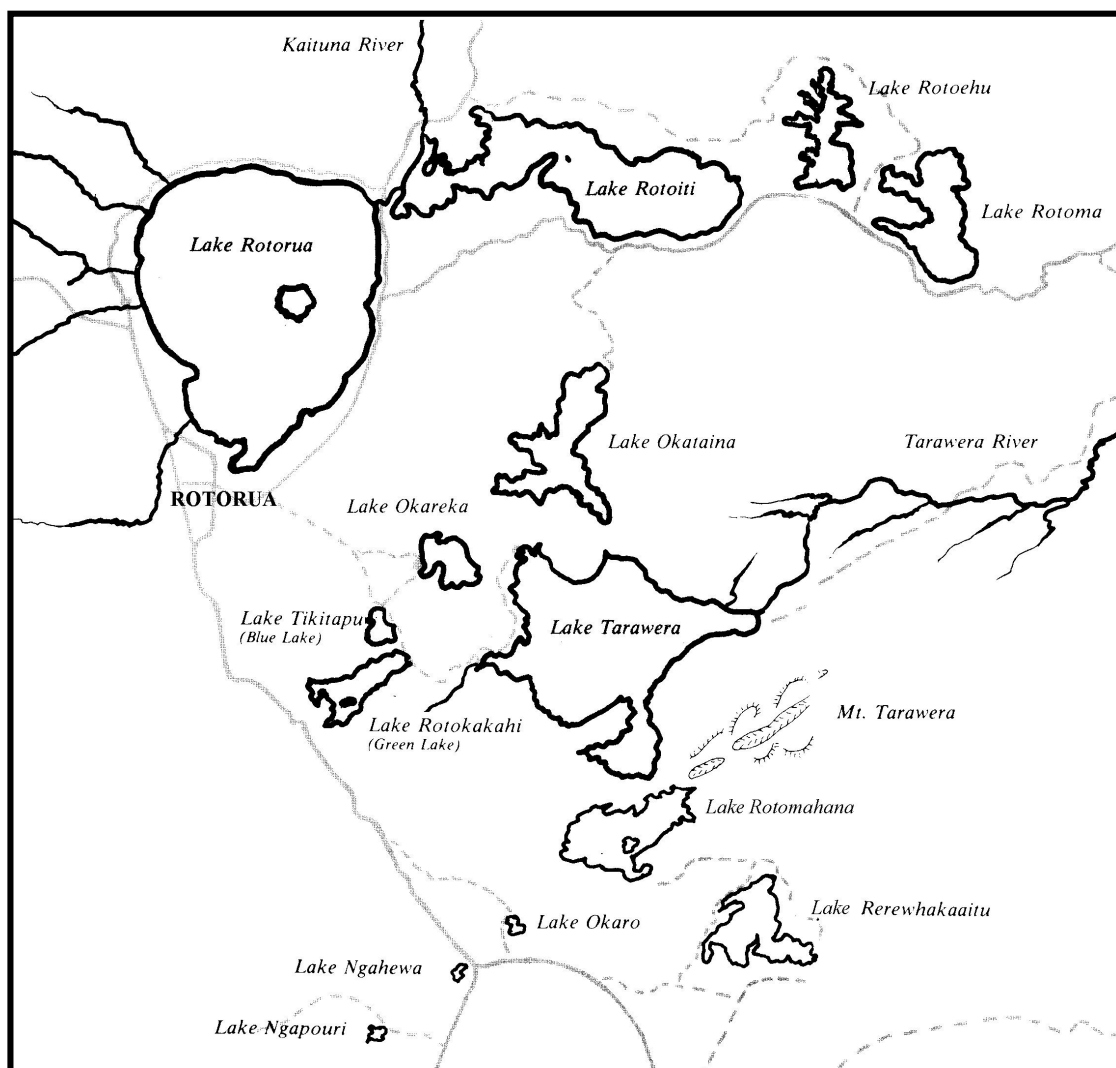


# Proceedings

## *ROTORUA LAKES 2011*

*Fix a Lake and Grow a City  
A Case Study of Rotorua*





# Proceedings

## *ROTORUA LAKES 2011*

*Fix a Lake and Grow a City  
A Case Study of Rotorua*

*APRIL 7th-8th 2011*

*Rotorua Convention Centre, Rotorua, New Zealand  
1170 Fenton Street, Rotorua, 3010*

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## EDITOR'S NOTE

Material for the Symposium Proceedings has been received as fully transcribed audio tapes and PowerPoint files. The editor then endeavoured to edit the spoken word to a written word format and included graphs and pictures from the PowerPoint slides, with discretion, in the body of each presentation. Where possible slides that contained only words were incorporated into the document text. Not all slides were included. The numbering used relates to the original PowerPoint presentation, not as presented in the Proceedings. These slides are in PDF files on a DVD at the back of these Proceedings. The papers were sent to the original presenter to ensure they were satisfied with the transcription.

Panel discussions have been included. These are a little more difficult to transcribe and there may be some errors or misinterpretations in the editing.

Poster presentations have been included in the Proceedings

I would like to thank all the presenters who have kindly helped me with editing. It is a mammoth and laborious task. In the interests of expediency and accuracy I very much appreciated their support. I would also like to thank Ian McLean, Lyn East, Liz Miller and my husband John who have spent their time looking for spelling, grammar and senseless meaning. There will be further mistakes but it is more important to produce this document as quickly as possible.

*Ann Green*

**Disclaimer:** These Proceedings report the formal presentations and open forum sessions of the Symposium, which was designed to encourage open discussion amongst those managing, studying or with an interest in the Rotorua Lakes region. The information is **not** intended to substitute for official policy statements from parent organisations.

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## FOREWORD - ROTORUA LAKES SYMPOSIUM 2011

**John Green**

Chair, LakesWater Quality Society Inc.

The ***Rotorua Lakes Symposium 2011*** was the seventh event of its kind hosted by LakesWater Quality Society. It was held in Rotorua, New Zealand on the 7<sup>th</sup> and 8<sup>th</sup> April 2011.

The theme of ***Fix a Lake and Grow a City - a Case Study of Rotorua*** broke new ground for LWQS. Earlier Symposia dealt with lakes and their catchments over the last ten years, increasing the understanding of water quality issues and the need for action as LWQS led the initiatives to restore and sustain the Rotorua Lakes for future generations.

This Symposium broke new ground as for the first time it also dealt with how prosperity of the Rotorua Lakes Region can be grown as water quality in the lakes is improved. It was designed to identify the key natural competitive advantages of the Rotorua region. Presenters with strong credentials drew on their experience to show how to harness the region's natural resources for economic growth and positive wellbeing for the region. It is our belief that strong economic growth will be a key driver and catalyst for enhancing and maintaining the natural resources of the region including lake water quality.

We encourage you to read carefully the messages and content in these Proceedings. The conclusions reached are that the Rotorua region is extremely rich in natural resources, cultural diversity and has a unique environment and economic opportunity. Our challenges are first to identify a thirty to fifty year vision for the city and its region with goals of economic prosperity and wellbeing for the community as a whole. Then we need to assemble the necessary resources under strong committed political and community-based leadership to achieve these goals.

The Symposium did not neglect water quality and lake restoration. Presenters reported on the current status of work to restore the lakes, as well as new ways of managing reduction in nutrient outflows from the land.

On behalf of LWQS, I extend our sincere thanks to all those speakers who prepared and presented papers and to the chairpersons: Mayor Kevin Winters, Emeritus Prof Warwick Silvester, Graeme Fleming, Roger Gordon, Rt. Hon Paul East and Ian McLean. We also thank Guy Salmon for his excellent summing up of the content and context of the Symposium.

The time and energy required to prepare and conduct these Symposia is most substantial. My special thanks go to our sub-committee of Brentleigh Bond, Ann Green, Lyn East, Don Atkinson, Ian McLean, Jim Howland, Warren Webber and Toby Curtis.

I also give grateful appreciation to our generous sponsors: Bay of Plenty regional Council, Rotorua District Council, Rotorua Energy Charitable Trust, Waiariki Institute of Technology and Rotorua Chamber of Commerce.

May the glimpse of a great future for Rotorua and its lakes be realised by its people and leaders of the district and may the lessons spread across New Zealand.



## **ROTORUA LAKES 2011**

### **FIX A LAKE AND GROW A CITY** **A CASE STUDY OF ROTORUA**

## **INTRODUCTION**

**John Green**

Chair, LakesWater Quality Society Inc.

Tena Kotou Katoa. Welcome to the 7<sup>th</sup> Lakes Water Quality Symposium, *Fix a Lake and Grow a City*. I will be your host for the next two days.

