Technical Supporting Document

Wither Hills Vineyards Marlborough Ltd (WHMVL) Water Permit Application U061185

February 2007

Environmental Science & Monitoring Group Technical Report 2007/1

MARLBOROUGH DISTRICT COUNCIL

1. Introduction

The aim of this report is to summarise and document the findings of recent research carried out by Marlborough District Council and its consultants on the sustainable yield of the Rarangi Shallow Aquifer.

In particular to assess the impact of water permit application U061185 (Wither Hills Marborough Vineyards Ltd), on nationally important local wetlands.

2. Executive Summary

a. *Current consented (U021014) level of abstraction of 1,100 m^3/day is sustainable under normal rainfall conditions, based on observed recovery of Rarangi Shallow Aquifer (RSA) levels following 2005/06 summer irrigation season*

b. *The similarity in levels between Rarangi Shallow Aquifer and Northern Wetlands suggest a single, interconnected water body. It follows that:*

   i. *areal extent of northern wetlands is dynamic and directly related to elevation of Rarangi Shallow Aquifer water table. Extent of Hinepango-Pipitea wetland more dependant on relative level in Wairau Diversion Channel and status of control gate than Rarangi Shallow Aquifer*

   ii. *water level differences between Rarangi Shallow Aquifer and wetlands are small. Dominant process appears to be recharge of northern wetlands by Rarangi Shallow Aquifer, but wetlands refill aquifer for short periods during significant rainfall events*

   iii. *wetland headwaters recede southward as part of the natural summer drainage process of Rarangi Shallow Aquifer, although there may be reaches that are saturated for longer where channel drainage is impeded*

   iv. *wetland recession is a natural, seasonal summer phenomena however abstraction from Rarangi Shallow Aquifer will accelerate process*

   v. *wetlands are groundwater dependant ecosystems and management of the Rarangi Shallow Aquifer can directly affect their areal extent*

   vi. *frequency of wetland recession south of Rarangi Road prior to operation of WHMVL consent is uncertain, but was unlikely to be an annual occurrence based on historical records*

   vii. *Northern Wetlands are predicted to dry-up almost every summer season if application is granted for an increased rate of 3,270 m^3/day, and be dry on average for 125 days*

   viii. *areal extent of Northern Wetland influences fate of recharge from the Pukaka Ranges which receives the highest rainfall. When Northern Wetland is fully extended to Pukaka Ranges, it is highly responsive to recharge and generates runoff that moves quickly through wetland system to Wairau Diversion*

c. *This conceptual model can be applied to predict the extent of wetlands based on Rarangi Shallow Aquifer status using known water table slopes. It follows that:*

   i. *wetlands reach full extent when Rarangi Shallow Aquifer elevations at Rarangi Road (well 4331) equal about 1.7 metres above mean sea-level*

ii. *when Rarangi Shallow Aquifer elevation at Rarangi Road (well 4331) equals 1.6 metres above mean sea-level, wetlands recede to southern boundary of WHMVL property), but still act dynamically to redistribute recharge through wetlands to Rarangi Shallow Aquifer or Wairau Diversion channel*

iii. *when Rarangi Shallow Aquifer elevation at Rarangi Road (well 4331) falls below 1.2 metres above mean sea-level, Northern Wetland system ceases to exist. Due to disconnection, Rarangi Shallow Aquifer doesn't respond dynamically to northern rainfall or runoff*

d. *Department of Conservation report concludes that wetlands are of national importance and represent some of the last remnants of a unique flora assemblage on East coast of South Island*

e. *Uruwhenua Botanicals identified the sensitivity of the wetland to hydrological change as indicated by the 2000/01 drought that killed many trees*

f. *The likelihood of a 2000/01 or 1997/98 magnitude drought occurring is likely to increase from once every 7 years since 1989 to 1 year in 3*

g. *Small direct drawdown effects are predicted to reach the coast under drier than normal conditions for a flow rate of 3,270 m^3/day over 100 day season. This will affect reliability of existing consents and permitted activity water users*

h. *Local thresholds and conditions are insufficient to ensure sustainable aquifer use in isolation. A cap on overall aquifer use would account for changes in recharge patterns associated with climate change and drought*

3. Water Management Issues

Potential issues facing the Rarangi Shallow Aquifer including seawater intrusion and drying up of domestic wells were identified over 2 decades ago. A more recent issue to surface is the potential for depletion of the local wetlands by groundwater pumping.

The establishment of the sentinel well network along the Cloudy Bay coast by Marlborough District Council in late 2000 enabled an active approach to water management to be adopted. The 12 square kilometre Rarangi area is the most intensively monitored aquifer in Marlborough, with 9 wells measuring a combination of groundwater levels and conductivities across 2 aquifers.

The small size and inherently low resilience of the Rarangi Shallow Aquifer means the fundamental water management issue is allocating within the sustainable yield on a long term basis. While short term, local effects can be managed via restrictive conditions on water permits; they aren't the most appropriate tool for addressing regional scale issues.

A ceiling on total allocation in combination with local controls is appropriate for Rarangi to provide for seasonal variability in recharge. In particular the combination of high demand beginning in September, and drought conditions extending into the following winter or successively dry summers. To reflect the limited storage of the Rarangi Shallow Aquifer, a seasonal allocation rather than a daily rate is appropriate. Alternatively the duration of the irrigation season has to be specified in terms of a start and finish date.

To date the sentinel well network has shown no evidence of seawater intrusion, but it is to be avoided at all costs as the effects are largely irreversible in terms of human time frames. Numerical model simulations by MDC/Wilson (2007) of Rarangi Shallow Aquifer behaviour, suggest the likelihood of the increased pumping rate (3,270 m^3/day) lowering Rarangi Shallow Aquifer levels at the coast over the duration of a normal summer irrigation season is low, but could occur in conjunction with a dry summer such as 2002/03.

If these effects are propagated this far, it would reduce the reliability of existing water users including Rarangi Golf Club (U940544 & U040869) by triggering thresholds in sentinel wells sooner than if this consent were operating in isolation. There is also uncertainty as to the long-term, cumulative effect of pumping from domestic water wells at the newly established Edgwater Estate, at the coast.

In terms of the second issue, it is likely that domestic wells located in the residential cluster to the south, will be protected by the trigger levels in monitoring wells 4329 and 4330, based on observations over the past 3 summer seasons. An increase in abstraction will simply mean the thresholds specified in consent conditions will be reached sooner. These monitoring wells were established as a condition of the initial water permit U021014.

The Rarangi wetlands complex is described by the Department of Conservation survey report as being of national importance, and representing the largest remaining example of this habitat assemblage on the East coast of the South Island. The value of these wetlands implies they should be maintained in their current state and vitality.

They have a variety of names but for the purposes of this report those northwards of Rarangi Road will be referred to as the Northern Wetlands, while those between Rarangi Road and the Wairau Diversion channel go by the name of the Hinepango-Pipitea wetland. Figure 1 is an oblique view from the Whites Bay Road showing the Northern Wetlands closest to the camera and the Hinepango-Pipitea wetland further to the south. Figure 2 is a close-up of the northern wetlands from the same vantage point.

Figure 1 : Rarangi Wetlands from Whites Bay Road Looking South

Until recently the nature of any hydraulic linkage between wetlands and the Rarangi Shallow Aquifer was uncertain. As a consequence it wasn't possible to predict the impact of groundwater abstraction on their status or health, particularly as their areal extent varies naturally. They reach their maximum extent in winter or spring and recede headwards in summer.

Figure 2 : Northern Wetland from Whites Bay Road Looking South-West

Before the effects of the increased pumping rate could be assessed, it was necessary firstly to confirm the nature of any hydraulic relationship existing between the wetlands and Rarangi Shallow Aquifer; and secondly to quantify the physiological dependence of the wetlands on the proximity of the shallow aquifer water table to plant root zones. A focus of this report is the analysis of wetlands hydrology as this has not been adequately addressed to date in the application.

4. Performance of Existing Consent

Water permit U021014 was granted by Marlborough District Council with conditions restricting its use to when Rarangi Shallow Aquifer levels were above certain thresholds, to maintain domestic wells, wetlands and avoid seawater intrusion.

A variation to this water permit was granted in 2006 allowing water to be taken from wells further to the north in addition to the original well-field. The original consent U021014, expires in April 2007 and an application (U061185) has been made to increase the pumping rate from 1,100 to 3,270 m^3/day.

A key part in the process of extending a resource consent is to review the performance of the existing permit. The Commissioner approved U021014 in 2003 on a short term basis with the intention that all parties learn from observations at the tailored monitoring well network. Of particular interest in this case is the extent to which pumping has directly affected residential supply water wells, wetlands and coastal sentinel wells.

Observations collected during the initial 3 seasons of the consent provide the most useful information on environmental impacts as they represent a live demonstration without the errors or assumptions associated with other approaches like mathematical modelling. While the past 3 seasons have not included a drought on the scale of a 1997/98 or 2000/01 event, it has shown the spatial extent of pumping.

Figure 3 shows the variation in Rarangi Shallow Aquifer level at the western (Red), eastern (Pink) and wetland (Green) monitoring wells. Water use is shown by the blue line in m^3/day on the right hand vertical axis.

The change in slope coinciding with the start or end of pumping, along with the divergence of the pink trace are indisputable proof of direct pumping effects at the Western Residential well 4330. This is expected given the short distance the well is located from the production well field. More surprising is the small effect at the western residential well 4329.

The effect at the wetlands well 4331 is more difficult to detect as the 700 metre separation distance means any response is delayed and correspondingly smaller. A drawdown of the order of 100 millimetres was predicted in the original application (Figure 4b PDP – Nov. 2005 CJ6006), for a pumping rate of 1,100 m^3/day, over a 100 day period.

Drawdowns were identified during the 2004/05 and 2005/06 summer seasons, although the delay appears to vary from several weeks to about a month, depending perhaps on the pumping regime and antecedent aquifer conditions. It is more difficult to identify specific pumping effects during the 2006/07 irrigation season due to the responsiveness of this site to rainfall, with recharge spikes and lower than average water use masking drawdown.

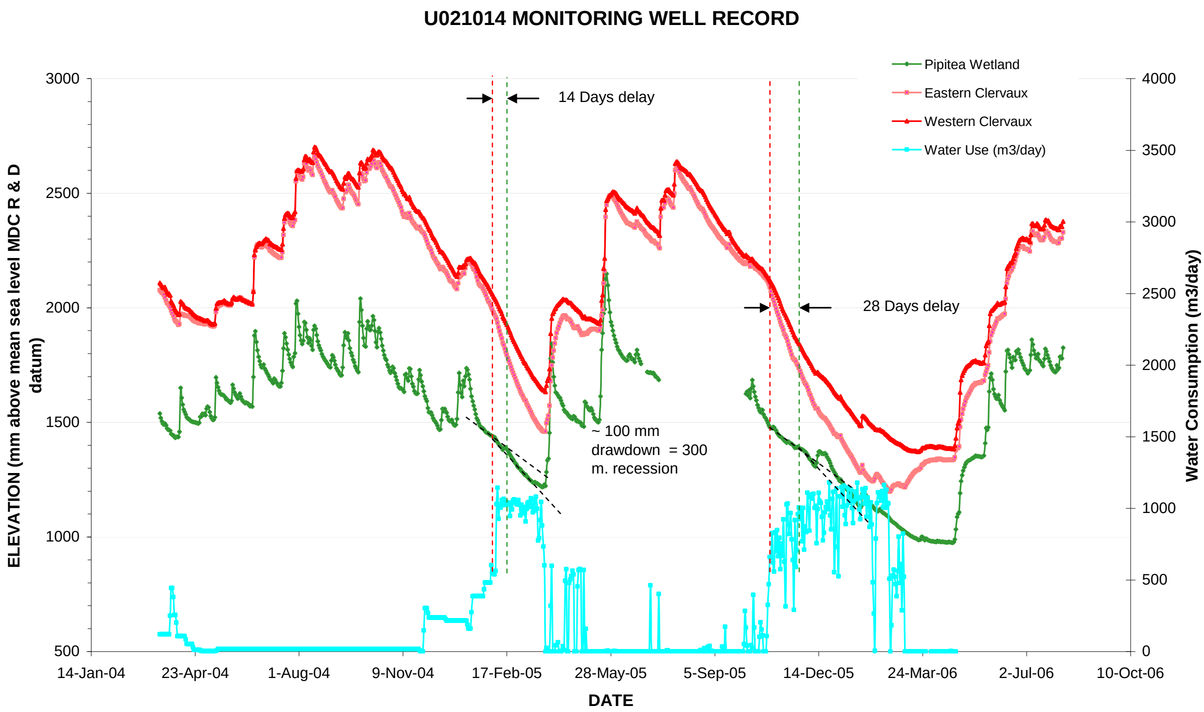


Figure 3 : WHMVL Monitoring Well Record 2004-2006

In terms of the effects of pumping on the seawater interface, Figure 4 shows the conductivity of Rarangi Shallow Aquifer water at MDC monitoring well 3668 (Hinepango Drive/DOC Reserve) from late 2000 through to early 2007 has risen slightly based on a 180 day moving average. However while there is a significant upward trend, in absolute terms groundwater conductivity remains within acceptable limits. The highest conductivity levels occur in late summer or early autumn each year, presumably in response to the inland movement of the interface due to less freshwater throughflow towards the coast. The dashed vertical lines mark the maximum annual conductivity value.

