BEFORE THE OTAGO REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER OF	Discharge Permit Application RM15.364 Clutha District Council

---

STATEMENT OF EVIDENCE OF DR MICHAEL JOHN CRAWSHAW GREER

ON BEHALF OF OTAGO REGIONAL COUNCIL

10/12/2021

TABLE OF CONTENTS

1. INTRODUCTION

QUALIFICATIONS AND EXPERIENCE

1.1 My name is Michael John Crashaw Greer. I work for Aquanet Consulting Ltd as a Senior Freshwater Scientist.

1.2 I hold a PhD degree in Ecology and a Bachelor of Science in Zoology from the University of Otago.

1.3 I have over 10 years of work experience in freshwater ecology, and have worked for local government, the Department of Conservation and NIWA. Since the 4th of March 2018, I have been employed by Aquanet Consulting Ltd. Prior to that I was employed by the Greater Wellington Regional Council as a Senior Environmental Scientist and Environment Canterbury as an Ecology Scientist.

1.4 Since joining Aquanet I have been engaged by 15 different regional, district or city councils, the Department of Conservation and various industry bodies, private companies/corporations to provide a variety of technical and scientific services in relation to water quality and aquatic ecology.

1.5 I have worked as a technical advisor on behalf of both consenting authorities and applicants on well over 100 resource consent applications, compliance assessments and/or prosecution cases. These applications have been for a wide range of activities, including wastewater discharges.

1.6 My work routinely involves providing assessment of effects on water quality and/or aquatic ecology, recommending or assessing compliance with resource consent conditions, and designing or implementing water quality/aquatic ecology monitoring programmes.

BACKGROUND AND ROLE

1.7 I was engaged in September 2018 by the Otago Regional Council (ORC) to provide a technical review of the resource consent application by Clutha District Council (CDC) for the discharge of treated wastewater from the Waihola Sewage Treatment Plant (STP) to the Lake Waihola outflow channel and the wider Waipori/Waihola Lake-Wetland complex (LWC). This review was limited to matters relating to surface water quality and ecology.

1.8 In September 2018 I documented my preliminary assessment of the application in a technical memorandum to ORC. This memorandum included:

(a) An assessment of the appropriateness of the methodologies used in the application to assess the current and future effects of the discharge on water quality, ecology and human health for recreation;

(b) An assessment of the potential current and future effects of the discharge on water quality and ecology;

(c) A preliminary review of the discharge volume and quality limits proposed in the application; and

(d) A description of the additional information needed to address my concerns with the effects assessment methodologies employed in the application. This was provided so that the identified information could be requested by ORC under S.92 (1) of the RMA.

1.9 In July 2019, I provided my final assessment of the application to ORC in an update of the April 2019 technical memorandum. The final memorandum included:

(a) My initial assessment;

(b) An assessment of the potential effects of the discharge on water quality and ecology based on information in the original application and the additional data provided by the applicant in response to ORC's S.92 request.

2. CODE OF CONDUCT

2.1 I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note and that I agree to comply with the code. My evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter to detract from the opinions which I express.

3. SCOPE

3.1 My evidence addresses the following matters:

(a) The initial review of the water quality and ecology components of the application that I provided to ORC;

(b) An assessment of the key limitations of the technical approaches taken in the application;

(c) The additional information I requested that ORC seek from the CDC under S.92 of the RMA; and

(d) My assessment of the potential effects of the discharge on water quality and ecology based on all the available information, including the applicants S.92 response.

3.2 It is my understanding that CDC have not formally agreed to change the main components of activity from what was originally proposed in the application. Accordingly, this evidence largely documents the information previously provided to ORC in the technical memorandum produced in September 2018 and updated in July 2019.

3.3 While a recent backflow minimisation report completed by CDC suggests that "[t]*he period effluent is discharged from the Waihola WWTP can be reduced to minimise or eliminate the backflow into Lake Waihola*" I have not considered such a change to the discharge regime in my evidence as:

(c) To my knowledge CDC have not agreed to a set of proposed conditions that reduce the discharge period; and

(d) The dye test results presented in the backflow minimisation report are questionable (see para. 7.5 to para 7.7).

