054	7.678	3.141
05/03/2015 17:48		11	391	7.848	7.472	2.935
05/03/2015 17:49		12	392	7.665	7.289	2.752
05/03/2015 17:50		13	393	7.541	7.165	2.628

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
05/03/2015 17:51		14	394	7.410	7.034	2.497
05/03/2015 17:52		15	395	7.297	6.921	2.384
05/03/2015 17:53		16	396	7.197	6.821	2.284
05/03/2015 17:54		17	397	7.110	6.734	2.197
05/03/2015 17:55		18	398	7.032	6.656	2.119
05/03/2015 17:56		19	399	6.963	6.587	2.050
05/03/2015 17:57		20	400	6.899	6.523	1.986
05/03/2015 17:59		22	402	6.774	6.398	1.861
05/03/2015 18:01		24	404	6.670	6.294	1.757
05/03/2015 18:03		26	406	6.592	6.216	1.679
05/03/2015 18:05		28	408	6.516	6.140	1.603
05/03/2015 18:07		30	410	6.449	6.073	1.536
05/03/2015 18:12		35	415	6.308	5.932	1.395
05/03/2015 18:17		40	420	6.201	5.825	1.288
05/03/2015 18:22		45	425	6.107	5.731	1.194
05/03/2015 18:27		50	430	6.027	5.651	1.114
05/03/2015 18:32		55	435	5.954	5.578	1.041
05/03/2015 18:37		60	440	5.893	5.517	0.980
05/03/2015 18:42		65	445	5.840	5.464	0.927
05/03/2015 18:47		70	450	5.781	5.405	0.868
05/03/2015 18:52		75	455	5.748	5.372	0.835
05/03/2015 18:57		80	460	5.708	5.332	0.795
05/03/2015 19:02		85	465	5.670	5.294	0.757
05/03/2015 19:07		90	470	5.637	5.261	0.724

A3.1.3 Analysis

The recovery data analysis for well 72_5569 is presented in Figure A 3.2, which results in a transmissivity estimate of $T = 1.363$ m^2/day. This well is unconfined and therefore is likely to have bias towards an over-estimated transmissivity value. For conversion to hydraulic conductivity, the saturated thickness of the aquifer has been used $b = 36.46$ m. As such, $K = 0.037$ m/day or $K = 4.3 \times 10^{-7}$ m/sec. This compares with the low end of theoretical values for fine sand (2×10^{-7} to 2×10^{-4} m/sec). As the lithological log describes sand with pumice, this K-value is somewhat lower than expected, suggesting that permeability is impaired by a poorly sorted mix of sand and pumice and likely unrecorded silt and/or clay components.

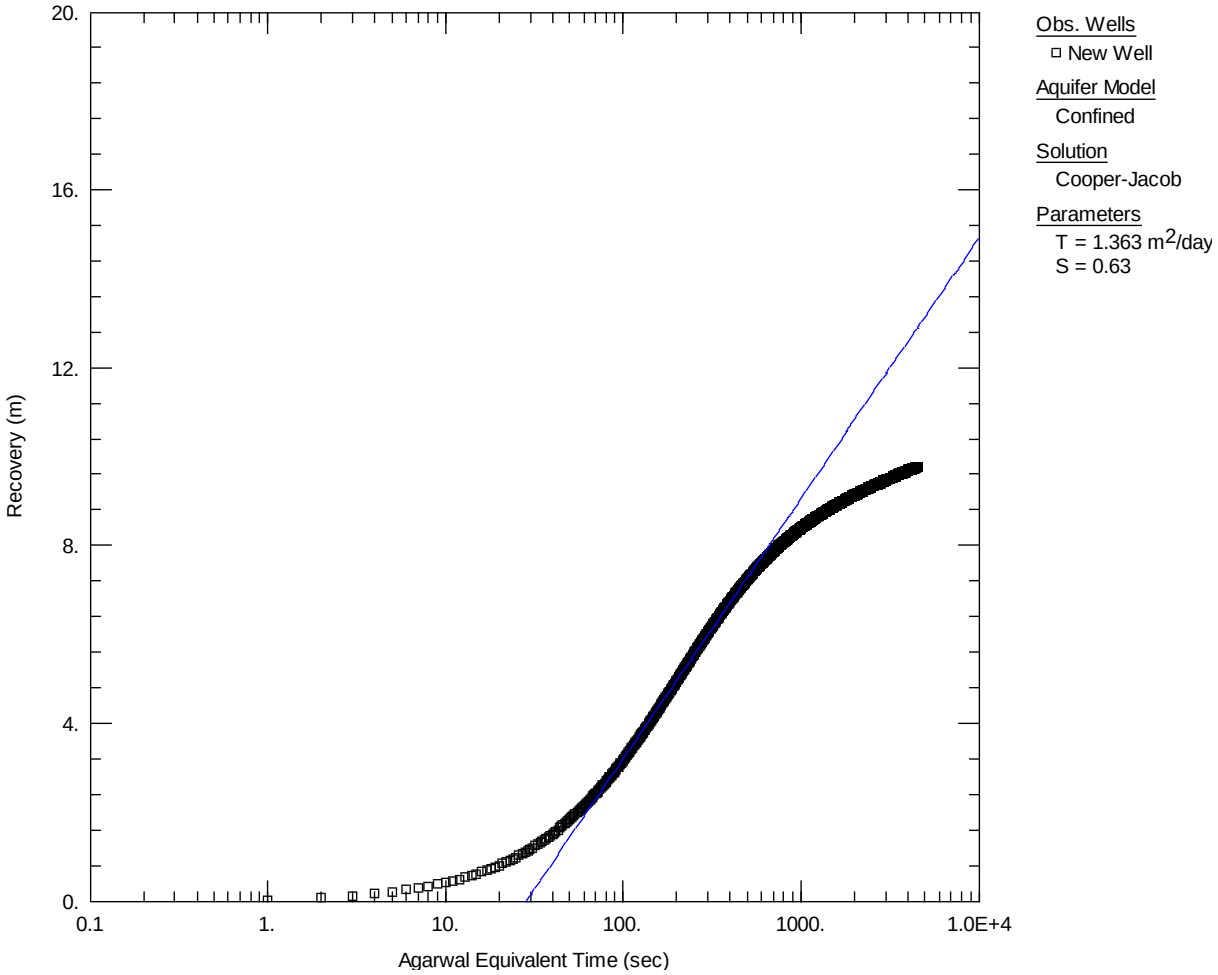
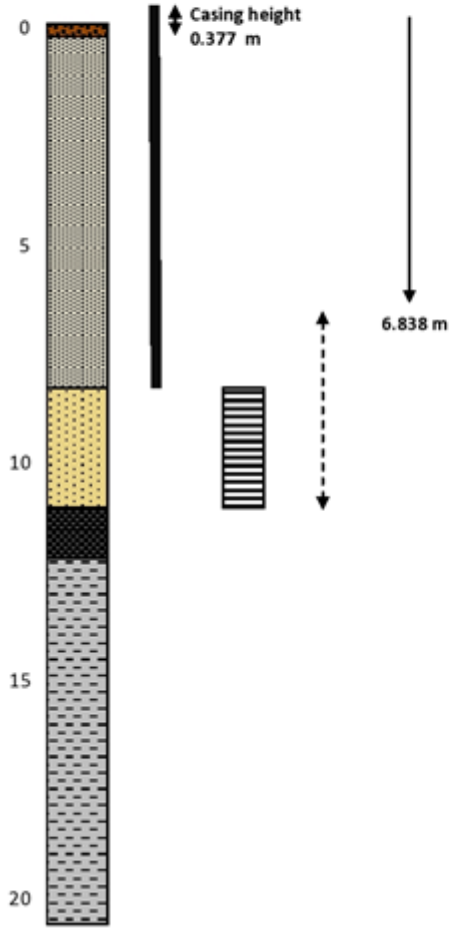


Figure A 3.2 Recovery data analysis for well 72_5569, resulting in $\boldsymbol{T = 1.363}$ m^2/day.

A3.2 HYDRAULIC TESTING DETAILS FOR WELL 72_6180

A3.2.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Saturated Thickness (m)	Data Logger Depth (m)
72_6180	5821557	1787878	20.9	8.4	100	100	8.4 - 11.2	3.1	N/A



Depth (m)		Dominant		Notes
0	0.2	Soil		Good test with nice recovery data. Recovery was measured using a handheld water level indicator only.
0.2	8.6	Clay		
8.6	11.7	Sands		
11.7	12.1	Peat-wood		
12.1	20.9	Silt		

Pumping test comments for 72_6180: A single well test was performed with both drawdown and recovery data collected on the 12/03/2015. The installed pump was not running for at least 24 hours prior to starting the hydraulic test. The pump was forced to run for 60 minutes and the pump rate stayed constant at 0.24 L/s during the test. Subsequently, the pump was turned off and recovery measured for 90 minutes. Only manual measurements were recorded during recovery as it was not initially planned to perform a pump test.

A3.2.2 Data

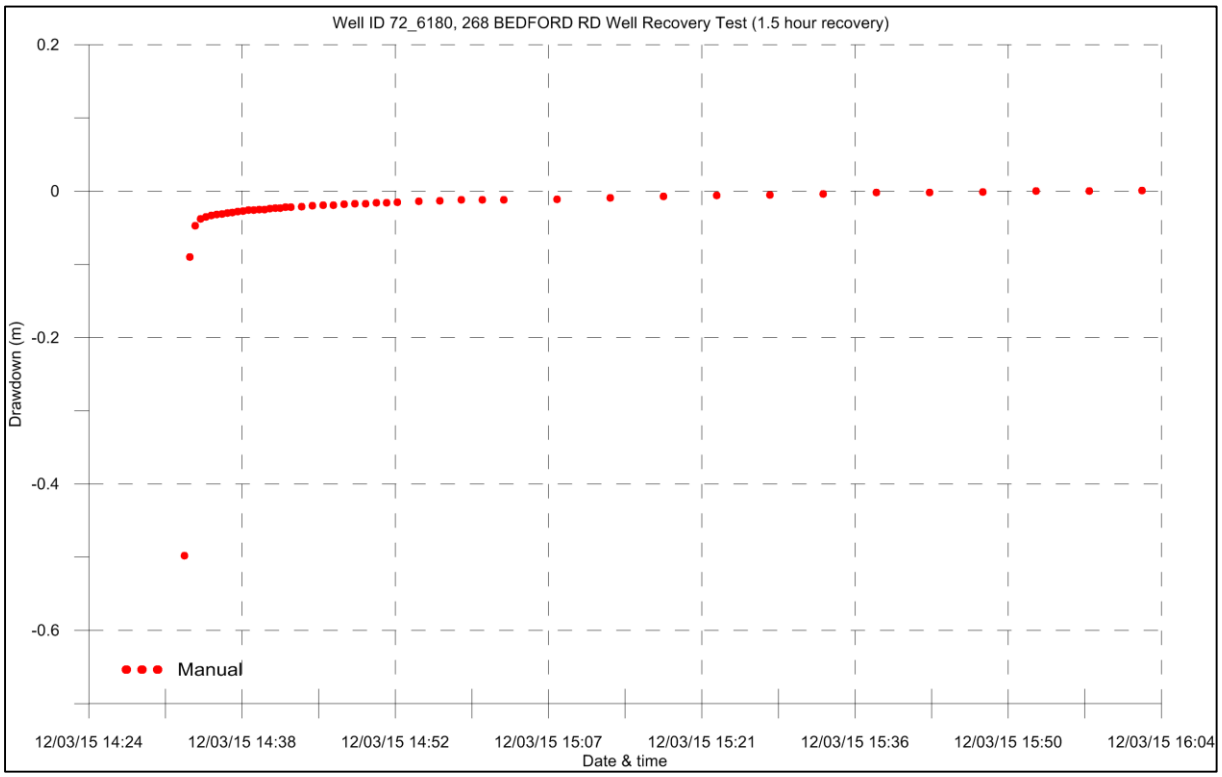


Figure A 3.3 Drawdown and recovery plot for well 72_6180.

Table A 3.2 Manual data recorded during hydraulic testing.

268 BEDFORD RD Well Recovery Test (1.5 hour recovery)			
MANUAL DATA			
Well Name/Site:	268 BEDFORD RD	**ID:**	72_6180
Location:	E1787878.448 N5821556.764	**Well depth:**	20.9 m
Elevation (gl):	20.887 m ASL	**Casing diam:**	100 mm
Date:	12/03/2015	**Casing depth:**	8.4 m BGL
Pump rate:	0.24 L/sec	**Elevation (MP):**	0.377 m
Screen:	8.4 – 11.2 m BGL	**SWL:**	6.838 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
12/03/2015 14:33:00	N/A	0	0	7.713	7.336	0.498
12/03/2015 14:33:30		0.5	0.5	7.305	6.928	0.090
12/03/2015 14:34:00		1	1	7.262	6.885	0.047
12/03/2015 14:34:30		1.5	1.5	7.253	6.876	0.038
12/03/2015 14:35:00		2	2	7.250	6.873	0.035
12/03/2015 14:35:30		2.5	2.5	7.248	6.871	0.033
12/03/2015 14:36:00		3	3	7.247	6.870	0.032
12/03/2015 14:36:30		3.5	3.5	7.246	6.869	0.031
12/03/2015 14:37:00		4	4	7.245	6.868	0.030
12/03/2015 14:37:30		4.5	4.5	7.244	6.867	0.029
12/03/2015 14:38:00		5	5	7.243	6.866	0.028
12/03/2015 14:38:30		5.5	5.5	7.242	6.865	0.027
12/03/2015 14:39:00		6	6	7.241	6.864	0.026

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
12/03/2015 14:39:30		6.5	6.5	7.241	6.864	0.026
12/03/2015 14:40:00		7	7	7.240	6.863	0.025
12/03/2015 14:40:30		7.5	7.5	7.240	6.863	0.025
12/03/2015 14:41:00		8	8	7.239	6.862	0.024
12/03/2015 14:41:30		8.5	8.5	7.238	6.861	0.023
12/03/2015 14:42:00		9	9	7.238	6.861	0.023
12/03/2015 14:42:30		9.5	9.5	7.237	6.860	0.022
12/03/2015 14:43:00		10	10	7.237	6.860	0.022
12/03/2015 14:44:00		11	11	7.236	6.859	0.021
12/03/2015 14:45:00		12	12	7.235	6.858	0.020
12/03/2015 14:46:00		13	13	7.234	6.857	0.019
12/03/2015 14:47:00		14	14	7.234	6.857	0.019
12/03/2015 14:48:00		15	15	7.233	6.856	0.018
12/03/2015 14:49:00		16	16	7.232	6.855	0.017
12/03/2015 14:50:00		17	17	7.232	6.855	0.017
12/03/2015 14:51:00		18	18	7.231	6.854	0.016
12/03/2015 14:52:00		19	19	7.231	6.854	0.016
12/03/2015 14:53:00		20	20	7.230	6.853	0.015
12/03/2015 14:55:00		22	22	7.229	6.852	0.014
12/03/2015 14:57:00		24	24	7.228	6.851	0.013
12/03/2015 14:59:00		26	26	7.227	6.850	0.012
12/03/2015 15:01:00		28	28	7.227	6.850	0.012
12/03/2015 15:03:00		30	30	7.227	6.850	0.012
12/03/2015 15:08:00		35	35	7.226	6.849	0.011
12/03/2015 15:13:00		40	40	7.224	6.847	0.009
12/03/2015 15:18:00		45	45	7.222	6.845	0.007
12/03/2015 15:23:00		50	50	7.221	6.844	0.006
12/03/2015 15:28:00		55	55	7.220	6.843	0.005
12/03/2015 15:33:00		60	60	7.219	6.842	0.004
12/03/2015 15:38:00		65	65	7.217	6.840	0.002
12/03/2015 15:43:00		70	70	7.217	6.840	0.002
12/03/2015 15:48:00		75	75	7.216	6.839	0.001
12/03/2015 15:53:00		80	80	7.215	6.838	0.000
12/03/2015 15:58:00		85	85	7.215	6.838	0.000
12/03/2015 16:03:00		90	90	7.214	6.837	-0.001

A3.2.3 Analysis

The recovery data analysis for well 72_6180 is presented in Figure A 3.4, which results in a transmissivity estimate of $T = 120.4$ m^2/day. For conversion to hydraulic conductivity, the saturated thickness of the aquifer has been used $b = 3.1$ m. As such, $K = 38.84$ m/day or $K = 4.5 \times 10^{-4}$ m/sec. Based on theoretical values, this suggests a medium sand (9×10^{-7} to 5×10^{-4} m/sec), which is consistent with the lithological log information that describes sand as screened.

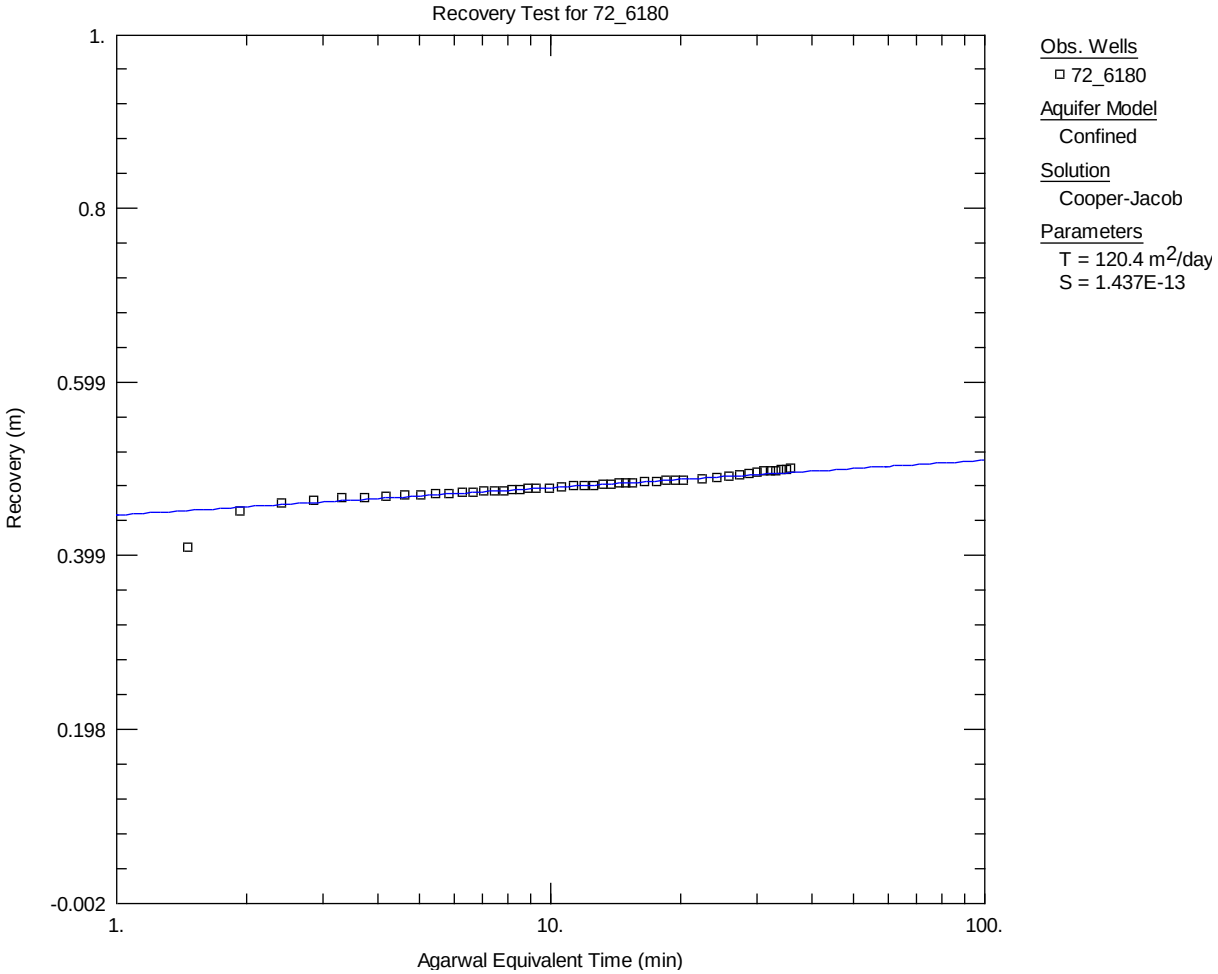
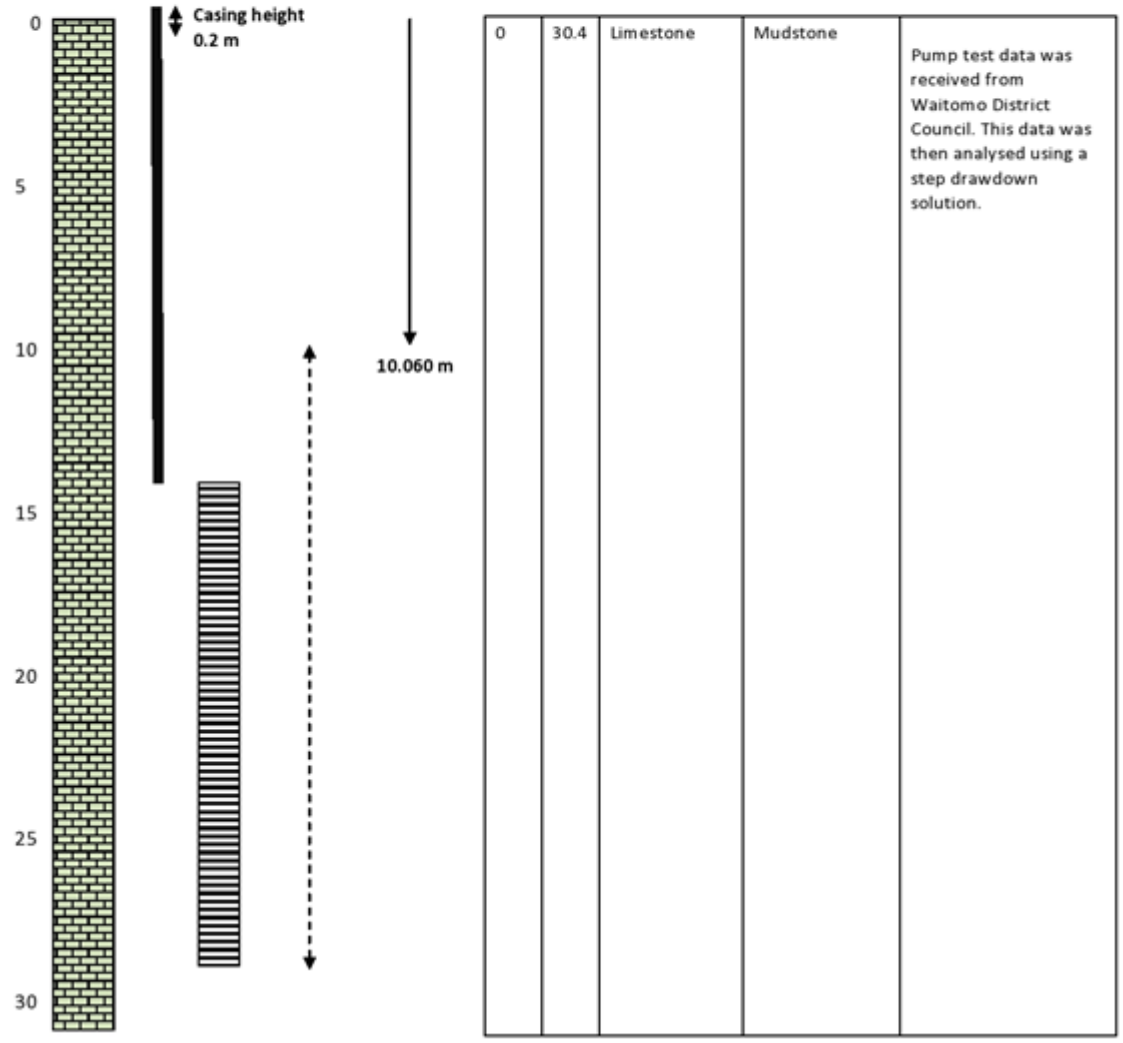


Figure A 3.4 Recovery data analysis for well 72_6180, resulting in $\boldsymbol{T = 120.4}$ m^2/day.