I would like to give a special welcome to Mayor Kevin Winters, the Councillors of the Bay of Plenty Regional Council and Rotorua District Council, the Mayors, Chairs and Councillors from other districts, speakers and chairs of this Symposium and a very warm welcome to our overseas guests - Mayor Bo Frank, from Sweden, the group of teachers and students from Earlham College, Richmond, Indiana, who were disrupted by the recent Christchurch earthquake and have taken the opportunity to be with us here today.

To our sponsors - The Bay of Plenty Regional Council, Rotorua District Council, Rotorua Energy Charitable Trust and the Waiariki Institute of Technology. Finally, a special welcome to all participants here today. We trust that the programme and the messages which we will project over the next two days will be a catalyst for action and positive change for this region.

Now to housekeeping – if you have any matters which are of concern to you, or any issues that you wish to have addressed, could you please approach those wearing a green name tag and they will direct you to whom you want.

It gives me great pleasure to ask the Chair of the Bay of Plenty Regional Council, and our major sponsor, to open this Symposium. Would you please welcome John Cronin.

**John Cronin, Chair, Bay of Plenty Regional Council**

Tena koutou, katoa and good morning all. Thank you, John, and welcome to our distinguished guests here today. It is a real privilege to be invited to open this Symposium. The gathering of you all on a two year cycle is a tribute to the work of the LakesWater Quality Society, and it is celebrating its 50 years of existence. But I would have to say, looking back over the last seven to nine years of the LakesWater Quality Society, it was galvanised into some new actions after a descent, and led by a formidable politician, Ian

---

McLean, and a lady by the name of Sally Brock, whom in those days we nicknamed 'the Rottweiler', because she never left us alone. She always pushed for water quality.

But it was that concern, led by the LakesWater Quality Society, after the deterioration of the quality of the lakes in 2003, which drove the community of Rotorua. They have come a long way now and obviously very much to the forefront of leaders in the community. It has been a journey for us all and the journey is not complete yet. The journey has been riddled with criticism, all talk and little action and not enough doing, but from the major sponsors, ourselves as the Regional Council, we were determined that the solutions would be science led and that has been a frustrating time until we had the science in place. That is now coming through. So progress has been made.

I am incredibly proud of the work of the Regional Council and the partnership with the Rotorua District Council and the Te Arawa Lakes Trust. The lakes are being cleaned up, we are working together and we are restoring them back to full health. Central Government has stepped up, they have provided funds and we are all very grateful for that.

The best minds are working on the solutions. Many are presenters to this Symposium. Their expertise will become obvious over the next couple of days. The list of guest speakers is formidable. They will challenge the status quo and I hope they will motivate you. I hope that you will leave here in two days' time and your reaction will be - "Great, it was well worth it," and you and I will have learnt just a little bit more on that journey to restore the lakes, the jewels in the crown of Rotorua, and iconic for New Zealand.

This Symposium is an ideal place for the sharing of ideas, comparing notes and learning from the experts. We know there is no quick fix, but by working together we will succeed. What seems now to be an insurmountable journey will be dealt with over time, it is just part of that journey. We will resolve and we will succeed. Enjoy this Symposium with an open mind. Listen. I am looking forward to an exciting couple of days.

I am delighted to declare this Symposium open.

Thank you.

---

## ***Session One - Opportunity***

**SESSION CHAIR:** John Green, Chair, LakesWater Quality Society

### **FIX THE LAKES : WHERE WE ARE AND WHAT CAN BE DONE?**

**Professor David Hamilton**

Centre for Biodiversity and Ecology Research  
The University of Waikato  
Hamilton  
davidh@waikato.ac.nz

*Dr David Hamilton currently holds the Bay of Plenty Regional Council Chair in Lakes Management and Restoration at Waikato University. He obtained a Doctor of Philosophy at Otago University, studying a series of South Island lakes, and that was the commencement of a career in lake management generally, with specific research interests in how algal blooms form, how nutrients are transformed and how models can be used for prediction and management of lake ecosystems. He spent twelve years at the University of Western Australia before returning to his current position at Waikato. In 2010 he received the New Zealand Freshwater Sciences Society Medal for Excellence for outstanding contributions to freshwater science.*

### **ABSTRACT**

Since the establishment of the Bay of Plenty Regional Council Chair in Lakes at Waikato University in 2002, the focus of in-lake research at the university has subtly changed from identification of lake water quality problems and causal agents of eutrophication, to alignment with management actions in specific lakes and use of models to help to address information gaps. In the Rotorua Lakes Symposium of 2003 I outlined four categories of lakes on the basis of morphology, mixing regime and trophic state. These categories also form a useful basis for formulating management actions and understanding how lakes in the different categories may respond. The categories previously outlined included: (1) eutrophic monomictic lakes (e.g. Okaro and Rotoiti) with anoxic bottom waters and periodic cyanobacteria (blue-green algae) blooms; (2) mesotrophic monomictic lakes where the bottom of the hypolimnion becomes anoxic briefly near the end of the stratified period (e.g. Okareka, Tikitapu, Rotokakahi and Okataina); (3) oligotrophic monomictic lakes with high water quality (Tarawera, Rotoma); (4) meso- and eutrophic polymictic lakes (e.g. Rotorua, Rotoehu and Rerewhakaaitu) which have temporary stratification. It is now pertinent to re-visit these lake categories in the context of interim changes in water quality, defined here through 'long-term' trends (past 9 years) and management actions undertaken.

Declining water quality in the eutrophic monomictic lakes (Okaro and Rotoiti) has been arrested and these lakes show long-term improvement, exemplified by decreasing frequency of cyanobacteria blooms. The improvement has been achieved through major management interventions to reduce internal nutrient loads through flocculation and external loads through a constructed wetland in Okaro, and a diversion wall for water from the Ohau Channel for Rotoiti. The duration of anoxia of bottom waters appears to be more resistant to these management actions, however, but this indicator should be used as the ultimate long-term index to evaluate the success of management actions.

---

I previously identified the vulnerability of the mesotrophic monomictic lakes (particularly Tikitapu, Okareka and Rotokakahi) to deteriorating water quality. This view has been reinforced by the relatively rapid deterioration of water quality in Lake Rotokakahi while Lake Okareka shows a long-term trend of increasing nitrogen and phosphorus concentrations. I also consider that Lake Tikitapu should remain in a 'threatened' category. Sewage reticulation is expected to reduce the risks of further deterioration of water quality in Tikitapu and Okareka, but it is unclear how long it may be until its effect becomes evident.

The oligotrophic monomictic lakes (Tarawera and Rotoma) show long-term deteriorating trends and active management may be required in the near future if these trends continue to an extent that anoxia develops in bottom waters.

The polymictic lakes vary in trophic status, from relatively unproductive Lake Rerewhakaaitu to mesotrophic Lake Rotorua and eutrophic Lake Rotoehu. There is no specific long-term trend of water quality in Lake Rotorua but both Rerewhakaaitu and Rotoehu show deterioration, with the former lake beginning to show anoxia of bottom waters and the latter being in an advanced state of eutrophication. Intervention strategies and strong controls on nutrient inputs are required for these lakes. An integrated modelling strategy linking together a climate model (CLIMFACTS), the NIWA catchment water and nitrogen load model ROTAN (Rotorua and Taupo Nitrogen model), a catchment phosphorus model (CLUES) and a lake model (DYRESM-CAEDYM), indicates quite substantial reductions in Lake Rotorua's catchment nutrient loads will be required to attain a target Trophic Level Index (TLI) deemed to yield acceptable water quality. Delayed responses to land use change from long groundwater travel times and the possibility of a warmer climate may exacerbate the need for reductions in catchment nutrient loads to meet the TLI goal.

## TRANSCRIPT

Tena koutou katoa and thank you for the welcome. I will go straight into the talk given the time frame that we are working to.

