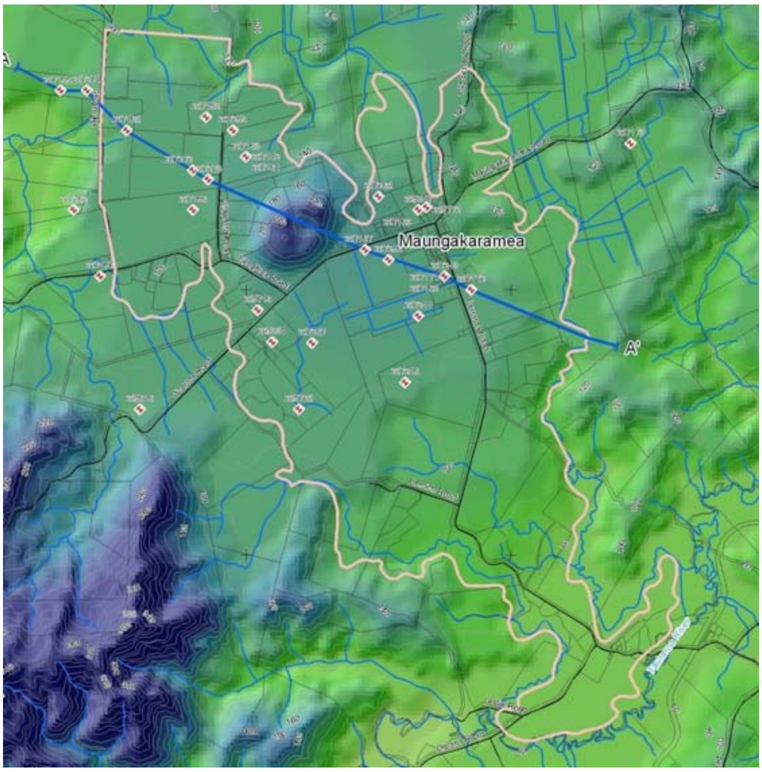
Preliminary Hydrogeological Investigations - Four Northland Aquifers

MAUNGAKARAMEA GROUNDWATER RESOURCE

- Report prepared for Northland Regional Council
- Final
- 28 March 2006



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Contents

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1. Introduction

Sinclair Knight Merz was commissioned by the Northland Regional Council (NRC) to provide a preliminary hydrogeological investigation of four Northland aquifers, including Three Mile Bush, Maungakaramea, Kaikohe and Matapouri Bay. These aquifers are classified as “at risk” aquifers under the Northland Regional Water and Soil Plan (NRC, 2004), due to high actual or potential groundwater demand or potential saltwater intrusion. Abstraction from these aquifers is controlled by specific rules in the Plan.

This report focuses on the hydrogeology of the Maungakaramea basalt aquifer. The aquifer is experiencing significant subdivision expansion, which may be placing pressure on the groundwater resource.

The information obtained from this preliminary hydrogeological study will assist the NRC to effectively manage the allocation of groundwater resources. The overall objectives of the study include the following:

- Provide an understanding of the aquifer hydrogeology - hydraulic characteristics, groundwater recharge and discharge dynamics.
- Provide a preliminary estimate of sustainable yield of the aquifer; and
- Identify information gaps and recommend future action required to enable sustainable management of the groundwater resource.

2. Background Information

2.1 Site Location

The Maungakaramea basalt aquifer is located approximately 14 km southwest of Whangarei township. The aquifer is about 2.3 km wide at the widest point and 6.7 km long, and elongated in the northwest to southeast direction. The total study area is 10.4 km^2. The aquifer is positioned between the Waitotama and Waionapu Rivers in the north and Tauraroa River in the south. Figure 1 shows the location and extent of the aquifer.

Most of the study area is relatively flat at an elevation of approximately 140 m above mean sea level (mAMSL). The basalt boundary slopes steeply down to the surrounding areas and rivers at approximately 100 mAMSL. The centre of the aquifer comprises a scoria cone forming a "horseshoe" hill with an elevation of 225 mAMSL.

The Maungakaramea basalt aquifer is adjacent to the much larger basalt area encompassing the Tangihua Ranges although these two aquifers are not connected.

Groundwater is generally used for horticultural irrigation and as a supplementary domestic supply. The aquifer is classified as "at-risk" based on the high actual or potential demand for groundwater for horticultural irrigation. The abstraction of groundwater from the basalt has the potential to reduce spring and stream flow from the basalt.

- **Figure 1. Locality plan.**

  (see A3 attachment at rear).

2.2 Regional Geology

Geology for the area is described on the 1:250,000 Geological Map Sheet 2A for Whangarei (Thompson, 1961), and is reproduced in Figure 2.