A3.3 HYDRAULIC TESTING DETAILS FOR WELL *72_2915*

A3.3.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Saturated Thickness (m)	Data Logger Depth (m)
72_2915	5753007	1789296	30.4	14.4	250	200	14.4 - 28.4	18.34	NA



(m)	Core Log	Casing	Screen	Saturated Thickness	Water Level	Depth (m)	Dominant	Secondary	Notes
						0	30.4	Limestone	Mudstone	Pump test data was received from Waitomo District Council. This data was then analysed using a step drawdown solution.

Pumping test comments for 72_2915: A 24 hour step well test was completed on 13/05/2005 by Aqua Consultants Limited to test for feasible production rate. The data was supplied by the Waitomo District Council in February 2015. The aquifer was pumped at 2.7 L/s for 120 minutes, then at 5 L/s for 120 minutes and lastly at 10 L/s for another 120 minutes. Recovery was measured for 1440 minutes after the pump was turned off. The aquifer only recovered to just over 58% of the drawdown generated after 24 hours of recovery. This suggests that there may be some restriction to the area extent of the aquifer.

A3.3.2 Data

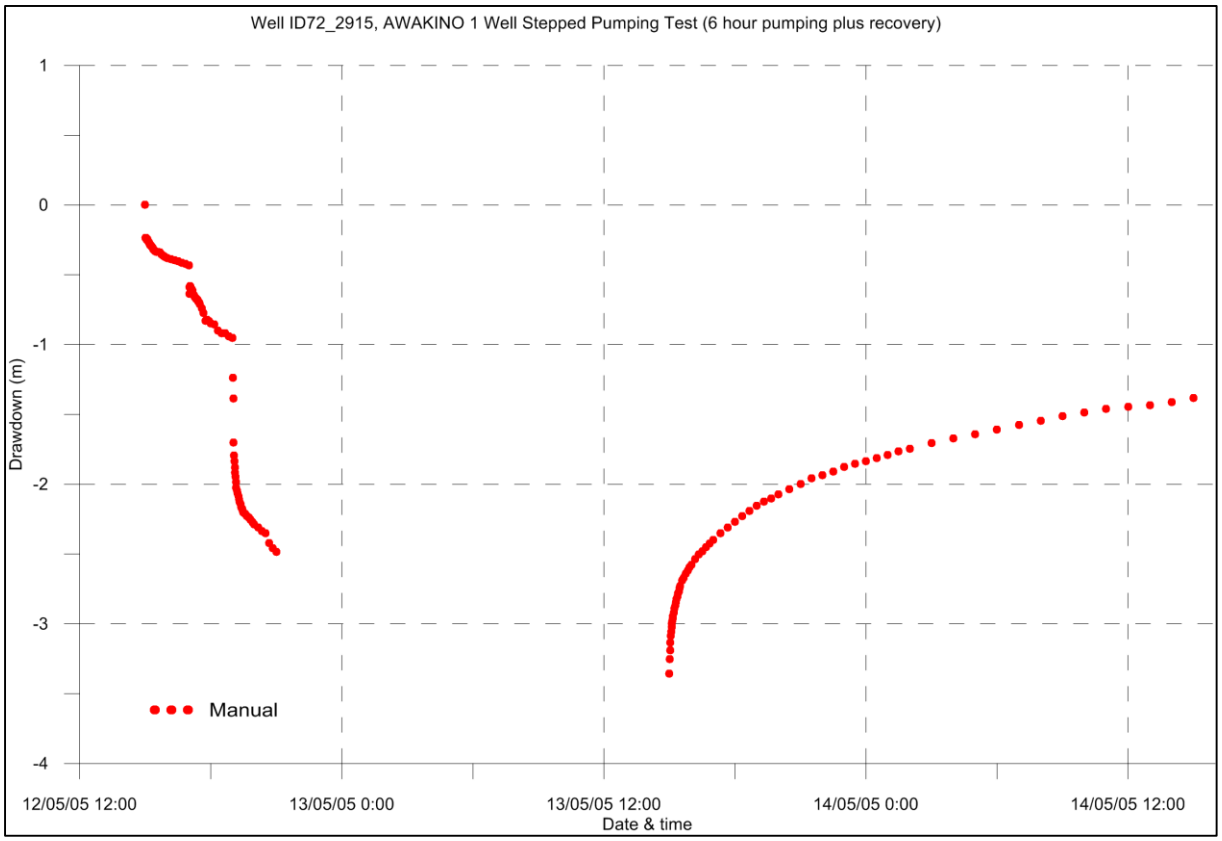


Figure A 3.5 Drawdown and recovery plot for well 72_2915.

Table A 3.3 Manual data recorded during hydraulic testing.

AWAKINO 1 Well Stepped Pumping Test (6 hour pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	AWAKINO 1	**ID:**	72_2915
Location:	E1789296 N5753007	**Well depth:**	30.4 m
Elevation (gl):	≈ 184 m ASL	**Casing diam:**	250 mm
Date:	12/05/2005	**Casing depth:**	14.4 m BGL
Stepped pumping rate:	2.7, 5.0, 10.0 L/sec	**Elevation (MP):**	0.2 m
Screen:	14.2 — 28.2 m BGL	**SWL:**	10.06 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
12/05/2005 15:00:00	0		0	10.260	10.060	0.000
12/05/2005 15:01:00	1		1	10.494	10.294	0.234
12/05/2005 15:02:00	2		2	10.497	10.297	0.237
12/05/2005 15:03:00	3		3	10.501	10.301	0.241
12/05/2005 15:04:00	4		4	10.505	10.305	0.245
12/05/2005 15:05:00	5		5	10.506	10.306	0.246
12/05/2005 15:06:00	6		6	10.508	10.308	0.248
12/05/2005 15:07:00	7		7	10.513	10.313	0.253
12/05/2005 15:08:00	8		8	10.519	10.319	0.259
12/05/2005 15:09:00	9		9	10.524	10.324	0.264
12/05/2005 15:10:00	10		10	10.530	10.330	0.270
12/05/2005 15:12:00	12		12	10.540	10.340	0.280

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
12/05/2005 15:14:00	14		14	10.547	10.347	0.287
12/05/2005 15:16:00	16		16	10.553	10.353	0.293
12/05/2005 15:18:00	18		18	10.560	10.360	0.300
12/05/2005 15:20:00	20		20	10.568	10.368	0.308
12/05/2005 15:22:00	22		22	10.576	10.376	0.316
12/05/2005 15:24:00	24		24	10.582	10.382	0.322
12/05/2005 15:26:00	26		26	10.588	10.388	0.328
12/05/2005 15:28:00	28		28	10.592	10.392	0.332
12/05/2005 15:30:00	30		30	10.595	10.395	0.335
12/05/2005 15:35:00	35		35	10.597	10.397	0.337
12/05/2005 15:40:00	40		40	10.599	10.399	0.339
12/05/2005 15:45:00	45		45	10.615	10.415	0.355
12/05/2005 15:50:00	50		50	10.627	10.427	0.367
12/05/2005 15:55:00	55		55	10.633	10.433	0.373
12/05/2005 16:00:00	60		60	10.640	10.440	0.380
12/05/2005 16:10:00	70		70	10.649	10.449	0.389
12/05/2005 16:20:00	80		80	10.656	10.456	0.396
12/05/2005 16:30:00	90		90	10.664	10.464	0.404
12/05/2005 16:40:00	100		100	10.673	10.473	0.413
12/05/2005 16:50:00	110		110	10.682	10.482	0.422
12/05/2005 17:00:00	120		120	10.692	10.492	0.432
12/05/2005 17:00:00	0		120	10.692	10.492	0.432
12/05/2005 17:01:00	1		121	10.897	10.697	0.637
12/05/2005 17:02:00	2		122	10.847	10.647	0.587
12/05/2005 17:03:00	3		123	10.842	10.642	0.582
12/05/2005 17:04:00	4		124	10.845	10.645	0.585
12/05/2005 17:05:00	5		125	10.852	10.652	0.592
12/05/2005 17:06:00	6		126	10.859	10.659	0.599
12/05/2005 17:07:00	7		127	10.863	10.663	0.603
12/05/2005 17:08:00	8		128	10.867	10.667	0.607
12/05/2005 17:09:00	9		129	10.871	10.671	0.611
12/05/2005 17:10:00	10		130	10.876	10.676	0.616
12/05/2005 17:12:00	12		132	10.899	10.699	0.639
12/05/2005 17:14:00	14		134	10.908	10.708	0.648
12/05/2005 17:16:00	16		136	10.917	10.717	0.657
12/05/2005 17:18:00	18		138	10.927	10.727	0.667
12/05/2005 17:20:00	20		140	10.934	10.734	0.674
12/05/2005 17:22:00	22		142	10.935	10.735	0.675
12/05/2005 17:24:00	24		144	10.942	10.742	0.682
12/05/2005 17:26:00	26		146	10.951	10.751	0.691
12/05/2005 17:28:00	28		148	10.960	10.760	0.700
12/05/2005 17:30:00	30		150	10.969	10.769	0.709
12/05/2005 17:35:00	35		155	10.999	10.799	0.739
12/05/2005 17:40:00	40		160	11.035	10.835	0.775
12/05/2005 17:45:00	45		165	11.088	10.888	0.828
12/05/2005 17:50:00	50		170	11.082	10.882	0.822
12/05/2005 17:55:00	55		175	11.092	10.892	0.832
12/05/2005 18:00:00	60		180	11.107	10.907	0.847
12/05/2005 18:10:00	70		190	11.115	10.915	0.855
12/05/2005 18:20:00	80		200	11.159	10.959	0.899
12/05/2005 18:30:00	90		210	11.179	10.979	0.919
12/05/2005 18:40:00	100		220	11.179	10.979	0.919
12/05/2005 18:50:00	110		230	11.200	11.000	0.940

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
12/05/2005 19:00:00	120		240	11.212	11.012	0.952
12/05/2005 19:00:00	0		240	11.212	11.012	0.952
12/05/2005 19:01:00	1		241	11.497	11.297	1.237
12/05/2005 19:02:00	2		242	11.645	11.445	1.385
12/05/2005 19:03:00	3		243	11.960	11.760	1.700
12/05/2005 19:04:00	4		244	12.054	11.854	1.794
12/05/2005 19:05:00	5		245	12.096	11.896	1.836
12/05/2005 19:06:00	6		246	12.140	11.940	1.880
12/05/2005 19:07:00	7		247	12.176	11.976	1.916
12/05/2005 19:08:00	8		248	12.205	12.005	1.945
12/05/2005 19:09:00	9		249	12.245	12.045	1.985
12/05/2005 19:10:00	10		250	12.284	12.084	2.024
12/05/2005 19:12:00	12		252	12.307	12.107	2.047
12/05/2005 19:14:00	14		254	12.326	12.126	2.066
12/05/2005 19:16:00	16		256	12.348	12.148	2.088
12/05/2005 19:18:00	18		258	12.369	12.169	2.109
12/05/2005 19:20:00	20		260	12.390	12.190	2.130
12/05/2005 19:22:00	22		262	12.402	12.202	2.142
12/05/2005 19:24:00	24		264	12.425	12.225	2.165
12/05/2005 19:26:00	26		266	12.438	12.238	2.178
12/05/2005 19:28:00	28		268	12.452	12.252	2.192
12/05/2005 19:30:00	30		270	12.463	12.263	2.203
12/05/2005 19:35:00	35		275	12.475	12.275	2.215
12/05/2005 19:40:00	40		280	12.488	12.288	2.228
12/05/2005 19:45:00	45		285	12.500	12.300	2.240
12/05/2005 19:50:00	50		290	12.515	12.315	2.255
12/05/2005 19:55:00	55		295	12.534	12.334	2.274
12/05/2005 20:00:00	60		300	12.547	12.347	2.287
12/05/2005 20:10:00	70		310	12.570	12.370	2.310
12/05/2005 20:20:00	80		320	12.595	12.395	2.335
12/05/2005 20:30:00	90		330	12.610	12.410	2.350
12/05/2005 20:40:00	100		340	12.680	12.480	2.420
12/05/2005 20:50:00	110		350	12.720	12.520	2.460
12/05/2005 21:00:00	120		360	12.745	12.545	2.485
13/05/2005 15:00:00		0	1380	13.618	13.418	3.358
13/05/2005 15:01:00		1	1381	13.512	13.312	3.252
13/05/2005 15:02:00		2	1382	13.448	13.248	3.188
13/05/2005 15:03:00		3	1383	13.393	13.193	3.133
13/05/2005 15:04:00		4	1384	13.346	13.146	3.086
13/05/2005 15:05:00		5	1385	13.315	13.115	3.055
13/05/2005 15:06:00		6	1386	13.284	13.084	3.024
13/05/2005 15:07:00		7	1387	13.258	13.058	2.998
13/05/2005 15:08:00		8	1388	13.239	13.039	2.979
13/05/2005 15:09:00		9	1389	13.221	13.021	2.961
13/05/2005 15:10:00		10	1390	13.206	13.006	2.946
13/05/2005 15:12:00		12	1392	13.177	12.977	2.917
13/05/2005 15:14:00		14	1394	13.150	12.950	2.890
13/05/2005 15:16:00		16	1396	13.125	12.925	2.865
13/05/2005 15:18:00		18	1398	13.103	12.903	2.843
13/05/2005 15:20:00		20	1400	13.082	12.882	2.822
13/05/2005 15:22:00		22	1402	13.063	12.863	2.803
13/05/2005 15:24:00		24	1404	13.043	12.843	2.783
13/05/2005 15:26:00		26	1406	13.026	12.826	2.766

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
13/05/2005 15:28:00		28	1408	13.004	12.804	2.744
13/05/2005 15:30:00		30	1410	12.989	12.789	2.729
13/05/2005 15:35:00		35	1415	12.949	12.749	2.689
13/05/2005 15:40:00		40	1420	12.929	12.729	2.669
13/05/2005 15:45:00		45	1425	12.902	12.702	2.642
13/05/2005 15:50:00		50	1430	12.878	12.678	2.618
13/05/2005 15:55:00		55	1435	12.857	12.657	2.597
13/05/2005 16:00:00		60	1440	12.837	12.637	2.577
13/05/2005 16:10:00		70	1450	12.798	12.598	2.538
13/05/2005 16:20:00		80	1460	12.762	12.562	2.502
13/05/2005 16:30:00		90	1470	12.739	12.539	2.479
13/05/2005 16:40:00		100	1480	12.711	12.511	2.451
13/05/2005 16:50:00		110	1490	12.686	12.486	2.426
13/05/2005 17:00:00		120	1500	12.660	12.460	2.400
13/05/2005 17:20:00		140	1520	12.611	12.411	2.351
13/05/2005 17:40:00		160	1540	12.570	12.370	2.310
13/05/2005 18:00:00		180	1560	12.529	12.329	2.269
13/05/2005 18:20:00		200	1580	12.490	12.290	2.230
13/05/2005 18:40:00		220	1600	12.453	12.253	2.193
13/05/2005 19:00:00		240	1620	12.414	12.214	2.154
13/05/2005 19:20:00		260	1640	12.384	12.184	2.124
13/05/2005 19:40:00		280	1660	12.361	12.161	2.101
13/05/2005 20:00:00		300	1680	12.331	12.131	2.071
13/05/2005 20:30:00		330	1710	12.294	12.094	2.034
13/05/2005 21:00:00		360	1740	12.257	12.057	1.997
13/05/2005 21:30:00		390	1770	12.218	12.018	1.958
13/05/2005 22:00:00		420	1800	12.195	11.995	1.935
13/05/2005 22:30:00		450	1830	12.169	11.969	1.909
13/05/2005 23:00:00		480	1860	12.136	11.936	1.876
13/05/2005 23:30:00		510	1890	12.114	11.914	1.854
14/05/2005 00:00:00		540	1920	12.095	11.895	1.835
14/05/2005 00:30:00		570	1950	12.073	11.873	1.813
14/05/2005 01:00:00		600	1980	12.050	11.850	1.790
14/05/2005 01:30:00		630	2010	12.025	11.825	1.765
14/05/2005 02:00:00		660	2040	12.007	11.807	1.747
14/05/2005 03:00:00		720	2100	11.964	11.764	1.704
14/05/2005 04:00:00		780	2160	11.931	11.731	1.671
14/05/2005 05:00:00		840	2220	11.904	11.704	1.644
14/05/2005 06:00:00		900	2280	11.868	11.668	1.608
14/05/2005 07:00:00		960	2340	11.837	11.637	1.577
14/05/2005 08:00:00		1020	2400	11.806	11.606	1.546
14/05/2005 09:00:00		1080	2460	11.771	11.571	1.511
14/05/2005 10:00:00		1140	2520	11.745	11.545	1.485
14/05/2005 11:00:00		1200	2580	11.722	11.522	1.462
14/05/2005 12:00:00		1260	2640	11.705	11.505	1.445
14/05/2005 13:00:00		1320	2700	11.695	11.495	1.435
14/05/2005 14:00:00		1380	2760	11.671	11.471	1.411
14/05/2005 15:00:00		1440	2820	11.642	11.442	1.382

A3.3.3 Analysis

The recovery data analysis for well 72_2915 is presented in Figure A 3.6, which results in a transmissivity estimate of $T = 296.7$ m^2/day. This analysis fits the curve to the central portion of the curve, which is considered the least influenced by other effects. For completions sake, Figure A 3.7 and Figure A 3.8 present two alternate analyses. For conversion to hydraulic conductivity, the saturated thickness of the aquifer has been used $b = 18.34$ m. As such, $K = 16.18$ m/day or $K = 1.9 \times 10^{-4}$ m/sec. Based on theoretical values, this suggests karst limestone (1×10^{-6} to 2×10^{-2} m/sec), which is consistent with the screened lithology of limestone with mudstone.

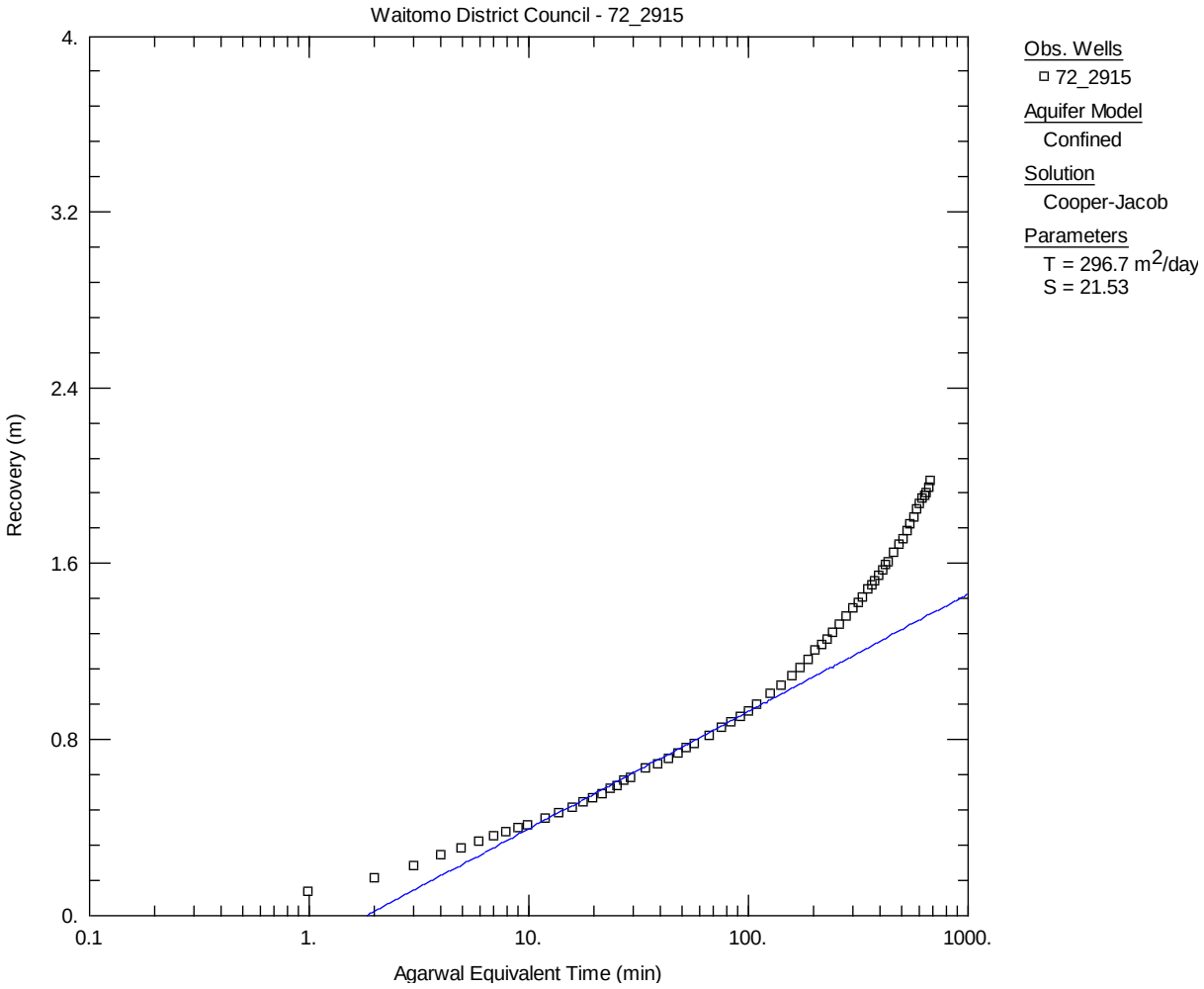


Figure A 3.6 Recovery data analysis for well 72_2915 fitting to the middle part of the curve, resulting in $\boldsymbol{T = 296.7}$ m^2/day.