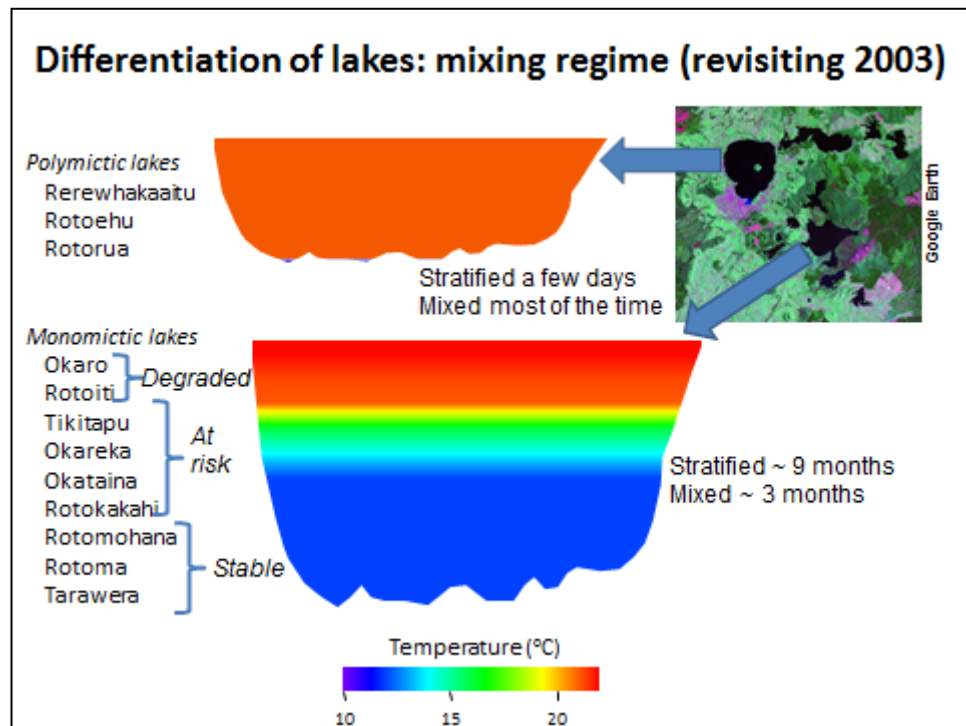
The title was - *Fix the Lakes : Where are we and what can be done?* I will focus mostly on where we are, and a little bit less on what can be done, which will be the follow up from other speakers.

A little bit of an outline first of all, and I want to pay tribute here to the LakesWater Quality Society. I have peers around the world, who are using the LakesWater Quality Society as a model for how to engage, how to activate science, how to be able to up skill their own aquatic skills; it is a very unique society. I cannot think of anywhere else in the world where a community based organisation could bring this many people together. It is a huge reflection on the efforts of many of the people in the LakesWater Quality Society and the knowledge that they have accrued over the past few years.

In 2003 I gave a paper to this same Symposium: A historical and contemporary review of water quality in the Rotorua Lakes. I will begin with revisiting some of that and look at what has happened in the interim. Then with a particular focus on Lake Rotorua, I will examine the trophic state of Lake Rotorua, and predictions of the Trophic Level Index. I should mention that I have focussed mostly on the water quality issue. There are, as you will see in the upcoming two days, a number of different issues and they relate to, for example, lake weed, which was why the LakesWater Quality Society was originally

founded, and also many of the culturally important species that inhabit these lakes and for which people such as Ian Kusabs are currently doing research.

### Slide 3

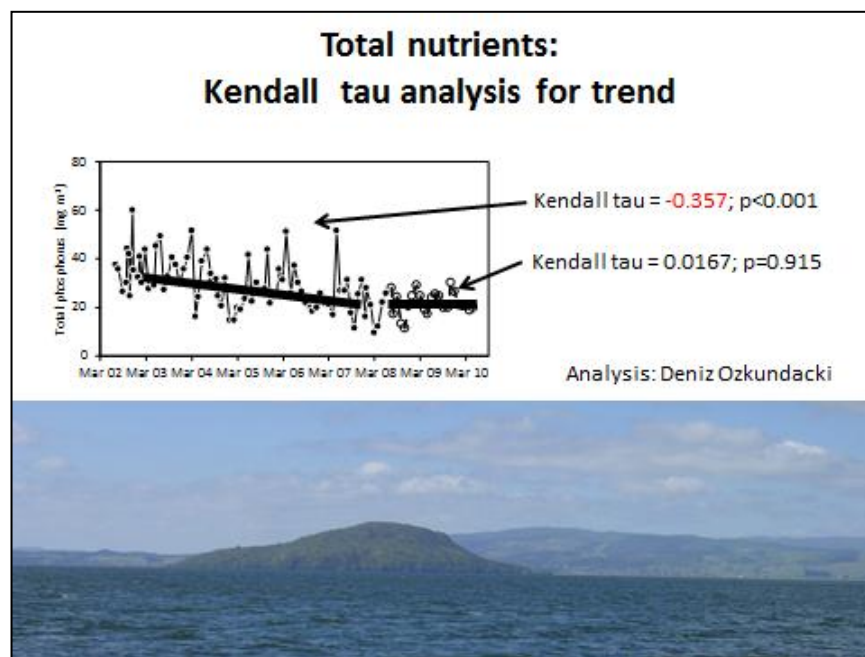


**Slide 3:** I want to begin with a couple of definitions, because if I do not get these definitions right then it may make it more difficult in the remainder of the talk. In 2003 I differentiated three lakes which are polymictic and nine of the lakes which are monomictic. During summer there is a temperature gradient from top to bottom in the lakes, with warm surface waters overlying cooler bottom waters. That gradient exists continuously in the monomictic lakes for about nine months of the year. For two or three months of the year, during winter, the lakes will mix from top to bottom and it is an opportunity for oxygen to replenish the underlying bottom waters.

These very interesting polymictic lakes tend to be more susceptible to the effects of nutrients going into them. They are generally shallower and they will stratify for periods of maybe a day or two, up to even a month in some cases. That means the water is replenished with oxygen in the bottom waters when they are mixed alternated with periods of stratification when that bottom oxygen is lost. In 2003 I categorised the nine monomictic lakes as two that were degraded, several that were at risk, and three that were stable. I am going to revisit that assessment and have a look at the categories that I allocated in 2003.

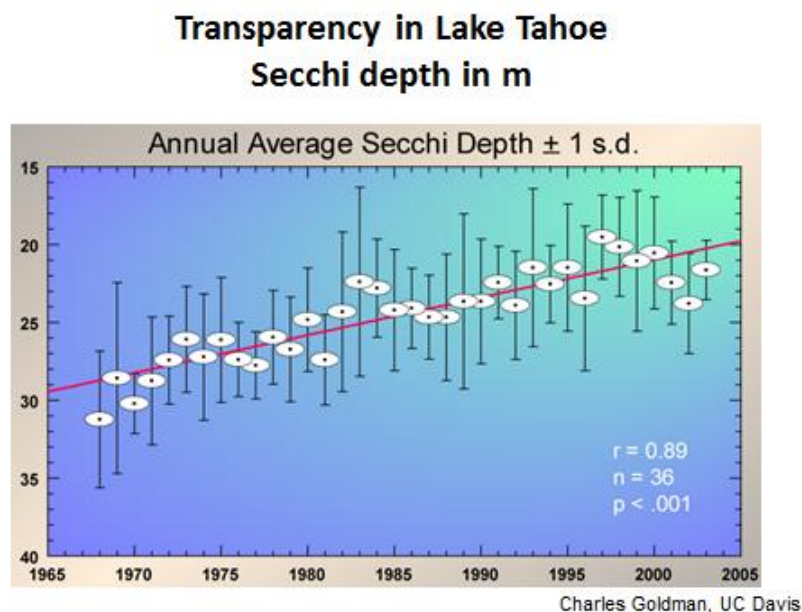
**Slide 4:** Firstly, I want to attribute some analysis here to Deniz Özkundacki. It is absolutely fantastic having someone, who was a PhD student, and now a Post-Doc, and is so competent with statistical modelling. I make no excuse for the fact that I have piggy-backed on much of what Deniz has done. In his research on total phosphorus concentrations shows a time series of trend lines fitted in this case to total phosphorus concentrations. We use a statistical test to see whether there is a significant slope to the line. You can see two cases, one in which there is a statistical significant trend and the other which is basically flat and no trend. This is what I will use when looking at the trends in these lakes.

#### Slide 4



**Slide 5:** Ideally we would like a data set like this which Charlie Goldman has for Lake Tahoe, going back to the mid 1960s. We do have data in Rotorua dating back to 1967 but the data set I use today is mostly derived from 2000 which is a good continuous sequence from Bay of Plenty Regional Council that enables us to look at trends in these lakes. The Tahoe case was an example where over fifty years there has been a decline in water clarity. In some cases Charlie Goldman was able to show that it needed up to a decade to clearly differentiate the long-term trend. With shorter time periods it may be difficult to see a trend, and in some cases the trend may even be reversed.

