

# MEMORANDUM



**To:** WQTAG Members

**From:** Andy Bruere  
**Lakes Operations Manager**

**Date:** 18 April 2013

**File Ref:**

**Subject:** **Water Quality TAG meeting - 16 April 2013 at Bay of Plenty Regional Council Office, Rotorua**

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## 1 **Apologies**

Apologies were received from Piet Verburg, Clive Howard-Williams, Warwick Silvester, Peter Dine, Mark Buckley, Hera Smith, Roku Mihinui, Trevor Stuthridge and Paul White.

Those in attendance were Kohji Muraoka, John McIntosh, Del Raurino, Deniz Özkundakci, David Hamilton, Mike Scarsbrook, Marie Dennis, Max Gibbs, Paul Scholes, Chris Palliser, Alison Lowe and Andy Bruere.

## 2 **Matters arising from last meeting**

### 2a **Letter for TAG re TLI protocol to Ministry for the Environment**

Paul did a presentation on the TLI protocol and TLI error. He compared Lake Watch TLI calculation versus manual TLI calculation only utilising parameters from the epilimnion.

Deniz raised the issue regarding the remaining size of error bars which could be over half a TLI unit. He suggested considering weighting to total nitrogen or total phosphorus depending on whether lake is limited by N or P. It was considered that these error bars were considerably less than using the Lake Watch programme, but at this stage this issue was only minor.

David Hamilton commented on the use of total nitrogen and total phosphorus, that this comes from an international protocol and Noel Burns added nitrogen due to its impact on lake productivity. He also raised that there are two main issues with respect to calculating TLI:

- 1 Whether TLI continues to be used nationally. He commented that nothing is resolved for water clarity due to natural contaminants that affect clarity
- 2 The monitoring protocol requires more consistency nationally so that TLI values from different regions can be compared. He stated that there was some value in updating original relationships and protocols.

John McIntosh stated that Bay of Plenty Regional Council used the TLI as a policy tool compared with the national objectives framework.

**Action:**

**Paul and Andy to write to MfE and also approach SWIM to reconsider the protocol and consider a review to address some of these issues.**

2b Covered in the item above.

2c Deferred until next meeting as Clive tendered his apologies.

2d Deferred until Ōkaro item 6D.

**3 STAG update**

**3a Rotoehu progress**

Kohji presented an update of the monitoring results for the de-stratification work occurring on Lake Rotoehu in a PowerPoint summary. He outlined the ongoing monitoring as well as the intense instrumental week which was conducted over the week of 26 February 2013. Some points that were raised during his presentation were as follows:

- Water clarity was extremely high in 1990, up to 8 metres but reduced in 1993.
- There was some evidence from the graphs he presented that oxygen depletion rates may be lower for 2012/2013 compared with 2011/2012 summer.
- Sediment monitoring differences between the main lake body and the northern arm (Area F), were likely to be due to less organic deposition.
- He presented bio-fish monitoring results.
- He presented results of the dye release in the southern device. The dye was lifted up and released and fell mainly back down to the thermocline but did not go below the thermocline. The thermocline at that stage was about 8 metres.
- He reported on current velocity from the flow meter before and after turning the machines off. There appeared to be some differences there.
- Max Gibbs commented that wind influences lake currents and needs further analysis of the ADCP meter information.
- Mike Scarsbrook raised a question, what is the key indicator for success.
- David Hamilton commented that it was a number of things including oxygen depletion prevention, possible disruption of phytoplankton at the surface, and that the role of the de-stratification may be just to weaken stratification over the summer period to allow natural mixing events to have more effect.

**3b Lake Ōkaro alum and Aqual-P applications**

David presented information on the impact of the last Aqual-P and alum dosing in December 2011 and July/August 2012. Further information and report will be presented in the near future but some of the main conclusions from this were:

- There was an immediate total phosphorus drop in 2011 and in 2012 after the July alum dosing.
- Algae numbers tended to increase immediately after the application. This may be due to clarification of the water allowing further light into algae remaining in the surface waters.

- Deniz commented that total phosphorus levels were as high as 0.2 part per million even after the application which is a very high level.
- Liquid alum application seemed to have a larger impact on reducing DRP than Aqual-P due to there being a larger equivalent amount of aluminium.
- There was an ammonium reduction evident with the application of Aqual-P.