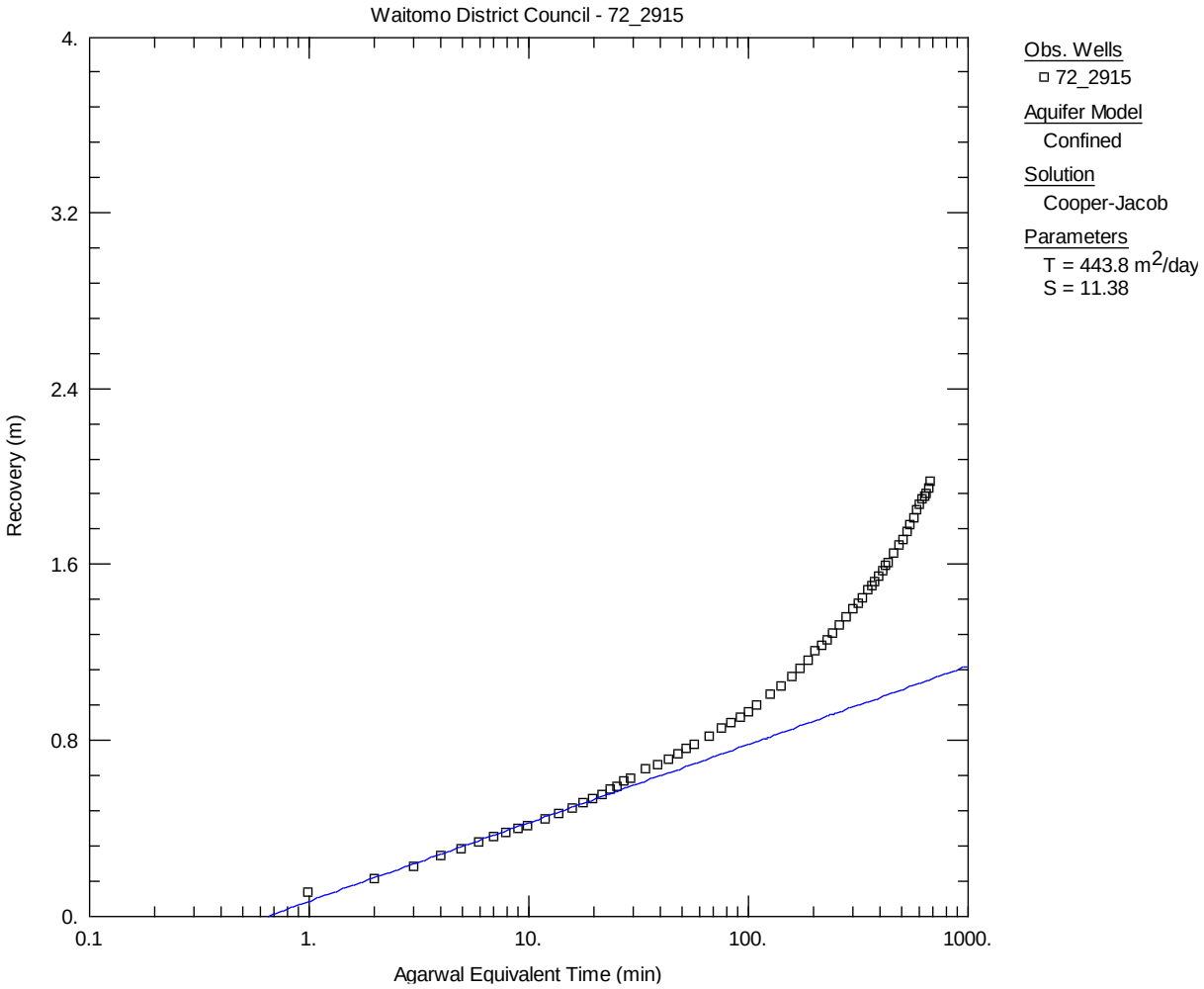


Figure A 3.7 Recovery data analysis for well 72_2915 fitting to the initial part of the curve, resulting in $\boldsymbol{T} = \mathbf{443.8}$ m^2/day.

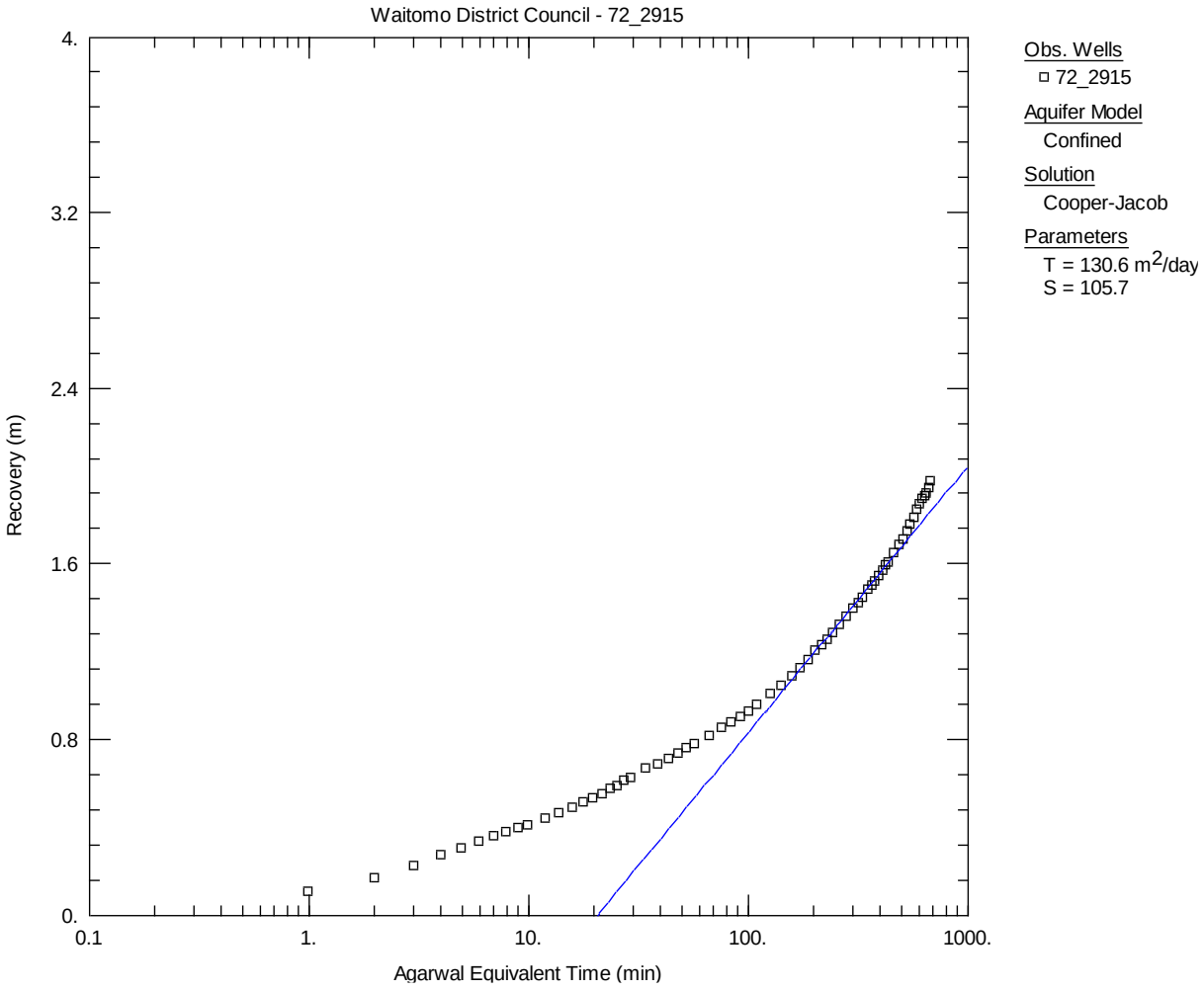
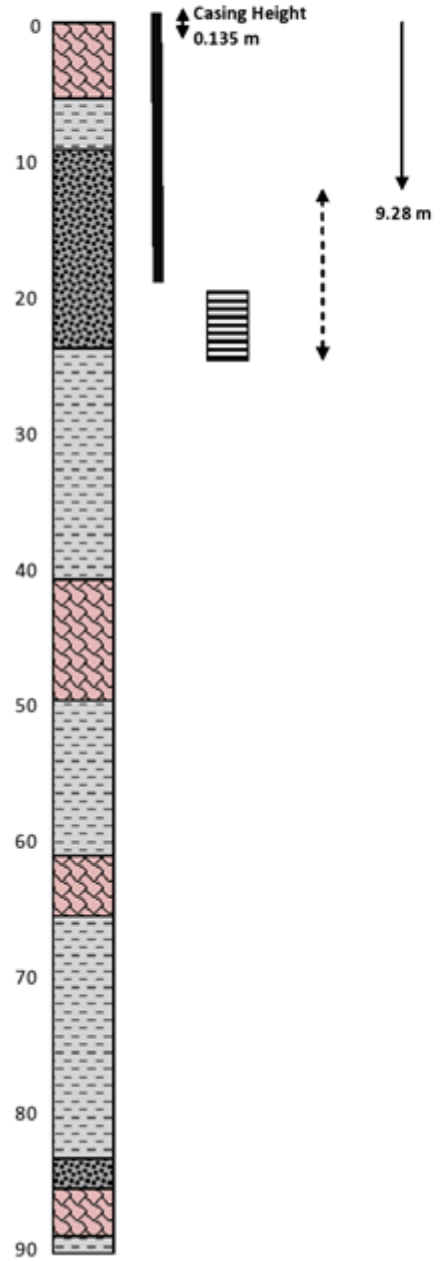


Figure A 3.8 Recovery data analysis for well 72_2915 fitting to the latter part of the curve, resulting in $\boldsymbol{T} = \mathbf{130.6}$ m^2/day.

A3.4 HYDRAULIC TESTING DETAILS FOR WELL 72_4014

A3.4.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Saturated Thickness (m)	Data Logger Depth (m)
72_4014	5809209	1789690	24.6	19	100	80	19 - 24.6	15.32	15 m



Depth (m)		Dominant	Secondary	Notes
0	5.7	Pumice	Sands	Pump test created a maximum drawdown of 16 cm only within less than 30 seconds. Recovery back to static happened in about 20 seconds. Submersible pump is obviously not strong enough to stress the aquifer. Actual bore is only 24.6 m deep but driller initially drilled deeper to investigate the lithology of the location.
5.7	8.8	Silt		
8.8	24.34	Gravels		
24.34	41.28	Silt	Gravels, Pumice	
41.28	49.34	Pumice	Peat-wood	
49.34	61.1	Silt, Peat-wood		
61.1	65.08	Pumice		
65.08	84.3	Silt	Clay	
84.3	86.8	Gravels		
86.8	89.4	Pumice		
89.4	89.6	Silt		

Pumping test comments for 72_4014: A single well test was performed with both drawdown and recovery data collected on the 05/03/2015. The installed pump was not running for at least 12 hours prior to starting the hydraulic test. The pump was forced to run for 90 minutes: the pump rate dropped from 1.23 L/s initially to 1.04 L/s after about 90

minutes. Subsequently, the pump was turned off and recovery measured for 30 minutes. Manual measurements were recorded during both phases of the test, while the data logger was only used for recovery measurements. Pumping created a maximum drawdown of 16 cm in less than 30 seconds. The recovery back to static happened in about 20 seconds. The installed submersible pump was probably not strong enough to stress the aquifer.

A3.4.2 Data

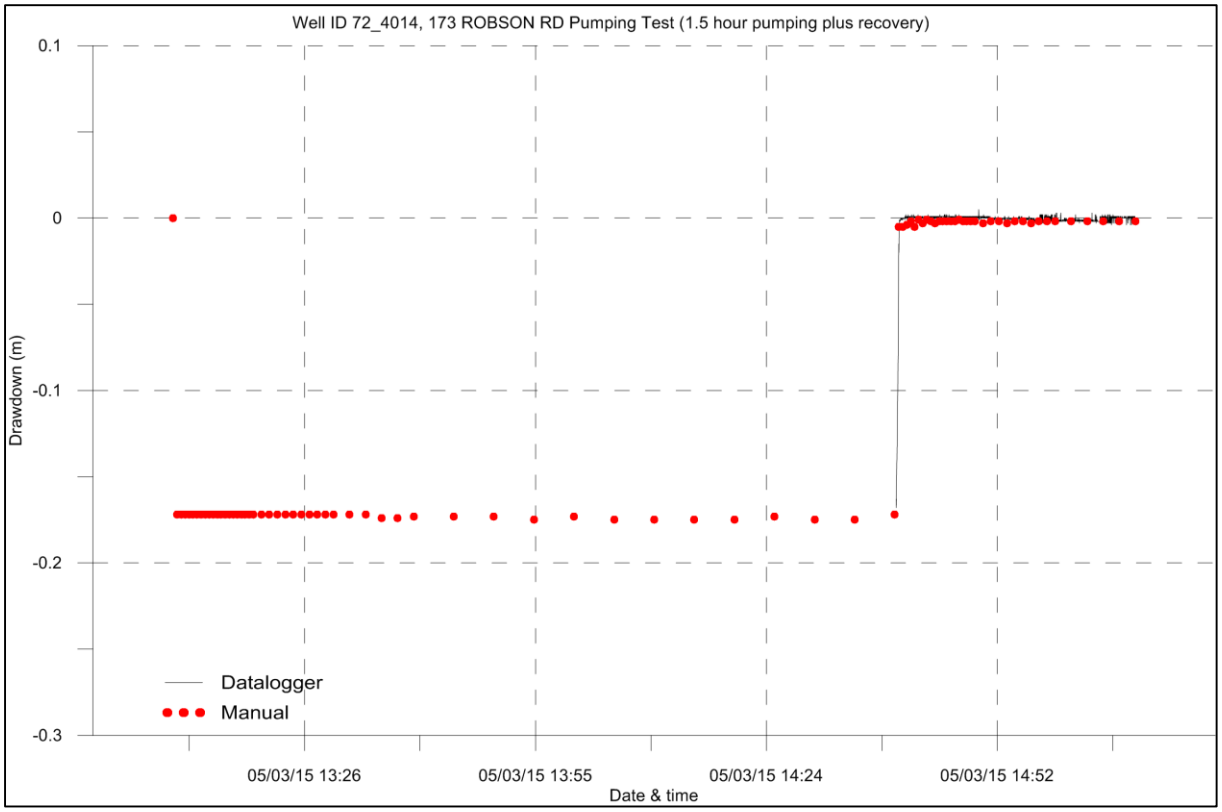


Figure A 3.9 Drawdown and recovery plot for well 72_4014.

Table A 3.4 Manual data recorded during hydraulic testing.

173 ROBSON RD Pumping Test (1.5 hour pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	173 ROBSON RD	**ID:**	72_4014
Location:	E1789689.784 N5809209.429	**Well depth:**	24.6 m
Elevation (gl):	24.322 m ASL	**Casing diam:**	100 mm
Date:	5/03/2015	**Casing depth:**	19 m BGL
Pump rate:	1.155 L/sec	**Elevation (MP):**	0.135 m
Screen:	19 – 24.6 m BGL	**SWL:**	9.280 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
05/03/2015 13:10:00	0		0	9.415	9.280	0.000
05/03/2015 13:10:30	0.5		0.5	9.587	9.452	0.172
05/03/2015 13:11:00	1		1	9.587	9.452	0.172
05/03/2015 13:11:30	1.5		1.5	9.587	9.452	0.172
05/03/2015 13:12:00	2		2	9.587	9.452	0.172
05/03/2015 13:12:30	2.5		2.5	9.587	9.452	0.172
05/03/2015 13:13:00	3		3	9.587	9.452	0.172
05/03/2015 13:13:30	3.5		3.5	9.587	9.452	0.172
05/03/2015 13:14:00	4		4	9.587	9.452	0.172
05/03/2015 13:14:30	4.5		4.5	9.587	9.452	0.172
05/03/2015 13:15:00	5		5	9.587	9.452	0.172
05/03/2015 13:15:30	5.5		5.5	9.587	9.452	0.172
05/03/2015 13:16:00	6		6	9.587	9.452	0.172
05/03/2015 13:16:30	6.5		6.5	9.587	9.452	0.172
05/03/2015 13:17:00	7		7	9.587	9.452	0.172
05/03/2015 13:17:30	7.5		7.5	9.587	9.452	0.172
05/03/2015 13:18:00	8		8	9.587	9.452	0.172
05/03/2015 13:18:30	8.5		8.5	9.587	9.452	0.172
05/03/2015 13:19:00	9		9	9.587	9.452	0.172
05/03/2015 13:19:30	9.5		9.5	9.587	9.452	0.172
05/03/2015 13:20:00	10		10	9.587	9.452	0.172
05/03/2015 13:21:00	11		11	9.587	9.452	0.172
05/03/2015 13:22:00	12		12	9.587	9.452	0.172
05/03/2015 13:23:00	13		13	9.587	9.452	0.172
05/03/2015 13:24:00	14		14	9.587	9.452	0.172
05/03/2015 13:25:00	15		15	9.587	9.452	0.172
05/03/2015 13:26:00	16		16	9.587	9.452	0.172
05/03/2015 13:27:00	17		17	9.587	9.452	0.172
05/03/2015 13:28:00	18		18	9.587	9.452	0.172
05/03/2015 13:29:00	19		19	9.587	9.452	0.172
05/03/2015 13:30:00	20		20	9.587	9.452	0.172
05/03/2015 13:32:00	22		22	9.587	9.452	0.172
05/03/2015 13:34:00	24		24	9.587	9.452	0.172
05/03/2015 13:36:00	26		26	9.589	9.454	0.174
05/03/2015 13:38:00	28		28	9.589	9.454	0.174
05/03/2015 13:40:00	30		30	9.588	9.453	0.173
05/03/2015 13:45:00	35		35	9.588	9.453	0.173
05/03/2015 13:50:00	40		40	9.588	9.453	0.173
05/03/2015 13:55:00	45		45	9.590	9.455	0.175
05/03/2015 14:00:00	50		50	9.588	9.453	0.173
05/03/2015 14:05:00	55		55	9.590	9.455	0.175
05/03/2015 14:10:00	60		60	9.590	9.455	0.175
24 Hour Pumping Test				**PERMANENT WELL**		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
05/03/2015 14:15:00	65		65	9.590	9.455	0.175
05/03/2015 14:20:00	70		70	9.590	9.455	0.175
05/03/2015 14:25:00	75		75	9.588	9.453	0.173
05/03/2015 14:30:00	80		80	9.590	9.455	0.175
05/03/2015 14:35:00	85		85	9.590	9.455	0.175
05/03/2015 14:40:00	90	0	90	9.587	9.452	0.172
05/03/2015 14:40:30		0.5	90.5	9.420	9.285	0.005
05/03/2015 14:41:00		1	91	9.420	9.285	0.005
05/03/2015 14:41:30		1.5	91.5	9.419	9.284	0.004
05/03/2015 14:42:00		2	92	9.417	9.282	0.002
05/03/2015 14:42:30		2.5	92.5	9.420	9.285	0.005
05/03/2015 14:43:00		3	93	9.416	9.281	0.001
05/03/2015 14:43:30		3.5	93.5	9.418	9.283	0.003
05/03/2015 14:44:00		4	94	9.416	9.281	0.001
05/03/2015 14:44:30		4.5	94.5	9.417	9.282	0.002
05/03/2015 14:45:00		5	95	9.418	9.283	0.003
05/03/2015 14:45:30		5.5	95.5	9.417	9.282	0.002
05/03/2015 14:46:00		6	96	9.417	9.282	0.002
05/03/2015 14:46:30		6.5	96.5	9.417	9.282	0.002
05/03/2015 14:47:00		7	97	9.417	9.282	0.002
05/03/2015 14:47:30		7.5	97.5	9.417	9.282	0.002
05/03/2015 14:48:00		8	98	9.416	9.281	0.001
05/03/2015 14:48:30		8.5	98.5	9.417	9.282	0.002
05/03/2015 14:49:00		9	99	9.417	9.282	0.002
05/03/2015 14:49:30		9.5	99.5	9.417	9.282	0.002
05/03/2015 14:50:00		10	100	9.417	9.282	0.002
05/03/2015 14:51:00		11	101	9.418	9.283	0.003
05/03/2015 14:52:00		12	102	9.417	9.282	0.002
05/03/2015 14:53:00		13	103	9.417	9.282	0.002
05/03/2015 14:54:00		14	104	9.418	9.283	0.003
05/03/2015 14:55:00		15	105	9.417	9.282	0.002
05/03/2015 14:56:00		16	106	9.417	9.282	0.002
05/03/2015 14:57:00		17	107	9.418	9.283	0.003
05/03/2015 14:58:00		18	108	9.417	9.282	0.002
05/03/2015 14:59:00		19	109	9.417	9.282	0.002
05/03/2015 15:00:00		20	110	9.417	9.282	0.002
05/03/2015 15:02:00		22	112	9.417	9.282	0.002
05/03/2015 15:04:00		24	114	9.417	9.282	0.002
05/03/2015 15:06:00		26	116	9.417	9.282	0.002
05/03/2015 15:08:00		28	118	9.417	9.282	0.002
05/03/2015 15:10:00		30	120	9.417	9.282	0.002

A3.4.3 Analysis

The recovery data analysis for well 72_4014 is presented in Figure A 3.10, which results in a transmissivity estimate of $T = 57.34$ m^2/day. This well is unconfined and therefore is likely to have bias towards an over-estimated transmissivity value. For conversion to hydraulic conductivity, the saturated thickness of the aquifer has been used $b = 15.32$ m. As such, $K = 3.74$ m/day or $K = 4.3 \times 10^{-5}$ m/sec. This is slightly lower than theoretical values for gravel (3×10^{-4} to 3×10^{-2} m/sec), indicating that it is likely to be a silty rather than clean gravel (the lithological log has the gravel unit bound top and bottom by silt).