The aquifer is comprised of Taheke basalt of Holocene age. Taheke basalt is the youngest member of the Kerikeri Volcanic Group. The Maungakaramea basalt aquifer has formed as a result of volcanic activity along the underlying north-south trending unnamed fault. A scoria cone marks the eruptive vent, and the lava flows extend in southeast and northwest directions from the vent.

The Maungakaramea basalt overlies and is bordered by shale, sandstone and siltstone of the Mata Formation. The shale is siliceous, hard and darkly coloured while the sandstone is micaceous, sulphurous and grey in colour. Mata Formation is of Cretaceous age.

Alluvial and swamp deposits overlie the basement and sedimentary rocks within the valleys surrounding the basalt area. These deposits consist of mud, peat, sand and minor gravel of Holocene to Recent age.

- **Figure 2. Geological map.**

  (see A3 attachment at rear).

2.3 Drillers Borelogs

There are 31 bores registered on the NRC bore database for the Maungakaramea study area. The bores are grouped predominantly in the central area of the basalt aquifer, surrounding the volcanic cone. No bore survey has been undertaken to confirm the total number of bores in the area but it is likely that there are other bores that are not registered with the NRC. Figure 1 shows the approximate locations of the registered bores within the aquifer.

The bores range between 9 and 76 m depth. The base of the basalt was intercepted between 48 and 67 m depth in 12 of the 26 bores drilled in the basalt. All bores are 75 to 100 mm in diameter and are generally unscreened through the basalt. Yields estimated from air lift tests or short term pumping ranges from 0.1 L/s to 3.7 L/s. In a few cases the bores have been blasted to enhance the yield (i.e., bore 207158 and 207160). The greatest yields are recorded in bores encountering fractured or vesicular basalt (i.e. 207272, 205847, 207267, 2027273 and 2027274). Some bore logs show several fractured zones.

A summary of bore construction details and the available aquifer parameters are included in Table 1.

▪ **Table 1. Bore information.**

Bore Number	Name	Easting	Northing	Date Drilled	Depth (m)	Static WL (mBTOC)	Cased depth (m)
205616	D Snelling	2617200	6593100	21/05/1993	11	2.0	8.0
205719	Dave Cunningham	2618087	6593847	13/05/1994	24	-	-
205720	H Buisman	2618400	6593100	13/06/1995	60	6.5	9.6
205772	WDC	2619360	6594620	24/02/1999	62	10.0	38.0
205834	Charlie Jellick	2618200	6593606	8/08/2000	19	3.3	12.0
205847	WDC-Stone Haven	2619300	6594600	28/11/2000	60	4.6	40.0
207142	R Adams	2618000	6595000	7/08/1967	-	-	-
207155	Cotton	2616600	6595500	8/12/1981	9	2.4	6.7
207156	Cotton	2617600	6594600	8/12/1981	11	3.6	3.6
207157	Hannam	2616900	6594100	1/12/1981	14	7.0	9.4
207158	T Crawford	2617700	6595300	12/11/1981	30	7.3	11.0
207160	T Crawford	2617100	6595200	5/11/1981	43	7.0	15.0
207163	R Adams	2618000	6595000	-	23	-	15.8
207164	R Adams	2618000	6595000	-	18	-	-
207167	WCC	2618900	6594300	12/04/1979	52	8.2	12.5
207168	N Anderson	2619500	6594100	-	30	7.0	13.0
207169	WCC	2619300	6594600	-	27	3.9	24.5
207171	D Walker	2619500	6594100	11/11/1964	14	7.0	8.5
207172	T O'Shea	2619700	6594000	28/11/1966	46	dry	-
207173	Boll Bros	2620901	6595100	21/06/1983	40	9.0	17.0
207243	N Anderson	2619500	6594100	21/01/1985	37	3.1	10.0
207244	N. Anderson	2619300	6593800	5/07/1985	76	-	12.0
207246	G Hawkins	2619200	6593300	17/07/1984	50	7.0	14.0
207256	K Walker	2619075	6594225	14/08/1985	30	9.0	13.0
207259	G Christensen	2617900	6595200	25/03/1986	64	8.0	11.3
207260	D Walker	2619000	6594700	18/11/1985	37	16.3	24.0
207262	S Roadley	2616700	6594600	4/11/1986	73	7.6	14.6
207267	K Farms	2618500	6593600	5/03/1987	68	1.0	16.0
207272	S Roadley	2617600	6594900	5/03/1989	70	10.0	13.0
207273	S Roadley	2617715	6594829	12/04/1989	72	9.6	13.0
207274	A Saundeson	2616800	6595500	19/01/1990	56	11.0	8.0

Notes: mBTOC = m below top of casing.