**Action:**

**An action from the previous meeting needed to be continued requesting that STAG group considers need for alum dosing into the future.**

- Deniz also commented that the Ōkaro modelling work that he is undertaking will be important in determining what might have happened to Lake Ōkaro if no restoration interventions had taken place.

#### 4 **Presentation on phytoplankton monitoring in the Bay of Plenty region by Alastair Suren**

Alastair presented a comprehensive PowerPoint on the overall phytoplankton monitoring in the lakes area. Some of the main summary points from this are as follows:

- There is an NERMN algal programme which monitors lakes quarterly and also has a summer cyanobacteria monitoring programme.
- The programme started in 1991.
- There has been no reporting undertaken on this programme since 2000.
- Paul et al presented a paper in 2012 on some aspects of the monitoring.
- Alastair is coordinating the trialling of molecular methods for algal monitoring with Suzi Wood of Cawthron Institute in Nelson.
- There is no feedback to plans or policies from the phytoplankton monitoring.
- As an example of some of the data which is available Alastair presented information on algal blooms in Rotoehu and Rotoiti for the past 20 years .

John McIntosh made the comment that Objective 12 in the Regional Water and Land Plan does create some link between the Plan and algal monitoring.

It was also discussed that the TLI is not a good indicator of algal issues for several reasons including that these are mid-lake samples versus high cyanobacteria levels closer to shore and that algal factors only contribute to one of four parameters in the TLI. Note: John Mac added after meeting: The TLI is an annual indicator whereas the algal monitoring requires an instantaneous indicator. There is probably a relationship between the annual TLI and the incidence of BG algal blooms but it is not appropriate to use the TLI as an instantaneous indicator.

Deniz commented that there is a need for phytoplankton data for the lake models. This is to allow modeller to parameterise the model. He stated that if phytoplankton monitoring was to stop then this would create a significant issue for development of any further lake models.

Alastair also informed the Group that there is an issue around processing of samples and staffing resource to analyse samples. He said that there was a considerable backlog of phytoplankton samples at times and that students were used when available to undertake

this analysis. This required training effort and also posed some risks with consistency of analysis using newly trained in-experienced student staffing. He commented that investigations into the use of molecular techniques may help resolve some of these issues.

**Action:**

- 1 **It was agreed by the Group that analysis regarding long term data set would be very desirable in the form of a report back to the TAG and probably to Council committees (Alastair).**
- 2 **Investigate whether there is any correlation between monitoring information available and the information of the monitoring buoys on our lakes. (Alastair)**
- 3 **It was agreed to form a small group from the TAG to discuss the on-going needs of Council and the programme around phytoplankton monitoring. This group would include Alastair, Maree, Deniz, Suzi Wood and David Hamilton. A proposal should be brought back to the TAG for advice back to the Strategy Group and Council.**

There was some discussion around other lake health indicators such as SPI. David made the comment that Lake SPI was not coming through at a national level.

John McIntosh made the comment that an issue statement or statements need to be prepared so that a planning process can proceed for management of lake weed and an appropriate monitoring procedure specified. This is likely to become more of an issue as we get algal issues under control and improve water clarity.

5 **NIWA internal load report from Clive and Piet**

Deferred until next meeting since both were not in attendance.

6 **Model updates (Deniz O)**

Deniz provided the following updates:

- (a) Rerewhakaaitu with a PowerPoint presentation.
  - The modelling project was in early stages.
  - Nitrogen inflows worked out so far by Deniz appeared to be low compared with nutrient budget calculated for Rerewhakaaitu.
  - This may be related to the disconnect between the surface water and groundwater in the catchment.
  - He is working through calibrating the model.
  - There are possibly some very low dissolved oxygen periods (polymictic lake).
  - The scenario modelling can commence shortly and will need some community involvement.
  - John McIntosh made the comment that the groundwater surface is below the level of the lake but can still get storm water flows into the lake, effectively receiving all storm water.
- (b) Lake Rotokakahi 1D model

Main points from Deniz were:

- This model has become important to develop due to the TLI decline in water quality.
- Aim to determine water quality decline drivers.

- Deniz was asking whether modelling the impact on Rotokakahi was of value.
- The model re-produces the anoxic situation of bottom waters that is being monitored.
- The lake appears to be two basins and this creates some issues with reproducing temperatures with the 1D model.

