SOUTHERN SPRINGS SECTOR HYDROLOGY

DATA UPDATE

Marlborough District Council – February 2008

Environmental Science & Monitoring Group

1. Introduction

The Southern Springs represent a special sector of the Wairau Aquifer on its extreme southern margin with the Southern Valleys Catchments. Potential water management issues include depletion of aquifer fed freshwater springs, and summer reductions in Taylor River flows through Blenheim.

The boundary of the southern springs sector is marked by the red line in Figure 1. The northern boundary is marked by Middle Renwick Road as far east as Severne Street, then follows Lakings Road to the Taylor River. This boundary is largely arbitrary except in the east where it is defined to exclude Murphys Creek, which represents a separate tributary of the Taylor River.

The southern boundary is based on geology and corresponds with the northern extent of the Speargrass geological Formation which hosts the Southern Valleys Catchments and Aquifers. It closely matches the axis of New Renwick Road except for the bulge near Green Lane. The western boundary is defined by the flattening of the surface topographic grade at the foot of the Fairhall and Omaka River fans. Effectively the Taylor River fixes the eastern margin of the Southern Springs sector, with the step coinciding with the Taylor River gravels at Waters Avenue. The diagonal dashed red line splitting the sector denotes the boundary between an unconfined aquifer structure to the west, and confined gravels to the east.

The blue lines within the sector and to the north-east represent freshwater springs, which rise in a belt from north to south across the Wairau Plain, with the Southern Springs forming the southern-most group. Spring Creek forms the northern spring group and emits the largest aquifer seepage with a median flow of 4 m^3/second at the Motorcamp recorder site.

This report includes discussion of Murphys Creek and Fultons Creek, which aren't strictly speaking located within the southern Springs sector, but are relevant to the discussion. The focus of this report is the Fairhall Co-op/Doctors Creek system which by virtue of its southerly locale is the lowest yielding of the Wairau Plain spring systems, and as a consequence its allocation limit reflects this.

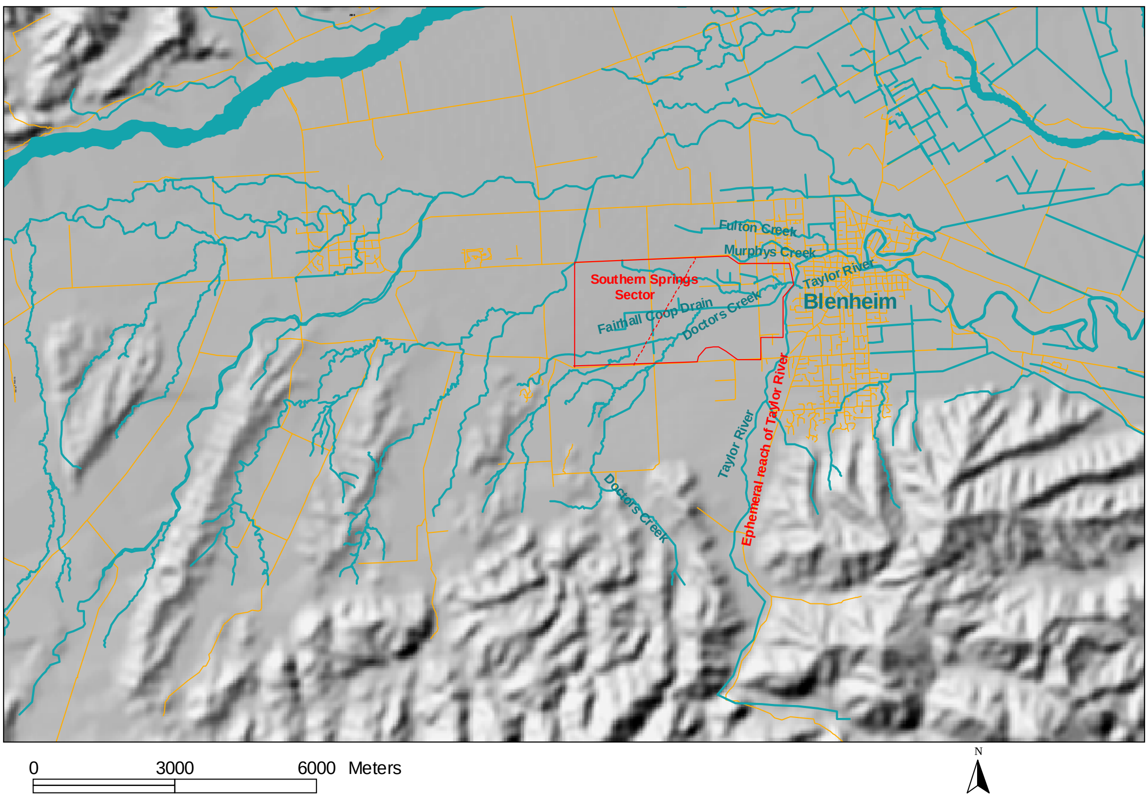

Figure 1 : Location Map

While the baseflow component for the Fairhall Co-op/Doctors Creek system originates from groundwater, Doctors Creek has a significant hill catchment of 50 square kilometres in area, which influences flows at the high end. The Doctors Creek hill catchment is shown by the red dashed line in Figure 2.

2. Background

The most comprehensive assessment of the Southern Springs water resource was carried out by Marlborough District Council staff in 2004 and the results compiled in a report prepared by Mark Gyopari of Phreatos Ltd in 2005 (Phreatos – 2005). Phreatos (2005) remains the primary source of reference for the hydrology of the Southern Springs, although some data are no longer up to date.

The purpose of this report is to provide an addendum to the Phreatos report, updating the flow information for Murphys Creek, Fultons Creek and Fairhall Co-op/Doctors Creek based on recent gaugings; and water demand from water permit details.

The Taylor River is normally ephemeral upstream of these aquifer fed springs, with no channel flow existing until the appearance of bedrock near the Marlborough District Council flow recorder site at Borough weir, shown by the red triangle in Figure 2. The confluence of Doctors Creek with the Taylor River represents the point above which channel flow disappears in a typical summer and is marked by the red circle.

