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Wairarapa Groundwater Model update

1. Purpose

To provide an update on progress with the Wairarapa groundwater investigation, summarising key preliminary findings from the first of three computer models developed for the Wairarapa valley.

2. Background

Groundwater is an important resource in the Wairarapa. It is intrinsically linked to many river and stream systems and supports numerous groundwater dependent ecosystems such as springs and wetlands. It is also important for public water supply, domestic use, stock water supply, irrigation and industry.

Demand for groundwater in the Wairarapa has increased rapidly over the last decade (Figure 1) with the total allocation from aquifers more than doubling during this period. Nearly half of the Wairarapa's groundwater zones defined in the Regional Freshwater Plan (RFP) are greater than 60% allocated.

The increase in demand for groundwater, coupled with a possible decline in groundwater levels in some areas – and potential effects on groundwater-dependant ecosystems – has led to a need to investigate the appropriateness of the allocation limits specified in the RFP. Consequently, a comprehensive review of the Wairarapa groundwater system commenced in 2006 with the view of providing a sound scientific platform for the review of groundwater allocation limits and management objectives.

The Wairarapa groundwater investigation has involved three distinct phases. Phase 1 involved a review of the entire Wairarapa valley groundwater system, culminating in the production of a snapshot model for the valley and a report, completed in late 2006 (see Report 07.136). Recommendations from Phase 1 were implemented through 2007 and 2008 with the Wairarapa valley broken into three detailed areas for computer modelling (Figure 2).

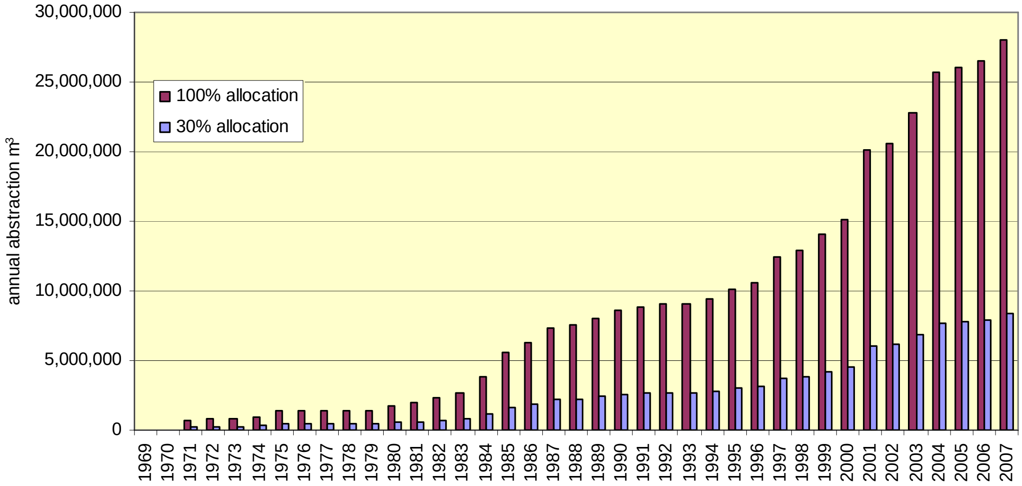

Figure 1: Consented groundwater takes in the middle Wairarapa valley 1969–2007 (the blue and maroon bars represent average estimates of the volumes of water actually used and consented respectively).

