MINUTES

TITLE: Environment & Planning Subcommittee Special Meeting
DATE: Monday, 28 August 2006
TIME: 9.30 am
VENUE: Council Chamber, 189 Queen Street, Richmond

PRESENT: Councillors E M O'Regan (Chair), R G Kempthorne, E Wilkins, S Borlase and T B King

IN ATTENDANCE: Manager Environmental Information (R Smith), Resource Scientists (J Thomas, T James), , Consent Planner (N Tyson), Landcare Research (T Davie, A Fenemor), Manager Consents (J Hodson), Policy Planner (M Baker), Cawthron Institute (R Young), Administration Officer (B Moore)

1. APOLOGIES

Moved Crs Kempthorne / Borlase
EP06/08/17

THAT apologies from Crs Bryant, Higgins, Henry and Riley for absence be sustained.
CARRIED

2. INVESTIGATION OF GROUND WATER IN THE UPPER MOTUEKA CATCHMENT- REPORT EP06/08/01

Resource Scientist Water/Special Projects, Joseph Thomas, spoke to the report contained within the agenda and a series of power point slides.

Moved Crs Kempthorne / Borlase
EP06/08/18

THAT report EP06/08/11, investigation of ground water in the Upper Motueka catchment, be received.
CARRIED

3. RIVER/GROUND WATER MODELLING IN THE UPPER MOTUEKA FOR MANAGEMENT – THE STEADY STATE MODEL - REPORT EP06/08/13

Doctor Tim Davie, a scientist of Landcare Research, Lincoln, spoke to this report contained within the agenda and illustrated the discussion with a series of power point slides.

Moved Crs Borlase / Wilkins
EP06/08/19

THAT report EP06/08/13, river ground water modelling in the Upper Motueka for management, the steady state model, be received.
CARRIED

4. FRESHWATER ECOLOGY AND IN STREAM VALUES IN THE UPPER MOTUEKA - REPORT EP06/08/12

Roger Young, Freshwater Ecologist of Cawthron Institute, spoke to this report contained within the agenda and a series of power point slides.

Moved Crs Borlase / Kempthorne
EP06/08/20

THAT report EP06/08/12, freshwater ecology and in stream values in the Upper Motueka be received.
CARRIED

5. UPPER MOTUEKA ALLOCATIONS AND WATER METERING/WATER USER COMMITTEE - REPORT EP06/08/14

Consent Planner Water, Neil Tyson, spoke to this report contained within the agenda. He said that where meters are not already installed, they are required for all consented takes in the Upper Motueka zone by 1 October 2006 in time for this 2006 / 2007 summer.

6. ATTACHMENTS OF REPORTS TO MINUTES

Copies of the four reports presented at this meeting are attached to these minutes to ensure that a full record is retained for this highly important subject of water investigation and management.

The meeting concluded at 12.25 pm.

Date Confirmed: **Chair:**

STAFF REPORT

TO: Environment and Planning Subcommittee

FROM: Joseph Thomas – Resource Scientist Water/Special Projects

COLLOBRATIVE PARTNERS: M Stewart, T Hong, S Cameron, C Daugney, T Tait (GNS Science) and T Davie (Landcare Research Ltd).

REFERENCE: W326

SUBJECT: **INVESTIGATION OF GROUNDWATER IN THE UPPER MOTUEKA CATCHMENT – REPORT EP06/08/11** – Report prepared for 28 August Meeting

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1. BACKGROUND

The area upstream of the Wangapeka confluence of the Motueka River catchment has a sizeable area of fertile alluvial river terrace land that is suitable for irrigated agriculture. Since the mid 90's there has been an increasing demand for irrigation water especially from groundwater in these terraces. Very little hydrogeological work had been undertaken in the past in this area to quantify the groundwater availability in these river terraces, their link to the river, the recharge components (river and rainfall as well as its quality). This data is critical in the evaluation of river depletion effects due to groundwater abstraction as well as to determine holistic and integrated allocation limits for the resource i.e. surface & groundwater. The drought in the summer of 1998/99 added extra pressure in terms of water allocation with the Nelson Marlborough Fish & Game Council seeking minimum flow requirements for the Motueka River and significant tributaries through the National Water Conservation Order Process. The catchment now is covered by a Water Conservation Order which specifies a flow sharing regime with more specific flow provisons for some rivers e.g. Wangapeka. Council has used the provisons of the order and known hydrological data to set allocation limits in the interim for the defined zones in the catchment. Council initiated investigations into the water resource of the area in late 1999. This report is the stage one output from the studies that have commenced since then and covers the investigations into the hydrogeology of the valley, the occurrence of groundwater, aquifer hydraulic properties and connectivity to river and storage and recharge processes.

1.1. Study Area/Monitoring

Figure 1 shows the extent of the groundwater investigations area. The hydrological monitoring network consists of seven groundwater level and groundwater chemistry monitoring bores, 11 isotope monitoring sites, six river flow recorder sites and eight rainfall sites (Figure 2)

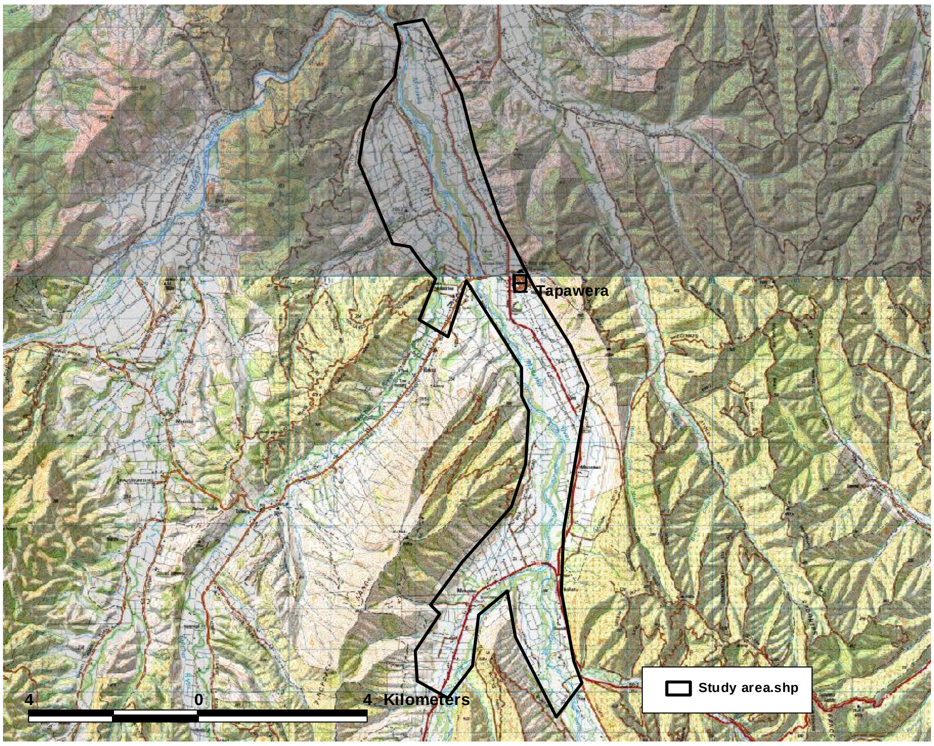

Figure 1: Location of groundwater Study Area

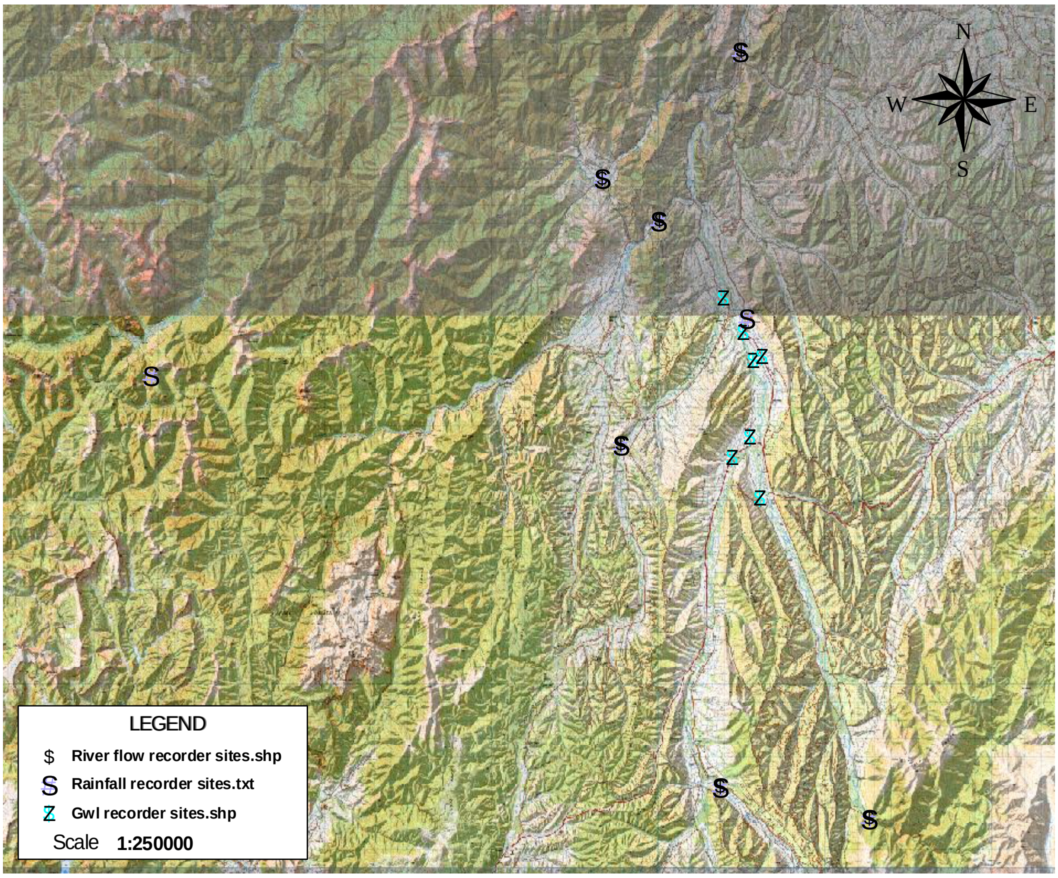

Figure 2: Monitoring Network

2. HYDROGEOLOGY

Hydrogeological mapping of the area has been carried out and this included field mapping and assessments as well as examination of all available bore/well logs from the area. Groundwater is primarily abstracted from shallow unconfined alluvial aquifers that occur in the Quaternary river terrace formations and modern river deposits. Five gravel formations have been identified upstream of the Wangapeka confluence. These are (from oldest to youngest) the Moutere Gravels, Manuka, Tophouse, Speargrass and modern river gravel formations. The Quaternary Gravels are underlain by the Moutere Gravel Formation. Figure 3 shows the simplified geology of the area.