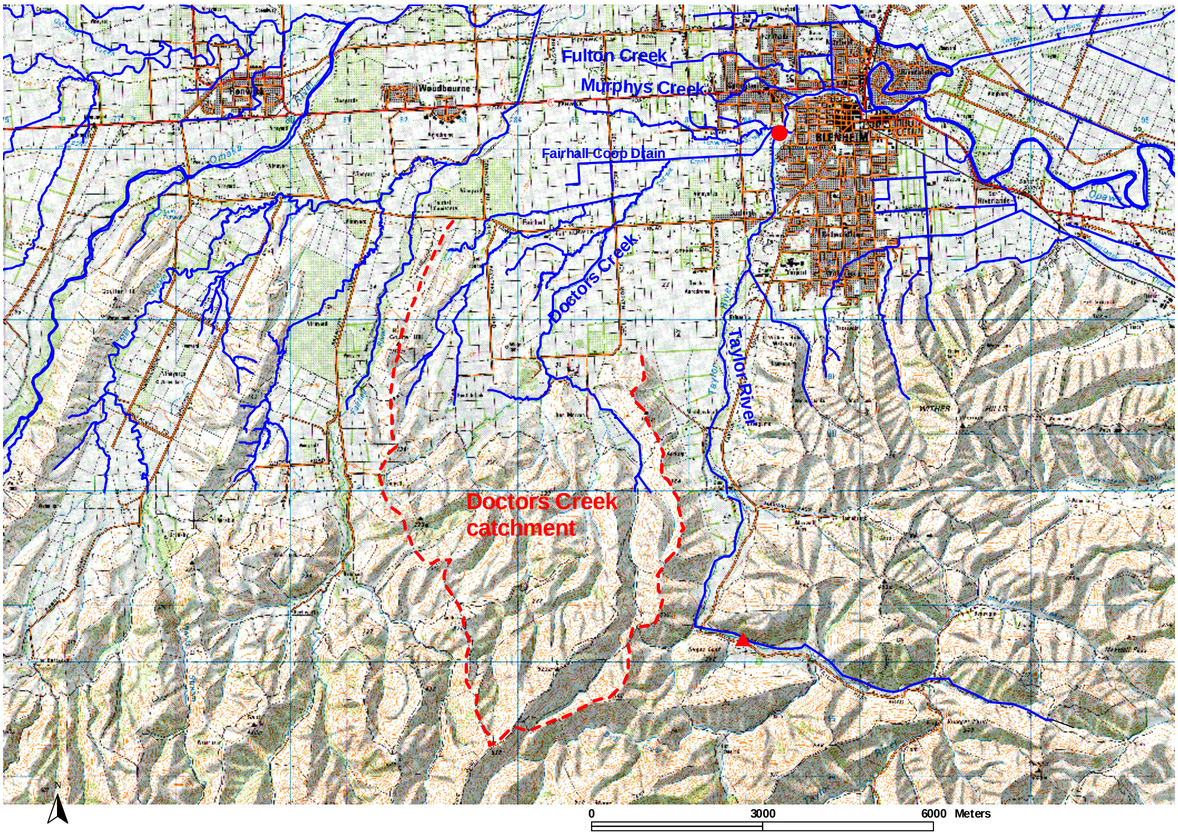

Figure 2 : Doctors Creek Catchment

This review was prompted by a series of recent water permit applications in the Southern Springs sector, and the implementation of the Southern Valleys Irrigation Scheme (SVIS) in 2004. The SVIS was established to supplement local water resources that were fully allocated in some seasons, and to allow expansion of irrigated vineyard in the southern valleys catchments to the south-west of Blenheim. Its operation has the potential to influence local hydrology, and it was timely to review any impact based on recent hydrological observations. This update is intended for general information purposes and to support the assessment of water permit applications by the Marlborough District Council.

3. Spring Flow Characteristics

Figure 3 shows the variation in weekly gauged flow for the 3 principal tributaries of the Taylor River in its middle reaches near Blenheim, for the period from January 2003 to late 2007. Under typical summer conditions these freshwater springs provide all of the Taylor River channel flow through the suburban area. This urban aquatic reach represents a natural character feature unique to Blenheim.

Some minor tributaries such as Chinamans Creek and Waterlea Creek have been omitted due to a lack of sufficient flow record. Notwithstanding this their contribution to Taylor River flow is minor compared to the flow of the 3 springs gauged on a weekly basis. For the purposes of this report the Hutcheson Street bridge is the downstream boundary for defining total or cumulative flows from tributaries or the Taylor River itself.

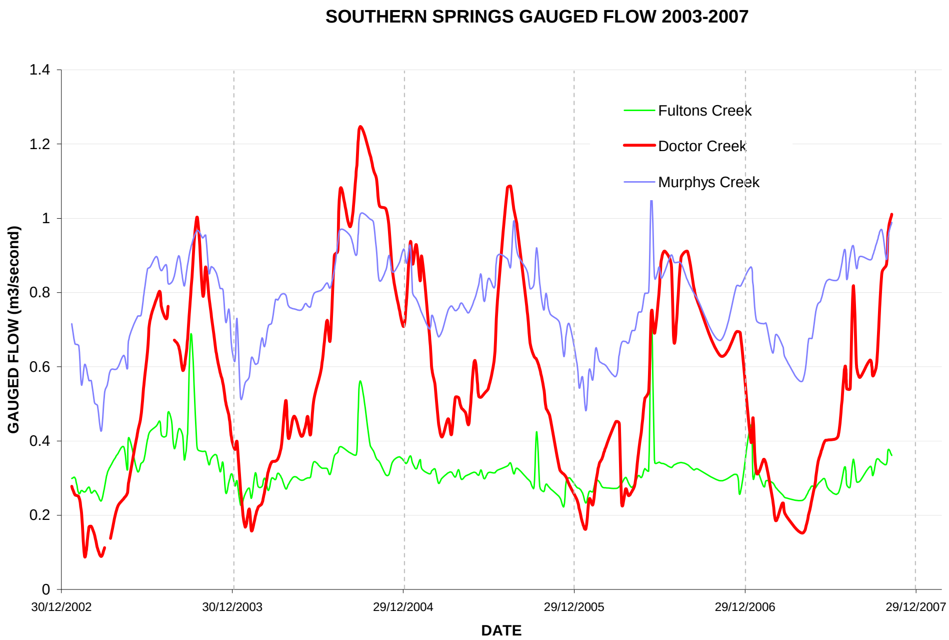

Figure 3 : Gauged Flows

The springs can be split into 2 broad groups based on their seasonal range in flow (Figure 3). Murphys Creek and Fultons Creek have relatively stable flows; particularly Fultons Creek, and behave like true springs. Whereas flow in the Fairhall Co-op/Doctors Creek system varies by 2 orders of magnitude, reflecting flood flows associated with runoff generated in the 50 km^2 Southern Valleys hill catchment (Figure 2). Springs exclusively fed from groundwater don't have a clearly defined catchment in a topographical sense, but draw groundwater from the immediate area.

There are significant differences between the flow regimes of Fultons Creek and Murphys Creek which are less easy to account for. One explanation for the larger variation in Murphys Creek flow are lower flows over summer associated with abstraction from municipal supply wells opposite its middle reaches, and for crop irrigation in its upper reaches (Figure 2). Or it may reflect changes in the geological structure of the alluvium which could influence spring emittance rates. Another explanation is more efficient drainage of the semi-urban area, generating higher storm runoff.

Alternatively it might reflect the relatively small variation in Fultons Creek flow following the introduction of the Southern Valleys Irrigation Scheme which increased groundwater throughflow in the area to the north. This possibility is discussed in section 9.

4. Spring Flow Characteristics

Table 1 summarises the characteristics of gauged flows for each of the 3 spring systems from 2003 to late 2007. Interestingly the median and mean flows in each of the 3 springs are similar. This was expected for Fultons Creek with its stable flow regime, but is surprising for Fairhall Co-op/Doctors Creek which exhibits such a large flow range.

In terms of flow range, Fultons Creek has the smallest standard deviation from the mean of 60 litres/second, followed by Murphys Creek with 120 litres/second and Fairhall Co-op/Doctors Creek at 270 litres/second. Another measure of dispersion is the inter-quartile range listed in the right hand column of Table 1. It describes the spread of the middle half of flows. As expected, flows are more tightly clustered around the median flow for Fultons Creek, and more dispersed for Fairhall Co-op/Doctors Creek.

