Date: 6 October 2009

To: Karen Wilson, Environment Southland

From: Vince Bidwell, Lincoln Ventures Ltd

Subject: **Eigenmodel analysis of Riversdale aquifer and stream depletion model**

This is a brief report on the results of applying the eigenmodel approach to dynamic analysis of groundwater level data from the Riversdale Aquifer, and application of the calibrated eigenmodel to stream depletion effects.

This report addresses results in the Excel spreadsheet *Riversdale eigenmodel.xls*, which contains the following worksheets:

- *L S recharge*: daily values of land surface recharge have been calculated from Riversdale rainfall and Penman PET, supplied by Environment Southland, for the period 4/12/2002 to 30/06/2009.

- *Eigenmodel*: simulates the response of groundwater level data (F45_0181) to the land surface recharge series.

- *Eigenmodel plot*: shows the model results. Half the data are used to calibrate the model, and half to demonstrate prediction performance.

- *Abstraction effects*: is a different form of eigenmodel used to predict stream depletion effects from pumped abstraction at a point. The model dynamic parameter is linked to the results from the *Eigenmodel* sheet. Pumping duration and location (yellow highlight) can be varied. The pump location *a/L* is the proportion of distance from the aquifer no-flow boundary to the surface water boundary.

- *Effects plot*: shows the graph of stream depletion response as a proportion of a steady pumping rate for a specified duration.

Discussion of results

Eigenmodel
The Riversdale aquifer has a hydraulic residence time of about 134 days (green highlight), so there is storage capacity only for 'within season' smoothing of pumping effects.

Eigenmodel plot
The most severe departures from model predictions are for periods of low groundwater level during summer. This demonstrates the effect of existing abstractions, which have not been simulated in the model. There are other prediction errors associated with modelling of land surface recharge. Some of these are possibly because recharge from existing irrigation is not taken into account.

Effects plot
The example plot shows that for 150 days steady pumping and *a/L* = 0.5 (middle of the aquifer) the maximum instantaneous depletion factor is about 0.7 of the pumping rate. By

setting a/L = 0.0 (pumping most remote from surface waters), the depletion factor is still above 0.6 for 150-day pumping.

The calculated stream depletion is a bulk effect on all the connected surface waters. Particular surface waters may be more or less sensitive to depletion, as you have noted in your reports.

General comments

The eigenmodel approach has a number of options that can be invoked to address particular policy issues. Some of these include multi-zone recharge inputs, including irrigation drainage and pumping, for example. Approximate methods can be used for aquifers with sparse data to obtain useful information for policy decisions.