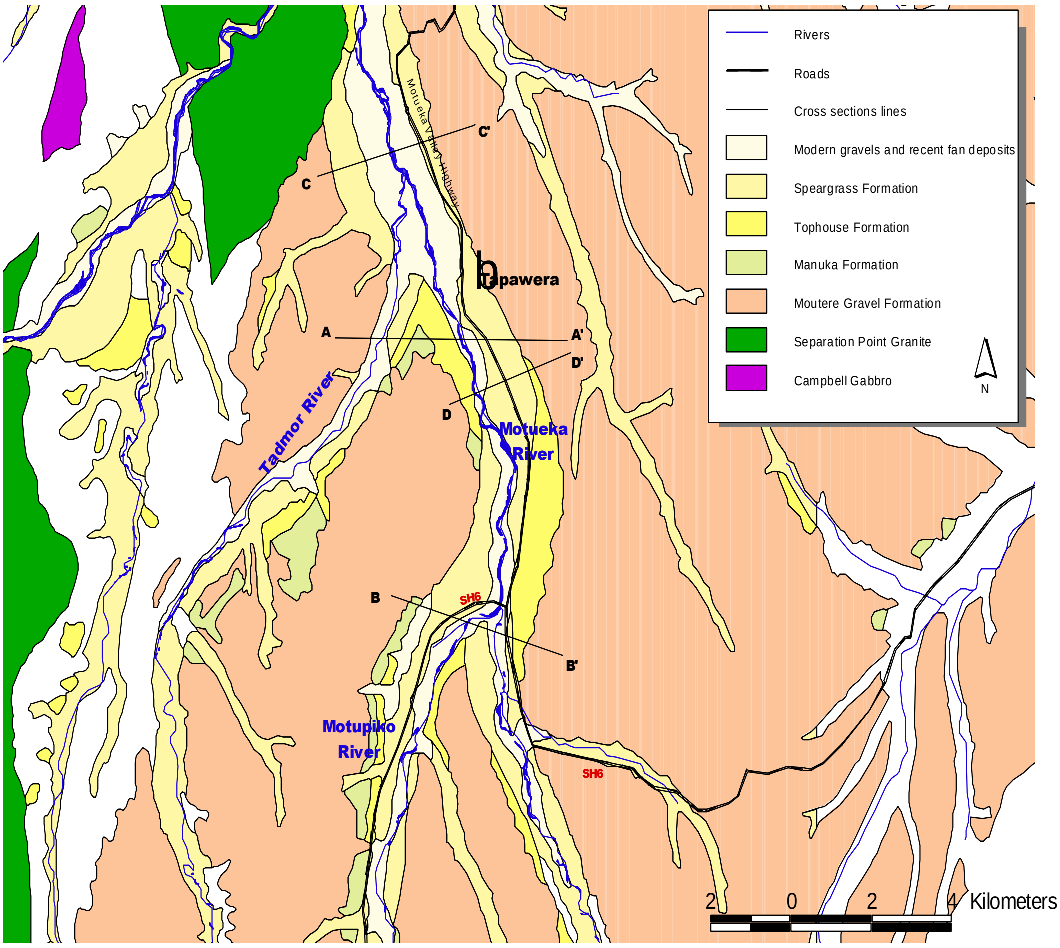

Figure 3: Simplified geology of the Upper Motueka area with locations of cross section lines

Table 1 shows the summary of the assessment and descriptions of each of the formations mapped in the area. Figure 4 shows one geological cross section AA' near Tapawera.

Formation	Approximate height above river level (m)	Description	Distribution	Saturated thickness	Groundwater potential
Modern Gravels	0 to 8	Silty sandy greywacke gravel.	Widespread throughout the Tadmor, Motueka, Motupiko valleys	3.5 to 9.0	Good
Speargrass	8	Slightly weathered greywacke gravel with clasts typically 0.2 m diameter in silty clay matrix. Overtopped by minor fans.	Widespread throughout the Tadmor, Motueka, Motupiko valleys	5 to 8.5	Good
Tophouse	25	Partly weathered greywacke gravel with clasts typically 0.2 m diameter in silty clay matrix. Overtopped by fan gravels and covered with loess up to 0.8 m thick.	Moderately widespread throughout the Tadmor, Motueka, Motupiko valleys	estimated 0 to 12 m*	Poor (from few available bore log data)
Manuka	65 to 70	Weathered greywacke gravel with clasts typically 0.2 m diameter in silty clay matrix. Overtopped by fans and covered with widespread loess up to 1.2 m thick.	Isolated distribution in the Tadmor and Motupiko valleys	estimated 0 to 20 m*	Unknown, but suspected poor
Moutere Gravel	0 to >70	Clay-bound gravel containing partly weathered, dominantly greywacke pebbles	Wide spread throughout the Tadmor, Motueka, Motupiko valleys	Unknown	Unknown

* These saturated thicknesses were estimated from extrapolation of groundwater level data in geological cross sections

Table 1: Summary of Quaternary river terrace formation

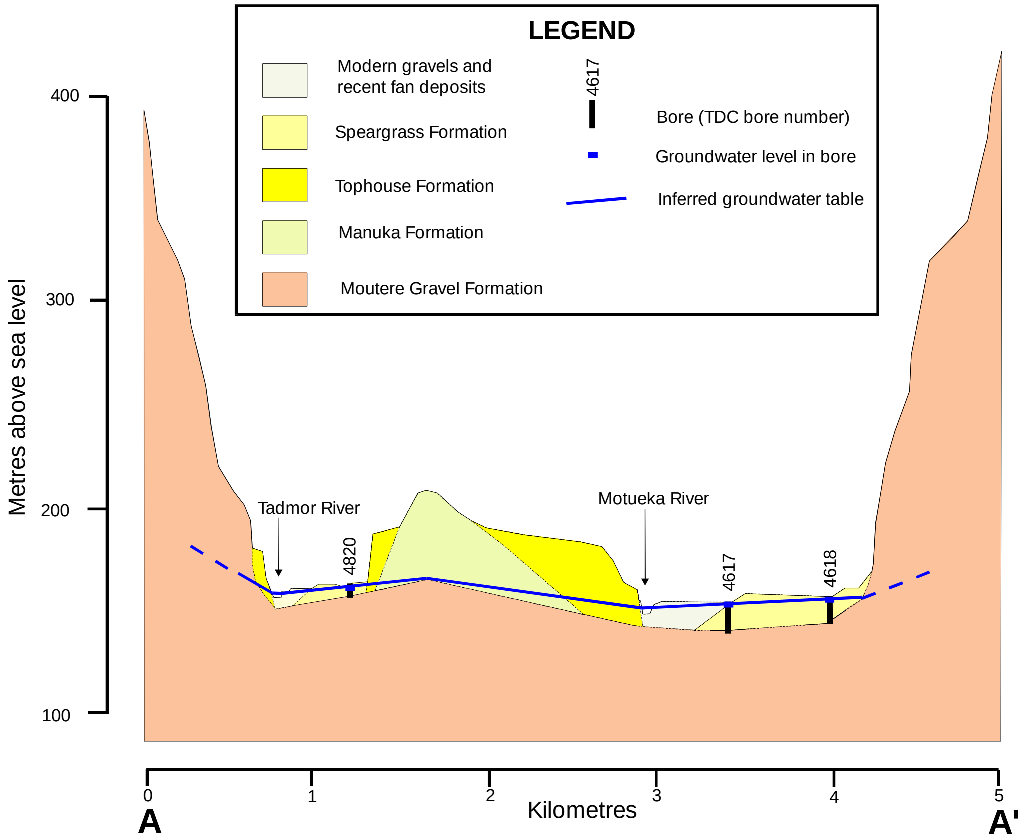

Figure 4: Cross Section AA' near Tapawera

2.1 Groundwater Recharge

There are three sources identified for groundwater recharge for the river terrace formations here i.e. groundwater discharge from the Moutere Gravels, rainfall infiltration and river flow loss. Due to the tight nature of the Moutere Gravels underlying the river terrace formation groundwater recharge from the Moutere Gravel is small. Rainfall infiltration based on mean rainfall of 1100 mm at Tapawera assuming infiltration just from the Speargrass and modern gravels is estimated at 350 l/s based on a recharge coefficient of 0.3. A mean annual rainfall recharge rate of 350 l/s (11 million m^3/yr) is about 36 % of the estimated groundwater through flow rate in the Motueka River Valley downstream of Tadmor River during dry summer low flow conditions.

The three main river systems that contribute to flow in the Motueka Upstream of the Wangapeka River confluence are the Motueka, Tadmor and Motupiko rivers. Flow losses and gains have been identified from river gaugings and piezometric (water level in bores/wells/river) survey undertaken in the area. Figure 5 shows river loss and gains from gaugings carried out in February 2002.

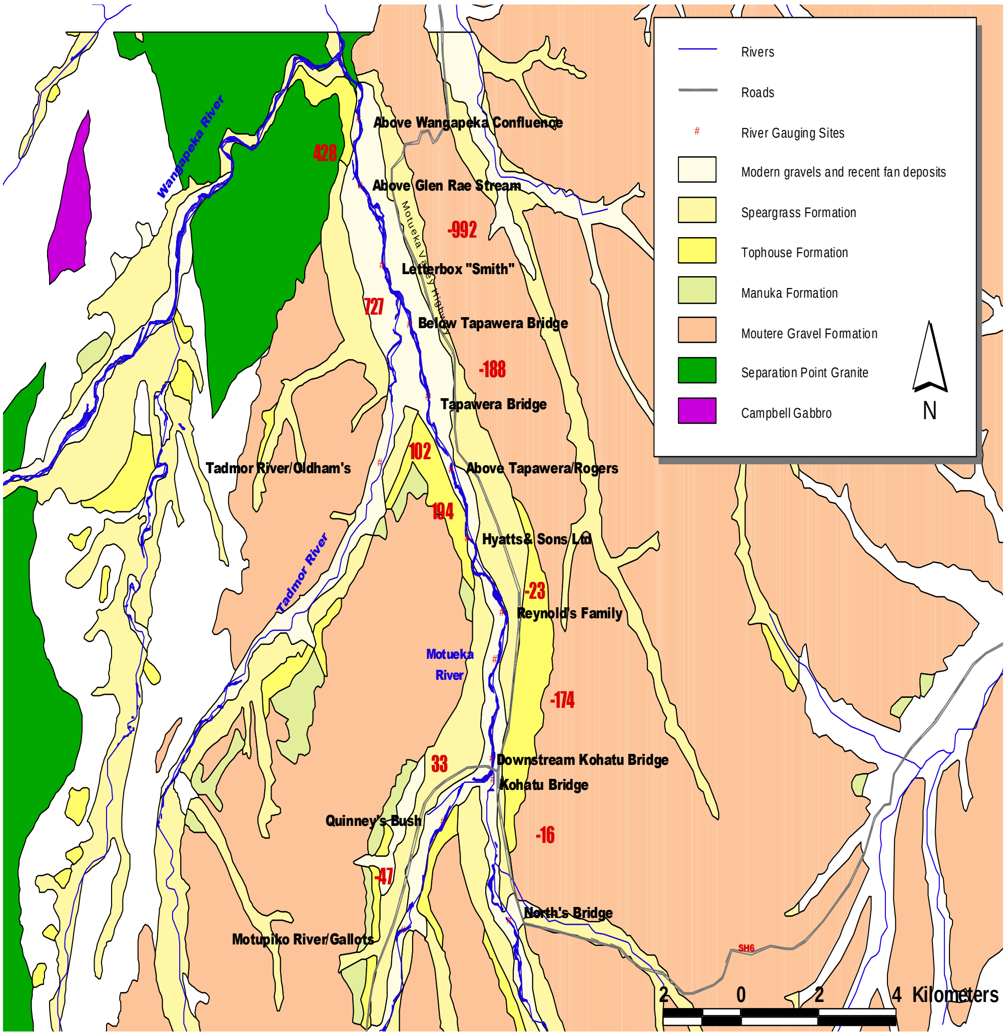

Figure 5: River flow loss and gain from gaugings in February 2002

Figure 6 shows the groundwater flow patterns monitored via the piezometric survey in February 2002.