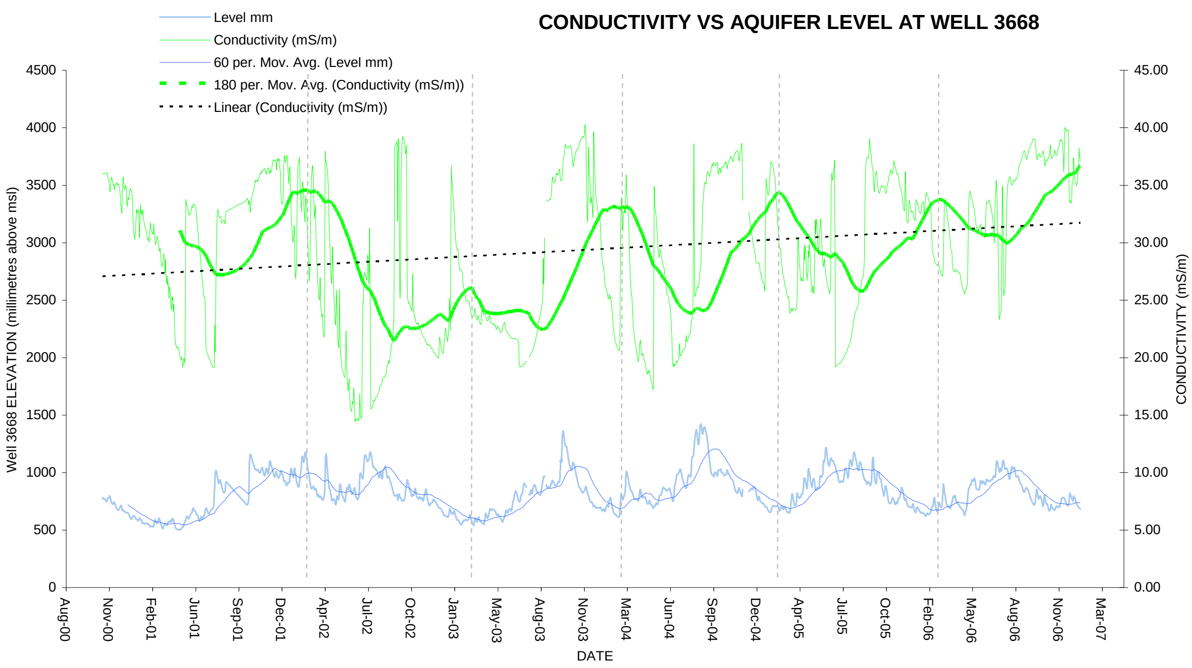


Figure 4 : Sentinel Well Record 2000-2007

In summary, the specially established monitoring well network measured the effects of the consent and these observations are in line with the applicant's predictions. However the absence of drier than normal conditions means little can be learnt about the long term sustainability of the current pumping rate.

5. Rarangi Shallow Aquifer Safe Yield

Historically the Rarangi Shallow Aquifer has been managed for domestic supply purposes due to the total reliance by the community on this water resource, and the lack of an alternative due to the absence of the Wairau Aquifer beneath Rarangi.

Due to the unique factors associated with Rarangi, a 2 tiered approach to water management is recommended involving a definition of safe yield to avoid over allocation, in conjunction with local controls. Defining safe yield in terms of a quantum of water that could be abstracted from the Rarangi Shallow Aquifer would maintain the reliability of current and future domestic supplies, provide certainty for existing water permit holders, account for climate change and signal the availability of water for future users.

Safe yield will vary from season to season. Given the circumstances at Rarangi a very conservative approach is justified until the effect of various levels of abstraction are demonstrated under drought conditions and ideally a series of dry summers.

Specific environmental thresholds are still necessary to manage local issues given the small size of the Rarangi Shallow Aquifer and as a consequence its sensitivity to the location of pumping stresses. For example thresholds in existing monitoring wells have worked well to avoid seawater intrusion, restrict interference effects between wells and maintain wetlands.

Environment Canterbury, the environmental regulatory authority in Canterbury allocates up to 50% of the effective recharge when the aquifer in question is well understood. It is invalid to adopt this rule of thumb for the Rarangi Shallow Aquifer given its small size provides limited buffering against drought, and the proximity of seawater along 2 boundaries. A figure of 35% is suggested, until the response of the Rarangi Shallow Aquifer is demonstrated through a low recharge event such as a 1997/98 or 2000/01 drought, for current levels of abstraction along with residential development.

		DEMAND	SUPPLY
Use	**Abstraction Rate (m3/day)**	**Annual Abstraction rate (m3)**	**Annual effective recharge to RSA (m3)**
Golf course irrigation over 150 days	1000	150000	Assume 99% probability of exceedance annual land surface recharge of 130 mm over 12 km2 plains = 1,560,000 m3
North Rarangi Community supply over 365 days	100	36500	
200 potential & existing domestic water supplies @ 5 m3/day over 365 days	1000	365000	Assume 99% probability of exceedance annual land surface recharge of 130 mm over 4 km2 of ranges = 520,000 m3
Wither Hills Marlb. Ltd vineyard irrigation over 150 days	1100	165000	
Wither Hills Marlb. Ltd vineyard irrigation over 150 days	2170	325500	
		716500	**2080000**
		1042000	

Table 1 : Rarangi Shallow Aquifer Water Balance

Table 1 is a comparison of potential water demand on the Rarangi Shallow Aquifer versus the volume calculated to be available during the driest year. The figure of 2,080,000 cubic metres was calculated by applying the annual effective recharge of 130 millimetres arriving at the Rarangi Shallow Aquifer water table in 99 out of 100 years.

The recharge rate was derived by the crown research institute HortResearch Ltd, as part of a pesticide risk assessment for Rarangi sandy soils. Input data for the SPASMO model was derived from a correlation between rainfall at Marshlands versus the old Marlborough Research Centre station at Grovetown. While this is a very conservative approach, with rainfall likely to be higher for sites closer to the Rarangi Ranges, it is likely to offset any long-term changes in climate such as a reduction in rainfall on the East coast of the South Island.

On this basis the current level of allocation represents 34% of the 1 in 100 year recharge rate, and the application rate, 50% of this figure.

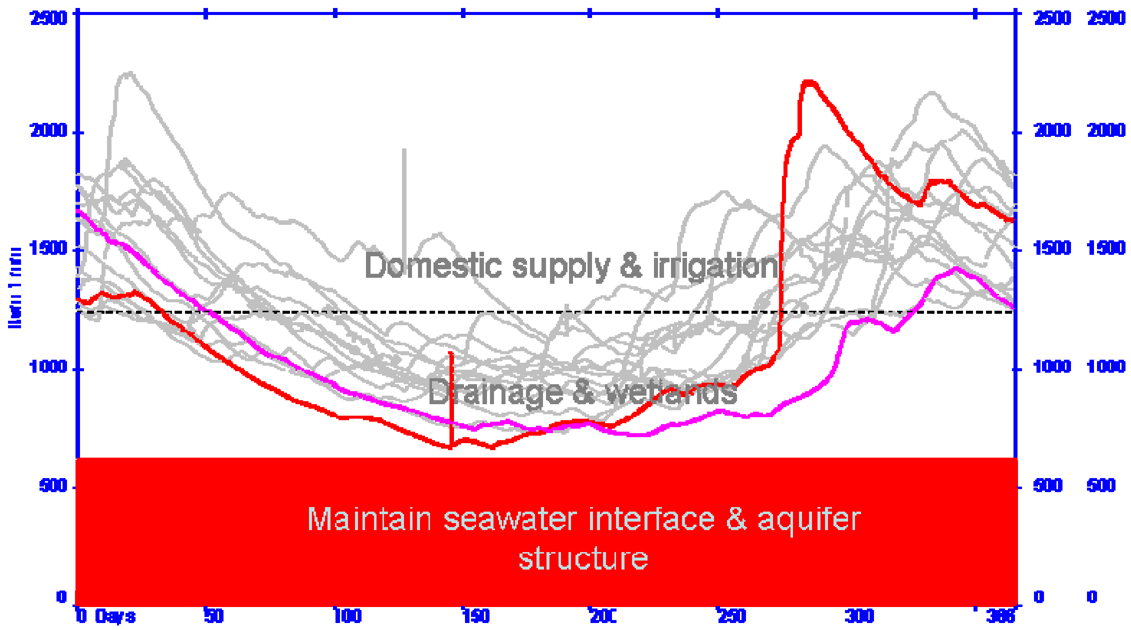


Figure 5 : Seasonal Variation in Rarangi Shallow Aquifer 1989-2007 at Golf Club

Figure 5 is a series of annual overplots showing the variation in Rarangi Shallow Aquifer level at Rarangi Golf Club well 1901, since 1989. The "0 days" marks the first of October, representing the start of the summer irrigation season or water year. The pink and red lines represent the 2000/01 and 1997/98 drought seasons respectively. Water level elevation in millimetres above mean sea level is shown on the vertical axis.

Figure 5 is useful for assessing sustainable yield based on water in storage, which can be calculated using observed aquifer level. The start of October is significant as it reflects the full point when the Rarangi Shallow Aquifer has reached its maximum level of recharge in spring, prior to summer drainage and abstraction over the following 12 months.

Due to its location, well 1901 approximates the average saturated thickness of the Rarangi Shallow Aquifer and the corresponding volume of water stored beneath its 12 square kilometre area. If we assume no more than 30% of storage can be abstracted for out of aquifer consented use, this fits well with a 3 way split between dead water that is needed to remain in the aquifer to retain the seawater interface in its current position, a middle component that provides for wetlands and aquifer drainage; and an upper discretionary portion that can be abstracted for residential use or crop irrigation.

Based on an aquifer storativity of 0.1, the volume of water comprising 30% of aquifer storage (600 millimetres) equals 720,000 m^3. This agrees with the figure in Table 1 representing 30% of recharge. The spring fill point level can also be used to fix an annual allocation limit based on aquifer status leading into summer.

Water for crop irrigation would only be available if aquifer levels recharged to the minimum observed elevation of 1.2 metres at the start of October each season, and only after permitted activity uses were satisfied. Essentially this is a stacking system which matches water use with seasonal recharge and accounts for climate drying or successive droughts.

Flow meter readings for WHMVL show irrigation water consumption varied from a minimum of 7,272 cubic metres during the 2003/04 summer to a maximum of 115,481 cubic metres during the 2005/06 season and an intermediate volume of 77,913 cubic metres in 2004/05 (Figure 6). Assuming a daily water use of 1100 m^3/day, as per the water permit, the length of the 2005/06 season was 104 days. The 2005/06 summer irrigation season wasn't particularly dry. Water use during the current 2006/07 summer season started in September, but only for a short period, before resuming again in early 2007.

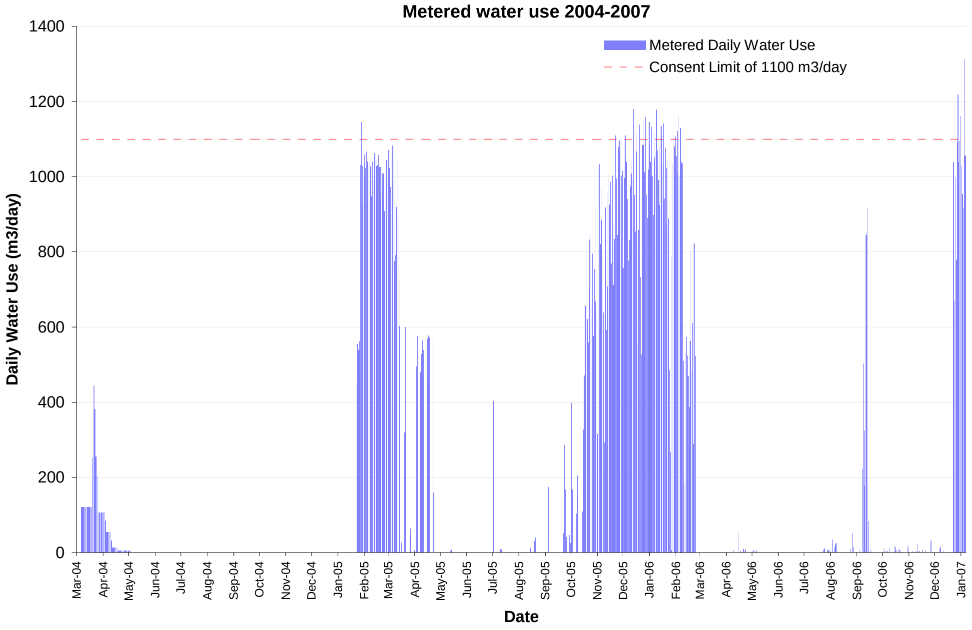


Figure 6 : WHMVL Metered Water Use

Figure 7 is a summary of Rarangi Shallow Aquifer, Wairau Aquifer, WHMVL water use and rainfall records for the period from March 2004 through to early 2007. Elevation is shown on the left hand vertical axis in millimetres above mean sea-level for aquifer records, date along the bottom axis and rainfall on the right hand vertical axis. Multiply the scale on the right hand vertical axis by 10 to read WHMVL water use in m^3/day.

