Groundwater resource management review of the South Otago Basins

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Executive Summary

The Pomahaka, Clydevale, Wairuna and Kuriwao groundwater Basins make up the South Otago Basins. Previous studies undertaken in 1999 – 2002 defined the basins as 'gravel alluvium aquifers' and two of the basins are managed as alluvial unconfined aquifers in the Regional Plan: Water for Otago (RPW).

A review of geological bore logs in the study area confirms that the basins are largely comprised of weathered/hard rock overlain by carbonecous claybound gravels. Quaternary alluvial gravels and boulders are located along the various surface water courses that traverse the basins.

In general, the piezometric surface (water table) follows the contours of the land, with the Pomahaka and Clutha rivers influencing localized flow. The groundwater levels are generally higher than the river levels, which suggest that the surface water bodies are discharge points for groundwater.

Aquifer tests and analysis was carried out in the Wairuna and Clydevale basins. The transmissivity (T) calculated from the single well aquifer tests ranged from 0.64 – 74 m^2/d with an average of 10 m^2/d. These values are more similar to rock/claybound gravel than to alluvium gravel. In comparison, an aquifer test carried out in the gravel alluvium in the Pomahaka basin resulted in a T of 3,000 m^2/d.

Due to the South Otago Basin being comprised of rock/weathered rock (clays) with rolling and steep terrain, recharge characteristics will differ from flat alluvial basins, as a high percentage of rainfall will runoff. Rainfall recharge was based on the rainfall recharge assessment carried out on the basins in 2012 (ORC, 2012) and numerical groundwater modeling.

Water chemistry analysis indicates that there are at least two types of groundwater present in the South Otago Basins. Groundwaters from shallow bores have the same chemical signature as the surface water. Both have higher proportions of sodium, potassium and chloride which may be due to cation exchange between sodium and potassium held in clay minerals and dissolved calcium in the soil zone. Groundwaters from deep bores have a longer residence time and appear to undergo anaerobic biological de-nitrification under reducing conditions.

Groundwater quality suggest that the groundwater may not be aesthetically pleasing as the pH and total iron levels are generally outside of the New Zealand Drinking Water Guideline (2005). Faecal coliform bacteria is present in seven bores located in the Pomahaka, Wairuna and Kuriwao basins. This is most likely due to local contaminants and/or poor well head protection.

The current groundwater management regime for the Pomahaka and Kuriwao basins may be overly restrictive as the RPW includes both the Pomahaka and Kuriwao basin aquifers in the C-series maps of Aquifers, Groundwater Zones and Groundwater Protection Zones (C13, C14 and C16). Based on results of the study, it is suggested that consideration be given to removing the Pomahaka and Kuriwao Aquifers from the C-series maps.

The surface water bodies in the Pomahaka Catchment all have natural and recreational values. To protect these, it is suggested that consideration be given to assigning an alluviual ribbon aquifer around the rivers with the highest values. The alluvial gravels along the Pomahaka and Waipahi Rivers are suggested as ribbon aquifers. Consideration should be given to including the nominated and agreed ribbon aquifers in Schedule 2C of the RPW. The remaining surface water bodies could be managed as set out in section 6.4.1A and 12.2.3.4 of the RPW.

Fractured rock aquifers differ from alluvial gravel aquifers. A rock aquifer relies on discontinuities such as joints, fractures, crevices etc to transmit water, therefore water availability is localized and it is not possible to manage the hard rock aquifer at a regional or even aquifer scale. The use of groundwater resource from the hard rock aquifer in the South Otago Basins and Otago is low, therefore the management of this resource is suitably covered in the existing RPW.

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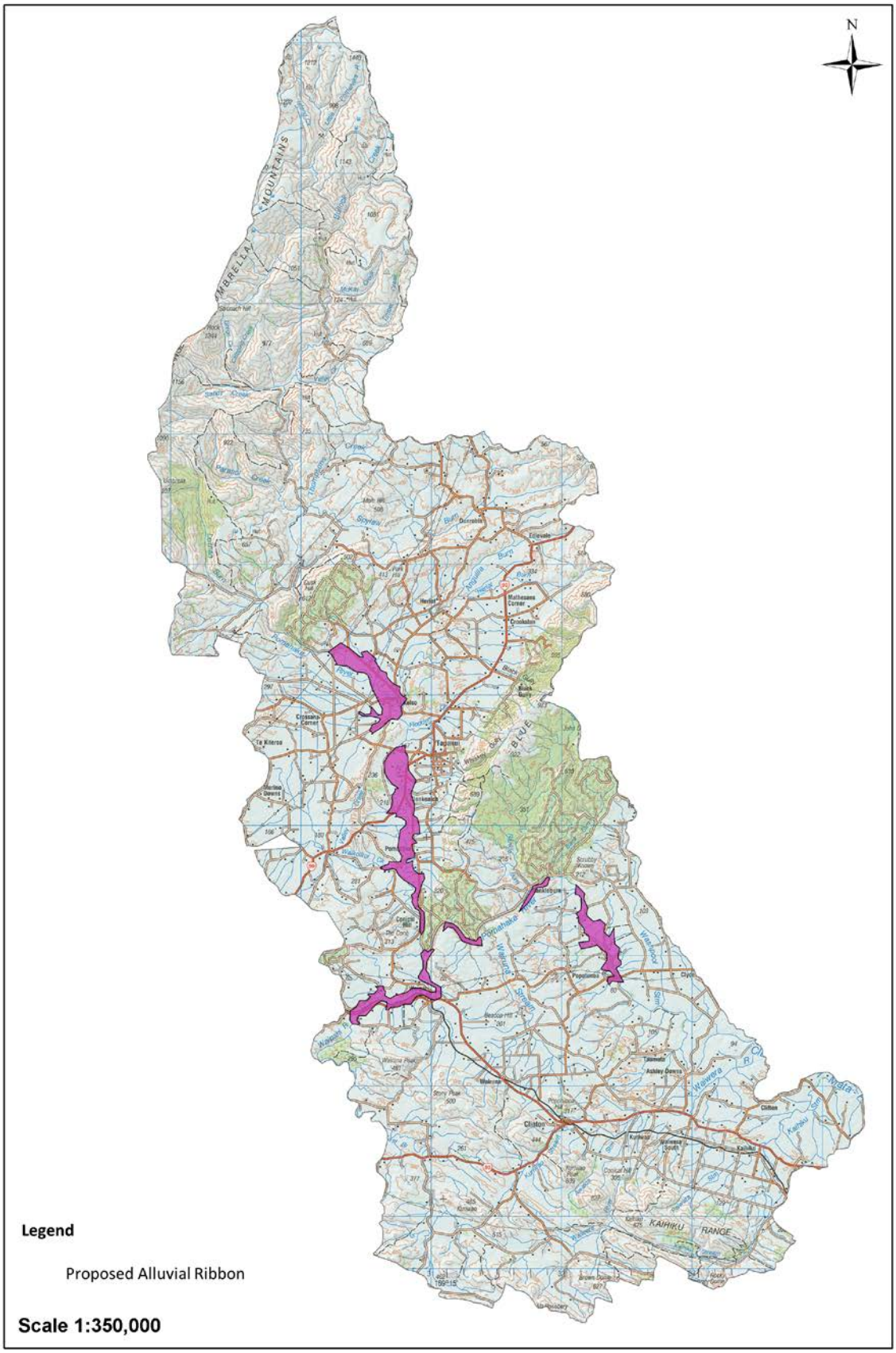

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1.0 Introduction

1.1 Background

Previous studies undertaken in 1999 – 2002 defined the South Otago Basin aquifers as 'gravel alluvium aquifers'. As a result, the Regional Plan: Water for Otago (RPW) includes both the Pomahaka and Kuriwao basin aquifers in the C-series maps of Aquifers, Groundwater Zones and Groundwater Protection Zones (C13, C14 and C16).

The objective of this report was to review all available information and update the groundwater management for the Pomahaka, Kuriwao and Clydevale/Wairuna aquifers. This was a desk based study and did not include any new investigations.

1.2 Setting

The Pomahaka, Clydevale, Wairuna and Kuriwao basin areas are located close to the eastern coast line in the Clutha District of Otago and make up the South Otago Basins. The majority of the study area is located within the Pomahaka Catchment, which is some 2060 km^2 in area. The Pomahaka Catchment has 10 water resources that support a diverse freshwater fish fauna and significant recreational pursuits carried out are game bird hunting and angling. The water resources are:

- Black Gully Creek
- Clutha/Mata-Au River
- Crookston Burn
- Flodden Creek
- Heriot Burn
- Pomahaka River
- Waikoikoi Stream
- Wairuna Stream
- Washpool Stream
- Waipahi River.

The Pomahaka River being one of the larger tributaries of the Clutha River in its lower reaches.

The Kuriwao Basin lies outside of the Pomahaka Catchment and straddles Waiwera River Catchment and Kaihiku Stream Catchment. Water resources associated with this basin are:

- Waiwera River
- Kaihiku Streams

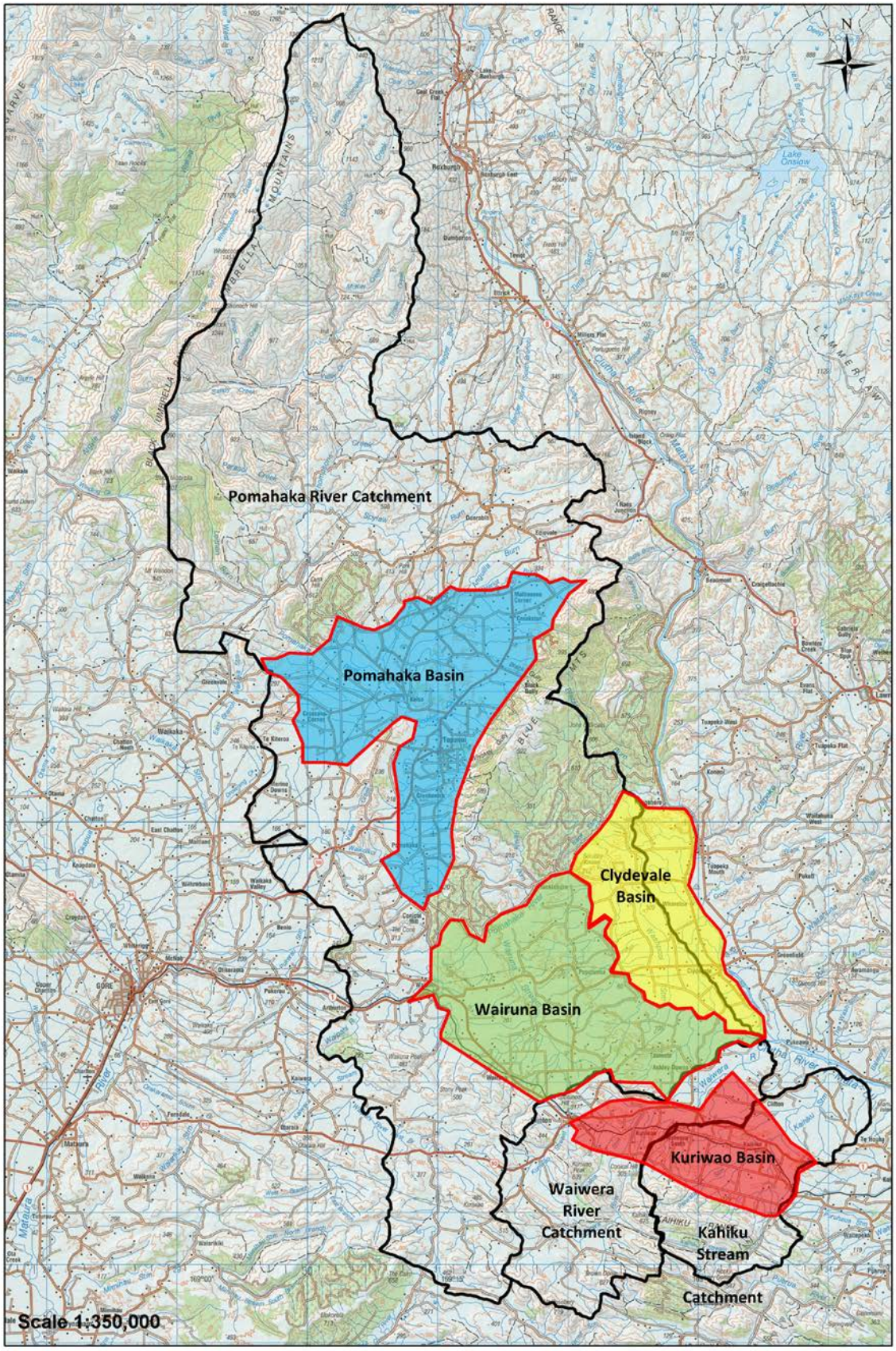


Figure 1: Location of South Otago basin study area

1.3 Geology

All four basins lie at the southern limit of the Central Otago region of tilted fault block ranges separated by fault angle depressions (Figure 2). The Blue Mountain Range situated between the Pomahaka and Clydevale/Wairuna Basin, trends north to north east and is up to 1,500 m in elevation. The Southern Otago Basins are formed from the Cretaceous to Centozoic Waipounamu Erosion Surface, which is of a complex fluvio-marine origin. The Hillfoot Fault and Livingstone Fault along with a series of south-east trending fault lines traverse the Clydevale/Wairuna/Kuriwao Basins (Turnbull, 2003)

North of the Livingston Fault, the basement rock is comprised of fine to medium grained grey sandstone and mudstone of the Caples Group. South of the Livingston fault the basement rock is comprised of coarse grained volcaniclastic sandstone and mudstone of the Little Ben Sandstone, Greville Formation and Waiua Formation. This is overlain by carbonaceous clay and deeply weathered clasts of quartz, greywacke, argillite, semischist and schist (claybound gravels) of the Eocene lignite measures, which outcrops in the south west of the mapped Pomahaka Basin. Thin veneers of Quaternary gravel, moraines and glacial till are present along the surface water bodies.

1.4 Topography

The upper Pomahaka catchment is bounded by the Umbrella mountains to the north and the Blue Mountains in the east while the land to the south and west is predominantly undulating hinterland. Steep valley and swampy flats of the Kaihuku range make up the western boundary of the Wairuna basin and southern boundary of the Kuriwao Basin, while the rest of the basins are made up of rolling hills with low lying areas present along some surface water courses.

1.5 Climate and land use

The climate for South Otago is temperate with regular rainfall averaging between 700 – 900mm/yr (higher elevations receiving more rainfall). The median summer air temperatures for the area are 15 – 16°C. Winter median air temperatures are 4 – 5°C.

The predominant land-use in the basins is either dairy farming or livestock production. Groundwater is mainly used for stockwater and dairyshed washdown, however there are some wells used for community supply/domestic use.

1.6 Bore locations and current abstractions

There are currently 277 bores located in the South Otago Basins. Of these, 123 have bore logs; 81 are constructed in basement rock, 19 are constructed in the claybound gravels and 23 are constructed in well sorted alluvium gravel (Figure 2). The type of geological formation the bores are constructed in control bore productivity. For example, bores constructed in the rock will generally produce less water than bores constructed in well sorted gravel alluvium. However, bores constructed in hard rock along fracture zones or straight line lineaments have potential to be much more productive than those wells constructed in massive rock.

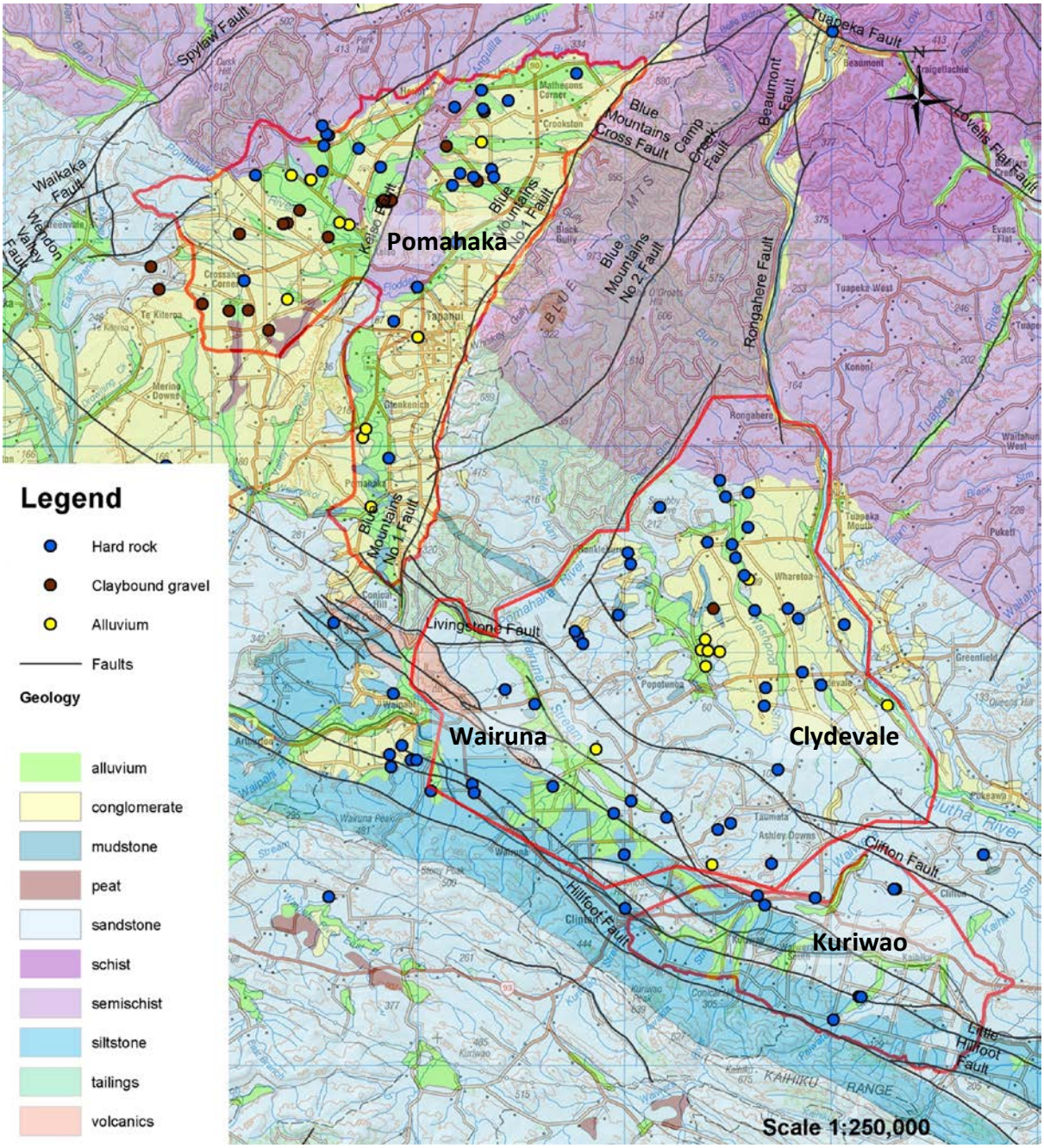


Figure 2: Map of Geological Units and bore construction locations in the Study Area. Map is Geological Map of the Murihiku Area (1:250,000), Turnbull, 2003.

There are 20 bores which have groundwater consents to abstract more than 25,000 litres per day (Figure 3). The majority of consented groundwater abstraction is from bores constructed in hard rock (12), followed by alluvium (5) then claybound gravels (2). The take depth and unit for one consent is unknown. The consented groundwater abstraction in the South Otago area is **0.65 Mm3/yr**.