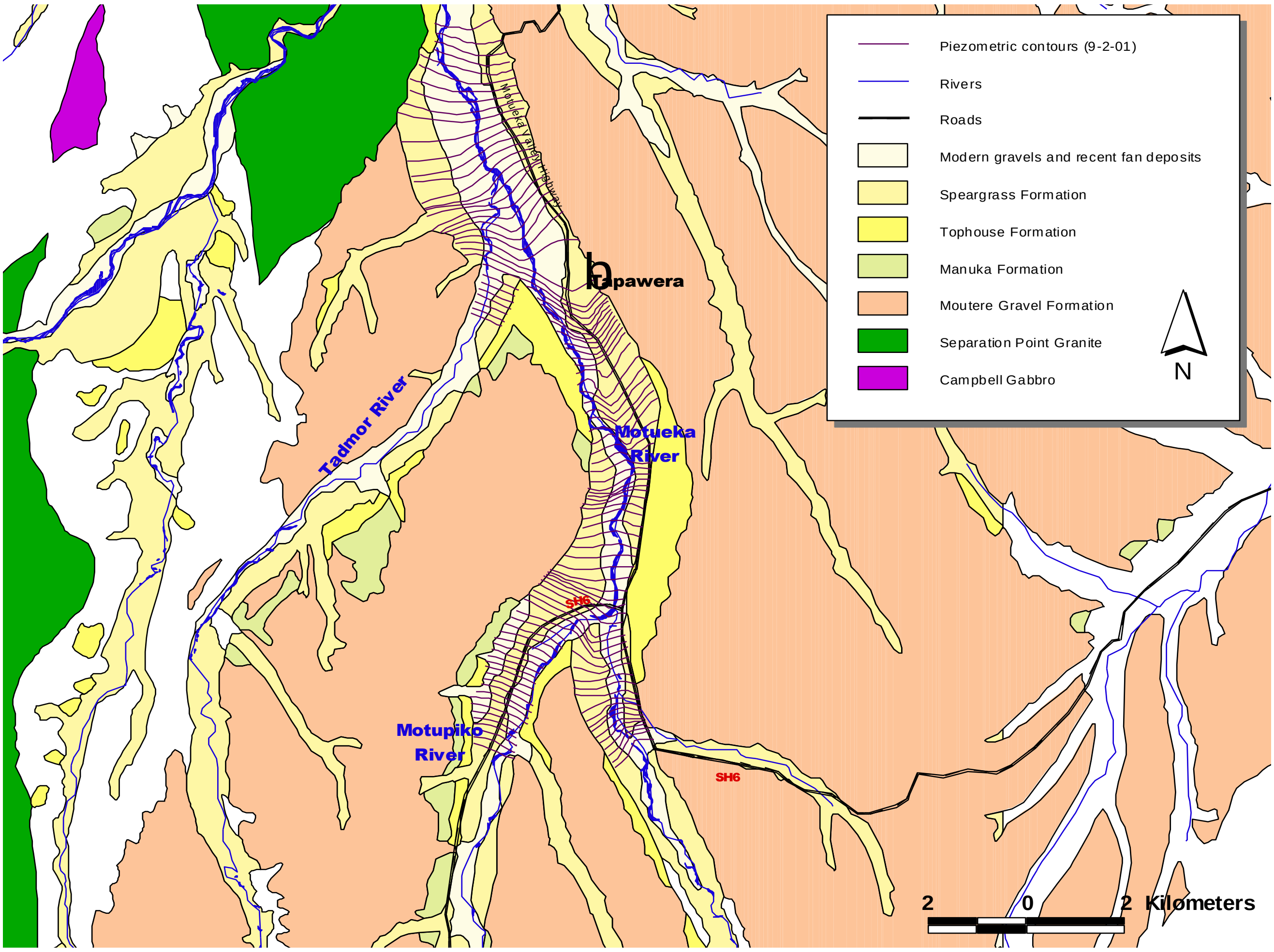

Figure 6: Piezometric map showing groundwater flow patterns in Upper Motueka February 2002

The piezometric and gauging data shows a complex flow pattern occurring between the rivers and aquifers. Overall river flow is lost to groundwater in reaches where the river valley widens and the cross sectional area of the aquifer increases. Conversely groundwater generally discharges into the river along the reaches where the river valley becomes narrower. Using the piezometric survey and aquifer hydraulic data surface and groundwater flow rates through the Modern Gravels and Speargrass Formation have also been calculated for different sections of the Upper Motueka area.

2.2 Groundwater Storage

Groundwater storage volume for the Modern Gravels and Speargrass Formation aquifers during low flow conditions has been estimated at 9.7 x 10^6 m^3 (9.7 million cubic metres) for the area covered by the piezometric map data. The storage was calculated from the average saturated thickness of 4.7 m based on groundwater levels in February 2001. The groundwater level at that time was below mean annual values for all sites; hence the storage volume estimate is representative of storage during dry summer conditions. Storage volumes will increase during non-drought conditions.

2.3. Stream Depletion

River/aquifer interactions are a significant issue in interconnected water resource systems. Understanding this correlation is important to managing the total resource. The abstraction of groundwater from the modern gravels and/or Speargrass Formation has the potential to cause depletion of the Upper Motueka River flow. Stream depletion curves have been developed for different reaches of the river based on test bore data and stream bed leakage calculated from flow gaugings. The rate of stream depletion from groundwater pumpage increases downstream in the Motueka River. This is due to the bed conductance increasing downstream, most likely as a function of stream width increasing downstream. Figure 7 shows the location of stream reaches along the Motueka River used in the stream depletion calculations. Figure 8 shows the depletion curves after I day pumping from the Modern gravels.

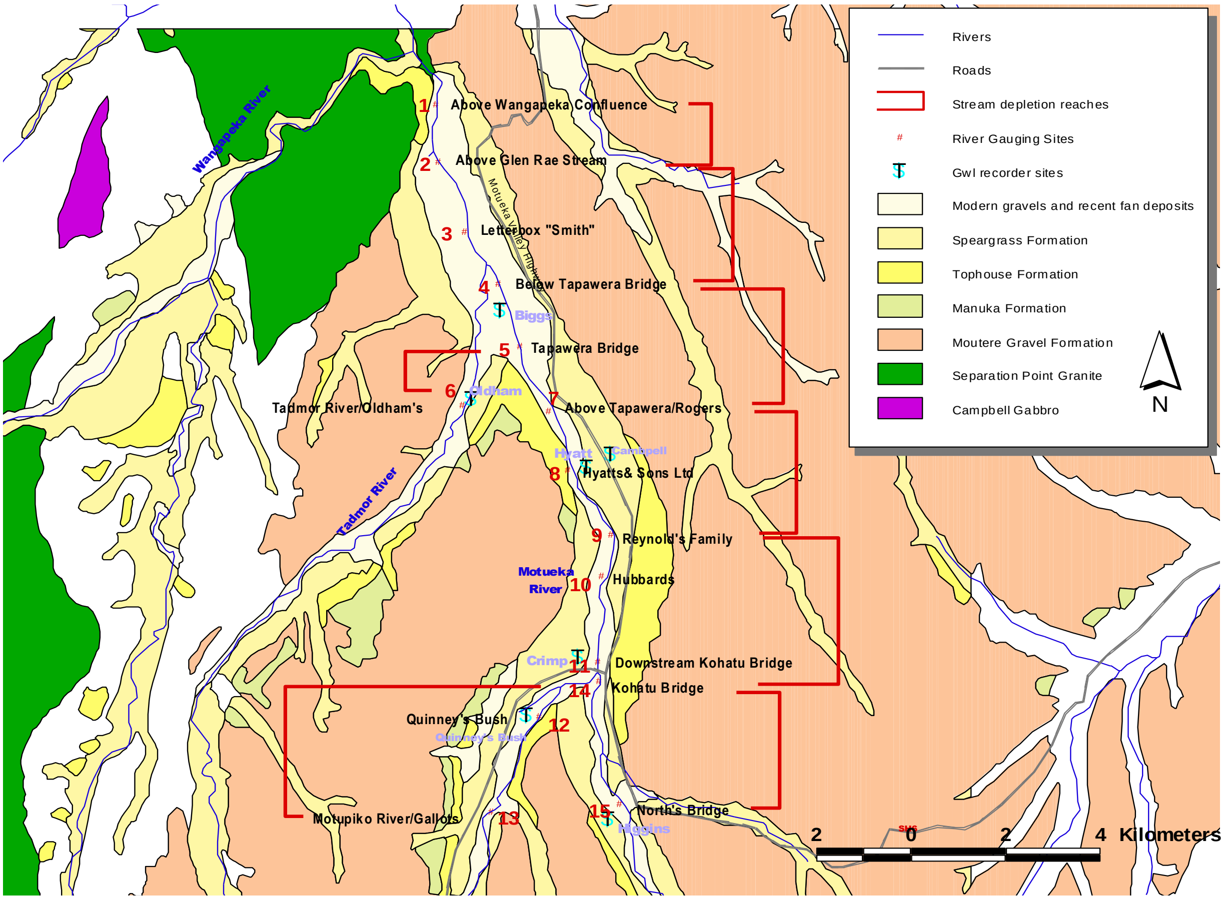

Figure 7: Stretches of Motueka Rivers used in stream depletion calculations

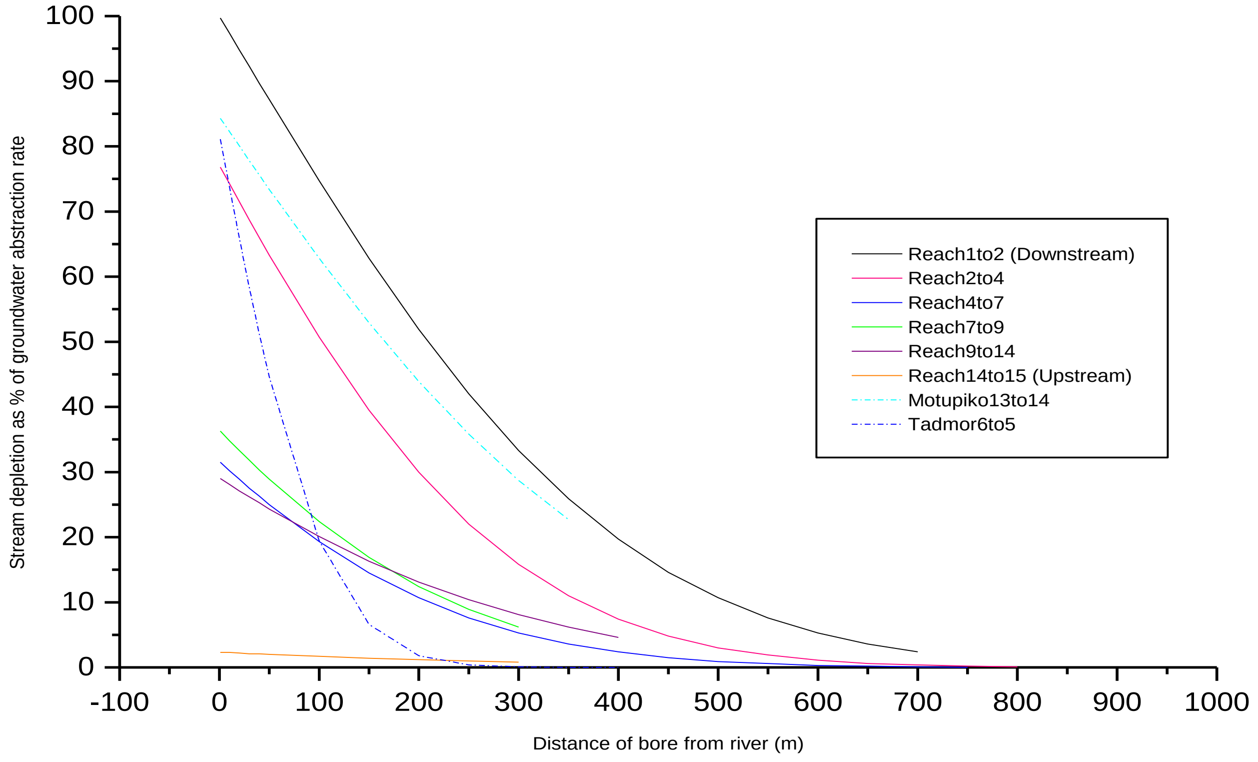

Figure 8: Stream depletion when pumping from within the Modern Gravels

2.4 Groundwater-River-Rainfall Modelling

In the first phase of this study an artificial neural network technique has been used to identify the correlation between river flow groundwater and rainfall. A predictive model was also developed of the relationship of groundwater levels (at Quinneys Bush and North's Bridge), the river flow rate (Motupiko & Motueka Gorge) and rainfall in the period 11 Sept 2000 to 31 July 2002. The relative strengths of the input variables i.e. groundwater level to flow and rainfall was also able to be assessed. The primary aim of this preliminary modelling work was to a broad understanding of the systems and its inter-correlation prior to development of a more refined spatial model of river aquifer interaction for the area. Figure 9 shows an example of the modelling of groundwater levels at Quninneys Bush based on rainfall and flow variable over the duration of the model run. Table 2 shows the sensitivity of groundwater at Quinneys to rainfall and flow.