The Group agreed that modelling for kakahi impact was worthwhile particularly on this lake here where it will be one of the species of significant interest the Māori owners.

David Hamilton made the comment kakahi were distributed between 2 to 10 metres in work done by Joe Butterworth in his thesis. Deniz commented that he would complete and report on the 1D model and then start the setup of a 3D model which would allow better representation of kakahi. He also mentioned the use of remote sensing to identify logging hot spots from satellite images over the logging period.

Alison Low mentioned that through the District Council she may have access to some better images.

**Action:**

**Alison to investigate access to satellite images and convey that information to Deniz O.**

Paul Scholes also raised that N release from pine tree roots had been reported on in a paper by Gerty Geilen of SCION.

(c) Tikitapu modelling 1D modelling

David presented on the 1D modelling for Tikitapu. Some points that he made were as follows:

- The lake has low silica and that's the main reason why diatoms in the lake are absent giving the lake its distinctive blue colour.
- The Group were aware that Chris Hendy had raised concerns regarding sediment disturbance and possible release of silica which could increase green algae concentrations.

Deniz made the comment that the risk of low DO was low and that phosphorus concentrations were very low within the lake. He suspects that any peaks in phosphorus concentration are related more to runoff events.

David was asking for any comments on scenarios to be modelling. He listed a number of scenarios that would be worth modelling which included septic tanks, storm flow inputs and other recreational monitoring. It was discussed that some storm flow monitoring would have to be undertaken to enable an input to the model.

**Action:**

**Paul Scholes to check out possible monitoring of storm inflows from roadside drains.**

David commented on 2011 SPI information that showed significant areas of native charophytes had been lost since the last survey. These occupy the lake bed up to about 3 metres below the lake surface.

John McIntosh asked the question has the lake changed with respect to water colour that could be attributed to silicon increase affecting algae numbers.

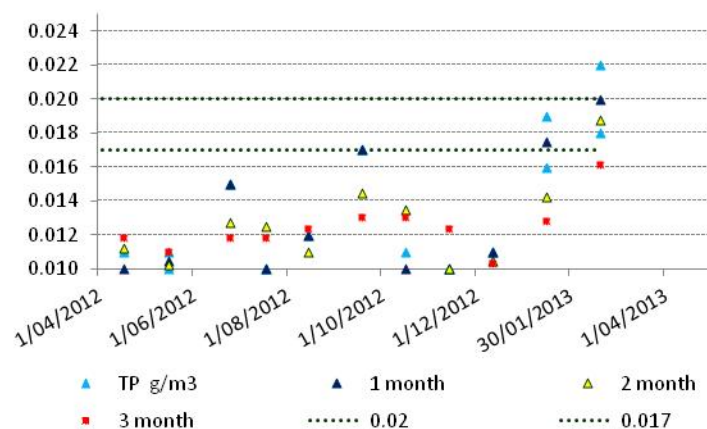
**Action:**

**Paul to initiate colour (440) monitoring in the NERMN programme to determine if there is any particular issue here.**

David suggested on the next meeting agenda, there should be a presentation on time series of vertical profiles of algal within the Alum dosing protocol

John McIntosh presented on this update of the protocol. The main point he showed was the graph Figure 3 below. This shows the impact of averaging P levels to increase or decrease the alum dosing by 10 litres per hour:

“Figure 3 shows recent TP data, up to February 2013, from the monthly monitoring of Lake Rotorua surface waters with monthly average statistics. “