2.4 Rainfall and Evaporation

There are three rainfall sites in the vicinity of the basalt aquifer, with records dating from 1958. Table 2 summarises the site details, locations, gaps in the data and long term average annual rainfall. Data from site **548211** has been used for analysis in this report because of record completeness.

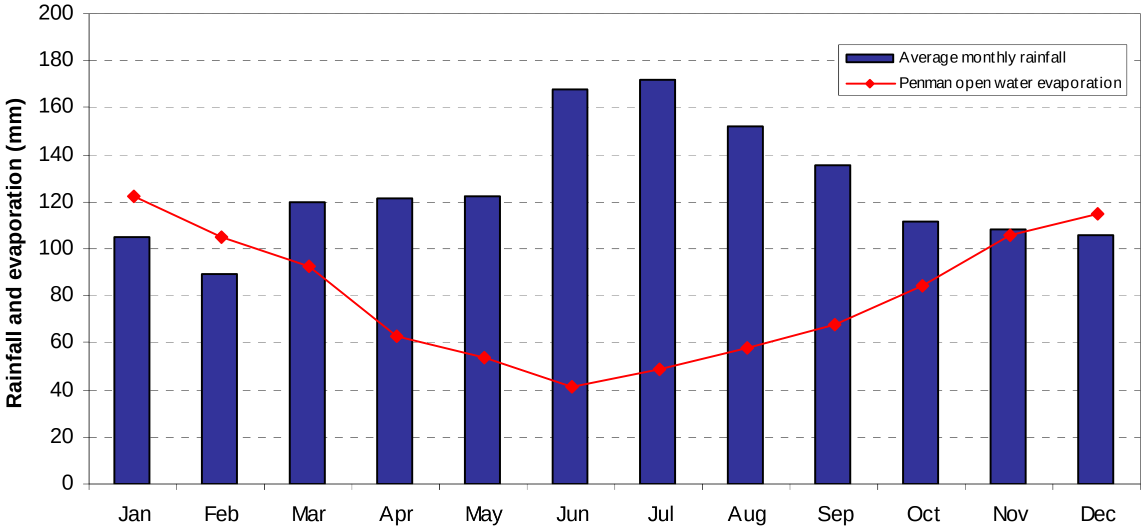
The annual average rainfall calculated over the 32 to 35 year period is 1,472 mm for site 548101, and 1,361 mm and 1,518 mm for sites 548201 and 548211, respectively. The annual average is calculated excluding years with missing data, which may explain the lower annual average rainfall for site 548101 and 548201.

Table 2. Rainfall sites.

Site	Easting	Northing	Record period	Missing Data	Average
Site 548101 Wairoa R at TANGIHUA	2626600	6595800	3/01/1958 - 1/07/1992	1958 (2), 1974 (1), 1977/78 (12), 1989 (1), 1991(3), 1992 (1)	1,472 mm
Site 548201 Otaika Stm at MANGAPAI	2624260	6602610	3/04/1970 - 1/03/2001	1970 (3), 1982/83 (13), 1989 (1), 1993/94 (9), 1995/96 (3), 1997 (4), 1998/99 (14),	1,361 mm
Site 548211 Tangihua at Jones (Mangapai)	2626300	6595200	1/01/1972 - 30/11/2004		1,518 mm

Figure 3 shows average monthly rainfall and evaporation for the study area. Long-term average evaporation for the study site was estimated using Penman Open Water evaporation data for Whangarei Aero AWS (Station A54737) for the period from 1991 to 2004 (missing records from 1993 to 1994). Monthly average rainfall totals have been calculated for site 548211.

Rainfall exceeds evaporation for all months except the summer months of December, January and February. This indicates that for most of the year there is sufficient excess water for groundwater recharge and/or surface water runoff, depending on event characteristics. Dry conditions during summer are common.



- **Figure 3. Average monthly rainfall and evaporation.**

2.5 Stream Flow

The basalt aquifer is bordered by the Waiotama River and its tributaries on the northwest side, Waionepu River and its tributaries on the northern side, and Tauraroa River and its tributaries on the southern side. These streams generally flow towards the northwest and southeast. The stream flow is sourced partly from the basalt aquifer and from the surrounding area. Spring and stream flow has been monitored by the NRC on a number of occasions since 1971. The location of the flow gauging sites is shown on Figure 4.

- **Figure 4. Monitoring and consents location.**

(see A3 attachment at rear).

Stream low flow ranges between 0.1 L/s at Waionepu Stream (0.4 km^2 catchment) and 173 L/s at Tauraroa Stream tributary (3.5 km^2 catchment). As the flow measurements were recorded during low-flow conditions, it is likely that the flows represent predominately spring discharge. Three gauging sites (1046691, 1146601 and 1146649), where flow ranges from 0.2 L/s to 173 L/s, are considered to capture stream flow from wider catchments other than the basalt aquifer.

