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## QUESTIONS

*Don Atkinson, LWQS:* Chris, there is an enormous amount of work being done and absolutely fundamental going forward with solutions to the catchment. Is it now fully funded and when will it be completed?

*Chris McBride:* It is fully funded. I believe we are going forward with the 1D modelling project now.

*Don Atkinson:* The modelling project that is indeed funded and under way.

*Chris McBride:* I think probably it should be perhaps three months away.

*Don Atkinson:* That is very encouraging.

*John Green, LWQS:* A question for our pest man but he has gone. I was going to say that having run a ten acre property on Lake Rotoiti the pests are unbelievable. The key is to get care groups throughout New Zealand focussing on targeting those particular pests. We killed thousands of rats and possums over our time and we still could not get on top of them. It is a challenge.

Going back to Chris and Paul, I really enjoyed your presentations because you have shown us how complex the Tarawera lakes system is. What I find interesting is that Tarawera looks like it is the main problem and it is not so much those outside lakes. Their TLIs are slightly higher than the central lake but what impact does the volcanic mountain have? You do not appear to have focussed on that at all. Does the mountain have some input of phosphorus that has not been measured or identified? I am so pleased with the work you are doing and keep it going because it is clearly a very complex system. Thank you.

*Chris McBride:* What impact does the mountain have? If it explodes again there will be a pretty big impact I would imagine. It has definitely had a big impact in the past as you can see from a sediment core. When we constructed the nutrient budgets in the pie charts that I presented, they are based on broad export rate coefficients that we assume for different land types and based on whatever published literature we can find for losses from that type of land cover. It is accounted for in the nutrient budgets but probably there has not been too much detail yet so maybe it is something we could focus more attention on.

*Gary Rushworth, Hawkes Bay Regional Council:* A question for Chris. You mentioned briefly the core. The model did not seem to include a lot about nutrient legacy. I have been working on Lake Tutira and we collected cores to understand internal cycling of nutrients. Is that part of the model?

*Chris McBride:* Yes. The diagram I presented was very much a simplification of what was represented. There are hundreds, maybe thousands of processes represented and it does not explicitly include release of nutrients from sediments and sediment legacies but it is part of the model.

*Gary Rushworth:* How would you rank its importance? Obviously it will vary from lake to lake. Is it something that New Zealand Scientists need to understand more about? How does it rank in terms of knowledge gap?

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*Chris McBride:* Absolutely, particularly the impacted lakes and those that stratify. The internal loading is a really important source of nutrients to the water column, as much or even more so, than external sources. It definitely needs to be considered in any system that is impacted or may be impacted.

*John La Roche, LWQS:* My question is related to alum dosing in Lake Ōkaro but equally in Lake Rotorua. The mechanism of alum dosing is that the aluminium sulphate forms a flock with the turbidity in the water that then settles out. It is certainly removing phosphorus and nitrogen by tying them up in the turbidity, but that flock forms a blanket right across the base of the lake that would not deteriorate very quickly. Are you investigating what happens from alum dosing on the floor of the lake and what is the long term effect of having a blanket of inert aluminium sulphate or aluminium hydroxide across the floor of the lake?

*Chris McBride:* I could comment quickly and then defer to Max Gibbs who is the expert on this. As part of the Lakes' Programme, we have ongoing studies taking sediment cores and monitoring aluminium concentrations in the sediments of both Lake Rotoehu and Lake Rotorua. We have just completed a follow-up study to that.

In terms of accumulation in the sediments there is some aluminium sulphate detectable mainly around the points of insertion of those dosed inflows but it is not dramatic. There may be some subsidiary effects in the long term accumulation preventing further release of alum into the water column. If the dosing were to be stopped, over time that layer would be buried in deeper sediments as organic matter settles onto the lake floor.

Max, have you anything to add or correct or anything else?

*Max Gibbs:* It is pretty much what you said. The idea of alum capping is that it resets the sediments, forms a very thin blanket, perhaps a couple of millimetres at the most, and that sequesters everything out of the water column at the time that it was applied. It also stops anything coming up from the sediments below. The lake is then reset, no phosphorus in it. Whatever happens from the catchment will cover it.

Overseas these layers get buried deeper and deeper into the lake and that legacy material is held within the sediments rather than recycling. The alum process gives a chance to reset the lake and gets the lake water quality improving, which we see in Lake Ōkaro.

*Andy Bruere, BOPRC:* I have a question for Chris. You talked about the uncertainty of our estimates of the phosphorus input from geothermal. Do you think there is a possibility that those geothermal inputs might be changing and increasing? That is something that we have not experienced before.

