BEFORE THE COMISSIONER APPOINTED BY

THE SOUTHLAND REGIONAL COUNCIL

In the matter	The Resource Management Act (RMA, 1991)
And	
In the matter of	A Resource Consent Application to include land use permits, water permits and discharge permits
By	Woldwide One Limited and Woldwide Two Limited (Applicant)

SUMMARY STATEMENT OF ABIGAIL PATRICIA LOVETT

2 October, 2019 (Revised 3 October, 2019)

1.0 I have provided a statement of evidence and addendum to that evidence, two technical reports and a supplementary report. I understand that all the information has been read and considered. I have a couple of key additional points regarding the following in response to previous topics discussed.

2.0 Iterations: Technical reports for WW1/2 were prepared separately at request of the reporting officer. These reports were superseded (to an extent) by a water quality report prepared by Dr. Freeman to cover all applications. The supplementary response report was prepared to Dr. Freemans report. I will also cover the following:

- 2.1 Heddon Bush School drinking water supply
- 2.2 Groundwater recharge
- 2.3 State of existing environment
- 2.4 Response to Dr. Freemans comments and discussion
- 2.5 Soil moisture monitoring

3.0 **Heddon Bush School Drinking Water Supply**:

3.1 Refer to Section 3.5 "Drinking water Supplies", Pg.34 of technical report (Lovett 2019a and 2019b).

3.2 Heddon Bush School previously used a bore (unknown number) to abstract groundwater for the water supply (1995 – 2017), however water levels in the bore declined and the bore ran dry in 2017. A replacement bore (E45/0718) was drilled in 2017 to 14.9 m BGL, screened from 14.2 – 14. 9 m BGL in 'gravels'.

3.3 Bacterial results of 46 water samples were provided by the school and 3 results were provided by the applicant. Based on sample result forms, samples were collected from either the bore or 'kitchen tap' and were analysed by the (accredited) Invercargill City Council water testing laboratory.

3.4 Concentrations of bacterial parameters including *E. coli*, faecal coliforms, and enterococci were consistently reported as 'absent' or below detection level (<1.0 cfu/100 mL). The single groundwater quality sample showed likely impact from land use processes including elevated nutrients (NO_3-N) of 2.33 mg/L and a total coliform count of 3 cfu/100 mL.

3.5 Water quality in the vicinity and upgradient of Heddon Bush School shows high nitrate levels, which in some cases breach the MAV for Drinking Water Standards of 11.3 mg/L.

3.6 Movement of groundwater is a lot slower than surface water systems and therefore that there is often a 'lag' effect (e.g., from when land use occurs and when changes are observed in the groundwater system); this is dependent on the hydrogeology of the aquifer (e.g., gravel versus sand). Calculations by Wilson et al., (2014) indicate that about 80% of the region is expected to have a transit time of less than five years, and 90% less than two years. Therefore, it is highly likely that the water quality effects of current land-use processes are reflected in the water quality of the shallow groundwater and surface water (e.g., Waimatuku Stream).

3.7 Regarding a Capture Zone (CZ) or Protection Zone (PZ). A CZ/PZ can be developed using available information (topography, geology, groundwater levels / piezometric surface). As referred to in Section 5.5, Pg 47 "*… capture zone modelling of the bore could be undertaken*

to determine the likely land surface area that is contributing recharge to the bore. Appropriate land use practices and mitigations could be implemented to ensure on-going security of the groundwater supply. "

3.8 It is understood that water goes through filtration and UV treatment (Hamilton pers. comm., 2019). This is also a requirement as a minimum treatment under the DWSNZ (2008) guidelines for water supplies in catchments with "… *frequent high concentrations of cattle, sheep, horses, or humans*…". Additional groundwater quality results for Heddon Bush School would be required to provide a more reliable determination of groundwater quality at the site. Like the applicant, I understand that the current monitoring regime is four times / year (e.g., three monthly). I do not know what frequency of sampling should be required for drinking water supply as this is in the expertise of a water supply / treatment specialist.

