

Appendix C:

Case Study C – Ohoka Stream, Environment Canterbury

In Ohoka, Canterbury, Environment Canterbury and Pattle Delamore Partners Ltd have undertaken a number of simple field measurements in the Ohoka Stream, to assess the conductance of the stream bed, as described in PDP (1999).

These measurements were taken to allow an assessment of the effects of a number of irrigation abstraction wells on the Ohoka Stream.

The Ohoka Stream is one of many spring fed streams that emerge towards the coastal margin of the Canterbury Plains. Their emergence is associated with the western extent of low permeability estuarine and marine deposits which overlie the permeable gravel aquifers found over the Plains. The uppermost aquifer is unconfined to the west of these surficial fine grained sediments, and to the east the aquifer is confined by these overlying low permeability strata.

Concerns regarding the effect of low stream flows on the aquatic habitat of the stream motivated Environment Canterbury to place conditions which restrict abstractions at times of low flow, on both surface water abstractions from the stream and also on groundwater abstractions adjacent to the stream. Minimum flow restrictions for the Ohoka Stream occur at a flow of 300 L/s for "A" permits and at a flow of 800 L/s for "B" permits as measured at the confluence with the Kaiapoi River. During the testing period the flow in the Ohoka Stream was monitored at 260 L/s.

Stream bed conductance measurements were made to allow a better prediction of the magnitude of stream depletion effect caused by groundwater irrigators.

The surface aquifer connected to the stream occurs from around 3 to 24 m depth and water levels range from 0.04 to 7 m below ground level.

Three types of tests were carried out at different points along the streambed: (1) Ring infiltrometer tests; (2) a seepage meter test; and (3) a stream gauging and groundwater piezometric survey. The methods used for these tests are described in section 6.1. The results of the tests are presented in Table C1. They show that hydraulic conductivity of the Ohoka Streambed varied between 4×10^{-6} m/s and 3×10^{-5} m/s.

Table C1: Results of Streambed Conductance Tests

Test	Field Measurement	Calculated Coefficients (iA)	Hydraulic Conductivity = Q/iA (m/s)
Single Ring Tests	Flow to maintain constant head in ring Q (m ³ /s)	Calculated from flow net analysis	
Mill Rd 1	7.2 x 10 ⁻⁷	0.060	1 x 10 ⁻⁵
Mill Rd 2	4.4 x 10 ⁻⁷	0.033	1 x 10 ⁻⁵
Mill Rd 3	3.8 x 10 ⁻⁷	0.021	2 x 10 ⁻⁵
Bradleys Rd 1	5.3 x 10 ⁻⁷	0.028	2 x 10 ⁻⁵
Bradleys Rd 2	2.3 x 10 ⁻⁷	0.022	1 x 10 ⁻⁵
Seepage Meter	Flow out of Seepage Meter (m ³ /s)	Calculated from piezometric survey	
Mill Rd	3.82 x 10 ⁻⁷	0.0914	4 x 10 ⁻⁶

Stream	Conductance $\Delta q/L\Delta h = K'W/M$ (m/s)	Width of Stream "W" (m)	Estimated Streambed thickness (m)	Hydraulic Conductivity "K" (m/s)
Gauging Survey				
Ohoka Stream	1.1 x 10 ⁻⁵	2.7	1.0	4 x 10 ⁻⁶
South Branch	2.6 x 10 ⁻⁵	1.0	1.0	3 x 10 ⁻⁵

The above values give an indication of the vertical hydraulic conductivity of the Ohoka Streambed. They can be compared with an aquifer hydraulic conductivity measurement in the area of approximately 1.4×10^{-3} (Moore 1995), a value that represents the horizontal hydraulic conductivity of the aquifer. Consequently the streambed hydraulic conductivity is around 100 to 1,000 times less than the aquifer.

The analytical method described in section 4.1 was used to estimate the amount of stream depletion caused by a well 15.4 m deep located 30 m from the Ohoka Stream, pumping at a rate of 26 litres per second.

For this example the following values were used:

$$Q = 26 \text{ L/s} = 0.026 \text{ m}^3/\text{s} \text{ (from ECan resource consent database)}$$

$$S = 0.1 \text{ (assumed)}$$

$$\ell = 30 \text{ m (from ECan database)}$$

$$T = 0.016 \text{ m}^2/\text{s} \text{ (Moore 1995), with an aquifer thickness of 11.4 m}$$

$$t = 30 \text{ days} = 2,592,000 \text{ s}$$

$$\lambda = 9 \times 10^{-6} \text{ m/s (based on } K' = 1 \times 10^{-5} \text{ m/s, stream width of 0.9 m and stream bed thickness of 1 m)} = 0.8 \text{ m/day}$$

These values give a stream depletion factor of 0.065 days.

The stream depletion rate after pumping for 30 days calculated using the Hunt equation is equal to 4.5 L/s or 17% of the well pumping rate.

At this site, there is some uncertainty regarding the appropriate storage coefficient to be used. Consequently a range of storage coefficients down to 0.001 has been considered. The stream depletion rate calculated after 30 days pumping where the storage coefficient is 0.001 would be 73%. Because of the sensitivity of the solution at this site to the storage coefficient it is desirable that a pumping test (or tests) be undertaken so as to better characterise this parameter.