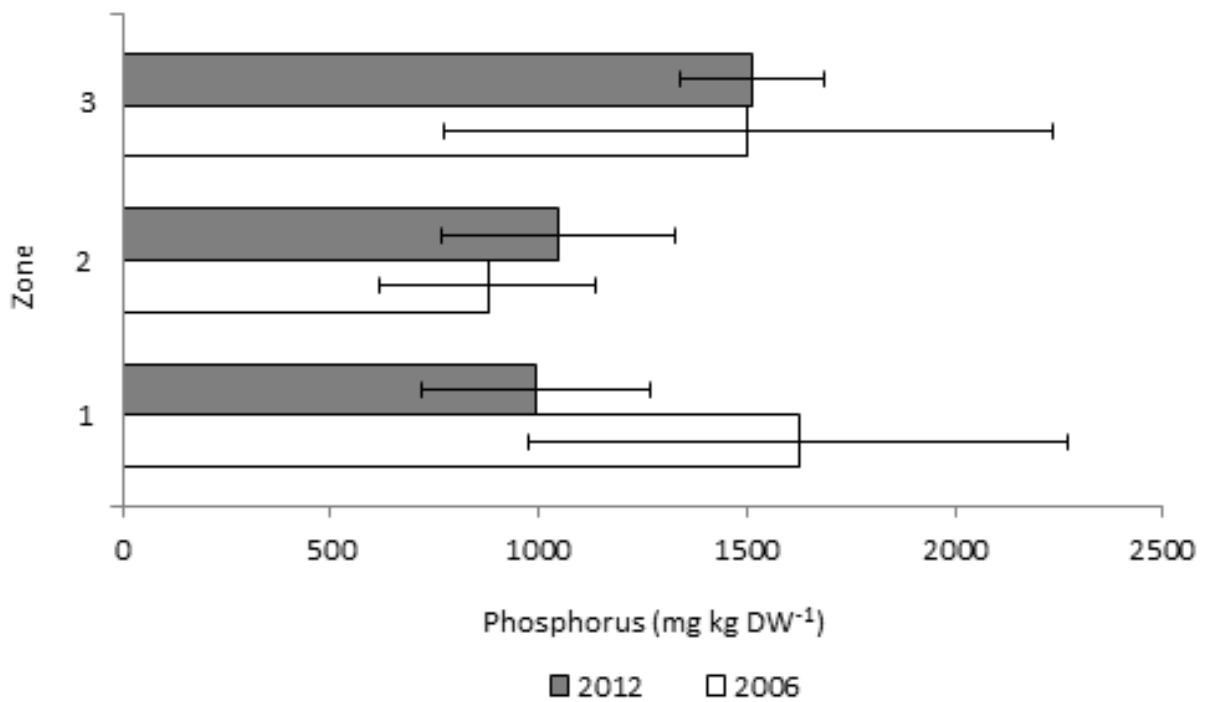
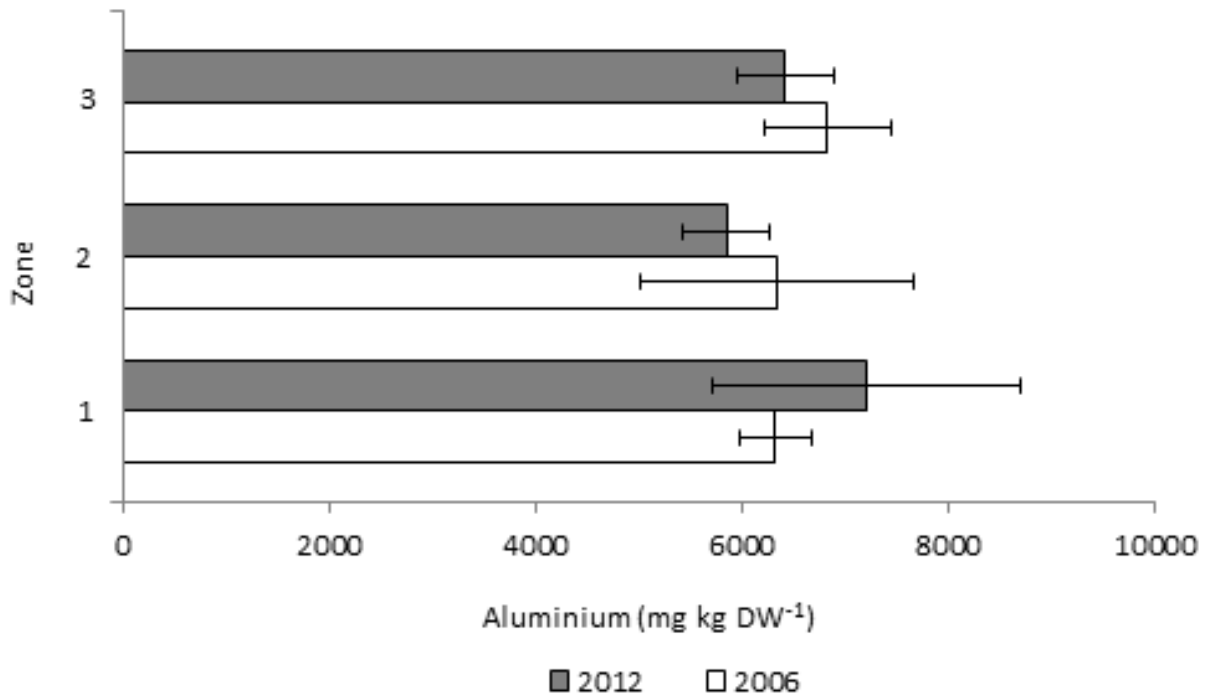
*Figure 3 The total phosphorus (TP) concentration in Lake Rotorua from 2 sites, with the one, two and three monthly average TP concentrations and the control band between 0.017 and 0.020 g/m3 TP, from monthly sampling between April 2012 and February 2013.*

