PATHWAYS FROM LAND TO STREAM – LESSONS FROM PUKEMANGA

Vince Bidwell[1*], Roland Stenger[2] and Greg Barkle[3]
[1]Lincoln Ventures Ltd, P O Box 133 Lincoln, Christchurch 7640
*email: bidwellv@lvl.co.nz
[2]Lincoln Ventures Ltd, Private Bag 3062, Hamilton 3240
[3]Aqualinc Research Ltd, Private Bag 14041, Hamilton 3252

The pathway taken by water from the land surface to a receiving water body is a major determinant of the resulting water quality. In the case of agricultural land use, phosphorus sorbed onto soil particles is usually transported by overland flow whereas nitrogen in solute form is leached by water that has passed through the soil profile. Most of this soil-drainage water, containing nitrate-nitrogen, is considered to enter groundwater before ultimately discharging to streams and other surface waters. Streamflow is maintained most of the time by groundwater discharge that can contain nitrate, and thus there is significant opportunity for stream ecology to be affected by water that has travelled by the groundwater pathway from land surface to surface waters.

Experimental observations at the 3 ha land surface catchment of Pukemanga Stream provided the opportunity to quantify the relative contributions of groundwater discharge and near-surface runoff to streamflow. This catchment on the Whatawhata Hill Country Research Station is steep (slopes up to 60°) and receives mean annual rainfall of about 1700 mm. The observations comprised: seven years of daily values and two years of hourly values of rainfall, PET, and streamflow; and 18 months of hourly groundwater level measured in a 30 m-depth (deep) well on a hillslope and a 5 m-depth (shallow) well near the stream.

The analytical approach was based on a hydrometric model that partitions drainage from the land surface into near-surface flow and recharge to groundwater, and then describes groundwater discharge to Pukemanga Stream in terms of the dynamics of a simplified aquifer. The resulting dynamic behaviour is compared with the record of groundwater level observations.

The results show that:

- About 40% of the topographical catchment contributes groundwater to Pukemanga Stream. The remainder probably flows into Kiripaka Stream for which Pukemanga is a tributary.
- About 85% of drainage from the land surface is recharge to groundwater. The associated maximum vertical hydraulic conductivity is 3.4 mm h^{-1}. The remaining 15% of drainage is ascribed to surface runoff and near-surface interflow.
- The dynamics of water levels in the deep (Figure 1) and shallow wells conform to the dynamics of predicted groundwater discharge as the baseflow of Pukemanga streamflow.

The implications for nutrient pathways from land use to effects on streams are:

- Nitrate-nitrogen leached from the soil profile is transported via groundwater that supplies most of the streamflow, most of the time.
- The topographical catchment does not necessarily coincide with the groundwater catchment supplying most of the flow to a particular stream.

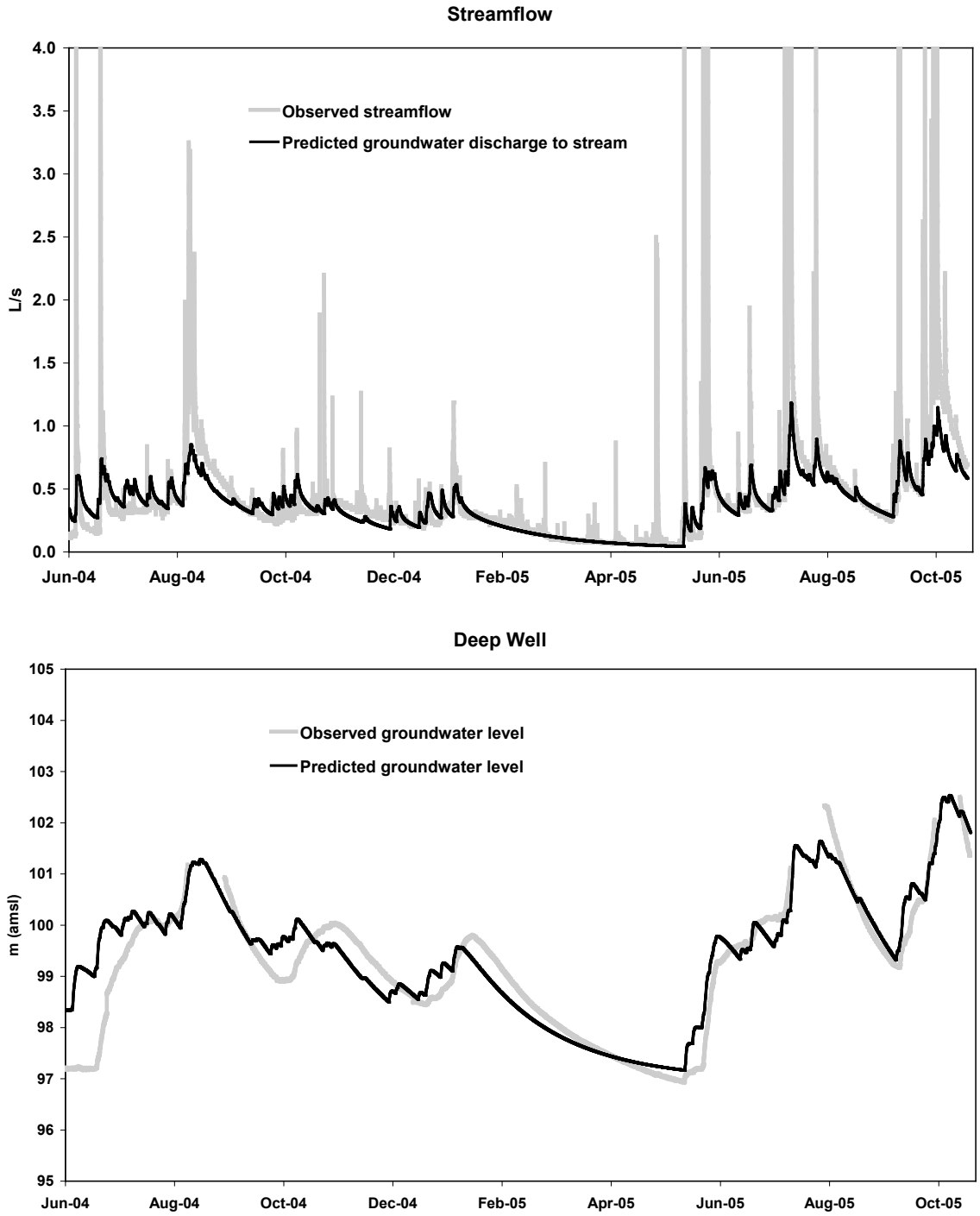

Figure 1. Streamflow and groundwater level observations at Pukemanga Catchment, with predicted groundwater discharge and groundwater levels from a dynamic hydrometric model.