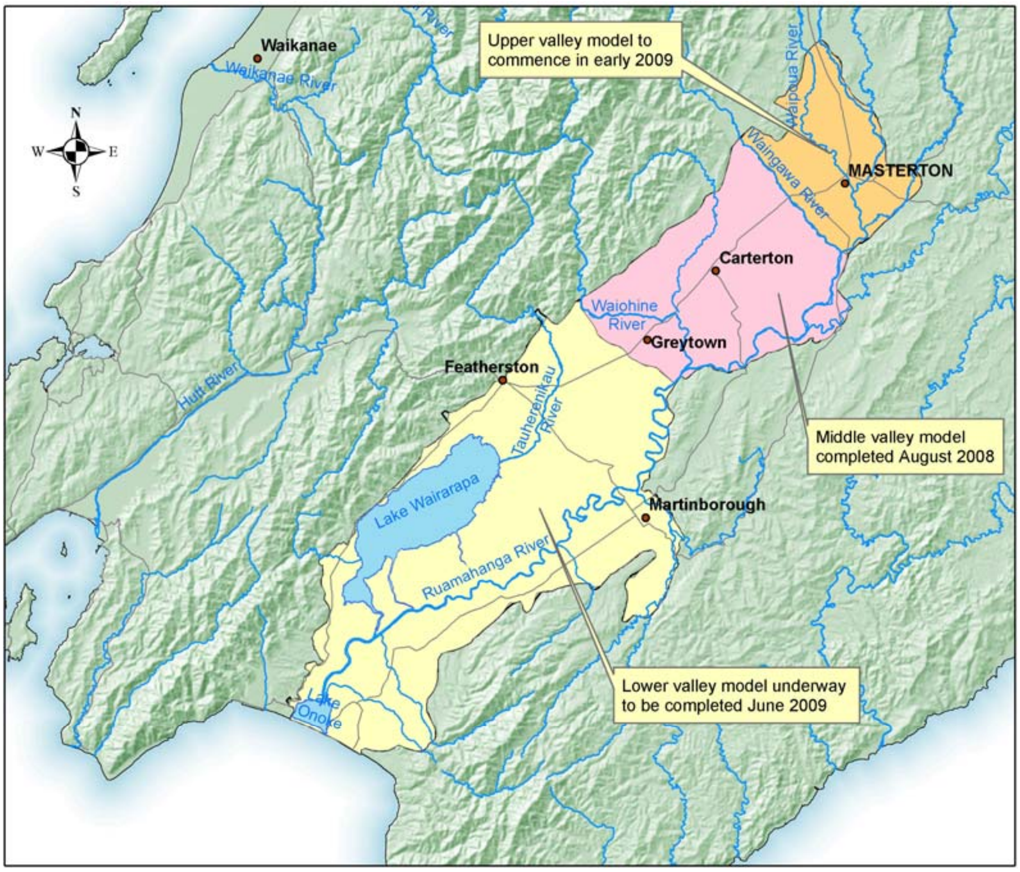

Figure 2: Location of the three modelling areas in the Wairarapa valley. The model areas are defined by groundwater boundaries that are similar in principle to river catchment boundaries. Each area comprises multiple groundwater zones (as defined in the RFP)

Phase 2 of the investigation involves the development of detailed computer models for each of the three areas shown in Figure 2. The model for the middle valley area has recently been completed and the remaining models are scheduled for completion by June 2009.

Phase 3 of the investigation will involve utilising the developed model outputs in groundwater management policies when the RFP is next reviewed.

3. Middle valley model

A computer-based groundwater model has been completed (calibrated) for the middle area of the Wairarapa valley. This area, like the remainder of the valley, consists of a very complex geological environment. Numerous faults and structures have deformed the area, modifying the way water flows in the environment (Figure 3). In many ways the aquifer system in the Wairarapa is more complex than other New Zealand areas of intensive groundwater use such as the Canterbury Plains.

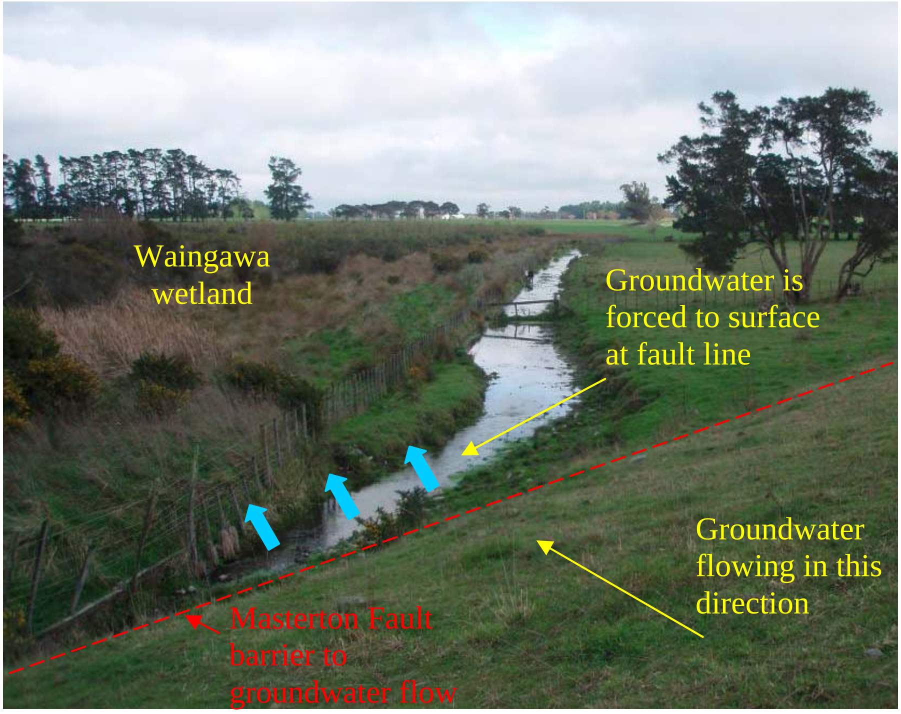

Figure 3: The Waingawa Swamp, a QEII covenanted wetland located south of Masterton, provides an example of the Wairarapa's complex geology. The Masterton Fault line (red line) is clearly visible as a small hill and forms a barrier to subsurface groundwater flow from right to left across the photo, forcing water to the surface at the fault and forming the wetland area.