**Action:**

- 1 **Come back and report on progress in six months' time for review. (September TAG)**
- 2 **It was discussed that John should also provide a dosing protocol for Lake Rotoehu phosphorus locking plants to the next TAG meeting.**

## 7 Sediment survey and alum budget - Rotorua

Deniz presented a PowerPoint. The sediment sampling was analysed in three zones they were broken into Zone 1 the inflow zone, Zone 2 the sedimentation zone and Zone 3 the low sediment accumulation zone. Graphics were presented on aluminium and phosphorus levels in these areas in the sediment. A report will be presented summarising the results.





Deniz made the comment that longer term changes in the lake and catchment need to be taken into account of and may have had more impact on water quality in Lake Rotorua than the alum dosing (see report).

Mark Scarsbrook also suggested that the early 1990s could be added to these graphs.

Deniz also presented information on alum mass balance to explore the fate of aluminium in the streams. He summarised the aluminium to P ratios in a number of applications from the literature and some were as high as 100:1 aluminium to P ratios and the best were about 2:1.

He then modelled the aluminium uptake over 2007-2011 as dose increased the residual aluminium started to lock lake phosphorus.

He discussed binding ratios of aluminium to phosphate. From modelling work he suggested that the binding ratio would have to be 4.5:1 to get full water column load from Lake Rotorua. To get the 90% of the internal loading from Lake Rotorua it would need a binding ratio of 3.5 or 4:1. Both these ratios seem very optimistic and that's one of the reasons he believes some other changes have happened in the catchment and lake to reduce phosphorus levels.

He also reported aluminium has not accumulated in Lake Rotorua. He is now working on extending the model to explain other causes of increased water quality.

## 8 Rotorua inflow report

Paul Scholes presented a PowerPoint on this. The Stakeholder Advisory Group was interested in what was happening to Lake Rotorua inflows. He analysed a Council data set from 1992 to present and also added data from Kit Rutherford, Geoff Fish and Ray Hoare. He stated that there was some data gaps in the mid-1990s to 2000.

### **Action:**

**Paul to circulate the report to the TAG group for any further comments.**

David Hamilton asked whether the 2012 information could be added.

Paul commented that information would be available soon but there were some issues with the flow data and that was the reason he had not added it.

This information will be reported to the Stakeholder Advisory Group once Council was aware of it.

## 9 Lake targets and achievements

Andy and John presented a brief summary on this. It was explained that the Lakes Restoration Programme was now outcome focused rather than action focused. This means that funding from Council and Crown was reliant on achieving certain nutrient reduction targets related to the TLI of each lake. A summary of this information has been presented in tabular form for each lake.

Andy suggested that rather than going through numbers on each table that John and Andy circulate to the Group a rationale for calculating certain numbers for each intervention and this be considered by the TAG Group.

### **Action:**

**Andy to circulate to the Group rationale for calculation of nutrient gains achieved.**

In terms of alum dosing, Deniz suggested alum dosing achievements could be calculated by doing jar testing on lake water to get appropriate aluminium to P ratios. John commented that this may be difficult as the Lake Rotorua water would have to be spiked with phosphorus to get meaningful results.

10 **Rotorua sewerage nutrient load information and resource consent options**

Alison Lowe presented on behalf of Mark Buckley, a PowerPoint presentation was made.