Gauged Flow									
Spring System	**Mean Gauged Flow (l/s)**	**Median Gauged Flow (l/s)**	**Standard deviation (l/s)**	**Maximum (l/s)**	**Minimum (l/s)**	**Range (l/s)**	**Lower quartile (l/s)**	**Upper Quartile (l/s)**	**Interquartile range (l/s)**
Fultons Creek at Nelson Street	320	310	60	733	220	513	280	340	60
Murphys Creek at mini railway bridge	770	782	120	1070	430	640	680	860	180
Doctors Creek upstream of Taylor River	540	520	270	1300	88	1212	320	750	430

Table 1 : Gauged Spring Flow Statistics Summary 2003-2007

Figure 4 is a correlation of gauged channel flow for each of the springs versus groundwater level in the nearby Marlborough District Council substation monitoring well 3954. Each dot represents a flow gauging which has been plotted against the corresponding aquifer level at Substation well 3954. Each of the 3 springs is denoted by a different colour.

It demonstrates the close relationship between freshwater spring flow, and groundwater elevation representing the driving force. This clearly understood and generally accepted principle is responsible for the occurrence of many freshwater springs throughout the central and lower Wairau Plain. The best correlation exists with Murphys Creek rather than Fultons Creek, due to the series of outliers above the general cluster of data points for the latter. These data can't be explained by increased leakage from the Upper Opawa River flow alone as some predate the introduction of SVIS. Fairhall Co-op/Doctors Creek has a less well defined relationship including a sharp increase in flow per unit rise in aquifer levels for elevations greater than 7.5 metres above sea-level, reflecting hill country catchment runoff.

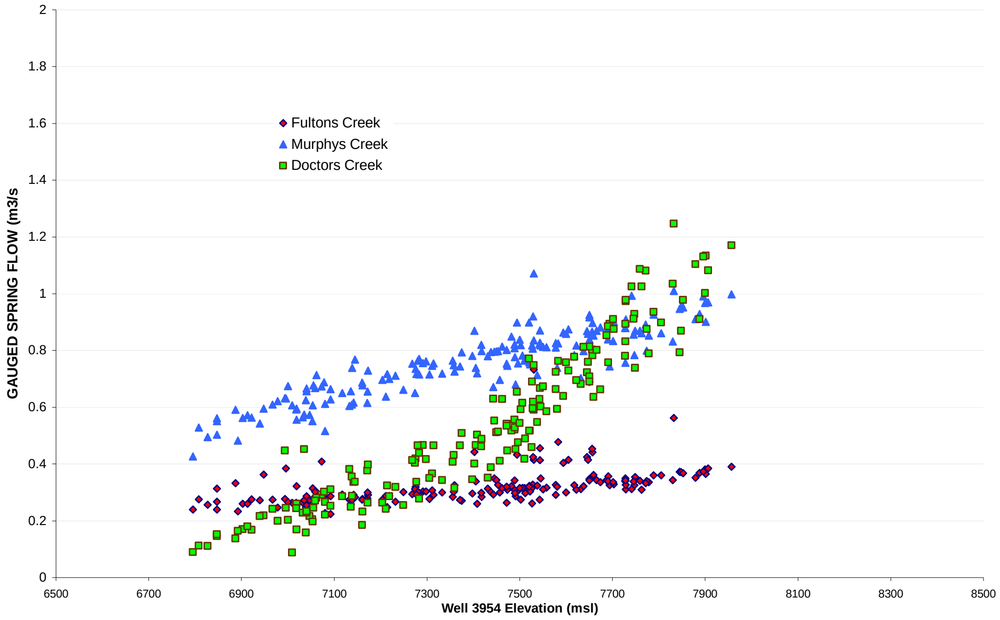

Figure 4 : Spring Flow Versus Aquifer Level

5. Relative Contribution to Taylor River

Figure 5 shows the percentage contribution each spring makes to Taylor River flow in its middle reaches. Murphys Creek is the largest tributary with between 40% and 60% of Taylor River flow. It plays a particularly important role in summer when aquifer seepage maintains Taylor River baseflow in the absence of catchment runoff. Contributions from Fultons Creek are relatively static at 20% of Taylor River flow. The Fairhall Co-op/Doctors Creek spring system can under higher flow conditions in winter or spring, be the majority contributor, providing nearly 50% of the Taylor River flow through Blenheim, when no Taylor River flow exists in the middle reaches. However this contribution can be as low as 10% under late summer conditions when flows are depleted due to water demand from crop irrigators.

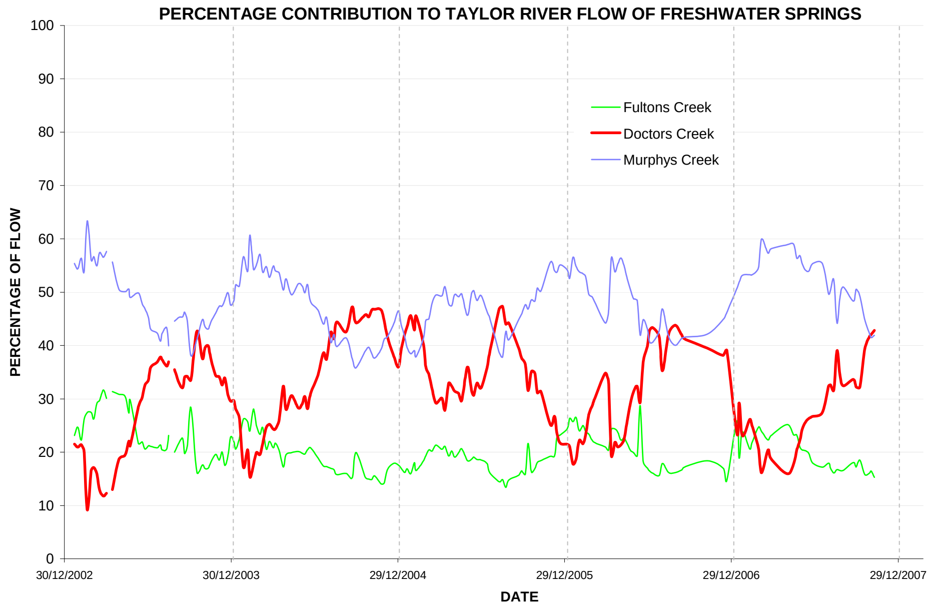

Figure 5 : Percentage Contribution to Taylor River

6. Fairhall Co-op/Doctors Creek Water Demand

The impact of abstraction by resource consent holders on Fairhall Co-op/Doctors Creek low flows is the prime focus of this report. Figure 3 shows the lowest gauged flow during this period of 88 litres per second occurred on the 17 of February 2003, and coincided with what is thought to be the last season of operation of the Korere dairy farm prior to its conversion to vineyard. Unfortunately it also corresponded with drier than normal rainfall conditions, making it difficult to separate out the man induced versus natural effects on channel flow.