Figure 7 shows that in general terms Rarangi Shallow Aquifer levels have recovered following the 2005/06 summer season.

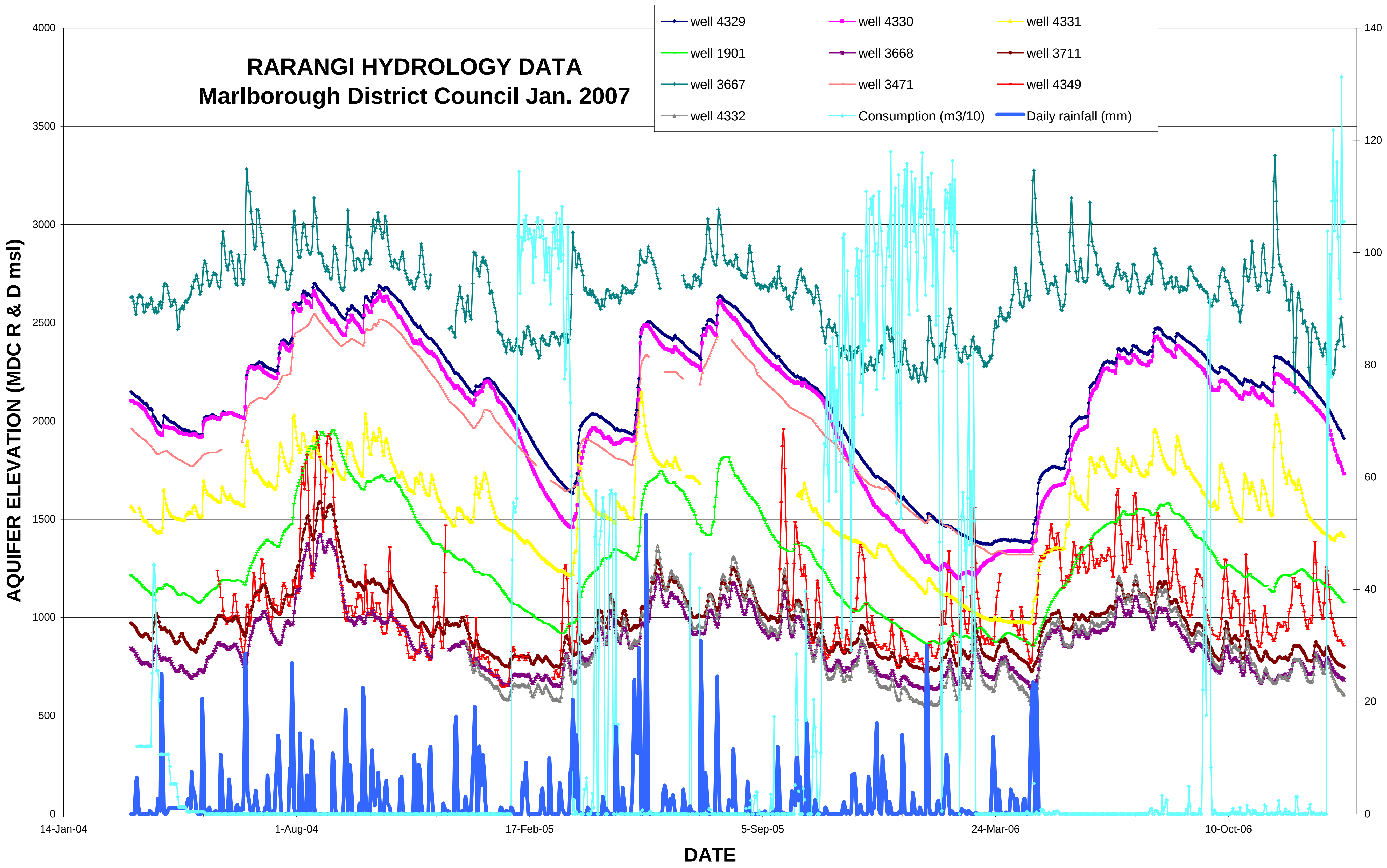


Figure 7 : Summary of Aquifer Level, Rainfall & Water Use 2004-2007

6. Rarangi Wetlands Investigation

A key uncertainty to be resolved before the effects of the WHMVL application could be quantified was whether a hydraulic relationship exists between the Rarangi Shallow Aquifer and wetlands, or whether they are independent. In other words, would drawing down Rarangi Shallow Aquifer levels result in an accelerated recession of the wetlands, and secondly would this affect their health and vigour. An alternative way of posing the second question is to ask whether the wetlands will survive, thrive or deteriorate if the application is approved.

Due to the national significance of the wetlands and a lack of specific information on their hydrology in the application, Marlborough District Council initiated a series of field studies consisting of the following components:

- *Well, wetland and vegetation level survey (Survey Solutions Ltd)*
- *Observation of seasonal change in well and wetland levels at 3 locations over a 1 year period (MDC)*
- *Specialist advice on the reliance of flora on Rarangi Shallow Aquifer (Wetlands NZ Ltd)*

7. Wetland Hydrology

In September 2006 Council commissioned a Blenheim survey company (Survey Solutions Ltd) to precisely level the elevation of all conspicuous water features along a pre-determined series of wetland transects, north of the Diversion channel. The locations of level observations are shown by the blue dots in Figure 8. The aim of the exercise was to determine if the wetlands and Rarangi Shallow Aquifer represented a single water body.

The axis of the survey is shown in Figure 8, starting on the south bank of the Wairau Diversion channel, and moving northwards up the Hinepango-Pipitea wetland as far as Rarangi Road. The survey continued from east to west along the southern boundary of the WHMVL vineyard with Rarangi Golf course, before moving north again to incorporate areas of important vegetation in 2 tributary wetlands near the Golf Club boundary and Pukaka Ranges. The datum of the survey was Marlborough District Council Rivers and Drainage datum (MDC R & D), originating from benchmarks on the left bank of the Wairau Diversion.

In addition to measuring any wetland and well water levels, the survey included various wetland plant species such as Flax, Cabbage Tree, Raupo and Kahikatea, to provide data for assessing the reliance of flora on Rarangi Shallow Aquifer levels.

The red lines in Figure 8 represent contours of Rarangi Shallow Aquifer water table for the Marlborough District Council winter 1989 piezometric survey. The figures are in terms of elevation in metres above mean sea-level.

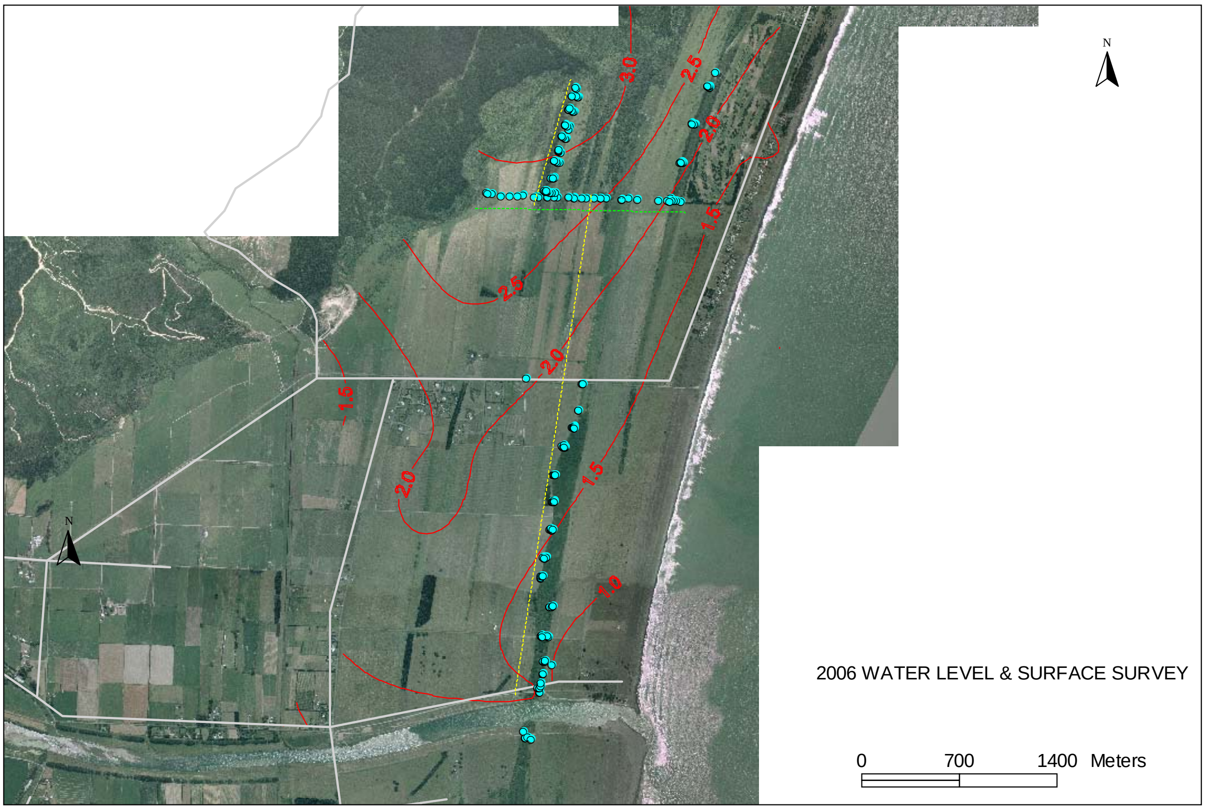


Figure 8 : Survey Route and Cross-Section Locations

Figure 9 is a cross-section based on the Spring 2006 survey, west from the Golf Club boundary to the western ranges, as shown by the green dotted line in Figure 8. General land surface is shown in brown, well water table in green and surface water features in blue. Elevation in metres above mean sea level (MDC R & D datum) is shown on the vertical axis.

The fact that the Rarangi Shallow Aquifer water table and wetland levels lie on the same line despite the large variability in land topography, supports the concept of a single interconnected freshwater body. It follows that a change in level in one will affect the other.

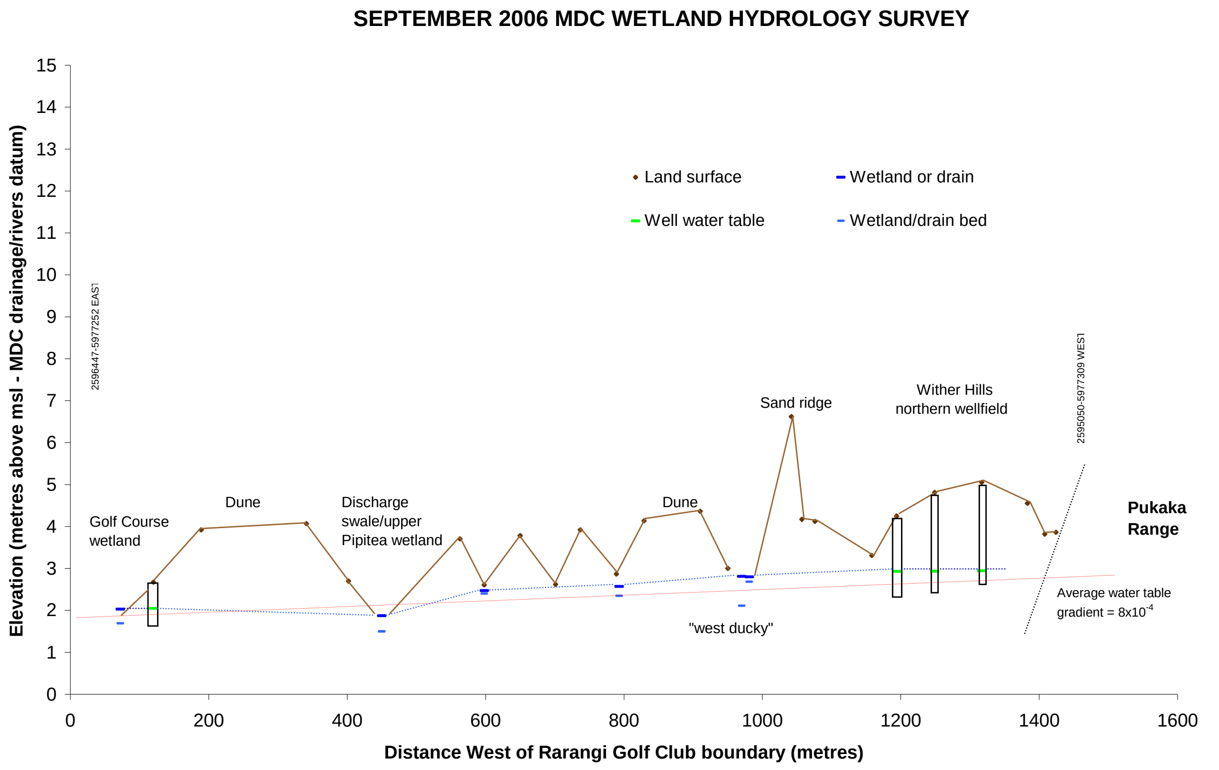


Figure 9 : Spring 2006 East to West Cross-Section

The only discontinuity is associated with the so called discharge swale, which lies below the general trend line (Figure 9). The regional Rarangi Shallow Aquifer water table grade line is shown by the dotted red line, which closely matches the gradient from the MDC piezometric survey contours in Figure 8.