3.4 I have not undertaken any additional monitoring or field investigations and my review relies on the data and information provided by ORC, CDC and their advisors.

3.5 My evidence considers information contained in:

(a) **The application** – *Waihola Sewage Treatment Plant: Application to discharge treated sewage effluent to the Lake Waihola outlet channel* (CDC);

(b) **The AEE** – *Waihola Oxidation Pond Discharge to the Lake Waihola outflow channel. Assessment of environmental effects. February 2014* (Ryder Consulting Ltd for CDC);

(c) **The ORC scientist review**[1] – *Waihola STP discharge to Lake Waihola outlet channel – consent renewal application* (Adam Uytendaal for Otago Regional Council (ORC);

(d) **The addendum to the application** – *Further Investigation of the Waihola STP discharge to the Lake Waihola outlet channel* (Ryder Environmental Ltd for CDC);

(e) **The indicated consent conditions** related to discharge volume and quality **–** Contained in Sections 2.2 and 6.0 of **the application** respectively;

(f) **The backflow minimisation report –** *Waihola Wastewater Treatment Plant Consent No: 2002.046 Condition 2 (C) Backflow Minimisation Report* (CDC)**;** and

(g) **The S.92 response** – *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* (CDC).

These documents are referred to throughout this evidence using the bolded terms above.

4. STATE OF AND RISKS TO THE WAIPORI/WAIHOLA LAKE-WETLAND COMPLEX

[1] Attached as Appendix 1

4.1 The Waipori/Waihola Lake-Wetland complex (LWC) is a large system composed of a number of different habitat and waterbody types. For the sake of brevity, I do not provide a detailed description of its state and values in this evidence. This information is contained in the AEE (Section 3), and I assume will be replicated in evidence lodged by the applicant. Instead, I only provide a brief description of the water quality of Lake Waihola.

4.2 Lake Waihola is a 6.2 ha shallow (~2 m) tidal lake located to the southwest of Dunedin. The lake's 7,587 ha catchment is predominately in pastoral land use, and this has resulted in it becoming supertrophic (fertile and saturated in phosphorus and nitrogen)[2].

4.3 Nutrient and phytoplankton concentrations in Lake Waihola are generally in the C attribute state under the National Policy Statement for Freshwater Management (NPS-FM) 2020[3], meaning that "*ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions* [and] *reduced water clarity is likely to affect habitat available for native macrophytes*. Of particular concern; data pulled from the Land Air Water Aotearoa website suggests that total phosphorus concentrations in Lake Waihola are approaching the NPS-FM 2020 national bottom line of 50 mg/m^3 (five year median up to November 2020 = 43 mg/m^3). Thus, any additional phosphorus load discharged to the lake represents an increased risk of this threshold being breached.

4.4 As eutrophication in Lake Waihola is the primary water quality issue in the LWC, my evidence is largely focused on the effects of nutrient loads (nitrogen and phosphorus) discharged from the Waihola STP to the lake.

[2] Otago Regional Council (2005). Lake Waipori and Lake Waihola: Trophic Level Status. Otago Regional Council Technical Report. ISBN 1-877265-17-9.
[3] Ozanne, R. (2021). State and Trends of River and Lake Water Quality in the Otago Region . Otago Regional Council Technical Report.

5. DESCRIPTION OF CURRENT AND FUTURE DISCHARGE VOLUMES

5.1 Based on the information provided in the application, my understanding of current and future effluent discharge volumes from the Waihola STP to the LWC is as follows:

(a) The existing resource consent (2002.046) allows for the discharge of 680 m^3/day under normal flows and up to 1020 m^3/day under wet weather conditions;

(b) Current average and maximum daily discharge volumes are 102 m^3/day and 341 m^3/day;

(c) The applicant considers a discharge volume of 350 m^3/day could be considered appropriate at present (pg. 8 of the application); and

(d) The applicant is proposing that consent conditions allow for the discharge of up to 680 m^3/day to account for potential population growth (pg. 9 of the application).