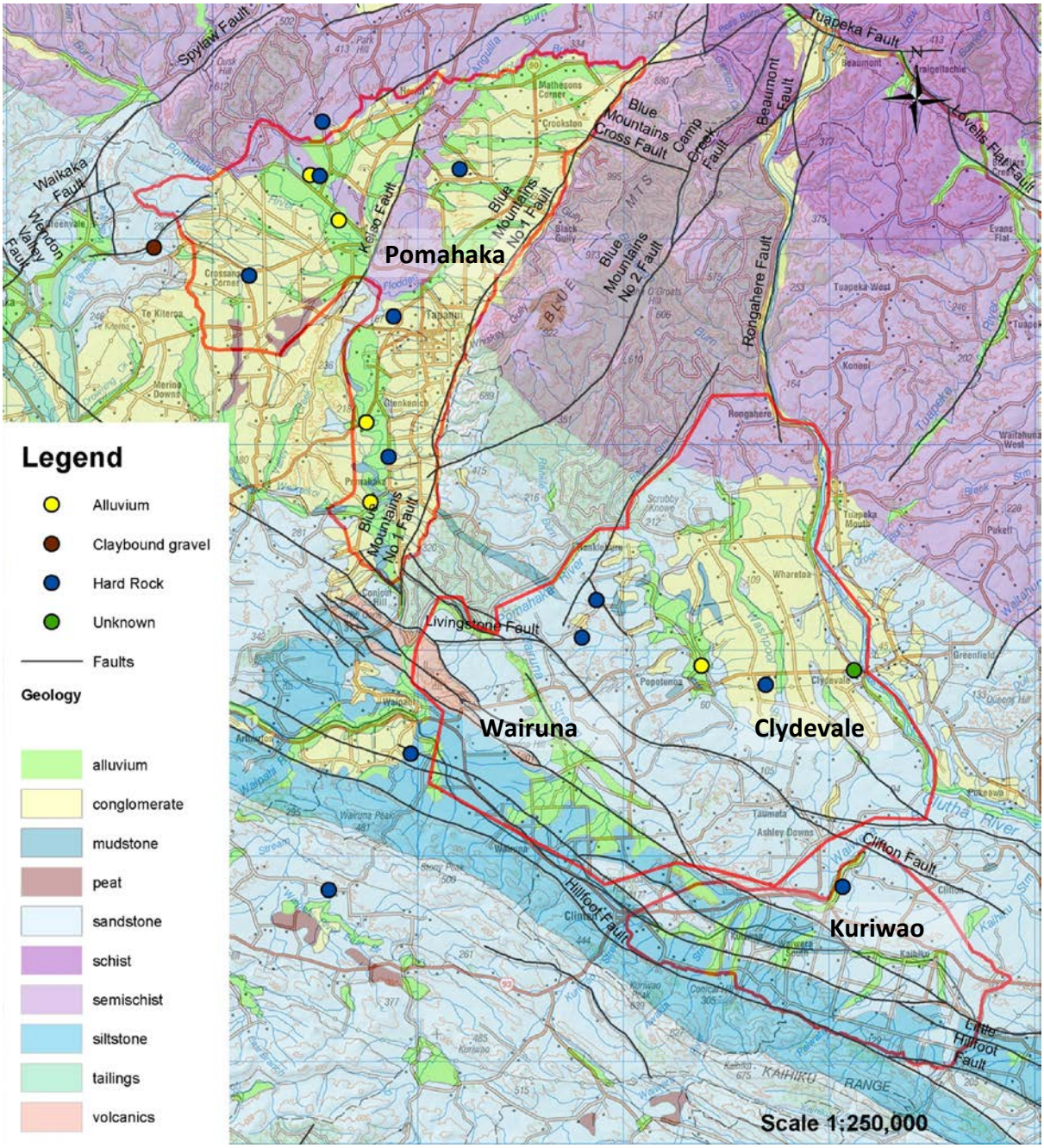


Figure 3: Map of Geological Units and location of consented groundwater takes. Map is Geological Map of the Murihiku Area (1:250,000), Turnbull, 2003.

Bore summary data is presented in Appendix A and consented groundwater abstraction summary is presented in Appendix B.

2.0 Groundwater hydrology

2.1 Aquifer extent

Previous groundwater investigations undertaken in 1999 – 2002 designated the four aquifer boundaries of the South Otago Basins and referred to them as unconfined gravel aquifers. Based on a review of the existing borehole information held in the ORC borehole database, the basins are largely comprised of hard rock and low yielding claybound gravel aquifers. Gravel that has characteristics like an unconfined gravel aquifer exists along surface water bodies that traverse through the basins. The unconfined gravel aquifers are more likely to be thin veneers of gravel placed along the flood plains during the meandering of the rivers, referred to as alluvial ribbons.

Whilst the western side of the mapped Pomahaka basin is comprised of late Quaternary gravels borelogs suggest that the gravels are claybound and flow test data suggests the gravels are low yielding. Some logs indicate that a semi-confined gravel lense is present; however this lense may not be continuous. For the most part, bores in this area are in close proximity to streams/creeks. Due to the low yielding properties, the likelihood of increased groundwater use is low, therefore designating an aquifer zone around the claybound gravels is unnecessary.

2.2 Groundwater flow patterns

The piezometric surface (water table) was calculated for both the South Otago Basin as a whole as well as each individual basin. Regionally, the groundwater flow direction follows the contours of the land, with the Pomahaka and Clutha rivers influencing flow. The groundwater generally flows south from Heriot to Pomahaka. Once past the Blue Mountains, the groundwater flows in an easterly direction towards the Clutha River/Mata Au. Locally the groundwater flow direction follows the contours of the land and flows towards discharge rivers and streams. Locally, groundwater levels are from wells screened in both alluvium and rock (Figure 4).

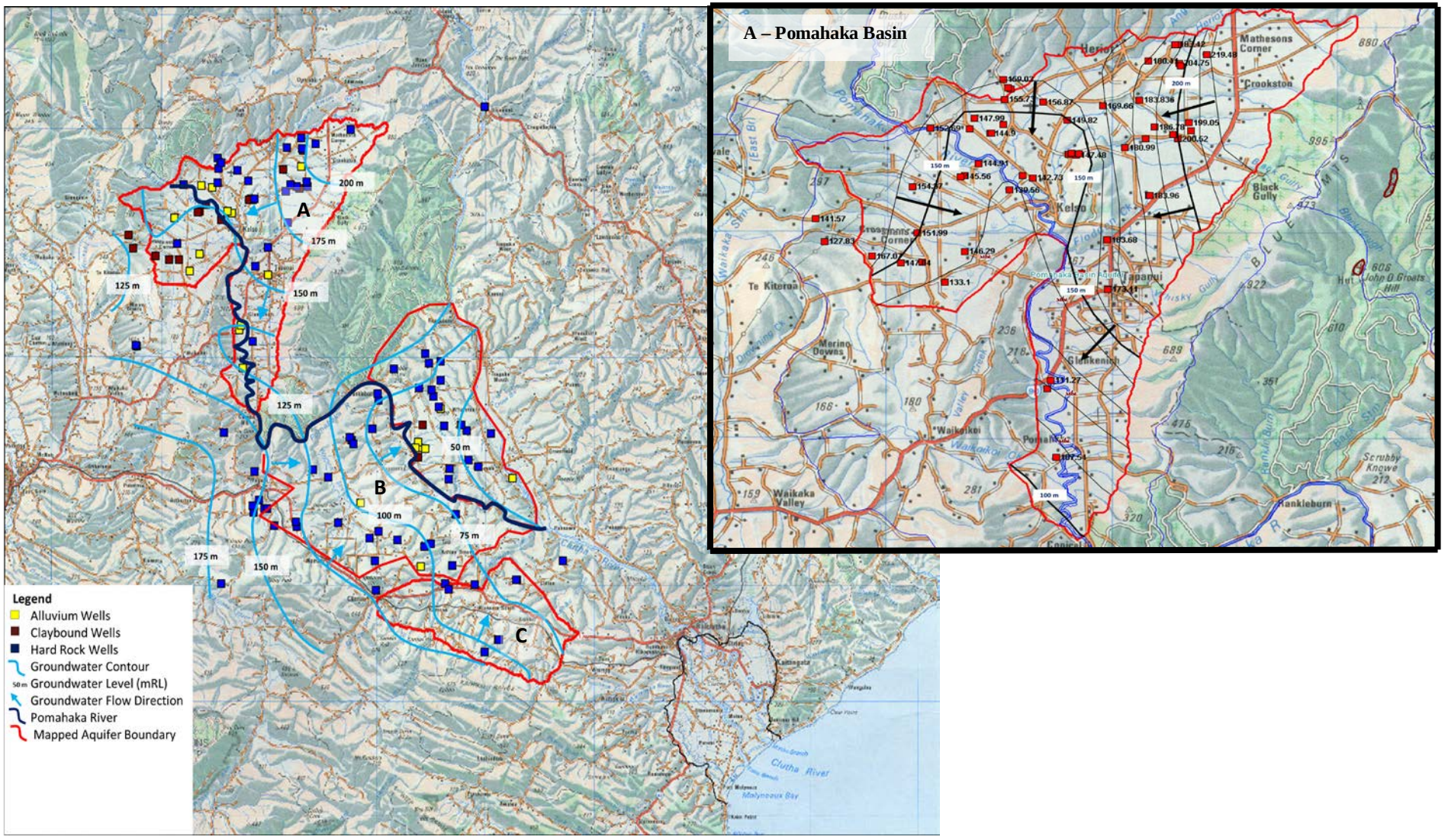
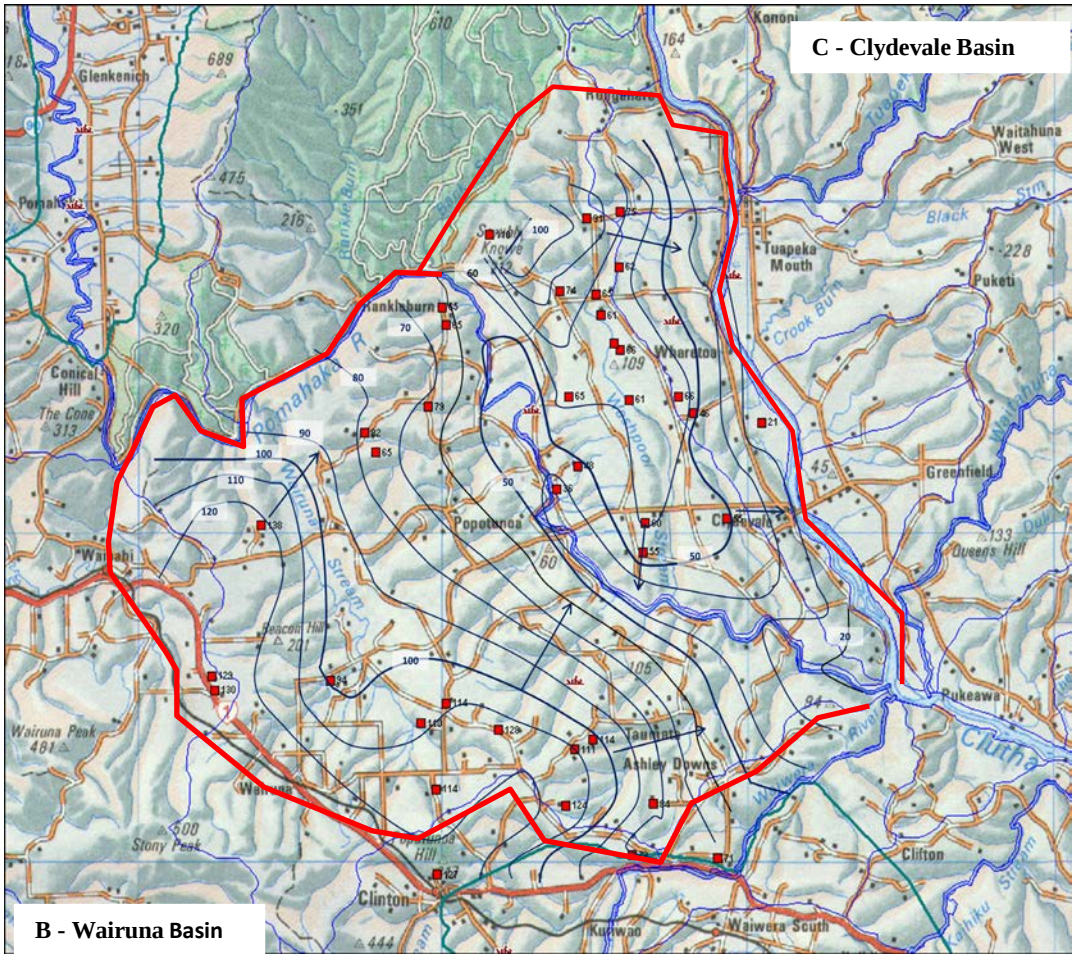


Figure 4 Piezometeic contours of the South Otago Basins



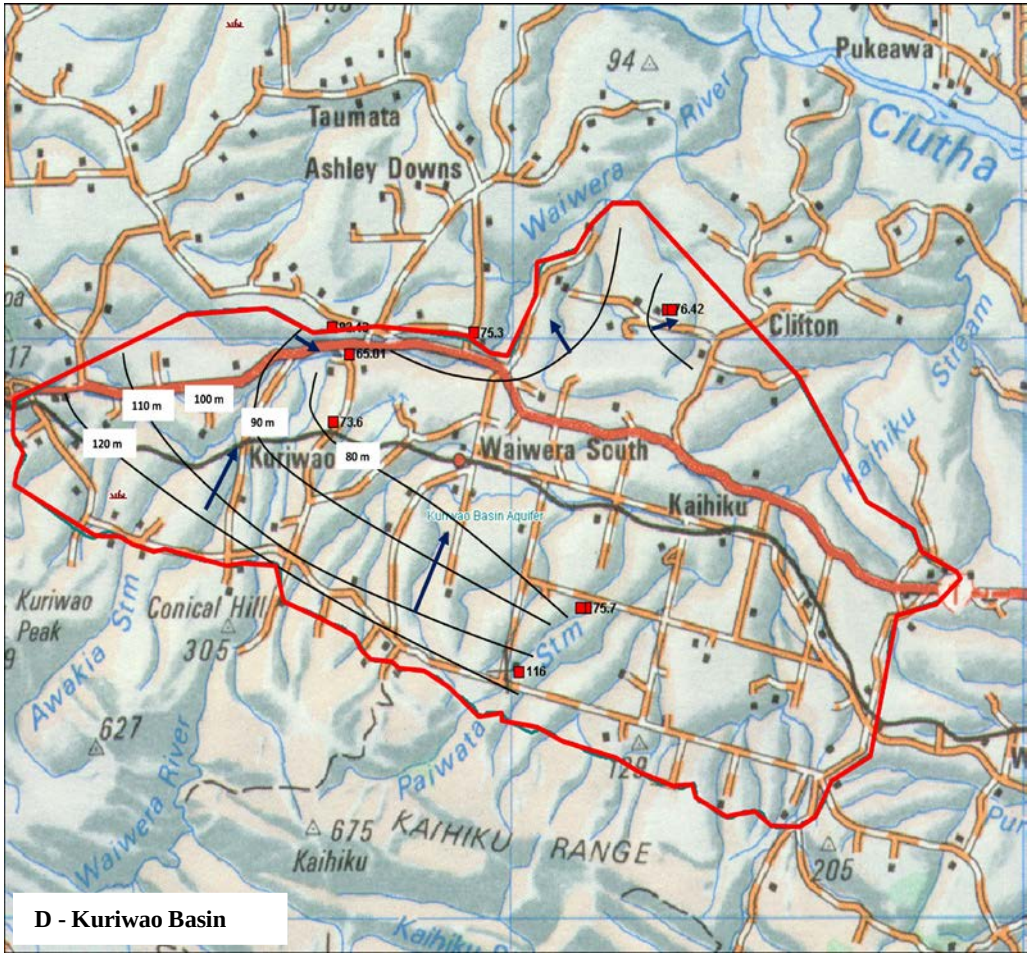


Figure 5: Piezometric contours of the South Otago Basins continued

2.3 Aquifer flow properties

In 2001, a total of 12 single-well constant rate aquifer tests were carried out in the Clydevale and Wairuna Basins, all of which are from wells constructed in hard rock. Five wells were in the Clydevale Basin and seven in the Wairuna Basin. The transmissivity (T) calculated from the single well aquifer tests ranged from 0.64 – 74 m^2/d with an average of 10 m^2/d.

In 2007, a single well step-drawdown test, followed by a constant rate discharge test was carried out in the alluvium within the Pomahaka Basin. Using the Theis method for unconfined aquifers, the analysis resulted in a transmissivity of approximately 3,000 m2/d.

For the rest of the study area, the available pump test data is limited to tests carried out by well drillers at the time of bore completion. Data obtained from bore logs comprised of a maximum measured pumping rate (Q) and drawdown (s) observed in the bore are used to calculate the Specific Capacity (Q/s). This value can be used as a general indicator of the aquifer permeability. However, the results are highly dependent on the construction of the bore, the pumping time and the tested flow rate. Therefore, results should only be used as a general indication of relative permeability.

The locations of aquifer tests are presented below in Figure 5. A table summary of estimated specific capacity values for each well with available data is presented in Appendix C.

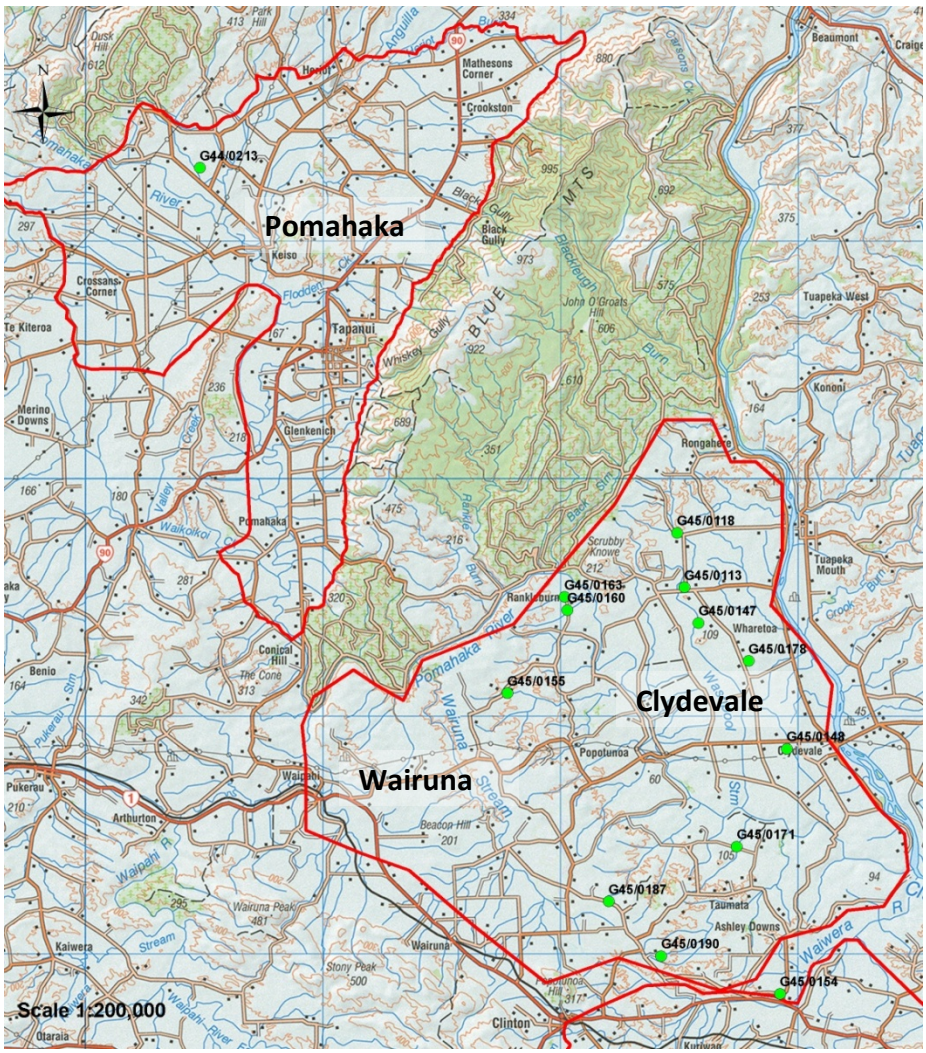


Figure 6: Location of Aquifer Tests

3.0 Groundwater recharge

Recharge is water entering the aquifer system. Recharge can occur through river flow loss or rainfall percolation down through the soil profile. Recharge sources for this location will be mainly from rainfall with a small amount of episodic recharge from rivers and streams.