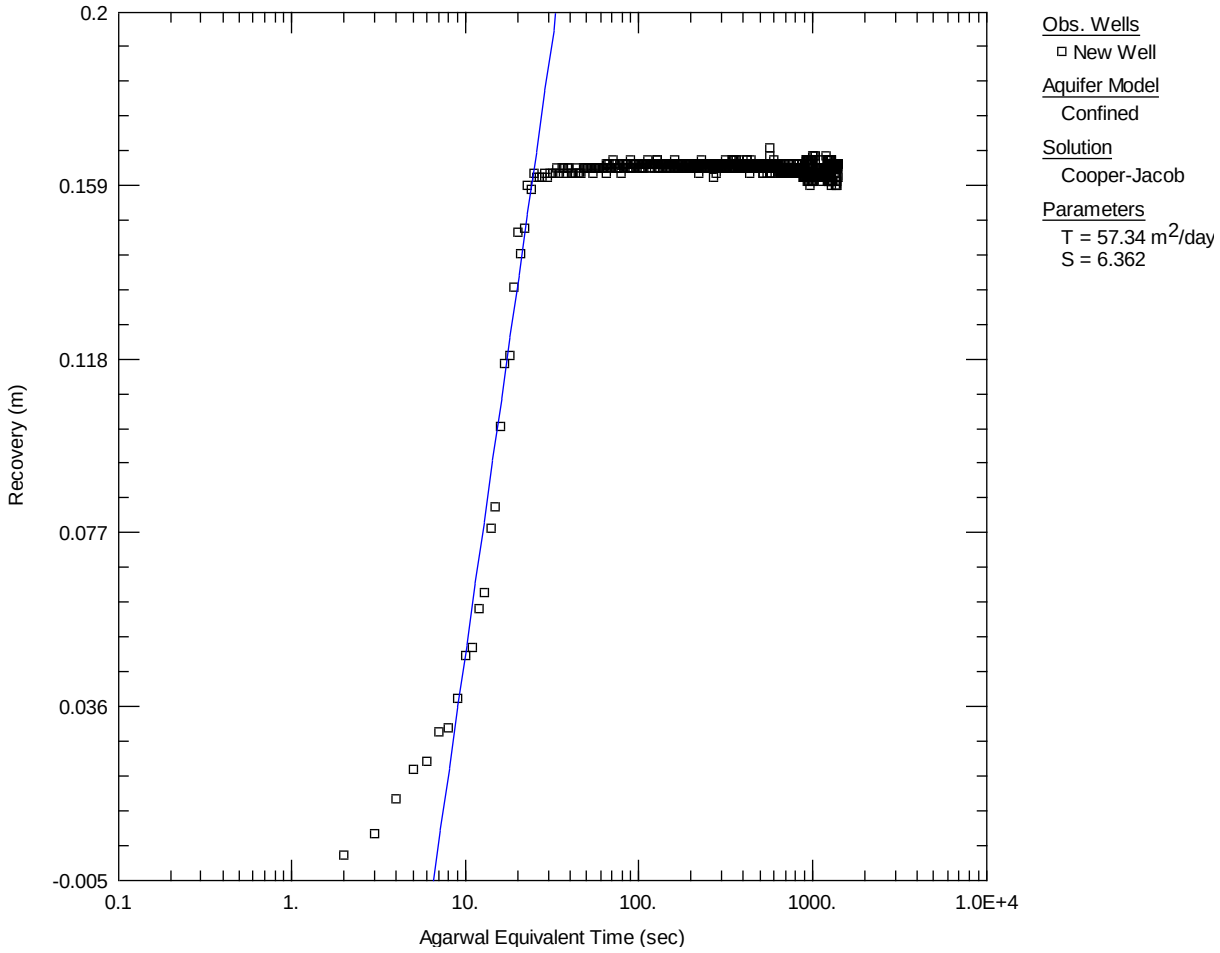
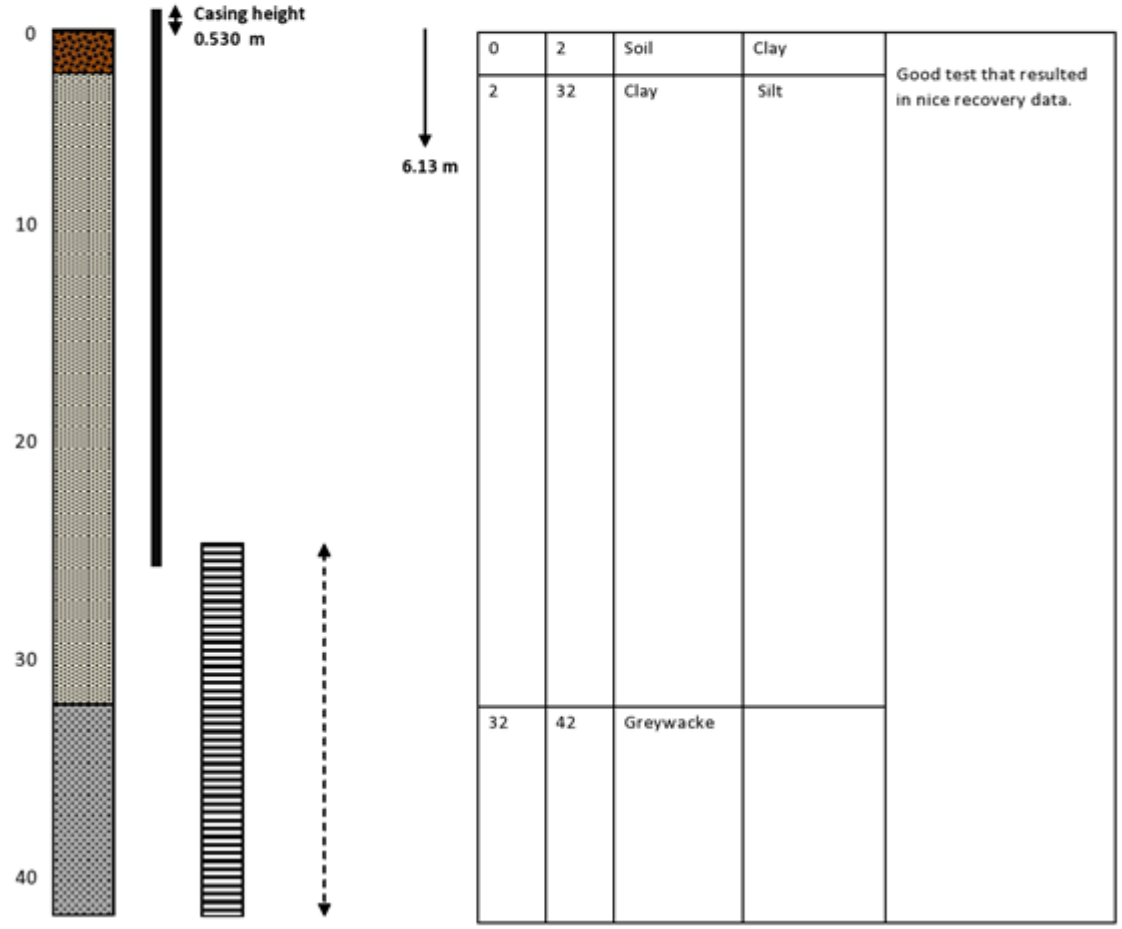


Figure A 3.10 Recovery data analysis for well 72_4014, resulting in $\boldsymbol{T = 57.34}$ m^2/day.

A3.5 HYDRAULIC TESTING DETAILS FOR WELL 72_5503

A3.5.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Screen Length (m)	Data Logger Depth (m)
72_5503	5753564	1797331	42	26	150	100	24 - 42	18	31.7



Pumping test comments for 72_5503: A single well test was performed with both drawdown and recovery data collected on the 23/04/2015. The installed pump was not running for approximately 18 hours prior to starting the hydraulic test. The pump was forced to run for 50 minutes: the pump rate dropped from 2.78 L/s initially to 2.11 L/s after about 40 minutes. Subsequently, the pump was turned off and recovery measured for 90 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test.

A3.5.2 Data

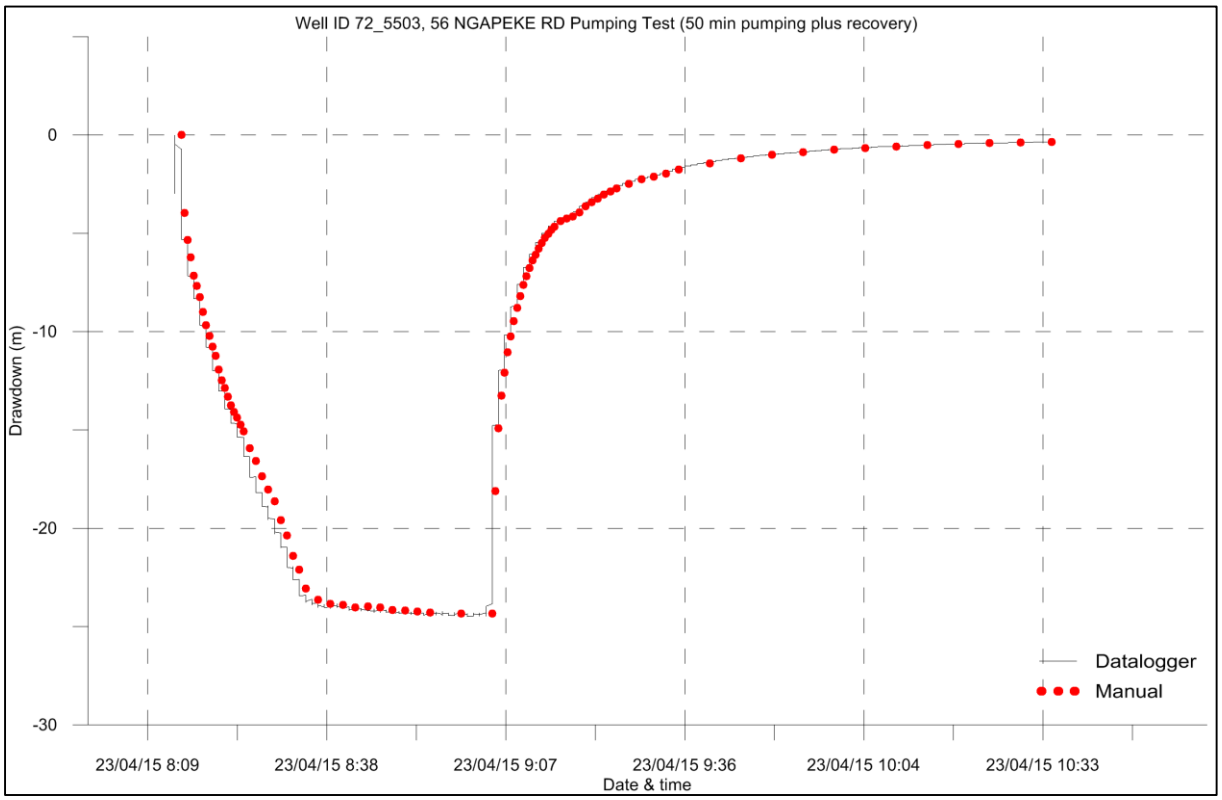


Figure A 3.11 Drawdown and recovery plot for well 72_5503.

Table A 3.5 Manual data recorded during hydraulic testing.

56 NGAPEKE RD Pumping Test (50 minutes pumping plus recovery) ***MANUAL DATA***						
Well Name/Site:	56 NGAPEKE RD			**ID:**	72_5503	
Location:	N1797331 E5753564			**Well depth:**	42 m	
Elevation (gl):	≈ 244 m ASL			**Casing diam:**	150 mm	
Date:	23/04/2015			**Casing depth:**	26 m BGL	
Pump rate:	2.45 L/sec			**Elevation (MP):**	0.53 m	
Screen:	24 – 42 m BGL			**SWL:**	6.130 m BGL	
24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
23/04/2015 08:15:00	0		0	6.660	6.130	0.000
23/04/2015 08:15:30	0.5		0.5	10.630	10.100	3.970
23/04/2015 08:16:00	1		1	12.000	11.470	5.340
23/04/2015 08:16:30	1.5		1.5	12.890	12.360	6.230
23/04/2015 08:17:00	2		2	13.815	13.285	7.155
23/04/2015 08:17:30	2.5		2.5	14.335	13.805	7.675
23/04/2015 08:18:00	3		3	14.920	14.390	8.260
23/04/2015 08:18:30	3.5		3.5	15.650	15.120	8.990
23/04/2015 08:19:00	4		4	16.330	15.800	9.670
23/04/2015 08:19:30	4.5		4.5	16.890	16.360	10.230
23/04/2015 08:20:00	5		5	17.415	16.885	10.755
23/04/2015 08:20:30	5.5		5.5	17.895	17.365	11.235
24 Hour Pumping Test				**PERMANENT WELL**		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
23/04/2015 08:21:00	6		6	18.585	18.055	11.925
23/04/2015 08:21:30	6.5		6.5	19.130	18.600	12.470
23/04/2015 08:22:00	7		7	19.540	19.010	12.880
23/04/2015 08:22:30	7.5		7.5	19.980	19.450	13.320
23/04/2015 08:23:00	8		8	20.400	19.870	13.740
23/04/2015 08:23:30	8.5		8.5	20.750	20.220	14.090
23/04/2015 08:24:00	9		9	21.030	20.500	14.370
23/04/2015 08:24:30	9.5		9.5	21.400	20.870	14.740
23/04/2015 08:25:00	10		10	21.740	21.210	15.080
23/04/2015 08:26:00	11		11	22.605	22.075	15.945
23/04/2015 08:27:00	12		12	23.240	22.710	16.580
23/04/2015 08:28:00	13		13	24.030	23.500	17.370
23/04/2015 08:29:00	14		14	24.690	24.160	18.030
23/04/2015 08:30:00	15		15	25.290	24.760	18.630
23/04/2015 08:31:00	16		16	26.250	25.720	19.590
23/04/2015 08:32:00	17		17	27.030	26.500	20.370
23/04/2015 08:33:00	18		18	28.070	27.540	21.410
23/04/2015 08:34:00	19		19	28.780	28.250	22.120
23/04/2015 08:35:00	20		20	29.720	29.190	23.060
23/04/2015 08:37:00	22		22	30.300	29.770	23.640
23/04/2015 08:39:00	24		24	30.520	29.990	23.860
23/04/2015 08:41:00	26		26	30.550	30.020	23.890
23/04/2015 08:43:00	28		28	30.680	30.150	24.020
23/04/2015 08:45:00	30		30	30.650	30.120	23.990
23/04/2015 08:47:00	32		32	30.700	30.170	24.040
23/04/2015 08:49:00	34		34	30.820	30.290	24.160
23/04/2015 08:51:00	36		36	30.850	30.320	24.190
23/04/2015 08:53:00	38		38	30.900	30.370	24.240
23/04/2015 08:55:00	40		40	30.950	30.420	24.290
23/04/2015 09:00:00	45		45	31.000	30.470	24.340
23/04/2015 09:05:00	50	0	50	31.000	30.470	24.340
23/04/2015 09:05:30		0.5	50.5	24.770	24.240	18.110
23/04/2015 09:06:00		1	51	21.590	21.060	14.930
23/04/2015 09:06:30		1.5	51.5	19.930	19.400	13.270
23/04/2015 09:07:00		2	52	18.740	18.210	12.080
23/04/2015 09:07:30		2.5	52.5	17.720	17.190	11.060
23/04/2015 09:08:00		3	53	16.900	16.370	10.240
23/04/2015 09:08:30		3.5	53.5	16.140	15.610	9.480
23/04/2015 09:09:00		4	54	15.450	14.920	8.790
23/04/2015 09:09:30		4.5	54.5	14.850	14.320	8.190
23/04/2015 09:10:00		5	55	14.290	13.760	7.630
23/04/2015 09:10:30		5.5	55.5	13.840	13.310	7.180
23/04/2015 09:11:00		6	56	13.430	12.900	6.770
23/04/2015 09:11:30		6.5	56.5	13.030	12.500	6.370
23/04/2015 09:12:00		7	57	12.760	12.230	6.100
23/04/2015 09:12:30		7.5	57.5	12.455	11.925	5.795
23/04/2015 09:13:00		8	58	12.160	11.630	5.500
23/04/2015 09:13:30		8.5	58.5	11.910	11.380	5.250
23/04/2015 09:14:00		9	59	11.690	11.160	5.030
23/04/2015 09:14:30		9.5	59.5	11.490	10.960	4.830
23/04/2015 09:15:00		10	60	11.320	10.790	4.660
23/04/2015 09:16:00		11	61	11.050	10.520	4.390
24 Hour Pumping Test				**PERMANENT WELL**		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
23/04/2015 09:17:00		12	62	10.920	10.390	4.260
23/04/2015 09:18:00		13	63	10.820	10.290	4.160
23/04/2015 09:19:00		14	64	10.610	10.080	3.950
23/04/2015 09:20:00		15	65	10.300	9.770	3.640
23/04/2015 09:21:00		16	66	10.085	9.555	3.425
23/04/2015 09:22:00		17	67	9.890	9.360	3.230
23/04/2015 09:23:00		18	68	9.690	9.160	3.030
23/04/2015 09:24:00		19	69	9.525	8.995	2.865
23/04/2015 09:25:00		20	70	9.375	8.845	2.715
23/04/2015 09:27:00		22	72	9.140	8.610	2.480
23/04/2015 09:29:00		24	74	8.925	8.395	2.265
23/04/2015 09:31:00		26	76	8.785	8.255	2.125
23/04/2015 09:33:00		28	78	8.640	8.110	1.980
23/04/2015 09:35:00		30	80	8.430	7.900	1.770
23/04/2015 09:40:00		35	85	8.100	7.570	1.440
23/04/2015 09:45:00		40	90	7.840	7.310	1.180
23/04/2015 09:50:00		45	95	7.675	7.145	1.015
23/04/2015 09:55:00		50	100	7.530	7.000	0.870
23/04/2015 10:00:00		55	105	7.410	6.880	0.750
23/04/2015 10:05:00		60	110	7.325	6.795	0.665
23/04/2015 10:10:00		65	115	7.250	6.720	0.590
23/04/2015 10:15:00		70	120	7.170	6.640	0.510
23/04/2015 10:20:00		75	125	7.130	6.600	0.470
23/04/2015 10:25:00		80	130	7.080	6.550	0.420
23/04/2015 10:30:00		85	135	7.055	6.525	0.395
23/04/2015 10:35:00		90	140	7.015	6.485	0.355

A3.5.3 Analysis

The recovery data analysis for well 72_5503 is presented in Figure A 3.12, which results in a transmissivity estimate of $T = 3.29$ m^2/day. For conversion to hydraulic conductivity, the screen length has been used $b = 18$ m. As such, $K = 0.18$ m/day or $K = 2.1 \times 10^{-6}$ m/sec. This is consistent with theoretical values for fractured hard rock (8×10^{-9} to 3×10^{-4} m/sec), indicating as expected that water is drawn from fractured greywacke.

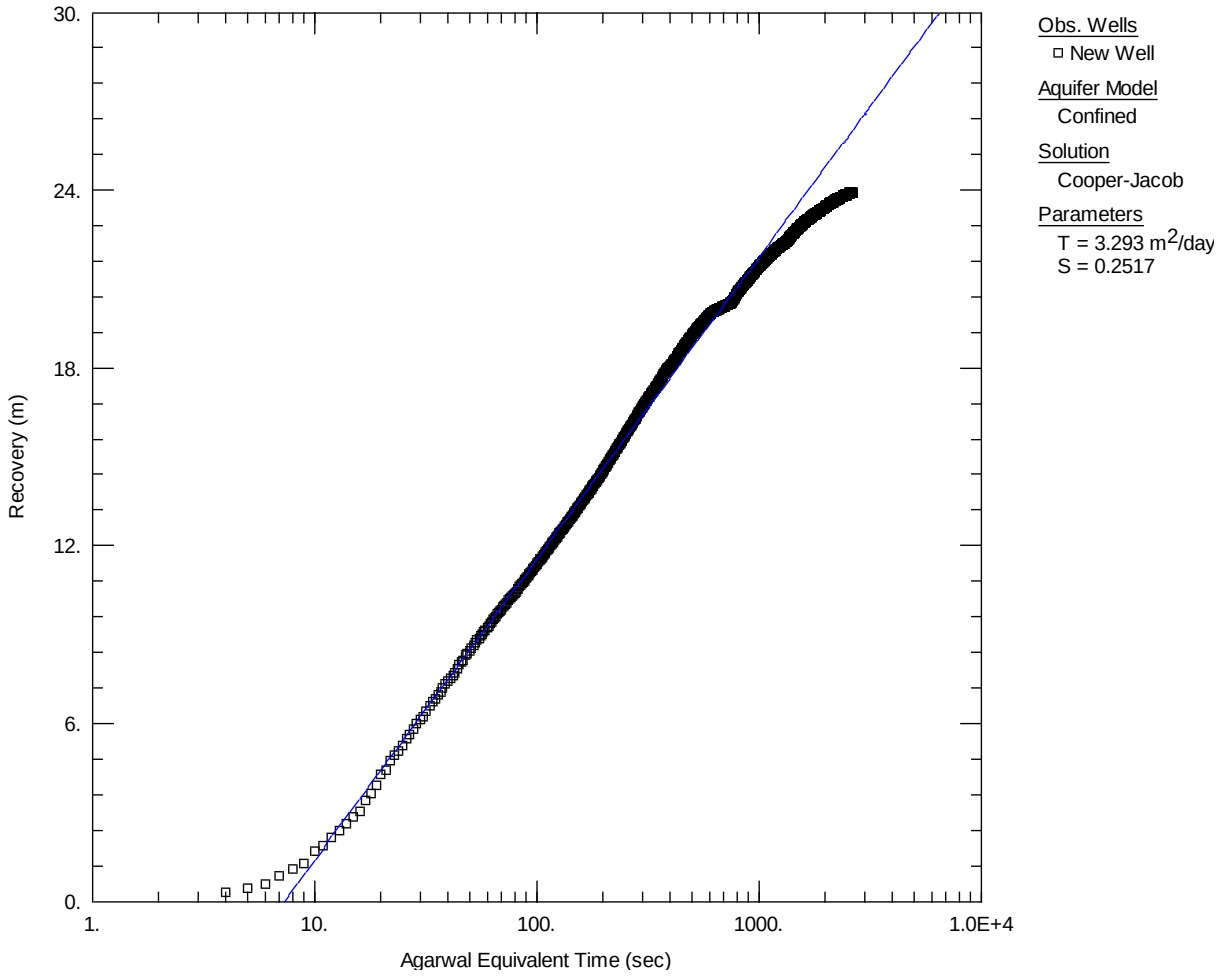


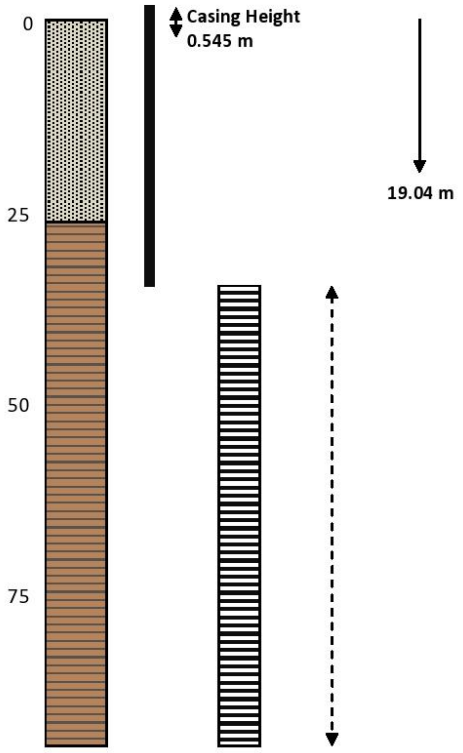
Figure A 3.12 Recovery data analysis for well 72_5503, resulting in $\boldsymbol{T = 3.29}$ m^2/day.