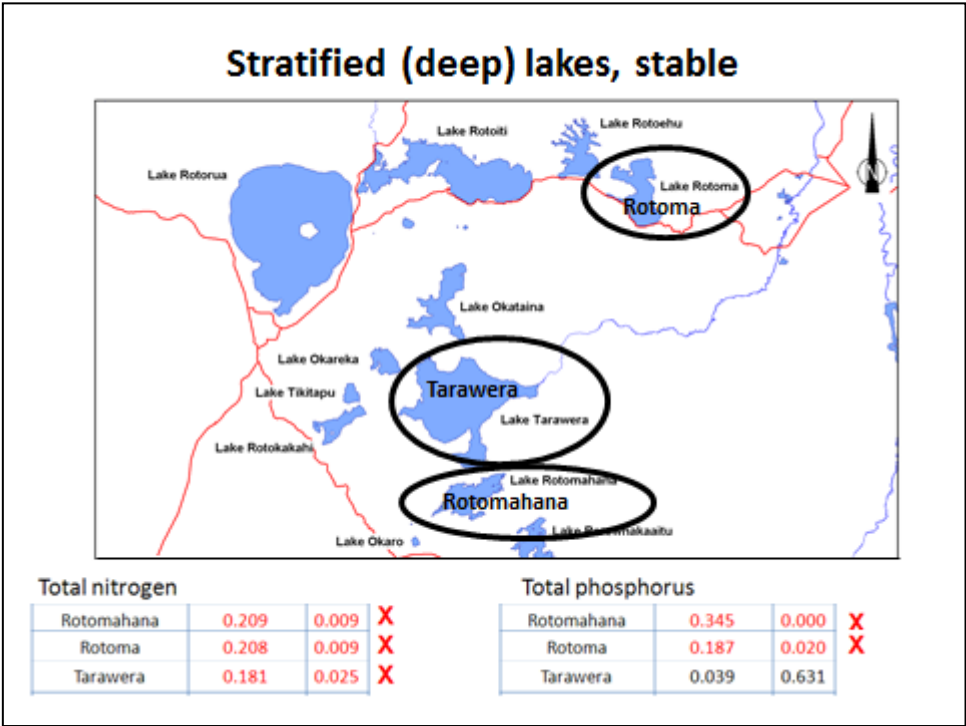
#### Slide 5



**Slide 6** shows our deep lakes that stratify for about nine months of the year. At the bottom there is the trend analysis which indicates the ones with crosses which have a negative trend of increasing concentrations and a tick which shows lakes with a trend of improvement, in other words lower concentrations. It is pretty clear that the three lakes – Rotomahana, Rotoma and Tarawera - have a trend of increasing total nitrogen

concentrations. Rotomahana and Rotoma show a trend of increasing total phosphorus concentrations.

Slide 6



I originally said these lakes were stable and they still are, however Rotomahana, in particular, has been subject to a hornwort weed invasion and that is a major challenge to move to a trend of change.

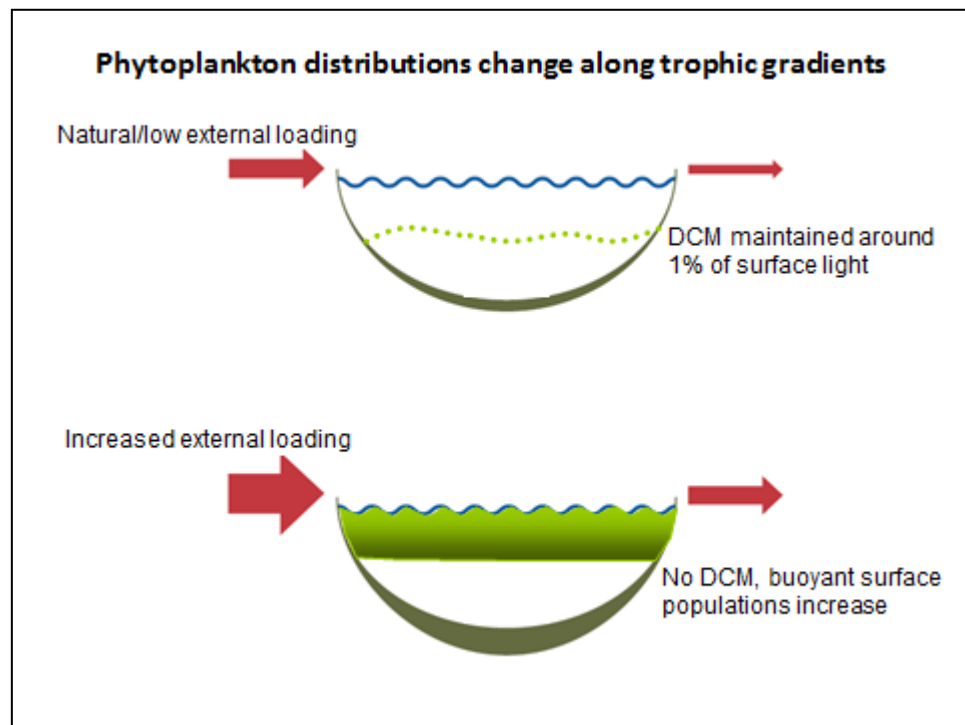
**Slide 7:** Let us not forget one of the lakes which is not within the Te Arawa lakes, but it is included as a private lake – Lake Rotokawau - a magnificent lake above Lake Rototoiti. This is a lake which is really a jewel amongst the gems and it has been largely unaltered in terms of its water quality.

Slide 7

**Lake Rotokawau: another stratified, stable deep lake**

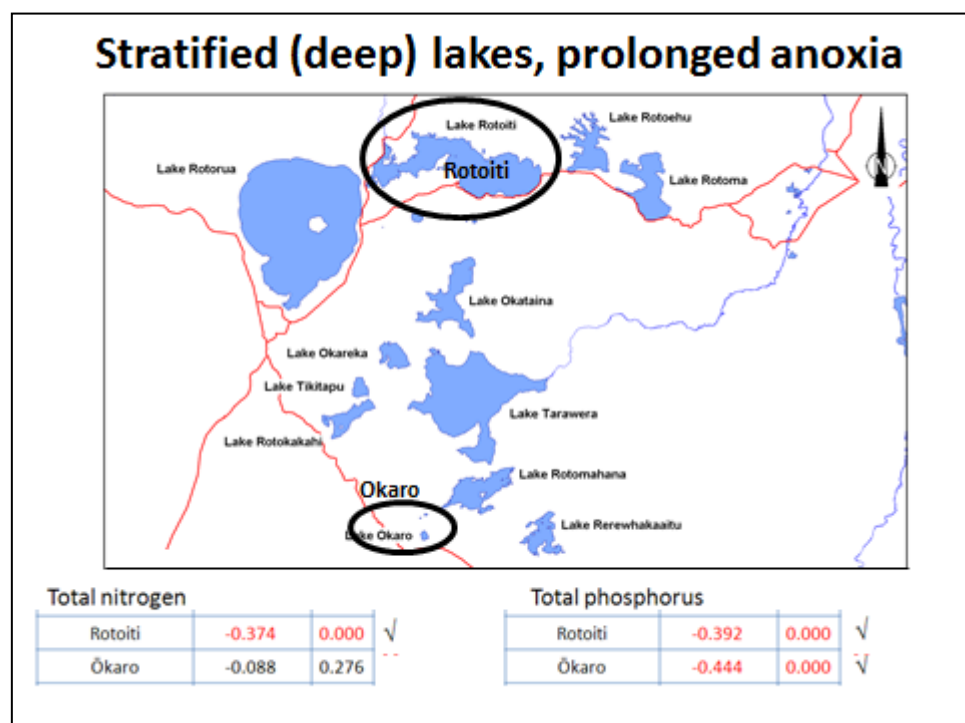


## Slide 8



**Slide 8:** To be able to understand what has happened with some of these lakes, you need to look at how the chlorophyll or algal concentrations have changed through time. The big change has been increased nutrient loading and distributions of chlorophyll. There has been a change from algal populations that were maximum very deep in the lakes, sometimes up to 20, 30, 40 metres deep, towards surface-reaching populations. Those deep populations were typically where the light was about 1% of the level at the water surface. As you increase nutrient loading the amount of growth in the surface increases and conditions are no longer conducive to having deep-growing populations. That has been a key factor in some of the transitions that have occurred, for example, in Lake Rotoiti.

## Slide 9





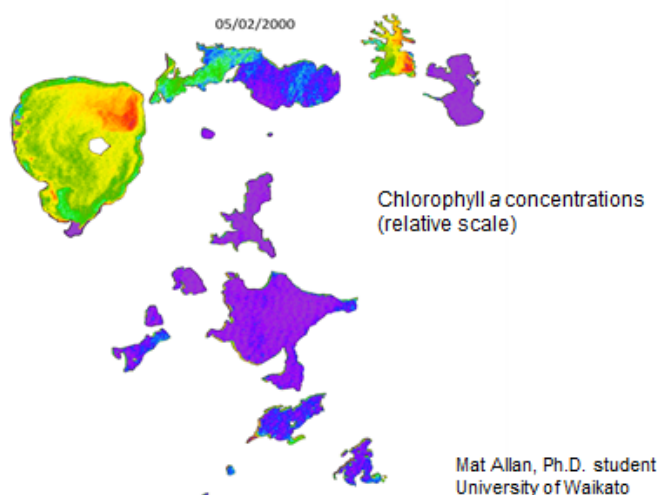
**Slide 10**

**Slide 9** is the 2003 analysis of what I consider to be stratified relatively deep lakes with prolonged anoxia, which is the complete loss of oxygen in the bottom waters during that stratified period. Rotoiti is improving, with lower concentrations of total nitrogen and total phosphorus. We know some of the reasons for this already, but just to reiterate.