A significant amount of field work has been completed over the last eighteen months to support the development of the model. This included the drilling of 11 new monitoring boreholes (Figure 4), a seismic geophysics survey, isotope chemistry sampling to determine groundwater age, a springs survey and the reading of meters on water takes.

The middle valley groundwater model has been developed using the best available data; it can and should be refined in the future as new data become available. The model is three-dimensional (Figure 5) and takes into account groundwater inputs (rainfall leakage through the soil zone and river bed leakage) and outputs (groundwater discharging to rivers, springs and wetlands) through time. The current model simulation runs from 1992 to 2007.

Figure 4: Example of recent field work with the drilling of a new monitoring borehole at Poterau Spring in the Te Ore Ore east of Masterton. The groundwater-fed stream in the foreground has been progressively drying up during summer months from year to year due to lowering groundwater tables. This new borehole and others installed across the valley will help improve our understanding of the complex connections between groundwater and surface water.

Water quality data played an important role in developing the model, including helping to age the water within various aquifers. Some groundwater was found to be less than a year old while water in many deeper aquifers is considerably older (>150 years), highlighting the sometimes long timeframes for aquifer water to get from rainfall to the paddock.

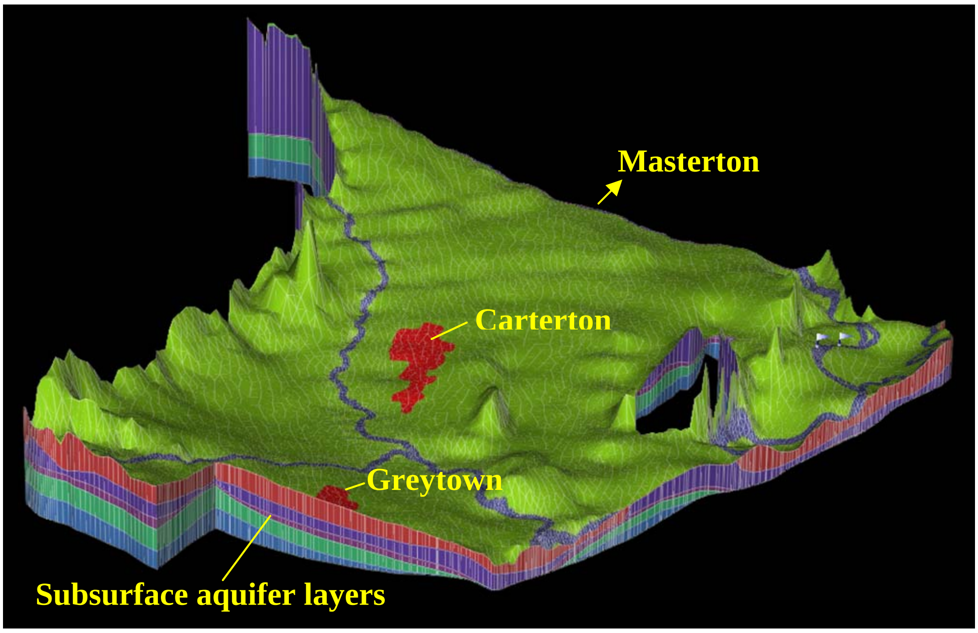

Figure 5: Three-dimensional visualisation of the produced computer model showing the “layer cake” of aquifers present in the middle Wairarapa valley.

4. Model results

The developed computer model is being used initially as a tool to test various water abstraction scenarios. By adjusting the groundwater abstraction rate in the model we can simulate the effects on groundwater levels or river flows through time.

The developed model has been run for four different scenarios to test the appropriateness of current allocation limits in the RFP. The four scenarios were:

1. No groundwater pumping – simulation of the natural state (i.e., no water abstraction).

2. Current groundwater use – our best estimate of current and historical consented groundwater usage 1992–2007 (15% to 40% of consented volume depending on how wet each year was).

3. 100% consented use – as if all consented abstraction was actually withdrawn from aquifers.

4. 100% safe yield – testing what would happen if all groundwater volumes quoted in the RFP were actually consented and abstracted from the ground (i.e., the worst-case scenario).

Results of modelling show that if the RFP aquifer safe yield volumes were consented and actually abstracted, significant effects would result (up to 2.5 cubic metres per second reduction in surface water flow in rivers in the middle valley during critical dry summer months). This can be demonstrated with modelled output flows in the Mangatarere Stream, located west of Carterton (Figure 6). The Mangatarere Stream and its tributaries have significant groundwater inputs and outputs, with groundwater maintaining a significant proportion of flow in the lower Mangatarere Stream during summer periods. Figure 6 shows the results of the four scenarios discussed above. The worst-case scenario (red line in Figure 6) results in a stream flow well below the minimum flow[1]; this highlights that at full use the groundwater system is over-allocated.