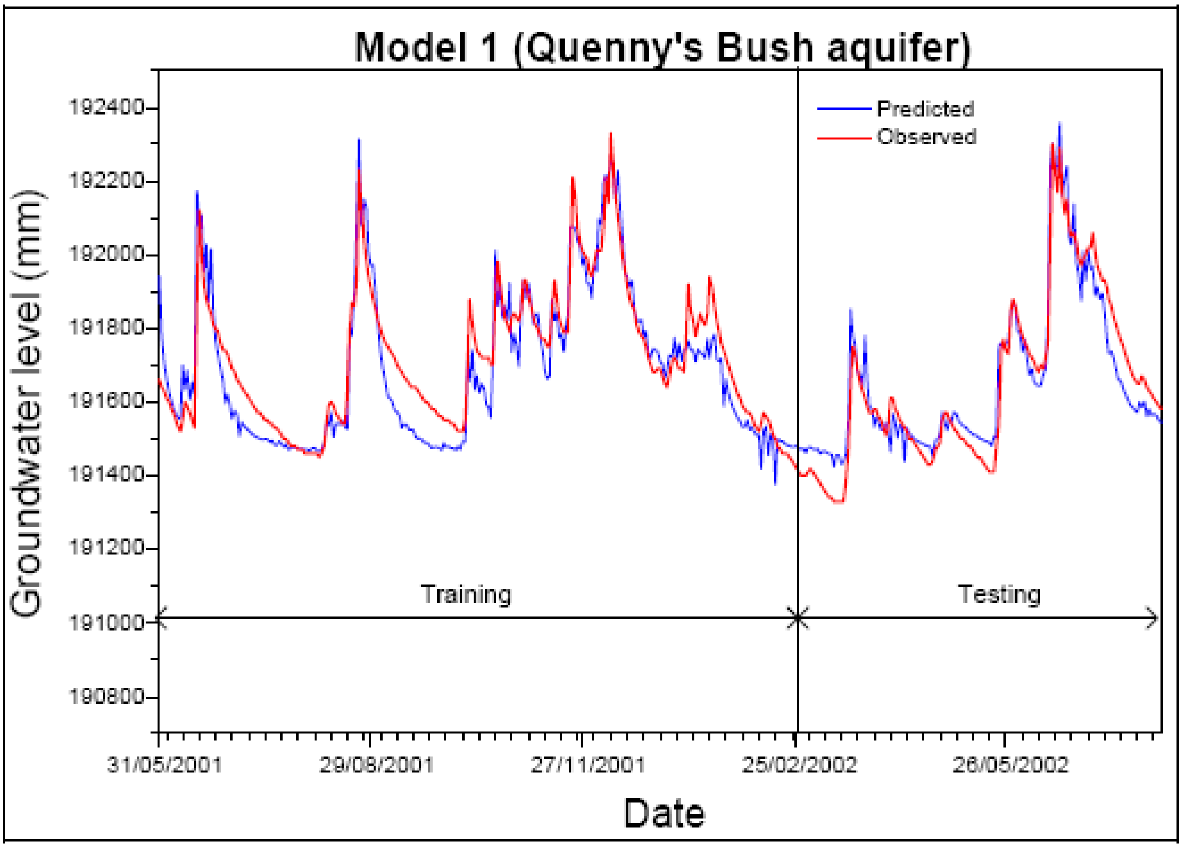

Figure 9: Results of neural network model at Quinneys Bush

Inputs	Groundwater level at Quinneys Bush
Rainfall	0.13
Motupiko River flow rate	0.87

Table 2: Relative variables sensitivity of Quinneys Bush Groundwater to flow and rainfall

3. GEOCHEMISTRY

The geochemistry of waters in the Upper Motueka Catchment was studied to gain understanding of the sources, flowpaths and residence times of waters in the catchment. Chemical measurements gave information on the major element chemistry in relation to aquifer geology and landuses. Isotopic analysis was also used to evaluate groundwater residence times. This geochemistry work contributes further to the development of the conceptual model of the groundwater-river interaction.

Groundwater samples were collected from eight bores and two springs. Surface water data was collected at both the Motueka River (3 sites) and Motupiko (1 site) and was integrated into this study. General analysis of the water quality data shows two major types of water. The Motupiko River and groundwater's from the Motupiko and Tadmor Valleys and on the west bank of the Motueka River downstream of the confluences with the Motupiko and Tadmor Rivers are all different from the Motueka type waters i.e. water from Upper Motueka through the Tapawera Plains. The waters here reflect the interaction with Moutere Gravel and terrace gravels derived from it. The Motueka Type water reflects a clear influence of the ultramafic geology and a higher magnesium/calcium/bicarbonate level occurring in those waters. The area around Kohatu and around the Tapawera Bridge by the Tadmor shows a mixed nature reflecting the influence of the Motueka Type Water.

Various isotopic techniques were also used to assess the source of recharge and residence times in the aquifers. Oxygen-18 data shows distinct differences between the Motueka Type water and the Motupiko-Type waters. The lower oxygen-18 value of the Motueka Type water reflects the source at a higher altitude i.e. above Motueka Gorge. Both river and groundwater displays these differences in oxygen-18 results. This shows the strong influence of the rivers on groundwater in the respective areas. Age evaluation using both Oxggen-18 variations over time (groundwater/river/rainfall) and also tritium show good agreement with ages ranging from 0-12 months. Near river groundwater has a young age and groundwater further away from the river in the board river terraces (i.e. above Tapawera) older at 7-12 months.

4. SUMMARY

- The hydrogeological investigations have provided a whole host of important base data in terms of the nature, extent and the nature of the recharge mechanism and river/groundwater/rainfall interactions.
- The sensitivity modelling has provided technical data in terms of degree of influence of different sources of recharge on groundwater
- The geochemistry analysis has identified distinct type of groundwater and their age, recharge and residence times.
- The thee key base outputs described above are critical to developing a holistic interactive surface/groundwater interaction model for refining water allocation and triggers in the Upper Motueka area.

5. RECOMMENDATION

Council receives this report.

Joseph Thomas
Resource Scientist – Water/Special Projects

STAFF REPORT

TO: Environment & Planning Subcommittee

FROM: Joseph Thomas – Resource Scientist Water/Special Pojects
Tim Davie – Scientist, Landcare Research, Lincoln
Timothy Hong – Scientist, GNS, Wairakei.

REFERENCE: W323

SUBJECT: **RIVER/GROUNDWATER MODELLING IN THE UPPER MOTUEKA FOR MANAGEMENT - THE STEADY STATE MODEL – REPORT EP06/08/13** – Report prepared for 28 August EPC Special Meeting

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1. BACKGROUND

The Upper Motueka area (The Motueka Catchment from the Wangapeka confluence upwards) has a sizeable area of fertile alluvial river terrace land that is suitable for irrigated agriculture. There is concern that extraction of shallow groundwater for irrigation may lower groundwater levels and consequently the baseflow of rivers/streams during the summer season due to strong shallow aquifer-surface water interactions in this area. This would reduce the availability of surface water to existing users and add pressure in terms of water allocation to keep minimum baseflow requirements for the Motueka River in compliance with the requirements of the Motueka River Conservation Order.

In order to manage the water resources of the Upper Motueka Catchment in a holistic manner the development of a three-dimensional groundwater flow model is required to analyse the effects of groundwater abstraction on rivers/streams flow and groundwater levels. The model is being developed in a joint study, conducted with the Institute of Geological and Nuclear Sciences (GNS), Landcare Research and Tasman District Council (TDC). The project is funded by Tasman District Council and Landcare Research through the Foundation for Research Science and Technology (FRST) funded Integrated Catchment Management (ICM) programme.

2. THE NUMERICAL MODEL

Many methods have been devised to simulate the interactions between a shallow aquifer and stream, ranging from relatively simple analytical methods to site-specific 3-dimensional numerical models. Models that describe water movement between shallow aquifer and stream systems at large spatial and temporal scales are comparatively new and still at the stage of development and improvement. In this study, a state-of-art adaptive finite element groundwater modelling system is implemented to simulate the relations and interactions between shallow aquifer and stream systems in the Upper Motueka River catchment. At this stage of the study the groundwater flow model is a steady-state; in future it will be progressed into a dynamic simulation model.

The model boundary of the Motueka groundwater flow model focuses from Korere, 15 km upstream of the Motupiko and Motueka confluence (i.e. Kohatu) to immediately above the Motueka/Wangapeka confluence. It also includes 8km of the Motueka upstream of Kohatu and 3 km of the Tadmor River upstream from its confluence with the Motueka River (Figure 1). The model boundary includes the majority of groundwater extraction in the Upper Motueka River catchment. The triangular mesh used in the model is deliberately designed to have greater sensitivity (smaller cells) nearest to the river where the groundwater-surface water interaction will be greatest.

