RM15.364

Request for further information under section 92(1) of the Resource Management Act 1991 (the Act) – Consent Number RM15.364.01: Discharge Permit - Water WAIHOLA STP

Date: 27 July 2019

Background

The Otago Regional Council sought an external review of the above application on behalf of the Clutha District Council. Based on this review[1], the ORC has sought further information[2]. The further information requests are reproduced below in black italics text and the responses to these are presented in blue text.

Information Requests

1. *Calculate total nutrient loads to the Lake Waihola Complex;*

Clarification

Firstly, we note that the Aquanet report states:

"In order to fully understand the effects of the discharge the applicant would need to calculate total nutrient loads to the LWC and determine the proportion of total loads that come from the STP.".

The acronym 'LWC', used throughout the Aquanet report, is an abbreviation for the wider Waipori/Waihola Lake-Wetland complex. LWC is also used in the ORC s92 (1) request, however under information request 1 above, it refers to the 'Lake Waihola Complex'. We assume the writer means the Waipori/Waihola Lake-Wetland complex (i.e., the LWC), and this is the approach we have used in this information response. It is important to note that information relating to nutrient loadings in this

[1] Aquanet Consulting Ltd assessment dated 6 June 2019.
[2] Otago Regional Council Letter (reference A1245563) dated 6 June 2019.

environment have typically assessed the wider wetland environment (the LWC), due largely in part to its complex hydrological nature, as noted below.

Background

The Waipori/Waihola Lake-Wetland Complex comprises the shallow coastal lakes of Lake Waipori and Lake Waihola, the Waipori River, the Taieri River, and several smaller tributaries, ponds and natural channels within the wetland area. The complex is influenced by inputs from the Waipori River, which is regulated by a hydroelectric power scheme, with the influence of the Taieri River restricted to tidal back flushing (Schallenberg *et al.* 2003[3]).

Inputs to Lake Waipori include the pumped water from the Main Drain[4] (including the tributaries Kirks Drain, Lee Creek and the Main Drain itself, which together comprise the West Taieri Drainage Scheme), the Waipori River and the Contour Channel (whose confluence is approximately 1.5 km upstream of Lake Waipori), and smaller tributaries such as the Meggat Burn and other unnamed channels draining adjacent land.

Inputs to Lake Waihola include surrounding land that is dominated by pine forests and pastoral farming, and from channels on the eastern side of the lake that are connected to the lower Waipori River and Taieri River.

Nutrient load assessments

The lower Taieri River catchment has been the subject of several nutrient load assessments on a number of occasions. Those we are most familiar with include Ryder 1995[5], Schellenberg & Burns 2003[6] and Ludgate 2018[7].

In this information response, we have collated relevant information from these sources to provide an overview of the relative contributions of nutrient sources to the LWC.

With respect to contributions from the Waihola STP, we have relied on the information provided in Aldon & Stewart 2018[8], as present in Table 1. That report

[3] Schallenberg, M., Burns, C.W., and Peake, B.M. 2003. A temperate, tidal lake-wetland complex 1. Water balance and ecological implications. *New Zealand Journal of Marine and Freshwater Research*. **37**: 415-428.
[4] The Main Drain is a man-made channel that receives water drained from the West Taieri Drainage Scheme: a network of drainage channel runoff, surface runoff and groundwater discharge from a large part (approximately 8000 ha) of the West Taieri floodplain that includes a large number of dairy farms. The Main Drain receives water from the drainage scheme, including Kirks Drain and Lee Creek, all converging at the Waipori pump station.
[5] Ryder, G.I. 1995. Factors affecting water quality in the lower Taieri River catchment. Prepared for Otago Regional Council by Robertson Ryder & Associates. 217pp
[6] Schallenberg, M., and Burns, C.W. 2003. A temperate, tidal lake-wetland complex 2. Water quality and implications for zooplankton community structure. *New Zealand Journal of Marine and Freshwater Research.* **37:** 429–447.
[7] Ludgate, B. 2018. Waipori Pump Station: Main Drain discharge to Lake Waipori - water quality review. Prepared for Otago Regional Council by Ryder Environmental.
[8] Aldon, B. & Stewart, B. 2018. Further Investigation of the Waihola STP discharge to the Lake Waihola Outlet Channel. Prepared for Clutha District Council.

recognised that effluent volumes currently discharged may be at the lower end of the spectrum; i.e., daily flow average of 102 m^3/d, but there is the potential for a significant increase, with consented volume being 680 m^3/d, and up to 1020 m^3/d allowable under wet weather conditions. Current and consented discharge volumes were used by ORC staff to calculate nitrogen and phosphorus loads (Table 1).