Figure 6 shows actual water use for the period from 1985 to 2007, for the Korere Farms and subsequent Korere Water Services consents. This is a long and useful period of record showing actual water use fell significantly following the cessation of irrigation for intensive dairying/cropping after the 2002/03 summer.

Overall mean daily water use is 1,100 cubic metres of water per day, although consumption has regularly exceeded the initial consented quota of 5,000 cubic metres. This pattern of fully accessing resource consent allocation is rarely seen for drip irrigation of grape crops under Marlborough conditions.

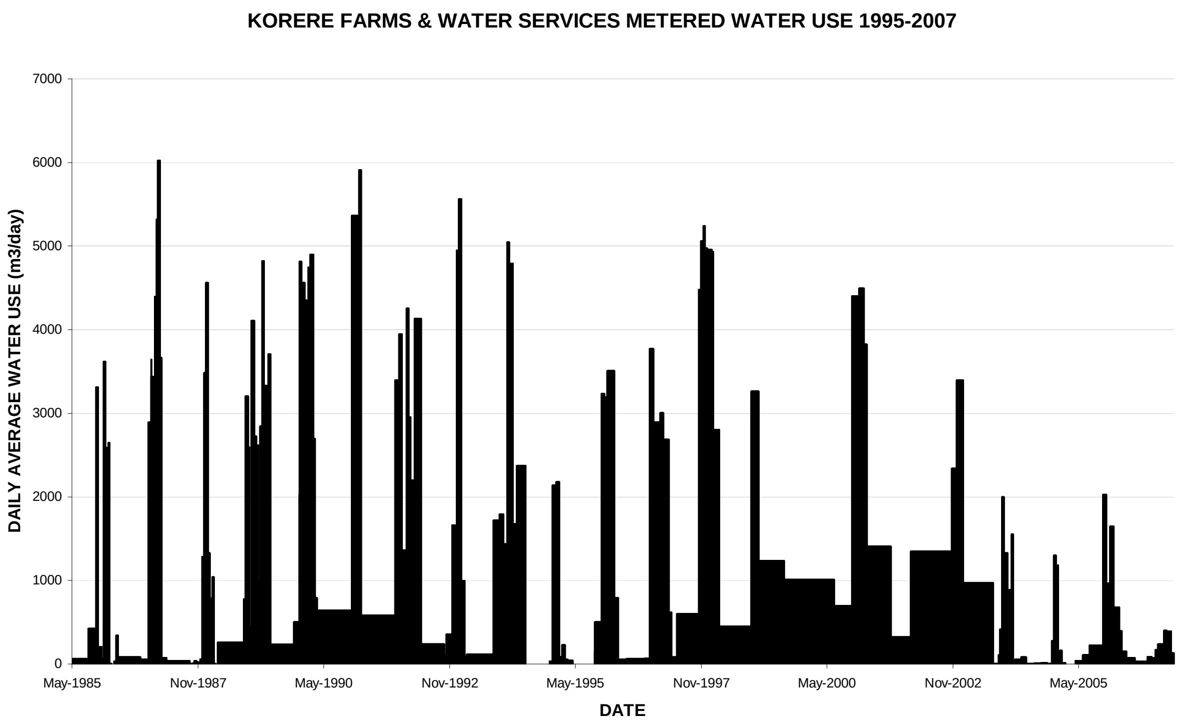

Figure 6 : Korere Farms Metered Water Use

It follows that Fairhall Co-op/Doctors Creek flows should on average be higher from 2004 onwards due to lower demand by irrigators. Figure 7 shows the variation in Fairhall Co-op/Doctors Creek gauged flow since 2003 in red, over-plotted against groundwater elevation at substation well 3954 in green. The dashed horizontal black lines show annual minimum channel flow has increased by about 75 litres per second since the 2002/03 summer, but the similarity between flow and aquifer level suggest the lift is primarily driven by seasonal variation rather than abstraction.

Figure 7 : Variation in Fairhall Co-op/Doctors Creek with Aquifer Level

7. Stream depletion Effects

Man induced reductions in Fairhall Co-op/Doctors Creek flow occur in 1 of 2 ways. The most obvious method is direct abstraction from the channel, or wells close by. The second mechanism involves the indirect effect of well abstractions operating at varying distances from the channel, and has until relatively recently been difficult to quantify due to the lack of analytical tools.

The effects of some individual well abstractions may in isolation be limited, but calculations of the cumulative effect show it is significant in some seasons. Recording instruments placed in the channel opposite wells confirm an alternating cycle in water level over summer which can only be explained by pumping.

Various methods have been used to quantify the indirect effect of pumping on Fairhall Co-op/Doctors Creek flow including mathematical models of the Southern Springs hydrological cycle. Phreatos (2005) used an analytical approach to calculate the cumulative rate of Fairhall Co-op/Doctors Creek flow depletion due to the combined effect of pumping from all wells. The predicted rate of stream depletion was 250 litres/second (Phreatos - 2005).

A weakness of this approach is uncertainty over aquifer hydraulic properties and in particular the conductivity of the streambed sediments. Predictions are particularly sensitive to this parameter, with small changes in its value resulting in large predicted changes in stream flow. To refine the value of this parameter for the Southern Springs area, the Marlborough District Council commissioned Sinclair Knight Merz Ltd to survey Fairhall Co-op/Doctors Creek in spring 2007 (SKM - 2008).

The cumulative stream depletion calculation initially carried out by Phreatos (2005) was repeated in December 2007 by Water Matters Ltd using higher values for stream bed conductance based on the field survey results (SKM – 2008), and updated resource consent details. The recalculated stream depletion rate using the scenario of wells pumping continuously at their maximum consented rate for 1 month, is 313 litres/second (Appendix A).

This represents an increase of 63 litres/second on the rate predicted in the 2005 Phreatos report. However it is likely that actual water use is significantly less based on historical metered water use under Marlborough conditions. Appendix A summarises the results for all active water permits operating in the Southern Springs area in October 2007.

Experience in the Southern Valleys Catchments demonstrates that only a proportion of consented quota is actually used depending on seasonal conditions. A rule of thumb based on known water consumption in the Southern valleys Catchments is that 50% of resource consent allocation is used on a daily basis under normal summer conditions. More water is required under drier conditions when plants transpire at a higher rate.

The next step was to compare the predicted channel depletion rate with observed summer low flows. Table 2 summarises the lowest gauged Fairhall Co-op/Doctors Creek flow for each of the past 5 years. The mean annual low flow (MALF) for this period is 189 litres per second.

These flows reflect the influence of abstraction and are lower than would naturally be the case, particularly under drier summer conditions. However without universal metered water usage figures, the natural flows of Fairhall Co-op/Doctors Creek in the absence of well pumping aren't accurately known yet.

Summer Irrigation Season	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**MALF 2002-07**
Minimum gauged Fairhall Co-op/Doctors Creek Flow (litres/second)	90	150	410	175	120	**189**

Table 2 : Annual Minimum Flows

The analysis in Appendix A predicted the potential stream depletion impact on Fairhall Co-op/Doctors Creek flow associated with well abstraction would be 313 litres/second. This reduces to 157 litres/second assuming 50% of allocation is actually used. An estimate of the natural flow in the absence of pumping can be derived by adding the estimated actual stream depletion effect of 157 litres/second onto the gauged flows over the past 5 years, and this is represented by the red dashed line in Figure 8. Based on this approach, the natural or background minimum summer flow is probably around 300 litres per second.