3.9 The risk scenarios to human health in my opinion:

- *E.coli* – low probability, high impact, (mitigated by filtration and UV treatment);
- Nitrate-nitrogen – moderate probability, lower impact, largely due to the fact that concentrations should be expected to gradually increase.

4.0 Groundwater recharge

4.1 As presented in Section 3 of the technical reports, groundwater in the Waimatuku, Central Plains, Upper Aparima Groundwater Management Zones is predominantly naturally recharged from rainfall. Rainfall infiltrates through the root zone and recharges the groundwater table at an estimated rate of *c.* 420 - 470 mm/yr (Wilson et al., 2011; Environment Southland, 2019). Rainfall recharge is the predominant process for which water enters these aquifers. Artificial recharge can also originate from irrigation recharge, including effluent irrigation.

4.2 Essentially, rainfall and irrigation recharge is the movement (flux) of water from the root zone to the saturated zone. This is also the process by which nutrients and contaminants are transported from the land surface to groundwater. Attenuation (such as denitrification) can occur.

4.3 Unless highly technical systems are in place to monitor soil moisture (e.g., installation of soil moisture sensors, geophysical mapping of soils) there is always some risk of irrigation recharge bypassing the vadose zone. Wilson et al., (2014) "… *Close (2010) notes that nitrate does not tend to sorb within the vadose zone because nitrate and the medium it travels through are both negatively charged. Denitrification does occur within the soil horizon and can occur under certain conditions in the saturated zone. Studies overseas have shown that denitrification does not tend to occur in the unsaturated zone because of the abundance of oxygen (e.g. Cannavo et al 2002)*."

4.4 As mentioned in previous evidence of Duncan, Dr. Roberts, and Dr. Freeman, instruments such as lysimeters can be installed to quantify the amount of rainfall that is recharged to the aquifer through direct measurement. There are two recharge monitoring sites in Southland located at Waipounamu (Gore) and Five Rivers. These sites measure ground level rainfall and also the volume of water that infiltrates below the root zone, which is assumed to reach the shallow groundwater system. These sites are quantitative only, and are not used to measure water quality. Detailed analysis of the recharge datasets for Southland is yet to be

undertaken. Early data indicated that recharge can occur throughout the year in Southland, which is in contrast to other regions such as Hawke's Bay, Canterbury, and Bay of Plenty sites.

4.5 It is important to note that groundwater abstracted from a bore is likely a combination of groundwater of different ages and transport pathways. In the hydrogeological setting of interest, the majority (if not all) of the groundwater has been recharged via rainfall/irrigation (as oppose to via losing reaches of rivers), and perhaps a small amount of recharge from local drains and streams.

4.6 Section 4.3: Land Surface Recharge. Soil moisture at Heddon Bush is generally >65% between May – September, indicating that drainage is likely to occur during this time. The following graph demonstrates that even in low soil moisture, during the middle of summer, rainfall events can promote rapid drainage to groundwater, as demonstrated by the early February rainfall event highlighted in the box.