**Slide 10** was Rotoiti 2003. Basically the lake was in a bad state and an invasive phytoplankton had come in to form blooms which were also reflected in relatively high nutrient levels in the lake.

**Slide 11** shows some remote sensing images from a Ph.D. student Mat Allen, whose poster is out in the foyer. The slide shows chlorophyll a concentrations. Using it as a relative scale, there is a bloom in Rotoehu, in Rotorua, and also a marked gradient of concentration through Rotoiti, which was very typical of what happened before the diversion wall.

### Variability of chlorophyll in the Rotorua lakes – based on remote sensing



**Slide 11**

**Slide 12:** Andy Bruere's photo shows very clearly this diversion wall taking the Ohau Channel water and diverting it towards the Kaituna through the Okere arm towards the Kaituna River, therefore bypassing the main entrance to the lake.

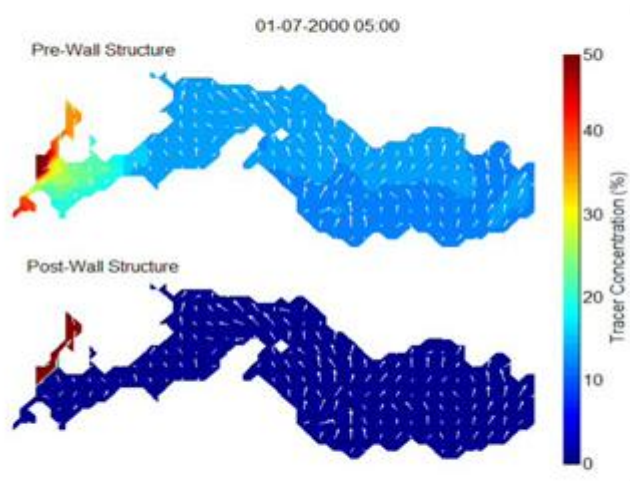


**Slide 13:** Three-dimensional modelling conducted by Nina Von Westernhagen and Kohji Muraoka, whose poster is also out in the foyer, shows a tracer coming in through the Ohau Channel. Pre-wall, very clearly shows the water was coming in and being dispersed right through the lake with dilution of the tracer. By contrast, once the wall is in place there is very little of that water that goes through to the lake. That is not always the case, but under proper operating

conditions, we should expect less than 1% of the water in this basin is derived from Lake Rotorua. This represents a major change in the hydrology and is really the primary explanation of why we are seeing that improvement in nutrient concentrations in Lake Rotoiti.

**Slide 13**

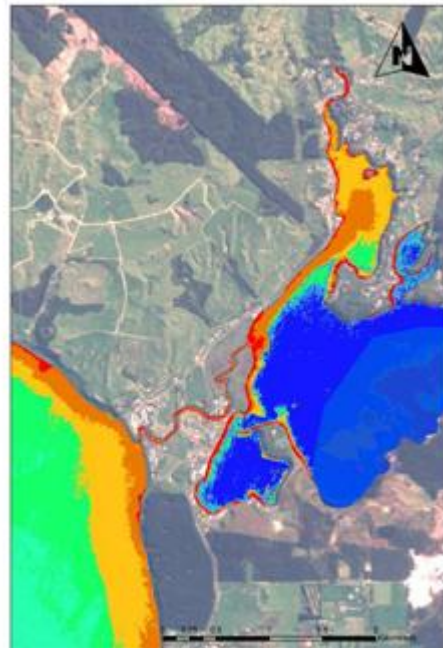
**Lake Rotoiti – pre and post-wall**



Kohji Muraoka, Nina von Westernhagen  
University of Waikato

**Slide 14** is a wonderful thermal image of Mat Allan's, showing Lake Rotorua and Lake Rotoiti and how the water comes through the Ohau Channel and gets diverted towards the Kaituna River with the wall in place.

**Slide 14**



**Satellite/aerial views of  
diversion wall,  
Lake Rotoiti**





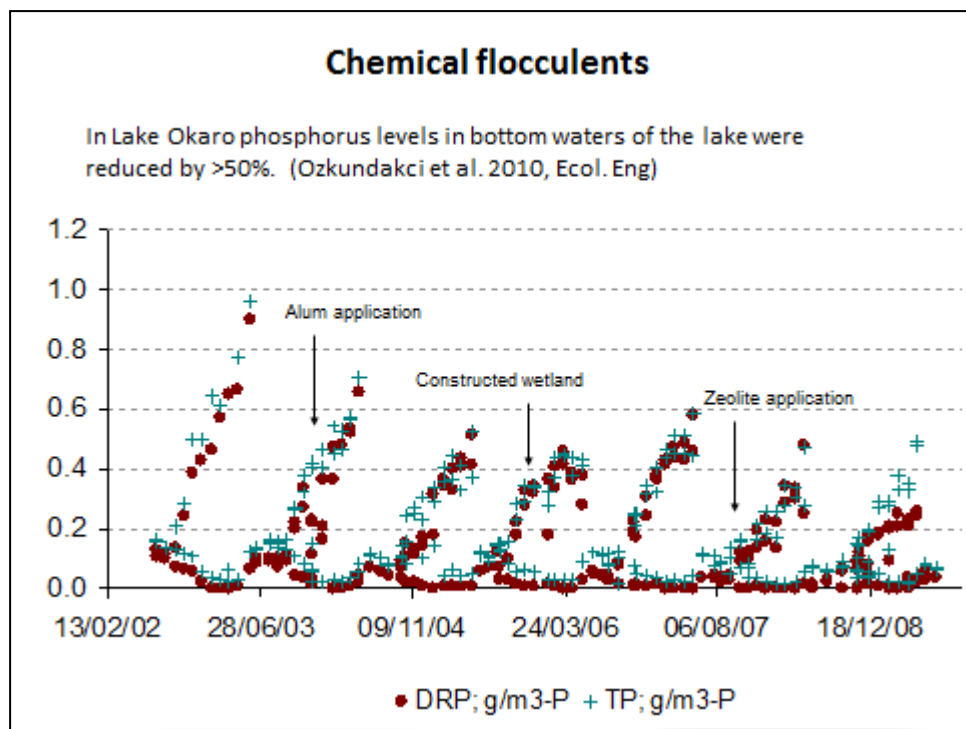
**Slide 17**

**Slide 17:** The other case is Lake Okaro which has had a number of actions, the most recent being application of modified zeolite, Aqual P, designed to coat the bottom sediments of this lake and stop the sediment nutrient releases.

**Slide 18** is a slide I have stolen from John McIntosh, which shows that phosphorus releases from the bottom sediments have been attenuated by at least 50% in response to that modified zeolite application. We have done a lot of work in association with NIWA, Scion and the Bay Of Plenty Regional Council to

look at some of the effects of the Aqual P, not just in terms of water quality, but also on the biota. It was one of a series of actions that have started to bring down the levels of phosphorus through time, but it does take some time.

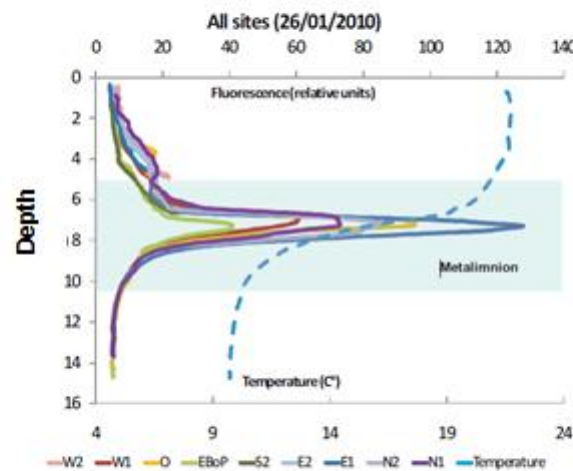
**Slide 18**



**Slide 19** shows that Lake Okaro also has this deep chlorophyll maximum and it explains a lot about why blooms suddenly appear and disappear. Bernard Simmonds and Marie Dennis did some work there in January last year, showing that most of the algae are sitting at about seven metres depth. What happens when these algae move, as they do occasionally, up to the surface? We suddenly get a bloom and it says that we need to know something about the dynamics of these algal species to understand why blooms occur.

