Chapter 34: Wairau Lagoon Catchment Groundwater

Introduction

The Wairau Lagoons are a series of estuarine wetlands located on the southern margin of the Wairau Plain. The catchments of Utawai, Seventeen Valley and Pukapuka Streams, along with numerous smaller waterways, all drain to the lagoons. Due to the low rainfall and underlying geology, all of the waterways are ephemeral and dry up throughout the summer months. Localised riparian aquifers fed by these ephemeral streams, are the only reliable source of water supply for the Wairau Lagoon Catchments in summer.

The larger and more significant Riverlands Aquifer occurs in the same area. It however, is located at depths of greater than 30 metres below the surface.

The north facing slopes of the area have proven popular for the development of vineyards and subdivisions over recent years. This development has increased the demand for water in the area.

Geology

The geological terrain eastward of Blenheim to Cape Campbell, is dominated by conglomerates of either marine or freshwater origin. The ridgelines are steeper and the underlying sediments are older, more cemented, and weathered than those that form the Southern Valleys.

The most permeable aquifer forming gravels are found closest to the surface and associated with sediments that have been recently deposited by streams. Deeper sediments are likely to be more poorly sorted and less permeable, making them poorer aquifers.

The alluvial deposits in the Wairau Lagoon Catchments were created by small low energy streams. The low energy of these streams means that the sediments have not been well sorted and therefore have a low permeability (Fig. 34.1).

The Wither Hills form the low range to the south of the Wairau Lagoons, Blenheim and the Riverlands area. They comprise of poorly sorted greywacke gravels and clays belonging to the Hillersden Formation. They were originally laid down as a terrestrial deposit as opposed to the hills further east forming the Redwood or Weld Passes, which are predominantly of marine origin.

The area to the south-east closer to the Awatere River catchment is made up of Wairau Conglomerate or Upton Formations, which contain marine fossils and large boulders up to 0.8 metres in diameter (Fig. 34.2).

The recently updated Wellington geological map of the area (Begg and Johnson - 2000) shows the presence of many faults trending mostly south-west to north-east. These faults make the geology complex and may influence groundwater flow. The Vernon Fault is the most significant and runs along the south-eastern edge of the Wairau Lagoon out to the White Bluffs (Fig. 34.3).

A cross-section of the local geological strata has been developed based on records from two wells in the Lower Seventeen Valley area, and three wells in the Utawai Creek Catchment (Fig. 34.4). These are relatively deep wells by Wairau Plain standards and show the local geology is variable over short distances and depths. The potential aquifer forming recent river gravels and conglomerates are of the order of 50 metres thick in the lower reaches of Seventeen Valley near the road-rail overbridge. At this depth underlying greywacke sandstone rock was intercepted by well 4649. Further south, well 4174 was originally drilled to a depth of 70 metres and intercepts marine sediments in its lower levels as indicated by the presence of shells. The nearby well 4696, was originally drilled to a depth of 58 metres and intercepts marine derived material of the Upton Formation.

The fine grained clays underlying the Wairau Lagoons are likely to have subsided by the order of tens of

Figure 34.1: Utawai Stream alluvial deposits.

Figure 34.2: Outcropping Upton Formation - Redwood Pass.