Previously the wetlands in this northern area were presumed to be perched above the level of the Rarangi Shallow Aquifer in summer, given the variable topography and elevations of up to 6 metres above sea-level. However the survey showed wetlands were always associated with topographic depressions. This is consistent with a conceptual model where wetlands represent interception of the ground surface by the Rarangi Shallow Aquifer water table.

Notwithstanding this, there may be isolated wetlands which become perched above the Rarangi Shallow Aquifer and are unable to drain due to the build-up of organic material. This is supported by the evidence of the April 2004 aquifer test conducted by WHMVL (PDP – November 2005).

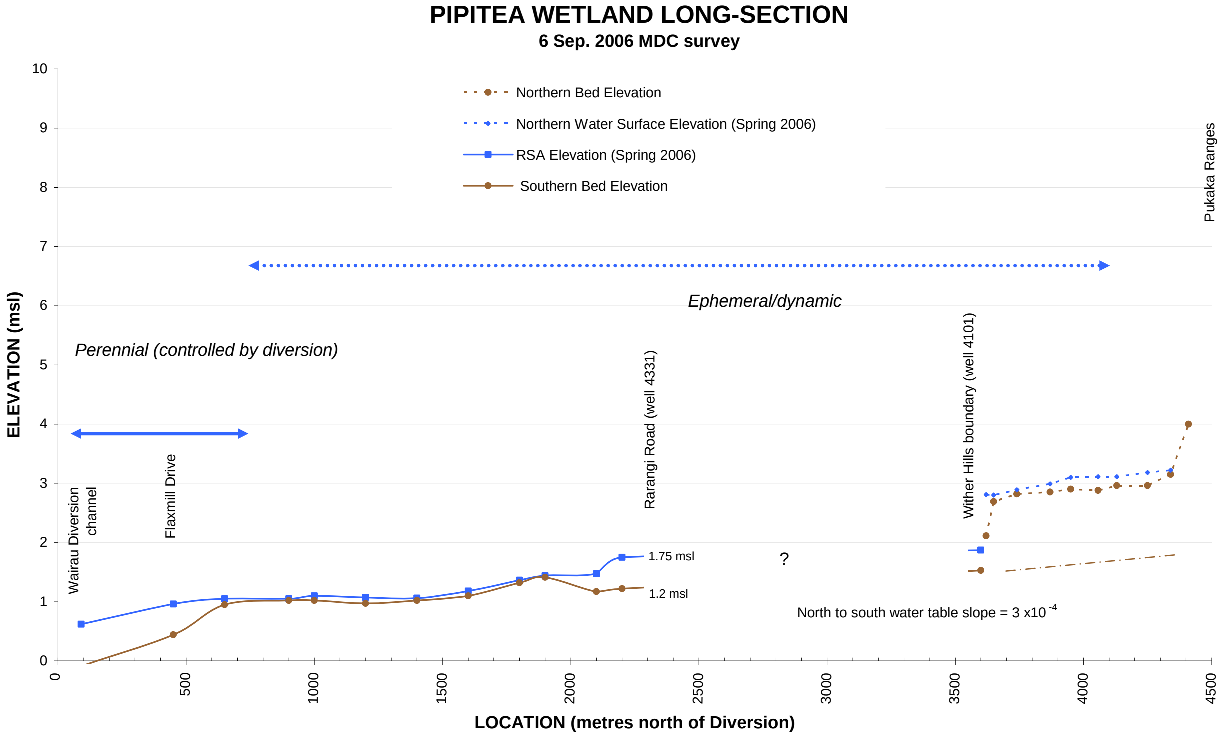


Figure 10 : Spring 2006 South to North Long-Section

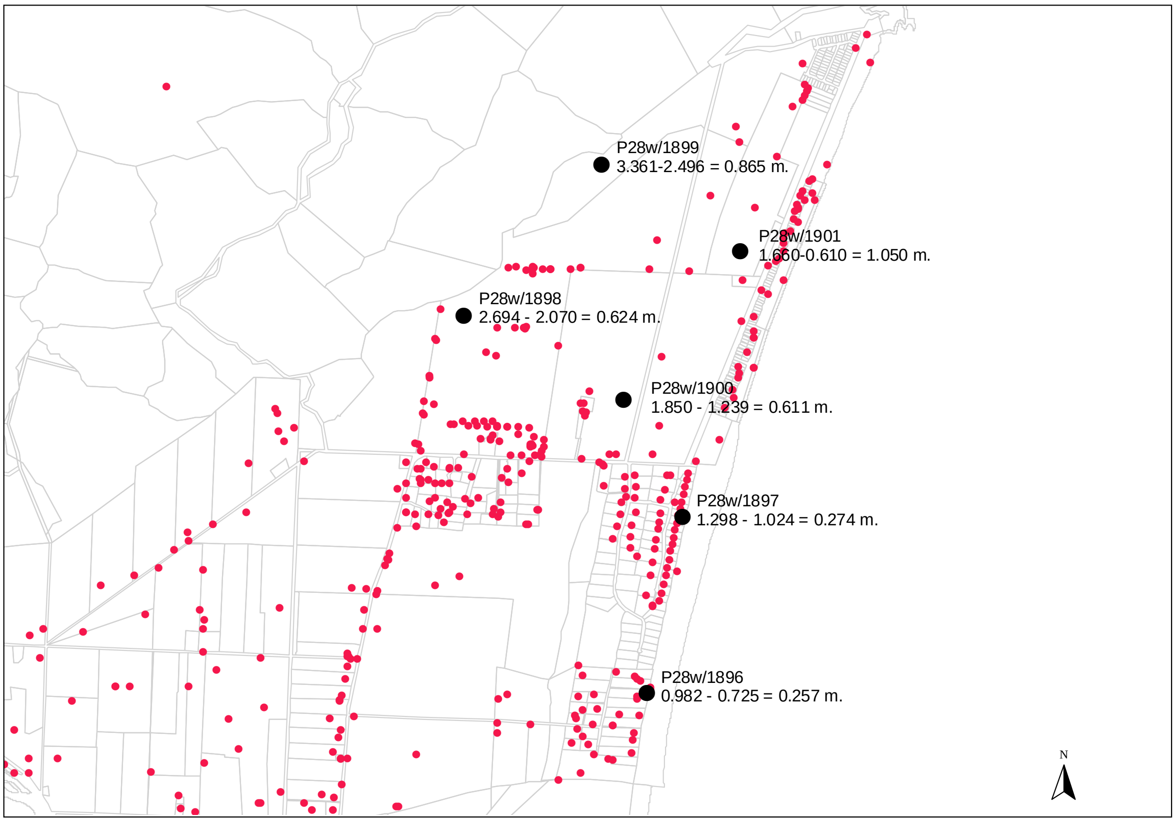
Figure 10 is a second section through the Rarangi Shallow Aquifer based on the Spring 2006 survey. This time the axis is from the Wairau Diversion channel north to the ranges as shown by the yellow dotted line in the aerial photograph (Figure 8). The blue and brown lines represent surface-water and channel bed observations respectively; no well levels are included.

The offset at the northern end of the long section represents the dog-leg westward from the discharge swale to the north-western wetland, rather than an actual step in elevation. The likely channel bed grade near the ranges is approximated by the light brown line. Elevation in metres above mean sea level (MDC R & D datum) is shown on the vertical axis.

Based on observation and local knowledge, the wetlands naturally recede southwards over summer when drainage and abstraction exceed aquifer recharge. This resembles a typical spring recession pattern driven by falling Rarangi Shallow Aquifer levels. This phenomenon is observed elsewhere on the Wairau Plain and is characteristic of a groundwater dependant springs.

The upper reaches of the wetland system experience a larger natural variation in Rarangi Shallow Aquifer levels and consequently are dryer for longer than the lower reaches, south of Rarangi Road. This variation is illustrated by the change in observed level between winter and summer at 6 wells in 1989 (Figure 11). The perennial nature of the wetlands in the lower reaches is also influenced by the stability of ocean levels and dependant on the status of its floodgate.

Effectively the Rarangi Shallow Aquifer hinges at the coast, meaning the channel section south of Rarangi Road is perennially saturated, while the extent of the upland reaches of the wetlands are dynamically linked to Rarangi Shallow Aquifer levels.



MDC 1989 RSA PIEZOMETRIC SURVEYS VARIATION IN RSA ELEVATION

Figure 11 : Seasonal Variation in 1989 Rarangi Shallow Aquifer Levels

The elevation of the Hinepango-Pipitea wetland channel bed has been accurately surveyed (MDC R & D datum) at 1.2 metres above mean sea level at Rarangi Road, meaning that when the Rarangi Shallow Aquifer water table as represented by the channel water level (blue line) falls to 1.2 metres elevation or less, the wetland ceases to exist upstream. On the basis that this phenomenon may occur naturally, this elevation was used to define the threshold level in well 4331 when resource consent U021014 has to cease pumping.

If we assume that a Rarangi Shallow Aquifer elevation of 1.2 metres approximates when wetlands cease to exist upstream (north) of Rarangi Road, it is possible to calculate the historical frequency of this occurring. However there is only a short period of record for well 4331 dating from 2004. As an alternative, record for well 4331 was synthesised using long-term record from well 1901 at Rarangi Golf Club.

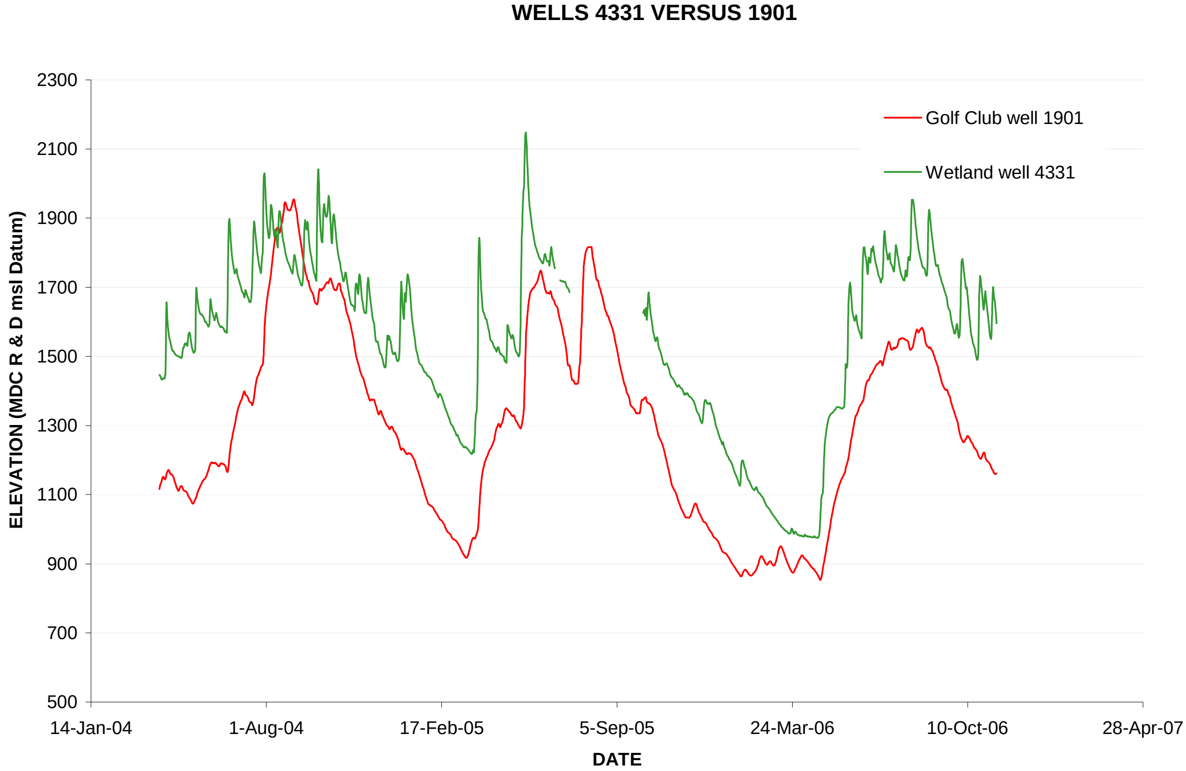


Figure 12 : Mean Daily Rarangi Shallow Aquifer Level at Wells 1901 & 4331

Level record from well 1901 dates from 1989 and includes several regionally significant droughts that have had a known effect on wetlands health (Uruwhenua Botanicals - 2006). Figure 12 shows the Rarangi Shallow Aquifer level record for well 1901 (red) and well 4331 (green); have a similar seasonal range in level, but the latter is more responsive to rainfall events. Figure 13 shows the correlation between wells 4331 and 1901 water levels is reasonably good and supports the approach.