Table 1. *Likely nutrient loads from Waihola STP (from ORC memorandum).*

	Total Nitrogen		**Total Phosphorus**	
	Daily (kg N)	Annual (kg N)	Daily (kg P)	Annual (kg P)
Current (102 m^3/day)	1.68	610	0.6	220
Consented (680 m^3/day)	11.22	4,100	4.01	1,460

Based on the investigation of the Waihola STP effluent plume (Stewart *et al.* 2016), considerable dilution was expected to take place before nutrients from the STP reach Lake Waihola. Additionally, it was anticipated that there would be input of nutrients from sources other than the Waihola STP (particularly rural runoff). This aspect is considered in more detail below.

Ryder (1995) undertook a comprehensive mass balance approach to assessing the contributions of various point and non-point source contaminant discharges to the lower Taieri River catchment. Further work was then undertaken by Schallenberg (see references above) and others (see Ludgate 2018 above), all of which used a mass balance approach.

Ryder (1995) used boundaries of the lower Taieri River catchment and topographical maps to identify land uses, based on local knowledge of the area and information supplied by the ORC. It is considered that that information presented in Ryder (1995) on land use intensity is conservative relative to the situation today, given the known increase in farming intensification on the Taieri Plain and in particular the intensity of farming activity on land immediately surrounding Lake Waihola.

The annual mass loadings produced by Ryder (1995) for nutrients in land runoff that would reach the LWC are presented in Table 2.

Table 2. *Predicted annual contribution of contaminants (tonnes/year) into the LWC from surrounding land. (source: Ryder 1995)*

Catchment	**Area**	**Total Nitrogen**	**Total Phosphorus**
	(km^2)	Annual (kg N)	Annual (kg P)
Lakes (land immediately surrounding lake)	108	55,418	6,288
Meggat Burn	35	12,395	2,100
Waipori River (surrounding land)	0.3	53	7
Hill tributaries (land surrounding lower Waipori R.)	3.3	1,113	154

Ludgate (2018) used water quality monitoring data from Lake Waipori inflows (Main Drain, Waipori River, and the Contour Channel) between 2000 and 2017, and river flow data from the Waipori River and pumped water volumes from the Main Drain to estimate mass loads of N and P to Lake Waipori (Table 3). While not all of this water discharges directly into Lake Waihola, it provides a useful test of the robustness of the various approaches used by Schallenberg (2003) and Ryder (1995).

Table 3. *Annual contribution of contaminants (kg/year) and percentage contribution into Lake Waipori from the Main Drain, the Waipori River, and the Contour Channel. (source Ludgate 2018)*

Parameter	Main Drain	Waipori River	Contour Channel
	Annual (kg N)	Annual (kg N)	Annual (kg N)
Total Nitrogen	26,700	70,900	13,100
Total Phosphorus	1,700	5,100	1,500

Ludgate's (2018) estimated contributions of 70,900 TN kg/yr and 5,100 TP kg/yr from the Waipori River are within the ball park of Schallenberg's estimates of 65,000 kg N and 7,700 kg P (Table 3). So, we can have some confidence in the approach used in our estimates of mass load contribution.

Note that the Ryder (1995) load estimates presented in Table 2 did not include contributions from the Waipori River or the Main Drain. Ludgate (2018) included estimates for these catchments.

2. *Determine the contribution of the Sewage Treatment Plant to total nutrient loads, either through a risk-based assessment (i.e. if xx% of the discharge enters to Lake Waihola Complex it will comprise xx% of the lake load), or a quantitative assessment (i.e. the Sewage Treatment Plant discharges xx T/yr. of x, xx% enters the Lake Waihola Complex, comprising xx% of total lake load).*

Bringing the above data together into Table 4 below, it is possible to derive a relative contribution of the Waihola STP to the total nutrient load to the LWC. Using the data provided above, this equates to 0.3% of TN and 1.3% of TP under current typical wastewater flows and 2.3% TN and 8.7% TP under the maximum consented wastewater flows. These relative contributions are arguably conservatively low given; (i) that the contribution from the Taieri River itself has not been considered (i.e., nutrients derived from the Taieri River catchment upstream of the catchments identified in Table 4 are able to find their way into the LWC on flood tides), (ii) the assumption that all the WTP discharge reaches Lake Waihola, which is highly unlikely to occur (Stewart *et al*. 2016[9]), and (iii) farming on land surrounding the LWC has intensified since the work of Schallenberg and Ryder.

[9] Stewart, B., Goldsmith, R., and Ryder, G. 2016. Assessment of the Waihola STP discharge to Lake Waihola outlet channel. Prepared for Clutha District Council by Ryder Consulting Ltd.