Table 3. Average low flow at flow monitoring sites.

River	Site	Location	Average low flow (L/s)	Range (L/s)
Waiotama trib (RH)	1046683	L Huffman/Tangihua Rd	10.59	7.1 - 17.6
Waiotama	1046684	1st small Stream up Bint Rd	1.13	0.6 - 2.3
Waionepu River trib	1046685	Bint Rd	13.88	7.6 - 22.2
Tauraroa trib	1046687	Quinn's culvert	12.85	8.4 - 18.3
Tauraroa River trib	1046688	Quinn's LH trib	5.80	2.0 - 17.0
Tauraroa River trib	1046690	Tauraroa Rd	18.54	2.2 - 41.1
TauraroaTrib	1046691	Leislie Rd	70.89	0.2 - 172.7
Waiotama trib (LH)	1146601	L Huffman/Tangihua Rd	7.97	5.2 - 8.2
Waiotama trib (LH)	1146609	Tangihua Rd	3.73	0.7 - 6.6
Waioneone u/n trib	1146615	Hibbert/Joy	0.35	0.2 - 0.7
Waionepu	1146644	Gillingham driveway	1.28	0.1 - 2.5
Waionepu River trib	1146645	Below Adams/Walkers	1.64	0.1 - 2.9
Tauraroa River trib	1146649	Behind Tauraroa Tip (windmill)	30.19	9.6 - 52.1

2.6 Water Abstraction

Summaries of the groundwater and surface water take consented allocations are given in Table 4 and Table 5, respectively. A reduction in groundwater levels from groundwater abstraction is likely to directly affect nearby spring flows, which will impact upon the stream environment and downstream surface water users. In comparison, surface water abstraction will have minimal effect on the recharge or availability of groundwater in the basalt aquifer, as the streams are groundwater discharge routes for the aquifer. Most surface water takes in the area are located outside or on the fringe of the aquifer. Figure 4 shows the location of the consented groundwater and surface water takes from the NRC database.

There are nine consented groundwater takes located mostly in the central part of the aquifer. The individual takes range from 6 to 150 m^3/day and the total consented groundwater allocation from the basalt aquifer is 708 m^3/day.

It is a permitted activity under the Northland Regional Water and Soil Plan (NRC, 2004) for existing users to abstract and utilise up to 30 m^3/day of groundwater for reasonable stock drinking water requirements and 2 m^3/day for domestic use. New abstractions are permitted to take 1 m^3/day from an "at-risk" aquifer. Due to the high level of uncertainty over the exact number and use of permitted takes in the area, permitted activity use has not assessed in this study. A bore and water use survey is required to identify all existing bores within the study area and assess actual use.

■ **Table 4. Summary of groundwater take consents.**

Site	Owner	Easting	Northing	Take (m^3/day)	Purpose
19960188101	Whangarei District Council	2619320	6594680	86	Public Water Supply
19990864201	Whangarei District Council	2619360	6594620	108	Public Water Supply
20000378401	K G Walker	2619000	6594200	80	Horticultural Irrigation
20010236101	P J Coghlan	2617130	6595305	110	Horticultural Irrigation
20010240501	Mr N J Carman	2617300	6595200	120	Horticultural Irrigation
20010318702	W L Flintoff	2617950	6595095	150	Horticultural Irrigation
20010463201	Carman Family Trust	2616950	6595490	6	Horticultural Irrigation
20051301301	Avogrove Limited	2618731	6594408	48	Horticultural Irrigation
20051316601	N J Lewin & F A Hopkin Limi	2619022	6594924	0*	Horticultural Irrigation
	Total consented allocation			**708**	

Notes: ***Consent is suspended and does not have an allocation.

There are six consented surface water takes (see Table 5) located within the Maungakaramea study area (Figure 4). The individual consent allocations range between 20 and 360 m^3/day, with a total consented allocation of 865 m^3/day.

Similar to the groundwater allocations, surface water allocations may not correspond to the actual surface water abstraction.

