Investigating the Transport and Fate of Nitrogen from Farms to River in the Lower Rangitikei Catchment

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Abstract

A sound understanding of the transport and fate of leached nitrate-nitrogen (NO_3^--N) in shallow groundwater is key to understanding the impacts of land use intensification on the quality of groundwater and surface water bodies. However, these are not well understood in the Lower Rangitikei catchment. This study was undertaken to assess the groundwater flow pattern and its interactions with the Rangitikei River; the redox conditions of the groundwater; and the extent of NO_3^--N attenuation in shallow groundwater in the Lower Rangitikei catchment.

Groundwater depths were collected from more than 100 wells to map the piezometric surface to inform the groundwater flow pattern within the study area. Groundwater interactions with the Rangitikei River were estimated qualitatively from two longitudinal river flow and water quality surveys (on 6th and 20th January 2015) under low-flow conditions. Fifteen wells were sampled and analysed in the study area during December 2014 to characterise the groundwater redox condition. A total of nine piezometers were installed at a range of depths (3 m and 6 m) on two dairy farms (sand country and river terrace) and one cropping farm (sand country). In these piezometers, NO_3^--N, dissolved oxygen (DO) and other parameters were monitored over March, April and May 2015. Single-well push-pull tests were used to measure NO_3^--N attenuation in shallow groundwater during May 2015.

Groundwater flow was largely influenced by the regional topography, particularly shallow groundwater (<30 m), where it flows from elevated areas such as Marton in a southerly direction towards the Rangitikei River. The longitudinal river flow and water quality surveys revealed a dynamic relationship between the river and the underlying aquifer. The surveys suggested groundwater discharges into the river both upstream and downstream of Bulls. The groundwater redox characterisation showed generally anoxic/reduced groundwater across the lower Rangitikei catchment area. Groundwater typically has a low DO concentration (<1 mg/L) with elevated levels of available electron donors, particularly dissolved organic carbon and Fe^{2+}. These groundwater characteristics provide for generally favourable conditions for NO_3^--N reduction. Monitoring at the installed piezometers

showed a generally low NO_3^--N concentration at these sites. The push-pull tests revealed NO_3^--N reduction occurring at all three sites, with the rate of reduction varying between 0.04 mg N L^{-1} hr^{-1} to 1.57 mg N L^{-1} hr^{-1}.

These results suggest that groundwater is likely to be connected with the Lower Rangitikei River. However, NO_3^--N concentrations in the river and groundwater were generally low, especially for the river at low flows. This suggests NO_3^--N may be undergoing reduction within shallow groundwater before it has a chance to seep into the river. Further evidence for appreciable levels of NO_3^--N reduction in the shallow groundwater is provided by the redox characterisation of reduced groundwater and the push-pull tests. However, more spatial and temporal surveys and *in-situ* measurements of denitrification occurrence in the shallow groundwater of the study area are required.

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