Table 4. *Predicted annual contribution of contaminants (tonnes/year) into the LWC from surrounding land and the Waihola STP based on information from non-point and point source discharges (conservative).*

Catchment	Area	Total Nitrogen	Total Phosphorus	% contribution	
				TN	TP
	(km²)	Annual (kg N)	Annual (kg P)	%	%
Lakes (immediately surrounding lake)	108	55,418	6,288		
Meggat Burn	35	12,395	2,100		
Waipori River (surrounding land)	0.3	53	7		
Hill tributaries (surrounding Waipori R.)	3.3	1,113	154		
Main Drain	Uncertain	26,700	1,700		
Contour channel	Uncertain	13,100	1,500		
Waipori River (upstream of ORC WQ monitoring site)	Uncertain	70,900	5,100		
Waipori STP Current (102 m^3/day)	N/A	610	220	0.3%	1.3%
Waipori STP Consented (680 m^3/day)	N/A	4,100	1,460	2.3%	8.7%

3. *Make an assessment of the likely contribution of the Sewage Treatment Plant discharge to the poor state of the Lake Waihola Complex based on the load data.*

Lake trophic level status and trends in nutrient concentration

ORC undertakes regular monitoring of Lakes Waipori and Waihola and uses this data to assess the trophic status of the lakes by way of the trophic level index (TLI). TLI is used to assess the water quality status of New Zealand lakes, and is calculated using three or four key variables of lake water quality: chlorophyll *a*, total phosphorus, total nitrogen, and clarity (although typically not used for calculating TLI for shallow lakes). The trophic status of lakes includes 'mesotrophic (medium)' (TLI = 3-4), 'eutrophic (high)' (TLI = 4-5), and 'supertrophic (very high)' (TLI = 5-6).

Monitoring of Lakes Waipori and Waihola between 1997/1998 and 2014/2016 found that both lakes have high TLI values (Table 5, Figure 1), and were generally classified as 'eutrophic', which 'reflects a lake that is significantly enriched with nutrients and is highly productive with a high algae biomass' (ORC 2017[10]). The data in Table 5 indicates that TLI values for Lake Waihola have not degraded over the monitoring period (1997 – 2016), and Figure 1 indicates that the TLI at two of the Lake Waihola monitoring sites has decreased (improved) over the monitoring period.

Total nitrogen and total phosphorus concentration medians and trends are presented in Figures 2 and 3. For Lake Waihola, Figure 2 indicates no trend (up or down) in nitrate concentration over the monitoring period and that phosphorus concentration is tending down (Figure 3).

[10] Otago Regional Council. 2017. Trophic level status for Lake Waipori and Lake Waihola. June 2017. Otago Regional Council, Dunedin.

Table 5. *TLI results for Lake Waihola and Lake Waipori between 1997 and 2016. Source: ORC (2017)*

Site	1997 to 1998	2002 to 2004	2014 to 2016	1997 to 2016
Lake Waipori				
Waipori - combined	4.02	4.11	4.23	**4.11**
Waipori - Mid	3.96	3.98	4.22	**4.19**
Waipori - South	4.08	4.24	4.28	**4.04**
Lake Waihola				
Waihola - combined	4.75	4.43	4.55	**4.58**
Waihola - Mid	4.48	4.28	4.43	**4.4**
Waihola - North	4.68	4.25	4.4	**4.45**
Waihola - South	5.07	4.77	4.81	**4.89**

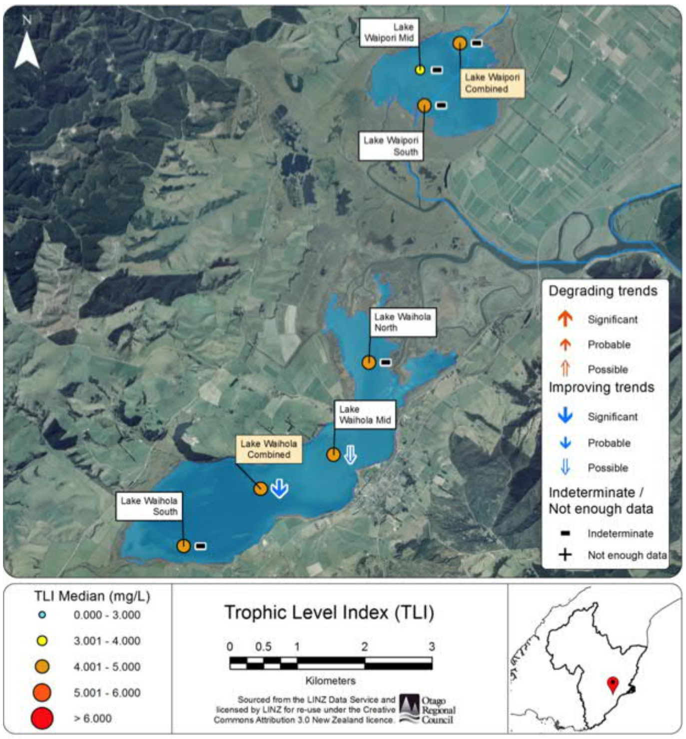

Figure 1. *Trends in the trophic level index in the Waipori/Waihola lakes from 1997/1998 to 2014/2016. Coloured circles indicate the median values used to define the boundaries of different trophic levels. Source: ORC (2017).*