The green and blue dashed lines in Figure 8 show the predicted potential and actual cumulative stream depletion rates for Fairhall Co-op/Doctors Creek flow respectively. These figures show a high proportion of summer flow has been allocated for out of stream use. The acceptability of this allocation regime depends on how the community value local aquatic ecology and its reliance on certain flow requirements.

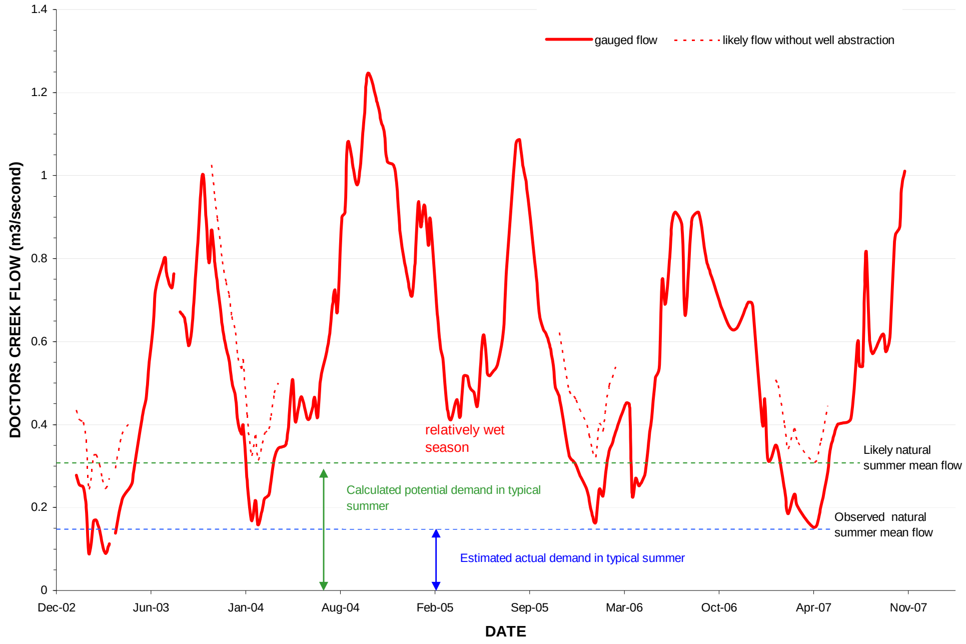

Figure 8 : Likely Impacts of Well Abstraction on Fairhall Co-op/Doctors Creek Flow

Interestingly over the past 5 seasons, resource consents with flow dependant conditions would only have been restricted for any length of time during the 2002/03 summer season when flows were below 150 litres/second for around 35 days. This represents a high level of reliability for consent holders with interruptions likely to occur for only 5% of the time.

Quantifying actual use is a high priority for the Marlborough District Council in this area to quantify actual use and impacts of resource consents. A preliminary estimate of total water use for the Southern Springs area is expected shortly based on water meter readings.

8. Downstream Effects on Taylor River Flow

Taylor River baseflow is largely dependant on Doctors Creek for recharge in the 700 metre long stretch from upstream of Murphys Creek, through to the headwaters at Doctors Creek. The contribution from influent seepage through the river bed is calculated as the difference between Taylor River flow and tributary flow. Its importance in maintaining baseflow is likely to increase downstream, although more gaugings are needed to quantify the gain reach by reach.

This headwaters reach is illustrated in Figure 9 showing a longitudinal Taylor River flow profile north from Alabama Road to the Hutcheson Street bridge. Channel flow in this headwaters reach is sensitive to withdrawals from the Southern Springs under drought conditions, when flows fall to the same magnitude or less than consented demand. This is illustrated in Figure 10 showing Taylor River flows for 3 simultaneous gaugings surveys conducted by the Marlborough District Council in January 1978 and on 2 occasions in March 2001.

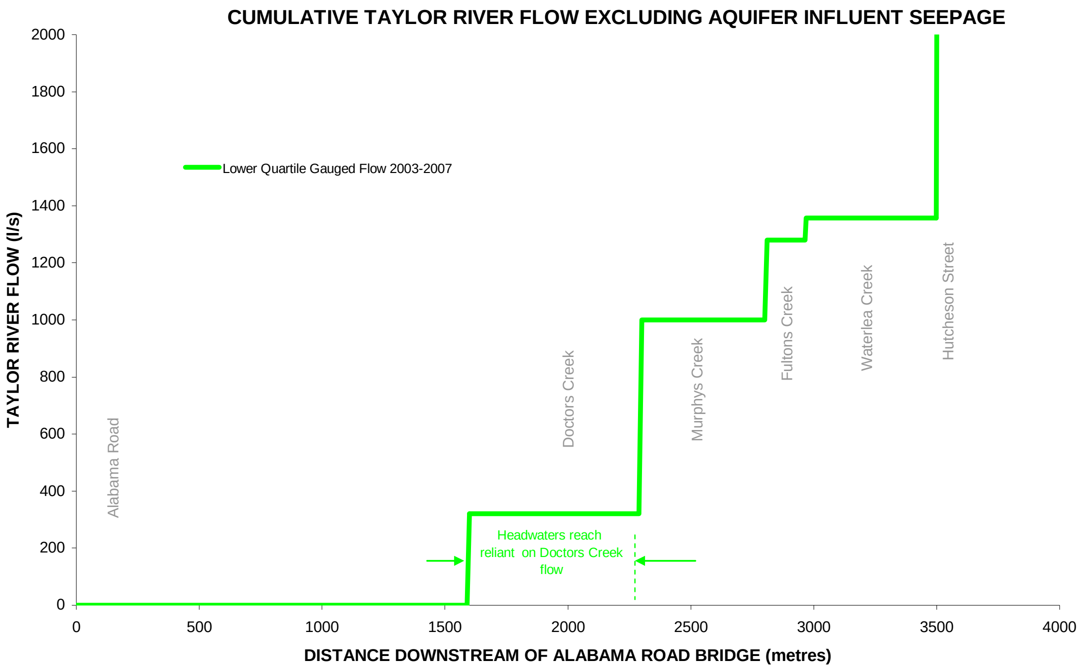

Figure 9 : Taylor River Tributary Flow Profile

Doctors Creek flows as low as 84 litres per second were gauged during the 2000-01 drought as shown by the red triangle in Figure 10. This flow represents the net drainage from the Southern Springs/Doctors Creek Catchment after consented abstraction. While this represented an extreme drought event, if demand increased by an added 84 litres per second or recharge declines long-term by the same amount, Doctors Creek would have ceased to flow and the headwaters of the Taylor River would recede northwards.