## Slide 19

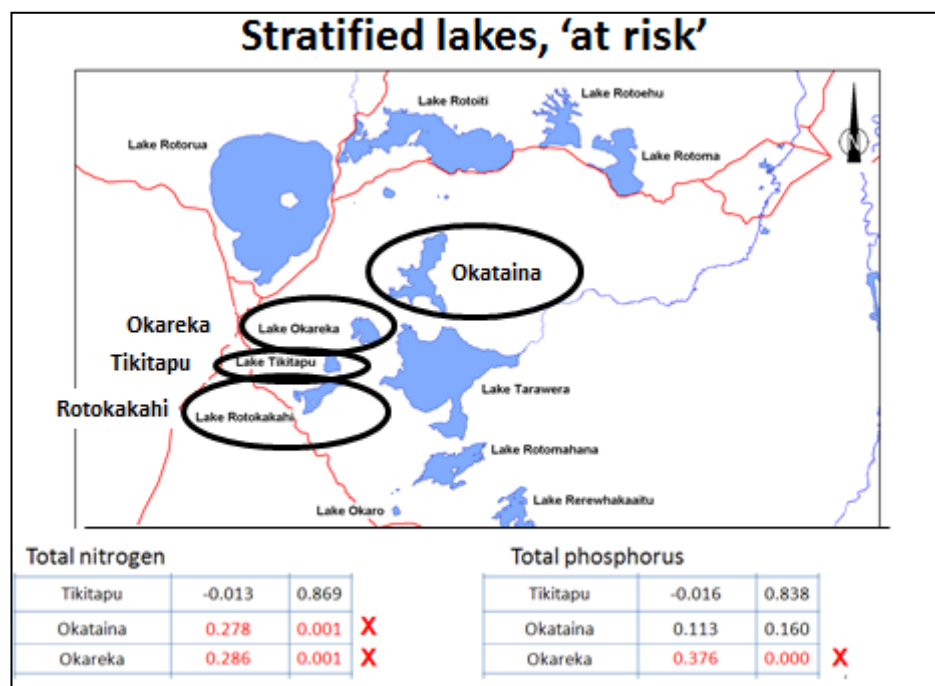
### 'Deep' chlorophyll maximum: Lake Okaro



Bernard Simmonds  
University of Waikato

**Slide 20:** These are the stratified lakes that were considered to be at risk. Some of these lakes have continued to show declines, some of which are not easily explained, such as Okataina, with increasing total nitrogen. That has been a fairly consistent case through the whole set of these lakes. Okareka shows phosphorus and nitrogen increasing, indicating a decline in terms of lake water quality.

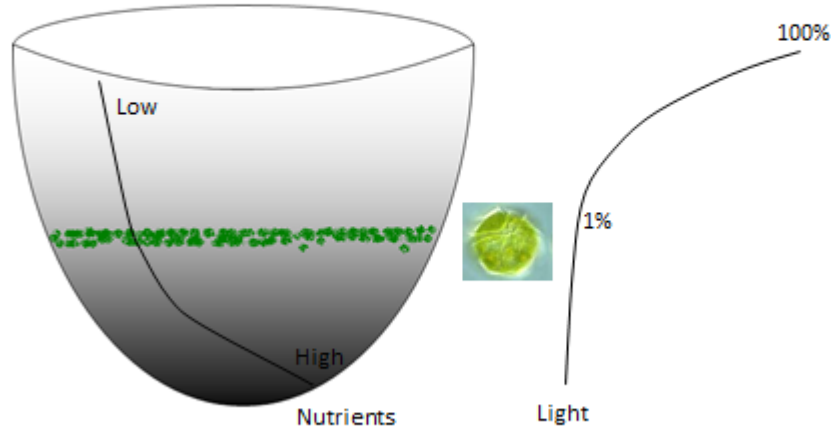
## Slide 20



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Slide 21

**A delicate balance for *Peridinium* in Tikitapu**  
***Trading off nutrients and light***



**Slide 21:** Just to emphasize the point, Tikitapu, the Blue Lake, with this deep chlorophyll maximum sitting at about 17 or 18 metres during the summer, the water is clear at the surface; it is laden with algae at 17 or 18 metres. It is very important that that layer remains as it stabilises water quality in the lake. We should expect, in lakes such as this where the sewerage diversion is either in place or progressing, that water quality should improve. We hope that many of the issues will start to dissipate, but there has to be vigilance, and still more work to be done.

**Slide 23:** Rotokakahi, more than any other lake, is the one that has shown huge declines. The data series is not complete so it does not enable me to show trends, but that lake, beyond any other, is the one that is very highly at risk.

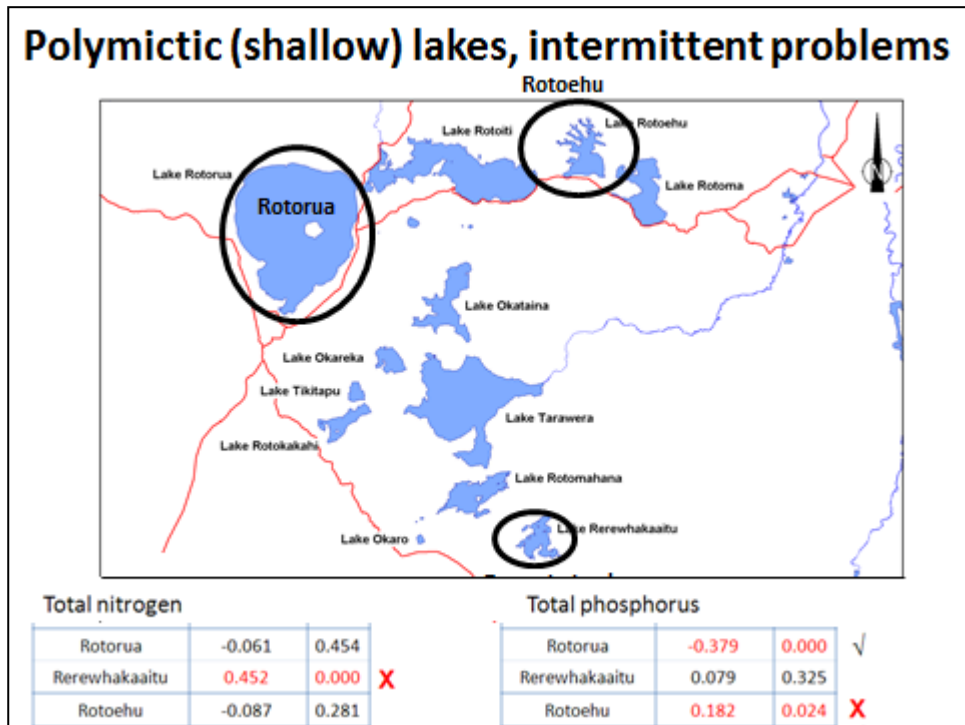
Slide 23

**Lake Rotokakahi: rapid decline**



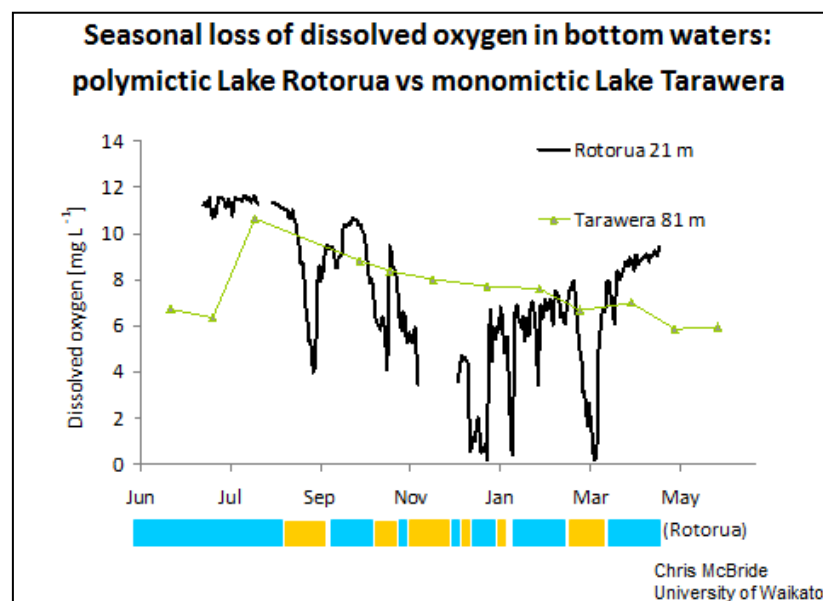
Photo: Rob Donald  
Environment BOP

Slide 24



**Slide 24:** Lastly I will move to the polymictic or shallow lakes with often intermittent problems. Examining the trends, Rotorua shows no real trend, and even an improvement in phosphorus (lower concentration), perhaps in response to some of the inflow treatments that are happening. Lake Rerewhakaaitu shows a significant trend relating to a declining water quality, in response to higher nitrogen. In Rotoehu there is an increase in total phosphorus concentrations.