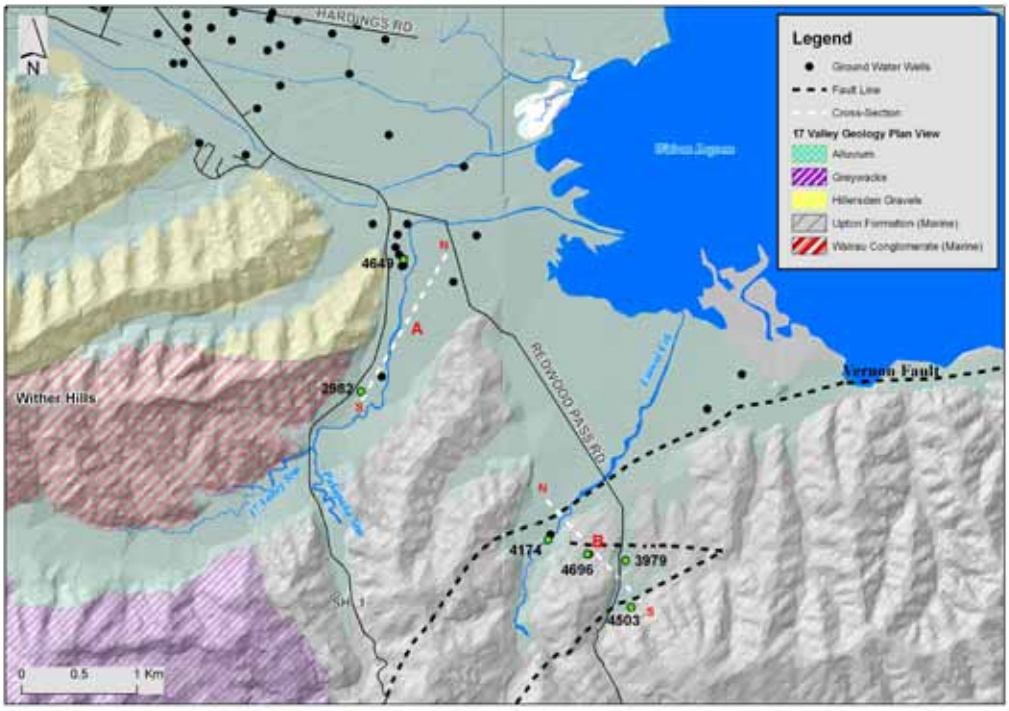

Figure 34.3: Geology and faults

metres over geological time (Ota et al - 2000). Sudden subsidence is likely to have occurred as a result of liquefaction during earthquake events such as the one that occurred in 1848. But the magnitude of the subsidence reflects a more gradual, ongoing process, involving the slow compaction of the compressible marine clays underlying the Wairau Lagoon and Lower Wairau area (Ota el al - 2000). The depth to basement may vary due to faulting at different sites.

Groundwater systems

Well depths vary from less than 10 metres to around 70 metres. The shallower wells tap the riparian type aquifers linked to streams, while the deeper wells source water from various buried lenses. The most productive strata are associated with shallow wells tapping the gravels linked to channel flow in Utawai, Seventeen Valley or Pukapuka Streams. This is only the case when there is surface flow to recharge the gravels. Where there is no stream flow, the yield of wells tapping these riparian gravels is likely to fall off rapidly because of their limited extent and low storage.

The distribution of groundwater within the conglomerate formations themselves remains uncertain. Their claybound geology precludes them from being anything but marginally economic aquifers. Well yields may be adequate for domestic needs, but are unlikely to be capable of providing enough groundwater for irrigating crops.

The water bearing lenses intercepted by drilling to date, have occurred at depths of greater than 20 metres below the surface. There are few patterns to their distribution and no discrete aquifers that occur universally throughout the area. Deeper water bearing lenses appear to occur at variable depths rather than as a single discrete aquifer. This lack of continuity reflects the heterogeneous nature of the conglomerate material and subsequent faulting.

Recharge and flow patterns

Streams in the Wairau Lagoon area are ephemeral and all channel flow in the lower reaches is lost to groundwater during summer. Recharge from streams and rainfall

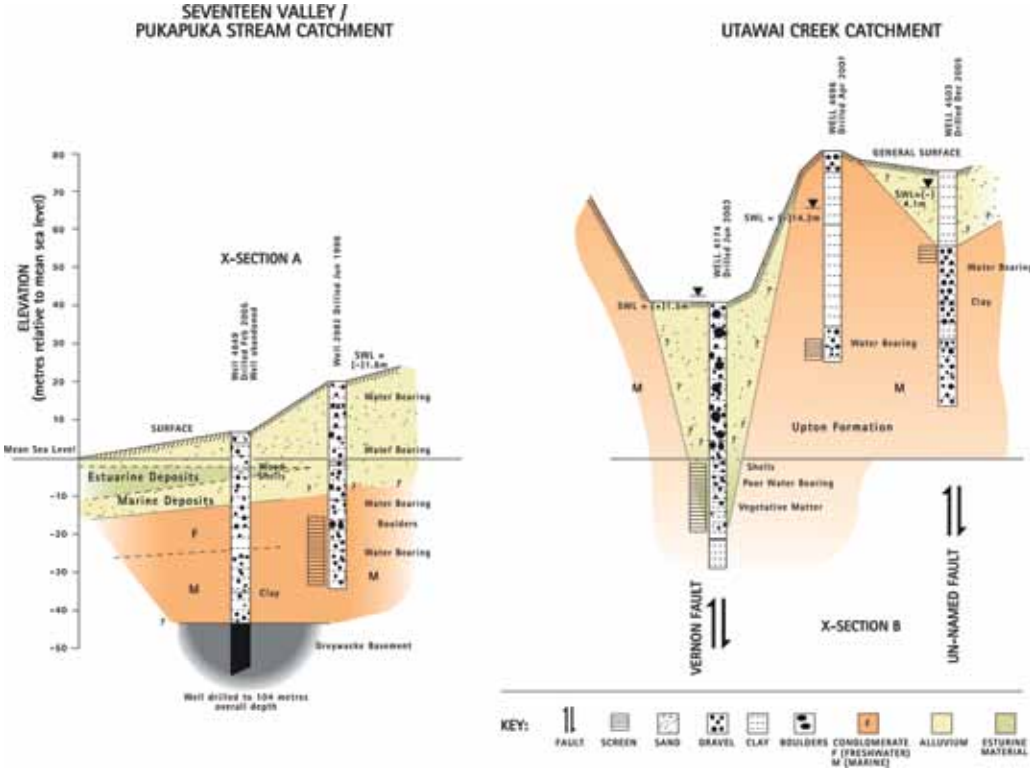

Figure 34.4: Geological x-sections

will top up riparian aquifers quickly, but is likely to take longer to reach deeper aquifer layers due to the low permeability of the geology.