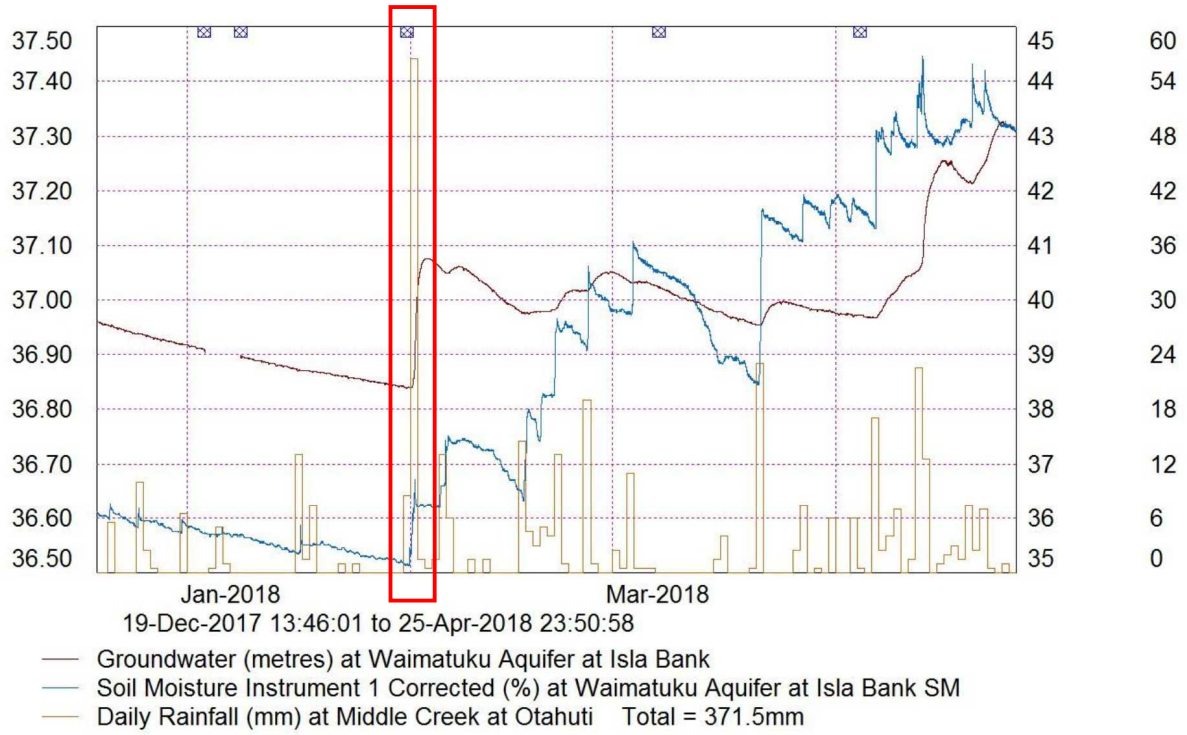

Figure 1: Groundwater level (m msl) in red; correct soil moisture (%); and daily rainfall (mm) for the Waimatuku Aquifer at Isla Bank.

5.0 State of existing environment

5.1 It is not disputed that surface and groundwater quality is significantly degraded in the Waimatuku Catchment, and considerably degraded in other catchments. In all catchments, water quality reduces considerably in a downstream / downgradient direction, with the most significant impacts in higher-order rivers and estuarine environments.

5.2 Regardless of 5 yr and 10 yr trends in water quality as shown by LAWA, some of which showed improvements and others which showed degradation, the 'state of the water quality' is a key issue to be considered.

5.3 Based on the short transit times evident in the Southland Region, there is a high probability that current land use processes (e.g., 2 – 5 years) are responsible for the water quality impacts that are currently observed in both surface water and groundwater environments.

5.4 MfE sampling protocol (now replaced by NEMS standards) allow for comparative groundwater sampling to be undertaken. This sampling protocol ensures that the groundwater is representative of the aquifer. I remain unchanged in my opinion that available groundwater quality data in the vicinity of Heddon Bush should not be disregarded, as implied by Dr. Freeman and as suggested by Mr Scandrett on the basis of potentially unlawful contamination of the aquifer by landowners with insecure wellheads.

6.0 Addressing of Dr. Freemans discussion and comments:

6.1 **Assessment of effects for increased groundwater abstraction:** Correct. I had not seen the Attachment 2 of Dr Freemans brief of evidence (16 September, 2019) until yesterday (1 October). Until the assessment was completed by the sub-consultant in August 2019, the potential effects of the increase in groundwater abstraction had not been addressed by the applicant. I have reviewed the calculation in the Aqualinc report and agree that the stream depletion assessment was sufficient to indicate that the effects of increased abstraction were adequate and that the applicant should not be subject to minimum flow requirements.

6.2 **Assessment of water quality for Waiau Catchment:** I agree that there is less water quality information available for the Orauea River Catchment. However, I maintain that consideration of that limited information should still be undertaken in an assessment of the existing environment.