A3.6 HYDRAULIC TESTING DETAILS FOR WELL 72_4759

A3.6.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Screen Length (m)	Data Logger Depth (m)
72_4759	5774489	1792572	90	32.5	150	100	32.5 - 90	57.5	40

(m)	Core Log	Casing Depth	Screen Depth	Screen Length	Water Depth	Depth (m)	Dominant	Secondary	Notes



0	25	Clay		Good test that resulted in nice recovery data although very week submersible pump.
25	120	Mudstone		

Pumping test comments for 72_4759: A single well test was performed with both drawdown and recovery data collected on the 23/04/2015. The installed pump was not running for at least 12 hours prior to starting the hydraulic test. The pump was forced to run for 180 minutes: the pump rate varied between 0.19 and 0.16 L/s during the test. Subsequently, the pump was turned off and recovery measured for 210 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test.

A3.6.2 Data

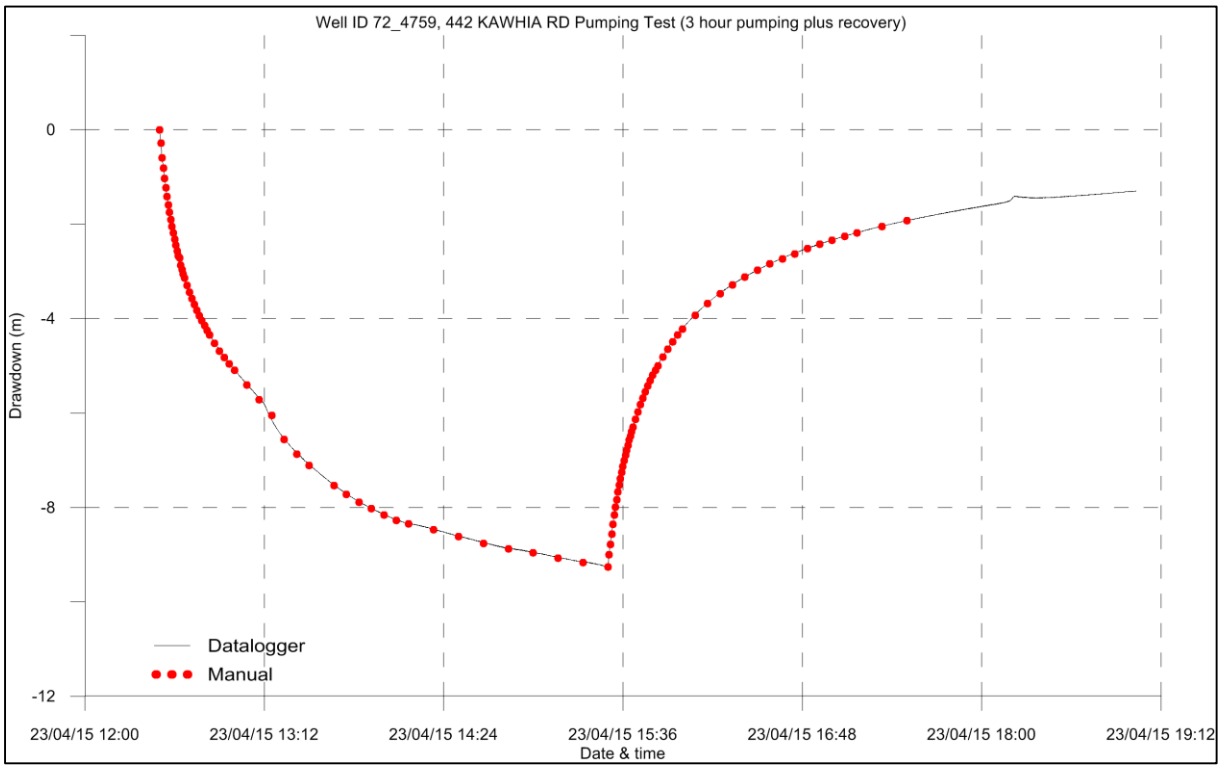


Figure A 3.13 Drawdown and recovery plot for well 72_4759.

Table A 3.6 Manual data recorded during hydraulic testing.

442 KAWHIA RD Pumping Test (3 hour pumping plus recovery) ***MANUAL DATA***						
Well Name/Site:	442 KAWHIA RD			**ID:**	72_4759	
Location:	E1792572 N5774489			**Well depth:**	90 m	
Elevation (gl):	≈ 50 m ASL			**Casing diam:**	150 mm	
Date:	23/04/2015			**Casing depth:**	32.5 m BGL	
Pump rate:	0.18 L/sec			**Elevation (MP):**	0.545 m	
Screen:	32.5 – 90 m BGL			**SWL:**	19.04 m BGL	
24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
23/04/2015 12:30:00	0		0	19.585	19.040	0.000
23/04/2015 12:30:30	0.5		0.5	19.870	19.325	0.285
23/04/2015 12:31:00	1		1	20.180	19.635	0.595
23/04/2015 12:31:30	1.5		1.5	20.400	19.855	0.815
23/04/2015 12:32:00	2		2	20.620	20.075	1.035
23/04/2015 12:32:30	2.5		2.5	20.820	20.275	1.235
23/04/2015 12:33:00	3		3	21.000	20.455	1.415
23/04/2015 12:33:30	3.5		3.5	21.180	20.635	1.595
23/04/2015 12:34:00	4		4	21.340	20.795	1.755
23/04/2015 12:34:30	4.5		4.5	21.495	20.950	1.910
23/04/2015 12:35:00	5		5	21.635	21.090	2.050

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
23/04/2015 12:35:30	5.5		5.5	21.775	21.230	2.190
23/04/2015 12:36:00	6		6	21.905	21.360	2.320
23/04/2015 12:36:30	6.5		6.5	22.030	21.485	2.445
23/04/2015 12:37:00	7		7	22.155	21.610	2.570
23/04/2015 12:37:30	7.5		7.5	22.260	21.715	2.675
23/04/2015 12:38:00	8		8	22.300	21.755	2.715
23/04/2015 12:38:30	8.5		8.5	22.460	21.915	2.875
23/04/2015 12:39:00	9		9	22.555	22.010	2.970
23/04/2015 12:39:30	9.5		9.5	22.645	22.100	3.060
23/04/2015 12:40:00	10		10	22.725	22.180	3.140
23/04/2015 12:41:00	11		11	22.885	22.340	3.300
23/04/2015 12:42:00	12		12	23.030	22.485	3.445
23/04/2015 12:43:00	13		13	23.165	22.620	3.580
23/04/2015 12:44:00	14		14	23.291	22.746	3.706
23/04/2015 12:45:00	15		15	23.415	22.870	3.830
23/04/2015 12:46:00	16		16	23.525	22.980	3.940
23/04/2015 12:47:00	17		17	23.630	23.085	4.045
23/04/2015 12:48:00	18		18	23.735	23.190	4.150
23/04/2015 12:49:00	19		19	23.835	23.290	4.250
23/04/2015 12:50:00	20		20	23.930	23.385	4.345
23/04/2015 12:52:00	22		22	24.105	23.560	4.520
23/04/2015 12:54:00	24		24	24.275	23.730	4.690
23/04/2015 12:56:00	26		26	24.415	23.870	4.830
23/04/2015 12:58:00	28		28	24.550	24.005	4.965
23/04/2015 13:00:00	30		30	24.680	24.135	5.095
23/04/2015 13:05:00	35		35	24.990	24.445	5.405
23/04/2015 13:10:00	40		40	25.300	24.755	5.715
23/04/2015 13:15:00	45		45	25.640	25.095	6.055
23/04/2015 13:20:00	50		50	26.145	25.600	6.560
23/04/2015 13:25:00	55		55	26.455	25.910	6.870
23/04/2015 13:30:00	60		60	26.700	26.155	7.115
23/04/2015 13:40:00	70		70	27.125	26.580	7.540
23/04/2015 13:45:00	75		75	27.315	26.770	7.730
23/04/2015 13:50:00	80		80	27.475	26.930	7.890
23/04/2015 13:55:00	85		85	27.616	27.071	8.031
23/04/2015 14:00:00	90		90	27.746	27.201	8.161
23/04/2015 14:05:00	95		95	27.857	27.312	8.272
23/04/2015 14:10:00	100		100	27.936	27.391	8.351
23/04/2015 14:20:00	110		110	28.058	27.513	8.473
23/04/2015 14:30:00	120		120	28.208	27.663	8.623
23/04/2015 14:40:00	130		130	28.345	27.800	8.760
23/04/2015 14:50:00	140		140	28.467	27.922	8.882
23/04/2015 15:00:00	150		150	28.548	28.003	8.963
23/04/2015 15:10:00	160		160	28.661	28.116	9.076
23/04/2015 15:20:00	170		170	28.755	28.210	9.170
23/04/2015 15:30:00	180	0	180	28.850	28.305	9.265
23/04/2015 15:30:30		0.5	180.5	28.590	28.045	9.005
23/04/2015 15:31:00		1	181	28.365	27.820	8.780
23/04/2015 15:31:30		1.5	181.5	28.150	27.605	8.565
23/04/2015 15:32:00		2	182	27.942	27.397	8.357
23/04/2015 15:32:30		2.5	182.5	27.750	27.205	8.165
23/04/2015 15:33:00		3	183	27.580	27.035	7.995
23/04/2015 15:33:30		3.5	183.5	27.420	26.875	7.835

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
23/04/2015 15:34:00		4	184	27.260	26.715	7.675
23/04/2015 15:34:30		4.5	184.5	27.115	26.570	7.530
23/04/2015 15:35:00		5	185	26.980	26.435	7.395
23/04/2015 15:35:30		5.5	185.5	26.840	26.295	7.255
23/04/2015 15:36:00		6	186	26.720	26.175	7.135
23/04/2015 15:36:30		6.5	186.5	26.590	26.045	7.005
23/04/2015 15:37:00		7	187	26.480	25.935	6.895
23/04/2015 15:37:30		7.5	187.5	26.375	25.830	6.790
23/04/2015 15:38:00		8	188	26.275	25.730	6.690
23/04/2015 15:38:30		8.5	188.5	26.160	25.615	6.575
23/04/2015 15:39:00		9	189	26.070	25.525	6.485
23/04/2015 15:39:30		9.5	189.5	25.975	25.430	6.390
23/04/2015 15:40:00		10	190	25.885	25.340	6.300
23/04/2015 15:41:00		11	191	25.720	25.175	6.135
23/04/2015 15:42:00		12	192	25.560	25.015	5.975
23/04/2015 15:43:00		13	193	25.410	24.865	5.825
23/04/2015 15:44:00		14	194	25.270	24.725	5.685
23/04/2015 15:45:00		15	195	25.140	24.595	5.555
23/04/2015 15:46:00		16	196	25.015	24.470	5.430
23/04/2015 15:47:00		17	197	24.900	24.355	5.315
23/04/2015 15:48:00		18	198	24.790	24.245	5.205
23/04/2015 15:49:00		19	199	24.685	24.140	5.100
23/04/2015 15:50:00		20	200	24.585	24.040	5.000
23/04/2015 15:52:00		22	202	24.400	23.855	4.815
23/04/2015 15:54:00		24	204	24.235	23.690	4.650
23/04/2015 15:56:00		26	206	24.075	23.530	4.490
23/04/2015 15:58:00		28	208	23.935	23.390	4.350
23/04/2015 16:00:00		30	210	23.805	23.260	4.220
23/04/2015 16:05:00		35	215	23.515	22.970	3.930
23/04/2015 16:10:00		40	220	23.270	22.725	3.685
23/04/2015 16:15:00		45	225	23.055	22.510	3.470
23/04/2015 16:20:00		50	230	22.870	22.325	3.285
23/04/2015 16:25:00		55	235	22.710	22.165	3.125
23/04/2015 16:30:00		60	240	22.565	22.020	2.980
23/04/2015 16:35:00		65	245	22.430	21.885	2.845
23/04/2015 16:40:00		70	250	22.320	21.775	2.735
23/04/2015 16:45:00		75	255	22.215	21.670	2.630
23/04/2015 16:50:00		80	260	22.105	21.560	2.520
23/04/2015 16:55:00		85	265	22.015	21.470	2.430
23/04/2015 17:00:00		90	270	21.925	21.380	2.340
23/04/2015 17:05:00		95	275	21.845	21.300	2.260
23/04/2015 17:10:00		100	280	21.768	21.223	2.183
23/04/2015 17:20:00		110	290	21.633	21.088	2.048
23/04/2015 17:30:00		120	300	21.517	20.972	1.932

A3.6.3 Analysis

The recovery data analysis for well 72_4759 is presented in Figure A 3.14, which results in a transmissivity estimate of $T = 0.56$ m^2/day. For conversion to hydraulic conductivity, the screen length has been used $b = 57.5$ m. As such, $K = 0.01$ m/day or $K = 1.1 \times 10^{-7}$ m/sec. This is consistent with theoretical values for fractured hard rock (8×10^{-9} to 3×10^{-4} m/sec), indicating as expected that water is drawn from fractured mudstone.

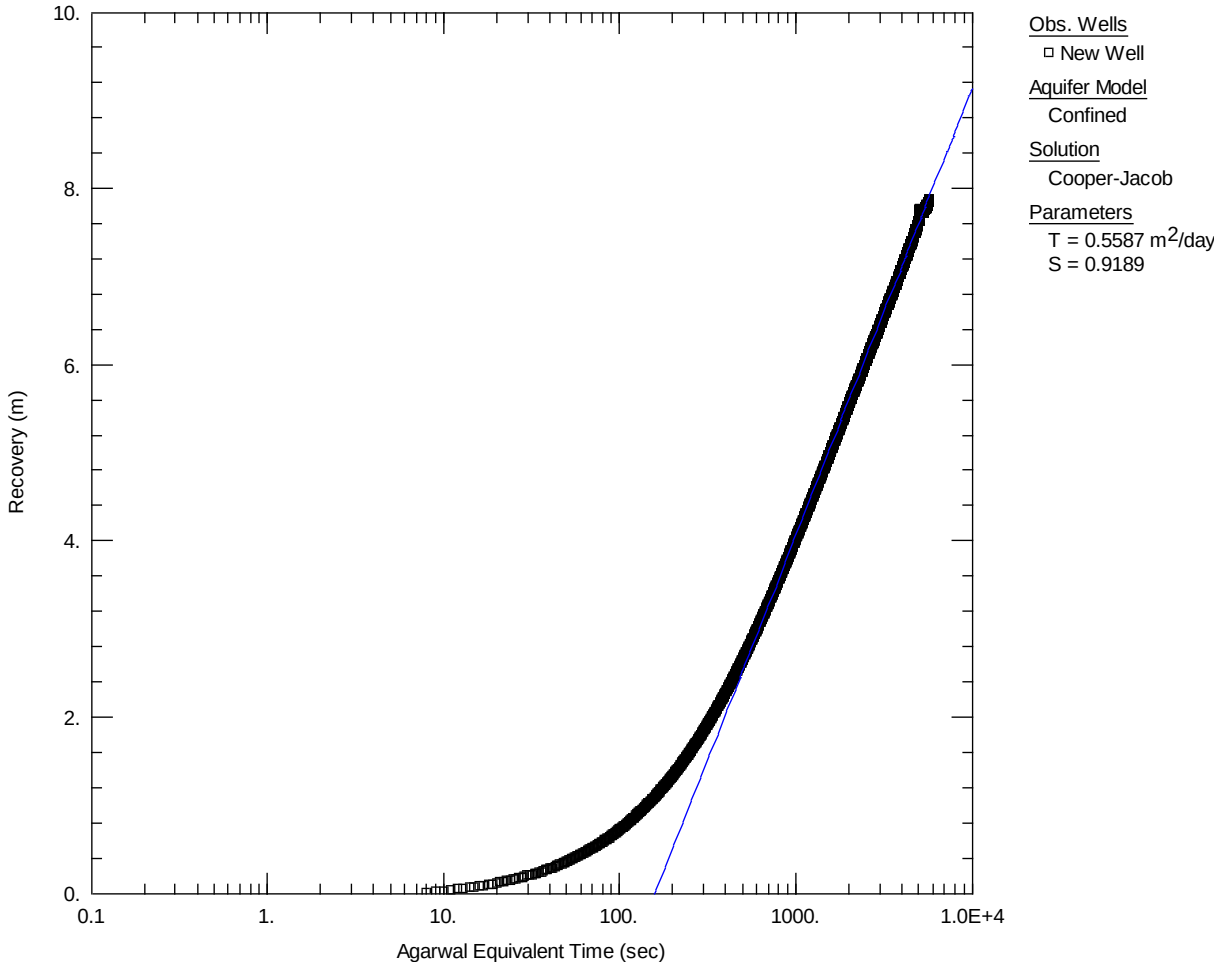
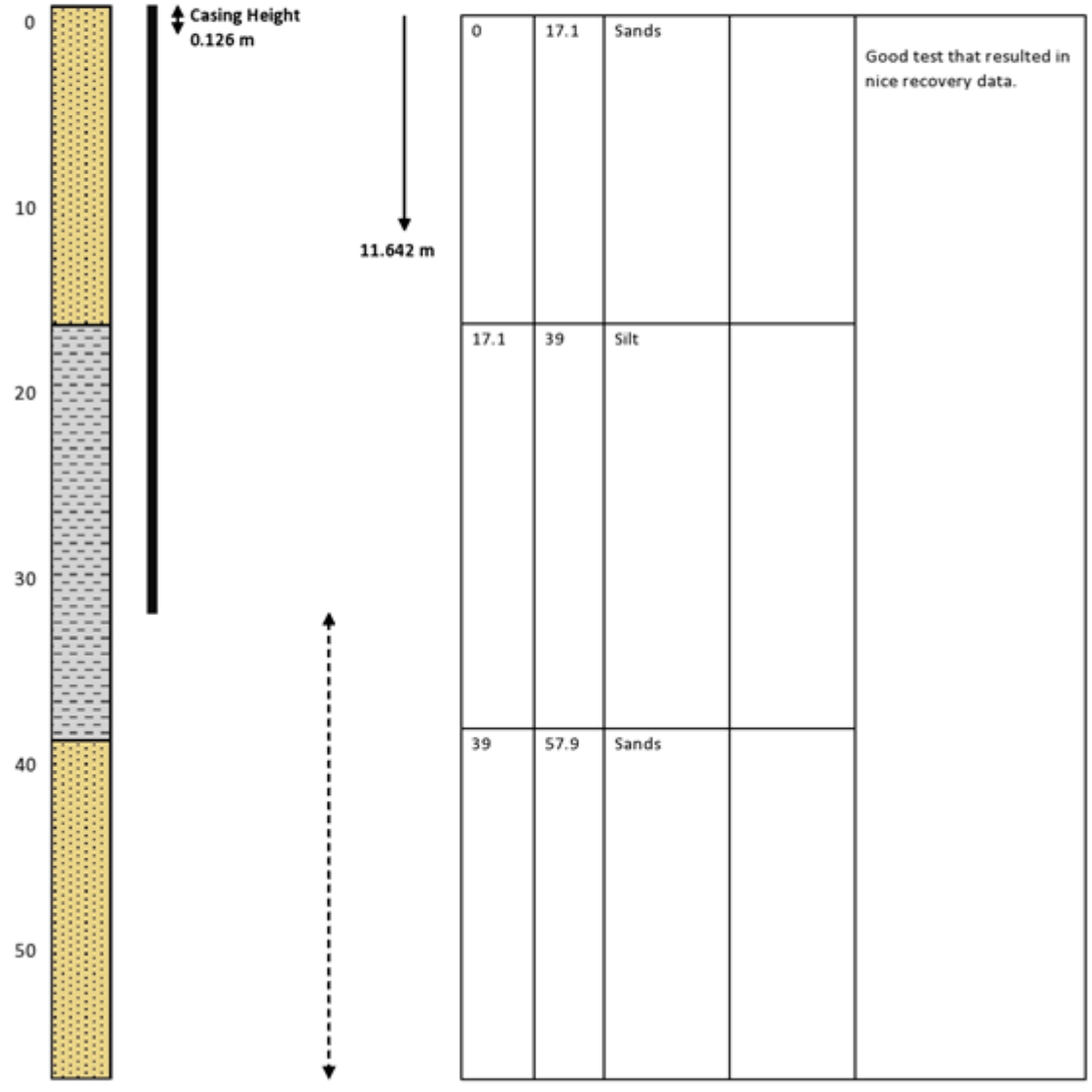


Figure A 3.14 Recovery data analysis for well 72_4759, resulting in $\boldsymbol{T = 0.56}$ m^2/day.

A3.7 HYDRAULIC TESTING DETAILS FOR WELL 70_632

A3.7.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Screen Length (m)	Data Logger Depth (m)
70_632	5799435	1793413	57.9	32.3	N/A	N/A	N/A	25.6	21.5



Pumping test comments for 70_632: A single well test was performed with both drawdown and recovery data collected on the 10/04/2015. The installed pump was not running for at least 12 hours prior to starting the hydraulic test. The pump was forced to run for 250 minutes: the pump rate dropped from 0.64 L/s initially to 0.58 L/s after three hours. Subsequently, the pump was turned off and recovery measured for 170 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test.