5.2 In short, the applicant is proposing consent conditions that would allow the volume of effluent discharged from the Waihola STP to the LWC to theoretically increase by ~570% (if the applicant discharged at the maximum proposed rate at all times).

6. CURRENT EFFECTS OF THE DISCHARGE

REVIEW OF THE ECOLOGY ASSESSMENT PROVIDED WITH THE APPLICATION

6.1 CDC's resource consent application and the AEE suggests that the Waihola STP discharge is currently having a less than minor to minor effect on water quality and ecology in the Lake Waihola outflow channel and the wider LWC. The ORC scientist review (Appendix 1) highlighted that there is insufficient data provided with the application to support this conclusion. In response the applicant conducted four rounds of water quality sampling at various points around the LWC and presented the results in the addendum to the application. While this additional sampling provides some insight into how water quality in the LWC compares to that of the effluent discharged from the Waihola STP, it is my opinion that by itself it is insufficient to support

the conclusion that the discharge is having a no more than minor effect.

6.2 Access issues meant CDC were unable to sample the outflow channel directly upstream and downstream of the discharge. Consequently, the addendum to the application does not provide further insight into the effects of the discharge on the outflow channel. Furthermore, the monitoring sites in Lake Waihola appear to have been located at least two kilometres away from where the discharge enters the lake (Stewart *et al.* (2016)[4] found that the discharge enters through the northern branch of the outlet channel). As such, any localised in-lake effects of the discharge would not have been detected.

6.3 In short, I agree with the ORC's scientist review, and it is my opinion that there is not enough evidence presented in the AEE and application to quantify the current effect of the Waihola STP discharge on water quality and ecology in the LWC.

DESCRIPTION AND REVIEW OF ADDITIONAL INFORMATION REQUESTED

6.4 In the addendum to the application, Ryder Consulting Ltd acknowledged that in order to understand the effects of the discharge on the LWC "*more data are needed with respect to nutrient loads likely to be introduced from the STP, the fate of those nutrients, and the likelihood of those nutrients contributing to further eutrophication of the LWC. Further, the contribution of nutrients introduced from the STP needs to be weighed against the contribution of nutrients introduced from other sources*". However, at the time of my initial review this work had not been done, and the addendum to the application added very little to my overall understanding of the effects of the discharge. Accordingly, as part of my initial assessment I requested the CDC:

(e) Calculate total nutrient loads discharged from the STP to the

[4] 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.

LWC;

(f) Determine the contribution of the STP to total nutrient annual loads, either through a risk-based assessment (i.e., if xx% of the discharge enters to LWC it will comprise xx% of the lake load), or a quantitative assessment (i.e., the STP discharges xx T/yr. of x, xx% enters the LWC, comprising xx% of total lake load); and

(g) Make an assessment of the likely contribution of the STP discharge to the poor state of the LWC based on the load data.

6.5 In the S92 Response CDC provides estimates of total nutrient loads to the LWC (based on previous studies) and conservatively[5] estimates the contribution of STP discharge to those loads based on current discharge volumes (Table 1). Through this method they demonstrate that the STP discharge is likely to contribute less than 0.5% of the total TN load to the LWC and just 1.3% of the TP load (Table 1). Accordingly, I am satisfied that the current STP discharge is unlikely to have a more than minor effect on water quality and ecology in the LWC. However, it still must be noted that the cumulative adverse effects of all nutrient discharges to the lake, including the STP discharge, are substantial.

[5] The contribution of the STP to LWC loads are likely being over-estimated by CDC as they have assumed that all of the discharge enters the LWC and that nutrient loads to the LWC from other activities have not increased since 1995.

Table 1: 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). Adapted from S.92 response.