6.3 **Wintering barn:** the addition of wintering barns would likely result in a decrease in effects on water quality (all other things remaining equal). However, an increase in cow numbers results in additional sludge from wintering barns and additional nutrients deposited on-paddock, including during summer. This increases the risk of additional nutrients entering surface waterways via overland flow and groundwater via leaching. Just to clarify – the increase in cow numbers on WW1 is from 540 - 700, equivalent to a 30% increase at WW1. If spread out over both WW1/WW2 dairy platforms, this is equivalent to a 10% increase in stock numbers. The actual reduction of nutrient loss 'in the real world' is heavily reliant on all of the mitigation measures in the Overseer model being implemented, and that the baseline to which the model is applied accurately reflects current, permitted farming activities.

6.4 **Phosphorus (P):** Generally accepted that P will be bound to soil matrix in saturated groundwater and unsaturated groundwater. I recognise this as being correct, but there are some uncertainties to this, such as limits as to the amount of P that can be adsorbed. Given that there are clear increasing trends of DRP and P in surface waterways there is potential that soils are reaching their maximum ability to adsorb phosphorous (if it is routed through groundwater), or that increasing phosphorus is transported via surface waterways. Dr. Freeman indicated words to the effect that [*even if there was a significant amount of P leaching into groundwater that will not be an issue for the drinking water supply*]. However, since (in this hydrological setting) groundwater discharges into downstream surface waterways and estuarine environments any increase in P should be taken into consideration.

6.5 **Vertical heterogeneity in water quality:** Dr. Freeman notes that in a multilevel bore, N-concentrations are lower at depth, and indicates that "all of the other results that show elevated Nitrate-N are from relatively shallow bores 4 – 10 m; school bore is definitely deeper (14.9 m BGL), and consistently relatively low 2 – 3 mg/L." There are only three samples for nitrate-nitrogen, therefore I would disagree that these values are 'consistently low'. It could be possible, as Dr. Freeman indicates, that slightly deeper groundwater is arguably separate from the shallower groundwater, or it is (more likely) just older groundwater that has not mixed with the shallow groundwater; however we do not have enough information on hydrogeology in that area to determine exactly why nitrate-nitrogen is lower).It is correct that would expect it to mix, conceivable that there is a source; "20 years' time it may rise".

6.6 **Groundwater sampling protocol:** As mentioned in my technical reports - the standard sampling protocol was formerly MfE (2008), and is now NEMS (2019). Three purge volumes and that parameters of pH, temperature, and electrical conductivity (EC) are stabilised within a required range. These sampling standards ensure that groundwater sampled is representative of the surrounding aquifer and reduces the chance that results will be misrepresentative due to local point source contamination.

6.7 **Wellhead protection**: Although issues with well head protection are commonly raised, these are not cited as the expected cause of wide spread increases in nitrogen in Southland. Contamination of groundwater should not be overlooked regardless of whether the contamination is derived from a point or diffuse source, and regardless of whether it is nutrient, bacterial, or other.

6.8 **Cumulative effects assessment as an omission:** I maintain that the added effects of effluent discharge to the Horner Block and increase of intensive winter grazing and increased stocking rates on WRO Block have not been adequately assessed. Regardless of Overseer comparison and in consideration of relative changes, there are additional effects (exports) onto HB and WRO that have not been addressed.

7.0 Other topics

7.1 Soil moisture monitoring is to be covered by Ms. Mears. I reiterate my concern regarding application of slurry and effluent, consideration of antecedent and future conditions, and question how the soil moisture monitoring site is actually incorporated into farm operation.

7.2 I would like to clarify the following statement was in regard to the submission by Mr Youngman and his inference that current water didn't reflect the poor water quality experienced 40 years ago "Just because something has been done poorly in the past (e.g., water quality was more degraded 40 years ago) does not provide an excuse to mark that poor quality as the baseline. Rather we would consider the baseline as pre-European and assess the effects of land use on the receiving environment on water quality results."

7.3 Water quality results are a representation of that point in time. Higher levels of variation occur in surface water compared to groundwater. However, the argument that the water quality is improving, is a relative one.