■ **Table 5. Summary of surface water take consents.**

Site	Owner	Easting	Northing	Take (m^3/day)	Purpose
19960235601	Mr T D Colquhoun	2617900	6593700	20	Horticultural Irrigation
19990250201	Grant Woolhouse Farm Trust	2621000	6590900	100	Horticultural Irrigation
20000241601	P C Wenzlick	2620000	6594300	45	Horticultural Irrigation
20000250903	Mr I R Taylor	2619900	6590800	360	Pasture/Crop Irrigation
20010215701	K R Walker	2617917	6594246	120	Horticultural Irrigation
20010250101	Quin Tm Limited	2620345	6591989	30	Horticultural Irrigation
20010318701	W L Flintoff	2618450	6595460	150	Horticultural Irrigation
20010777901	Mr J P Burton	2617917	6594246	40	Horticultural Irrigation
	Total consented allocation			**865**	

3. Aquifer Conceptualisation

3.1 Lithology

All available bore logs from the NRC bore database were analysed and used to delineate lithological differences and lithological units encountered in each bore. The analysis was used to construct a cross-section through the basalt and create a conceptual understanding of the aquifer. Detailed analysis of the available bore logs generally indicates the following aquifer lithology (from ground surface to base):

- Dark brown clay up to 13 m thick with occasional basalt and scoria boulders.
- Scoria layer of up to 10 m thick in various parts of the aquifer.
- Occasional thin grey ash layers.
- Vesicular and non-vesicular basalt greater than 67 m thick with occasional fracturing. The extent and location of fracturing is variable.
- Mudstone, sandstone and shale underlying the basalt.

The borelog descriptions are generally consistent with the regional geology described in Section 2.2.

Figure 5 shows a cross-section through the basalt aquifer (west – east orientation). The location of the cross-section is shown on Figure 1. The cross-section delineates different lithological units as well as fracture zones identified in the driller's logs. A correlation between fractured zones has not been attempted because of a lack of information but the zones are indicated to show the nature of the aquifer. The lithology of the cone is assumed to be comprised mainly of scoria, similar to other volcanic cones in the area (e.g. Three Mile Bush).

- **Figure 5. Cross section A-A'.**

  (see A3 attachment at rear).

The basalt thickness varies from 1.8 to greater than 61 m on the cross-section, with the thickest part of the basalt is encountered near the scoria cone. The surface east and west of the cone is covered with clay of variable thickness. Underlying the surface clay is the scoria layer, which is particularly thick in the eastern part of the area. Thickness of the scoria can be up to 10 m. In the western part of the aquifer a zone of fractured basalt is encountered with a thickness of approximately 11 m.

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3.2 Groundwater Levels

Groundwater levels have been monitored in one bore for a period of 16 years. The bore details are shown in Table 6 and the location of the groundwater monitoring bore (Roadley) is shown on Figure 4.

Table 6. Groundwater monitoring bore details.

Site number	Site name	Bore ID	Bore depth (m)	Monitoring period
5481001	Roadley at Maungakaramea	207272	72	22/11/1989 - 28/04/2005

Groundwater levels for the monitoring bore were measured approximately every month and range between 6.4 m and 11.8 m below ground level (mBGL). Depth to groundwater for other bores in the area, obtained from the drillers' logs, varies between 1 and 16 mBGL. There is no evidence of any long-term decline in groundwater levels over the period of monitoring.

Figure 6 shows monthly groundwater level fluctuation in the monitoring bore and the correlation with monthly rainfall for the rainfall site 548211. Groundwater recharge occurs during the winter and spring months when rainfall is high. This is consistent with the discussion in Section 2.4 regarding the availability of water for groundwater recharge. The groundwater response following rainfall events is relatively fast while groundwater level recession is slower, lasting a few months.

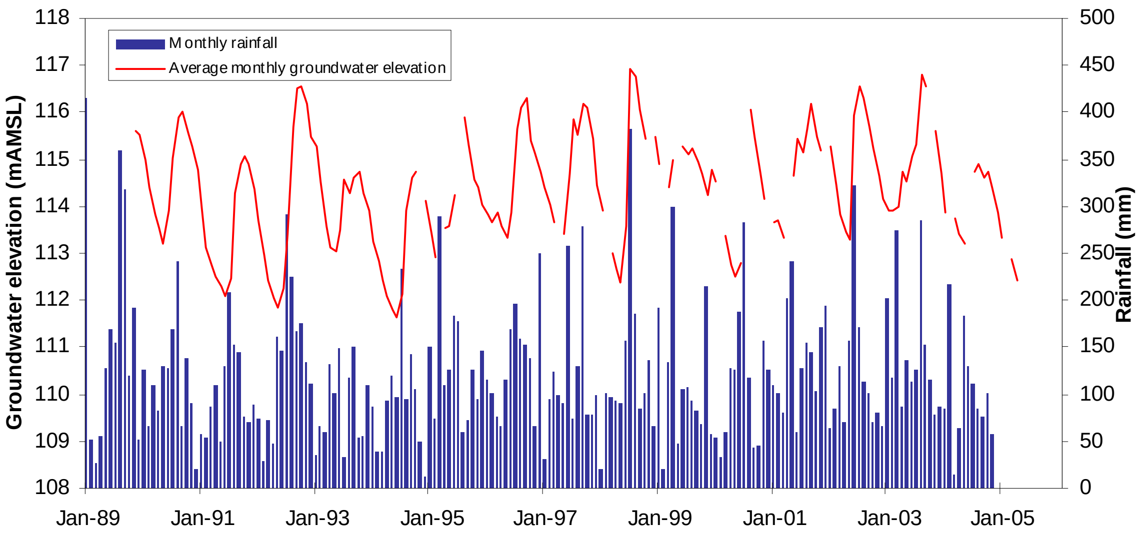

Figure 6. Correlation of groundwater hydrograph and rainfall.