The main points from the presentation were as follows:

- The resource consent application is a bridging consent.
- The proposal is to change the conditions that allow for the discharge of nitrogen from the land treatment system as it has been setting a resource consent condition for some time.
- The resource consent expires in 2021 and other options will need to be implemented prior to that time.
- Rotoiti and Rotomā sewerage is on hold until such time as decisions on alterations to the land treatment system have been made.
- The options for Rotoiti and Rotomā reticulate back into the town's sewerage treatment plant or reticulate to Kawerau. Alison commented that the Kawerau reticulation was not favourable due to control of sewerage going to some other district council.
- Currently less than 30 tonnes of nitrogen are being discharged from the land treatment system due to a low rainfall period. However the three to five year averages are about 37 tonnes of nitrogen annually.
- Phosphorus is below the 3 tonne limit. It has been moving down the profile to 47 cm and there is still sufficient soil absorption capability left.
- One of the reasons for going for resource consent change is to shift the point of compliance from the stream to the discharge point.

That change will allow 51 tonnes of nitrogen at the plant which would imply about 37 tonnes of nitrogen annually would reach the Waipa Stream.

- The application would include an increase in phosphorus from 3 to 4 tonnes of P annually.
- The treatment plant receives about 60 tonnes of phosphorus annually and they irrigate about 30 tonnes of phosphorus to the forest.

David Hamilton asked why there was an application to increase in the P load when they comply. Alison responded that this was looking to the future to ensure they continue to comply.

Alison then explained the scoping options which were presented in the PowerPoint. These included (from PPT):

No	Option Description	Capital Cost (\$m)	NPV (\$M) (7% rate at 40yrs period)	Comments
1	Expanded Land Treatment System (Slow Rate Irrigation)	23.25 (Based on 384 ha purchased land)	38.22	Confirm availability of contiguous land
2	Discharge to Waterway (Existing LTS decommissioned)	19.72	28.85	Treatment arrangement to meet cultural requirements. Trials required to confirm denitrification bed performance.
3	Denitrification bed to replace existing LTS	6.89	28.40	Trials required to confirm denitrification bed performance.
4	Improve existing constructed wetland	7.2 – 12.4	23.4 – 34.2	Trials required to confirm wetland performance
5	New discharge site. (Existing LTS decommissioned)	(A) 14.85 – 47.75 (B) 18.48 – 21.81	(A) 36.39 – 64.12 (B) 40.12 – 43.46	Availability of land for purchase and stakeholder acceptance within the catchment

Mark Scarsbrook asked whether Rotorua District Council is reducing inflows to the waste treatment plant.

David Hamilton asked about water conservation in homes and commented that in Brisbane they had reduced water consumption per head of capita from 280 litres per person to 120 litres per person per day.

Alison Lowe said the hydraulic load was the main issue on the land treatment system area due to tree health.

Paul Scholes asked about the production of struvite and Alison suggested that this plant was too small to do that commercially. David commented that this was being done on individual farms in Canada and that he would contact Ken Ashley for further information on that.

Max Gibbs suggested that they consider in eight years' time that way we will be better off with land outside the catchment so they only spend once on treatment of the disposal area. He also suggested a cut and carry system would be ideal. This would probably involve getting out of the Rotorua catchment downstream into the Kaituna catchment.

**Action:**

**David, Andy and Paul to meet with Rotorua District Council staff regarding sewage options and discuss how decisions have been made to include or exclude options and the impact on lake targets.**

Alison reiterated that there was no intention to renew the consent in 2021.

John McIntosh commented on the bridging consent. He commented the monitoring point was a shift away from the mill and forest affected area which is out of the control of Rotorua District Council. He also commented that 50 tonnes of nitrogen at the plant transfers to 30 tonnes of nitrogen from the irrigation area in in the ROTAN report. He also presented Table 1 below which is an adaptation of the Rutherford and other table from 1989. He was suggesting there was possible capacity in the lake for the additional N. His suggestion is that the 435 tonnes of nitrogen (lake target) and the 30 tonnes nitrogen (irrigation target) from sewerage are the lower end of a range.