3.1 Rainfall recharge

Rainfall recharge occurs when the soils are wetter than the field capacity and water can percolate down through the soil profile to the underlying water table. The majority of the South Otago Basin is comprised of rock with rolling and steep terrain. Therefore, the recharge characteristics will differ from flat alluvial basins, as a high percentage of rainfall will contribute to surface water runoff. Weathering of the exposed rocks over time has altered the composition of the rock to clay at the surface. This weathering inhibits the vertical movement of rainwater into the rock aquifer.

The ORC published a rainfall recharge assessment for the Pomahaka, Clydevale/Wairuna and Kuriwao 'aquifers' based on the soil moisture balance model described by Rushton et al. (2006). The key assumption made in the recharge calculations is that water is able to freely drain from the soil profile into underlying permeable geology. It should be noted that these values should be considered as *potential* recharge only, as the basin's substrate is predominately greywacke (ORC, 2011).

A 3-dimensional groundwater model was created in 2002. The model calibration assumed that 3.5% of annual rainfall would recharge the Clydevale Basin and 2.5 % would recharge the Wairuna aquifer (ORC, 2002). Due to the similar geology, it is expected that the amount of recharge reaching the aquifer in the Pomahaka and Kuriwao would be similar. The percentage of rainfall that recharges the aquifer is dependent on the hydraulic conductivity of the soils/rock and fracture zones, therefore the percentage of recharge to the aquifer may change across the aquifer and a localized recharge approach should be used.

The median rainfall recharge for each basin and associated 3D groundwater model calibration is presented below in Table 1.

Table 1: Rainfall recharge modeling results and assumed recharge for South Otago Basins

Aquifer	Area (Ha)	Average Rainfall (mm/yr)	Median Recharge (Mm^3/yr)	3-D model results % recharge reaching aquifer
Clydevale/Wairuna	35,454	627 (lowlands) 771 (highlands)	55.3	3.5% / 2.5%
Kuriwao	10,424	670 (lowlands) 911 (highlands)	22.2	-
Pomahaka	21,894	925	47.4	-

3.2 River discharge

Two gauging stations are located along the Pomahaka River. Pomahaka at Glenken is located just as the Pomahaka River comes out of the rock gorge and enters the Pomahaka Basin. Pomahaka at Burkes Ford is located midway through the Clydevale/Wairuna Basin (Figure 7).

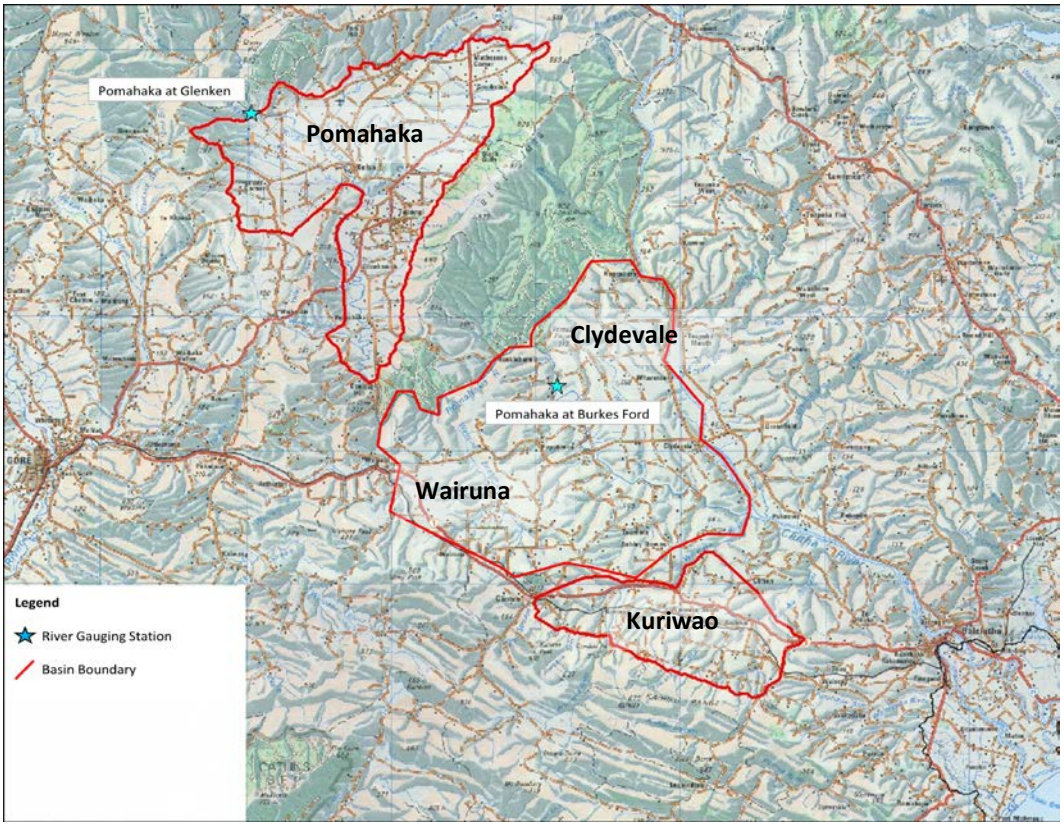


Figure 7: Location of Pomahaka River gauging stations

Comparison of the flow rate at both gauging stations indicates that there is a gain to the Pomahaka River of 22.5 Mm^3/yr as it passes through the Pomahaka and Clydevale/Wairuna basins (Figure 8). The increase is due to a combination of groundwater and surface water inflows.

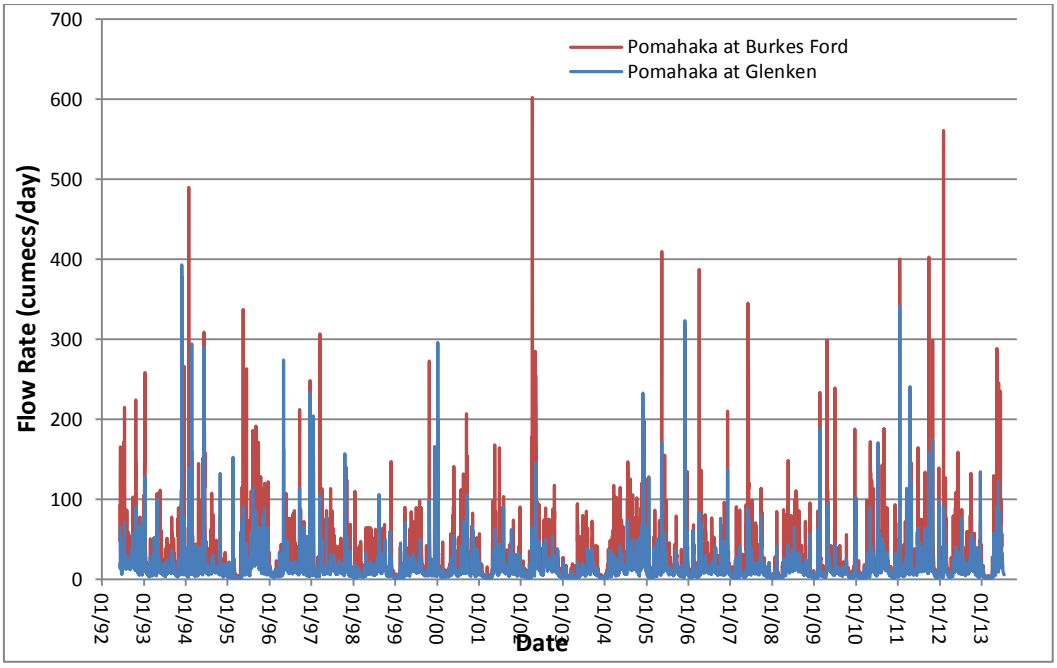


Figure 8 : Comparison of up gradient and down gradient flow of the Pomahaka River

Surface water quality samples show an increasing concentration of nitrate/nitrite nitrogen (NNN) as the Pomahaka River traverses the aquifer (Figure 9). This suggests that the land use in the catchment is having an effect on the water quality. It is likely the increase in NNN may be due to the contribution of overland flow and surface discharge; groundwater discharging into the water bodies may play a part as well. It also correlates well with the percentage of surface water runoff being higher due to the steep terrain of the area and that the basins substrate is predominately rock (or weathered rock).

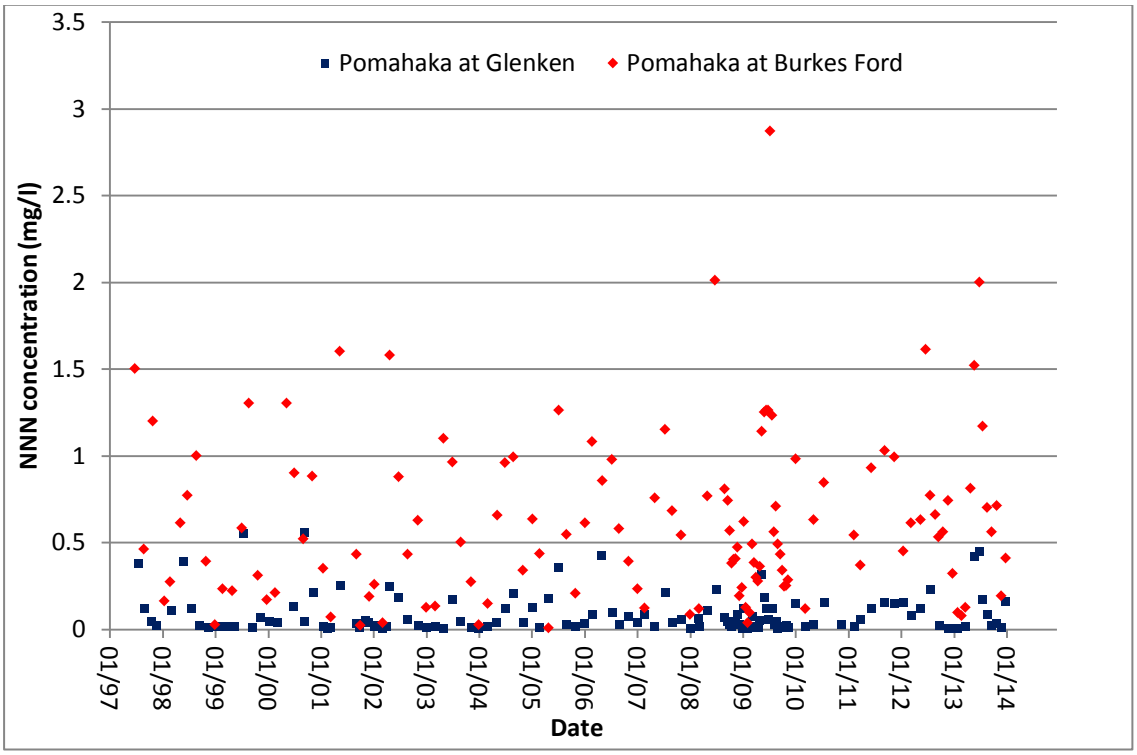


Figure 9: Comparison NNN at surface water gauging stations Pomahaka at Glenken and Burkes Ford

4.0 Groundwater chemistry and quality

Chemical analysis was available from 21 bores from the South Otago Basins. The bores ranged in depth from 3 – 150 m. Five bores were constructed in alluvium, 12 bores were constructed in rock. Construction details of four wells are unknown. The location, depth and monitoring geological unit of each bore is presented below on Figure 10.

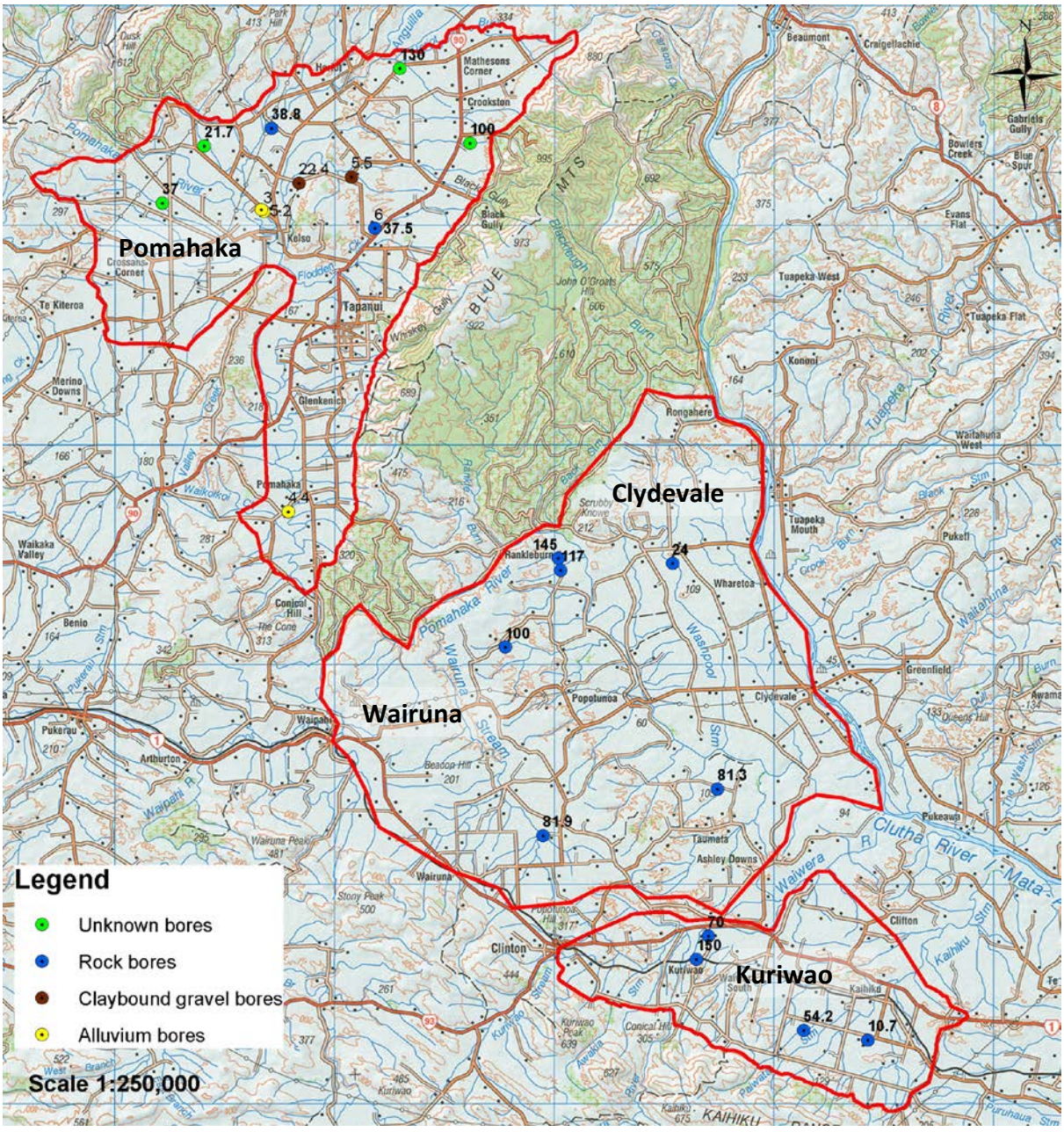


Figure 10: Location, depth and monitoring geological unit of bores where chemical analysis was available

4.1 Groundwater chemistry

Six major ions (Ca_2^+, Mg_2^+, K^+, Na^+, HCO_3^-, CL^- and SO_4^{2-}) form the main constituents of the samples collected in the South Otago Basins. The concentrations of these ions in groundwater are determined by their original composition in recharge water and the hydrogeochemcial processes occurring in the soil and groundwater systems. These factors can lead to different hydrochemcial "signatures" for groundwater in different hydrogeological environments. Identification of the hydrochemcial signatures can assist in the determination of recharge processes and aquifer boundaries.

Tri-Linear Piper Diagrams (Figure 11) can be used to visualize these hydrochemical signatures and to classify groundwater types. The percentages of cations (Ca_2^+, Mg_2^+, K^+ and Na^+) are plotted on the bottom left triangle of the diagram and anions (HCO_3^-, CL^- and SO_4^{2-}) on the bottom right. The two data points on the cation and anion triangles are then combined into the quadrilateral field that shows the overall chemical properties of the water samples. Several surface water samples from the Pomahaka River are also plotted to allow comparison between the chemical composition of surface water and groundwater.

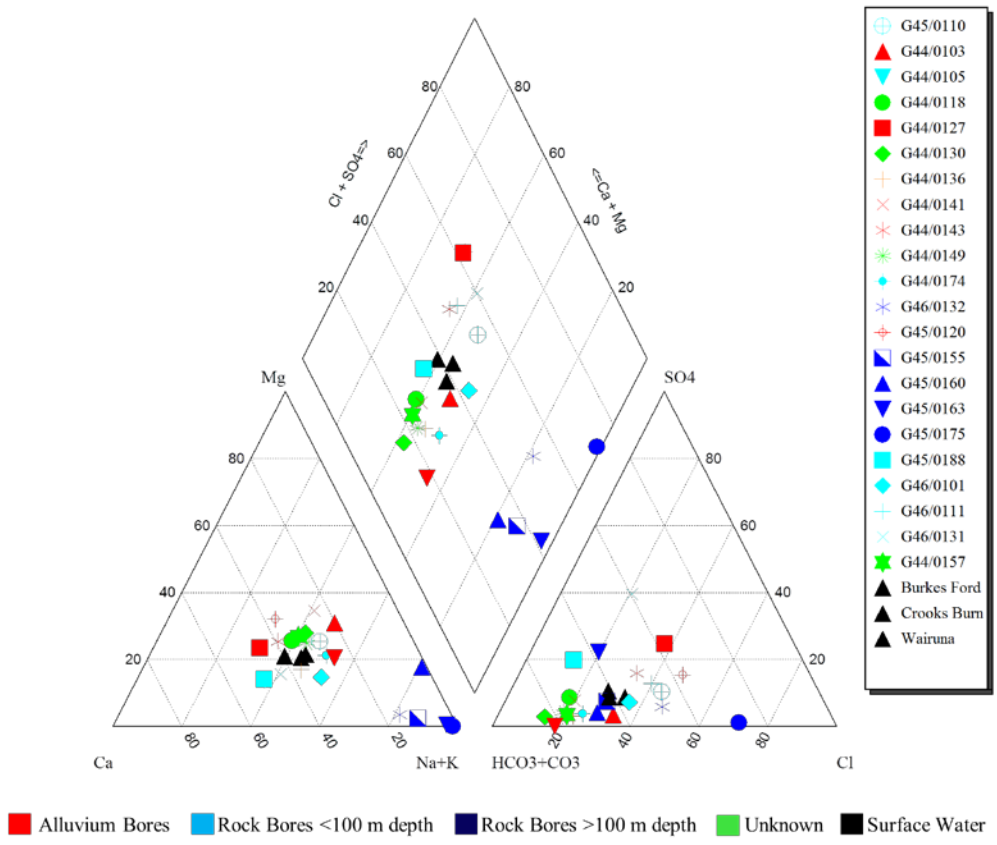


Figure 11: Tri-linear piper diagram – South Otago Bores

The alluvium and shallow rock (< 100 m) samples plot close to the middle of the combined anion-cation field on the Piper Diagram and may be broadly classified as calcium-bicarbonate or sodium-bicarbonate composition. These samples have a very similar composition to surface water in the Pomahaka Catchment, suggesting that groundwater from these wells may be derived from the same source.

