Executive Summary

Lake Rotorua Phosphorus Workshop 3rd Nov 2016

The following summarises workshop findings from three keynote presenters:

Phosphorus Loss Sources in BoP Region (Prof. David Hamilton, University of Waikato)

- To achieve the target TLI for Lake Rotorua both catchment N and P need to be reduced. Sustainable target levels have been set in the BOPRC Policy statement and in the Rotorua/Rotoiti Action Plan.
- The catchment nutrient reduction strategy must have regard for the in-lake N:P ratio. It is acceptable to reduce them concurrently, but the ratio itself should not be reduced below the long-term average of 12:1. A reduction in the N:P ratio could lead to cyanobacteria becoming dominant with some that can potentially fix N from the atmosphere.
- In Lake Rotorua bioassays it has been shown that cyanobacteria increase growth in response to additions of N and P individually, but the response to the addition of both N and P is larger than observed with the addition of only N or P alone.
- The response to additional N or P can vary from season to season depending upon which nutrient is limiting at the time. Sometimes the response is to N or P, but often it's to both simultaneously.
- The Alum dosing programme has reduced available phosphorus in Lake Rotorua. Total P has been reduced to in-lake target levels since about 2012 due to the alum dosing programme. The target level is 20 µgP/L In Lake Rotorua. Alum dosing has resulted in a reduction in cyanobacteria presence since 2010 and there have been no health warnings due to cyanobacteria blooms in recent years.
- When the lake stratifies, most commonly in summer, bottom waters begin to de-oxygenate with consequent release of nutrients from bottom sediments. Alum appears to have had a role in reducing this release. A reduction in nutrients results in a reduction in algal growth, which in turn reduces the volume of decomposing material settling on the lake bed. The injection of alum effectively initiates a positive feedback loop; stream dosing of alum beyond the level required to inactivate phosphorus in the stream helps to create a residual that controls both natural and anthropogenic sources of P in the lake.
- Alum dosing is identified as a short-term intervention to manage P until catchment N and P loads are controlled and approach the sustainable catchment targets. It is expected that alum dosing will be phased out as these targets are realised.
- N and P from land take different pathways through the soil and water. Generally N travels as a soluble phase with water, whereas P attaches readily to soil particles and travels overland, often as the result of erosion. The techniques available to reduce N leaching will mostly not provide a similar magnitude of reduction in the loss of P from the same area of land. There is a

need to address P run-off from land use and transport in streams. The objective should be to increase the retention of P on the land in order to reduce downstream effects.

- Assessment of P inputs to Lake Rotorua from the catchment indicate that around half of the stream and groundwater inputs are from natural geological sources. Anthropogenic inputs which may be able to be managed by land use controls contribute the other half of the P load reaching Lake Rotorua. Hence, any reduction of the P load coming from anthropogenic sources (catchment land use) can only ever address about 50% of the total catchment P load.

- Science advice is that management of algal blooms in Lake Rotorua cannot be achieved by catchment management of P alone unless in-stream/in-lake controls (e.g., alum dosing) are used. Current management of P through the alum dosing programme has resulted in an approximately 50% reduction in P concentrations in the lake, with the alum addressing both natural and anthropogenic sources, including in-lake releases.

- Both diffuse and point-source urban storm water discharge have been identified as potentially significant contributors to in-lake phosphorus.

- Removal of urban storm water P could be greatly enhanced by improved engineering interventions.

P losses and mitigation (Prof. Richard McDowell, Lincoln University)

- There can be a wide seasonal variation in P loss due to climate, soil type, topography and land management. The interaction of these factors with land management and farmer environmental practice has a significant effect on the level of P loss from season to season and from farm to farm. Best management practices are available to minimise P loss from land.

- There is a positive relationship between soil test P (Olsen P) and the P in surface runoff and leaching. In terms of common pastoral farming land uses within the Lake Rotorua catchment dairy farming contributes the greatest N loss; deer farming is likely to have the greatest sediment loss on a per hectare basis. Any land use can contribute P losses depending on soil P, slope, climate,

- There is a need to understand the difference between agronomic optimum and economic optimum for P fertility. The latter is more important for farm profitability, and tends to be lower than agronomic optimum, hence lower P run-off.

- Soil Olsen P levels should be maintained no higher than the agronomic optimum because losses of P are potentially greatest from areas with higher Olsen P. However, these losses only become real where there is a hydrological link to streams .

- Fertilisers, grazing management, and dung are the main sources of P loss within a farm environment.

- The bulk of P loss from farming systems can be attributed critical source areas. It is important to target these areas in addressing mitigation and ensure mitigations are correctly implemented and maintained. Dealing with Critical Source Areas (CSAs) can dramatically increase the cost-effectiveness of mitigation strategies

- P loss mitigations should be specific to the enterprise and match the region, taking account of the key local environmental factors including: critical source areas (small areas that account for most losses), climate, farming and grazing management, fertiliser and effluent management, flow paths, soil types and characteristics.

- Various P mitigation measures can have variable environmental effectiveness. A useful metric is $/kg of nutrient (N or P) retained on-farm

- Farm mitigations that are designed to address N leaching will not necessarily achieve the same level of P mitigation (and vice versa). If changes to both N and P are required then assessment of the efficacy of the mitigation for each nutrient should be understood.

- There is little research measuring the load of N and P from the harvesting of Radiata Pine forest. Hence, losses may be greater or less than predicted using the OVERSEER model predictions within the Rotorua Catchment. The data suggests that sediment loads from harvesting are high; if we assume a set P concentration for this sediment then P losses should also be high

- Key priorities to achieve P reduction: recognise that land management decisions heavily impact P loss; target Critical Source Areas of P loss; assess the cost-effectiveness of mitigations; develop a plan to put the appropriate mitigation options in place.

Nutrient losses from forestry (Dr. Peter Beets, Scion)

- Forestry plantations currently do not typically receive N or P applications to boost production.

- Forest sites converted from pastoral farming can be highly productive. The soil nutrient stores at ex pasture sites are generally much higher than trees actually need. This can result in legacy nutrient loss effects throughout the first rotation, and possibly longer.

- During forest harvesting, the nutrient cycle is interrupted and nutrient export (loss) during the time where the seedlings are establishing can be expected to occur in drainage water.

- N leaching in the first 3 years after planting can be significant. N is produced from decaying organic matter and can be as high as 70kgN/ha/year, prior to attenuation occurring.

- Stream water monitoring is not always a good indicator of losses from the forest operations. Within-stream nutrient processes can be highly variable.

- Sediment runoff during harvest operations is a key source of sediment and associated P loss to water. The management of sediment runoff during harvesting must be a key consideration during forest planting planning. Provide buffer zones that effectively stop runoff during forest harvest and ensure steep slopes that cannot be buffered are not planted for production forestry.

- Current forestry nutrient focus is on matching supply and demand (using modelling) and on live and dead biomass-N pools. First rotation radiata pine initial places a high demand on soil N stores (1000kg/ha removed from mineral soil), however subsequent demands on soil stores decrease appreciably, assuming continued use of conventional stem only harvesting operations.