*Chris McBride:* It is certainly possible. It is outside my domain, and probably Paul White would be much better placed to respond. It is something we definitely need to look into as part of the study assessing what the geothermal quantity might be. Part of that picture is how it might be changing through time, which is especially important because it is such a large fraction of the inputs to the lake. We need to understand that if we make changes in Tarawera and the other lakes, how might that affect natural variation of phosphorus inputs from geothermal sources.

*Max Gibbs:* John Green raised a very important point about the influence of the mountain. In Lake Taupo we know that there is a hydrothermal vent at the bottom of the lake which

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was discovered by GNS. We have been monitoring it since about 1975. We can pick up the chemistry difference from this vent. We know that it couples with eruptions in Mt Ruapehu and the southern mountains and with large earthquakes across the system. Has anybody looked to see whether there is an equivalent vent at the bottom of Lake Tarawera rather than just at Hot Water Beach?

*Chris McBride:* Perhaps we should. Perhaps another way we could look at this is following up on Matt Hamilton's mid-2000 study that I mentioned, using sodium as a tracer for potential geothermal inputs. Maybe we need to do a follow up study on that as well.

*Fred Stevens, Rotorua Lakes Community Board:* I have been living at Tarawera for over 30 years now. We have never been able to get a straight answer to, 'Did we have a Tarawera Action Plan?' Several years ago it was demoted to a Tarawera Restoration Plan. My understanding is that an action plan has more statutory weight. The reason we were told it was put back to a restoration plan was because they are waiting for more data. From what Chris McBride said it sounds as though works are being undertaken at the moment. I just want to ask Chris Ingle when are we likely to get the Tarawera Restoration Plan put back to a Tarawera Action Plan?

*Andy Bruere, BOPRC:* Thanks Fred. First of all, the reason it was called a restoration plan was because when the nutrient budget work was undertaken there were no identified sources of nutrient, particularly phosphorus, which we could reduce to meet the reduction target required to make a sustainable land use change around the lake. So they decided to call it a restoration plan. We will convert that to an action plan when we have identified nutrient sources and actions that will definitely meet those targets. In terms of timing it is reliant on this modelling work and on the farm environment plan work and then on the work that Chris McBride talked about with conceptual modelling.

Giving you a timeframe is probably a bit like a politician's promises at the moment, it is likely to be broken. I would prefer to say we will work through that work and see what information we have to achieve those reductions. It is a watch this space, sorry.

*Fred Stevens:* It still does not answer my question but thank you.

*Chris McBride:* You mentioned statutory weight, but I do not think either of them has any statutory weight. The name of the action plan or whatever we call it is semantics really. What you are looking for that has statutory weight is the Regional Plan and the Regional Policy Statement. We have just made a decision to start that Regional Policy Statement process of identifying outcomes for water quality in these lake catchments which is coming up quite soon. We have to get Council go ahead on a few things and sort a few more but once we have changes to the Regional Plan that will have effect on land use in the catchments.

*Bob Armstrong, Gisborne Point, Rotoiti:* As a long standing member of the LWQS, I am intrigued not only with the information that has been gathered but also the method of gathering it, particularly the three wells, which we saw drilled around the shores of Tarawera. Two of the wells were on an area where inlet water would obviously be coming in, but I noted with interest that the third well appeared to be at the outlet. Could I ask why that was chosen and if so what valuable information was received from that particular well?

*Paul White:* That well was sited for two purposes. The first one was a water budget purpose trying to understand the inflows and outflows of Tarawera. It has been observed

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that the surface flow at the bridge by the camp ground is about 3 cubic metres a second less than the flow below the falls, so downstream that river gains a substantial amount of water.

The first question was where is that water coming from, could it be coming from the lake? David Hamilton and I supervised a Masters student maybe ten years ago, Nicolas Gillon. He did an interesting project with options of inflows and outflows to and from Tarawera. Our best guess was about 2 cubic metres a second was missing in the water budget, so it looked as though the increase of flow at Tarawera Falls came from the lake somehow. So we sited the well there to intercept geology that was capable of transmitting about 2 to 3 cubic metres a second from the lake. That is important to the lake model because there is 2 to 3 cubic metres a second that we need to make the whole budget work and we had to see where it was going.

We drilled a couple of wells, one about 90 metres deep and the other about 80 metres, and intersected the same geological material, fractioned rhyolite, which is at the Tarawera Falls. It had sufficient hydraulic properties to be able to provide 2 to 3 cubic metres a second. There was some other work done but I think the problem is more or less solved. That flow is probably coming from the lake bed somewhere.

The second purpose of having the well there was to have it in a pristine catchment. The other wells on the western side were purposely drilled in the town to see what impacts of land use in the catchment behind the wells were having on the shallow and deep ground waters. That was demonstrated by the Dollimore well that I showed the results from. A relatively pristine catchment showed that the nitrate concentrations are much lower, consistent with native forests.