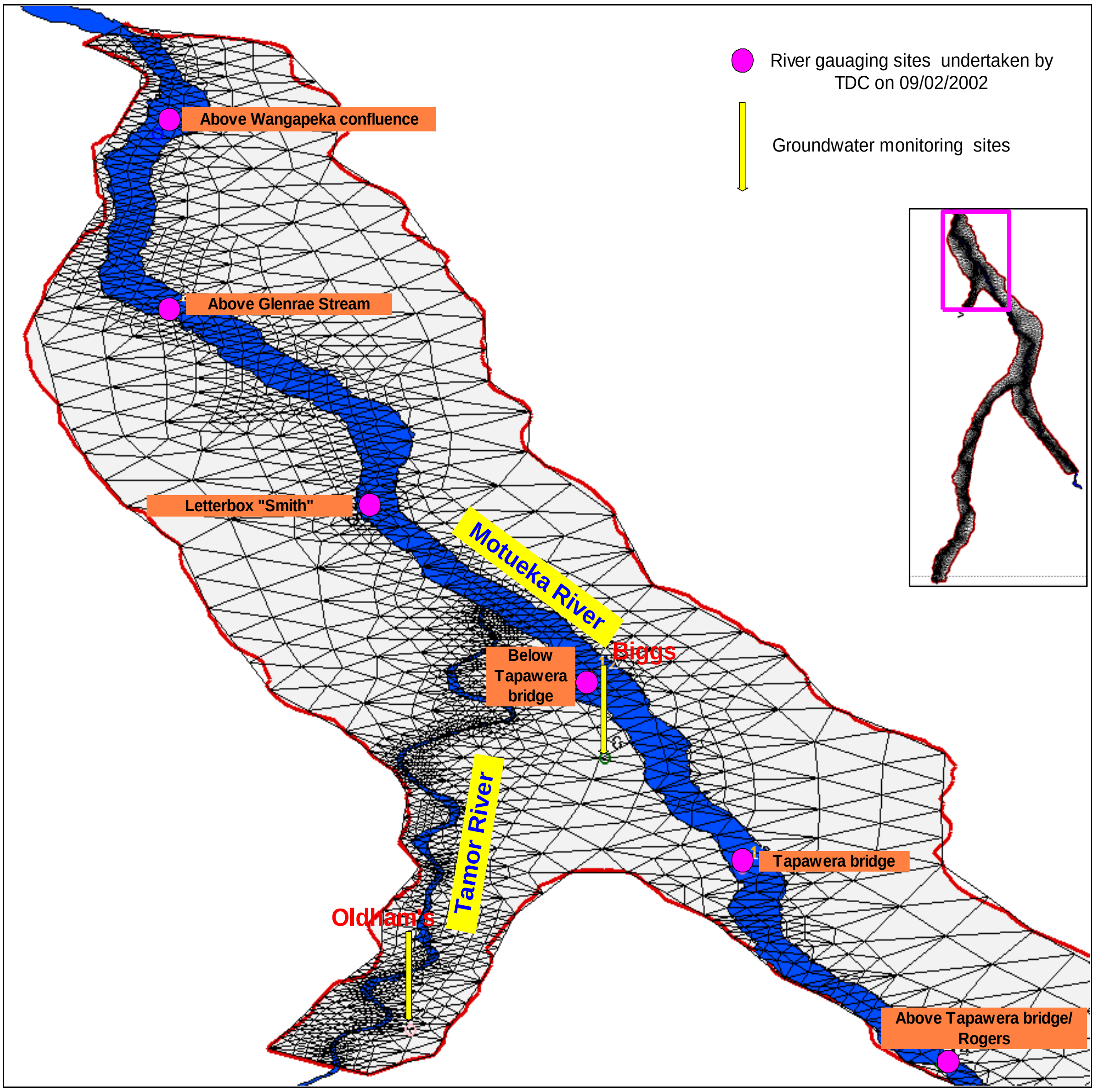


Figure 1 Close up two-dimensional view of the Upper Motueka groundwater model domain with aquifer discretization and a finite element mesh. Total area of model domain is shown in inset box. The blue area is river channel. N.B. the finer mesh immediately adjacent to the river channel.

3. PARAMETERS AND VARIABLES USED TO RUN THE MODEL

In order to simulate a groundwater flow system with a numerical finite element model, the hydraulic characteristics of the aquifer and confining beds must be specified for each nodal point of triangular elements evident in figure 1. The hydraulic characteristics normally required to simulate a groundwater flow system are aquifer thickness, hydraulic conductivity, and specific storage. Specific storage is not specified for this study because all simulations are for the steady-state conditions. The aquifer thickness in the model domain is described in the previous report. Hydraulic conductivity was first estimated from a priori knowledge of the groundwater system and then used as an adjustable parameter to calibrate the model.

The main variable used in the model is rainfall, which is used by the model to calculate surface recharge. The annual average rainfall at Tapawera site for the period 1993 to 2001 years is 1100mm. To generate the regional recharge model in the model domain, the recharge coefficient is estimated to be 0.3 on the basis of the rainfall recharge data in the Canterbury Plains. The mean annual rainfall recharge to aquifers is estimated at $0.121*10^{-4}$m/day (350 l/sec) on recharge coefficient of 0.3. The spatial distribution of annual average rainfall is strongly correlated to the topographic elevation. Therefore it is assumed that the recharge in the high elevation area is a little higher than the recharge in the lower valleys in the model domains. The recharge is assigned to each finite element mesh of the model. The regional rainfall recharge distribution is shown in Figure 2.

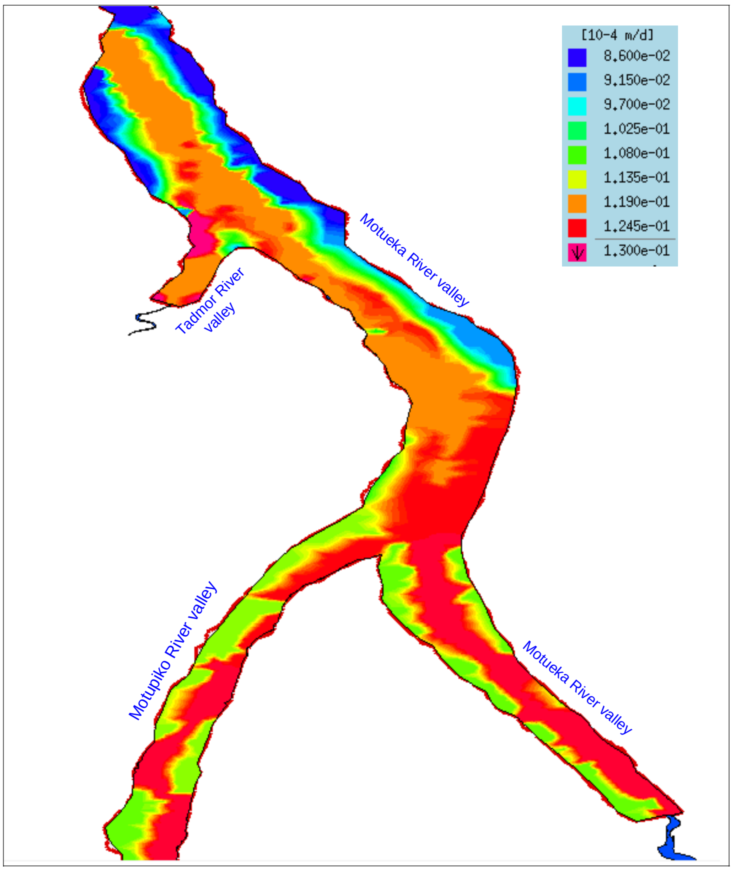


Figure 2 Spatial distribution of rainfall recharge used in the model.

The second major variable used in the model is river flow, i.e. the water flowing into the model domain from upstream of the model boundary. These were estimated using information from nearby TDC flow gauges (Motupiko at Christies; Motueka at Gorge; Tadmor at Mudstone).

4. CALIBRATION OF THE MODEL

Groundwater flow modelling needs to establish a best fit between observed and predicted head distribution through a phase of model calibration process. The model used here has been calibrated using water level recording from eight TDC groundwater monitoring wells. The model has been calibrated using visual comparison of the match between predicted and observed values at each of monitoring wells. The part of the model concerned with the river was also calibrated on the basis of eleven river gauging sites and piezometric survey. undertaken by TDC staff (particularly 09/02/02). In order to match river flows loss and gain through the flow budget analysis. The following parameters in the groundwater model were optimised:

- spatial hydraulic conductivity
- spatial in-transfer coefficient and out-transfer coefficient between river and aquifer

The results from the calibration are shown in tables 1 and 2. The model calibration shows good results in terms of both groundwater levels and river flow loss and gain. For example, the February 2002 gauging data shows that the Motueka River reaches between Tapawera bridge and Hyatts and between Above Wangapeka confluence and Above Glenrae Stream gain flows of approximately 25573 m^3/day (295 l/sec) and 36979 m^3/day (428 l/sec) from groundwater, respectively. The Upper Motueka groundwater flow model predicts that there is a flow gain of 25932 m^3/day (300 l/sec) between Tapawera bridge and Hyatt (Figures 23 and 24) and of 36102 m^3/day (418 l/sec) between Above Wangapeka confluence and Above Glenrae Stream.

Table 1 Observed River flow loss and gain and predicted after calibration. + and – represent river flow gain and loss, respectively.

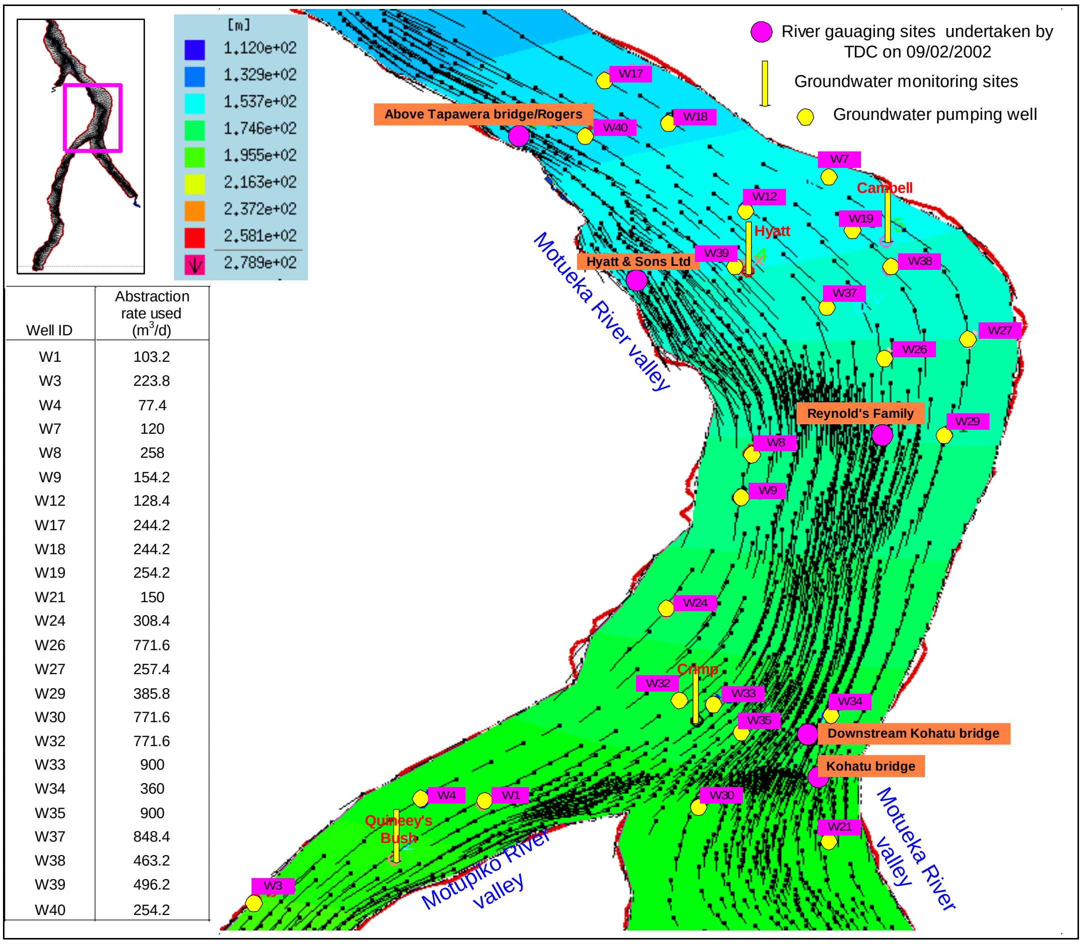
Reach	X	Y	Discharge (m^3/day)	Observed river loss or gain (m^3/day)	Predicted river loss or gain (m^3/day)
Kohatu bridge	2496187	5972915	132969	No gauging	??
Downstream Kohatu	2496152	5973305	153878	No gauging	??
Reynolds	2496422	5976055	138844	-15034	-16217 between Hyatt and Downstream Kohatu
Hyatts	2495515	5977426	136857	-1987	
Rogers	2495102	5978701	153619	16761	17031
Tapawera bridge	2494499	5980096	162432	8812	8901

Reach	X	Y	Discharge (m^3/day)	Observed river loss or gain (m^3/day)	Predicted river loss or gain (m^3/day)
Below Tapawera	2494040	5981439	146188	-16243	-16436
Smiths	2493328	5982558	209002	62813	60498
Glenrae	2492777	5984045	123292	-85708	-83452
Above Wangapeka confluence	2492737	5985290	160272	36979	36102

Table 2 Observed groundwater levels and predicted groundwater levels after calibration for the eight monitoring sites.