However, rainfall and surface water would normally have a higher proportion of calcium and lower proportions of chloride than observed in these samples. The higher proportions of sodium, potassium and chloride in the surface water and shallow groundwater samples may be due to cation exchange between sodium and potassium held in clay minerals and dissolved calcium in the soil zone. These cation exchange processes coupled with mixing of shallow and deeper groundwater will continue within the groundwater system providing additional variation of these parameters. The mixing of water could be due to the bore construction straddling different strata, upwelling of deeper groundwater from the hills as it discharges to the Pomahaka River or proximity of bores to faults.

The hard rock bores greater than 100 m may be classified as sodium-chloride composition which may be representative of older groundwater with a longer residence time and the higher chloride content of the marine sediments found at these depths.

The anion triangle shows that sulphate is proportionally low in most samples. This may be due to reducing conditions, although this would be unexpected in the shallow alluvium samples. Low oxygen, reducing conditions usually occur in deeper groundwater and may also be associated with elevated levels of dissolved iron and manganese and low concentrations of nitrate due to anaerobic biological de-nitrification. This trend is seen in three groundwater samples (G44/0105, G46/0131 and G45/0155).

Trends in chemistry with bore depth can be seen in the groundwater quality results. These trends confirm that there are mixed water types in the South Otago Basins (Figure 12-13). pH, alkalinity, sodium and total dissolved solids all increase with bore depth, whilst magnesium decreases with depth. calcium and sulphate are constant, apart from spikes for bores constructed in shallow rock (< 100m) and Chloride spikes for bores constructed in deep rock (> 100m).

Generally, all the bores constructed in the alluvium have a pH less than 6, $HC0_3^-$ is the dominant anion and they are low in total dissolved solids, but high in nitrate.

Shallow rock bores (< 100m) have a higher pH and are higher in dissolved solids than groundwater from the alluvium bores. They also show a spike in calcium and sulphate. Groundwater in these bores may represent mixing between shallow and deep groundwater and or the longer residence time of groundwater at these depths.

Deep bores (> 100m) constructed in rock have a higher pH and are higher in sodium and total dissolved solids than all of the other bores. This may indicate that the groundwater has a greater residence time and is therefore older and does not receive recharge from rainfall. The higher chloride content is likely due to the higher chloride content of the marine sediments found at these depths. Nitrate concentrations in these wells are very low which may indicate anaerobic biological de-nitrification under reducing conditions or old groundwater relatively unaffected by recent land use changes. Ammonium concentrations are slightly higher in the deep wells which may also indicate

nitrate reduction.

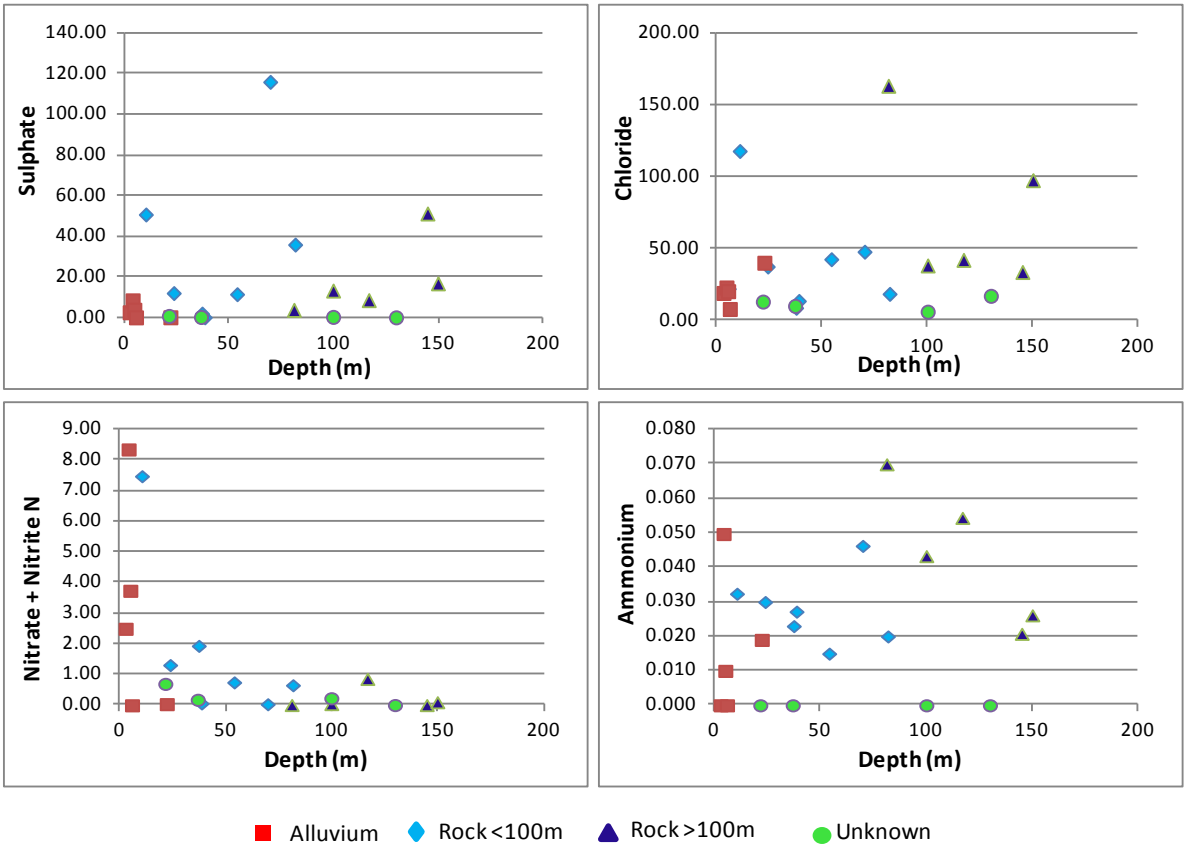


Figure 12: Trends in groundwater chemistry in groundwater in South Otago

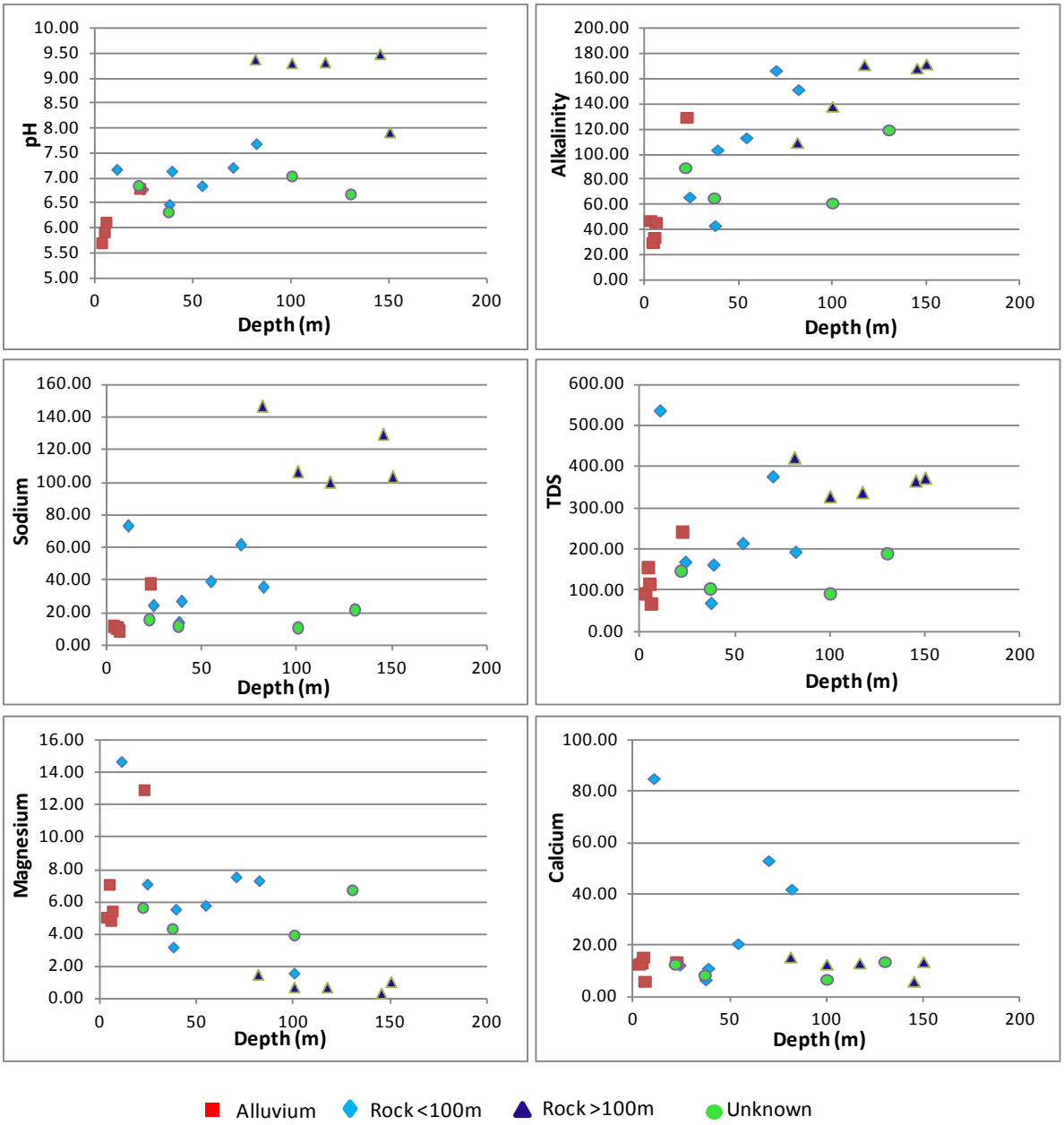


Figure 13: Trends in groundwater chemistry in groundwater in South Otago continued.

4.2 Groundwater quality

Average water quality results have been compared to relevant water quality standards and guidelines (Table 3). A summary of the water quality standards and guidelines used is provided in Table 2. Results of the chemical and physical analyses are presented in Appendix D.

Comparison to the guidelines reveals that the majority of the samples (15) have pH values outside of the New Zealand Drinking Water Standards (NZDWS) guideline range of 7.0 – 8.5. Eleven samples have pH lower than 7.0 and 4 samples have a pH higher than 8.5. All of the samples with low pH (apart from G44/0149) are < 100 m deep, whilst samples with a higher pH than 8.5 are > 100 m in depth. Whilst pH generally will not affect the health of humans/animals, low pH (< 6.0) risks deterioration of bores, pipes, pumps, irrigation and stock water equipment due to corrosion or fouling.

Seven groundwater samples exceed the NZDWS aesthetic guideline for total iron and one groundwater sample exceeds the guideline for bicarbonate (HCO_3^-). All samples were within the NZDWS guidelines or maximum acceptable values for calcium, chloride, magnesium, manganese, sodium and sulphate. Several samples exceeded the ANZECC recreational purposes guidelines for manganese.

Seven groundwater samples returned positive counts of faecal coliform bacteria over the NZDWS maximum acceptable value (note: some individual samples also exceed the ANZECC stock water guidelines). The highest count of 6,500 cfu/100mL sampled on 25/10/2001 was taken from well G46/0131 (Appendix D). The average results range from 3.67 – 735.22 cfu/100mL. Of the seven samples, four of them are located in wells < 20 m deep and three are located in wells > 50 m deep. These wells are located in the shallow alluvium/claybound gravel wells in the Pomahaka Basin and deep rock wells in Kurwaio. The contamination is most likely due to localized contaminants source and or poor wellhead protection.

Very low nitrite-nitrate nitrogen (NNN) levels have generally been measured. Some elevated levels were recorded for shallow wells < 10 m depth. The average ranged from < 0.01 – 8.36 mg/L. Whilst the average values are below the NZDWS maximum acceptable value and the ANZECC guidelines for recreational purposes, some individual samples do exceed these values. NNN in some shallow wells often exceeded the ANZECC trigger values for freshwater protection.

There is an increasing trend of NNN in two wells G44/0127 (Pomahaka) and G45/0110 (Clydevale). These trends are most likely due to intensification of land for dairy use (Figure 14).

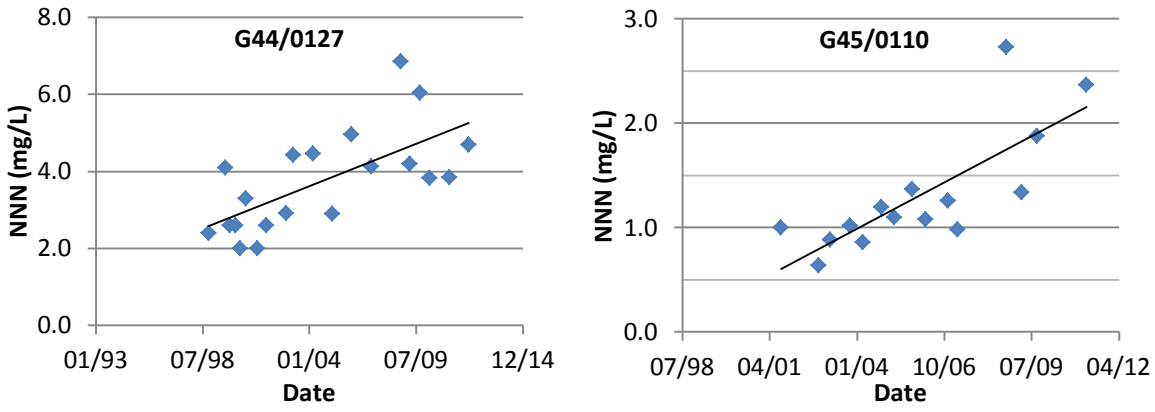


Figure 14: Increasing trends in NNN in the Pomahaka and Clydevale Basins

The chemical analysis ranges from 1998 – 2012 and includes results for a range of physical and chemical properties. The water quality results are presented in Appendix D, summary of the water quality standards and guidelines and the average water quality results are presented below in Table 2 and 3.

Table 2: Summary of the water quality standards and guidelines

		Guidelines and Standards			
Parameter	**Abbreviation**	**Drinking Water Standards for New Zealand 2005**	**ANZECC Guidelines for Livestock Drinking Water**	**ANZECC trigger values for freshwater 95% level of protection**	**ANZECC Guidelines for recreational purposes**
Nitrate N	NO_3-N	11.3 mg/L[3]	90.3 mg/L	7.2 mg/L	10.0 mg/L
Nitrite N	NO_2-N	0.06 mg/L[3]	-	-	1.0 mg/L
Ammoniacal Nitrogen	NH_4-N	-	-	0.9 mg/L	-
Conductivity	EC	-	-	-	-
pH	pH	7.0 – 8.5[1]	-	-	6.5 – 8.5
Faecal coliforms	FC	<1[3] cfu/100mL	100 cfu/100mL	-	-
Bicarbonate	HCO_3	-	-	-	-
Calcium	Ca	100 mg/L[1,2]	1000 mg/L	-	-
Chloride	Cl	250 mg/L[1]	-	-	400 mg/L
Magnesium	Mg	100 mg/L[1,2]	-	-	-
Manganese	MnD	0.4 mg/L[3]	-	1.9 mg/L	0.1 mg/L
Sodium	Na	200 mg/L[1]	-	-	300 mg/L
Sulphate	SO4	250 mg/L[1]	1000 mg/L	-	400 mg/L
Total Iron	FeD	0.2 mg/L[1]	-	-	-
Total Dissolved Solids	TDS	1000 mg/L[1]	2400 mg/L		1000 mg/L

[1]Guideline value for aesthetic determinant
[2] Guideline value is for total hardness (Ca + Mg)
[3]Maximum acceptable value

Table 3: Average groundwater chemistry and quality results

Well ID	Sample Frequency	Depth (m)	Lithology	X	Y	Temp	EC	pH	FCC	CO_3	HCO_3	Ca	Cl	DRP	K	Mg	Na	NH_4-N	NNN	SO_4	TDS	FeT	FeD	MnD
						C°	uS/cm		cfu/ 100ml	mg/litre														
G44/0143	1	3	Alluvium	2216600	5472600	12.2	0.18	5.72	-	-	48.00	13.00	19.00	0.007	2.40	5.10	12.00	0.005	2.50	12.00	92.69	-		
G45/0120	13	4.4	Alluvium	2217697	5458946	12.1	0.21	5.94	-	-	30.50	13.46	22.81	0.025	3.57	7.14	10.98	0.020	8.36	10.02	156.33	1.04		
G44/0127	19	5.2	Alluvium	2216495	5472696	11.8	0.19	6.13	8.2	1.00	34.65	15.77	20.23	0.015	2.25	4.90	10.95	0.009	3.74	17.86	116.00	0.05		
G44/0141	10	6	Alluvium	2221650	5471830	10.7	0.11	6.42	325.00	1.00	46.60	6.34	7.85	0.341	1.75	5.48	9.04	0.010	1.78	3.80	68.00	0.05	0.05	
G44/0103	1	22.4	Claybound	2218200	5473900	14.6	3.30	6.81	-	-	130.00	14.00	40.00	0.047	1.50	13.00	38.00	0.019	0.04	5.60	242.52	-		
G44/0136	19	5.5	Claybound	2220588	5474172	11.6	0.27	7.26	16.22	1.00	128.25	21.75	21.97	0.014	1.27	6.05	30.55	0.012	0.28	4.13	174.50	4.15		
G46/0111	9	10.7	Rock	2244014	5434867	11.7	0.82	7.19	209.33	1.00	239.50	85.38	117.66	0.483	0.80	14.75	73.55	0.020	7.49	50.59	536.67	0.13	1.00	0.06
G45/0110	14	24	Rock	2235170	5456560	11.6	0.24	6.79	-	1.00	66.67	12.63	37.37	0.083	1.00	7.15	24.69	0.017	1.31	11.94	169.33	-		
G44/0174	9	37.5	Rock	2221655	5471831	11.3	0.12	6.49	-	1.00	44.00	6.91	8.68	0.085	1.00	3.25	14.24	0.013	1.94	1.85	69.58	1.30		
G44/0105	9	38.8	Rock	2216957	5476389	11.3	0.22	7.16	<1	1.00	104.10	11.44	13.47	0.024	1.02	5.60	27.27	0.027	0.06	0.02	162.42	1.36		0.01
G46/0101	14	54.2	Rock	2241094	5435312	11.5	0.33	6.88	8.50	1.00	113.73	21.00	42.27	0.026	0.64	5.83	39.39	0.012	0.74	11.44	214.60	0.22	0.68	0.24
G46/0131	13	70	Rock	2236769	5439613	12.1	0.61	7.23	735.22	1.00	167.15	53.39	47.67	0.006	0.43	7.60	61.98	0.036	0.03	115.81	376.67	1.97	0.01	0.06
G45/0188	6	81.9	Rock	2229251	5444196	11.6	0.42	7.71	-	1.00	152.00	42.25	18.37	0.022	0.78	7.37	36.00	0.013	0.66	35.78	193.60	-		0.26
G45/0155	4	100	Rock	2227548	5452769	12.9	0.57	9.33	<1	1.00	138.75	10.89	38.13	0.010	0.77	1.64	106.75	0.035	0.04	13.18	328.33	-		0.11
G45/0160	10	117	Rock	2230080	5456260	12.0	0.48	9.34	<1	1.00	171.73	1.51	42.00	0.153	1.56	11.71	100.37	0.046	0.86	8.48	338.41	-		0.17
G45/0171	1	81.3	Rock	2237191	5446299	-	0.77	9.40	-	1.00	110.00	1.73	163.00	0.009	0.40	0.07	147.00	0.070	0.01	3.70	423.00	-		
G45/0163	15	145	Rock	2229967	5456808	12.6	0.56	9.51	<1	1.00	169.06	3.33	33.58	0.011	1.12	0.39	129.75	0.019	0.01	51.08	366.50	-		
G46/0132	9	150	Rock	2236222	5438551	11.6	0.61	7.94	3.67	1.00	172.40	16.58	97.39	0.004	0.39	2.41	103.72	0.021	0.10	16.73	373.33	0.38		
G44/0118	1	21.7	Unknown	2213900	5475600	13.6	0.20	6.87	-	-	90.00	13.00	13.00	0.045	0.92	5.70	16.00	0.005	0.70	8.40	147.76	-		
G44/0157	1	37	Unknown	2212000	5473000	15.0	0.14	6.34	-	-	66.00	8.80	10.00	0.061	0.83	4.40	12.00	0.005	0.18	2.40	104.61	-		
G44/0130	1	100	Unknown	2226000	5475700	14.6	1.20	7.06	-	-	62.00	7.10	6.00	0.053	0.63	4.00	11.00	0.005	0.23	1.70	92.71	-		
G44/0149	1	130	Unknown	2222800	5479100	11.8	0.23	6.70	-	-	120.00	14.00	17.00	0.003	0.99	6.80	22.00	0.005	0.01	5.20	190.00	-		

red – denotes exceeds exceeds guideline value or standard in Table 2

– Pomahaka Basin

– Wairuna Basin

– Clydevale Basin

– Kuriwao Basin

5.0 Groundwater Resource Management

5.1 Implications for water management

The new information for the South Otago basin aquifers has implications for water management, as the Regional Plan: Water for Otago (RPW) is based on the results of the 1999 - 2002 studies. The current groundwater management regime for the Pomahaka and Kuriwao basins may be overly restricted as the majority of the basins are hard rock or low yielding claybound gravel, not connected to the surface water and rely mainly on localized recharge and discontinuities for long yielding water supply. However, the presence of recent gravel alluvial ribbons in the basins means that groundwater management has the potential to affect surface water bodies in the Pomahaka Catchment which have significant natural and recreational values. These matters are explained below.