Catchment		Total nitrogen load	Total phosphorus load
Lakes		55,418 kg/yr	6,288 kg/yr
Meggat Burn		12,395 kg/yr	2,100 kg/yr
Waipori River		53 kg/yr	7 kg/yr
Hill tributaries		1,113 kg/yr	154 kg/yr
Main Drain		26,700 kg/yr	1,700 kg/yr
Contour channel		13,100 kg/yr	1,500 kg/yr
Waipori River		70,900 kg/yr	5,100 kg/yr
Waipori STP – Current (102 m^3/d)		610 kg/yr	220 kg/yr
Waipori STP – Proposed (680 m^3/d)		4,100 kg/yr	1,460 kg/yr
Summary			
Current volume (102 m^3/d)	Total load	180,289 kg/yr	17,069 kg/yr
	STP contribution	0.3%	1.3%
Full implementation of proposed volume (680 m^3/d)	Total load	183,779 kg/yr	18,309 kg/yr
	STP contribution	2.2%	8.0%
Potential increase in load		2%	7%

7. FUTURE EFFECTS OF THE DISCHARGE

REVIEW OF THE ECOLOGY ASSESSMENT PROVIDED WITH THE APPLICATION

7.1 The applicant is proposing to upgrade the Waihola STP. These upgrades will improve effluent five-day biochemical oxygen demand (BOD_5), suspended solids, *E. coli* and nutrient concentrations, and the indicated consent conditions for these parameters are well below current measured concentrations. Accordingly, if discharge volumes do not increase in the future there will be a reduction in the contaminant loads entering the LWC from the Waihola STP. However, in their review, the ORC scientist raised concerns that the requested discharge volume is, on average, six time greater what is currently leaving the plant (see para. 5.1 and para. 5.2), and highlighted that the increase in discharge volume could increase contaminant loadings to the LWC. I agree with this assessment; improvements in water quality in the LWC resulting from the STP upgrades will be offset if increases in discharge volumes are proportionally higher than the decreases in effluent contaminant

concentrations.

7.2 In my initial review I opined that the expected decreases in effluent *E. coli* concentrations were sufficiently large (99% reduction) that it is unlikely that discharge volumes will increase to the extent that future *E. coli* input to the LWC will be greater than current. However, I noted that effluent total nitrogen and phosphorus concentrations are only expected to decrease by ~10%. Therefore, even a small increase in discharge volume could result in an increased in nutrient loads to the LWC, and if the indicated discharge volumes are fully implemented the amount of nutrients entering the LWC from the Waihola STP could increase by ~600%. The effect of these increases on nutrient concentrations in the LWC, and the follow-on effects on ecosystem and human health, cannot be assessed from the AEE and the application as they do not describe the STP's current or future contribution to water quality in the wider receiving environment. However, as total phosphorus concentrations in Lake Waihola are approaching the NPS-FM 2020 national bottom (see para. 4.2), any increase in phosphorus loading would increase the risk of this threshold being breached.

DESCRIPTION AND REVIEW OF ADDITIONAL INFORMATION REQUESTED

7.3 As stated in para. 6.4, my initial assessment included a request for CDC to provide a nutrient load assessment for the discharge and the LWC.

7.4 From the load information provided in the S.92 response it appears that the proposed discharge volumes (described in para. 5.1 and para. 5.2) have the potential to cause a 2% (3.49 t/yr) increase in total nitrogen loads to the LWC, and a 7% (1.24 t/yr) increase in total phosphorus load (Table 1). Furthermore, the relative contribution of the STP discharge to total nitrogen load could increase from 0.3% to 2% and its contribution to total phosphorus load could increase from 1.3% to 8.7% (Table 1). While the estimated increases in nutrient loads are conservative[5], they still indicate that the proposed discharge has the potential to cause more than minor adverse effects on water quality and ecology in the LWC given its already degraded state. Of most concern is the potential for significant increases in total

phosphorus in Lake Waihola as concentrations are already approaching the NPS-FM 2020 national bottom line.