**TABLE 1. Lake Rotorua Nutrient Inputs and Water Quality**

Factors (1)	1965 (2)	1976-77 (3)	1981-82 (4)	1984-85 (5)	Target (6)
Population	25,000	50,000	52,600	54,000	—
Phosphorus inputs (t/yr)					
Raw sewage	5	18	30	47	—
Treated sewage	5	7.8	20.6	33.8	3
Stream	34	34	34	34	34
Internal	0	0	20	35	0
Total	39	41.8	74.6	102.8	37
Nitrogen inputs (t/yr)					
Raw sewage	34	100	170	260	—
Treated sewage	20	72.5	134	150	30
Stream (including septic tanks)	455	485	420	415	405
Septic tanks	50	80	15	10	0
Internal	0	0	140	>260	0
Total	475	557.5	694	>825	435
Average lake water quality					
Total phosphorus (mg/m <sup>3</sup> )	—	23.8	47.9	72.6	20
Total nitrogen (mg/m <sup>3</sup> )	—	310	519	530	300
Chlorophyll (mg/m <sup>3</sup> )	—	5.5	37.8	22.6	10
Chlorophyll a (peak; mg/m <sup>3</sup> )	—	28	62	58	17-24
Secchi disc (m)	2.5-3	2.3	1.9	1.7	2.5-3
Oxygen depletion rate (g/m <sup>3</sup> /day)	—	0.4	0.7	0.9	0.25

Note: Catchment area = 424 km<sup>2</sup>; surface area = 81 km<sup>2</sup>; mean depth = 10.7 m; volume = 0.865 km<sup>3</sup>; outflow rate = 18.5 m<sup>3</sup>/s; and residence time = 1.5 year.

### Update of Table 1 (Rutherford et al 1989) Nitrogen

	1990-95	1995-00	2000-05	2005-10	2010	2011	Target
<b>Nitrogen input</b>							
Raw sewage t/y							
To irrigation site t/y	83	94	64	76	47	54	
Treated sewage t/y	25	35	38	35	32	41	30
Stream t/y <sup>a</sup>	483	473	470	476	484	475	375
Septic tank t/y	18	18	18	15	10	10	0
Internal t/y	61	167	156	117	65	45	0
Rainfall t/y	30	30	30	30	30	30	30
Sub-total tN/y	617	723	712	673	621	601	435
In-lake change tN/y	-7	-111	-54	0	-121	-128	
Total tN/y	610	612	658	673	500	473	435
<b>Median lake quality</b>							
Total phosphorus mg/m <sup>3</sup>	53	31	42	33	32	17	20
Total nitrogen mg/m <sup>3</sup>	421	422	454	464	345	326	300
Mean chlorophyll a mg/m <sup>3</sup>	9	11	26	19	15	15	10
Secchi disc m	2.4	3.2	2.6	2.6	2.6	3.3	2.5-3

### Update of Table 1 (Rutherford et al 1989) Phosphorus

Table 2 Summary of nitrogen and phosphorus inputs to Lake Rotorua from 1990 to 2011. Adapted from Howard-Williams et al (1986), Rutherford et al (1989) and Rutherford et al (2011).

	1990-95	1995-00	2000-05	2005-10	2010	2011	Target
<b>Phosphorus input</b>							
Raw sewage t/y							
To irrigation site t/y	12	26	30	30	17	20	
Treated sewage t/y	1	1	1	1	1	3	3
Stream t/y <sup>a</sup>	37	37	37	37	37	37	33
Internal t/y	12	19	17	17	20	6	0
Rainfall t/y	1	1	1	1	1	1	1
P locked t/y	0	0	0	0	-16	-22	
Sub-total tP/y	51	58	56	56	43	25	37

There was some discussion around this during his presentation and the TAG members agreed that the 435 tonnes of nitrogen was the calculated target through a number of processes for the sustainable load for Lake Rotorua. There was no agreement from the TAG that this would be the lower end of any sustainable nitrogen load.

## 11 **Other business**

Mark Scarsbrook raised DNZ representation on the TAG. He stated that he felt a new staff member with DNZ, David Burger may be a more suitable DNZ representative. TAG members agreed that David would be a suitable DNZ representative and it was suggested that Mike becomes the alternate representative if David is not available for continuity.

### **Action:**

**Mike to convey to David that he is invited to future Water Quality TAG meetings and provide email address to WQTAG convenor for future invites.**

**Meeting closed at 4:45 pm.**

Andy Bruere  
**Lakes Operations Manager**