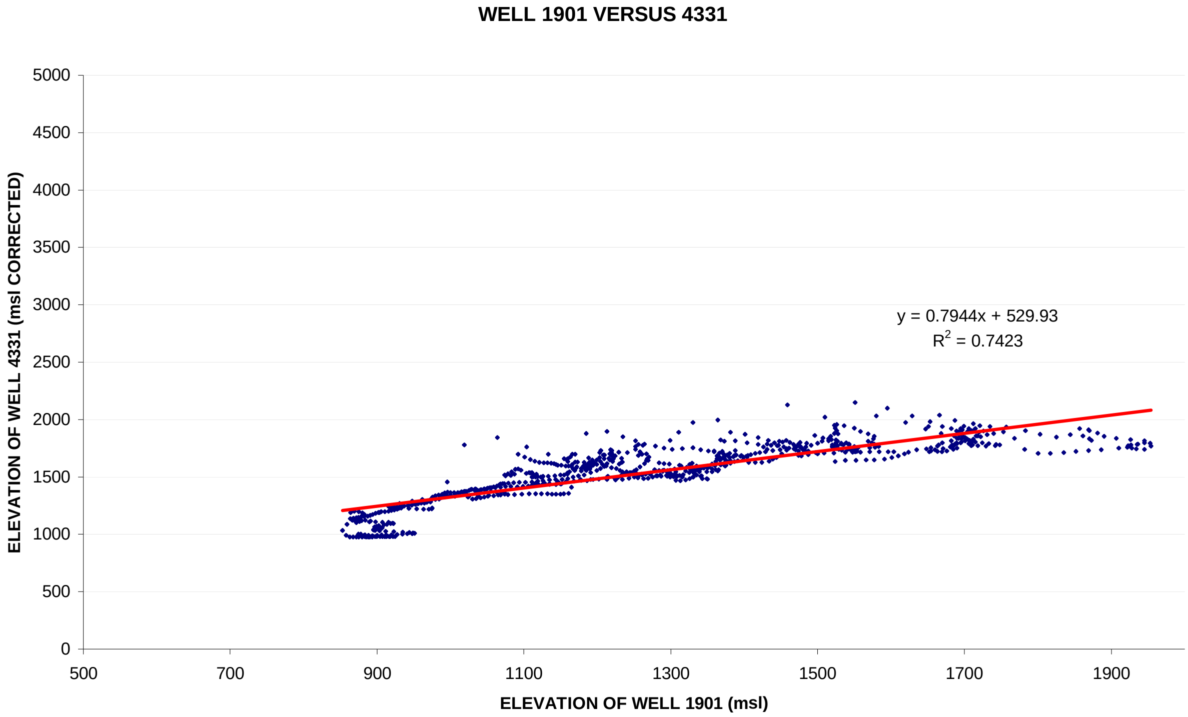


Figure 13 : Aquifer Elevation for Well 4331 Versus Well 1901

Figure 14 shows the synthetic record for well 4331 (blue) from 1989 versus the observed record in red since 2004. There is a good correlation between the observed and predicted values. The red lines represent the thresholds for the conditions in consent U021014 for the 50% and 100% restrictions respectively. The grey line represents the likely fall in Rarangi Shallow Aquifer level associated with the proposed 3,270 m^3/day pumping rate, as approximated by a drop of 150 millimetres.

The figure of 150 millimetres is sourced from Figure 18 in the October 2006 PDP report showing the predicted extent of the proposed pumping regimes of 3270 m^3/day at the wetlands monitoring wells 4331 after 100 days of pumping. It is possible that a drawdown of this magnitude occurs under the present consented take of 1,100 m^3/day, and that a larger drawdown would occur in a dry season at the proposed pumping rate. In other words, that the wetlands are being affected under the current water permit regime.

The predicted levels in the Rarangi Shallow Aquifer at well 4331 prior to the advent of significant pumping by WHMVL during the 2005/06 summer season, would have fallen to less than 1.2 metres on 4 occasions over 15 years, or every 3.5 years on average. Aquifer levels would have been below 1.2 metres elevation for between 40 and 150 days.

Under the proposed pumping rate of 3,270 m^3/day, levels are predicted to fall below the 1.2 metre threshold on 14 out of the 15 years with an average duration of 125 days. This would mean the wetlands upstream of Rarangi Road would be dry virtually every season, instead of 1 summer in around 3. Of the 2 regionally significant droughts experienced since 1989, the 1997/98 event caused the lowest predicted levels but the 2000/01 drought lasted longer, with 150 days when well 4331 levels were less than 1.2 metres elevation. This is assuming rainfall recharge falling directly onto the wetlands is ineffective during summer.

We know the wetlands were adversely affected by the 2000/01 summer drought (Uruwhenua Botanicals - 2006). The spreadsheet model predicts the equivalent of a 1997/98 or 2000/01 drought event in terms of lower Rarangi Shallow Aquifer levels, will occur in 9 out of 15 years under a higher pumping rate regime.

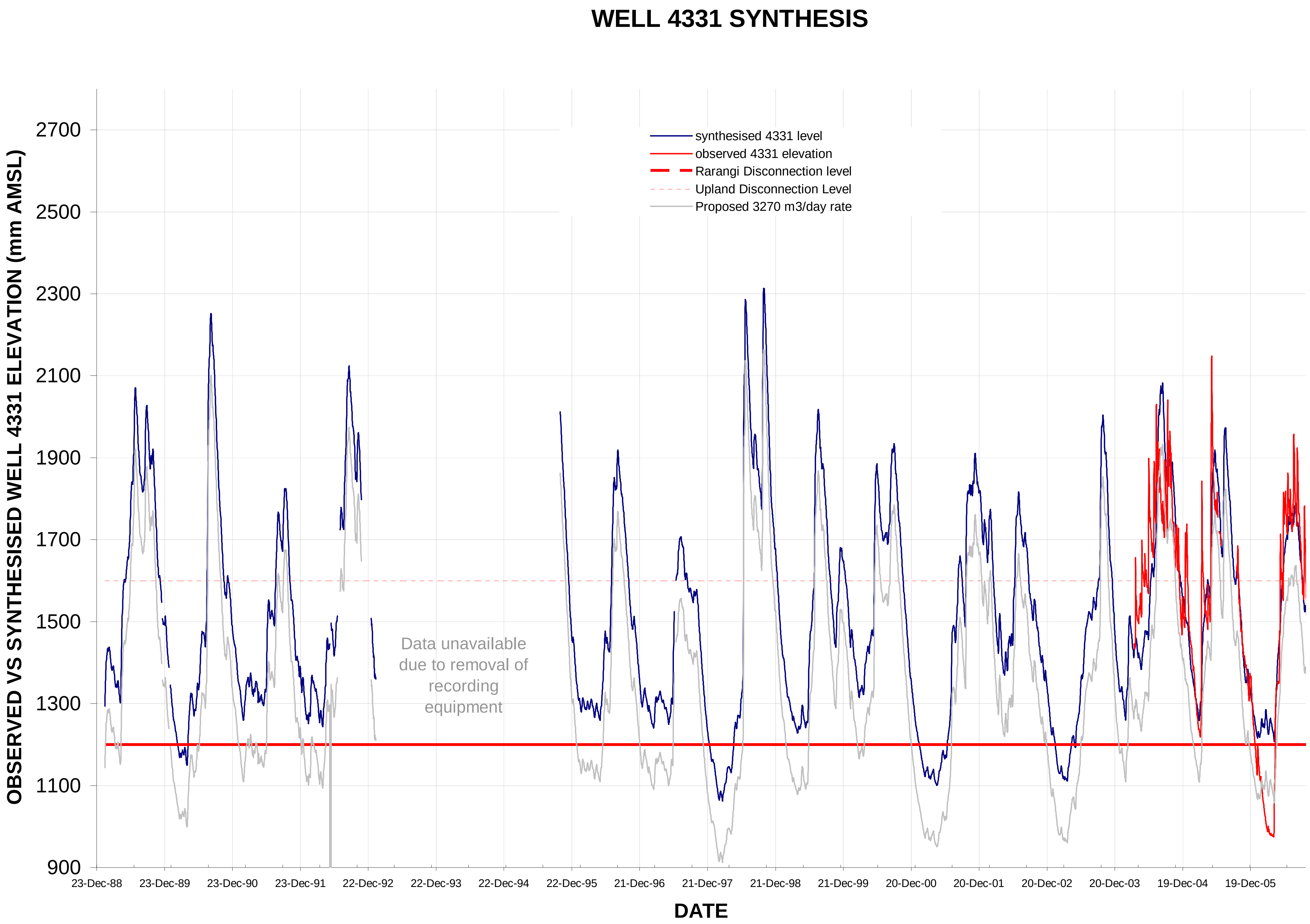


Figure 14 : Observed versus Synthesised Record for Well 4331

Marlborough District Council developed a numerical model of the Rarangi Shallow Aquifer to improve understanding of aquifer processes and to check on estimated changes in wetland extent using the synthetic data approach. This is probably the most sophisticated model of the Rarangi Shallow Aquifer in existence due to its transient mode. It is well calibrated and reproduces observed records. Because it has a time varying capability, it can be used to answer questions about the effects of various pumping scenarios.

Predictions by the model used to support the application (PDP – 2006), are different in some cases to those from the MDC model. These differences can largely be explained by model assumptions relating to rates of recharge, with for example the MDC model not allowing for recharge during the 2002/03 summer whereas the PDP model assumes a constant rate.

Figure 15 is an extract of model output showing predicted Rarangi Shallow Aquifer water levels for the 2002/03, 2003/04 and 2004/05 summer periods. The black line represents pre-WHMVL, in other words no pumping. The blue triangles represent predicted drawdown for the current 1,100 m^3/day rate over a 100 day irrigation season. The orange diamonds represents the predicted drawdown for the proposed pumping rate of 3,270 m^3/day for 100 days.

Prediction Method	Days when Rarangi Shallow Aquifer Level Elevation is less than 1.2 (msl)		
	No WHMVL pumping	**WHMVL = 3,270 m^3/day**	**Difference in days**
Synthetic Record	86	183	**97**
Numerical Model	112	170	**58**

Table 2 : Comparison of Predictions for 2002/03 Summer Season

The significance of the 2002/03 season is that it represents a relatively dry summer with implications for wetland health. The number of days when aquifer level is below 1.2 metres elevation and consequently the wetlands are dry, is annotated on the plot and compared with the predictions from the synthetic model in Table 2.

The synthetic model predicted the Northern Wetlands would be dry for an extra 97 days or approximately 3 months, in addition to the 86 days during the 2002/03 summer season when the wetlands probably ceased to exist due to natural causes. By comparison the numerical model predicted an extra 58 days, or in round figures 2 months.

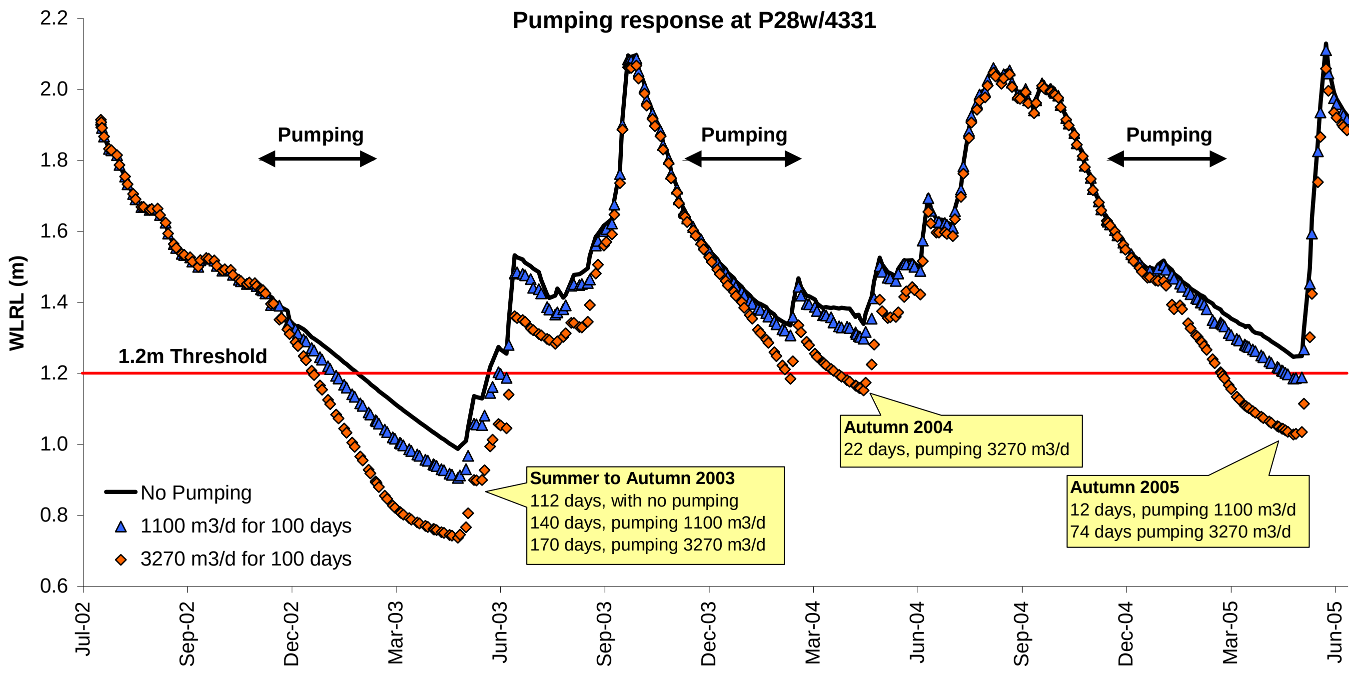


Figure 15 : Numerical Model Analysis Output

8. Transient Relationship between Rarangi Shallow Aquifer & Wetland

The Spring 2006 MDC level survey showed the northern wetlands were the surface definition of the Rarangi Shallow Aquifer. However this represented a snapshot in time during a period of high aquifer levels, and longer record was needed to verify if this was a permanent relationship. To track the relativity in levels over a 12 month period and identify seasonal dynamics, Marlborough District Council installed a series of 3 paired water level recorders in the North Rarangi area in September 2006.