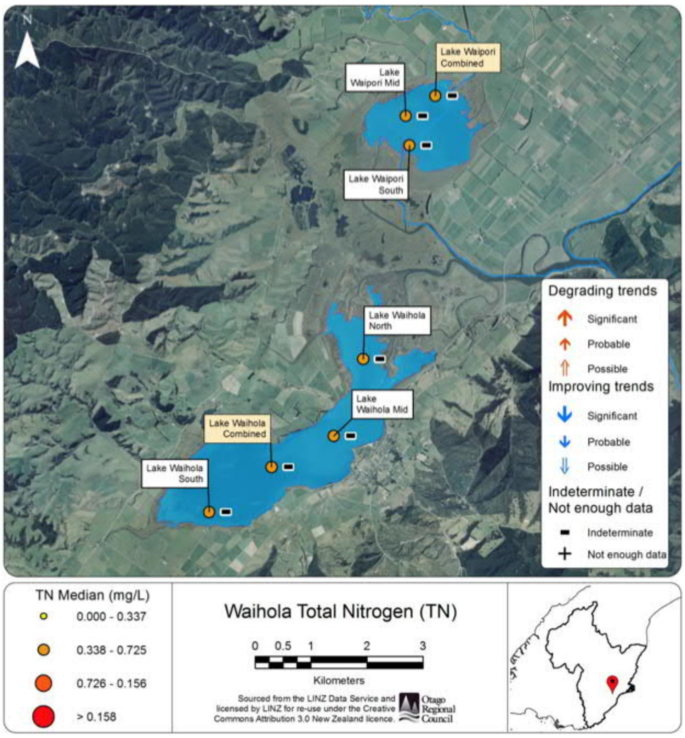

Figure 2. *Trends in total nitrogen in the Waipori/Waihola lakes from 1997/1998 to 2014/2016. Coloured circles indicate the median values used to define the boundaries of different trophic levels. Source: ORC (2017).*

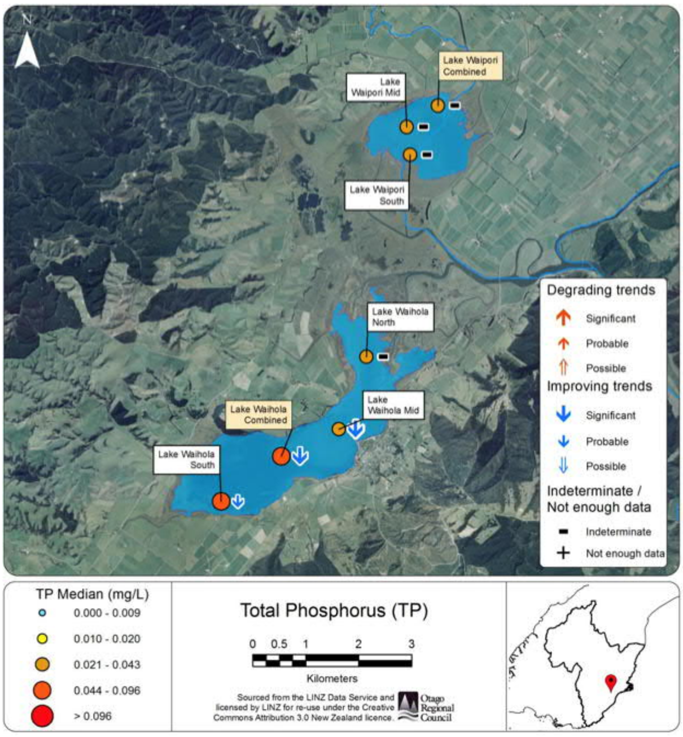

Figure 7. *Trends in total phosphorus in the Waipori/Waihola lakes from 1997/1998 to 2014/2016. Coloured circles indicate the median values used to define the boundaries of different trophic levels. Source ORC (2017).*

There is no doubt that nutrient concentrations in Lake Waihola and Lake Waipori are high, and that both lakes are very enriched. However, the contribution of the Waipori STP discharge to this enrichment appears to be less than minor with respect to nitrogen and minor with respect to phosphorus. This assessment is couched with the understanding that it is unlikely that all of the STP discharge reaches either lake due to the location of the outfall and the manner in which discharge is managed in relation to tidal state. It is noted that the ORC report (ORC 2017) on lake TLI's states: "… *in Lake Waihola the TLI shows a significant decreasing trend over time suggesting that water quality in Lake Waihola may be improving.*"