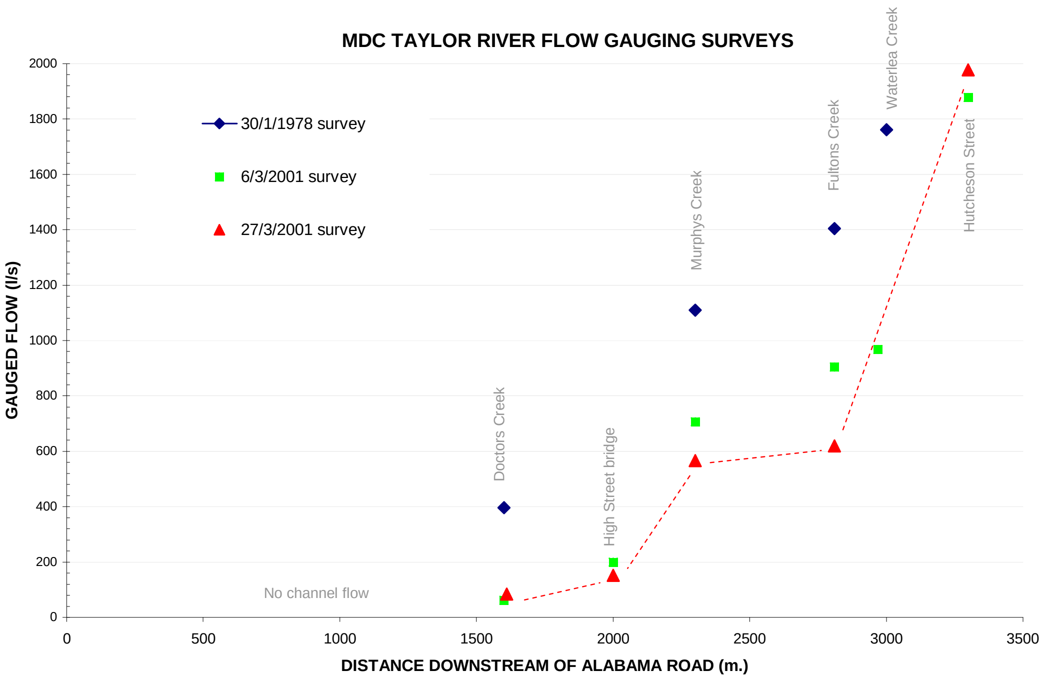

Figure 10 : Taylor River Gauging Surveys

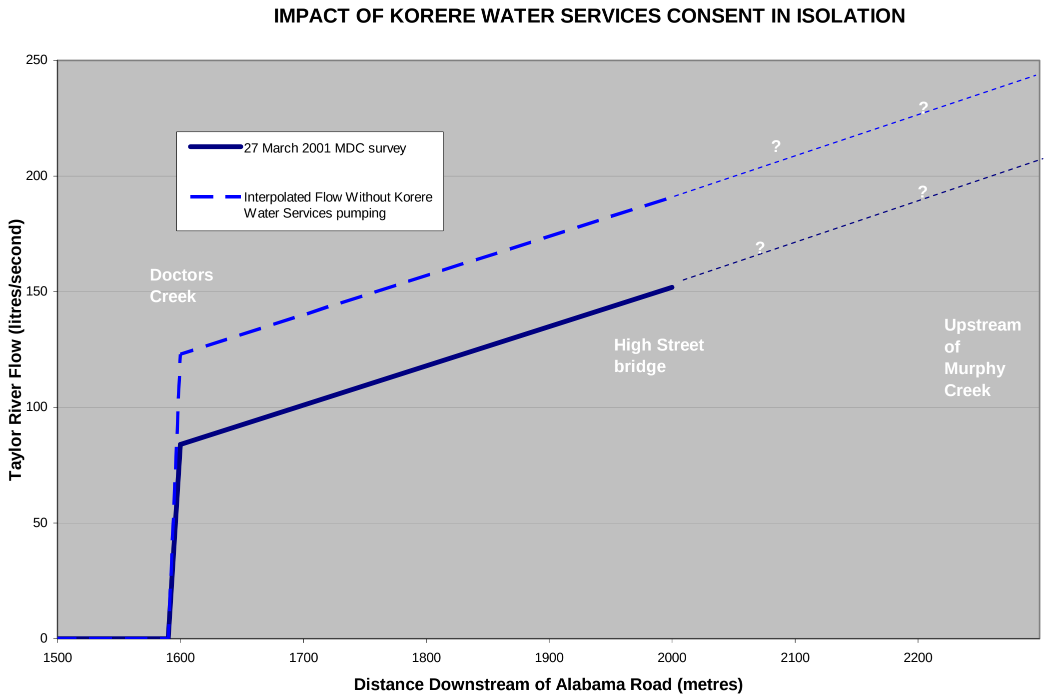

Figure 11 : Korere Water Services Effects on Taylor River

It is important to isolate the effects of the Korere Water Services water permit application. Figure 11 is a close-up view of the Taylor River flow profile for the 27 March 2001 drought event for the critical headwaters reach from Doctors Creek through to just above the confluence with Murphys Creek. The solid dark blue line represents the measured flow, while the dashed line indicates flow in the absence of the Korere Water Services pumping. Because the only intermediate gauging exists for High Street, the change in Taylor River channel flow has been extrapolated downstream using the same slope, assuming a constant rate of influent seepage through the river bed.

9. Effects of Opawa River Re-watering on Doctors Creek

The introduction of enhanced Gibson Creek flows associated with SVIS, has involved the diversion of Wairau River water through the Upper Opawa River system when flows at Tuamarina exceed 8 m^3/second. Significant flow losses to groundwater via seepage through the bed of the channel occur to the north of the Southern Springs, and have the potential to increase aquifer levels, and as a consequence spring flow. For example during the February 2005 Marlborough District Council gauging survey, 48% of losses to groundwater occurred in the vicinity of Hammerichs Road.

While Figure 3 suggests less variability in Fultons Creek flow since the introduction of SVIS, this data series is far from conclusive. Figure 12 shows a times series of Opawa River flow at Blicks Lane in the mid plains area in green, versus groundwater level at substation well 3954 from 2004 to 2007 in red. Rises in well level following increases in Opawa River flow at Blicks Lane suggest a cause and effect relationship.

There should be an identifiable impact on aquifer levels given the magnitude of the measured channel losses. While there are certainly observed rises in shallow piezometers operated by the Assets and Services department of the Marlborough District Council in the north-west Blenheim area, the response at deeper groundwater sites isn’t as conclusive (MDC – 2006).