Site Name	Grid Ref	X	Y	Observed GWL (m)	Predicted GWL (m)
Oldham	N28:9350-7895	2493500	5978950	150.35	149.1
Biggs	N27:9409-8087	2494085	5980869	136.62	137.1
Campbell	N28:9643-7777	2496432	5977765	155.58	156.2
Hyatt	N28:9593-7750	2495927	5977500	154.97	155.3
Crimp	N28:9574-7343	2495743	5973426	179.11	181.6
Quinney's Bush	N28:9465-7217	2494645	5972174	191.30	191.7
Higgins	N28:9638-6996	2496379	5969958	201.51	199.23

Figure 3 show the contour map of predicted groundwater head distribution with vectors indicating groundwater flow direction at the area of the confluence of the the Motupiko River and the Motueka River, respectively. This is included to show the type of model output that can be expected in a dynamic model currently being developed.



Well ID	Abstraction rate used (m^3/d)
W1	103.2
W3	223.8
W4	77.4
W7	120
W8	258
W9	154.2
W12	128.4
W17	244.2
W18	244.2
W19	254.2
W21	150
W24	308.4
W26	771.6
W27	257.4
W29	385.8
W30	771.6
W32	771.6
W33	900
W34	360
W35	900
W37	848.4
W38	463.2
W39	496.2
W40	254.2

Figure 3 Predicted groundwater levels and groundwater flow pattern after calibration at the confluence of the Motupiko River and the Motueka River.

5. SUMMARY

- The effects of water abstraction from groundwater and surface water is a growing issue for water management in the Upper Motueka River catchment. The purpose of this study is to develop a three-dimensional groundwater flow model that is capable of analysing the effects of groundwater abstraction on stream flow and groundwater levels in order to manage the water resources in the Upper Motueka area sustainably.

- In this study, an adaptive finite-element groundwater modelling system is implemented to simulate the relations and interactions between shallow aquifer and river systems in the Upper Motueka River catchment.

- This report provides results from the development of the model in a steady state condition. The study will continue with the development of the model into a dynamic state for transient and water management simulations.

- The steady-state Upper Motueka groundwater flow model has calibrated using water level recording from the eight groundwater monitoring wells and on the basis of measurement on the basis of river gauging data. The model has been calibrated using visual comparison of the match between predicted and observed values. During calibration the hydraulic conductivity and the in and out transfer coefficients (between river and aquifer) were optimised. The model calibration shows good results in terms of both groundwater levels and river flow loss and gain.

- In this work, it is demonstrated that the Upper Motueka groundwater flow model developed in 3-D adaptive finite-element structure is feasible and can be used as a tool to investigate the effect of the abstraction on the river flow and groundwater levels. The next step, a dynamic Upper Motueka groundwater flow model currently being developed. This dynamic model will provide a better understanding of groundwater flow and its interaction with surface water in the Upper Motueka River catchment, and provide a tool to assess different water allocation management regimes in the Upper Motueka River catchment.

6. RECOMMENDATION

Council receives this report.

Joseph Thomas
Resource Scientist – Water/Special Projects

Tim Davie
Scientist – Landcare Research – Lincoln

Timothy Hong
Scientist – GNS - Wairakei

STAFF REPORT

TO: Environment & Planning Subcommittee

FROM: Roger Young – Freshwater Ecologist - Cawthron Institute
Joseph Thomas – Resource Scientist Water/Special Pojects

REFERENCE: W323

SUBJECT: **FRESHWATER ECOLOGY AND INSTREAM VALUES IN THE UPPER MOTUEKA – REPORT EP06/08/12 – Report Prepared for 28 August Meeting**

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1. BACKGROUND

One of the primary goals of the Integrated Catchment Management (ICM) research project is to improve understanding of the water resources in the Motueka Catchment and assist water resources management. An important part of this understanding relates to the in-stream values that are supported within the catchment and how these values may be affected by changes in flow. Several studies related to this topic have been conducted in the Upper Motueka Catchment over the last 6 years as part of the ICM project and are summarised in this report. These studies relate to:

- Water quality and river health throughout the Motueka Catchment
- Flow-habitat modelling
- Fish movement and implications for habitat requirements
- Assessing the importance of groundwater/surface water interactions

2. WATER QUALITY AND RIVER HEALTH

Water quality has been assessed by TDC and Cawthron at 16 sites on a monthly or quarterly basis throughout the catchment since 2000. Two sites (Gorge and Woodstock) are also part of the National River Water Quality Network and sampled monthly by NIWA since 1989. Stream invertebrate communities have also been sampled at many sites throughout the catchment by TDC, Cawthron and others as an indicator of the health of the river system. The results from these studies have been reviewed in TDC's report on the 'State of Surface Water Quality in Tasman District' in June 2005 (Young, James & Hay 2005).

In terms of the Upper Motueka Catchment, water quality was generally good at most sites. However, problems with high concentrations of faecal indicator bacteria and nutrients were evident at sites that drained subcatchments dominated by pastoral land use (Kikiwa, Motupiko; Figure 1). Water temperatures exceeded guideline values during the summer at several sites, particularly where there was little riparian vegetation and shading (Kikiwa, Tadmor; Figure 2A). The health of the river ecosystem, as indicated by stream invertebrate community composition, ranged from satisfactory to very good in the Upper Motueka (Figure 2B).

These results indicate that water quality and instream values are generally good in the Upper Motueka. However, there are concerns with some areas where pastoral land use and lack of riparian vegetation appear to be having an effect on water quality. This needs to be considered further if increases in water storage and allocation allow more intensive agriculture.

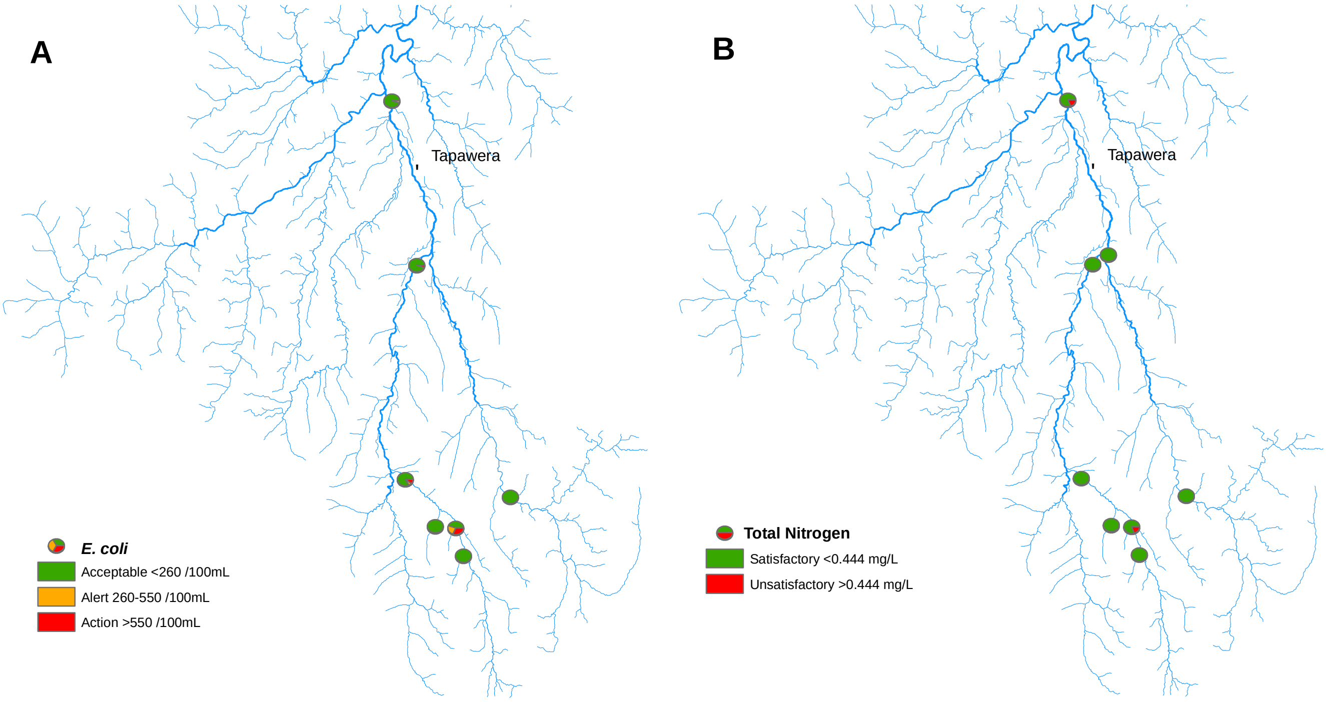

Figure 1 Proportion of measurements of faecal indicator bacteria (A) and total nitrogen (B) that met or exceeded guidelines.

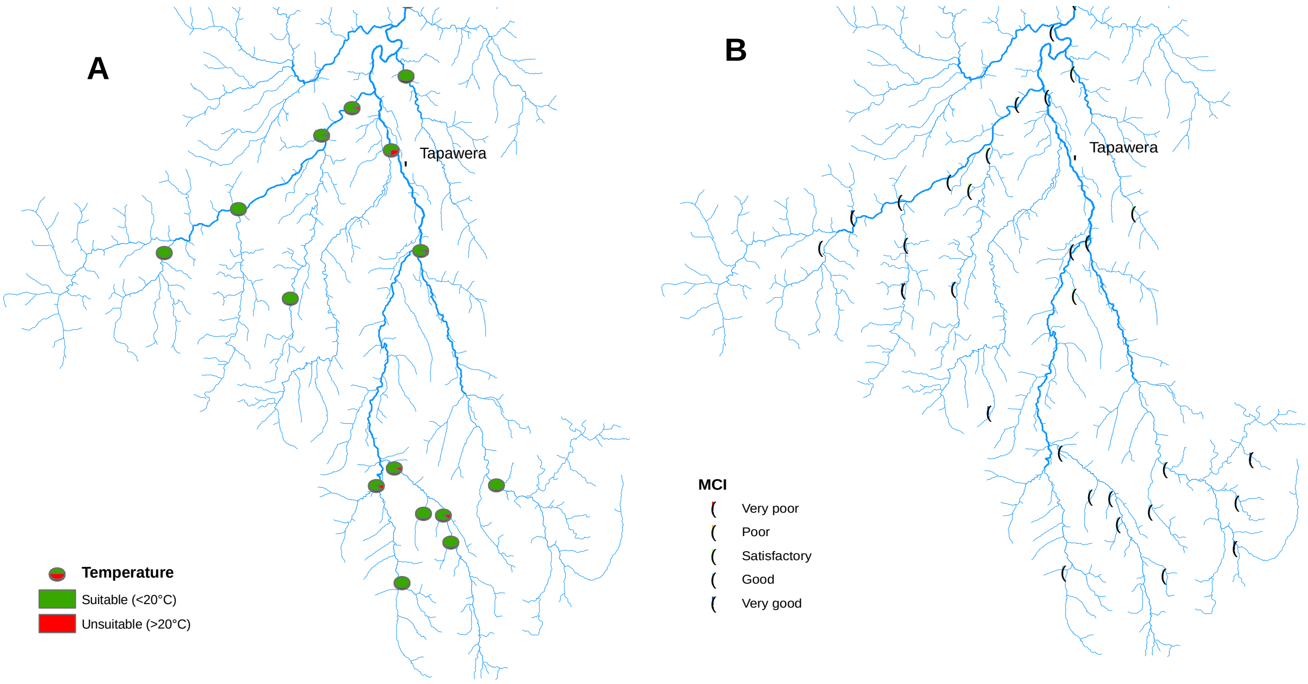

Figure 2 (A) Proportion of the summer period when temperature measurements exceeded criteria for ecosystem health. (B) Average macroinvertebrate community index (MCI) scores.

The long-term water quality dataset from the Gorge and Woodstock (sampled monthly since 1989) enables an assessment of trends over time. Most water quality parameters showed no trends. However, there was a significant increase in nitrate-nitrogen concentration at Woodstock from 1989 to 2005 (Figure 3). Fortunately, this rate of increase is relatively low (2.6% per year), and concentrations are typically below guideline limits for protection of ecosystem health (444 mg/m^3). Nevertheless, this trend in water quality should be considered in future resource management decisions in the Upper Motueka catchment.