A3.7.2 Data

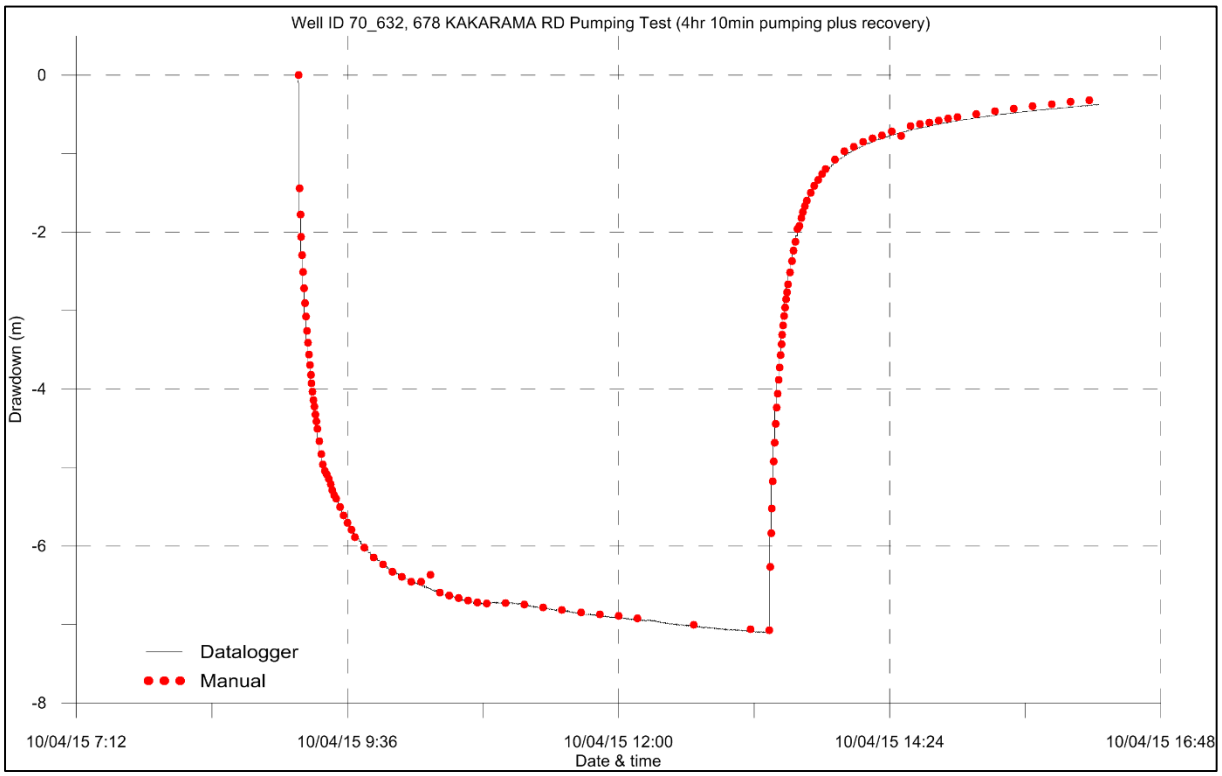


Figure A 3.15 Drawdown and recovery plot for well 70_632.

Table A 3.7 Manual data recorded during hydraulic testing.

678 KAKARAMA RD Pumping Test (4 hours 10 minutes pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	678 KAKARAMA RD	**ID:**	70_632
Location:	E1793412.679 N5799435.095	**Well depth:**	57 m
Elevation (gl):	40.499 m ASL	**Casing diam:**	100 mm
Date:	10/04/2015	**Casing depth:**	32.3 m BGL
Pump rate:	0.630 L/sec	**Elevation (MP):**	0.126 m
Screen:	32.3 – 57 m BGL	**SWL:**	11.642

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
10/04/2015 09:10:00	0		0	11.768	11.642	0.000
10/04/2015 09:10:30	0.5		0.5	13.210	13.084	1.442
10/04/2015 09:11:00	1		1	13.546	13.420	1.778
10/04/2015 09:11:30	1.5		1.5	13.832	13.706	2.064
10/04/2015 09:12:00	2		2	14.062	13.936	2.294
10/04/2015 09:12:30	2.5		2.5	14.279	14.153	2.511
10/04/2015 09:13:00	3		3	14.487	14.361	2.719
10/04/2015 09:13:30	3.5		3.5	14.672	14.546	2.904
10/04/2015 09:14:00	4		4	14.843	14.717	3.075
10/04/2015 09:14:30	4.5		4.5	15.025	14.899	3.257
10/04/2015 09:15:00	5		5	15.178	15.052	3.410
10/04/2015 09:15:30	5.5		5.5	15.330	15.204	3.562
10/04/2015 09:16:00	6		6	15.464	15.338	3.696
24 Hour Pumping Test				**PERMANENT WELL**		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
10/04/2015 09:16:30	6.5		6.5	15.591	15.465	3.823
10/04/2015 09:17:00	7		7	15.697	15.571	3.929
10/04/2015 09:17:30	7.5		7.5	15.804	15.678	4.036
10/04/2015 09:18:00	8		8	15.908	15.782	4.140
10/04/2015 09:18:30	8.5		8.5	15.994	15.868	4.226
10/04/2015 09:19:00	9		9	16.096	15.970	4.328
10/04/2015 09:19:30	9.5		9.5	16.184	16.058	4.416
10/04/2015 09:20:00	10		10	16.275	16.149	4.507
10/04/2015 09:21:00	11		11	16.432	16.306	4.664
10/04/2015 09:22:00	12		12	16.595	16.469	4.827
10/04/2015 09:23:00	13		13	16.731	16.605	4.963
10/04/2015 09:24:00	14		14	16.815	16.689	5.047
10/04/2015 09:25:00	15		15	16.857	16.731	5.089
10/04/2015 09:26:00	16		16	16.911	16.785	5.143
10/04/2015 09:27:00	17		17	16.980	16.854	5.212
10/04/2015 09:28:00	18		18	17.055	16.929	5.287
10/04/2015 09:29:00	19		19	17.122	16.996	5.354
10/04/2015 09:30:00	20		20	17.167	17.041	5.399
10/04/2015 09:32:00	22		22	17.275	17.149	5.507
10/04/2015 09:34:00	24		24	17.378	17.252	5.610
10/04/2015 09:36:00	26		26	17.476	17.350	5.708
10/04/2015 09:38:00	28		28	17.562	17.436	5.794
10/04/2015 09:40:00	30		30	17.657	17.531	5.889
10/04/2015 09:45:00	35		35	17.791	17.665	6.023
10/04/2015 09:50:00	40		40	17.916	17.790	6.148
10/04/2015 09:55:00	45		45	18.006	17.880	6.238
10/04/2015 10:00:00	50		50	18.096	17.970	6.328
10/04/2015 10:05:00	55		55	18.164	18.038	6.396
10/04/2015 10:10:00	60		60	18.223	18.097	6.455
10/04/2015 10:15:00	65		65	18.226	18.100	6.458
10/04/2015 10:20:00	70		70	18.135	18.009	6.367
10/04/2015 10:25:00	75		75	18.364	18.238	6.596
10/04/2015 10:30:00	80		80	18.403	18.277	6.635
10/04/2015 10:35:00	85		85	18.435	18.309	6.667
10/04/2015 10:40:00	90		90	18.466	18.340	6.698
10/04/2015 10:45:00	95		95	18.487	18.361	6.719
10/04/2015 10:50:00	100		100	18.504	18.378	6.736
10/04/2015 11:00:00	110		110	18.494	18.368	6.726
10/04/2015 11:10:00	120		120	18.517	18.391	6.749
10/04/2015 11:20:00	130		130	18.554	18.428	6.786
10/04/2015 11:30:00	140		140	18.583	18.457	6.815
10/04/2015 11:40:00	150		150	18.617	18.491	6.849
10/04/2015 11:50:00	160		160	18.640	18.514	6.872
10/04/2015 12:00:00	170		170	18.660	18.534	6.892
10/04/2015 12:10:00	180		180	18.689	18.563	6.921
10/04/2015 12:40:00	210		210	18.770	18.644	7.002
10/04/2015 13:10:00	240		240	18.832	18.706	7.064
10/04/2015 13:20:00	250	0	250	18.840	18.714	7.072
10/04/2015 13:20:30		0.5	250.5	18.036	17.910	6.268
10/04/2015 13:21:00		1	251	17.606	17.480	5.838
10/04/2015 13:21:30		1.5	251.5	17.291	17.165	5.523
10/04/2015 13:22:00		2	252	16.943	16.817	5.175
10/04/2015 13:22:30		2.5	252.5	16.694	16.568	4.926

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
10/04/2015 13:23:00		3	253	16.452	16.326	4.684
10/04/2015 13:23:30		3.5	253.5	16.210	16.084	4.442
10/04/2015 13:24:00		4	254	16.004	15.878	4.236
10/04/2015 13:24:30		4.5	254.5	15.826	15.700	4.058
10/04/2015 13:25:00		5	255	15.650	15.524	3.882
10/04/2015 13:25:30		5.5	255.5	15.492	15.366	3.724
10/04/2015 13:26:00		6	256	15.336	15.210	3.568
10/04/2015 13:26:30		6.5	256.5	15.200	15.074	3.432
10/04/2015 13:27:00		7	257	15.077	14.951	3.309
10/04/2015 13:27:30		7.5	257.5	14.956	14.830	3.188
10/04/2015 13:28:00		8	258	14.840	14.714	3.072
10/04/2015 13:28:30		8.5	258.5	14.731	14.605	2.963
10/04/2015 13:29:00		9	259	14.622	14.496	2.854
10/04/2015 13:29:30		9.5	259.5	14.537	14.411	2.769
10/04/2015 13:30:00		10	260	14.432	14.306	2.664
10/04/2015 13:31:00		11	261	14.282	14.156	2.514
10/04/2015 13:32:00		12	262	14.137	14.011	2.369
10/04/2015 13:33:00		13	263	14.006	13.880	2.238
10/04/2015 13:34:00		14	264	13.894	13.768	2.126
10/04/2015 13:35:00		15	265	13.731	13.605	1.963
10/04/2015 13:36:00		16	266	13.691	13.565	1.923
10/04/2015 13:37:00		17	267	13.587	13.461	1.819
10/04/2015 13:38:00		18	268	13.512	13.386	1.744
10/04/2015 13:39:00		19	269	13.436	13.310	1.668
10/04/2015 13:40:00		20	270	13.372	13.246	1.604
10/04/2015 13:42:00		22	272	13.270	13.144	1.502
10/04/2015 13:44:00		24	274	13.178	13.052	1.410
10/04/2015 13:46:00		26	276	13.104	12.978	1.336
10/04/2015 13:48:00		28	278	13.027	12.901	1.259
10/04/2015 13:50:00		30	280	12.965	12.839	1.197
10/04/2015 13:55:00		35	285	12.844	12.718	1.076
10/04/2015 14:00:00		40	290	12.740	12.614	0.972
10/04/2015 14:05:00		45	295	12.680	12.554	0.912
10/04/2015 14:10:00		50	300	12.621	12.495	0.853
10/04/2015 14:15:00		55	305	12.575	12.449	0.807
10/04/2015 14:20:00		60	310	12.534	12.408	0.766
10/04/2015 14:25:00		65	315	12.487	12.361	0.719
10/04/2015 14:30:00		70	320	12.542	12.416	0.774
10/04/2015 14:35:00		75	325	12.416	12.290	0.648
10/04/2015 14:40:00		80	330	12.390	12.264	0.622
10/04/2015 14:45:00		85	335	12.370	12.244	0.602
10/04/2015 14:50:00		90	340	12.346	12.220	0.578
10/04/2015 14:55:00		95	345	12.324	12.198	0.556
10/04/2015 15:00:00		100	350	12.303	12.177	0.535
10/04/2015 15:10:00		110	360	12.264	12.138	0.496
10/04/2015 15:20:00		120	370	12.229	12.103	0.461
10/04/2015 15:30:00		130	380	12.197	12.071	0.429
10/04/2015 15:40:00		140	390	12.168	12.042	0.400
10/04/2015 15:50:00		150	400	12.140	12.014	0.372
10/04/2015 16:00:00		160	410	12.111	11.985	0.343
10/04/2015 16:10:00		170	420	12.088	11.962	0.320

A3.7.3 Analysis

The recovery data analysis for well 70_632 is presented in Figure A 3.16, which results in a transmissivity estimate of $T = 2.38$ m^2/day. For conversion to hydraulic conductivity, the screen length has been used $b = 25.6$ m. As such, $K = 0.09$ m/day or $K = 1.1 \times 10^{-6}$ m/sec. When compared to theoretical values, this is consistent with fine, medium or coarse sand (2×10^{-7} to $2 \times 10^{-4}, 9 \times 10^{-7}$to $5 \times 10^{-4}, 9 \times 10^{-7}$to 6×10^{-3} m/sec). This is consistent with the screened lithology of mostly sand, with a portion of silt.

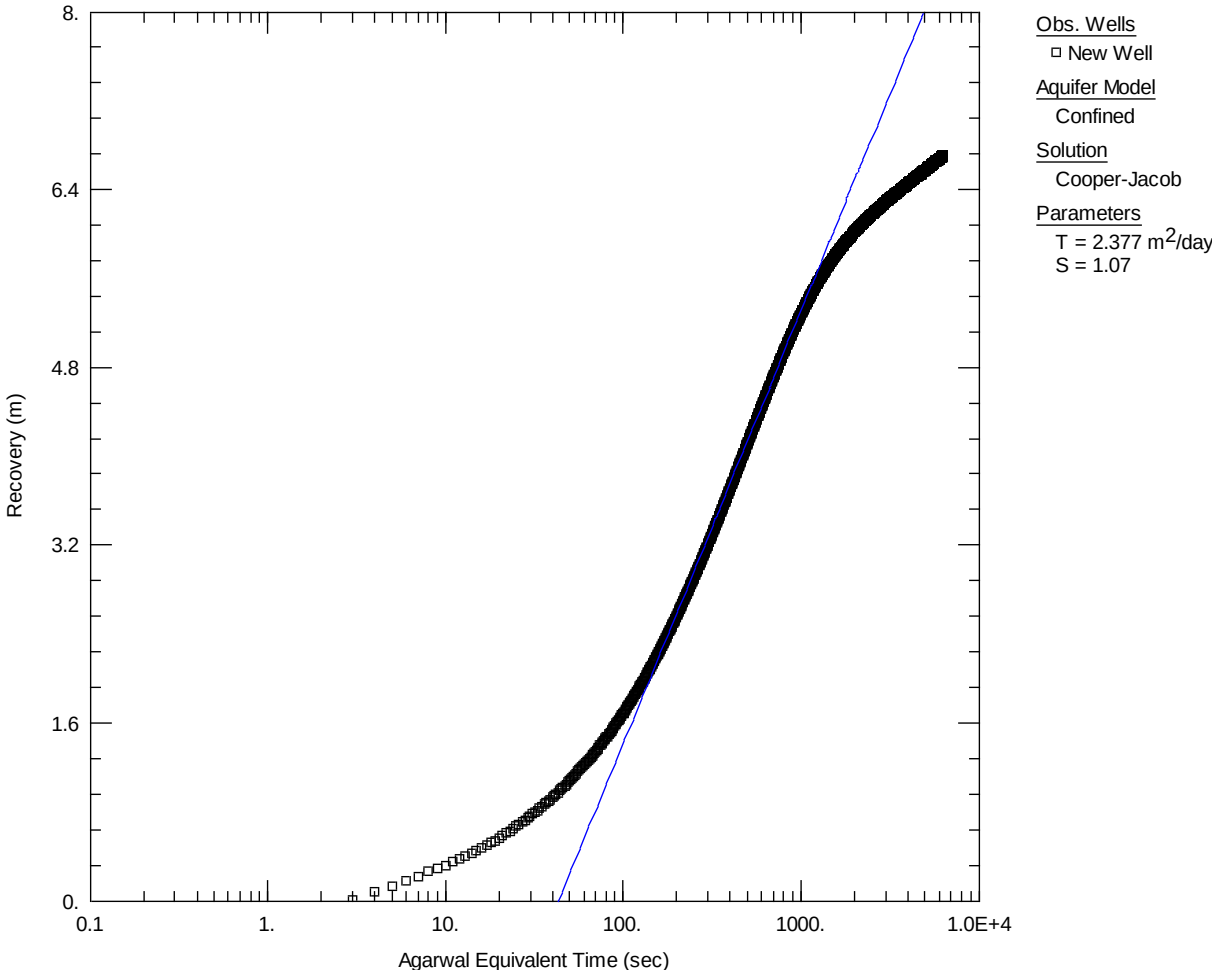
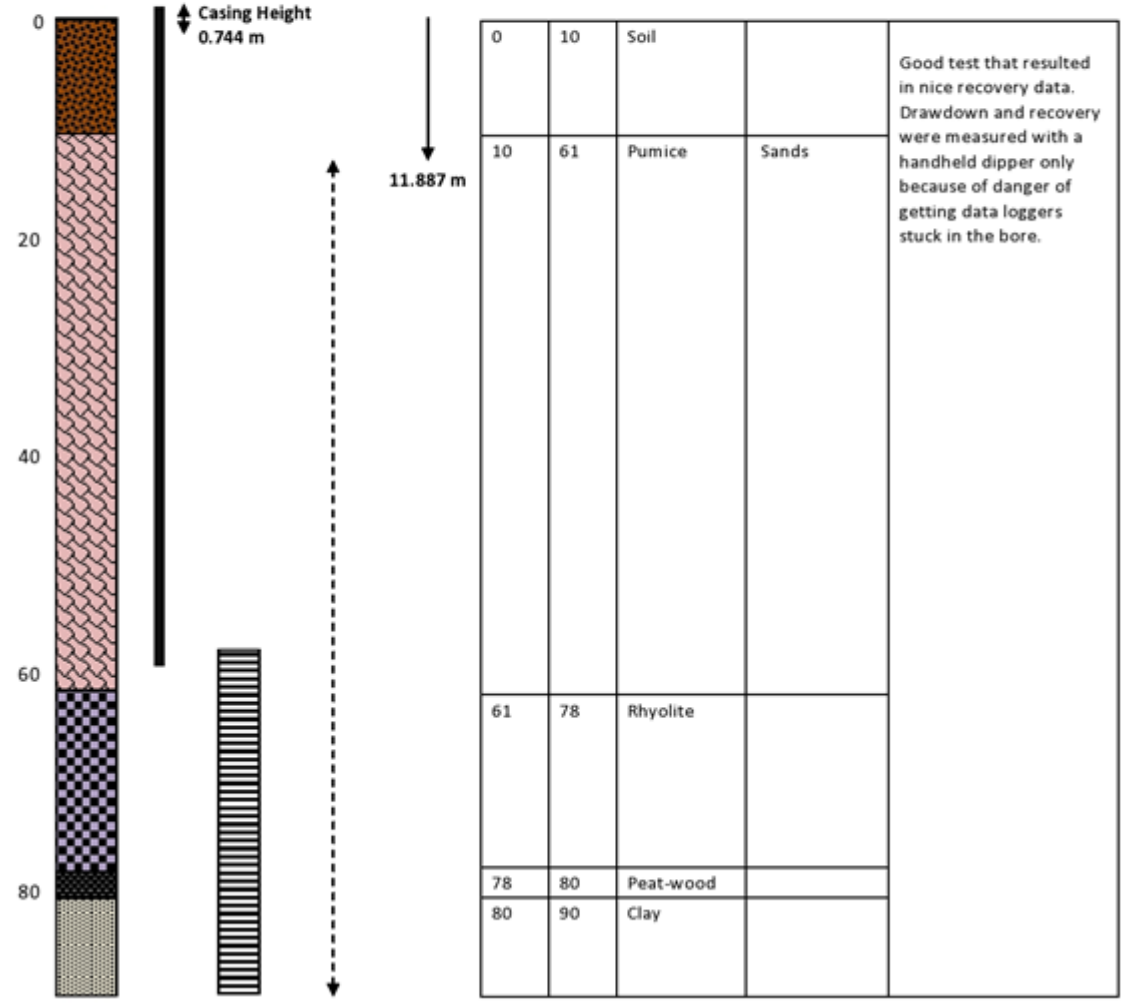


Figure A 3.16 Recovery data analysis for well 72_632, resulting in $\boldsymbol{T = 2.38}$ m^2/day.

A3.8 HYDRAULIC TESTING DETAILS FOR WELL 72_5300

A3.8.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Saturated Thickness (m)	Data Logger Depth (m)
72_5300	5767877	1813323	88	58.5	100	80	58 - 88	76.113	N/A



Pumping test comments for 72_5300: A single well test was performed with both drawdown and recovery data collected on the 22/04/2015. The installed pump was not running for at least 12 hours prior to starting the hydraulic test. The pump was forced to run for 160 minutes and the pump rate stayed constant between 2.0 L/s and 2.2 L/s during the test. Subsequently, the pump was turned off and recovery measured for 500 minutes. Only manual measurements were recorded during the test, due to a high risk of getting data loggers stuck in the bore.

A3.8.2 Data

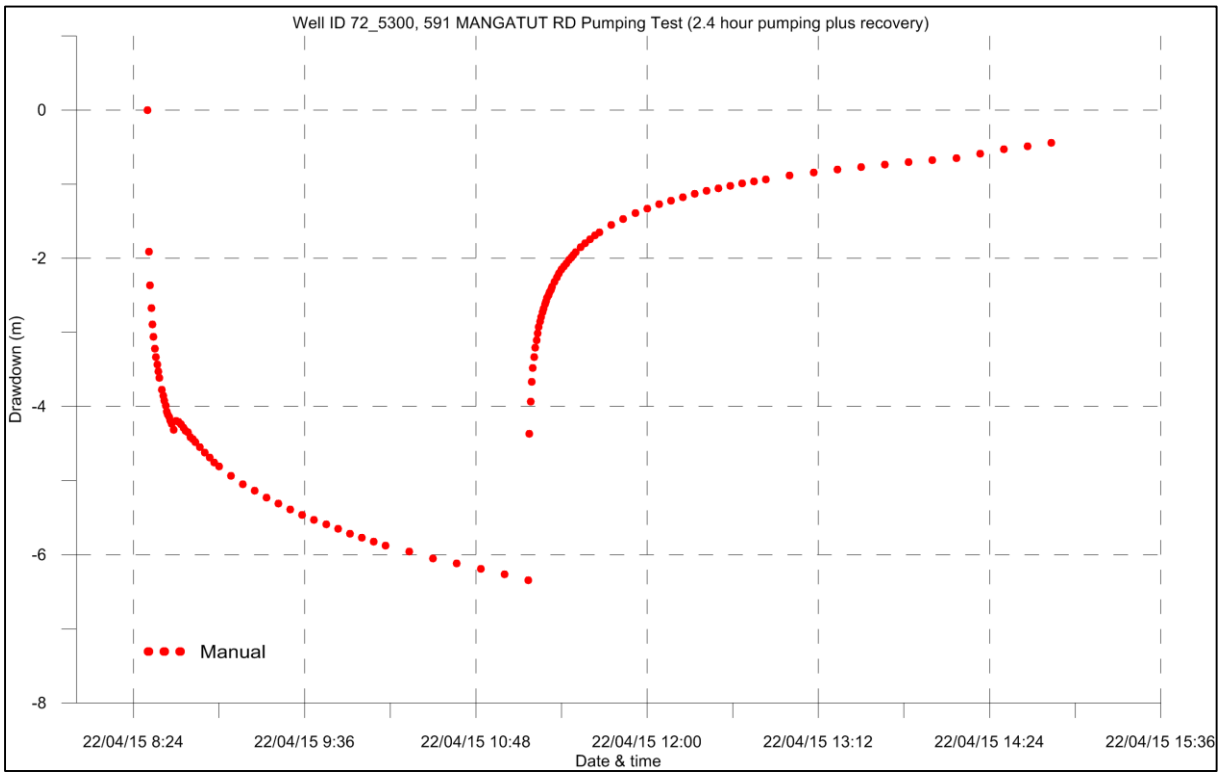


Figure A 3.17 Drawdown and recovery plot for well 72_5300.