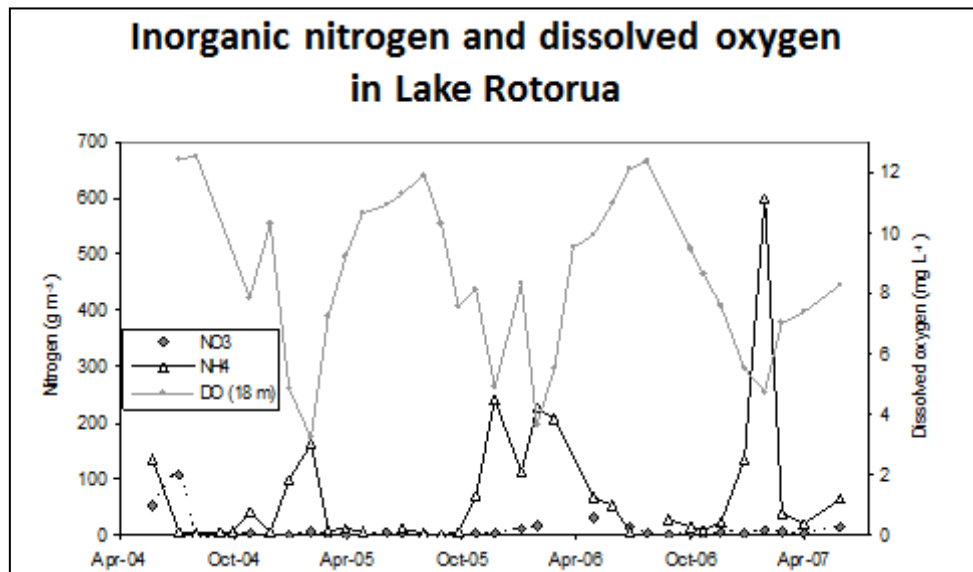
Slide 26



**Slide 26:** Back to Lake Rotorua – a pretty remarkable lake in a way, because if we look at the trends of oxygen over the stratified period oxygen will reach a peak in late winter, and then the lake stratifies intermittently over summer. There is a fairly consistent decline in levels of oxygen during stratification. For a lake such as Tarawera, there is still plenty of oxygen left at the end of summer stratification, about 4 or 5mg/l, so about half of the oxygen available has been used as part of the decomposition process in the bottom

waters. If you contrast that with Lake Rotorua, there is a really massive decline once the water stratifies, and this is intermittent, because the lake sometimes stratifies and then mixes. For the stratification period shown here, oxygen plummets very quickly, and then when it remixes it replenishes that oxygen. That is a very critical step.

Slide 27

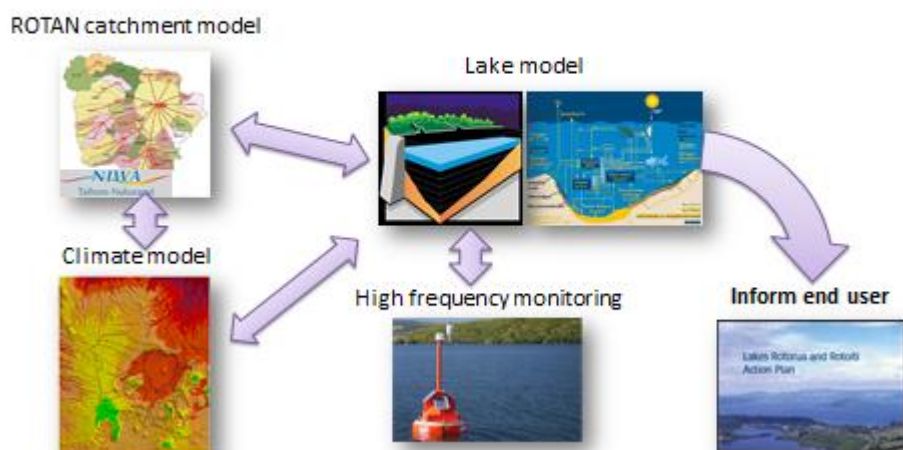


**Slide 27:** Why is it so critical? When oxygen declines there is an almost inverse relationship with, for example, ammonium, increasing very rapidly. The nutrients are released and the internal 'motor' of this lake (i.e. algal growth) starts to activate with the oxygen loss. I should say too that Chris McBride, who has deployed the buoy that monitors every fifteen minutes, has provided us with great insight into oxygen dynamics in Lake Rotorua.

**Slide 28:** The last part I want to talk about is Lake Rotorua modelling as a decision support tool. The objective is to be able to feed a lake model, which predicts Trophic Level Index, with a catchment and climate model, coupled with some of our high frequency modelling, to be able to derive the types of action plans that might be necessary to manage water quality in Lake Rotorua.

Slide 28

### Lake Rotorua modelling as a decision support tool

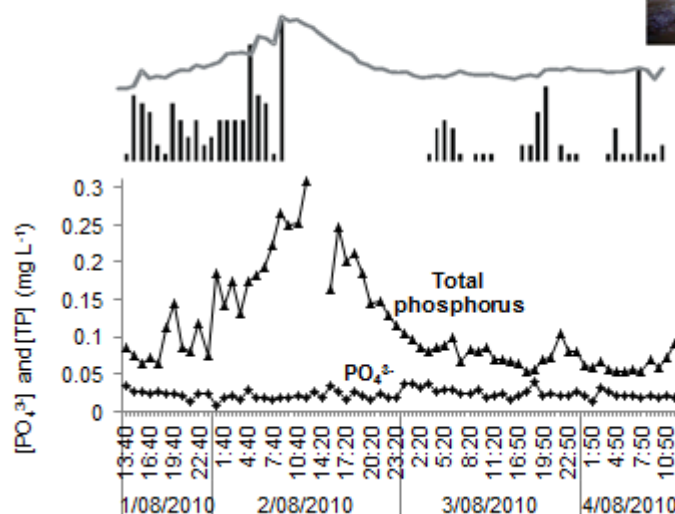


## Slide 29

### Changes in phosphorus concentrations in a stormflow event



Jonathan Abell  
University of Waikato

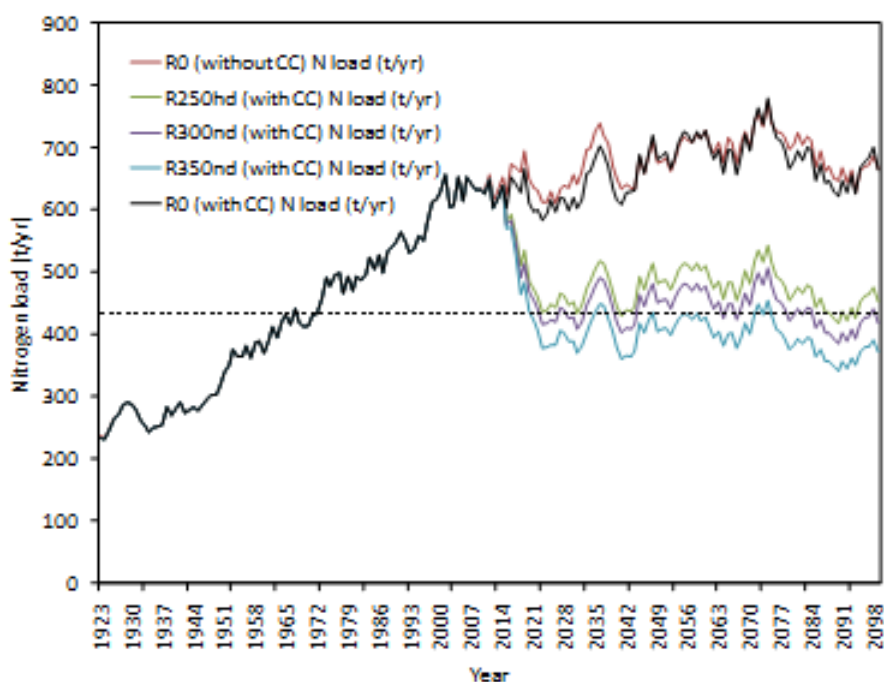


**Slide 29:** Part of this has involved looking at inflows, and Jonathan Abell's Ph.D. work looks at what happens in storm events. This slide shows the response of, for example, total phosphorus and phosphate concentrations in the Puarenga in response to a moderate storm event. Jonathan's work has built on previous work by Kit Rutherford and Ray Hoare to better understand what happens, and what the fate of the material brought into the lake, is in those storm events.

**Slide 30:** Kit Rutherford's NIWA Rotan Model feeds into the lake model. We take a series of time periods from the present, and project different management actions into the future. The slide shows reducing nitrogen loads to see whether we could attain a dashed line corresponding to what is considered to be the sustainable nitrogen load to the lake.