5.2 C-series maps of Aquifers, Groundwater Zones and Groundwater Protection Zones

The Regional Plan: Water for Otago (RPW) includes both the Pomahaka and Kuriwao basin aquifers in the C-series maps of Aquifers, Groundwater Zones and Groundwater Protection Zones (C13, C14 and C16). That was based on the presumption they are gravel alluvium aquifers and are connected to surface water. As noted above, the majority of the basins are hard rock and are not connected to surface water making the current groundwater management for these basins overly restrictive. Consideration should therefore be given to removing the Pomahaka and Kuriwao Aquifers from the C-series maps of the RPW.

5.3 Gravel alluvium management

The RPW allows the designation of 'alluvial ribbons'. Groundwater takes within alluvial ribbon aquifers are treated as surface takes with restriction imposed during low river flows (where applicable) as per Section 6.4.1A of the RPW.

No alluvial ribbons are presently defined in the RPW for the South Otago basin because the studies undertaken in 1999- 2002 identified the basins as being gravel alluvial aquifers, which subsequently resulted in the entire basin being mapped as an aquifer. The review has therefore defined potential alluvial ribbons for the purposes of further consideration as to whether to amend the RPW. The suggested alluvial ribbons are based on two reaches of the Pomahaka River and one reach of the Waipahi Stream which have the highest natural values (Figure 1).

Notwithstanding the comments in 5.2 above, the identified ribbon aquifers may be vulnerable to leachate contamination because of their connection to surface water. Consideration should therefore be given to defining the ribbon aquifers as nitrogen sensitive zones in the RPW (on the H-map series). Additional work would be required to determine which leaching rate (15, 20 or 30 kg/N/ha) should be applied.

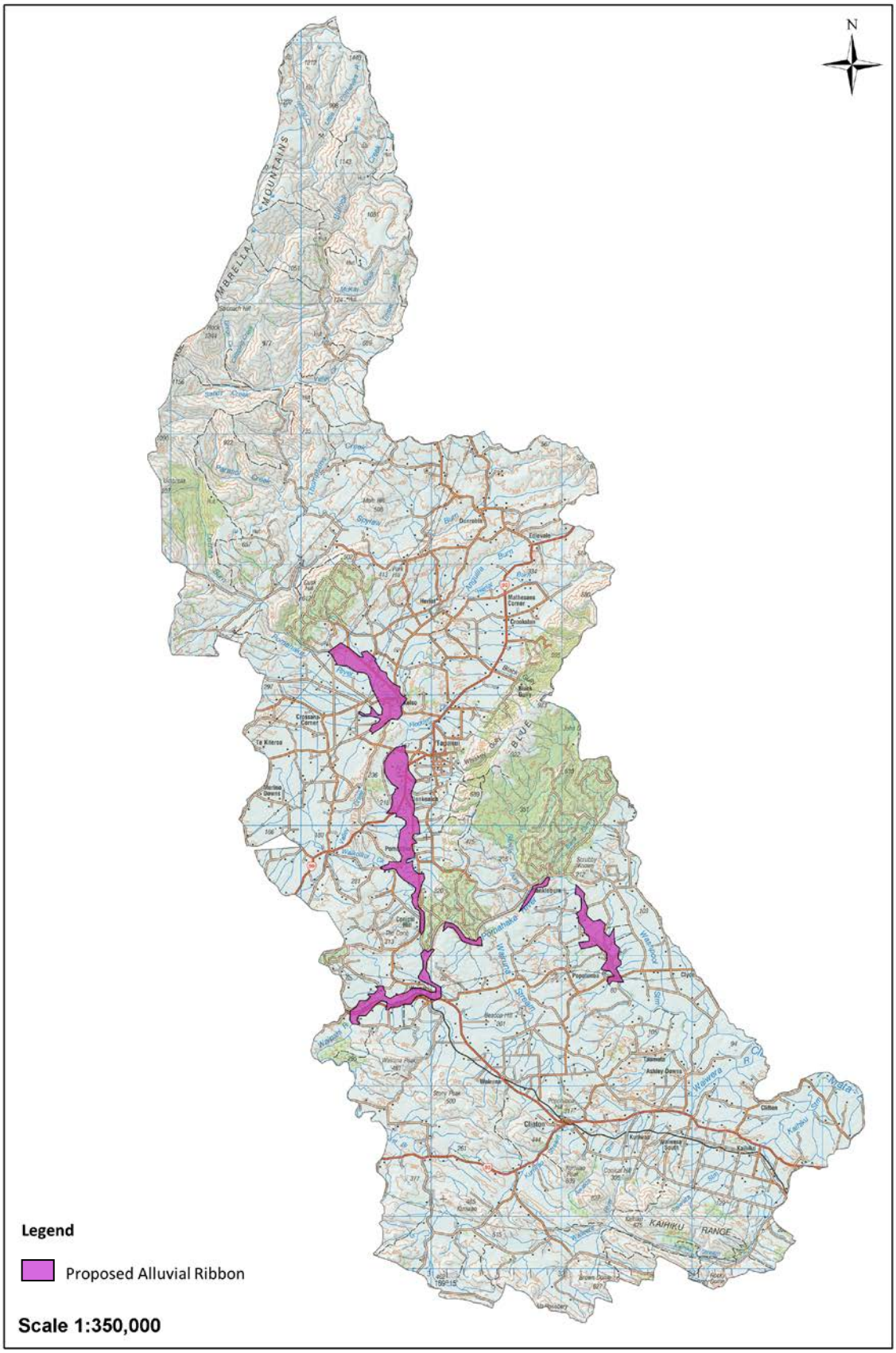


Figure 15 Proposed alluvial ribbon aquifers in the Pomahaka, Waiwera and Kaihiku Catchments

5.4 Management of hard rock aquifers

Fractured rock aquifers differ from alluvial gravel aquifers. Alluvial gravel aquifers transmit water through pore spaces between the individual granules and groundwater is generally continuous throughout the area of the aquifer. A rock aquifer relies on discontinuities such as joints, fractures, crevices etc to transmit water. Therefore, the availability of long-yielding water is localized and depends on the interconnection of the discontinuities (Figure 16). This means it is difficult to set allocation limits for the aquifer, yet it is still important to manage the groundwater resource.

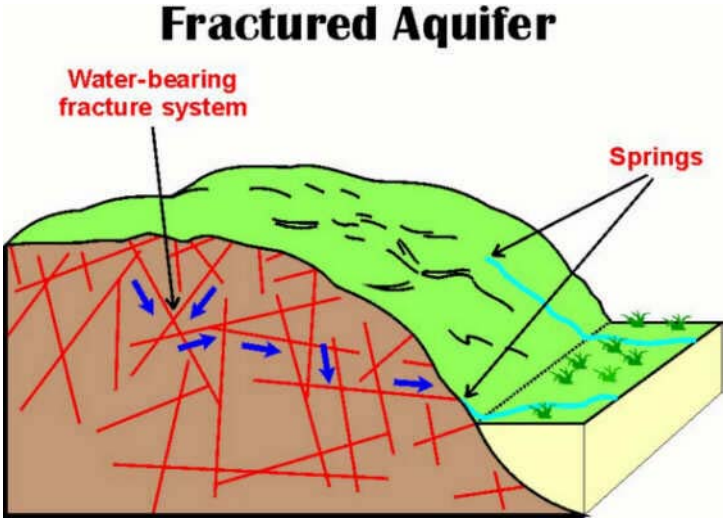


Figure 16: Example of fractured rock aquifer and groundwater flow along discontinuities

Due to the groundwater resources being localized, it is not possible to manage the hard rock aquifer at a regional or even aquifer scale. This is because the water resources will not be the same throughout the aquifer. For example, bores located within close proximity to each other, may not intercept the same discontinuity even though they are within the same rock mass. Currently the demand for water resources from fractured rock aquifers in both the study area and in the Otago Region is low. Therefore, the management of this resource is suitably covered in the existing RPW.

When the rock aquifer resource is in greater demand, a detailed management regime taking on the localized approach can be applied.

6.0 Conclusions

- All of the information reviewed indicates that the four basins that make up the South Otago Basins are predominately rock aquifers with self limited supplies. The permeability of the rock aquifer is dependent on fractured rock zones;
- Review of hydraulic properties shows that wells that target the thin veneers of Quaternary alluvium along the surface water bodies demonstrate properties of higher yielding material;
- Review of the groundwater levels shows that for the most part the piezometric levels are higher than the surface water bodies, meaning that the surface water bodies are discharge points for groundwater;
- Water chemistry analysis indicates that there are at least two types of groundwater present in South Otago Basins. Groundwater from shallow bores has the same chemical signature as the surface water. Both have higher proportions of sodium, potassium and chloride which may be due to cation exchange between sodium and potassium held in clay minerals and dissolved calcium in the soil zone. Groundwater from deep bores has a higher residence time and appears to undergo anaerobic biological de-nitrification under reducing conditions.
- Groundwater quality results indicate that the groundwater may not be aesthetically pleasing as the pH and total iron levels are generally outside of the drinking water guideline. Faecal coliform bacteria is present in seven bores. This is most likely due to local contaminants and/or poor well head protection;
- Nitrate/nitrite nitrogen (NNN) levels are below the guideline, however an increasing trend is visible in two monitoring wells located in the Pomahaka and Clydevale basins;
- Due to the geology and hydraulic nature of the South Otago basins, consideration should be given to removing the Pomahaka, and Kuriwao from the C-series maps of the RPW;
- The surface water bodies in the study area all have natural and recreational values. To protect these, it is suggested that an alluviual ribbon aquifer be assigned around the Pomahaka and Waipahi Rivers, which have the highest value. Upon consultation with all relevant parties, consideration should be made to identify these ribbon aquifers and implement them onto the C-map series of the RPW;
- The ribbon aquifers may be vulnerable to leachate contamination and therefore, consideration should be given to identify the ribbon aquifers as nitrogen sensitivity zone on the H-map series; and
- Whilst the long yielding groundwater in rock aquifers is dependent on discontinuities, it is still important to manage the groundwater resource. Due to the low use of the rock aquifer, the management of this resource is suitably covered in the RPW.

7.0 References

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Appendix A – Bore data summary

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G44/0127	5.20	0.100	-1.20	2216495	5472696	143.93	McNeill	Alluvium
G44/0141	6.00	1.200	-3.60	2221650	5471830	187.56		Alluvium
G44/0176	10.00	0.100	0.00	2222900	5476700	0.00	McNeill	Alluvium
G44/0189	11.50	0.100	-5.00	2213700	5475100	156.16	McNeill	Alluvium
G44/0190	18.43	0.125	-7.75	2233820	5452056	37.32	McNeill	Alluvium
G44/0208	6.00	0.150	-2.80	2216043	5472817	145.85	McNeill	Alluvium
G44/0213	9.50	0.152	-4.00	2214661	5474877	159.00	McNeill	Alluvium
G44/0221	12.00	0.000	-3.70	2214629	5474871	148.60	McNeill	Alluvium
G45/0100	11.50	0.100	-6.70	2234400	5452000	55.14	McNeill	Alluvium
G45/0106	5.00	0.125	-2.50	2233700	5451300	38.48	McNeill	Alluvium
G45/0107	9.00	0.100	0.00	2233700	5452600	0.00	McNeill	Alluvium
G45/0145	6.00	0.100	-3.40	2234000	5441700	127.05	McNeill	Alluvium
G45/0156	5.70	0.000	0.00	2233500	5452100	0.00	McNeill	Alluvium
G45/0158	20.00	0.100	-10.20	2213500	5469100	156.49	McNeill	Alluvium
G45/0162	123.00	0.100	0.00	2228400	5447300	0.00	McNeill	Alluvium
G45/0174	24.50	0.100	-5.10	2235800	5455500	77.45	McNeill	Alluvium
G45/0198	14.00	0.150	-3.50	2242500	5449400	17.57	McNeill	Alluvium
G45/0225	5.20	0.500	-3.50	2217529	5459057	111.04	McNeill	Alluvium
G45/0237	6.00	0.150	-3.35	2219816	5467258	176.46	McMilans	Alluvium
G45/0238	5.50	0.150	-3.60	2219822	5467261	176.46	McMilans	Alluvium
G45/0239	5.50	0.150	-3.50	2219816	5467254	176.46	McMilans	Alluvium
G45/0240	5.20	0.500	-3.68	2217148	5462405	115.70	McNeill	Alluvium
G45/0241	5.55	0.900	-4.15	2217298	5462808	115.42	McNeill	Alluvium
F44/0100	52.00	0.100	-11.00	2206900	5470700	152.57	McNeill	Claybound
F45/0101	30.00	0.100	-17.60	2207300	5469600	145.43	McNeill	Claybound
F45/0108	52.18	0.150	-3.93	2209393	5468873	171.00	McNeill	Claybound
G44/0103	22.40	0.150	-7.64	2218200	5473900	160.50	McNeill	Claybound

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G44/0165	33.00	0.100	-12.70	2214100	5473400	157.61	McNeill	Claybound
G44/0173	21.00	0.100	-9.10	2218400	5473800	156.58	McNeill	Claybound
G44/0179	33.00	0.100	-3.00	2222700	5474800	207.07	McNeill	Claybound
G44/0188	55.00	0.100	-11.80	2213500	5472800	161.95	McNeill	Claybound
G44/0201	8.00	0.300	-2.10	2221205	5476500	185.94	McNeill	Claybound
G44/0210	22.50	0.300	-12.30	2218072	5473828	156.77	McNeill	Claybound
G44/0218	12.00	0.152	-8.00	2211190	5472262	162.37	South Drill	Claybound
G44/0219	21.63	0.152	-9.32	2218547	5473887	159.47	McNeill	Claybound
G44/0220	38.80	0.150	-22.94	2223035	5478162	214.21	McNeill	Claybound
G44/0222	60.00	0.150	-12.70	2213312	5472748	158.26	McNeill	Claybound
G44/0227	32.00	0.000	-2.00	2215480	5472105	141.56	McNeill	Claybound
G45/0104	50.00	0.100	-26.00	2212600	5467600	159.10	McNeill	Claybound
G45/0169	28.70	0.150	-7.30	2234100	5454100	72.31	McNeill	Claybound
G45/0208	42.20	0.150	-15.30	2211615	5468573	162.65	McNeill	Claybound
G45/0236	78.50	0.152	-11.50	2210673	5468543	158.54	McNeill	Claybound
F45/0102	112.00	0.150	-8.40	2224200	5478700	148.60	McNeill	Rock
F45/0107	45.69	0.150	-12.78	2223394	5475381	148.51	McNeill	Rock
G44/0102	62.00	0.100	-2.50	2235600	5455700	162.88	McNeill	Rock
G44/0105	75.10	0.150	-8.14	2231800	5444000	162.41	McNeill	Rock
G44/0123	33.00	0.150	-5.43	2211972	5475113	156.02	McNeill	Rock
G44/0124	82.00	0.125	-9.10	2229758	5442190	190.79	McNeill	Rock
G44/0125	87.50	0.100	-2.00	2224000	5450200	201.66	McNeill	Rock
G44/0126	129.00	0.138	-9.30	2221600	5478400	164.51	McNeill	Rock
G44/0129	80.10	0.150	-10.37	2229500	5453800	189.71	McNeill	Rock
G44/0137	35.00	0.100	-19.10	2211400	5470000	204.46	McNeill	Rock
G44/0163	54.00	0.100	0.00	2227500	5480000	168.53	McNeill	Rock
G44/0174	45.00	0.138	0.00	2234400	5460300	187.56	McNeill	Rock

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G44/0175	124.00	0.150	-3.90	2219000	5447500	209.73	McNeill	Rock
G44/0177	145.00	0.100	-5.80	2229967	5456808	266.28	McNeill	Rock
G44/0183	25.50	0.150	-1.40	2234300	5443400	227.88	McNeill	Rock
G44/0191	48.00	0.150	-8.60	2235000	5457200	50.10	McNeill	Rock
G44/0193	132.50	0.150	0.00	2237191	5446299	156.73	McNeill	Rock
G44/0197	72.00	0.152	-29.50	2227765	5452407	158.12	McNeill	Rock
G44/0209	36.00	0.100	-6.00	2231500	5459000	211.83	McNeill	Rock
G44/0212	24.00	0.150	-9.00	2235170	5456560	189.48	McNeill	Rock
G44/0215	26.00	0.150	-15.00	2218473	5446475	213.79	McNeill	Rock
G44/0217	256.00	0.150	-25.20	2236536	5449384	161.25	McNeill	Rock
G45/0103	61.00	0.150	-7.80	2218402	5447056	89.49	McNeill	Rock
G45/0105	54.20	0.150	-5.53	2241094	5435312	86.22	McNeill	Rock
G45/0110	97.00	0.100	-7.00	2221500	5474600	71.89	McNeill	Rock
G45/0113	40.00	0.100	-0.60	2242900	5440500	79.36	McNeill	Rock
G45/0115	119.40	0.150	-8.50	2239894	5482012	76.60	McNeill	Rock
G45/0116	84.00	0.150	-5.40	2215723	5453446	171.09	McNeill	Rock
G45/0117	37.50	0.150	-4.90	2221655	5471831	0.00	McNeill	Rock
G45/0118	41.14	0.150	-9.04	2222983	5478293	92.56	McNeill	Rock
G45/0140	47.00	0.125	-16.00	2235800	5459700	77.02	McNeill	Rock
G45/0146	47.30	0.152	-3.10	2222407	5445631	0.00	McNeill	Rock
G45/0147	31.20	0.150	-3.20	2239865	5434190	69.28	McNeill	Rock
G45/0148	81.30	0.150	-4.68	2220416	5445292	55.38	McNeill	Rock
G45/0150	75.50	0.150	-23.20	2235766	5458039	138.24	McNeill	Rock
G45/0152	31.00	0.100	-1.00	2230100	5444800	48.75	McNeill	Rock
G45/0154	81.90	0.150	-5.73	2229251	5444196	77.30	McNeill	Rock
G45/0155	82.00	0.100	-2.00	2207603	5461063	0.00	McNeill	Rock
G45/0157	90.00	0.152	-1.00	2215265	5476525	127.00	McNeill	Rock