3.3 Piezometric Surface

Piezometric contours were constructed using static water level information from the NRC bore database, groundwater level data from the monitoring bore, estimated ground level elevations and several discharge point elevations around the perimeter of the basalt aquifer (springs/streams).

Figure 7 shows the approximate water table configuration. The most elevated groundwater levels are recorded in the vicinity of the volcanic cone located in the central part of the aquifer. The general groundwater flow direction is radially outwards from the central scoria cone area towards the margin of the basalt and surrounding streams.

- **Figure 7. Piezometric contours.**

  (see A3 attachment at rear).

3.4 Aquifer Hydraulic Properties

Information on the aquifer's hydraulic properties was available from five aquifer hydraulic tests within the study area and from a number of drillers yield tests. Table 7 summarises the hydraulic properties. The tests provide only transmissivity (T) values, therefore hydraulic conductivity (K) was estimated from the average saturated thickness of the aquifer at each bore location.

Transmissivity values range between 2 and 379 m^2/day. The lowest transmissivity value was obtained from the Whangarei District Council public water supply bore (bore 207169) and is attributed to a relatively compact zone of basalt with a very small fractured zone(s). The highest transmissivities were obtained from the Crawford irrigation bores (bore 207158 and 207160) with values ranging from 193 to 397 m^2/day. Both of these bores encountered large fractured zones.

Hydraulic conductivity was estimated at between 0.07 and 17.8 m/day (Table 7). These values are within the lower to mid range of published values for basalt hydraulic conductivity of 0.009 to 900 m/day (Freeze and Cherry, 1979).

- **Table 7. Pumping test information.**

Bore ID	Owner	Date	Bore depth (m)	S (m)	Q (m^3/day)	T (m^2/day)	K (m/day)	Drawdown (m)
207158	Crawford	23/03/1982	30	22.3	280	193 - 397	8.6 – 17.8	1.3
207160	Crawford	23/03/1982	43	36	156	56 - 147	1.5 – 4.1	4.9
207168	Anderson	15/08/1983	37	18	100	8.3	0.4	6.2
207169	Whangarei County Council	14/03/1980	27.4	21	86	2	0.1	13.0
207246	Hawkins	4/04/1985	50	30.1	86 - 161	2 – 6.1	0.07 – 0.2	20.9
	AVERAGE					101		

Notes: Q = discharge rate; S = saturated thickness; T = transmissivity; K = hydraulic conductivity.

3.5 Groundwater Recharge

Rainfall is considered to be the main source for groundwater recharge to the basalt aquifer. There are no other major recharge sources to the basalt aquifer, as the streams are discharge points around the perimeter of the basalt aquifer and the surrounding geology is considered to be less permeable than the basalt. The approximate recharge zone for the Maungakaramea aquifer including scoria cone and elevated basalt area (approximately 100 to 140 mAMSL) is shown as a shaded area on Figure 1.

The recharge assessment is assessed using a number of factors including:

- the area contributing to the recharge,
- annual rainfall over the area and
- the rainfall recharge coefficient, which is estimated based on hydraulic properties of the lithological units.

The scoria cone and basalt have areas of approximately 0.4 km^2 and 10.0 km^2 respectively.

The recharge coefficient for the basalt area is estimated to be 22% to 44% of rainfall. This range in recharge coefficient is similar to those assessed for the basalt aquifers at Kaikohe and Pukekohe from soil moisture water balance modelling (NRC, 1992). Recharge coefficients for the nearby Three Mile Bush aquifer (SKM, 2006), calculated from specific yield and magnitude of water level rise during various rainfall events, ranges from 28% to 49%.

Estimation of the recharge to the scoria volcanic cone is based on infiltration rates of 55% to 65%, assuming that most of the cone is built from highly permeable scoria deposits. The wide range for both recharge coefficients indicates the uncertainty involved in estimation of the recharge coefficient, without more detailed analysis.

Table 8 summarises the parameters used in the assessment of groundwater recharge and the recharge figures for the aquifer. Total combined annual average recharge to the aquifer is estimated to range from 10,065 m^3/day to 19,380 m^3/day.