COMMENT ON THE RELEVANCE OF THE BACKFLOW MINIMISATION REPORT

7.5 The backflow minimisation report presents the results of three dye tests used to assess whether shortening the duration of the discharge (currently 6 hours; latter half of incoming tide and initial half of outgoing tide) can prevent effluent discharged from the Waihola STP entering Lake Waihola. Based on the results of the dye tests the report concludes that "[t]*he period effluent is discharged from the Waihola WWTP can be reduced to minimise or eliminate the backflow into Lake Waihola*".

7.6 Were CDC to implement a discharge regime that eliminated backflow into Lake Waihola the issues I have raised regarding the future effects of the discharge in para. 7.1 to para. 7.4 would no longer apply. However, in my opinion the methodology used in the dye test means the results cannot be used as evidence that backflow to Lake Waihola can be eliminated.

7.7 The only data collected during the dye tests described in the backflow minimisation report were visual observations of the movements of the dye plume. No water samples were collected when the shortened discharge regime were tested. Thus, it is not possible to conclude that the dye did not reach Lake Waihola; it may simply have been diluted to a concentration that was not visually detectable. This is relevant as from an effects perspective it is nutrient loads not concentrations that matter. Potentially relevant; the discharge volume during the shortened discharge regime test was also just 15% of that being requested by CDC in the application. Accordingly, the results do not necessarily reflect what may be occur with full implementation of the indicated consent conditions.

7.8 It is also worth noting that to my knowledge the applicant has not formally agreed to a shorter discharge period, and that dye test results presented in the backflow minimisation report show that the current regime does result in effluent entering Lake Waihola. Furthermore, if the discharge regime is changed so that the relative import of the

Taieri river as a receiving environment is increased, then it would be appropriate for the applicant to conduct a more detailed (compared to the current AEE) assessment of the direct and cumulative future effects of the discharge on that water body.

8. REVIEW OF INDICATED CONSENT CONDITIONS

8.1 The numeric effluent quality limits in Table 7 of the application are generally appropriate as the Stage 2 thresholds represent a significant improvement from what is currently discharged from the STP. Furthermore, they are framed in a manner that is statistically consistent with approach recommended in the *New Zealand Municipal Wastewater Monitoring Guidelines*; i.e., compliance against a 95th percentile concentration limit is assessed using the number of exceedances in consecutive samples. However, I note that it would be beneficial from an effects management perspective to adopt a two-threshold framework whereby limits are set for median concentrations as well as 95th percentile concentrations.

8.2 While the proposed effluent quality limits reflect a significant improvement from current state, the proposed discharge volume is far greater than what currently leaves the plant. As such, the indicated conditions still allow for a degradation in water quality and ecology in the LWC. To ensure that the effects on the STP are not increased from current the proposed discharge volumes would need be decreased to better reflect the current operation of the plant. Alternatively, consent conditions could set load-based compliance standards rather than concentration and volume limits. This would allow the applicant to discharge at whatever volume they need to so long as they implement adequate treatment to ensure the effects on the LWC are not increased from current.

9. CONCLUSIONS

9.1 The current effects of the Waihola STP discharge on water quality and ecology are unlikely to be more than minor as it only contributes a very small proportion of the total nutrient load to the LWC. However, the cumulative adverse effects of all nutrient discharges to Lake Waihola, including the STP discharge, are substantial.

9.2 The proposed discharge volumes has the potential to cause more

than minor effects on water quality and ecology in the future, as they are substantially higher than the volumes currently being discharged from the STP and allow for a significant increase in nutrient loads to the LWC. As Lake Waihola is approaching the NPS-FM 2020 national bottom line for total phosphorus any increase in discharge volume from the STP also increases the risk of this threshold being breached.

9.3 The recommended effluent quality limits are generally appropriate as they represent an improvement from what from is currently discharged from the Waihola STP and are consistent with the *New Zealand Municipal Wastewater Monitoring Guidelines*. However, setting limits for median concentrations as well as 95th percentile concentrations would be beneficial from an effects management perspective.