The first Rarangi Shallow Aquifer and wetland recorder pair was centred on the drainage ditch termed the Discharge Swale located on the main axis of the Hinepango-Pipitea Wetland at the southern boundary of the WHMVL property with Awarua Farms. The associated Rarangi Shallow Aquifer well 4101 (E8) is located approximately 50 metres to the north-east (Figure 16).

The second pair incorporated the most easterly of the wetland features otherwise known as the Golf Course wetland, together with Rarangi Shallow Aquifer well 4074 (E10) located about 100 metres to the west. The last water level recorder was installed in the Hinepango-Pipitea Wetland channel, just south of Rarangi Road, opposite the permanent Rarangi Shallow Aquifer monitoring well 4331 (Figure 16).

9. Plant Dependence on Rarangi Shallow Aquifer

Figures 17 to 19 show the variation in mean daily water level for the 3 paired recorder sites. There is a close match between the elevation of Rarangi Shallow Aquifer well level and the neighbouring wetland levels for the Eastern Wetland and Hinepango-Pipitea Wetland sites, but less similarity at the Discharge Swale site. These observations support the spring 2006 water level survey results.

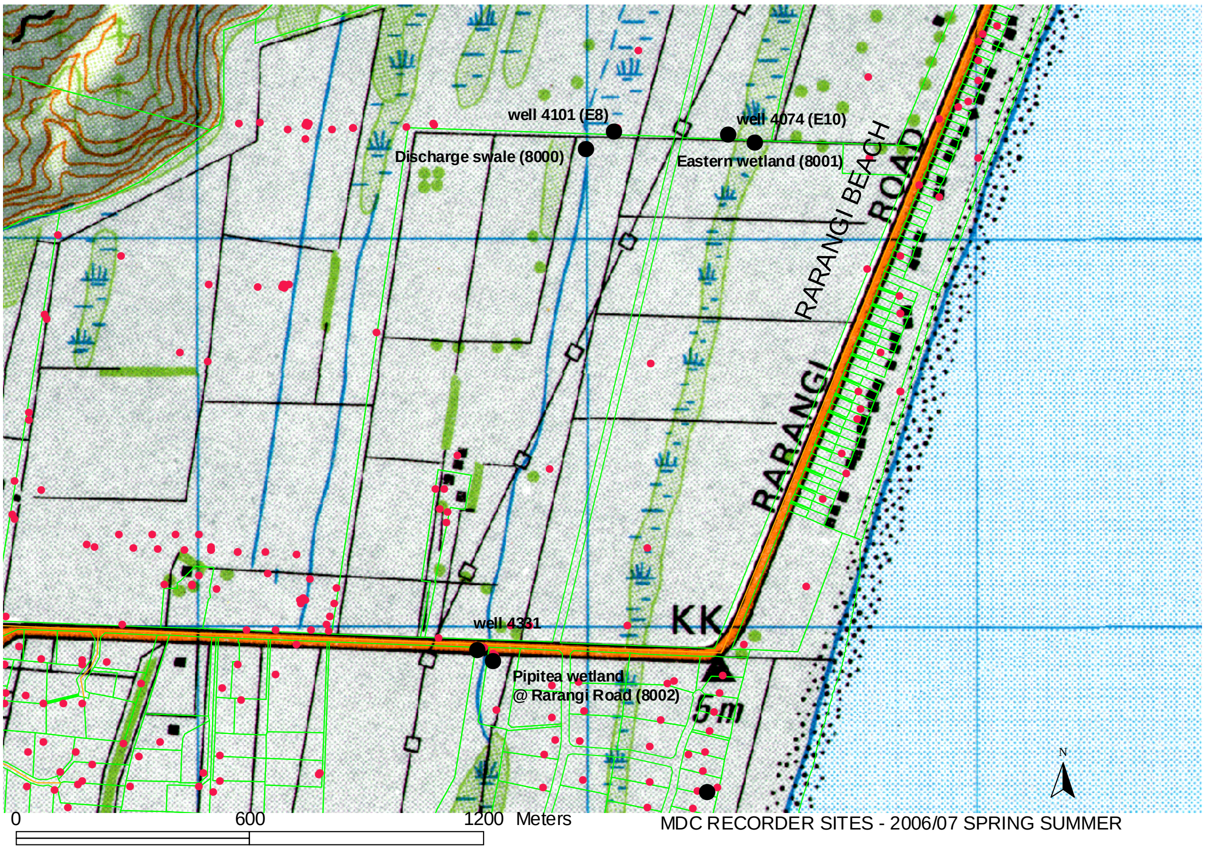


Figure 16 : MDC Temporary Recorder Site Locations

In summary then, preliminary field measurements show a fine balance exists between the wetland and shallow aquifer levels. The dominant process for the period when consent application U061185 will be exercised is for the Rarangi Shallow Aquifer to lose water to the wetlands, with the reverse occurring intermittently during wet episodes.

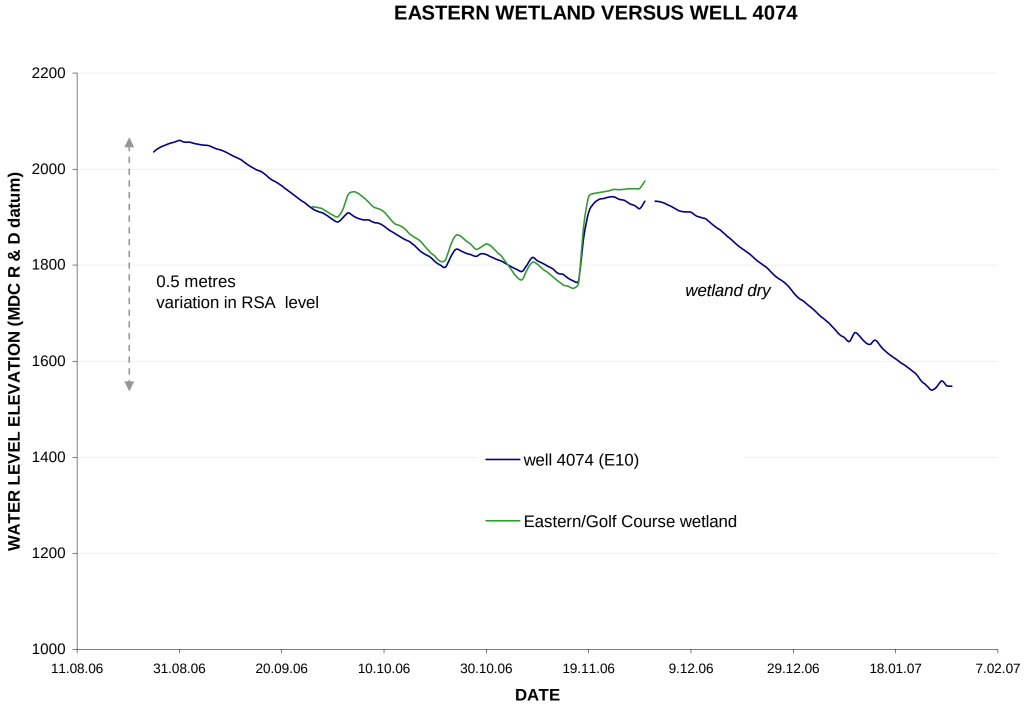


Figure 17 : Eastern Wetland versus Well 4074 (E10)

The Eastern Wetland level doesn't appear as responsive as the other wetland sites, with levels remaining high rather than receding, suggesting an impedance to lateral drainage southwards. The green line representing the wetland is higher during quick-flow, but lower during recession, relative to the Rarangi Shallow Aquifer level in blue.

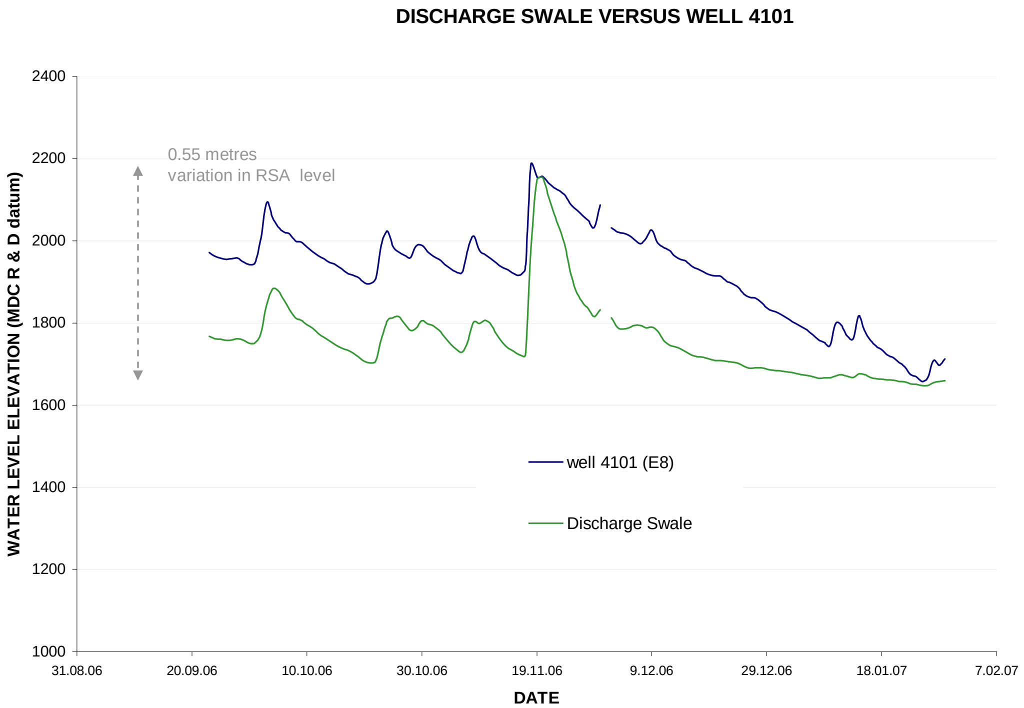


Figure 18 : Discharge Swale versus Well 4101

The Discharge Swale site differs to the other wetland sites, having a Rarangi Shallow Aquifer level 200 millimetres above the wetland channel level, except towards the end of January 2007 when levels converge. It will be interesting to track the relativity of levels into autumn. Notwithstanding this, Rarangi Shallow Aquifer level is higher, meaning the wetland is dependant upon it. Interestingly the wetland elevation exceeds that of well 4101 for a few hours during the rainfall event on the 11 November 2006.