Table 8. Recharge estimation to the basalt aquifer.

Area	Recharge area (m^2)	Average annual rainfall (mm)	Recharge coefficient (%)	Rainfall infiltration (mm/yr)	Daily groundwater recharge (m^3/day)
Scoria cone	0.4×10^6	1,518	55 - 65	334 - 668	9,150 – 18,299
Basalt	10.0×10^6	1,518	22 - 44	835 - 987	915 – 1,081
TOTAL	10.4×10^6				**10,065 – 19,380**

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3.6 Groundwater Discharge

Groundwater discharge from the aquifer is estimated using hydraulic properties of the basalt shown in Table 7, and the piezometric surface shown in Figure 7. Table 9 summarises the parameters used in the assessment of groundwater discharge.

Hydraulic conductivity is estimated from the average transmissivity given in Table 7 of 101 m^2/day and an average saturated thickness for the aquifer of 24.7 m. The average saturated thickness was assessed from bores located close to the edge of the aquifer. The average hydraulic conductivity of the aquifer is 4 m/day.

The hydraulic gradient for the aquifer is approximately 0.01 m/m in the areas of discharge.

The total length of the discharge zone around the perimeter of the basalt aquifer is approximately 10 km.

Discharge for the aquifer has been estimated at 15,808 m^3/day. This is within the estimated recharge range of 10,065 m^3/day to 19,380 m^3/day.

- **Table 9. Estimated daily groundwater discharge.**

Average hydraulic gradient (m/m)	Average hydraulic conductivity (m/day)	Discharge area	Discharge volume (m^3/day)
0.01	4	16 km × 24.7 m	15,808

Note: Discharge perimeter does not include northwest area of aquifer. Saturated thickness and hydraulic gradient expected to be less in this area, resulting in negligible additional discharge volume.

The groundwater discharge assessment contains a number of uncertainties, increasing the error associated with the analytical calculation. In particular, the transmissivity adopted for the calculation may not represent the true value due to variation in permeability throughout the aquifer from fractures. In addition, the saturated thickness and hydraulic gradient was based on information from a limited number of bores.

The highest gauged stream low flow sourced entirely from the basalt aquifer is 41.1 L/s (i.e. 3,551 m^3/day) from site 1046690 (see Section 2.5). This stream discharge is sourced from a catchment area of approximately 2.2 km^2, which is roughly 20% of the total recharge catchment area of 10.4 km^2 shown in Table 8[1]. The stream low flow is roughly proportionate to the total discharge estimate of 15,808 m^3/day.

[1] The catchment area for site 1046690 has been estimated from the minimal contour information available (i.e. 20 m LINZ contours). The actual catchment area may change with increased topographic contour detail.

4. Assessment of Sustainable Yield

The sustainable yield of the aquifer is defined in this study as the volume of groundwater available for abstraction without adversely affecting environmental systems (i.e. spring/stream flow). Rainfall recharge of the groundwater system is considered the potential upper limit of water available for abstraction, without taking into account the ecosystem requirement. The groundwater recharge estimated in Section 3.5 ranged between 10,065 m^3/day to 19,380 m^3/day.

In the absence of more detailed site-specific investigations, the sustainable yield is in this study assumed to be 40% of rainfall recharge. The remaining 60% of rainfall recharge is for maintaining environmental flows and account for permitted surface water use (30%), and to allow for uncertainties associated with the calculation of recharge (30%). Sustainable yield is therefore estimated to range from 4,026 to 7,752 m^3/day.

Total groundwater allocation for the aquifer is 708 m^3/day (see Section 2.6), and total surface water abstraction (which is mainly groundwater-fed) is 865 m^3/day. The total aquifer allocation of 1,573 m^3/day is below the most conservative estimate of sustainable yield of 4,026 m^3/day. This suggests that the aquifer is currently below full allocation. It should be noted however, that permitted activity use has not been assessed in this study, which is likely to result in total aquifer allocation being greater than assumed.

Individual groundwater takes may still influence environmental flows in close proximity to the bore, depending on the magnitude and timing of the abstraction. Individual takes where this may be a concern should be monitored and restricted if required.

To confirm the amount of sustainable yield and groundwater use, it would be necessary to undertake a detailed hydrogeological investigation.

5. Summary & Conclusions

This study is a preliminary hydrogeological assessment of the Maungakaramea basalt aquifer groundwater resource. The assessment of the recharge/discharge dynamics and sustainable yield is based on information derived from bore logs, aquifer tests and long term monitoring data.