An analysis of environmental isotopes shows the groundwater from well 4174 to be at least 200 years old, and possibly significantly older (Morgenstern & van der Raaij – 2007). The water contains methane which indicates advanced reducing conditions, limited contact with the atmosphere and probably a confined structure. This is consistent with the artesian static pressure and lithology recorded by the driller.

The $\delta^{18}O$ ratio of the groundwater in well 4174 is -9.52 $^{0}/_{00}$, which is significantly more negative than present high-altitude Wairau River water or rainfall derived groundwater. This indicates paleo-water recharged in a cooler climatic period (Morgenstern & van der Raaij – 2007).

Hydraulic properties

The Wairau Lagoon aquifer sediments consist of relatively impermeable claybound gravels or clays, which by their very nature don't store or transmit groundwater easily. Transmissivity values derived from well drillers productivity tests range from 1 to 2 m^2/day. The yield of wells drilled to date are an order of magnitude lower than those of the Southern Valleys Aquifers. This makes them very low yielding by Wairau Plain standards.

Groundwater chemistry

Groundwater chemistry is likely to vary with well depth. Shallow waters in riparian gravels are similar to stream flow or rainfall. Deeper water is moving very slowly due to the low permeability sediments and the groundwater as a result becomes mineralised through extended contact with local rocks over time (Fig. 34.5 and Fig. 34.6).

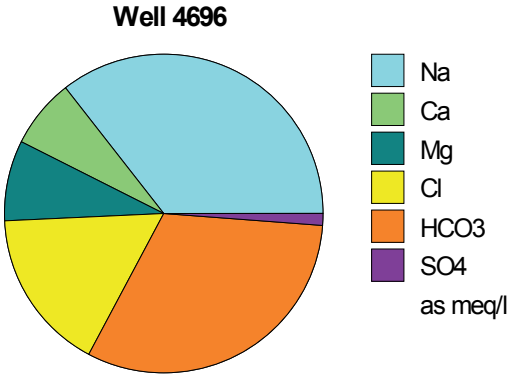

Figure 34.5: Well 4696 groundwater composition.

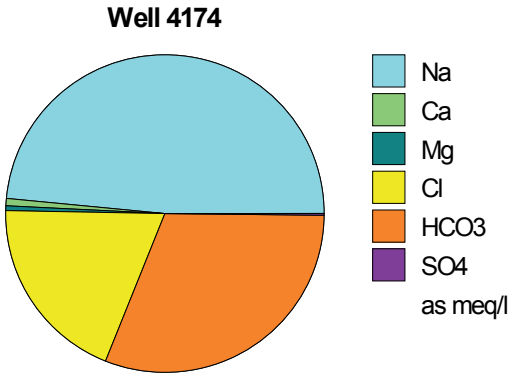

Figure 34.6: Well 4174 groundwater composition.

While well 4174 is not particularly deep by Wairau Plain standards, its water chemistry is evolved meaning it is likely to have been underground for a long time. Its water is classified as Na-HCO_3-Cl type based on the dominant salts present. It has virtually no sulphate, calcium or magnesium present which is another common sign of older groundwaters. Well 4174 intercepts marine deposits and this partly explains the presence of chloride.

A number of other attributes also indicate a long residence time underground. These include the presence of nitrogen in its ammoniacal form, rather than as nitrate. The presence of methane indicates advanced reducing conditions and explains the high levels of iron and manganese. pH is high due to the reduction processes generating bicarbonate. The absence of nitrate or sulphate is explained by their consumption through natural denitrification. Elevated boron and fluoride concentrations are also consistent with older groundwater through evolution or faulting.

The composition of groundwater from the neighbouring well 4696 is quite different to that of 4174, with significant portions of sulphate, calcium and magnesium. The reasons for this variability are unclear.

References:

Begg, J.G, Johnson, M.R, 2000. Geology of the Wellington Area, Institute of Geological and Nuclear Sciences Ltd, 1:250,000 Q map 10

Morgenstern, U, and van der Raaij, R., 2007. Well P28w/4174 age interpretation, GNS Science Ltd, Letter report No. 2007/238LR prepared for the Marlborough District Council

Ota, Y, Brown, L.J, Fujimori, T, Miyauchi, FT, 2000. Vertical tectonic movement in northeastern Marlborough: stratigraphic, radiocarbon, and paleoecological data from Holocene estuaries; NZ Journal of Geology and Geophysics, 1995, Vol. 38: 269-282