9.4 To ensure that the effects on the LWC are not increased from current, the proposed discharge volumes would need to be decreased to better reflect the current operation of the plant. Alternatively, consent conditions could set load based compliance standards rather than concentration and volume limits. This would allow the applicant to discharge at whatever volume they need to, so long as they implement adequate treatment to ensure the effects on the LWC are not increased from current.

9.5 If additional time is needed to define a condition framework that will adequately provides for future growth without further degrading water quality in the LWC, the available information suggests that there would be a low risk of more than minor adverse effects occurring if CDC were to be granted a short-term consent to allow for the required technical work to be completed.

APPENDIX 1 - THE ORC SCIENTIST REVIEW

Waihola STP discharge to Lake Waihola outlet channel – consent renewal application

Adam Uytendaal (ORC Science team), 20/1/2016

Activity(ies) applied for & existing similar activities.

CDC are applying for a 35 year consent to discharge treated sewage effluent to the Lake Waihola outflow channel. The consent would replace an existing 15 year discharge consent that expires on the 1st of September 2017.

CDC are proposing to upgrade the existing treatment plant to provide improved effluent quality, particularly as it relates to bacteria (*E. coli*), suspended solids and BOD_5 levels. The design of the new plant is yet to be decided. It is the opinion of the applicant that in light of plant upgrade and proposed discharge limits, a 35 year consent is appropriate on the proviso the STP will have no more than minor effects on the receiving environment.

Values and significance

In support of the application, an Assessment of Environmental Effects (AEE) was carried out by Ryder Consulting Ltd. (Ryder, 2014) on behalf of CDC. The AEE provides a comprehensive summary of the characteristics and values of the receiving environment, being the Lake Waihola outlet channel and the Waipori/Waihola Lake-Wetland complex (LWC). I agree with the values summary provided by Ryder (2014) and include some additional points below.

Values and significance of the Lake Waihola outlet channel and LWC –

- Existing high natural values as identified in Schedule 1A, ORC Regional Plan: Water for Otago (2013)
- The LWC forms the most significant waterfowl habitat in the Otago region[6]
- The wetland complex has been recognised as an area of 'national and regional importance for wildlife in general, fisheries and botany' (Cromarty and Scott, 1995)
- The LWC supports a regionally significant whitebait and eel fishery[1]
- The lower Taieri River (that the LWC drains to) has high angler usage rates of around 7600 angler days per year representing around 9% of Otago rivers angler effort over the period covered by the 2007/2008 National Angler Survey (Unwin, 2009)
- The LWC supports a number of threatened native fish including the giant kokopu (*Galaxias argenteus* - "At Risk" and "Declining"), the longfin eel (*Anguilla dieffenbachia* - "At Risk" and "Declining" and Conservation Dependent) and Inanga (*Galaxias maculatus* - "At Risk" and "Declining"). Conservation status taken from Goodman *et al.* (2013)
- There is an Inanga spawning site in the immediate vicinity of the STP discharge (P Ravenscroft, ORC, pers. com)
- Lake Waihola has high contact recreation value and is popular for water sports such as water skiing, rowing, sailing, fishing and duck shooting.

[6] http://www.doc.govt.nz/Documents/science-and-technical/nzwetlands12.pdf

Further eutrophication and degradation of the LWC would negatively impact these values.

Effects

The applicant states there is little evidence of an effect on the receiving environment based on the current STP discharge. However, data on which to base this conclusion is largely non-existent. This is acknowledged by the applicant in the consent application (see below).