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G45/0160	100.00	0.100	0.00	2227548	5452769	0.00	McNeill	Rock
G45/0161	80.00	0.100	-7.50	2207683	5460982	115.66	McNeill	Rock
G45/0163	35.00	0.100	-4.40	2215200	5475300	70.49	McNeill	Rock
G45/0167	95.00	0.150	-2.70	2221877	5475174	115.15	McNeill	Rock
G45/0170	43.00	0.150	-4.50	2236543	5439736	122.42	McNeill	Rock
G45/0171	80.00	0.150	-13.30	2227400	5453000	0.00	McNeill	Rock
G45/0173	35.00	0.100	-12.00	2222900	5479200	63.31	McNeill	Rock
G45/0175	60.00	0.100	-4.00	2229800	5439600	127.70	Southland	Rock
G45/0177	50.00	0.150	0.00	2218600	5450000	145.75	McNeill	Rock
G45/0178	97.00	0.100	0.00	2222498	5475006	65.00		Rock
G45/0179	117.00	0.138	-39.00	2230080	5456260	78.85	McNeill	Rock
G45/0181	91.40	0.100	-4.60	2215455	5440175	144.45	McMillan	Rock
G45/0183	5.70	1.000	-13.30	2218400	5461408	114.58	McNeill	Rock
G45/0184	51.00	0.100	0.00	2238400	5451000	90.23	McNeill	Rock
G45/0186	50.00	0.100	-2.00	2239000	5440100	93.49	McNeill	Rock
G45/0187	40.00	0.100	-0.60	2242800	5440500	135.73		Rock
G45/0188	38.87	0.125	-5.54	2216957	5476389	123.87	McNeill	Rock
G45/0191	0.00	0.150	0.00	2219700	5446800	85.89		Rock
G45/0194	36.50	0.150	-1.90	2234900	5443700	102.94	McNeill	Rock
G45/0195	72.70	0.150	-2.10	2236100	5454000	115.85	McNeill	Rock
G45/0197	84.00	0.150	-17.17	2218654	5468031	112.68	McNeill	Rock
G45/0199	80.40	0.150	-9.50	2215200	5477500	79.13	McNeill	Rock
G45/0203	80.00	0.100	-1.90	2234700	5459500	168.71	McNeill	Rock
G45/0204	22.80	0.100	-13.50	2233800	5457300	162.41	McNeill	Rock
G45/0205	30.00	0.100	-2.00	2241200	5435300	166.38	McNeill	Rock
G45/0214	54.80	0.138	-4.40	2215400	5477100	178.00	McNeill	Rock
G45/0215	81.40	0.150	-9.10	2237700	5454100	80.01	McNeill	Rock

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G45/0216	42.00	0.100	-3.00	2223500	5475000	85.38	McNeill	Rock
G45/0219	20.00	0.138	-1.60	2239300	5450400	187.70	McNeill	Rock
G45/0220	90.00	0.150	-2.00	2236886	5441756	0.00	McNeill	Rock
G45/0222	10.60	0.150	-3.30	2240430	5453307	123.22	McNeill	Rock
G45/0223	240.00	0.150	-19.30	2236607	5450259	72.68	McNeill	Rock
G45/0226	61.00	0.150	-2.70	2219783	5469675	179.91	McNeill	Rock
G45/0228	84.90	0.150	-6.33	2236200	5440200	132.36	McNeill	Rock
G45/0231	97.00	0.100	-6.20	2218030	5475500	21.08	McNeill	Rock
G45/0232	130.00	0.152	-2.00	2247139	5442161	139.69	South Drill	Rock
G45/0242	115.00	0.150	-7.80	2226300	5445500	94.29	McNeill	Rock
G46/0100	54.00	0.152	0.00	2225432	5449487	129.19	McNeill	Rock
G46/0101	88.10	0.000	-2.40	2215512	5477044	77.50	McNeill	Rock
G46/0135	71.00	0.150	-2.55	2238200	5453600	77.70	McNeill	Rock
G46/0137	101.00	100.000	-16.00	2219449	5446805	119.20	McMillan	Rock
G46/0138	48.00	0.100	-9.90	2222500	5445200	69.51	McNeill	Rock
F44/0012	0.00	0.000	0.00	2209282	5471551	0.00		Unknown
F45/0103	100.00	0.100	0.00	2207600	5466000	0.00		Unknown
F45/0104	100.00	0.100	0.00	2209000	5467500	0.00		Unknown
F45/0105	25.00	0.152	0.00	2208500	5459500	0.00		Unknown
F45/0106	50.00	0.100	0.00	2206800	5460600	0.00		Unknown
F45/0109	0.00	0.000	0.00	2208609	5456975	0.00		Unknown
G44/0100	12.00	0.100	0.00	2214500	5472400	0.00	McNeill	Unknown
G44/0101	30.00	0.100	0.00	2215200	5473800	0.00	McNeill	Unknown
G44/0117	51.00	0.100	-3.14	2222900	5474600	203.66	McNeill	Unknown
G44/0118	21.70	0.100	-4.30	2213900	5475600	152.29	McNeill	Unknown
G44/0121	10.00	0.100	3.00	2219600	5476200	166.66		Unknown
G44/0130	100.00	0.100	0.00	2226000	5475700	275.29	McNeill	Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G44/0133	0.00	0.000	0.00	2221800	5476500	0.00		Unknown
G44/0134	0.00	0.000	0.00	2226000	5472700	0.00		Unknown
G44/0135	0.00	0.000	0.00	2220100	5474300	0.00	Owner	Unknown
G44/0136	5.50	0.050	-1.30	2220588	5474172	182.29		Unknown
G44/0138	0.00	0.000	0.00	2221600	5470900	0.00		Unknown
G44/0139	19.80	0.150	0.00	2222200	5470800	0.00		Unknown
G44/0140	0.00	0.000	0.00	2219300	5470600	0.00		Unknown
G44/0142	0.00	0.000	0.00	2217500	5472000	0.00		Unknown
G44/0143	3.00	0.100	0.00	2216600	5472600	0.00		Unknown
G44/0144	0.00	0.000	0.00	2214100	5473400	0.00		Unknown
G44/0145	6.10	0.000	0.00	2213800	5471800	0.00	McNeill	Unknown
G44/0147	5.00	0.100	0.00	2216800	5472200	0.00		Unknown
G44/0148	0.00	0.000	0.00	2222700	5479300	0.00		Unknown
G44/0149	130.00	0.100	0.00	2222800	5479100	0.00		Unknown
G44/0150	0.00	0.050	0.00	2217500	5471800	0.00		Unknown
G44/0151	8.00	0.300	0.00	2217500	5471800	0.00		Unknown
G44/0152	4.00	0.300	0.00	2217500	5472500	0.00		Unknown
G44/0154	2.10	1.800	0.00	2221200	5471300	0.00		Unknown
G44/0155	0.00	0.000	0.00	2226300	5473000	0.00	McNeill	Unknown
G44/0156	1.00	0.000	0.00	2221300	5475900	0.00		Unknown
G44/0157	37.00	0.100	0.00	2212000	5473000	0.00		Unknown
G44/0158	0.00	0.000	0.00	2212600	5473600	0.00		Unknown
G44/0159	0.00	0.000	0.00	2214500	5472400	0.00		Unknown
G44/0160	0.00	0.025	0.00	2214500	5472300	0.00		Unknown
G44/0161	0.00	0.000	0.00	2213386	5475358	0.00		Unknown
G44/0166	10.00	0.000	0.00	2214700	5471500	0.00		Unknown
G44/0167	3.00	0.001	0.00	2224400	5476700	0.00		Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G44/0168	4.00	0.100	0.00	2213500	5475300	0.00		Unknown
G44/0169	50.00	0.100	0.00	2216500	5474100	0.00	McNeill	Unknown
G44/0170	0.00	0.000	0.00	2212000	5472000	0.00		Unknown
G44/0171	100.00	0.100	0.00	2221900	5475000	0.00	McNeill	Unknown
G44/0172	76.00	0.100	-13.20	2222800	5479200	196.62	McNeill	Unknown
G44/0180	100.00	0.100	0.00	2227200	5483500	0.00	McNeill	Unknown
G44/0185	14.00	0.150	0.00	2218200	5475000	0.00	McNeill	Unknown
G44/0186	40.00	0.125	0.00	2216300	5476500	0.00		Unknown
G44/0187	100.00	0.100	0.00	2222500	5479200	0.00		Unknown
G44/0195	100.00	0.150	0.00	2215800	5476500	0.00		Unknown
G44/0196	15.00	0.100	0.00	2217100	5472500	0.00		Unknown
G44/0198	6.00	0.115	0.00	2215500	5471500	0.00		Unknown
G44/0199	50.00	0.100	0.00	2214500	5472500	0.00		Unknown
G44/0200	50.00	0.100	0.00	2214500	5472100	0.00		Unknown
G44/0203	100.00	0.150	0.00	2216900	5475300	0.00		Unknown
G44/0204	8.00	0.030	0.00	2213900	5474500	0.00		Unknown
G44/0206	40.00	0.200	0.00	2239000	5481700	0.00		Unknown
G44/0207	10.00	0.100	0.00	2215200	5473800	0.00		Unknown
G44/0211	30.00	0.150	0.00	2220806	5474718	0.00		Unknown
G44/0214	0.00	0.000	0.00	2220800	5471900	0.00		Unknown
G44/0228	0.00	0.000	0.00	2215158	5474945	0.00		Unknown
G45/0101	0.00	0.100	0.00	2225300	5444500	0.00	McNeill	Unknown
G45/0102	10.00	0.050	0.00	2219000	5456400	0.00	McNeill	Unknown
G45/0112	100.00	0.100	0.00	2237500	5440300	0.00	McNeill	Unknown
G45/0114	35.00	0.125	0.00	2235600	5457300	0.00	McNeill	Unknown
G45/0120	4.40	1.000	-3.00	2217697	5458946	111.88		Unknown
G45/0121	0.00	0.000	0.00	2216500	5458800	0.00		Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G45/0122	3.00	0.000	0.00	2217700	5463700	0.00		Unknown
G45/0123	0.00	0.000	0.00	2220400	5465000	0.00	Owner	Unknown
G45/0124	20.00	1.200	0.00	2218800	5459800	0.00		Unknown
G45/0125	4.00	0.100	0.00	2220200	5469800	0.00	McNeill	Unknown
G45/0126	9.10	1.500	0.00	2220300	5466500	0.00		Unknown
G45/0127	9.40	0.150	0.00	2221300	5468200	0.00		Unknown
G45/0128	0.00	0.000	0.00	2218200	5460500	0.00		Unknown
G45/0129	0.00	0.000	0.00	2217800	5460600	0.00		Unknown
G45/0130	0.00	1.200	0.00	2221800	5469000	0.00		Unknown
G45/0131	4.00	0.900	0.00	2221800	5468800	0.00		Unknown
G45/0132	18.30	0.000	0.00	2215300	5468900	0.00		Unknown
G45/0133	0.00	0.000	0.00	2240300	5443300	0.00		Unknown
G45/0134	9.00	0.000	0.00	2236800	5442000	0.00		Unknown
G45/0135	0.00	0.000	0.00	2229900	5443200	0.00		Unknown
G45/0136	90.00	0.130	0.00	2228400	5442800	0.00		Unknown
G45/0138	9.00	1.000	0.00	2223400	5446900	0.00		Unknown
G45/0139	20.00	0.000	0.00	2231600	5441000	0.00		Unknown
G45/0141	47.00	0.300	0.00	2242800	5440500	0.00		Unknown
G45/0143	12.00	0.100	0.00	2242000	5449800	0.00	McNeill	Unknown
G45/0149	100.00	0.100	0.00	2226400	5445200	0.00	McNeill	Unknown
G45/0153	10.00	0.100	0.00	2232700	5452700	0.00	McNeill	Unknown
G45/0159	6.00	0.100	0.00	2220756	5468689	0.00	McNeill	Unknown
G45/0164	75.00	0.100	0.00	2227500	5447300	0.00	McNeill	Unknown
G45/0165	100.00	0.100	0.00	2240200	5453100	0.00	McNeill	Unknown
G45/0166	100.00	0.100	0.00	2230400	5450800	0.00	McNeill	Unknown
G45/0168	100.00	0.100	0.00	2234000	5449700	0.00		Unknown
G45/0172	100.00	0.100	0.00	2236200	5440200	0.00		Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G45/0180	100.00	0.100	0.00	2237600	5453300	0.00		Unknown
G45/0185	100.00	0.100	0.00	2224000	5447000	0.00		Unknown
G45/0189	50.00	0.100	0.00	2234500	5455500	0.00		Unknown
G45/0190	100.00	0.073	-23.79	2234000	5441700	0.00	McNeill	Unknown
G45/0192	100.00	0.100	0.00	2224600	5443300	0.00		Unknown
G45/0193	100.00	0.100	0.00	2230400	5446900	0.00		Unknown
G45/0196	100.00	0.100	0.00	2244000	5442300	0.00		Unknown
G45/0200	160.00	0.150	0.00	2238800	5442600	0.00		Unknown
G45/0201	100.00	0.150	0.00	2243900	5441800	0.00		Unknown
G45/0206	50.00	0.120	0.00	2235772	5459540	0.00		Unknown
G45/0207	50.00	0.150	0.00	2247400	5440700	0.00		Unknown
G45/0209	21.50	0.250	-3.85	2241731	5450721	18.41	Barber	Unknown
G45/0210	21.00	0.250	-3.50	2241718	5450737	18.41	Barber	Unknown
G45/0211	19.20	0.250	-3.26	2241744	5450704	18.41	Barber	Unknown
G45/0212	0.00	0.000	0.00	2217693	5458948	0.00		Unknown
G45/0213	0.00	0.000	0.00	2217718	5458978	0.00		Unknown
G45/0217	0.00	0.000	0.00	2233900	5450100	0.00		Unknown
G45/0218	0.00	0.000	0.00	2236000	5448200	0.00		Unknown
G45/0221	0.00	0.000	0.00	2221082	5445276	0.00		Unknown
G45/0224	0.00	0.000	0.00	2235500	5459400	0.00		Unknown
G45/0227	0.00	0.000	0.00	2211782	5469931	0.00		Unknown
G45/0229	0.00	0.000	0.00	2219000	5458200	0.00		Unknown
G45/0230	0.00	0.000	0.00	2232409	5448917	0.00		Unknown
G45/0233	0.00	0.000	0.00	2234436	5451975	0.00		Unknown
G45/0234	0.00	0.000	0.00	2222869	5448238	0.00		Unknown
G45/0235	0.00	0.000	0.00	2219008	5458287	0.00		Unknown
G46/0102	150.00	0.125	0.00	2236500	5438500	0.00	McNeill	Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G46/0103	0.00	0.050	0.00	2232800	5436400	0.00		Unknown
G46/0104	0.00	0.050	0.00	2232400	5436800	0.00		Unknown
G46/0105	10.10	0.050	0.00	2233500	5436300	0.00		Unknown
G46/0106	10.70	0.000	0.00	2246300	5434700	0.00		Unknown
G46/0107	0.00	0.000	0.00	2242900	5435900	0.00		Unknown
G46/0108	0.00	0.000	0.00	2236700	5439700	0.00		Unknown
G46/0109	0.00	0.000	0.00	2230263	5437809	0.00		Unknown
G46/0110	0.00	0.000	0.00	2234506	5436152	0.00		Unknown
G46/0111	10.70	0.000	0.00	2244014	5434867	0.00	McNeill	Unknown
G46/0112	34.00	0.100	0.00	2242300	5434100	0.00		Unknown
G46/0113	0.00	0.000	0.00	2234600	5439400	0.00		Unknown
G46/0114	0.00	0.000	0.00	2239200	5438300	0.00		Unknown
G46/0115	0.00	0.030	0.00	2233000	5439500	0.00		Unknown
G46/0116	0.00	0.000	0.00	2233300	5439100	0.00		Unknown
G46/0117	13.00	0.000	0.00	2240400	5436700	0.00		Unknown
G46/0118	15.00	0.000	0.00	2238100	5438700	0.00		Unknown
G46/0119	0.00	0.000	0.00	2239300	5437200	0.00		Unknown
G46/0120	0.00	0.000	0.00	2240700	5435500	0.00		Unknown
G46/0122	12.00	0.050	0.00	2240500	5435500	0.00		Unknown
G46/0123	12.00	0.050	0.00	2243300	5439200	0.00		Unknown
G46/0124	25.00	0.050	0.00	2243300	5439200	0.00		Unknown
G46/0126	0.00	0.000	0.00	2247000	5434100	0.00		Unknown
G46/0127	0.00	0.000	0.00	2247000	5433800	0.00		Unknown
G46/0128	0.00	0.000	0.00	2247700	5435200	0.00		Unknown
G46/0129	15.00	0.060	0.00	2246000	5435000	0.00		Unknown
G46/0130	24.00	0.100	0.00	2243000	5433500	0.00		Unknown
G46/0131	70.00	0.130	0.00	2236769	5439613	0.00		Unknown

Bore No	Depth (m)	Diameter (m)	SWL (m)	Easting	Northing	Elevation (mRL)	Driller	Constructed In
G46/0132	150.00	0.130	-10.47	2236222	5438551	84.07		Unknown
G46/0133	8.00	0.000	0.00	2235300	5438900	0.00		Unknown
G46/0136	100.00	0.150	0.00	2211600	5438000	0.00		Unknown
G46/0143	0.00	0.000	0.00	2217013	5436559	0.00		Unknown
G46/0144	0.00	0.000	0.00	2217013	5436559	0.00		Unknown
H45/0218	0.00	0.000	0.00	2250000	5440000	0.00		Unknown