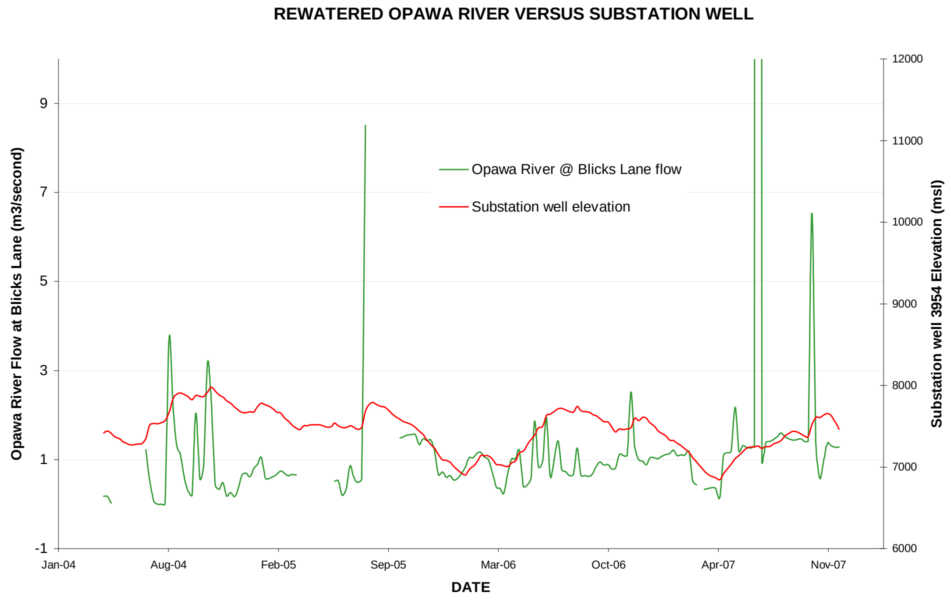

Figure 12 : Aquifer Level Versus Mid Plains Opawa River Flow

Another analytical approach is to compare aquifer level with controlled changes in Gibson Creek flow at the Wairau River intake. The advantage of this method is it provides known and well defined changes in measured channel flow, which should be easier to identify in the aquifer record if a hydraulic link exists. Figure 13 shows Wairau River intake flow in blue with substation well level in green, and rainfall represented by the blue histogram. However there are few changes that can't be accounted for by rainfall alone.

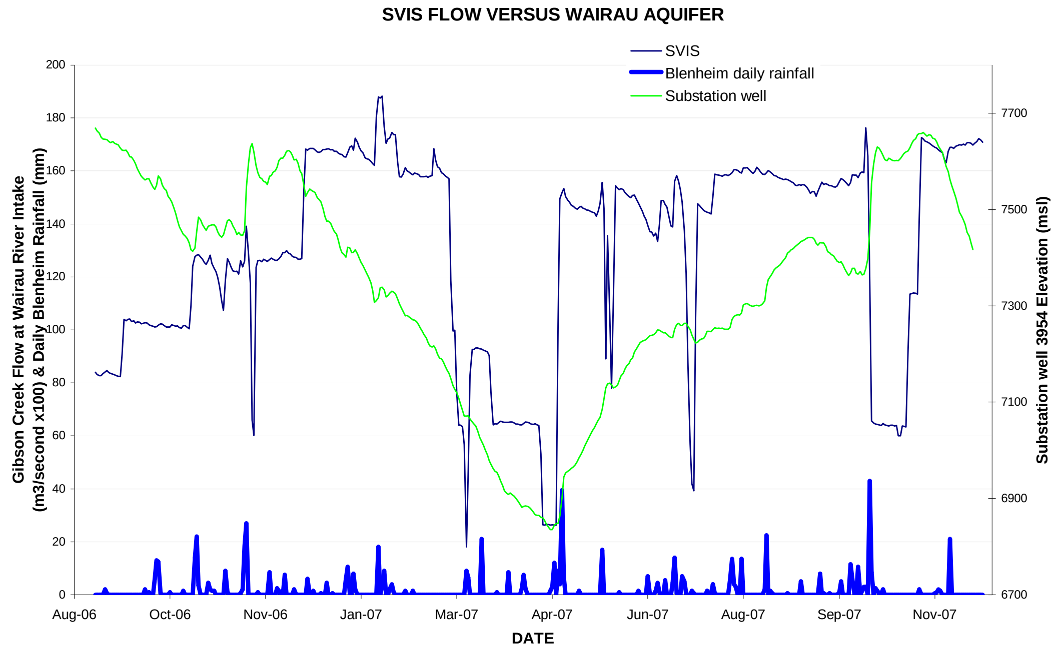

Figure 13 : Wairau River Controlled Flow

10. Conclusions

- *Marlborough District Council have collected a comprehensive series of flow gaugings characterising the Southern Springs dating from 2002*
- *Fairhall Co-op/Doctors Creek flow is the predominant tributary of suburban Taylor River channel flow in spring/winter, but its contribution typically falls to 25% over the critical summer period when demand on water resources peaks*
- *The headwaters reach comprising the upper 700 metres of the Taylor River is reliant on Doctors Creek flow for maintaining baseflow, and is sensitive to consented abstraction under drought conditions*
- *The cumulative impact associated with consented groundwater use on Fairhall Co-op/Doctors Creek flow has been recalculated at 313 litres/second*
- *This rate represents an increase of 63 litres/second compared with the 250 litres/second figure reported by Phreatos (2005)*
- *The increase is explained by the higher streambed conductance values used in the 2007 calculation based on measured field values*
- *The real rate of depletion is likely to be around half this figure as the actual rate of use is known to be a proportion of consented use*
- *This represents a high proportion of typical summer minimum channel flow in Fairhall Co-op/Doctors Creek at 80% of the 2002-2007 mean annual low flow*
- *Flow data show resource consents would only have been restricted for an extended period once during the 2002-2007 period based on standard consent condition thresholds of 150 litres/second or less*
- *This corresponds to a 95% reliability for consents with flow dependant conditions*
- *The supplementary benefits of leakage from the Southern Valleys Irrigation Scheme to groundwater or on southern springs flow remains uncertain based on current hydrological monitoring*
- *It is likely that catchment yield originating from the Southern Valleys will fall from 2030 onwards based on predictions of future climate variability*
- *The conversion of dairy/cropping land to crops with lower water demand such as grapes has reduced actual use and is unlikely to be entirely offset by new crop types or non-agricultural demands*

11. References

Marlborough District Council – 2006 : NW Blenheim, Sewer Pumpstations and Catchments – Technical report Oct 06 S W Sargent, Service development Engineer, MDC

Phreatos Ltd - 2005 : Hydrogeological Investigation of the Southern Springs, Wairau plains - Prepared for the Marlborough District Council

SKM Ltd - 2008 : Streambed Conductance Survey - Prepared for the Marlborough District Council (In preparation)

Water Matters Ltd - 2007 : Recalculation of analytical model of Southern Springs Stream depletion effects – Prepared for the Marlborough District Council

12. Appendix A

Predicted Cumulative Stream Depletion Rate

Scenario: 30 days of pumping at 100% of consented rate

* Measured to closest spring bed. If well is located west of permanent spring, distance is to ~permanent spring location:
Yelverton: 2586000/5965620
Coop Drain: 25856630/5964750