The formation of the aquifer is a result of volcanic activity from the Maungakaramea volcanic centre. The surrounding geology is comprised of shale, sandstone and siltstone of the Mata Formation, which is of significantly lower permeability. The base of the basalt was encountered between 2.5 m and greater than 67 m depth. The thickest part of the basalt is near the scoria cone. Groundwater yields vary between 0.1 and 3.7 L/s, depending on the extent of fracturing. Groundwater levels vary between 1 and 16 mBGL.

The groundwater table elevation is highest around the scoria cone with a radial gradient towards the edges of the basalt flow. This determines groundwater flow directions and discharge areas from the basalt. The major discharge areas from the basalt are identified as the areas adjacent to Waitotama and Waionapu Rivers in the North and the lower elevated area adjacent to Tauraroa River in the South.

Long-term groundwater levels from the Roadley monitoring bore do not indicate any long-term decline in levels over the period of monitoring.

Rainfall recharge is the main source of recharge to the aquifer. The infiltration rate to the aquifer varies depending on type of rock and surface cover characteristics. Infiltration rate to the volcanic cone is estimated to range from 55 to 65% of average annual rainfall, assuming that the cone consists predominately of scoria deposits. For the basalt area, infiltration rates are lower and are estimated to range from 22% to 44% taking into account the low permeability of the clay and ash deposits covering the basalt.

Hydraulic conductivity of the Maungakaramea basalt aquifer is at the lower to middle end of the range typical for basalt aquifers. This is likely due to a low degree and connectivity of fracturing.

A preliminary assessment of sustainable yield based on estimated rainfall recharge suggests that the aquifer is below full allocation. There are a number of uncertainties associated with the calculation of rainfall recharge used in the sustainable yield assessment, mainly due to the limited amount of bore and hydraulic information available and aquifer heterogeneity. Likewise the estimation of actual groundwater use may be incorrect. The sustainable yield of the aquifer should therefore be treated conservatively.

The main issues potentially affecting the quantity of groundwater in the study area include the following:

- ***Bore location*** – after extended periods of pumping, bores located close to the edge of the basalt or shallow bores may experience reduced yields due to more pronounced groundwater dewatering.
- ***Basalt permeability*** – the average permeability of the basalt is relatively low to moderate compared to literature values, which suggests generally low fracture and vesicle connectivity.
- ***Groundwater quality*** **-** there is no monitoring data to verify the groundwater quality.

6. Limitations

Several limiting factors were encountered in this preliminary hydrogeological assessment of the basalt aquifer. These limitations impact upon the interpretation of results in the study and include:

Bore position and elevation

- Potentially erroneous positions of some of the bores (easting and northing) may wrongly represent the aquifer extent and characteristics.
- Bore elevations were derived from current topographic data (LINZ 20 m contours). Inaccuracies in bore elevation will affect the piezometric surface plot and the base of aquifer plot. The bores should be surveyed for more accurate assessment.

Spring location and elevation

- Surveying of springs in the area will improve the accuracy of the piezometric contour plot.

Spatial distribution of bores and bore logs

- There is a lack of bore information in some areas. A bore survey may increase the level of knowledge in those areas, such as depth to base of aquifer and groundwater levels.

Monitoring data

- Long term groundwater level data only exists for one bore – for any future modelling it would be beneficial to have more information.
- Groundwater quality data was unavailable for this assessment. For a long term allocation strategy it would be necessary to monitor groundwater quality.

Groundwater and Surface Water Actual Use

- A bore and water use survey would improve the assessment of sustainable yield.

Soil infiltration

- Rainfall infiltration rates were estimated in this study. Knowledge of soil infiltration rates across the basalt plateau and the scoria cone will improve the accuracy of rainfall recharge calculations.

7. Recommendations

Based on the preliminary findings contained within this report, SKM recommends the following:

- Survey the monitoring bores and springs. This information will enable refinement of the piezometric surface plot and hydraulic gradient used in the rainfall recharge calculation.
- Soil infiltration tests will provide more accurate rainfall infiltration rates in the basalt and scoria areas. This will enable a better understanding of groundwater recharge dynamics.
- Bore and water use survey to improve the accuracy of the sustainable yield calculation. Council may wish to consider this option should future monitoring information indicate adverse effects are occurring on environmental flows, or refinement of the analytical rainfall recharge calculation from the recommendations above indicates there is less recharge occurring than estimated in this study.
- Groundwater quality monitoring would be necessary to evaluate the existing water quality and long term trends. The basalt aquifer may be vulnerable to contamination because of its existing horticultural land use across most of the aquifer.
- Continuous (daily) groundwater level monitoring with incorporated additional monitoring bores. This information would be used in more detailed numerical analysis of the resource if required. Monitoring should continue through the whole hydrological year to allow the effects of abstraction to be better assessed. The location of additional monitoring bores should be determined with consultation between SKM and NRC.

8. References

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