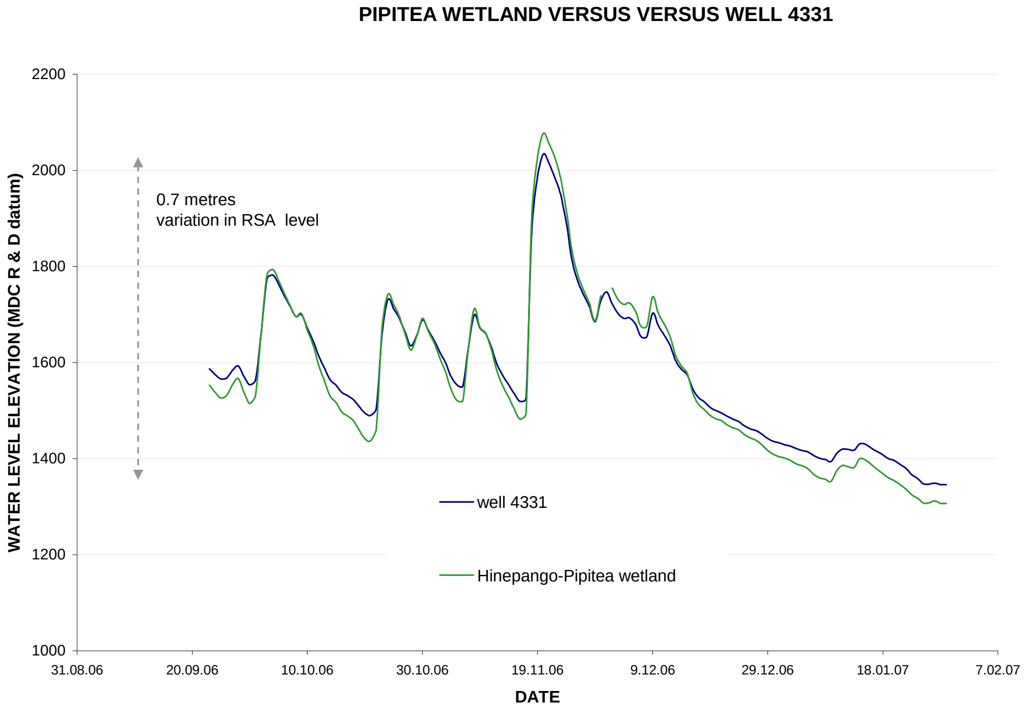


Figure 19 : Hinepango-Pipitea Wetland versus Well 4331

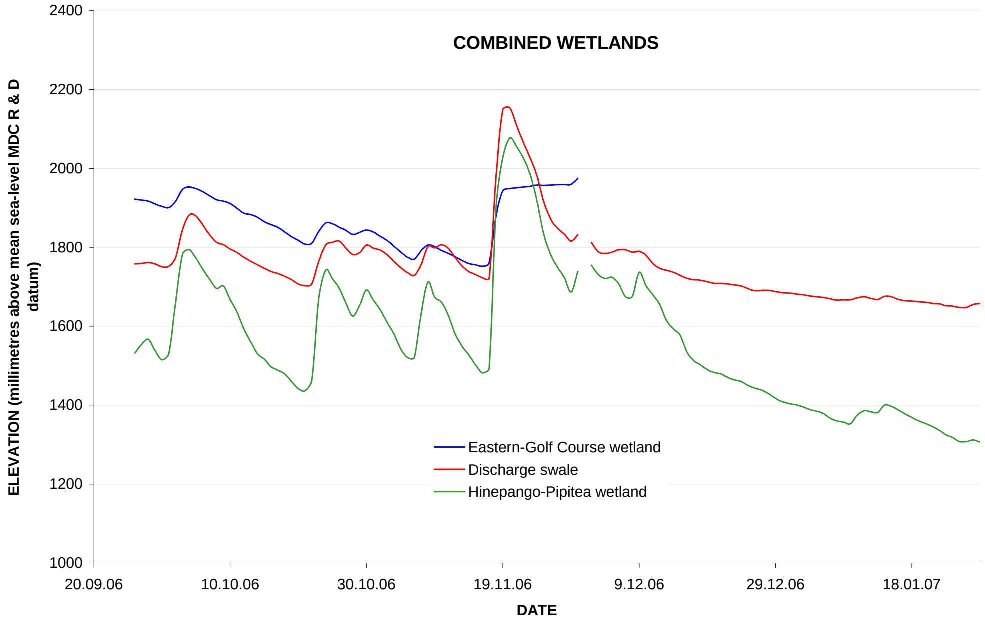


Figure 20 : Combined Wetland Sites

Interestingly the largest variation in both wetland and Rarangi Shallow Aquifer levels was measured at the Pipitea Wetland site at Rarangi Road, and emphasises the role of the Northern Wetlands as a catchment and runoff generating area. Water rapidly transits the area with some recharging the aquifer through bank storage, while remaining water flows down the channel network to the Diversion.

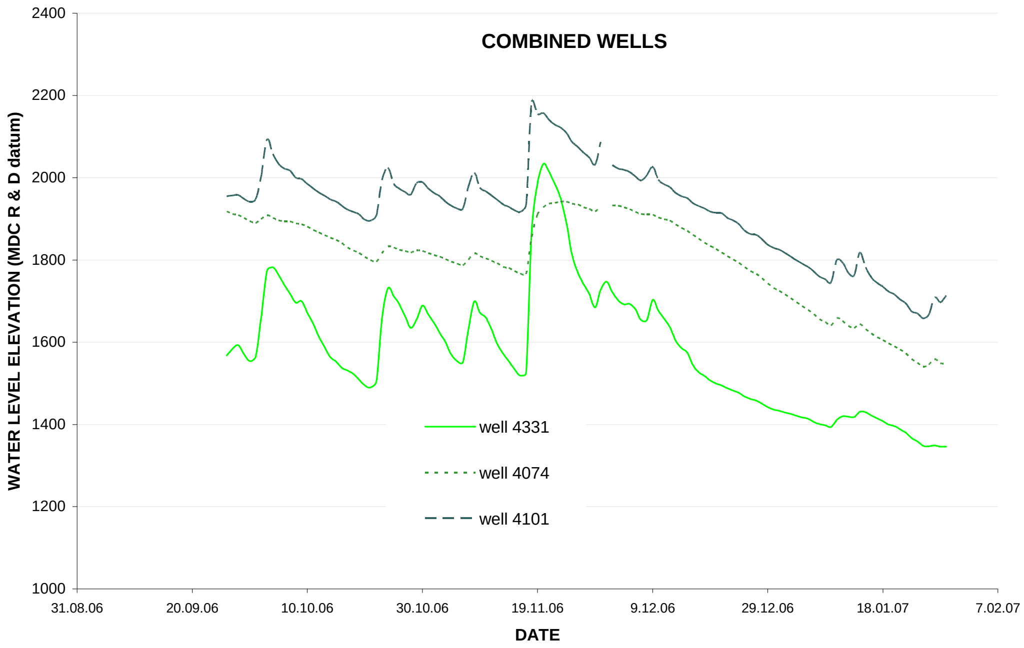


Figure 21 : Combined Rarangi Shallow Aquifer Sites

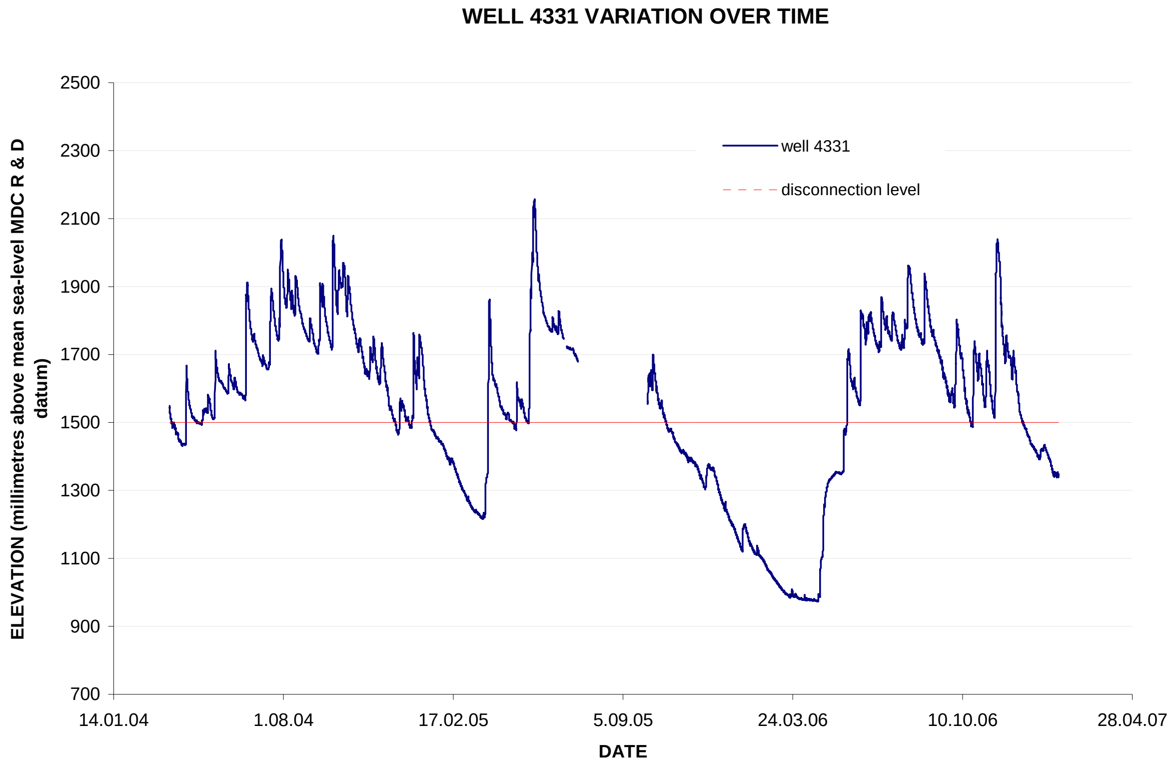


Figure 22 : Responsiveness of Hinepango-Pipitea Wetland Well

Figure 22 illustrates the variation in water level at well 4331 situated close to the Hinepango-Pipitea Wetland, from March 2004 through to January 2007. The vertical axis shows the elevation of the Rarangi Shallow Aquifer water table in millimetres above mean sea-level. Water level values represent hourly observations.

The well shows 2 quite different responses to rainfall depending on antecedent aquifer conditions. When Rarangi Shallow Aquifer levels are equal to or greater than an elevation of 1.5 metres above mean sealevel as marked by the red line, the response is dynamic, whereas for the same rainfall event when Rarangi Shallow Aquifer levels are low, the response at well 4331 is sluggish.

This phenomenon reflects the areal extent of the wetlands and their responsiveness to recharge. The wetlands are fully extended when Rarangi Shallow Aquifer elevations are greater than about 1.5 metres above mean sea-level and their ability to generate runoff is at its optimum.

10. Reliability of Consent Application U061185

The application is for a very large volume of water by Marlborough standards and in addition to assessing the environmental effects; the reliability of the proposal is also pertinent. A standard method for predicting how frequently a proposal may be restricted involves extrapolating current record, and requires no knowledge of aquifer properties.

For example Figure 23 shows a period of record from the 2005/06 summer season where the dark blue line represents the water level at well 4330, and the light blue line metered water use. We know from several seasons of well level record that well 4330 responds instantaneously to changes in pumping rate at the southern well-field.

The change in slope of the solid dark blue line in late October 2005 represents the fall in well level corresponding to a pumping rate of 1,100 m^3/day. Because the fall in water level in a well over time is proportional to pumping rate, the drawdown likely to occur at well 4330 if the pumping rate were increased to 3270 m^3/day, can be predicted and is denoted by the dotted blue line in Figure 23.

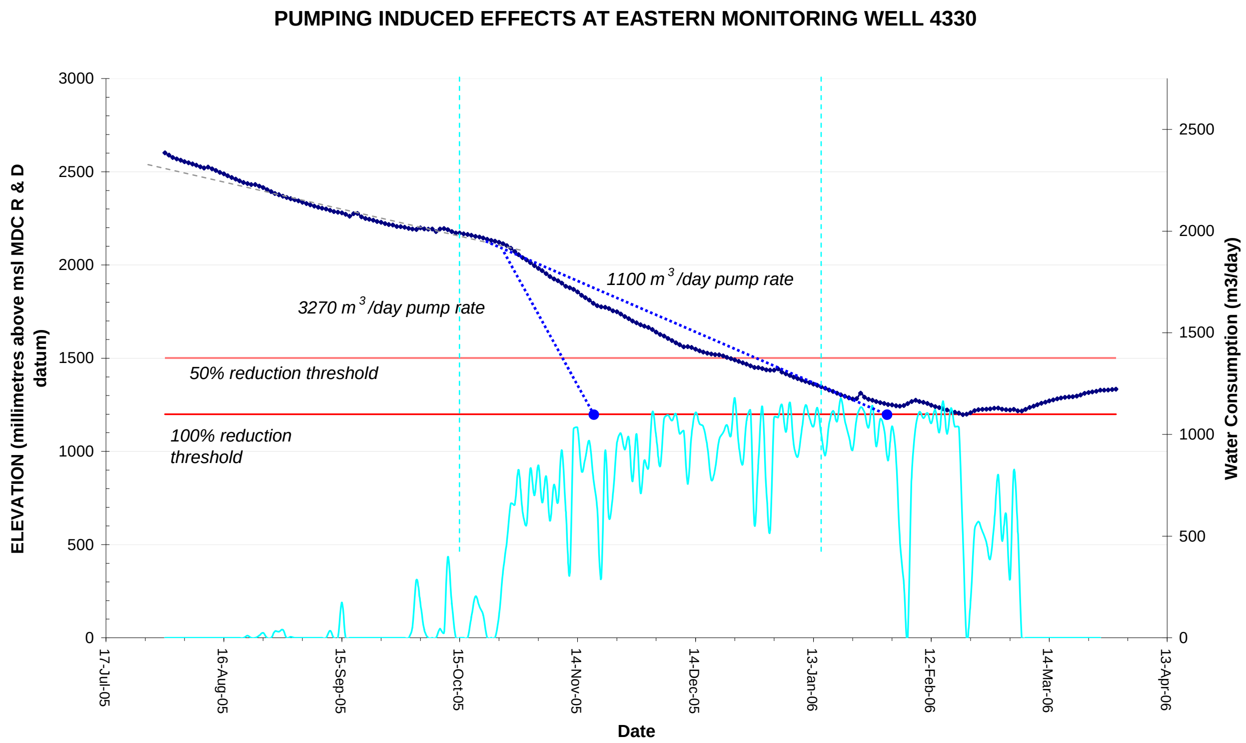


Figure 23 : Observed & Predicted Drawdown Effects

Therefore under the same circumstances the 50% reduction threshold represented by the upper red line would be reached approximately 1.5 months earlier, and total cut off would occur before Christmas. Water level record shows the Rarangi Shallow Aquifer receives limited recharge in the first 4 months of the calendar year, so any cessation of pumping is likely to be permanent for the remainder of that summer irrigation season.