Table A 3.8 Manual data recorded during hydraulic testing.

591 MANGATUT RD Pumping Test (2.4 hours pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	591 MANGATUT RD	**ID:**	72_5300
Location:	E1813323 N5767877	**Well depth:**	88 m
Elevation (gl):	≈ 170 m ASL	**Casing diam:**	100 mm
Date:	22/04/2015	**Casing depth:**	58.5 N/A
Pump rate:	2.04 L/sec	**Elevation (MP):**	0.744 m
Screen:	58 – 88 m BGL	**SWL:**	11.887 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
22/04/2015 08:30:00	0		0	12.631	11.887	0.000
22/04/2015 08:30:30	0.5		0.5	14.544	13.800	1.913
22/04/2015 08:31:00	1		1	14.995	14.251	2.364
22/04/2015 08:31:30	1.5		1.5	15.302	14.558	2.671
22/04/2015 08:32:00	2		2	15.527	14.783	2.896
22/04/2015 08:32:30	2.5		2.5	15.694	14.950	3.063
22/04/2015 08:33:00	3		3	15.855	15.111	3.224
22/04/2015 08:33:30	3.5		3.5	15.964	15.220	3.333
22/04/2015 08:34:00	4		4	16.067	15.323	3.436
22/04/2015 08:34:30	4.5		4.5	16.158	15.414	3.527
22/04/2015 08:35:00	5		5	16.248	15.504	3.617
22/04/2015 08:36:00	6		6	16.405	15.661	3.774
22/04/2015 08:36:30	6.5		6.5	16.489	15.745	3.858

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
22/04/2015 08:37:00	7		7	16.550	15.806	3.919
22/04/2015 08:37:30	7.5		7.5	16.618	15.874	3.987
22/04/2015 08:38:00	8		8	16.697	15.953	4.066
22/04/2015 08:38:30	8.5		8.5	16.743	15.999	4.112
22/04/2015 08:39:00	9		9	16.772	16.028	4.141
22/04/2015 08:39:30	9.5		9.5	16.819	16.075	4.188
22/04/2015 08:40:00	10		10	16.865	16.121	4.234
22/04/2015 08:41:00	11		11	16.950	16.206	4.319
22/04/2015 08:42:00	12		12	16.830	16.086	4.199
22/04/2015 08:43:00	13		13	16.841	16.097	4.210
22/04/2015 08:44:00	14		14	16.873	16.129	4.242
22/04/2015 08:45:00	15		15	16.922	16.178	4.291
22/04/2015 08:46:00	16		16	16.960	16.216	4.329
22/04/2015 08:47:00	17		17	16.982	16.238	4.351
22/04/2015 08:48:00	18		18	17.048	16.304	4.417
22/04/2015 08:49:00	19		19	17.076	16.332	4.445
22/04/2015 08:50:00	20		20	17.113	16.369	4.482
22/04/2015 08:52:00	22		22	17.180	16.436	4.549
22/04/2015 08:54:00	24		24	17.256	16.512	4.625
22/04/2015 08:56:00	26		26	17.323	16.579	4.692
22/04/2015 08:58:00	28		28	17.387	16.643	4.756
22/04/2015 09:00:00	30		30	17.440	16.696	4.809
22/04/2015 09:05:00	35		35	17.568	16.824	4.937
22/04/2015 09:10:00	40		40	17.684	16.940	5.053
22/04/2015 09:15:00	45		45	17.768	17.024	5.137
22/04/2015 09:20:00	50		50	17.864	17.120	5.233
22/04/2015 09:25:00	55		55	17.945	17.201	5.314
22/04/2015 09:30:00	60		60	18.019	17.275	5.388
22/04/2015 09:35:00	65		65	18.096	17.352	5.465
22/04/2015 09:40:00	70		70	18.160	17.416	5.529
22/04/2015 09:45:00	75		75	18.222	17.478	5.591
22/04/2015 09:50:00	80		80	18.285	17.541	5.654
22/04/2015 09:55:00	85		85	18.349	17.605	5.718
22/04/2015 10:00:00	90		90	18.400	17.656	5.769
22/04/2015 10:05:00	95		95	18.455	17.711	5.824
22/04/2015 10:10:00	100		100	18.511	17.767	5.880
22/04/2015 10:20:00	110		110	18.590	17.846	5.959
22/04/2015 10:30:00	120		120	18.683	17.939	6.052
22/04/2015 10:40:00	130		130	18.751	18.007	6.120
22/04/2015 10:50:00	140		140	18.825	18.081	6.194
22/04/2015 11:00:00	150		150	18.898	18.154	6.267
22/04/2015 11:10:00	160	0	160	18.978	18.234	6.347
22/04/2015 11:10:30		0.5	160.5	17.000	16.256	4.369
22/04/2015 11:11:00		1	161	16.566	15.822	3.935
22/04/2015 11:11:30		1.5	161.5	16.298	15.554	3.667
22/04/2015 11:12:00		2	162	16.112	15.368	3.481
22/04/2015 11:12:30		2.5	162.5	15.963	15.219	3.332
22/04/2015 11:13:00		3	163	15.838	15.094	3.207
22/04/2015 11:13:30		3.5	163.5	15.737	14.993	3.106
22/04/2015 11:14:00		4	164	15.642	14.898	3.011
22/04/2015 11:14:30		4.5	164.5	15.557	14.813	2.926
22/04/2015 11:15:00		5	165	15.483	14.739	2.852
22/04/2015 11:15:30		5.5	165.5	15.425	14.681	2.794

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
22/04/2015 11:16:00		6	166	15.357	14.613	2.726
22/04/2015 11:16:30		6.5	166.5	15.312	14.568	2.681
22/04/2015 11:17:00		7	167	15.254	14.510	2.623
22/04/2015 11:17:30		7.5	167.5	15.213	14.469	2.582
22/04/2015 11:18:00		8	168	15.166	14.422	2.535
22/04/2015 11:18:30		8.5	168.5	15.129	14.385	2.498
22/04/2015 11:19:00		9	169	15.093	14.349	2.462
22/04/2015 11:19:30		9.5	169.5	15.057	14.313	2.426
22/04/2015 11:20:00		10	170	15.016	14.272	2.385
22/04/2015 11:21:00		11	171	14.953	14.209	2.322
22/04/2015 11:22:00		12	172	14.891	14.147	2.260
22/04/2015 11:23:00		13	173	14.838	14.094	2.207
22/04/2015 11:24:00		14	174	14.785	14.041	2.154
22/04/2015 11:25:00		15	175	14.746	14.002	2.115
22/04/2015 11:26:00		16	176	14.703	13.959	2.072
22/04/2015 11:27:00		17	177	14.659	13.915	2.028
22/04/2015 11:28:00		18	178	14.622	13.878	1.991
22/04/2015 11:29:00		19	179	14.589	13.845	1.958
22/04/2015 11:30:00		20	180	14.547	13.803	1.916
22/04/2015 11:32:00		22	182	14.484	13.740	1.853
22/04/2015 11:34:00		24	184	14.430	13.686	1.799
22/04/2015 11:36:00		26	186	14.378	13.634	1.747
22/04/2015 11:38:00		28	188	14.324	13.580	1.693
22/04/2015 11:40:00		30	190	14.284	13.540	1.653
22/04/2015 11:45:00		35	195	14.184	13.440	1.553
22/04/2015 11:50:00		40	200	14.101	13.357	1.470
22/04/2015 11:55:00		45	205	14.025	13.281	1.394
22/04/2015 12:00:00		50	210	13.962	13.218	1.331
22/04/2015 12:05:00		55	215	13.904	13.160	1.273
22/04/2015 12:10:00		60	220	13.853	13.109	1.222
22/04/2015 12:15:00		65	225	13.807	13.063	1.176
22/04/2015 12:20:00		70	230	13.763	13.019	1.132
22/04/2015 12:25:00		75	235	13.725	12.981	1.094
22/04/2015 12:30:00		80	240	13.688	12.944	1.057
22/04/2015 12:35:00		85	245	13.653	12.909	1.022
22/04/2015 12:40:00		90	250	13.624	12.880	0.993
22/04/2015 12:45:00		95	255	13.594	12.850	0.963
22/04/2015 12:50:00		100	260	13.567	12.823	0.936
22/04/2015 13:00:00		110	270	13.518	12.774	0.887
22/04/2015 13:10:00		120	280	13.473	12.729	0.842
22/04/2015 13:20:00		130	290	13.437	12.693	0.806
22/04/2015 13:30:00		140	300	13.401	12.657	0.770
22/04/2015 13:40:00		150	310	13.367	12.623	0.736
22/04/2015 13:50:00		160	320	13.337	12.593	0.706
22/04/2015 14:00:00		170	330	13.311	12.567	0.680
22/04/2015 14:10:00		180	340	13.282	12.538	0.651
22/04/2015 14:20:00		210	370	13.222	12.478	0.591
22/04/2015 14:30:00		240	400	13.162	12.418	0.531
22/04/2015 14:40:00		270	430	13.120	12.376	0.489
22/04/2015 14:50:00		300	460	13.075	12.331	0.444

A3.8.3 Analysis

The recovery data analysis for well 72_5300 is presented in Figure A 3.18, which results in a transmissivity estimate of $T = 21.53$ m^2/day. This well is unconfined and therefore is likely to have bias towards an over-estimated transmissivity value. For conversion to hydraulic conductivity, the saturated thickness of the aquifer has been used $b = 76.1$ m. As such, $K = 0.28$ m/day or $K = 3.3 \times 10^{-6}$ m/sec. The screen here spans 'rhyolite' (interpreted as Pakaumanu ignimbrite), 'Peat-wood' and clay. Compared to theoretical values, this is consistent with the expected fractured igneous rock and fine, medium or coarse sand (8×10^{-9} to 3×10^{-4}, 2×10^{-7} to 2×10^{-4}, $9 \times 10^{-7}$to 5×10^{-4}, $9 \times 10^{-7}$to 6×10^{-3} m/sec).

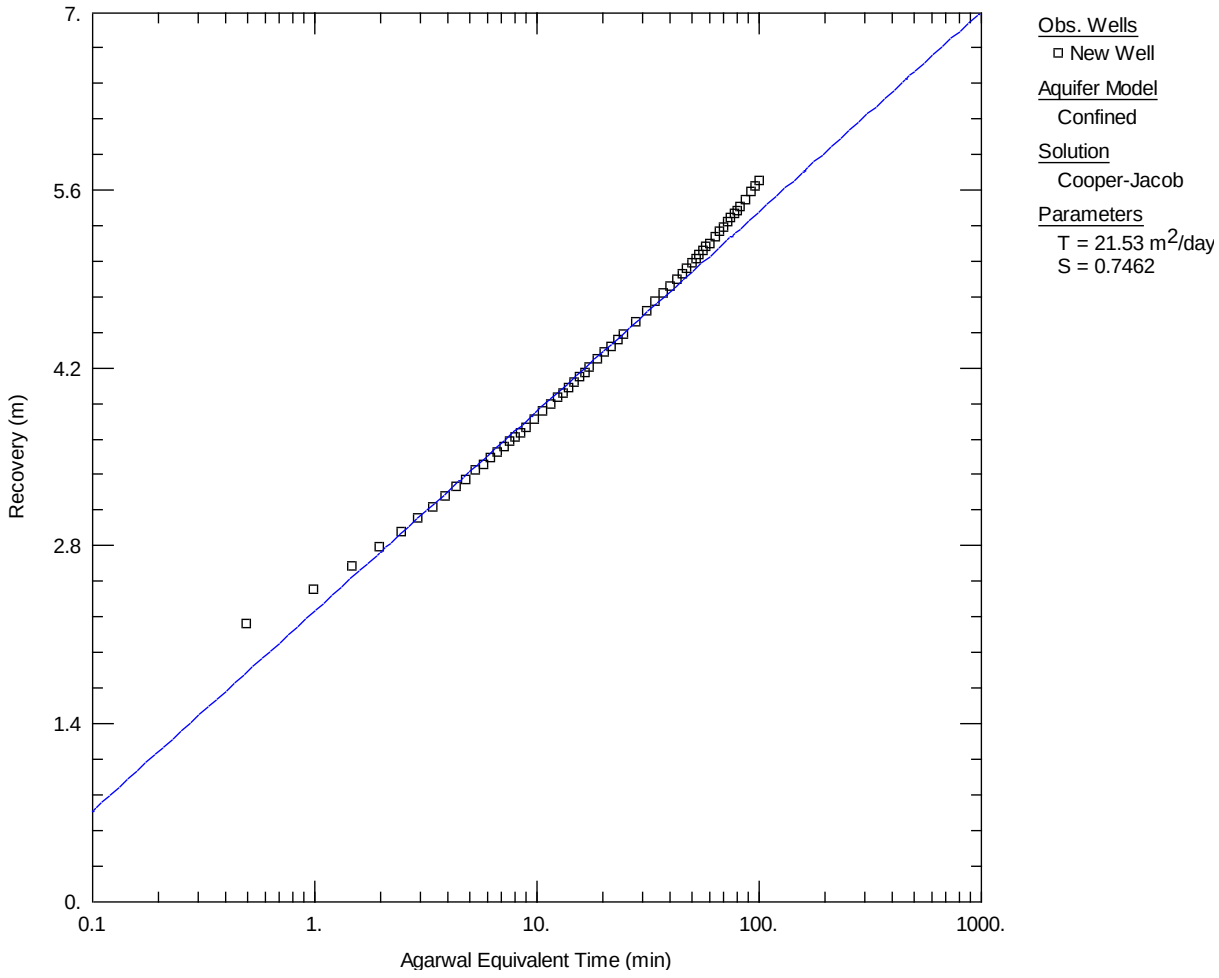
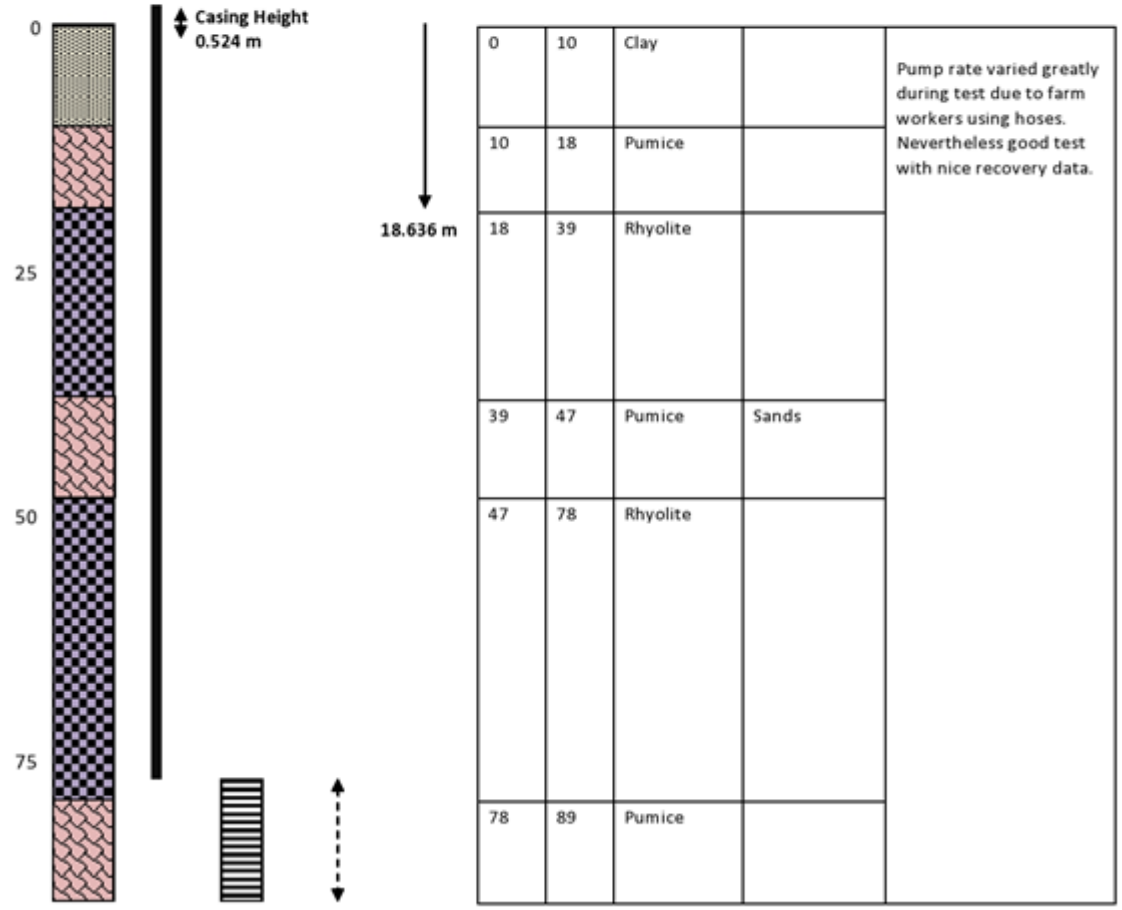


Figure A 3.18 Recovery data analysis for well 72_5300, resulting in $\boldsymbol{T = 21.53}$ m^2/day.

A3.9 HYDRAULIC TESTING DETAILS FOR WELL 72_5009

A3.9.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Screen Length (m)	Data Logger Depth (m)
72_5009	5760312	1813181	89	76.5	100	80	76.5 - 89	12.5	60



Pumping test comments for 72_5009: A single well test was performed with both drawdown and recovery data collected on the 24/04/2015. The installed pump was not running for only 4.5 hours prior to starting the hydraulic test and therefore the water level was not quite static at the beginning of test (the farmer forgot to turn the pump off the evening before as requested). The pump was forced to run for 50 minutes: the pump rate varied between 1.96 and 2.38 during the test due to farmers using various hoses in the cowshed. Subsequently, the pump was turned off and recovery measured for 60 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test.

A3.9.2 Data

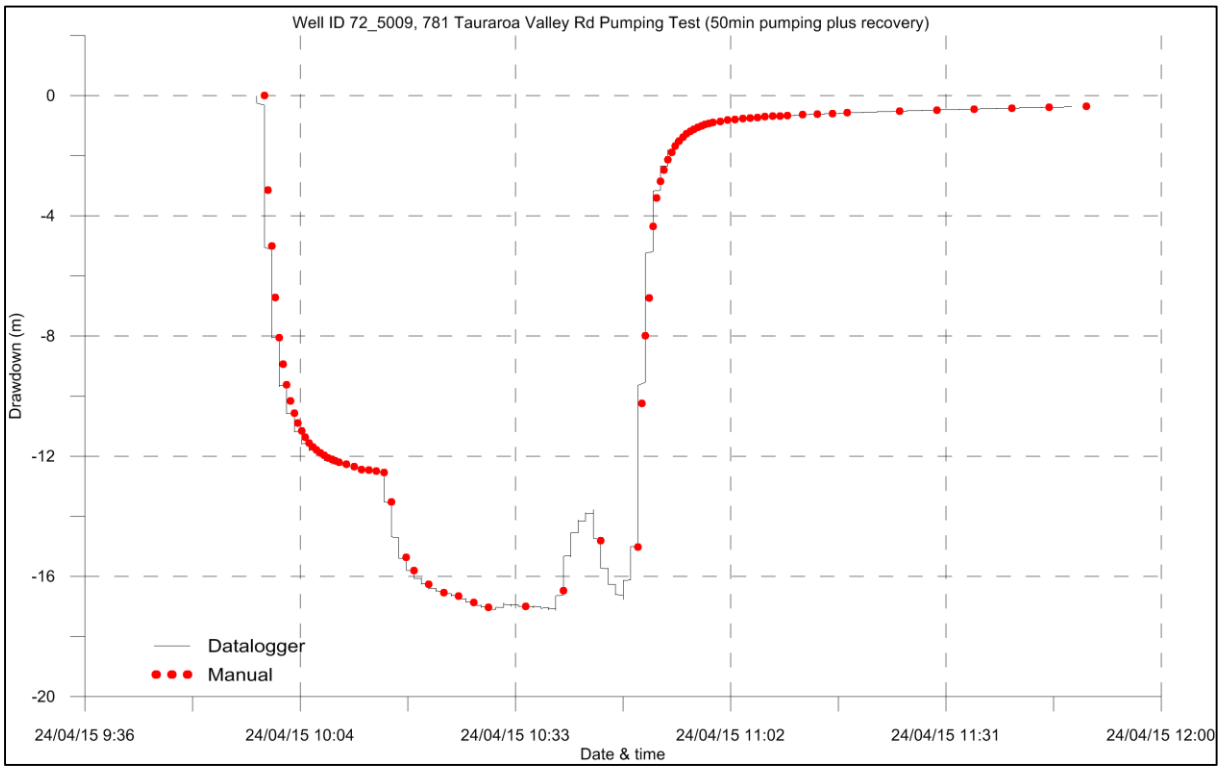


Figure A 3.19 Drawdown and recovery plot for well 72_5009.

Table A 3.9 Manual data recorded during hydraulic testing.

