A Statement of the Significance of Phosphorus and Nitrogen in the Management of the Rotorua lakes
June 2014

1 This statement is the collective thoughts of a Technical Advisory Group (TAG) established by Bay of Plenty Regional Council, Te Arawa Lakes Trust and Rotorua District Council to assess technical aspects of lake research. It aims to present a scientific view of the contribution of phosphorus and nitrogen to the current condition of the Rotorua lakes.

2 Eutrophication of some Rotorua lakes first became evident in the early 1960s due to increased phytoplankton and macrophyte biomass caused principally by greater loads of phosphorus and nitrogen and the introduction of invasive macrophytes..

3 Phosphorus and nitrogen enrichment is not generally considered to cause excessive growth of introduced aquatic macrophytes (oxygen weeds). Indeed, lake management aimed at reducing phytoplankton growth and improving water clarity may cause macrophyte beds to become more vigorous and expand in area, which may necessitate control actions such as weed harvesting.

4 The Bay of Plenty Regional Council's Regional Water and Land Plan is aimed at restoring lake water quality to that which prevailed during an earlier period prior to widespread public issues with phytoplankton blooms. The consequence of not meeting this goal is likely to be:

(i) Increased frequency of occurrence of nuisance algal blooms.
(ii) Water clarity decline.
(iii) Periods of de-oxygenation of the bottom waters of lakes and associated increased releases of phosphorus and nitrogen from the lake sediments that exacerbate declining water quality.

5 Increases in nutrient loads to the lakes have been associated with land use change over many decades, from forests to more intensive forms of agriculture such as dairying, as well as intensification within individual agricultural industries. Nutrient inputs from sewage have also contributed to increases in nutrient loads as human populations around the lakes have expanded, and prior to changes in treatment and disposal of wastewater (e.g. Lake Rotorua in 1991) and recent sewage reticulation of some lakes (e.g. Tikitapu, Okareka and parts of Rotoiti).

6 Internal nutrient loads (viz. nutrient releases from the lake bed) can contribute substantially to total nutrient loads to some lakes, particularly in those that have been affected by eutrophication (e.g. Rotorua, Rotoehu, Okaro and Rotoiti).

7 A combination of catchment management and in-lake actions has been used to address excess nutrient loads that lead to lake eutrophication. Examples include land use change, improved management practices in forestry and agricultural industries, inflow diversion in Lake Rotoiti, dosing alum to two inflows to Lake Rotorua, in-lake chemical treatments in lakes Okaro, Okareka and Okawa Bay of Lake Rotoiti, destratification, wetland construction or enhancement, as well as sewage reticulation and treatment.

8 Evidence from recent monitoring data indicates that the alum dosing of two inflows to Lake Rotorua (Utuhina commencing 2006 and Puarenga commencing 2010) is highly effective in reducing phosphorus and, to lesser extent, nitrogen concentrations in the lake water, resulting in improved water clarity and reduced

occurrence of algal blooms. Similarly, the Ohau Channel diversion wall completed in 2008 has been effective in reducing nutrient loads into Lake Rotoiti and improving water quality.

9 Land disposal of treated wastewater from the Rotorua Treatment Plant commencing in 1991 was initially highly effective in reducing its nutrient load on Lake Rotorua but there has been a net increase in the total nutrient load to Lake Rotorua due to increases in diffuse pollution (particularly nitrate) from agriculture. Furthermore, despite improved treatment (viz. higher relative rates of nutrient removal) by the Rotorua Treatment Plant, it may be difficult to further reduce nutrient loads from this source because the land disposal site has become progressively less effective in removing nitrogen and wastewater inputs to the treatment plant have progressively increased with sewage reticulation of lakeside communities. Without management intervention the nutrient loads from this source are expected to increase.

10 Ultimately reducing nutrient inputs from sewage to the lowest loads practicable, in combination with matching catchment land use (urban and rural) with sustainable lake nutrient inputs is the only way to achieve the community goals set in the Water and Land Plan if reliance on short term interventions is to be phased out. Reductions in nutrient loads through sewage reticulation and better treatment provide reliable long--term gains that can have almost immediate benefits, particularly where the communities are located on porous soils close to the lakes. In some cases sewage reticulation alone can provide the reduction target needed to restore a lake and provide certainty of nutrient reduction targets.

11 Bioassays have been carried out intermittently in a number of lakes from the 1970s to present. Phytoplankton responses to these small-scale additions of nitrogen and phosphorus have varied amongst lakes and in some cases within individual lakes. Unless there is compelling reason to target only reductions in phosphorus under a strategy of a single nutrient limiting phytoplankton productivity, reductions in both nitrogen and phosphorus inputs should be undertaken concurrently. A focus only on nitrogen reductions is not advisable as it may increase the probability that the phytoplankton population becomes dominated by undesirable cyanobacteria. The primary objective should be to reduce concentrations of nitrogen and phosphorus in the lake water to the point where they limit the productivity of phytoplankton.

12 The ongoing programme is one of adaptive management based on the outcomes of research, implementation of actions and monitoring, both within the catchment and in some cases within lakes.