This poses the question as to whether the increased volume can be sustained in terms of the current consent trigger levels and whether it is reliably available in a normal summer season. Consent shouldn't be granted if there is no reasonable expectation of it being exercised.

Another point to consider is the potential for the wetlands to be dry from spring and not recover even in the absence of pumping by WHMVL, until autumn given the Rarangi Shallow Aquifer is in a pattern of recession over summer.

11. Consent Thresholds

It is an appropriate time to review the validity of the thresholds defined in consent U021014, based on the 3 seasons of record available at monitoring wells 4329, 4330, 4331 and 4332.

Of key interest is the 1.2 metres above mean sea level threshold specified in consent condition 10. This is the cut-off level for the wetland monitoring well 4331, which triggered the cessation of pumping in March 2006. The 1.2 metres elevation was chosen to maintain the Pipitea wetland in terms of its current areal extent. Recent investigations of wetland hydrology and their reliance on Rarangi Shallow Aquifer status by Marlborough District Council support this value.

An elevation of 0.8 metres above mean sea level was defined as the interim threshold at well 4074 to maintain wetlands, as part of the variation to consent U021014. It was intended that this value be reviewed in light of further observations of water level at the site. Marlborough District Council installed a continuous water level recorder in well 4074 and the grantee was required to take weekly dip measurements of aquifer level.

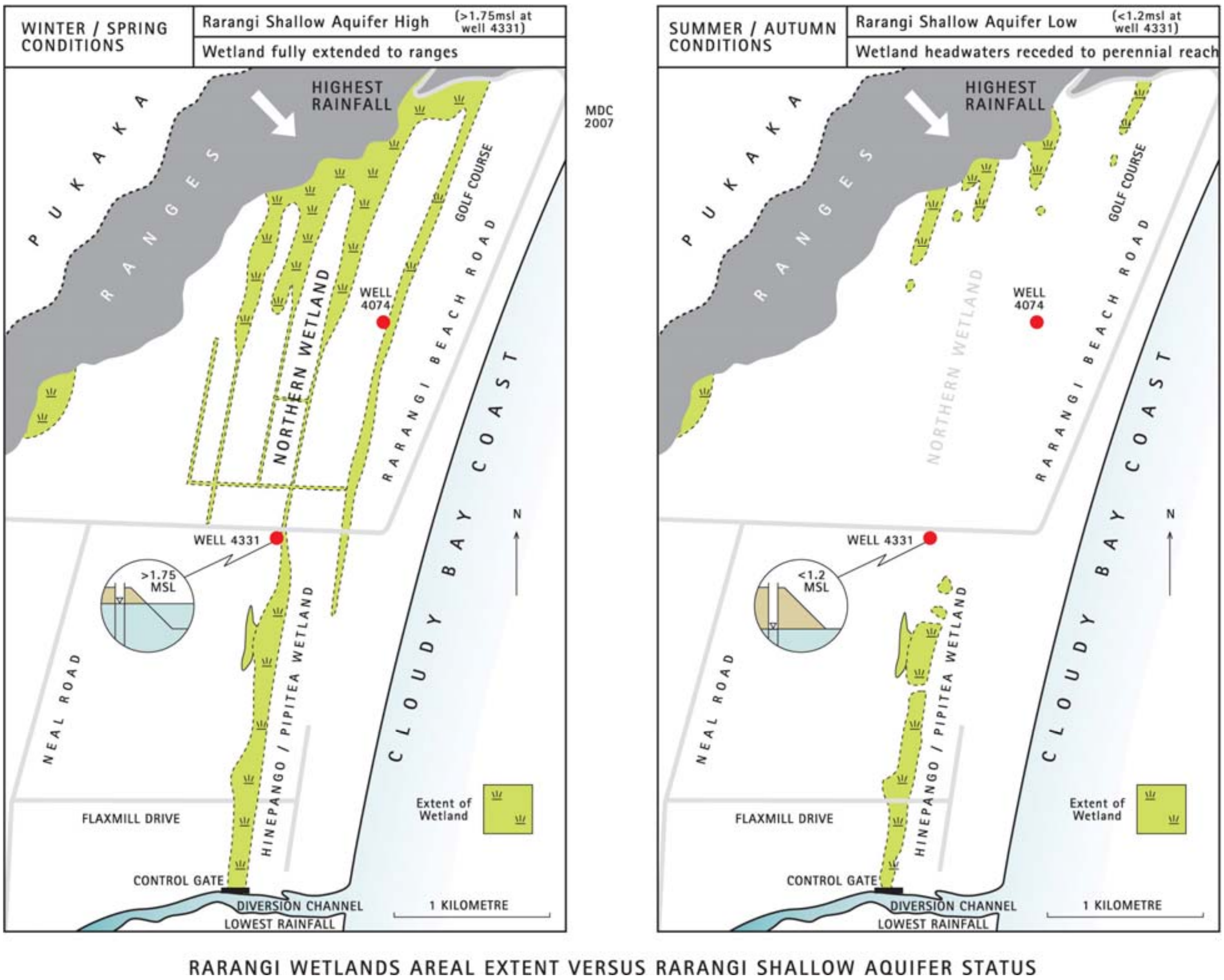


Figure 24 : Areal Extent of Wetlands Versus Rarangi Shallow Aquifer Status

It is recommended that an elevation of 1.2 metres above mean sea level be adopted as this well is located on the same contour of the Rarangi Shallow Aquifer surface as wetland well 4331, and has the same role of maintaining wetland health, particularly with the shift of the well field to the north.

The thresholds in the 2 residential monitoring wells 4329 and 4330 appear to have worked well, although several submitters reported problems with well capacity. However it is difficult to attribute these directly to the operation of WHMVL due to the absence of significant effects exhibited by the record from well 3471 (Brent Williams – Isobel Place).

Reduced direct drawdown effects on domestic water wells in the Clervaux Estate were anticipated following the shift of part of the production well-field northward in accordance with the consent variation. Consequently there are no grounds for modifying the existing cut-off thresholds to protect domestic water wells on the corner of Rarangi and Neal Roads.

Recent analysis of aquifer behaviour has highlighted the susceptibility of the Rarangi Shallow Aquifer to over allocation given the combination of successive droughts in conjunction with increased pumping. A ceiling on annual allocation based on aquifer status going into an irrigation season is recommended to compliment local monitoring controls. As quota is currently defined, there is no limit on how many days the consent U021014 can be exercised and bears no resemblance to the water stored in the Rarangi Shallow Aquifer.

Figures 24 and 25 conceptualise the change in areal extent of the wetland system as the level of the Rarangi Shallow Aquifer water table rises and falls.

12. Survey & Level Datum

As a result of contradictory elevations for well 4331 between those provided by the grantee in 2004 and a long-section survey commissioned in September 2006 by Marlborough District Council, Ayson and Partners re-surveyed all 4 monitoring wells in early 2007.

Part of the issue was the origin of the survey and in particular the definition of mean sea-level. Given the overriding resource management issue being addressed through the consent conditions relates to sea-water intrusion, the definition of mean sea-level must correspond with that used for the early warning sentinel wells along the coast. Otherwise the active management strategy adopted to avoid the interface migrating inland too far loses its physical meaning.

The sentinel wells form part of the Marlborough District Council regional aquifer monitoring or hydrometric network; which allows water levels in streams, springs, the sea and aquifers to be physically related.

The discrepancy in well elevations is of the order of several hundred millimetres too high for the two residential and wetland wells. This magnitude of error equals the difference between the level when restrictions would be imposed on aquifer users and seawater intrusion would occur.

In terms of current water levels depicted on the Marlborough District Council web site and based on the original level survey, the western residential well 4329 elevation is too high by 317 millimetres, the eastern residential well by 285 millimetres and the Hinepango-Pipitea wetland well 4331 is too high by 212 millimetres. As a consequence of this Rarangi Shallow Aquifer levels will be closer to any threshold levels by these amounts at these sites.

Elevations in all water level conditions need to be defined in terms of the Marlborough District Council Rivers and Drainage datum based on an elevation at Trig KK at Blue Gums Corner of 5.057 metres above mean sea-level.

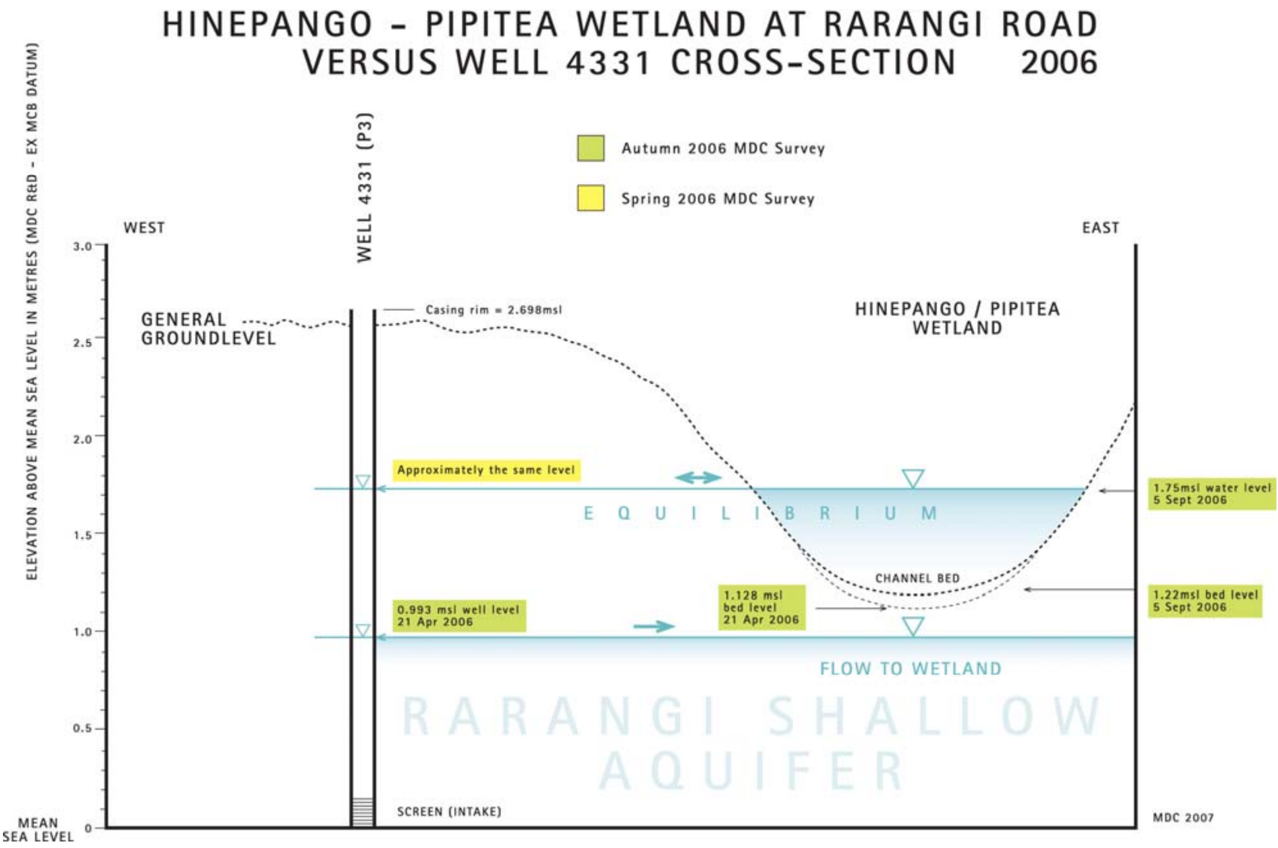


Figure 25 : Seasonality of Wetland Versus Rarangi Shallow Aquifer Level at well 4331

Appendix A : Wetland Photographs

Discharge Swale Temporary Recorder Site

December 2006

7 January 2007

30 January 2007

Eastern or Golf Club Wetland Temporary Recorder Site

December 2006

5 January 2007

30 January 2007

Pipitea Wetland at Rarangi Road Temporary Recorder Site

December 2006

5 January 2007

30 January 2007

Appendix B : References

Variation to Conditions 1.3, 2 and 8.2 of Resource Consent U021014 : Pattle Delamore Partners Ltd - November 2005 (Figure 4b)

Vegetation Monitoring of the Rarangi Wetlands – Interim Report For Wither Hills Vineyards Marlborough : Uruwhenua Botanicals – April 2006

2006RarangiSurevyWellElevatons.xls : Survey Solutions Ltd December - 2006

Assessment of Environmental Effects for Groundwater Abstraction at Rarangi (Replacement of Consnet U021014) : Pattle Delamore Partners Ltd - October 2006 (Figure 18)

Rarangi Shallow Aquifer Sustainability Report : MDC/Scott Wilson – January 2007

\\kpa....O:\ResourceConsent\2006\061001-061500\U061185-Rarangi Shallow Aquifer vs Wetlands Report-Memo-Various-PDa.doc Saved 23/07/2007 12:54:00