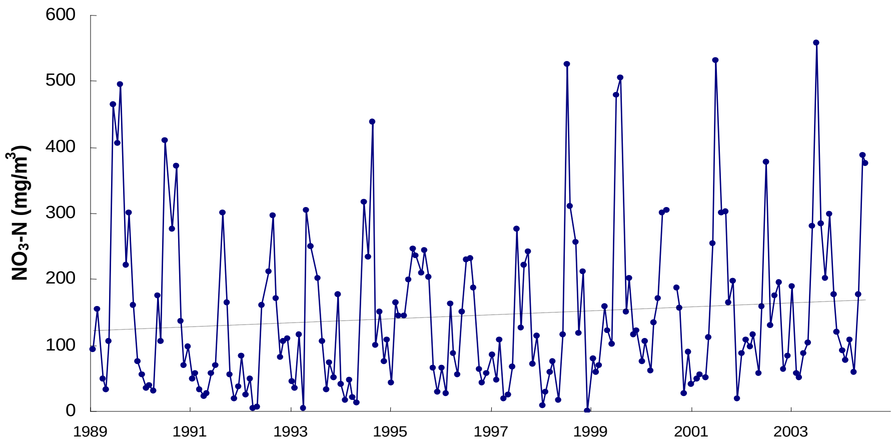

Figure 3 Increase in nitrate-nitrogen concentration at the Woodstock sampling site from 1989 to 2005.

3. FLOW-HABITAT MODELLING

A key question with water resources management is “How much water can be abstracted from a river without affecting the ecological, cultural, aesthetic and recreational values associated with that river system?” This is not a simple question, but there are a variety of methods that can be used to help guide decisions.

- Historic flow methods are the easiest to apply and use information from the existing flow regime to set minimum flows (*e.g.* 1-in-5 year low flow).

- Hydraulic methods require some field surveys and predict how depth, velocity and river width will change with flow. Flow management decisions can then be based on an acceptable degree of change in these parameters compared to the natural flows (*e.g.* < 10% reduction in river width).

- Habitat methods are the most sophisticated and relate changes in depths and velocities with the habitat requirements of particular species. However, these methods require intensive field surveys and still attract controversy regarding the interpretation of the model outputs. Using habitat methods, flow management decisions can be based on an acceptable change in the availability of suitable habitat for particular species (*e.g.* retain 90% of adult trout habitat available at the natural mean annual low flow). A special feature of habitat methods is that they can help to predict how an altered flow regime may actually improve habitat availability compared with the natural situation. However, this is only applicable in large swift rivers where reductions in velocity will benefit most species, including the ones with high flow demands.

Habitat methods were used in the negotiations involved with the Motueka Water Conservation Order to describe how habitat availability changes with flow in the middle and lower reaches of the Motueka River. However, until recently there has been no similar information to guide water resources management in the Upper Motueka Catchment. A 2-dimensional habitat survey was conducted on a 400 m long section of the Motueka River upstream of Tapawera. Flow measurements indicate that there are substantial losses of surface water to the aquifer in this reach of the river and therefore this section was considered to represent the reach that experiences the most pronounced effects of low flows.

Habitat availability for flow demanding species like adult trout, longfin eels and torrentfish was predicted to decline quite rapidly in this reach below about 4 m^3/s (Figure 4). In contrast, habitat availability for species that prefer shallow, slow water (*e.g.* dwarf galaxias and upland bullies) was predicted to increase as flows reduce (Figure 4).

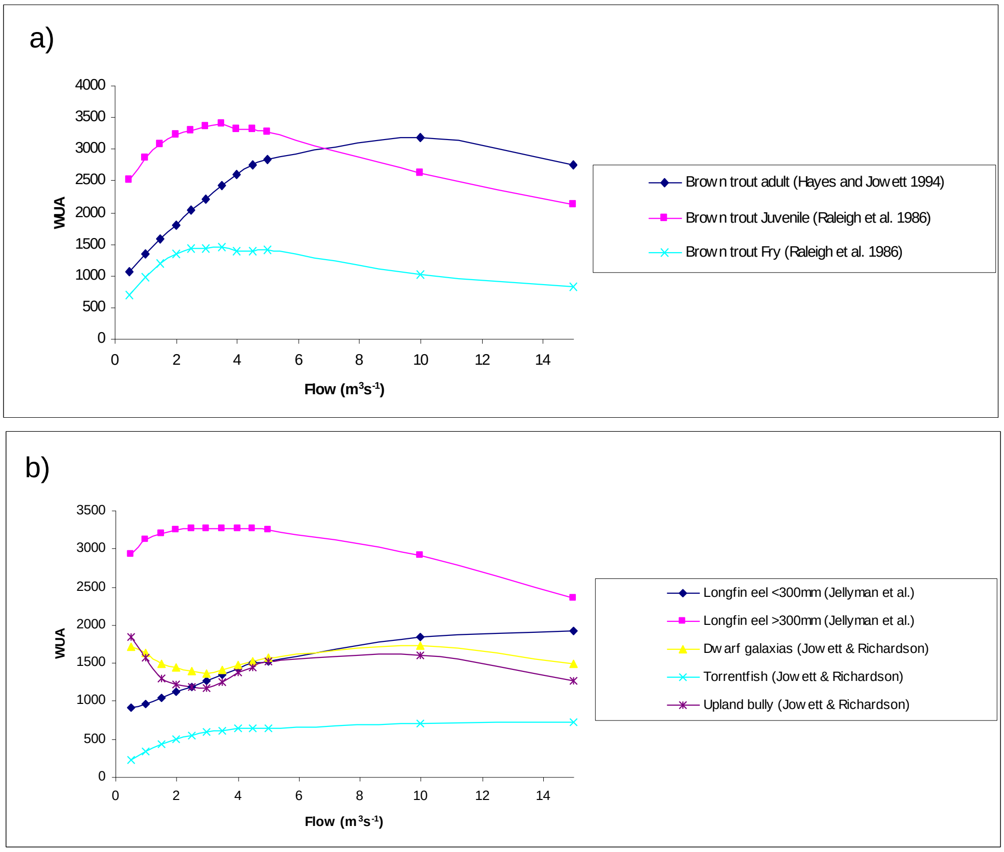

Figure 4 Predicted changes in habitat availability (WUA) for (a) different life stages of brown trout and (b) native fish species in the Tapawera reach of the Motueka River.

When setting minimum flows for instream values, the assumption is made that habitat availability at the minimum flow is a limiting factor. Choices also need to be made regarding which species or values are chosen as the critical ones to guide flow management. Candidates for critical value status include flow sensitive species, rare species, or species with high fishery value. In this case, habitat availability for adult brown trout is an appropriate critical value, since trout are sensitive to flows and the Motueka supports a highly valued trout fishery.

The final decision on an appropriate flow regime relates to what level of habitat availability should be maintained. The level of habitat retention is somewhat arbitrary since current scientific knowledge is not sufficient to identify levels below which impacts will occur. In reality, this choice is about risk management. The greater the value of the resource, the less risk is acceptable (*i.e.* highly valued instream resources warrant a higher level of protection than low values instream resources). A level of 90% habitat retention compared to natural flows is suggested for this reach given the high value of the Motueka fishery. This corresponds to a minimum flow of 1.2 m^3/s, compared with an estimated natural mean annual low flow of 1.55 m^3/s. If a 80% habitat retention level was chosen, the corresponding minimum flow would be 0.9 m^3/s, but there would be a greater risk of observing reductions in fish abundance.

4. FISH MOVEMENT AND IMPLICATIONS FOR HABITAT REQUIREMENTS

The results presented above regarding changes in habitat availability with flow are only relevant for parts of the river system. Fish and some invertebrates have the ability to move throughout a river catchment and seek refuge elsewhere if conditions at their present location are unsuitable. For example, some anglers consider that several tributaries of the Motueka (such as the Motupiko and Rainy) provide good fishing during October-December when flows are moderate, but poor fishing later in the season when flows are typically at their lowest. One explanation for this is that adult trout may move downstream and spend the height of summer in the lower Motueka where flows and water temperatures provide more favourable habitat. Therefore, it may not be appropriate to try and protect adult trout habitat in these tributaries during low flow periods if they typically find refuge elsewhere in the catchment.

To investigate this issue we radiotagged 49 adult trout in the Rainy and Motupiko rivers in September/October 2004 (Figure 5). There was a small amount of initial downstream movement by some fish prior to Christmas, but most of the trout that we were able to regularly relocate remained within the Motupiko River throughout the summer. Flows were relatively high throughout the summer of 2004/05, and these trout appeared to be content remaining in the larger deeper pools in the Motupiko. Only 3 fish were relocated in the Motueka River downstream of the confluence with the Motupiko.

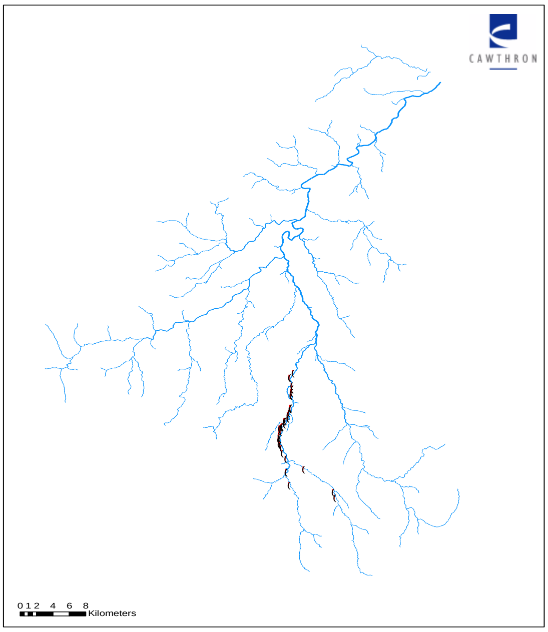

Figure 5 Initial release locations for the 49 radiotagged trout released in Sept/Oct 2004.

Unfortunately, we lost contact with almost half of the trout we had tagged, despite searching most of the catchment by plane on several occasions. It's not clear if the radiotransmitters failed, the trout were caught and removed from the river, or if the fish migrated beyond our search area. Transmitter failure seems most likely explanation. Interestingly, the 'Good Friday' 2005 flood had a big impact on the 22 trout that we knew were still alive and well in the Motupiko River. Almost 40% of them were definitely killed during the flood with radio signals coming from beneath gravel bars and debris jams, while a further 18% were not relocated after the flood and may have also perished.

The results from this study were not conclusive in terms of fish movements, although it does indicate that some adult trout can persist in the Motupiko over summer and probably depend on deep pools for habitat.

Further research related to this topic is underway in conjunction with a Masters student from Otago University (Ricky Olley). He is using the chemical composition of trout otoliths (or earbones) to try and determine patterns of fish movement. Otoliths continue to grow throughout the life of a fish and so record how old they are (Figure 6) and potentially where they've been. The initial results from this work look promising. Juvenile fish from the same tributaries have similar levels of strontium in their otoliths, but there are substantial differences among juveniles collected from different tributaries suggesting that it will be possible to define chemical signatures specific to different parts of the catchment. Results from some adult trout otoliths show large variations in chemical composition from the centre to the edge of the otolith suggesting pronounced migration over the life of these fish. Further analyses will hopefully enable a match between the chemical composition and likely location of fish during different stages in their lives.

Figure 6 A photo of a cross-section through an otolith from a 10 year old trout showing the annual growth rings.