Page 12, paragraph 4, CDC consent application -

> Clutha District Council has not sampled the outlet channel, as this is not required by the current consent. In addition the fact that flow occurs in both directions depending on the state of the tide makes sampling upstream and downstream of the outfall somewhat meaningless as a way of evaluating the impact of the discharge on the Channel. Ryder reports that there is little water quality data for the Channel and suggests that water quality in Lake Waihola itself is the best indicator available for the Outlet Channel. He notes that the lake is supertrophic, saturated in phosphorus and nitrogen. The former has trended up in recent years, while the latter has trended down, but the lake is nitrogen limited. Turbidity in the lake is usually high and the lake has a high percentage of saturated oxygen with low E.coli levels which mean the lake is usually safe for swimming. However, the high nutrient loads can promote algal blooms, when it becomes unsafe for swimming.

Page 16, paragraph 2, CDC consent application -

> In considering the earlier reports, it must be noted that, in a general sense, land use and farm intensities have changed since then. However, there is insufficient water quality data to determine whether this has had an effect on the water quality in the outlet channel.

Page 17, CDC consent application -

Ryder Consulting Ltd has completed an assessment to support this application.[15] The conclusion of that assessment is:

The discharge of effluent from the Waihola oxidation pond to the outflow channel of Lake Waihola has a minor effect on water quality that is restricted to a localised area immediately downstream of the discharge point. This effect is temporary and shifts with the changing tide. The discharge does not appear to adversely affect aquatic plant, benthic macroinvertebrate, fish or bird communities. The minor and localised effect of the discharge on water quality in the outflow channel is expected to have minimal, if any, effects on water quality and aquatic communities in Lake Waihola, the surrounding wetland, or the lower Waipori and Taieri Rivers.[16]

As Ryder notes,[17] there is little water quality data from the outlet channel to support these observations. However, Clutha District Council did obtain eight samples between February 1998 and September 2002 which were analysed for BOD_5, faecal coliforms, enterococci and suspended solids. Table 5 shows the results of that monitoring, expressed as geomeans for each contaminant.

	BOD_5 g/m^3	Faecal Coliforms cfu/100ml	Enteroccoci cfu/100ml	Suspended Solids g/m^3
20m Upstream of Outfall	1.4	99	9	23.9
20m Downstream of Outfall	1.6	74	7	27.6

Table 5: Contaminant Parameter Geomeans, Upstream to Downstream

These results need to be treated with care. First, there are only eight samples. Second, while "upstream" in the context of the table means towards Lake Waihola from the outfall and "downstream" towards the sea, no record of the direction of the current at the time of sampling was made. Neither was the actual time of sampling recorded. Thus, any comparison between upstream and downstream results may not be valid, as the current at the time may well have been from the downstream location towards the upstream location.[18]

Given the lack of data to assess potential effects on the receiving environment, it is not possible to conclude if the STP discharge will have 'no less than minor effects' on the receiving environment, particularly as it relates to nutrient enrichment and eutrophication of the LWC.

Potential for backflow of enriched effluent to enter Lake Waihola

Condition 2(c) of the existing Waihola STP discharge consent states the consent holder shall undertake an investigation to determine potential for effluent backflow to enter Lake Waihola prior to the expiry of the consent:

> (c) The consent holder shall undertake an investigation into the options for minimising the backflow of effluent into Lake Waihola. This investigation shall specifically assess the possibility of reducing the period of time effluent is discharged. The consent holder shall provide a final report on this investigation to the Consent Authority prior to the expiry of this consent. The report shall detail the time frame for implementing any proposed changes to the disposal regime.

To date this investigation has not been carried out so it is not possible to comment on potential for nutrient enriched effluent to enter Lake Waihola and add to the degraded trophic state of the lake.

Given the lack of monitoring data and focussed investigations, a robust assessment of effects on water quality, particularly as it relates to nutrient enrichment of Lake Waihola, the Waihola outflow channel and the wider LWC is by necessity limited.

Areas of concern

Proposed contaminant concentration limits

pH, *E. coli*, suspended solids and BOD_5

The proposed limits for pH, *E. coli*, BOD_5 and suspended solids are believed to be satisfactory and represent a significant improvement on current discharge levels of these variables. The proposed *E. coli* limit would eliminate any risk bacteria loading from the STP poses on contact recreation values as it relates to exposure to bacteria.