Appendix B – Consented groundwater takes

Bore ID	Depth (m)	Lithology	Annual Take m3/yr	Consent Number	Purpose activity	Consent holder
F45/0102	82	Claybound	17698.8	2001.202	Dairying	Merino Downs Dairy Limited
G45/0199	240	Rock	22173	2003.098	Dairy Shed and Stock Watering	Owen Geoffrey and Andrew James Johnston
?	?	?	20088	2004.882	Domestic Water Supply	Clydevale Village Waterworks Limited
G44/0213	9.5	Alluvium	88437	2006.403	Dairsy Shed and Irrigation	Roulston & Co Limited
G45/0226	91.4	Rock	35280	2008.306	Dairy Shed, Stock and Domestic	Kaiwera Farm Management Limited as partner of
G45/0225	5.2	Alluvium	19152	2008.314	Dairy Shed and Stock Watering	Bryce Warrack McKenzie and Karen Elizabeth McKenzie and Macdonald
G44/0163	80.4	Rock	72900	2008.397	Dairy Shed and Stock Watering	Andrew James Dick
G44/0208	6	Alluvium	25931	2004.443.V1	Dairy Shed and Stock Watering	Kelso Dairy Limited
G44/0212	95	Rock	16460	RM12.133.01	Dairy Shed and Stock Watering	Carmichael Holdings Limited
G45/0157	5.7	Rock	26700	2006.814.V1	Dairy Shed	Westline Farms Limited
G45/0214	84	Rock	34675	2008.369.V1	Dairy Shed and Stock Watering	David John Wilson and Tamara Ann Basey-
G45/0232	101	Rock	38325	2009.206.V1	Dairy Shed and Stock Watering	Luxmore Dairies Limited
G45/0241	5.5	Alluvium	30660	2010.208V1	Dairy Shed and Stock Watering	Westholm Dairies Limited
G44/0228	?	Rock	7560	RM10.345.01	Dairy Shed and Stock Watering	Roulston & Co Limited
?	?	Rock	40880	RM10.456.01	Dairy Shed and Stock Watering	Don Telford Limited
G45/0227	?	Rock	16352	RM11.077.01	Dairy Shed and Stock Watering	BK Dairy Limited
G45/0106	5	Alluvium	35040	RM11.094.01	Dairy Shed and Stock Watering	Hinemoa Heights Limited
F44/0014	35	Claybound	21900	RM12.052.01	Dairy Shed and Stock Watering	Springhills Dairy Limited
G45/0255	128	Rock	39420	RM12.175.01	Dairy Shed and Stock Watering	Tunoa Downs Limited
G45/0242	72	Rock	21900	RM13.142.01	Dairy Shed and Stock Watering	Nanne Otto Dogterom and Coquet Trustees
G44/0208	6	Alluvium	25,931	2004.443.V1	Dairy Shed and Stock Watering	Kelso Dairy Limited
F45/0102	82	Claybound	17698.8	2001.202	Dairying	Merino Downs Dairy Limited
G45/0199	240	Rock	22173	2003.098	Dairy Shed and Stock Watering	Owen Geoffrey and Andrew James Johnston

Appendix C – Table summary of estimated specific capacity

Well No	Depth (m)	SWL (m)	Driller drawdown (m)	Driller pump rate (m3/d)	Q/s
Rock Wells					
G45/0103	61	-7.8	32	16.37	0.51
G46/0135	71	-2.55	51.5	33.12	0.64
G45/0167	95	-2.7	71	63.59	0.90
G45/0116	84	-5.4	60	54.60	0.91
G44/0126	129	-9.3	55.7	54.60	0.98
G44/0125	87.5	-2	46	46.08	1.00
G45/0161	80	-7.5	26	32.70	1.26
G45/0115	119.4	-8.5	94	120.96	1.29
G45/0140	47	-16	19	25.10	1.32
G44/0175	124	-3.9	63	87.30	1.39
G45/0150	75.5	-23.2	41.2	64.80	1.57
G45/0154	81.9	-5.73	53	95.04	1.79
G45/0146	47.3	-3.1	32.3	72.68	2.25
G44/0177	145	-5.8	31	87.30	2.82
G46/0100	54	0	48	145.36	3.03
G45/0147	31.2	-3.2	21.2	76.37	3.60
F45/0107	45.685	-12.78	23.2	109.00	4.70
G45/0118	41.14	-9.04	28	146.88	5.25
F45/0102	112	-8.4	24.55	155.50	6.33
G45/0181	91.4	-4.6	22.33	141.73	6.35
G45/0226	61	-2.7	20.3	152.75	7.52
G44/0123	33	-5.43	15	123.84	8.26
G44/0124	82	-9.1	4	34.90	8.73
G44/0137	35	-19.1	6.9	65.60	9.51
G45/0155	82	-2	16	163.66	10.23
G45/0163	35	-4.4	10.6	109.00	10.28
G44/0105	75.1	-8.14	16	172.80	10.80
G45/0105	54.2	-5.53	11	122.40	11.13
G45/0170	43	-4.5	13.5	152.75	11.31
G45/0148	81.3	-4.68	16.7	197.30	11.81
G45/0117	37.5	-4.9	9.1	109.00	11.98
G44/0102	62	-2.5	6.8	87.30	12.84
G45/0160	100	0	9.1	120.00	13.19
G44/0129	80.1	-10.37	11.2	172.80	15.43
G45/0222	10.6	-3.3	5.2	81.76	15.72
G45/0231	97	-6.2	8.3	152.70	18.40
G45/0110	97	-7	7.8	158.00	20.26
G45/0197	84	-17.17	8.71	198.72	22.82
G45/0203	80	-1.9	8.1	185.50	22.90
G46/0137	101	-16	7.2	170.20	23.64
G44/0197	72	-29.5	6.32	163.52	25.87
G45/0195	72.7	-2.1	6.5	190.80	29.35

Well No	Depth (m)	SWL (m)	Driller drawdown (m)	Driller pump rate (m3/d)	Q/s
G44/0174	45	0	3.5	174.60	49.89
G44/0215	26	-15	2.6	130.93	50.36
G46/0138	48	-9.9	2.1	109.00	51.90
G44/0209	36	-6	2	104.70	52.35
G45/0113	40	-0.6	3.4	196.40	57.76
G45/0183	5.7	-13.3	4.8	327.00	68.13
Claybound Gravel Wells					
F44/0100	52	-11	36	52.7	1.46
F45/0101	30	-17.6	6.8	98.2	14.44
F45/0108	52.18	-3.93	33.5	112.32	3.35
G44/0165	33	-12.7	8.3	65.5	7.89
G44/0173	21	-9.1	11	31.7	2.88
G44/0179	33	-3	14.5	49	3.38
G44/0188	55	-11.8	11.2	78.6	7.02
G44/0201	8	-2.1	4.9	39.3	8.02
G44/0210	22.5	-12.3	7.7	39.3	5.10
G44/0218	12	-8	3	90.8499	30.28
G44/0219	21.63	-9.32	18.3	34.523	1.89
G44/0220	38.8	-22.94	6.9	103.68	15.02
G44/0222	60	-12.7	13	172.8	13.29
G44/0227	32	-2	26	45.42	1.74
G45/0169	28.7	-7.3	12.27	112.32	9.15
G45/0208	42.2	-15.3	1.7	130.9	77
G45/0236	78.5	-11.5	32.2	129.6	4.02
Alluvium Wells					
G44/0127	12	-1.2	2.4	196.4	81.83333
G44/0176	10	0	4.1	196.4	47.90244
G44/0189	11.5	-5	0.2	196.4	982
G44/0190	11.5	-7.75	0.05	172.8	3456
G44/0208	6	-2.8	1.5	174.6	116.4
G44/0213	20	-4	8	8176	1022
G44/0221	18.43	-3.7	2.6	1555.2	598.1538
G45/0100	5	-6.7	3	79.49	26.49667
G45/0106	6	-2.5	0.1	98.2	982
G45/0145	9.5	-3.4	0.2	130.9	654.5
G45/0158	5.2	-10.2	1.3	196.4	151.0769
G45/0198	5.2	-3.5	0.3	196.4	654.6667
G45/0225	6	-3.5	0.1	163.52	1635.2
G45/0240	6	-3.68	1.2	163.52	136.2667
G45/0241	9.5	-4.15	0.7	95.39	136.2714

Appendix D - Water quality

ID	Depth	Geology	Date	Temp	EC	pH	CO_3	HCO3	Ca	Cl	DRP	FeT	FeD	K	Mg	Na	NH3-N	NNN	SO_4	MnD	TDS	FCC	AsD	DO
				C°			mg/l																	
G44/0103	22.4	Claybound	10/11/1998	15.4		6.8		130	14.0	40.0	0.047	0.32		1.50	13.00	38.00	0.019	0.038	5.60					
G44/0105	38.8	Rock	12/11/1998	13.2	0.22	7.2		120	10.0	13.0	0.024	0.47		0.97	5.60	28.00	0.025	0.009	<0.02		178.12			
			16/09/1999	11.3	0.23	7.4		120	11.0	14.0	0.018	1.60		0.99	5.40	26.00	0.019	0.010	<0.02		179.06	<1		
			28/06/2000	9.4	0.20	7.4		120	11.0	13.0	0.004	2.00		1.10	5.60	26.00	0.018	0.003	<0.02		130	<1		
			3/10/2000	10.4	0.23	7.3		97	11.8	12.4	0.019			0.97	5.84	25.60	0.030	0.007	<0.02		153.69	<1		4.1
			9/05/2001	10.8	0.21	7.0		94	12.2	12.5	0.010			1.00	5.80	30.00	0.010	<0.005	<0.02		155.54	<1		
			24/10/2001	10.76	0.21	6.8		98	11.7	16.2	0.005			0.93	5.80	28.50	0.040	0.004	<0.02		161.20	<1		
			24/09/2008	11.6	0.23	6.9		98	11.4	13.4	0.048		0.52	1.05	5.48	26.80	0.040	0.010	<0.02	0.24	125		<0.005	
			10/03/2009	11.87	0.23	7.2		98	11.6	13.4	0.040		0.80	1.17	5.42	28.70	0.030	0.490	<0.02	0.254	159.65		<0.005	
			11/03/2010	12.52	0.22	6.9		96	11.5	13.1	0.035		0.64	0.99	5.31	26.00	0.030	0.010	0.06	0.223	153.67			
			22/03/2011	11.1	0.19	7.5	1	100	12.2	13.7	0.036		0.76	1.03	5.73	27.10	0.030	0.010	<0.02		160.62			
G44/0118	21.7	?	12/11/1998	13.6	0.20	6.9		90	13.0	13.0	0.045	<0.05		0.92	5.70	16.00	<0.005	0.700	8.40					
G44/0127	5.2	Alluvium	10/11/1998	13.6	0.17	5.9		41	11.0	17.0	0.008	<0.05		2.00	4.50	9.80	<0.005	2.400	14.00			<1		
			16/09/1999	10.1	0.21	6.0		33	15.0	22.0	0.006	<0.05		2.50	5.40	11.00	<0.005	4.100	20.00		130.00	<1		
			15/12/1999	12.8	0.17	6.4		36	7.6	17.0	0.002	<0.05		1.90	5.30	10.00	<0.005	2.600	17.00			<1		
			28/03/2000	13.9	0.15	5.7		35	11.0	16.0				1.80	3.90	9.80	0.012	2.600			120.00	<1		
			27/06/2000	6.9	0.13	6.1		34	11.0	15.0	0.009	<0.05		2.20	4.00	9.40	<0.005	2.000	12.00		92.00	<1		
			3/10/2000	9.9	0.18	6.5		24	14.4	17.9	0.005			1.81	5.18	9.30	<0.01	3.300	15.30			<1		7.8
			8/05/2001	11.9	0.13	5.7		21	11.4	14.4	0.005			1.80	3.90	10.40	<0.01	2.000	12.90			<1		
			24/10/2001	10.65	0.18	5.6		21	14.5	25.1	0.008			1.97	5.20	11.30	<0.01	2.600	22.10			23.00		
			30/10/2002	10	0.20	5.7		35	13.0	22.3	0.005		<0.03	1.90	5.50	10.00	<0.01	2.910	22.00			<1		
			19/03/2003	13.17	0.18	5.7		34	11.0	22.5	0.005		<0.03	1.70	3.60	11.00	<0.01	4.430	15.20			1.00		
			16/03/2004	13.57	0.18	5.9		27	11.0	13.8	0.005		<0.03	1.80	4.10	11.00	<0.01	4.460	7.10			<1		
			22/03/2005	14.89	0.16	6.5		38	14.0	20.0	0.014		<0.03	2.10	5.10	11.00	<0.01	2.890	23.00			2.00		

			13/03/2006	11.32	0.21	6.9		78	36.0	22.2	0.056			2.94	5.97	12.80	<0.01	4.950	19.20			5.00		
			14/03/2007	14.49	0.25	7.5		75	36.4	26.5	0.036			2.23	5.37	11.40	<0.01	4.130	20.20	<.005		<2		
			24/09/2008	9	0.26	5.7		27	18.7	25.5	0.041		0.01	3.11	5.98	12.60	<0.01	6.860	23.00	<.005	141		<0.005	
			10/03/2009	12.21	0.19	5.8		23	14.7	20.8	0.023		0.04	2.85	4.80	11.20	<0.01	4.200	20.50	<.005	102.00	10.00	<0.005	
			14/09/2009	12.66	0.23	6.2		22	19.1	22.7	0.014		0.01	2.50	5.84	13.10	<0.01	6.030	18.20	<.005	125.00	<1	<0.005	
			11/03/2010	11.72	0.19	6.6		23	14.0	19.2	0.008		0.12	2.38	4.51	11.90	<0.01	3.830	17.90	<.005	102.00	<2		
			22/03/2011		0.16	6.2	1	27		19.6	0.019			2.61	4.10	10.80	<0.01	3.850	21.90					
			22/03/2012		0.23	6.1	1	39		25.0	0.014			2.90	5.80	11.20	<0.01	4.700	17.90					
G44/0130	100	?	11/11/1998	14.6	1.20	7.1		62	7.1	6.0	0.053	0.05		0.63	4.00	11.00	<0.005	0.230	1.70					
			11/11/1998	14.6	0.33	7.4		150	21.0	22.0	0.006	1.10		1.20	6.90	33.00	<0.01	0.025	4.20			<1		
			16/09/1999	10	0.31	7.4		150	26.0	23.0	0.002	4.70		1.40	6.60	32.00	0.009	0.003	4.40		200.00	1.00		
			15/12/1999	14.08	0.31	7.8		150	23.0	23.0	0.001	1.70		1.10	7.00	29.00	0.012	0.003	4.10			<1		
			28/06/2000	5.9	0.27	7.5		150	23.0	23.0	0.001	9.10		1.40	6.50	31.00	<0.005	0.004	3.30		170.00	1.00		
			3/10/2000	9.4	0.31	7.3		123	24.1	20.7	0.005			1.24	6.43	29.80	<0.01	<0.005	4.00			<1		6.64
			8/05/2001	8.9	0.29	7.1		119	25.2	20.8	0.005			1.20	6.80	34.00	<0.01	0.005	4.30			<1		
			24/10/2001	11.5	0.30	7.0		122	24.1	25.0	0.001			1.21	6.60	33.00	<0.01	0.021	4.50			<4		
			30/10/2002	11.06	0.28	7.0		151	20.0	24.0	0.005		0.06	1.00	6.10	29.00	<0.01	<0.005	4.20			<1		
			19/03/2003	12.6	0.30	7.1		147	18.0	25.1	0.005		0.26	1.50	4.60	29.00	<0.01	<0.005	4.60			<1		
G44/0136	5.5	Claybound	16/03/2004	14.48	0.16	5.7		23	11.0	17.4	0.005		<0.04	1.90	4.00	9.20	<0.01	5.040	14.30			6.00		
			22/03/2005	13.17	0.22	7.1		150	18.0	21.0	0.014		1.00	1.20	5.50	31.00	0.020	0.013	3.10			120.00		
			13/03/2006	11.28	0.21	7.2		126	22.8	21.4	0.021			1.18	6.24	40.20	0.020	0.081	3.13			4.00		
			14/03/2007	10.98	0.25	8.4		122	21.9	23.9	0.013			1.06	5.44	33.80	<0.01	0.010	3.13	0.068		<2		
			9/04/2008	10.68	0.31	7.4		125		22.1	0.005		0.96						2.50	0.052		<2	<0.005	
			24/09/2008	13.7	0.32	7.1		125	21.5	21.4	0.026		0.55	1.25	5.63	28.30	0.020	0.010	3.35	0.064	174.00	2.00	0.08	
			10/03/2009	10.8	0.23	7.1		126	23.6	21.2	0.020		2.21	1.09	5.96	31.90	0.020	0.010	3.05	0.058	171.00	1.00	<0.005	
			14/09/2009	13.19	0.31	7.5		119	24.0	20.0	0.020		0.44	1.15	5.95	32.40	<0.01	0.010	3.11	0.061	169.00	1.00	<0.005	
			11/03/2010	13.32	0.30	7.0		121	22.6	20.8	0.019		2.50	1.45	5.76	32.60	<0.01	0.010	3.60	0.07	163.00	10.00		
			22/03/2011		0.28	7.7	1	120		21.6	0.020			1.38	6.23	28.20	<0.01	0.010	2.80					

			22/03/2012		0.06	7.5	1	146		22.0	0.087			1.18	6.70	33.00	<0.01	0.050	2.90					
G44/0141	6	Alluvium	10/11/1998	10.3	0.12	5.6		23	6.6	8.8	0.014	0.05		1.50	2.40	7.70	0.006	3.800	6.00					
			15/09/1999	10.3	0.11	5.8		17	5.6	9.2	0.013	0.05		1.20	2.20	8.70	<0.01	4.100	6.60		68.00			
			15/12/1999	10.71	0.10	5.6		21	5.7	9.3	1.400	0.05		3.20	8.90	0.01	<0.01	2.900	5.60			1100.00		
			1/05/2000																			190.00		12.8
			3/10/2000	11.6	0.13	6.9		49	7.3	7.8	0.920			3.62	12.60	0.01	<0.01	0.730	1.80			4.00		15.4
			24/10/2001	10.56	0.13	6.4		52	7.4	2.1	0.027			0.91	3.69	15.80	<0.01	0.400	10.56			<1		
			30/10/2002	10.87	0.12	6.3		56	6.5	8.9	0.710			3.20	13.00	0.01	<0.01	1.740	1.60			<1	<0.03	
			19/03/2003	10.73	0.13	6.3		66	5.5	8.6	0.016			1.00	2.60	15.00	<0.01	0.994	1.40			<1	<0.03	
			16/03/2004	10.91	0.12	6.5		61	4.9	8.3	0.100			1.10	2.90	13.00	<0.01	1.230	1.40			<1	<0.03	
			22/03/2005	11.08	0.10	7.2		67	6.4	7.8	0.103			1.00	3.10	16.00	<0.01	0.983	1.50			<1	<0.03	
			14/03/2007	10.38	0.11	7.5	1	54	7.5	7.7	0.104			0.79	3.41	14.20	<0.01	0.920	1.51			6.00		
G44/0143	3	Alluvium	12/11/1998	12.2	0.18	5.7		48	13.0	19.0	0.007	0.05		2.40	5.10	12.00	<0.005	2.500	12.00					
G44/0149	130	?	12/11/1998	11.8	0.23	6.7		120	14.0	17.0	0.003	3.60		0.99	6.80	22.00	<0.005	0.008	5.20					
G44/0157	37	?	11/11/1998	15	0.14	6.3		66	8.8	10.0	0.061	0.05		0.83	4.40	12.00	<0.005	0.180	2.40					
G44/0174	37.5	Rock	28/03/2000	12.01	0.12	5.8		46	7.1	8.9				1.20	2.90	11.00	0.019	2.200			120.00	<1		
			28/06/2000	10.6	0.10	6.0		25	6.3	11.0	0.010	1.30		1.40	3.00	9.40	0.027	3.900	4.90		72.00	<1		
			8/05/2001	11	0.10	6.1		29	6.8	9.0	0.043			0.90	2.90	12.40	<0.01	2.000	2.50			<1		
			13/03/2006	10.76	0.09	6.6		57	7.7	7.7	0.113			0.89	3.88	16.80	<0.01	0.986	1.22			<1		
			24/09/2008	11.4	0.14	6.3		53	7.0	8.0	0.120			0.98	3.48	15.40	<0.01	1.110	1.10	0.008	76.00	<1	0.006	
			10/03/2009	11.13	0.12	6.5		37	7.3	9.3	0.090			0.91	3.30	14.80	<0.01	2.890	1.32	<0.005	68.00	<1	<0.005	
			14/09/2009	12.15	0.13	7.1		51	7.5	7.7	0.109			0.91	3.70	15.50	<0.01	1.150	1.33	<0.005	74.00	<1	<0.005	
			11/03/2010	11.13	0.14	7.1		53	7.1	7.6	0.096			0.91	3.41	18.20	<0.01	1.030	1.34	<0.005	77.00	<1		0.16
			22/03/2011		0.12	6.9	1	45	5.4	8.9	0.102			0.89	2.67	14.70	<0.01	2.210	1.10		0.08			
G45/0110	24	Rock	22/08/2001	9.9	0.23	6.5		56	13.0	25.7	0.044			1.00	8.00	24.00	0.030	1.000	10.50					
			31/10/2002	11.25	0.22	6.5		78	10.0	34.2	0.047			0.81	6.90	23.00	<0.01	0.640	8.20				<0.001	
			17/03/2003	12.14	0.24	6.6		75	9.9	36.8	0.091			1.10	5.10	24.00	0.030	0.887	8.20					
			28/10/2003	11.05		6.5		72	12.2	36.9				0.89	6.54	24.00	0.020	1.020	8.50					