% PUMPING RATE	*CONSTANTS*
1	t (total)
	t (off)
	σ

Confined Aquifer INPUTS (m,days)													*Confined Aquifer OUTPUTS*		
CONSENT	Name	P28w/	E	N	Depth (m)	Dist* (m)	Reach	Q (m3/d)	T (m2/d)	S	λ (m/d)	K'/B'	Q(l/s)	q/Q %	q (l/s)
041972	WHVM	1404	2586192	5964780		10	FCD	6480	1500	0.010	10	10	75.00	89.71	67.28
030804	Pickering	1428	2586078	5964777	13.8	20	FCD	1469	1600	0.010	10	10	17.00	89.11	15.15
040525	Korere Farms	1731	2586061	5964791	14.3	6	FCD	2975	1600	0.010	10	10	34.43	89.56	30.84
000045	Wiffen Vines	3617	2586343	5964782	18.0	12	FCD	400	1440	0.001	10	10	4.63	91.92	4.26
040021	Wiffen Vines	0995	2587170	5964350	17.2	485	Lower Drs	289	500	0.001	5	0.1	3.34	89.42	2.99
040515	St Clair	1025	2587200	5964130	14.9	705	Lower Drs	289	250	0.001	5	0.1	3.34	82.77	2.77
000309	Marris	1426	2587500	5964400	11.6	455	Lower Drs	354	500	0.001	5	0.1	4.10	89.87	3.68
060590	Chippies	4039	2588158	5964635	14.8	265	Lower Drs	197	500	0.001	5	0.1	2.28	92.69	2.11
070726	Golding etc	1849	2587780	5964400	8.1	470	Lower Drs	354	500	0.001	5	0.1	4.10	89.64	3.67
071118	Couper & VdGeest	2007	2587185	5964450	11.3	385	Lower Drs	330	500	0.001	5	0.1	3.82	90.90	3.47
021178	Bishell	2511	2587500	5964700	13.2	160	Lower Drs	520	1000	0.001	5	0.1	6.02	93.76	5.64
991348	Rose	3560	2587362	5963870		975	Lower Drs	50	250	0.001	5	0.1	0.58	77.29	0.45
001224	Lloyd	3735	2587766	5964502	8.1	370	Lower Drs	236	1000	0.001	5	0.1	2.73	91.55	2.50
071220	Kapiti Views Trust	4706	2587612	5964410	16.0	450	Lower Drs	2454	1000	0.001	5	0.1	28.40	90.71	25.76
000695	Mufaletta	2314	2586220	5963810	14.0	250	Upper Drs	20	500	0.010	20	10	0.23	82.41	0.19
041122	Mafaletta	3857	2586217	5964242	32.2	20	Upper Drs	280	500	0.010	20	10	3.24	95.48	3.09
070785	T D King Properties	0635	2586731	5965672	4.9	215	Yelverton	162	2000	0.010	10	10	1.88	82.73	1.55
040049	Weaver	0665	2586700	5965500	3.7	50	Yelverton	171	2000	0.010	10	10	1.98	87.28	1.73
001504	Newman	0685	2586400	5965300	15.1	110	Yelverton	405	1500	0.010	10	10	4.69	86.46	4.05
011378	Saul	1558	2587100	5965650		290	L Yelverton	414	500	0.001	5	0.1	4.79	92.32	4.42
010448	Gordon	1717	2586350	5965370	12.0	30	Yelverton	359	1800	0.050	10	10	4.16	79.13	3.29

000336	King	2047	2586455	5965896	7.8	450	Yelverton	40	2000	0.010	10	10	0.46	76.52	0.35
020166	Jones-Shipley	2317	2586610	5965250	10.6	205	Yelverton	367	1000	0.010	10	10	4.25	83.52	3.55
980928	Rhodes	3355	2586323	5965359	15.0	40	Yelverton	100	1800	0.050	10	10	1.16	78.60	0.91
001389	Hogg	3603	2586977	5965287	15.9	70	L Yelverton	120	1000	0.001	5	0.1	1.39	94.72	1.32
011379	Clifford	3782	2586910	5965424	23.6	5	L Yelverton	300	1200	0.001	5	0.1	3.47	95.02	3.30
020093	Vanstone	3842	2587045	5965149	16.4	75	L Yelverton	142	1000	0.001	5	0.1	1.64	94.66	1.56
011383	Jowett	3925	2586480	5965315	11.4	115	Yelverton	22	1000	0.010	10	10	0.25	87.05	0.22
030982	Jolley	4105	2586318	5965521	10.3	115	Yelverton	210	1200	0.050	10	10	2.43	76.37	1.86
060584	McGuire	4554	2586273	5965786	13.4	280	Yelverton	154	1200	0.050	10	10	1.78	66.01	1.18

Unconfined Aquifer INPUTS (m,days)													*Unconfined Aquifer OUTPUTS*		
CONSENT	**Name**	**P28w/**	**E**	**N**	**Depth (m)**	**Dist (m)**	**Reach**	**Q (m3/d)**	**T (m2/d)**	**S**	**λ (m/d)**		**Q(l/s)**	**q/Q %**	**q (l/s)**
060666	Hammond	0745	2584600	5964300	9.1	1125	FCD	2500	800	0.010	20		28.94	57.95	16.77
040475	Radich	0932	2585614	5965577	13.0	390	Yelverton	120	2000	0.050	20		1.39	70.51	0.98
010004	Willowhaugh	1784	2585792	5965673	12.7	215	Yelverton	640	2000	0.050	20		7.41	79.00	5.85
060666	Hammond	1989	2584663	5964596	17.0	980	FCD	2500	1000	0.050	20		28.94	32.48	9.40
001402	Gardiner	2062	2585431	5965131	16.5	420	FCD	1600	1800	0.050	20		18.52	68.45	12.68
970733	Bishell M D	2275	2583683	5965676	20.3	2320	Yelverton	1350	1500	0.050	20		15.63	6.68	1.04
041278	Parkes	2650	2585398	5965623	12.1	610	Yelverton	450	1800	0.050	20		5.21	59.28	3.09
050668	Linford Vines	3222	2585184	5965429	15.0	810	FCD	80	1700	0.050	20		0.93	49.47	0.46
010776	Ashmore	3223	2584233	5964186	19.6	1500	FCD	580	800	0.010	20		6.71	46.84	3.14
010245	Montana	3237	2583867	5964719	25.2	1765	FCD	3212	800	0.010	20		37.18	39.75	14.78
060401	Brindle Hurst	3240	2584283	5965923	18.3	1750	Yelverton	220	2000	0.010	20		2.55	57.15	1.46
041581	Hart & Carr	3416	2585520	5965525	17.0	495	Yelverton	157.5	1800	0.050	20		1.82	64.77	1.18
020364	Donaldson	3602	2584774	5963776	10.6	1300	FCD	28	500	0.050	20		0.32	8.13	0.03
950585	Rossiter & Anderson	3746	2585345	5965323	15.1	635	FCD	415	1800	0.050	20		4.80	58.12	2.79
041446	Korere Water Services	3830	2585587	5964756	14.8	10	FCD	2885	1800	0.050	20		33.39	89.73	29.96
020980	Campbell	4071	2584885	5963777		1225	FCD	30	500	0.050	20		0.35	9.96	0.03
030750	Caythorpe Trust	4164	2584872	5965823	23.7	1150	Yelverton	1400	1500	0.050	20		16.20	33.45	5.42
031184	Paynter	4355	2585976	5965973	8.0	350	Yelverton	49.6	1500	0.050	20		0.57	71.01	0.41
040514	Yealands	4212	2585636	5964960	14.8	205	FCD	180	1700	0.050	20		2.08	79.35	1.65
								19,509				**Confined**	**226**	**0.89**	**202**
								37,906				**Unconfined**	**439**	**0.25**	**111**
								57,415				**Total**	**665**	**0.47**	**313**

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