Nutrients

The proposed concentration limits for total phosphorus and total nitrogen are high and would be typical of those expected of largely untreated sewage effluent.

In recent years Lake Waihola has experienced cyanobacteria (blue-green algae) blooms that have impacted on the recreation values of the lake[7]. Further eutrophication of Lake Waihola poses ongoing and increased risk of problematic algal blooms.

Operating discharge volumes and nutrient loads versus consented discharge volumes and nutrient loads

The current discharge permit allows a daily effluent discharge of 680 m^3/day and up to 1020 m^3/day under wet weather conditions (when storm-water inflows exceed the capacity of the oxidation). The consented (current consented and requested) average daily discharge volume is more than 6 times the actual average operating outflow volume of 102 m3/day[8].

Based on operating discharge volumes and measured concentrations of nitrogen (estimated from NH_4-N) and phosphorus, average daily and annual STP nutrient loads can be calculated and

[7] http://www.odt.co.nz/regions/otago/279328/algal-bloom-affecting-lake-waihola-worsens
[8] CDC consent application Page 9, paragraph 5.

compared to those expected should the pond be running at the consented daily discharge volume of 680 m^3/day. The comparison is provided in the following table:

	Nitrogen		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	4100	4.01	1460

Note: nitrogen loads are based on CDC measured mean ammoniacal nitrogen concentrations of effluent

Should the STP discharge effluent at the consented volume, nutrient loads would increase significantly. This is an important point to consider given:

- Assessment of effects is based on the current discharge volumes leaving the oxidation pond NOT the consented volumes
- The current degraded 'super trophic' status of Lake Waihola
- Ongoing issues of algae blooms
- Potential for further eutrophication of the LWC should oxidation pond discharge volumes increase over existing operating volumes WITHOUT significant reductions in effluent nutrient concentrations.

In summary

- Lake Waihola and the Waipori/Waihola Lake-Wetland complex (LWC) has very high natural and recreational values
- Lake Waihola is in a degraded 'super trophic' state based on ORC assessments. Additional nutrient inputs will further exacerbate the problem and threaten LWC natural and recreational values
- It is not possible to comment on the fate of Waihola STP effluent and its capacity to enter Lake Waihola and further impact lake eutrophication levels due to a lack of studies to assess this
- Receiving environment monitoring data is almost non-existent and limited to a single sampling date carried out by Ryder Consulting Ltd (2014). Monitoring data is therefore inadequate to determine potential long-term effects on the receiving environment
- Current operating STP discharge volumes are very low compared to consented volumes. If the STP was operated at consented discharge volumes nutrient loading would increase by over 6 times the existing loading.

References:

Cromarty, P. & Scott, D.A. (eds) (1995) "A Directory of Wetlands in New Zealand". Department of Conservation, Wellington, New Zealand. http://www.doc.govt.nz/Documents/science-and-technical/nzwetlands12.pdf

Goodman, M., Dunn, N.R., Ravenscroft, P., Allibone, R.M., Boubee, A.T., David, B.O., Griffiths, M., Ling, N., Hitchmough, R.A., Rolfe, J.R. (2014) "Conservation status of New Zealand freshwater fish, 2013". *New Zealand Threat Classification Series 7.* Department of Conservation, Wellington, 12 p.

Ryder Consulting (2014) "Waihola Oxidation Pond Discharge to the Lake Waihola Outflow Channel. Assessment of Environmental Effects. February 2014". Prepared for Clutha District Council by Ryder Consulting Ltd. Document version 5/2/14.

Unwin, M. (2009) "Angler usage of lake and river fisheries managed by Fish and Game New Zealand: results from the 2007/08 National Angling Survey". NIWA Client Report No: CHC2009-046.
(http://www.fishandgame.org.nz/sites/default/files/National%20Angler%20survey%202007-8%20Martin%20Unwin%202009.pdf)