Future modelling scenarios will involve working back from minimum flows in rivers, streams, springs and wetlands to establish safe groundwater yields. Further down the track the model will be valuable in testing various climate change scenarios and the impact of these on the Wairarapa groundwater resource. For example, a predicted decrease in precipitation can be taken into account by adjusting the model’s rainfall input thereby simulating the effects reduced rainfall on groundwater levels or river flows through time.

[1] Note this is an “indicative” minimum flow as it applies to the flow measured in the Mangatarere Stream at the Gorge and is applied to the flow in the stream at Belvedere Road.

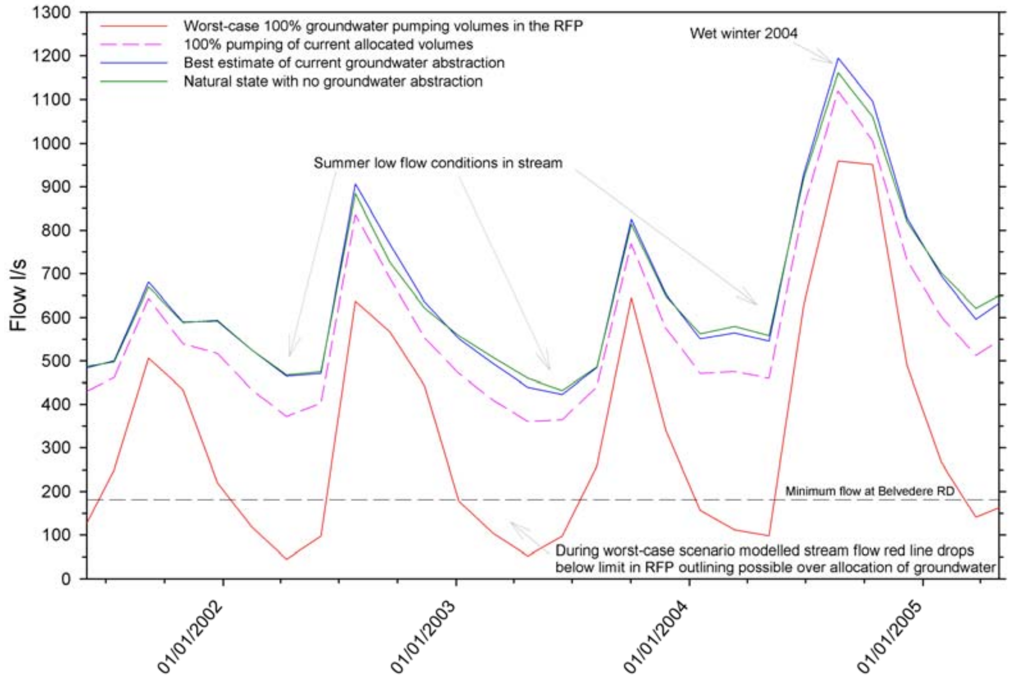

Figure 6: Preliminary results from four modelled scenarios showing groundwater inputs to the Mangatarere Stream, near Carterton. Note the worst-case scenario shows that stream flow may fall well below the current indicative minimum flow for the stream.

5. Synthesis

The first of three groundwater models for the Wairarapa valley has been successfully completed, enabling different climatic and water abstraction scenarios to be tested for the middle valley area. Work will continue on the other two model areas during 2008/09; the Upper and Lower valley areas.

Work is also being undertaken to integrate developed groundwater and surface water models to enable a better understanding of the interaction between groundwater and surface water systems. Coupling groundwater and surface water models in a project like the Wairarapa Groundwater Investigation is a very complex task and represents new modelling territory in New Zealand.

Preliminary groundwater modelling results for the middle valley area suggest that safe yields for some groundwater zones in the Wairarapa may be set too high. Further work is required to confirm whether this is the case and, if so, to determine more appropriate allocation limits.

6. Communication

A number of technical reports have been prepared on the Wairarapa Groundwater Investigation to date. Further reports on each of the detailed model areas are scheduled for publication in June 2009. As well as progress committee reports, news articles are released periodically to keep the public informed of the work. The next community update will appear in this month's *Rural Service Newsletter*.

7. Recommendations

It is recommended that the Committee:

1. ***Receives** the report; and*
2. ***Notes** the contents.*

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		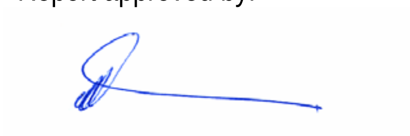
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