			18/03/2004	12.53	0.23	6.6		73	1.3	38.2	0.062			1.40	0.08		0.040	0.862	7.50					
			19/10/2004	10.9	0.23	6.6		75	9.9	35.0	0.096			0.75	5.70	24.00	<0.01	1.200	10.00					
			17/03/2005	12.53	0.19	7.6		76	11.0	36.0	0.095			1.00	6.70	26.00	0.030	1.100	9.90					
			11/10/2005	11.2	0.19	7.6		61	14.3	35.4	0.095			1.06	8.21	24.50	<0.01	1.370	11.70					
			14/03/2006	11.53	0.18	7.1		65	13.5	34.3	0.093			1.01	7.98	21.30	<0.01	1.080	8.69					
			21/11/2006	11.84	0.18	7.1		61	13.2	37.0	0.097			0.95	7.79	20.30	<0.01	1.260	11.60	<0.005				
			13/03/2007	12.01	0.22	7.1		63	14.0	35.5	0.089			0.84	7.58	20.90	<0.01	0.984	9.15	<0.005				
			18/09/2008	11.1	0.32	6.4		63	16.3	43.3	0.085			1.17	9.07	31.00	<0.01	2.730	25.40	<0.005	182.00		<0.005	
			16/03/2009	12.45	0.29	6.5		61	15.6	42.2	0.100			0.83	8.21	25.20	<0.01	1.340	11.80	<0.005	158.00		<0.005	
			10/09/2009	12.07	0.31	6.7		60	17.2	41.5	0.081			1.03	9.44	28.60	<0.01	1.880	17.30		168.00		<0.005	
			29/03/2011		0.31	6.5	1	61	18.0	48.5	0.091			1.11	10.00	28.90	<0.01	2.370	20.70					
G45/0120	4.4	Alluvium	11/11/1998	13.1	0.18	5.6		18	11.0	19.0	0.009	0.05		2.50	5.20	11.00	<0.005	6.900	12.00					
			15/09/1999	13.8	0.11	5.9		14	6.2	9.8	0.003	0.05		1.60	2.00	7.20	<0.01	3.100	9.40		79.00	5.00		
			15/12/1999	13.1	0.25	5.9		14	17.0	35.0	0.001	0.05		2.70	7.50	12.00	<0.005	11.000	6.50					
			28/03/2000	13.6	0.26	5.0		14	0.1	19.0	0.258			4.00	6.90	14.00	0.019	9.700			270.00			
			28/06/2000	7.75	0.15	5.6		13	9.6	18.0	0.006	0.05		2.60	4.40	9.80	<0.005	6.800	10.00		120.00	<1		
			4/10/2000	8.2	0.15	6.6		10	10.7	17.7	0.008			2.11	4.31	8.00	0.020	5.300	9.50			190.00		5.8
			9/05/2001	12	0.21	5.1		6	15.7	28.1	0.008	3.40		3.40	6.20	13.30	<0.01	8.200	9.70			<1		
			25/10/2001	9.93	0.16	5.1		10	12.0	20.1	0.001	2.63		2.63	4.70	10.70	<0.01	6.700	8.90			1.00		
			30/10/2002	11.1	0.34	6.2		55	21.0	33.9	0.005			4.00	14.00	13.00	0.140	14.400	8.30			1.00		
			19/03/2003	13.9	0.30	5.2		13	16.0	41.8	0.009			4.90	5.30	15.00	0.020	17.000	9.20			1.00		
			16/03/2004	13.46	0.31	6.7		95	14.0	24.7	0.007			5.60	14.00	11.00	<0.01	10.300	10.50			14.00		
			22/03/2005	14.36	0.20	6.7		53	17.0	20.0	0.007			3.60	6.20	8.70	<0.01	7.660	9.70			<1		
			13/03/2006	11.95	0.15	6.5		62	16.4	15.0	0.019			5.09	10.80	10.30	<0.01	5.180	12.40			<1		
			14/03/2007	12.54	0.19	7.2		50	21.8	17.2	0.012			5.21	8.39	9.75	<0.01	4.800	14.10	<0.005		16.00		
G45/0155	100	Rock	30/08/2001	11.35	0.53	9.2		15	1.7	23.3	0.006			0.90	0.40	130.00	<0.01	0.130	3.50			<1		
			23/09/2008	13	0.57	9.3		186	1.2	40.0	0.011			0.66	0.20	130.00	0.060	0.010	17.80	<0.005	333.00		0.006	
			17/03/2009	14.77	0.60	9.3		188	1.2	47.2	0.013			0.65	0.15	131.00	0.040	0.010	15.30	<0.005	332.00	<1	<0.005	
			9/09/2009	12.31	0.58	9.5	1	166	39.4	42.0	0.011			0.88	5.79	36.00	0.030	0.010	16.10	0.165	320.00	<1	<0.005	

G45/0160	117	Rock	24/08/2001	7.9	0.54	9.3		159	2.4	43.5	0.005			2.10	0.70	132.00	0.020	0.009	9.90			<1		
			31/10/2002	11.52	0.54	9.2		217	0.1	47.7	0.005			2.60	0.50	110.00	<0.01	0.008	9.00					
			17/03/2003	11.95	0.57	9.5		227	1.3	50.9	0.006			1.40	0.60	120.00	0.040	0.005	8.90				<0.001	
			28/10/2003	13.5	0.58	9.6		217	2.1	50.7	1.570			0.79	123.00	0.03	<0.005	9.370					<0.001	
			18/03/2004	12.11	0.55	9.2		218	3.2	51.0	0.010			1.80	0.57	120.00	0.050	0.005	9.50				<0.001	
			19/10/2004	11.42	0.52	9.4		210	0.1	46.0	0.013			0.85	0.44	110.00	0.030	0.005	9.20				<0.001	
			17/03/2005	17.69	0.47	9.3		210	1.2	45.0	0.014			1.50	0.44	120.00	0.020	0.019	9.00				<0.001	
			11/10/2005	10.22	0.20	8.9		60	1.1	17.8	0.020			1.03	0.50	5.01	0.240	0.046	3.17					
			14/03/2006	11.99	0.40	8.7		87	1.5	42.7	0.017			1.70	0.59	129.00	0.030	0.006	8.08					
			21/11/2006	11.97	0.39	9.5		222	1.7	27.2	0.012			1.87	0.74	132.00	0.030	0.006	5.71	<0.005				
			13/03/2007	11.54	0.50	10.2	1	62	1.9	39.5	0.009			1.50	0.73	126.00	0.030	0.005	12.30	0.006				
G45/0163	145	Rock	24/08/2001	10.9	0.55	9.5		164	9.0	42.3	0.005			1.40	0.09	137.00	<0.01	0.007	15.90			<1		
			31/10/2002	12.36	0.55	9.4		211	0.1	35.3	0.005			0.91	0.06	110.00	<0.01	0.006	22.00				<0.001	
			17/03/2003	12.29	0.58	9.7		219	0.8	34.8	0.009			1.40	0.17	120.00	0.040	0.001	28.10				<0.001	
			28/10/2003	12.31	0.60	9.5		207	0.8	35.0	0.005			1.06	0.08	132.00	0.020	0.006	35.50				<0.001	
			18/03/2004	12.32	0.58	9.4		211	30.0	34.2	0.009			1.00	4.90	34.00	0.010	0.009	41.20				<0.001	
			19/10/2004	11.42	0.55	9.5		190	0.1	32.0	0.015			0.52	0.07	120.00	0.020	0.005	44.00				<0.001	
			17/03/2005	12.65	0.45	9.4		190	1.8	32.0	0.012			0.87	0.08	120.00	0.020	0.005	51.00				<0.001	
			11/10/2005	12.71	0.45	8.8		140	0.9	30.8	0.011			1.20	0.09	140.00	0.020	0.005	53.60					
			14/03/2006	12.76	0.44	8.5		170	1.0	30.5	0.014			1.27	0.08	145.00	0.020	0.011	56.00					
			21/11/2006	12.67	0.44	9.7		54	1.0	28.2	0.013			1.37	0.09	139.00	0.020	0.017	55.20	<0.005				
			13/03/2007	12.53	0.56	10.3		180	0.8	32.1	0.009			1.05	0.07	137.00	0.020	0.005	64.30	<0.005				
			23/09/2008	13.7	0.62	9.6		146	0.9	32.2	0.012			1.20	0.08	166.00	0.020	0.010	63.60	<0.005	365.00		<0.005	
			17/03/2009	14.78	0.69	9.6		147	1.0	36.6	0.013			1.23	0.08	137.00	0.020	0.010	76.70	<0.005	378.00		<0.005	
			9/09/2009	13.28	0.66	9.7		201	0.9	33.6	0.013			1.05	0.07	149.00	0.020	0.010	69.00	<0.005	361.00		<0.005	
			9/03/2010	12.91	0.66	9.7		137	1.0	32.6	0.024			1.17	0.11	140.00	<0.01	0.010	68.10	<0.005	362.00	<1	<0.005	
			29/03/2011		0.65	9.7	65	138		35.0	0.011			1.15	0.07	150.00	0.020	0.010	73.10					
G45/0171	132.5	Rock	3/09/2001	10.8	0.78	9.73		58	1.7	158	0.01			0.6	0.05	155	0.02	0.014	1.3					
			18/09/2008	12.2	0.76	9.3		115	1.43	147	0.01			0.5	0.04	218	0.07	<0.01	3.64	<0.005	419		<0.005	

			16/03/2009	13.9	0.77	9.4	1	110	1.7	163.0	0.009			0.40	0.07	147.00	0.070	0.010	3.70	<0.005	423.00		<0.005	
G45/0188	81.9	Rock	30/08/2001	10.29	0.37	7.2		131	52.0	8.9	0.012			0.90	6.00	21.00	<0.01	1.200	9.50		0.01	<1		
			23/09/2008	11.4	0.44	7.6		154	53.2	16.7	0.032			0.90	7.63	31.70	<0.01	1.310	47.90	<0.005	252.00		<0.005	
			17/03/2009	13.29	0.43	7.7		158	32.7	24.4	0.019			0.60	7.92	47.20	0.020	0.010	29.90	0.006	237.00		<0.005	
			9/09/2009	11.45	0.44	7.8		152	38.1	18.5	0.024			0.88	5.65	34.50	<0.01	1.210	53.00	0.206	243.00		<0.005	
			9/03/2010	11.64	0.43	8.0		157	37.0	20.4	0.030			0.81	8.33	37.10	0.020	0.060	35.90	<0.005	236.00	<2	<0.005	
			29/03/2011		0.41	7.9	1	160	40.5	21.3	0.016			0.58	8.66	44.50	<0.01	0.140	38.50					
G46/0101	54.2	Rock	6/11/1998	12.7	0.39	7.2		180	38.0	35.0	0.001	0.88		0.34	5.20	36.00	0.016	0.022	25.00					
			14/09/1999	9.8	0.35	7.0		140	25.0	42.0	0.020	0.05		0.61	5.20	43.00	0.008	0.700	11.00		250.00	<1		
			14/12/1999	14.2	0.35	6.9		130	22.0	41.0	0.008	0.05		0.62	6.30	45.00	0.012	0.470	10.00			1.00		
			21/03/2000	13.3	0.34	7.2		130	21.0	41.0	0.015	0.05		0.52	5.60	42.00	<0.01	0.630	10.00		230.00	<1		
			28/06/2000	8.1	0.30	7.1		120	20.0	41.0	0.014	0.05		0.78	6.90	39.00	0.019	0.580	11.00		200.00	16.00		
			5/10/2000	8.2	0.35	6.8		99	21.2	39.3	0.016			0.78	6.61	39.40	0.020	0.590	11.00			<1		6.4
			9/05/2001	11.9	0.32	7.0		91	21.0	40.3	0.021			0.60	6.40	40.40	<0.01	0.520	10.50			1.00		
			29/10/2002	11.8	0.32	6.6		109	15.0	43.5	0.020			0.45	5.50	32.00	<0.01	0.650	10.10			6.00		
			18/03/2003	11.64	0.34	6.6		115	16.0	47.1	0.016			1.10	4.30	39.00	<0.01	0.612	10.60			<1		
			15/03/2004	11.61	0.32	6.5		115	16.0	47.1	0.034			0.50	5.00	37.00	<0.01	0.747	10.70			<1		
			16/03/2005	11.85	0.32	6.3		110	17.0	43.0	0.045			0.63	5.50	36.00	<0.01	0.999	10.00			4.00		
			14/03/2006	12.02	0.24	7.0		93	20.0	41.6	0.047			0.70	6.21	41.90	<0.01	1.050	9.28			<1		
			13/03/2007	11.71	0.29	8.1		91	20.6	42.9	0.041			0.60	6.04	40.30	<0.01	1.050	12.40	0.048		<1		
			29/04/2008	12.33	0.39	6.6				45.2	0.01		0.01				<0.01	0.94	10.6	0.114				2.15
			25/09/2008	11.5	0.35	6.4		91	19.0	44.3	0.049			0.73	6.26	38.50	<0.01	1.270	9.69	0.034	191.00		<0.005	
			10/03/2009	12.57	0.37	6.6	1	92	23.2	44.9	0.046			0.65	6.41	41.30	<0.01	1.150	10.40	0.054	202.00		0.01	
G46/0111	10.7	?	5/11/1998	13.3	0.89	7.4		260	95.0	130.0	0.001	0.10		0.63	16.00	73.00	0.006	12.000	59.00					
			14/09/1999	10.4	0.96	7.5		270	92.0	130.0	0.001	0.27		0.92	17.00	71.00	0.034	9.000	61.00		570.00	<1		
			14/12/1999	15.4	0.96	7.4		260	110.0	120.0	0.002	0.09		0.60	17.00	84.00	0.022	11.000	56.00			66.00		
			21/03/2000	13.5	0.85	7.4		260	74.0	110.0	0.002	0.05		0.43	13.00	70.00	<0.005	9.100	44.00		530.00	550.00		
			28/06/2000	8.4	0.30	7.1		270	90.0	110.0	0.003	0.14		0.90	14.00	76.00	<0.005	4.200	47.00		510.00	12.00		
			5/10/2000	9	0.94	7.0		210	90.9	116.0	4.800			1.19	15.70	79.20	0.080	7.200	53.00			15.00		

			9/05/2001	12.3	0.74	7.1		194	74.9	93.6	0.005			0.60	13.90	71.30	<0.01	2.800	41.10			12.00		
			25/10/2001	10.9	0.82	6.9		194	78.0	106.0	0.001			0.55	13.90	75.00	<0.01	4.200	44.80			920.00		
			29/10/2002	10.5	0.91	7.0		237	88.0	140.0	0.005			0.86	17.00	68.00	0.020	8.680	55.10			80.00		
			18/03/2003	12.85	0.84	7.1		240	61.0	121.0	0.005			1.30	10.00	68.00	<0.01	6.680	44.90			8.00		
G46/0131	70	Rock	6/11/1998	12.5	0.52	8.7		190	8.9	96.0	0.001	<0.05		0.33	1.20	110.00	0.012	0.044	9.20					
			14/12/1999	14	0.66	7.2		170	80.0	37.0	0.001	3.70		0.39	13.00	51.00	0.066	0.032	150.00			5.00		
			21/03/2000	14.8	0.47	7.7		190	41.0	38.0	0.003	1.50		0.10	4.80	45.00	<0.01	0.016	37.00		300.00	<1		
			29/06/2000	5.4	0.59	7.1		150	66.0	36.0	0.005	0.70		0.67	13.00	49.00	0.015	0.048	160.00		430.00	<1		
			5/10/2000	13.5	0.93	7.0		116	84.2	57.9	0.005			0.77	17.90	86.10	0.080	0.042	262.00			32.00		8
			9/05/2001	11.6	0.51	7.0		148	46.2	40.8	0.005			0.27	6.50	60.00	<0.01	0.011	65.00			28.00		
			25/10/2001	11	0.74	6.6		121	70.0	50.0	0.001			0.54	13.50	75.00	0.090	0.008	186.00			6500.00		
			29/10/2002	11.6	0.62	8.0		174	58.0	44.5	0.005			0.03	0.20	9.40	0.030	0.019	155.00			<1		
			18/03/2003	12.62	0.64	7.2		189	43.0	49.9				1.10	5.50	61.00	0.070	0.011	115.00			13.00		
			15/03/2004	13.41	0.53	7.0		176	38.0	47.2				0.21	4.90	52.00	0.020	0.005	62.00			4.00		
			16/03/2005	13.13	0.62	6.6		210	48.0	46.0	0.013			0.77	5.50	64.00	0.060	0.012	100.00			2.00		
			14/03/2006	12.23	0.44	6.8		175	50.4	41.5	0.011			0.31	5.95	75.10	0.020	0.042	93.20			24.00		
			13/03/2007	11.91	0.49	7.9		164	46.2	41.8	0.008			0.20	5.68	64.20	<0.01	0.097	64.90	0.313		<2		
			25/09/2008	11.2	0.73	6.6	1		67.5	40.8	0.012			0.36	8.71	65.90	<0.01	0.090	162.00	0.213	400.00	9.00	<0.005	
G46/0132	150	Rock	6/11/1998	12.3	0.32	6.9		140	21.0	43.0	0.010	0.05		0.55	5.40	40.00	<0.005	0.660	11.00					
			14/09/1999	12.3	0.70	8.8		180	6.6	130.0	0.002	0.05		0.39	0.65	120.00	0.034	0.052	11.00		380.00	9.00		
			14/12/1999	12.7	0.68	8.9		180	5.7	120.0	0.001	0.05		0.30	0.59	120.00	0.012	0.130	10.00			1.00		
			21/03/2000	12.14	0.65	8.5		200	45.0	100.0	0.005	1.60		0.11	5.10	47.00	0.020	0.049	10.00		380.00	1.00		
			29/06/2000	8.5	0.59	8.4		210	9.6	100.0	0.003	0.13		0.43	1.20	130.00	0.007	0.007	12.00		360.00	<1		
			5/10/2000	11.3	0.69	8.5		145	7.9	95.0	0.005			0.42	1.01	138.00	0.040	0.005	12.80			390.00		2.7
			9/08/2001	11.8	0.51	6.7		148	47.0	40.5	0.005			0.29	6.60	60.20	<0.01	0.043	63.00			30.00		
			25/10/2001	11.7	0.66	7.3		155	12.0		0.003			0.19	1.91	132.00	0.020	0.018	11.20			5.00		
			29/10/2002	10.6	0.68	6.9		177	5.3	126.0	0.005			0.10	0.98	120.00	<0.01	0.021	12.80			<1		
			18/03/2003	12.25	0.66	8.5		189	5.7	122.0	0.005			1.10	0.65	130.00	0.050	0.022	13.50			<1		