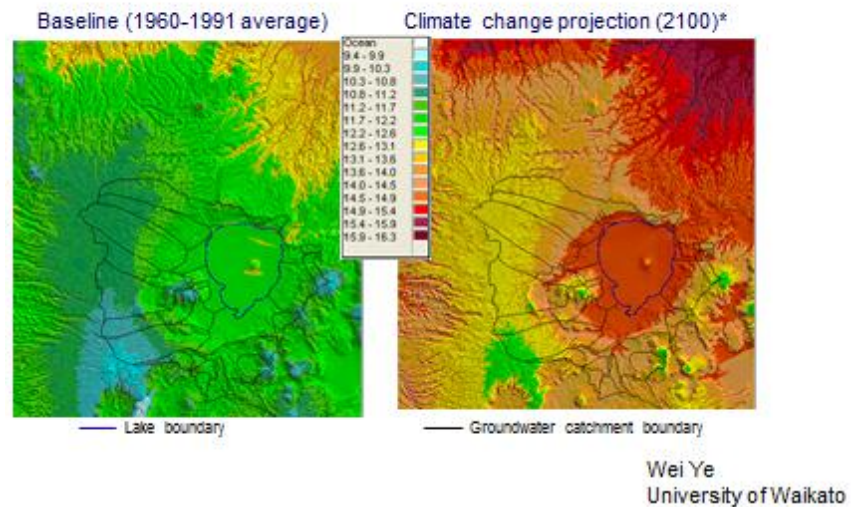
### 4-year average N load

## Slide 30



## Slide 31

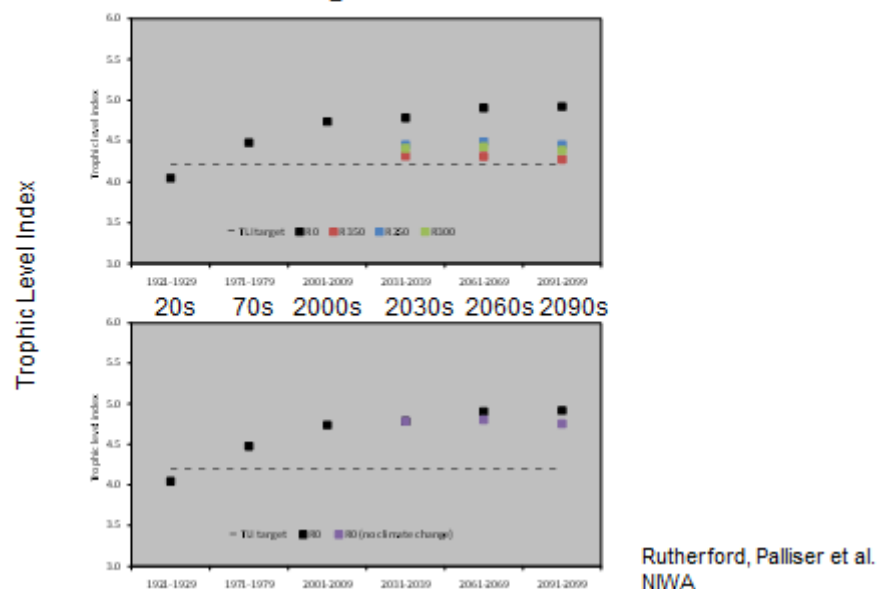
Lake Rotorua annual mean temperature (°C)



**Slide 31:** We have various cases corresponding to a current climate, a changed climate, and different nitrogen loads. We include climate change effects in our work. Lake Rotorua, in what we consider our baseline climate and our modified climate, is likely to have an increase of about 2.5 degrees Celsius by 2100. We run with and without a projected climate change to allow for comparisons in these cases.

## Slide 32

### Trophic Level Index values for different nutrient loading and climate scenarios



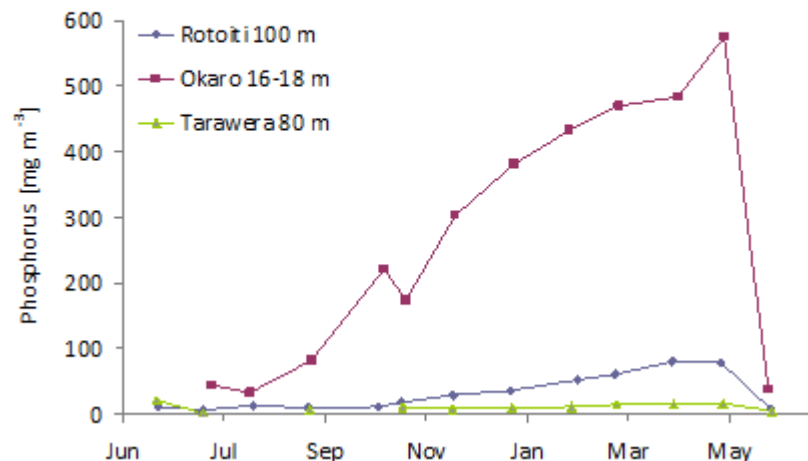
**Slide 32:** The key output variables are the Trophic Level Index which has been our marker to evaluate these different nutrient loading and climate scenarios. Kit Rutherford and Chris Palliser supplied us with the inputs to evaluate different cases of nitrogen loading from the Lake Rotorua catchment.

The desired Trophic Level Index is the dashed line. In the 1920's we were below it. By the 1970s we were just above it and by 2000 somewhat more, and ultimately business as

usual would put us at a level of about 5.1 or 5.2. In other words the percentage of blue-green algae would increase as the Trophic Level Index increased. In response to various management actions we can gradually bring back down the Trophic Level Index towards the baseline. We evaluated the effect of climate change and saw a subtle, but perhaps important effect, where climate change would make it more difficult, in this case the black line, to attain a given trophic level index.

Slide 34

### Phosphate concentrations in bottom waters of three Rotorua lakes with varying oxygen levels

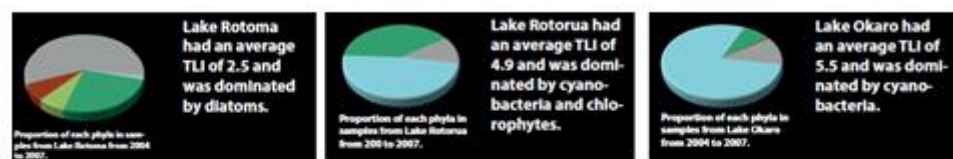


**Slide 34:** So, a brief summary just to remind ourselves of what that loss of oxygen means to these lakes in response to increased external nutrient loading. Lake Tarawera still has about 50% of its oxygen left in bottom waters at the end of stratification. Lake Rotoiti, prior to the wall, shows a trend of greater oxygen consumption and in the case of a lake like Okaro there is severe oxygen depletion.

**Slide 35** shows that phytoplankton species change along trophic gradients. What do I mean by that? As we increase the level of nutrients we start to see species change so that the dominant diatoms, or a mixed assemblage of phytoplankton, are replaced by the

### Phytoplankton species change along trophic gradients

Slide 35



Lake Rotoma



Lake Rotorua  
Photo: D. Trolle

Wendy Paul  
University of Waikato

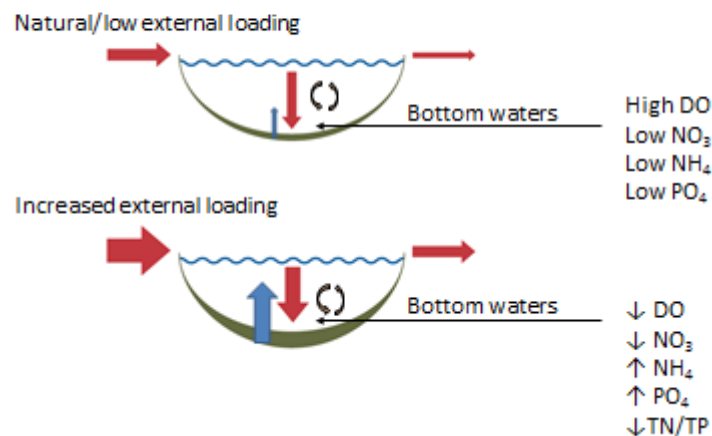
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cyanobacteria. Wendy Paul has a poster that very clearly shows this. We get mixed assemblages in the lakes with low trophic state, going up to, in this particular case, Lake Okaro, which is more than 75% dominated by cyanobacteria or blue-green algae over the summer. Why is this so significant? The blue-green algae are the ones that are buoyant; they are the bloom-forming species. As you start to put more nutrients into the lakes the blue-green algae start to become very dominant.

**Slide 37** is an attempt at a summary. Under low external loading most of the nutrients sediment out and we do not tend to get algal blooms. As we increase that external loading we start to generate this 'internal engine' within the lake, which recycles nutrients and fuels some of the cyanobacterial blooms that we see in the degraded lakes.

**Slide 37**

### **Nutrient cycling changes along trophic gradients**



To finish I want to thank a number of people - not directly by name - but just to say that this is really a piece of work that has been contributed by several organisations, such as NIWA, