MEMORANDUM

Bay of Plenty REGIONAL COUNCIL

To: Andy Bruere
Lake Operations Manager

From: Paul Scholes **Date:** 25 September 2015
Environmental Scientist

File Ref:

Subject: **Recommendations for monitoring alum dosing effect Lake Rotorua**

Hi Andy,

In response to your memorandum I have commented on ideas for future monitoring to potentially be undertaken to clarify and monitor the impact of the alum programme on Lake Rotorua. Also have added some analysis on DO on Lake Rotorua but potentially need some correlation with climate data to round this out.

The recommendations from David's report are:

"1. We recommend that consideration be given to wider use of biota as an assessment tool for monitoring potential chronic effects from alum in the lake. Tissue sampling could be conducted on key species (e.g. kākahi, koura and trout) to encompass a broad representation of different feeding strategies and species of cultural and recreational significance.

Comment:

Consent 65321 has several conditions to characterise the potential impacts of alum dosing in the Utuhina Stream, and similar conditions are also contained in consent 65559 for Puarenga alum dosing.

9.6 *Wild fish, namely trout, common bully and koura, shall be sampled annually to generate relative density estimates in three sections of the stream:*

- *50 to 100 metres upstream,*
- *50 to 100 metres downstream, and*
- *50 metre section in the vicinity of Lake Road.*

9.7 *Fisheries sampling shall also be undertaken annually in the three sections of the stream identified in condition 9.6 above for the purposes of bioassay of common bully and/or koura to test for bioaccumulation of aluminium in fish tissue.*

9.8 *Macroinvertebrate sampling shall be undertaken at the same frequency as the fisheries sampling required by condition 9.6 above to examine the effects on communities.*

The latest report (Ling, 2014) pertaining to these consent conditions shows some evidence of aluminium bioaccumulation was seen in the gills of koura and common bully resulting from continuous alum dosing of the Utuhina Stream. Alum exposure in these species does not appear to affect their health or abundance in the stream. There was no observed differences between upstream control and alum-exposed sites. MCI

scores were similar to previous samples obtained before and after commencement of alum dosing in 2006. No obvious effects of alum dosing on stream fish or macroinvertebrate communities were observed.

There is a concern that first symptoms of aluminium effects on fish and koura are clogging of the gills, followed by further physiological impacts. This coupled with the low buffering capacity of Lake Rotorua and the risk of increased acidity leading potentially to a toxic aluminium state, creates the potential for adverse ecological consequences. Tempero (2015) has concluded that the risks to the local ecology of short-term alum dosing with conservative application rates is low. These could be exacerbated by accidental alum release at high dosage rate and/or geothermal additions that create more acidic conditions.

Current consent conditions require annual eco-toxicological monitoring in the Utuhina and Puarenga around Sulphur Bay. The question remains if it is necessary to expand this monitoring into the wider Lake Rotorua environs?

Characterisation of aluminium content of biota in Lake Rotorua could be valuable should alum treatment continue longer then envisioned. Knowing the current and future health of aquatic organisms under a regime of variable lake management and natural perturbations will also add valuable insight to ongoing lake management strategies. However, such information gathering can be costly and time consuming and could and data value may be compromised by the complexities of natural variations versus anthropogenic impacts.

2. We recommend that a regular, repeatable monitoring protocol be adopted for determining phytoplankton nutrient limitation in Lake Rotorua. Analysis of the data should include considerations of alum dosing rates, concentrations of inorganic and total nutrients, and time of year in relation to phytoplankton composition.

Is this primarily for model input? Need to know model requirements to establish any monitoring programme. Phytplankton nutrient limitation could be species dependant so how would results be best utilised and is it achievable to test a range of species of agglomeration? Requirements: algae identification (seasonal sampling); lake water chemistry (tie-in with existing programme or a need for high intensity monitoring to test biogeochemical gradients); bioassays; others?

Benefits would be not only to help modelling but also to develop the nutrient limitation understanding.

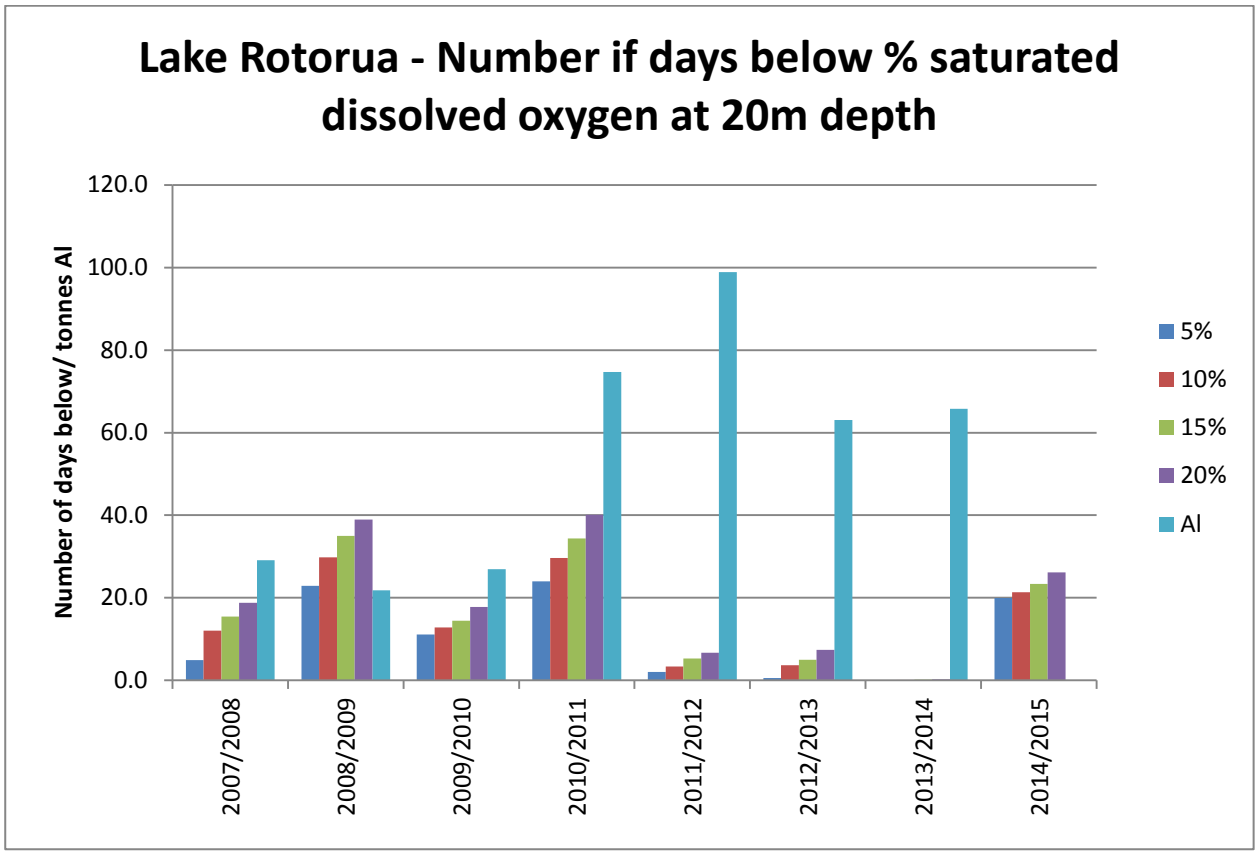
3. We recommend close examination of pH from the high-frequency lake monitoring buoy to better understand its variability and the possibility of any untoward consequences from relationships between alum dosing, phytoplankton biomass and pH variations.

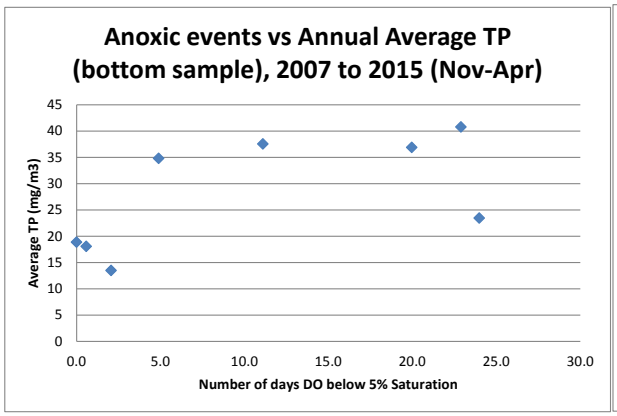
pH calibration issues have been a historical problem and this must be considered. Is this useful at the monitoring buoy, especially when we see movement of Sulphur Bay waters at times along the eastern side of the lake. Better to locate near the Utuhina Stream entry to Lake Rotorua?

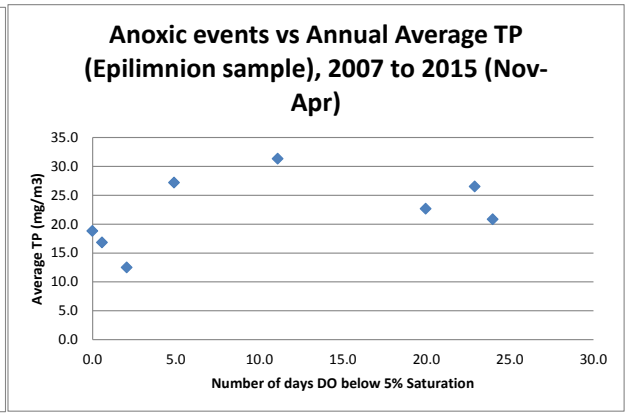
4. We recommend that increased frequency of in-lake measurements of Al be complemented with development of a dynamic module for simulating Al concentration in DYRESM-CAEDYM, should this model continue to be used to provide key information on the effectiveness of alum and to generate hypothetical scenarios (e.g., if alum dosing was not undertaken).

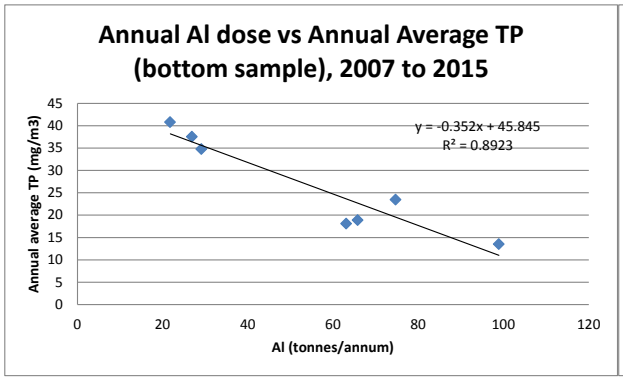
Currently monitoring of Al is monthly at two sites, what frequency is required for the model and how long should a monitoring programme extend for? Spatial scale?

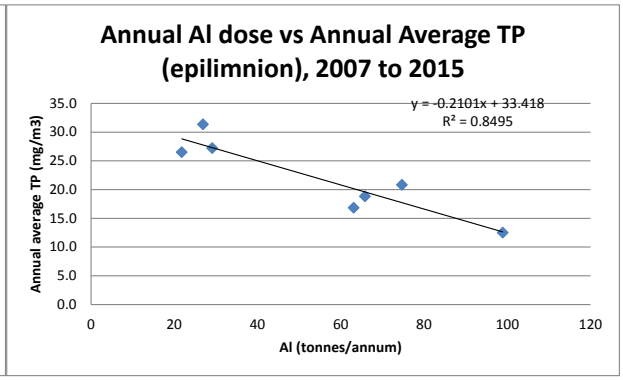
5. Sediment oxygen demand over stratification events should be calculated from high-frequency lake buoy data. The most recent six-year period of high-frequency monitoring as well as data collected in 2004-5 can be used to examine any conspicuous trends and potential correspondence to alum dosing."

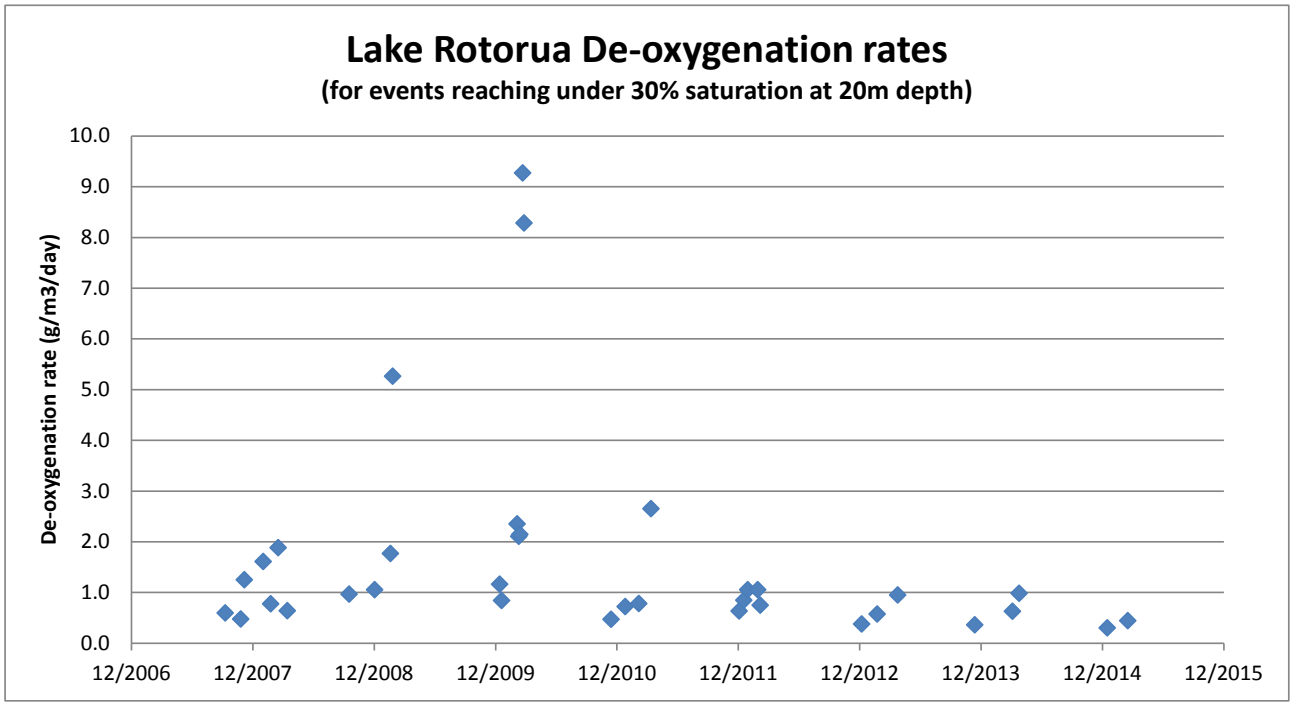


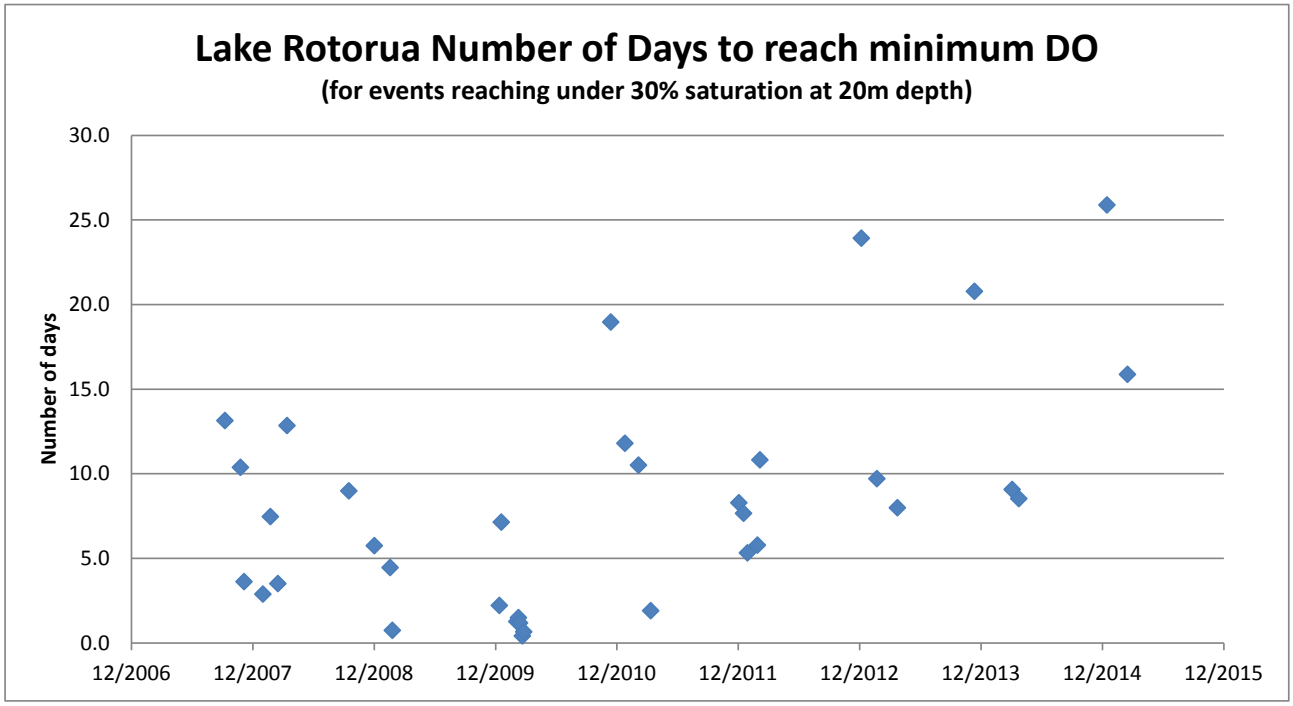









Lake Rotorua De-oxygenation rates
(for events reaching under 30% saturation at 20m depth)
De-oxygenation rate (g/m3/day)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
12/2006
12/2007
12/2008
12/2009
12/2010
12/2011
12/2012
12/2013
12/2014
12/2015


Lake Rotorua Number of Days to reach minimum DO
(for events reaching under 30% saturation at 20m depth)
Number of days
30.0
25.0
20.0
15.0
10.0
5.0
0.0
12/2006
12/2007
12/2008
12/2009
12/2010
12/2011
12/2012
12/2013
12/2014
12/2015