781 Tauraroa Valley Rd Pumping Test (50 minutes pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	781 Tauraroa Valley Rd	**ID:**	72_5009
Location:	E1812036 N5760170	**Well depth:**	89 m
Elevation (gl):	≈ 279 m ASL	**Casing diam:**	100 mm
Date:	24/04/2015	**Casing depth:**	76.5 m BGL
Pump rate:	2.151 L/sec	**Elevation (MP):**	0.524 m
Screen:	76.5 – 89.0 m BGL	**SWL:**	18.636 m BGL (rising at 0.2 m/hr)

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
24/04/2015 10:00:00	0		0	19.160	18.636	0.000
24/04/2015 10:00:30	0.5		0.5	22.300	21.776	3.140
24/04/2015 10:01:00	1		1	24.160	23.636	5.000
24/04/2015 10:01:30	1.5		1.5	25.880	25.356	6.720
24/04/2015 10:02:00	2		2	27.210	26.686	8.050
24/04/2015 10:02:30	2.5		2.5	28.100	27.576	8.940
24/04/2015 10:03:00	3		3	28.780	28.256	9.620
24/04/2015 10:03:30	3.5		3.5	29.320	28.796	10.160
24/04/2015 10:04:00	4		4	29.730	29.206	10.570
24/04/2015 10:04:30	4.5		4.5	30.060	29.536	10.900
24/04/2015 10:05:00	5		5	30.310	29.786	11.150
24/04/2015 10:05:30	5.5		5.5	30.530	30.006	11.370
24/04/2015 10:06:00	6		6	30.720	30.196	11.560
24 Hour Pumping Test				**PERMANENT WELL**		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
24/04/2015 10:06:30	6.5		6.5	30.850	30.326	11.690
24/04/2015 10:07:00	7		7	30.960	30.436	11.800
24/04/2015 10:07:30	7.5		7.5	31.060	30.536	11.900
24/04/2015 10:08:00	8		8	31.140	30.616	11.980
24/04/2015 10:08:30	8.5		8.5	31.210	30.686	12.050
24/04/2015 10:09:00	9		9	31.265	30.741	12.105
24/04/2015 10:09:30	9.5		9.5	31.315	30.791	12.155
24/04/2015 10:10:00	10		10	31.360	30.836	12.200
24/04/2015 10:11:00	11		11	31.430	30.906	12.270
24/04/2015 10:12:00	12		12	31.510	30.986	12.350
24/04/2015 10:13:00	13		13	31.600	31.076	12.440
24/04/2015 10:14:00	14		14	31.615	31.091	12.455
24/04/2015 10:15:00	15		15	31.650	31.126	12.490
24/04/2015 10:16:00	16		16	31.710	31.186	12.550
24/04/2015 10:17:00	17		17	32.690	32.166	13.530
24/04/2015 10:19:00	19		19	34.530	34.006	15.370
24/04/2015 10:20:00	20		20	34.960	34.436	15.800
24/04/2015 10:22:00	22		22	35.420	34.896	16.260
24/04/2015 10:24:00	24		24	35.700	35.176	16.540
24/04/2015 10:26:00	26		26	35.810	35.286	16.650
24/04/2015 10:28:00	28		28	36.035	35.511	16.875
24/04/2015 10:30:00	30		30	36.195	35.671	17.035
24/04/2015 10:35:00	35		35	36.155	35.631	16.995
24/04/2015 10:40:00	40		40	35.640	35.116	16.480
24/04/2015 10:45:00	45		45	33.980	33.456	14.820
24/04/2015 10:50:00	50	0	50	34.180	33.656	15.020
24/04/2015 10:50:30		0.5	50.5	29.400	28.876	10.240
24/04/2015 10:51:00		1	51	27.150	26.626	7.990
24/04/2015 10:51:30		1.5	51.5	25.900	25.376	6.740
24/04/2015 10:52:00		2	52	23.520	22.996	4.360
24/04/2015 10:52:30		2.5	52.5	22.560	22.036	3.400
24/04/2015 10:53:00		3	53	22.010	21.486	2.850
24/04/2015 10:53:30		3.5	53.5	21.630	21.106	2.470
24/04/2015 10:54:00		4	54	21.300	20.776	2.140
24/04/2015 10:54:30		4.5	54.5	21.050	20.526	1.890
24/04/2015 10:55:00		5	55	20.840	20.316	1.680
24/04/2015 10:55:30		5.5	55.5	20.670	20.146	1.510
24/04/2015 10:56:00		6	56	20.550	20.026	1.390
24/04/2015 10:56:30		6.5	56.5	20.430	19.906	1.270
24/04/2015 10:57:00		7	57	20.340	19.816	1.180
24/04/2015 10:57:30		7.5	57.5	20.280	19.756	1.120
24/04/2015 10:58:00		8	58	20.220	19.696	1.060
24/04/2015 10:58:30		8.5	58.5	20.170	19.646	1.010
24/04/2015 10:59:00		9	59	20.123	19.599	0.963
24/04/2015 10:59:30		9.5	59.5	20.080	19.556	0.920
24/04/2015 11:00:00		10	60	20.060	19.536	0.900
24/04/2015 11:01:00		11	61	20.015	19.491	0.855
24/04/2015 11:02:00		12	62	19.980	19.456	0.820
24/04/2015 11:03:00		13	63	19.950	19.426	0.790
24/04/2015 11:04:00		14	64	19.925	19.401	0.765
24/04/2015 11:05:00		15	65	19.905	19.381	0.745
24/04/2015 11:06:00		16	66	19.890	19.366	0.730
24/04/2015 11:07:00		17	67	19.865	19.341	0.705

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
24/04/2015 11:08:00		18	68	19.850	19.326	0.690
24/04/2015 11:09:00		19	69	19.835	19.311	0.675
24/04/2015 11:10:00		20	70	19.830	19.306	0.670
24/04/2015 11:12:00		22	72	19.800	19.276	0.640
24/04/2015 11:14:00		24	74	19.777	19.253	0.617
24/04/2015 11:16:00		26	76	19.755	19.231	0.595
24/04/2015 11:18:00		28	78	19.735	19.211	0.575
24/04/2015 11:20:00		30	80	19.270	18.746	0.110
24/04/2015 11:25:00		35	85	19.673	19.149	0.513
24/04/2015 11:30:00		40	90	19.650	19.126	0.490
24/04/2015 11:35:00		45	95	19.614	19.090	0.454
24/04/2015 11:40:00		50	100	19.582	19.058	0.422
24/04/2015 11:45:00		55	105	19.551	19.027	0.391
24/04/2015 11:50:00		60	110	19.523	18.999	0.363

A3.9.3 Analysis

The recovery data analysis for well 72_5009 is presented in Figure A 3.20, which results in a transmissivity estimate of $T = 2.79$ m^2/day. For conversion to hydraulic conductivity, the screen length has been used $b = 12.5$ m. As such, $K = 0.22$ m/day or $K = 2.6 \times 10^{-6}$ m/sec. The screen here spans mainly pumice, with a portion of 'rhyolite' (interpreted as Pakaumanu ignimbrite). Compared to theoretical values, this is consistent with the expected fractured igneous rock and fine, medium or coarse sand (8×10^{-9} to 3×10^{-4}, 2×10^{-7} to 2×10^{-4}, $9 \times 10^{-7}$to 5×10^{-4}, $9 \times 10^{-7}$to 6×10^{-3} m/sec).

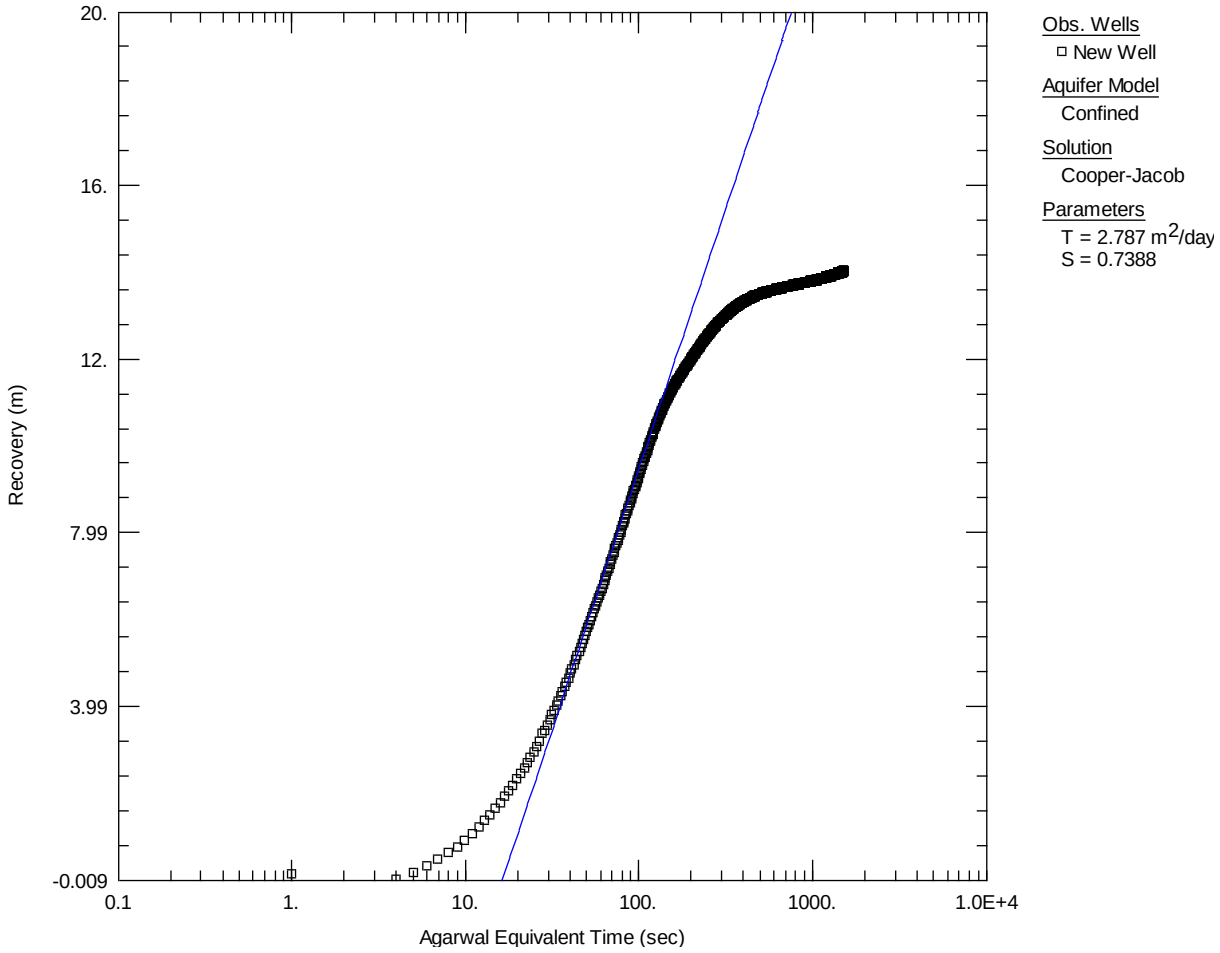
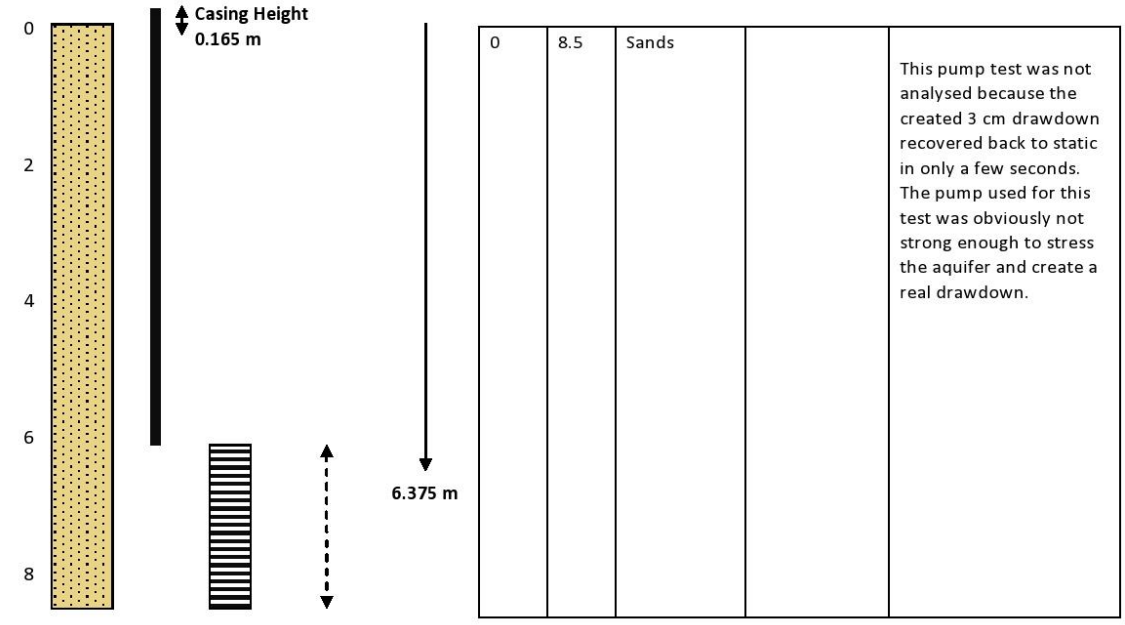


Figure A 3.20 Recovery data analysis for well 72_5009, resulting in $\boldsymbol{T = 2.79}$ m^2/day.

A3.10 HYDRAULIC TESTING DETAILS FOR WELL 70_796

A3.10.1 Pumping test and well details

Well ID	NZTM Northing	NZTM Easting	Bore Depth (m)	Casing Depth (m)	Casing Dia (mm)	Screen Dia (mm)	Screen Int (m)	Screen Length (m)	Data Logger Depth (m)
70_796	1799480	5798940	8.5	6	100	85	6 - 8.5	2	8.1



Pumping test comments for 70_796: A single well test was performed with both drawdown and recovery data collected on the 10/04/2015. The bore has no pump installed so the water level is always static. The GNS whale pump was used to pump water from the bore for 60 minutes: the pump rate stayed constant at 0.16 L/s during the test. The whale pump did not create a sufficient drawdown (pump too weak) so it was turned off after 60 minutes. Subsequently, the pump was turned off and recovery measured for 30 minutes. Data loggers were deployed and manual measurements were recorded during both phases of the test. Drawdown and recovery of only about 3 cm occurred within the first 5 seconds of starting the particular phases of the test, therefore the data was not analysed.

A3.10.2 Data

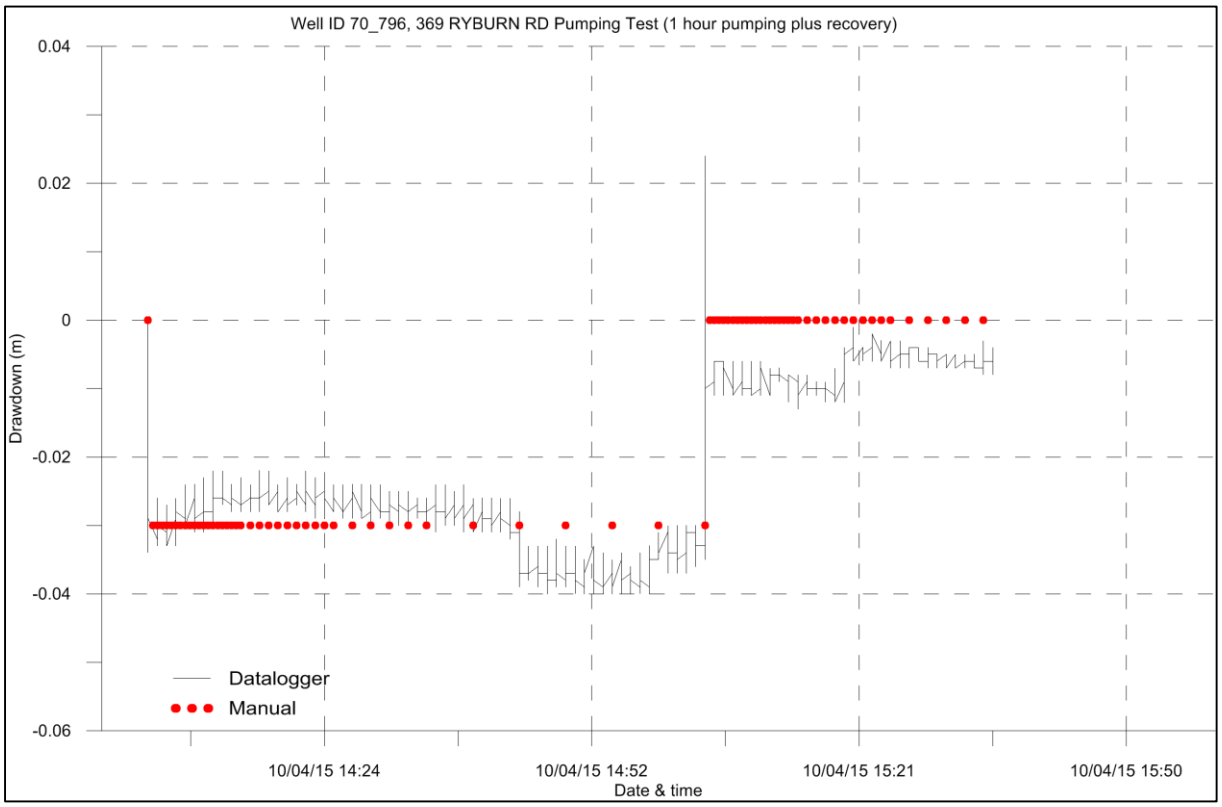


Figure A 3.21 Drawdown and recovery plot for well 70_796.

Table A 3.10 Manual data recorded during hydraulic testing.

369 RYBURN RD Pumping Test (1 hour pumping plus recovery)			
MANUAL DATA			
Well Name/Site:	369 RYBURN RD	**ID:**	70_796
Location:	E1799479.832 N5798940.394	**Well depth:**	8.5 m
Elevation (gl):	37.173 m ASL	**Casing diam:**	80 mm
Date:	10/04/2015	**Casing depth:**	6.0 m BGL
Pump rate:	0.115 L/sec	**Elevation (MP):**	0.165 m
Screen:	6 – 8.5 m BGL	**SWL:**	6.375 m BGL

24 Hour Pumping Test				**PERMANENT WELL**		
Actual Time	**Elapsed Time (minutes)**			**Groundwater**	**Groundwater**	**Drawdown**
d/m/yr hh:mm:ss	**Pumping**	**Recovery**	**Total**	**m BMP**	**m BGL**	**m**
10/04/2015 14:05:00	0		0	6.540	6.375	0.000
10/04/2015 14:05:30	0.5		0.5	6.570	6.405	0.030
10/04/2015 14:06:00	1		1	6.570	6.405	0.030
10/04/2015 14:06:30	1.5		1.5	6.570	6.405	0.030
10/04/2015 14:07:00	2		2	6.570	6.405	0.030
10/04/2015 14:07:30	2.5		2.5	6.570	6.405	0.030
10/04/2015 14:08:00	3		3	6.570	6.405	0.030
10/04/2015 14:08:30	3.5		3.5	6.570	6.405	0.030
10/04/2015 14:09:00	4		4	6.570	6.405	0.030
10/04/2015 14:09:30	4.5		4.5	6.570	6.405	0.030
10/04/2015 14:10:00	5		5	6.570	6.405	0.030
10/04/2015 14:10:30	5.5		5.5	6.570	6.405	0.030

24 Hour Pumping Test				PERMANENT WELL		
Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
10/04/2015 14:11:00	6		6	6.570	6.405	0.030
10/04/2015 14:11:30	6.5		6.5	6.570	6.405	0.030
10/04/2015 14:12:00	7		7	6.570	6.405	0.030
10/04/2015 14:12:30	7.5		7.5	6.570	6.405	0.030
10/04/2015 14:13:00	8		8	6.570	6.405	0.030
10/04/2015 14:13:30	8.5		8.5	6.570	6.405	0.030
10/04/2015 14:14:00	9		9	6.570	6.405	0.030
10/04/2015 14:14:30	9.5		9.5	6.570	6.405	0.030
10/04/2015 14:15:00	10		10	6.570	6.405	0.030
10/04/2015 14:16:00	11		11	6.570	6.405	0.030
10/04/2015 14:17:00	12		12	6.570	6.405	0.030
10/04/2015 14:18:00	13		13	6.570	6.405	0.030
10/04/2015 14:19:00	14		14	6.570	6.405	0.030
10/04/2015 14:20:00	15		15	6.570	6.405	0.030
10/04/2015 14:21:00	16		16	6.570	6.405	0.030
10/04/2015 14:22:00	17		17	6.570	6.405	0.030
10/04/2015 14:23:00	18		18	6.570	6.405	0.030
10/04/2015 14:24:00	19		19	6.570	6.405	0.030
10/04/2015 14:25:00	20		20	6.570	6.405	0.030
10/04/2015 14:27:00	22		22	6.570	6.405	0.030
10/04/2015 14:29:00	24		24	6.570	6.405	0.030
10/04/2015 14:31:00	26		26	6.570	6.405	0.030
10/04/2015 14:33:00	28		28	6.570	6.405	0.030
10/04/2015 14:35:00	30		30	6.570	6.405	0.030
10/04/2015 14:40:00	35		35	6.570	6.405	0.030
10/04/2015 14:45:00	40		40	6.570	6.405	0.030
10/04/2015 14:50:00	45		45	6.570	6.405	0.030
10/04/2015 14:55:00	50		50	6.570	6.405	0.030
10/04/2015 15:00:00	55		55	6.570	6.405	0.030
10/04/2015 15:05:00	60	0	60	6.570	6.405	0.030
10/04/2015 15:05:30		0.5	60.5	6.540	6.375	0.000
10/04/2015 15:06:00		1	61	6.540	6.375	0.000
10/04/2015 15:06:30		1.5	61.5	6.540	6.375	0.000
10/04/2015 15:07:00		2	62	6.540	6.375	0.000
10/04/2015 15:07:30		2.5	62.5	6.540	6.375	0.000
10/04/2015 15:08:00		3	63	6.540	6.375	0.000
10/04/2015 15:08:30		3.5	63.5	6.540	6.375	0.000
10/04/2015 15:09:00		4	64	6.540	6.375	0.000
10/04/2015 15:09:30		4.5	64.5	6.540	6.375	0.000
10/04/2015 15:10:00		5	65	6.540	6.375	0.000
10/04/2015 15:10:30		5.5	65.5	6.540	6.375	0.000
10/04/2015 15:11:00		6	66	6.540	6.375	0.000
10/04/2015 15:11:30		6.5	66.5	6.540	6.375	0.000
10/04/2015 15:12:00		7	67	6.540	6.375	0.000
10/04/2015 15:12:30		7.5	67.5	6.540	6.375	0.000
10/04/2015 15:13:00		8	68	6.540	6.375	0.000
10/04/2015 15:13:30		8.5	68.5	6.540	6.375	0.000
10/04/2015 15:14:00		9	69	6.540	6.375	0.000
10/04/2015 15:14:30		9.5	69.5	6.540	6.375	0.000
10/04/2015 15:15:00		10	70	6.540	6.375	0.000
10/04/2015 15:16:00		11	71	6.540	6.375	0.000
10/04/2015 15:17:00		12	72	6.540	6.375	0.000
10/04/2015 15:18:00		13	73	6.540	6.375	0.000
24 Hour Pumping Test				PERMANENT WELL		

Actual Time	Elapsed Time (minutes)			Groundwater	Groundwater	Drawdown
d/m/yr hh:mm:ss	Pumping	Recovery	Total	m BMP	m BGL	m
10/04/2015 15:19:00		14	74	6.540	6.375	0.000
10/04/2015 15:20:00		15	75	6.540	6.375	0.000
10/04/2015 15:21:00		16	76	6.540	6.375	0.000
10/04/2015 15:22:00		17	77	6.540	6.375	0.000
10/04/2015 15:23:00		18	78	6.540	6.375	0.000
10/04/2015 15:24:00		19	79	6.540	6.375	0.000
10/04/2015 15:25:00		20	80	6.540	6.375	0.000
10/04/2015 15:27:00		22	82	6.540	6.375	0.000
10/04/2015 15:29:00		24	84	6.540	6.375	0.000
10/04/2015 15:31:00		26	86	6.540	6.375	0.000
10/04/2015 15:33:00		28	88	6.540	6.375	0.000
10/04/2015 15:35:00		30	90	6.540	6.375	0.000