5. GROUNDWATER-SURFACE WATER INTERACTIONS

As outlined in the separate report on the groundwater modelling, there appears to be some significant interactions between surface water and groundwater in the reach of the Motueka River between Kohatu and the confluence with the Wangapeka River. Measurements of river flow through this reach indicate increases in flow in some sections (*i.e.* gaining sections), and decreases in flow in other sections (*i.e.* losing sections). Cold upwelling groundwater could provide important refuges for fish and other stream life during low flow periods in summer when water temperatures are known to exceed guidelines for ecosystem health. To investigate this further we deployed temperature loggers in 2 sections that are considered to be gaining water and 3 sections considered to be losing water to determine if there are any broad-scale differences in the temperature regimes of these contrasting sections. We also deployed loggers in a groundwater well (Hyatts) and at the source of a springfed stream (Hinetai Hops) to measure groundwater temperatures for comparison.

The temperature regimes of the gaining and losing sections were very similar, indicating little broad-scale impact of groundwater inputs to the river. The only possible effect was slightly lower daily maximum temperatures (<2°C) in one of the gaining reaches near the mouth of the Tadmor River (Figure 7). This difference is unlikely to be ecologically significant.

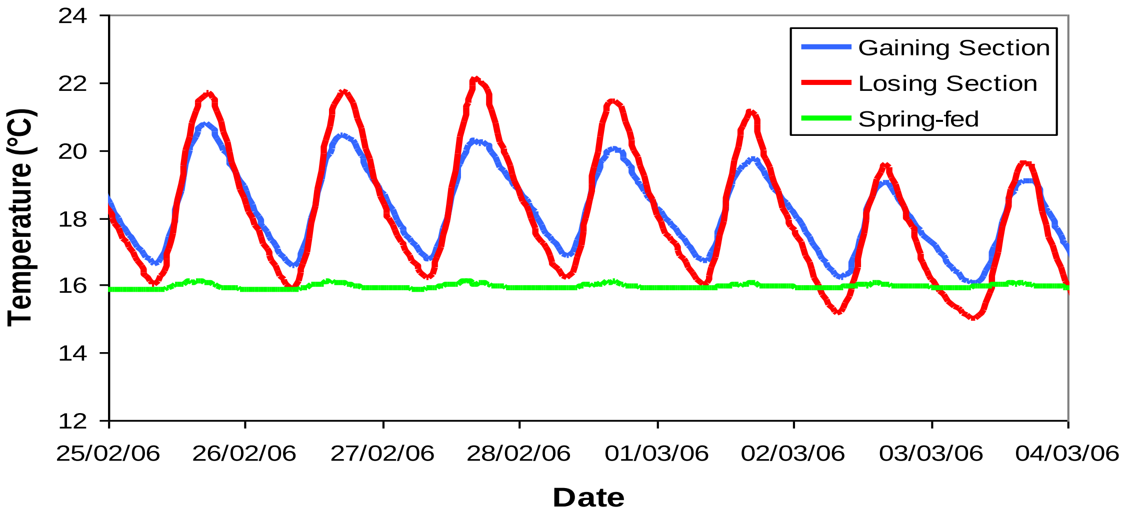

Figure 7 Contrasting temperature regimes between a gaining and losing section in the Motueka River near Tapawera. Temperatures from a spring-fed stream at Hinetai Hops are shown for comparison.

We also conducted some more detailed surveys of the reach looking for specific locations where cold groundwater was up-welling. We initially thought that groundwater may well-up into the bottom of deep pools, perhaps leading to a layer of cold water providing a refuge for fish. However, all the pools throughout the reach were well mixed with no indication of cold water near the bottom. The most substantial thermal variations were found in some remnant side-channels where water temperatures were up to 4°C colder than in the main river (Figure 8). The depth of many of these side channels means that they are unlikely to act as refuges for adult trout. However, they may provide important habitat for other species during warm periods. Large numbers of native fish were seen in some of these side-channels. It is not clear if the cold water entering these side-channels is true groundwater, or recent river water that has simply passed through gravel bars in the river bed.

Figure 8 Side-channel of the Motueka River receiving cold groundwater.

Surface water/Groundwater interactions are not large enough to result in large sections of the river acting as thermal refuges during warm periods. However, there are some side-channels in this reach that are significantly cooler than the main river water and may provide important habitat for some species. Some further work on 'What's living in these side-channels?' and 'Where the water entering these side channels comes from?' is planned for this summer.

6. SUMMARY

The Upper Motueka Catchment supports a wide variety of in-stream values and generally has good water quality. The main issues appear to be associated with intensive pastoral development leading to increased concentrations of faecal indicator bacteria and nutrients. A long-term dataset indicates that dissolved nitrate concentrations at Woodstock have increased slowly over the last 15 years. Water temperatures in some areas regularly exceed guidelines for ecosystem health. In the smaller streams this could be mitigated by promoting riparian plantings to increase shade.

There are a variety of methods that can be used to help guide decisions on flow allocation. A two-dimensional habitat survey was conducted on a section of the Motueka River near Tapawera to predict how habitat will change with flow in this reach. A 90% habitat retention level is suggested for this reach, which corresponds to a minimum flow of 1.2 m^3/s. There would be a greater risk of observing impacts at lower minimum flows.

Fish may migrate throughout the Motueka Catchment in response to changes in flow. Therefore, it may be pointless trying to maintain sufficient flows for some species if they typically find refuge elsewhere in the catchment. A radiotagging study of adult trout movement from the Rainy and Motupiko rivers was somewhat inconclusive regarding migration patterns. However, some adult trout remain in the Motupiko River throughout the summer and rely on deep pools for habitat. Further work using chemical tracing techniques is underway and showing promise.

Upwelling groundwater has the potential to provide cool-water refuges for aquatic life during the height of summer. Broad-scale measurements of the temperature regime in gaining and losing sections of the Motueka River between Kohatu and the Wangapeka confluence indicate that surface water/groundwater interactions are not large enough to result in large sections of the river acting as thermal refuges. However, there are some side-channels in this reach that are significantly cooler than the main river water and may provide important habitat for some species.

7. RECOMMENDATION

That Council receives this report.

Roger Young	Joseph Thomas
Freshwater Ecologist	**Resource Scientist**
Cawthron Institute	**Water/Special Projects**

STAFF REPORT

TO: Environment & Planning Subcommittee

FROM: Neil Tyson, Consent Planner - Water

REFERENCE: W326

SUBJECT: **UPPER MOTUEKA WATER METERING / WATER USER COMMITTEE - REPORT EP06/08/14 – REPORT PREPARED FOR 28 AUGUST MEETING**

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1. WATER METERING

Water metering by consent holders in Upper Motueka Zone (UMZ) was signaled by Council in Schedule 31.1B PTRMP with an implementation/meter installation date of 2006. The policy basis for water metering is set out in Policy 30.2.11 of the Tasman Resource Management Plan (PTRMP) and states:

a) to ensure compliance with permit allocations or allocation limits; or

b) when there is full allocation of water in a zone; or

c) when there is a need for water use data to assess effects of abstraction on a water resource or in relation to an allocation limit; or

d) in any zone where there is a rationing trigger.

All the above apply in the UMZ where there is an operative Water Conservation (Motueka River) Order 2004 and where the allocation limit for three of the four subzones has now been reached as can be seen in the following table.

Table 1:

UPPER MOTUEKA ZONE		
ALLOCATION STATUS (JUNE 2006)	ALLOCATION LIMIT	CURRENT
Wangapeka Subzone	265	265
Motupiko Subzone	110	110
Tadmor Subzone (total augmented flow)	56	56
Tapawera Plains Subzone	515	395
Unnamed Subzone (inc Baton, Dove to)	54	105
	1000	931

From Table 1, the total allocation for the UMZ under the PTRMP is 1000 l/sec. The Dove catchment, Stanley Brook, Baton and the small area down to Woodstock also fall within the UMZ. Including all current water permits, 931 l/sec (+/-10 l/sec) of the 1000 l/sec is currently allocated as of June 2006. Since then three additional consents have been granted and two-four applications are pending (e.g "further information" status) in the Tapawera Subzone. In other words, we are close to full allocation in the UMZ if the Dove catchment, where consents total approx 95 l/sec, continues to be included.

Accurate and timely water meter data is an essential tool in managing the District's valuable and limited water resource. The information is used for:

- Management of the districts water resources and improving/enhancing future understanding of the system;
- Monitor the effectiveness and suitability of the policy provisions within the TRMP and the exercise of resource consents;
- Bona fide review/renewal of existing consents; and
- Compliance with drought restrictions

Where meters are not already installed, they are required for all consented takes in the UMZ by 1 October 2006, in time for this 2006/7 summer. The need for meters was confirmed when the majority of UMZ water permits expired and were renewed during 2004, and consent conditions to this effect were imposed at that time. Approximately eight consents did not expire in 2004 as they have 2026 expiry dates under the RMA.

During 2006, staff wrote to all UMZ consent holders reminding them of the water meter requirement and advising that no exceptions or exemptions had been granted. This letter also included an invitation to consent holders still requiring a meter to contact Council staff if they wanted to be involved in a bulk purchase of meters which Council staff offered to arrange. Bulk buying has been common practice where metering is proposed in a new zone. Staff visit the users who express an interest and identify the optimal location for a meter and the meter size required. Staff then collate the numbers and arrange for the bulk purchase of meters through a local supplier. Incidentally, the invitation was extended to new consent holders in the Wai-iti Dam Service Zone (WDSZ). Of the potential 100 or so meters required for both (ie UMZ and WDSZ) zones, 18 meters were ordered through this process and these will be available for installation prior to October 2006.

The bulk buy process is considered win-win, as users obtain meters at a good price and Council benefits in that we get a good quality meter that complies with the Council's *Water Meter Specifications* as stated in the PTRMP.

2. METER INSPECTIONS AND DATA COLLECTION

Prior to summer 2006, users will be posted forms for recording weekly meter readings. These forms are then required to be returned (postage paid) each month, November to April inclusive. Even if consent holders are not irrigating they are asked to advise via a NIL USE form so that Council has a complete record and compliance action doesn't result.

Once the meter is installed, a Council staff person will call to check the installation and meter details. Users don't need to be present for these checks unless the meter is in a locked shed or otherwise difficult to locate.

This summer water users will have a great tool for getting the best out of their irrigation system and Council will get accurate data on actual water use.

3. (UMZ) WATER USER COMMITTEE

Water Rationing in the UMZ requires consultation with the Upper Motueka Zone Water User Committee regarding possible water rationing when the flow of the Motueka River at Council's Woodstock recorder site falls to 7,500 litres per second.

Rationing in the UMZ pursuant to the WCO and the PTRMP, requires actual consumptive use to not exceed 12% of the flow at Council's Woodstock recorder and, for Wangapeka users, to not exceed 6% of the flow at Council's Walters Peak recorder. In fact, when the Tapawera Subzone becomes fully allocated, Step 1 is unlikely to be triggered earlier than a 12 year low flow (approximately 6,250 litres per second). Until full allocation is reached, rationing will occur less frequently than this. To implement rationing, Council needs to review total allocations in each zone at least annually to determine the river flow at which rationing would be triggered and this trigger flow needs to be made available to the user committee and permit holders prior to the irrigation season.

The meeting of UMZ users planned for 7.00pm, 28 August 2006, Tapawera Community Centre, is therefore both timely and opportune as it provides for an election of user representatives for the UMZ, with the aim of representation from each subzone.

Under Policy 30.1.26 PTRMP, Council encourages and supports the functioning of water user committees in water management zones with representatives, as appropriate, from abstractive users, iwi, dischargers of contaminants, those affected by the water extraction or diversion, and those with an interest in instream uses and values, including the Department of Conservation and the Nelson Marlborough Fish and Game Council, to:

a) advise the Council in the development and implementation of water management policies;

b) assist the Council in managing water usage during drought periods, including assistance with rationing or rostering arrangements;

c) assist the Council in implementing programmes of education and advocacy for good practice methods of water use;

d) assist the Council in the development of water classification standards

It is understood the current water user committee was elected in 1999.

N Tyson
Consent Planner, Water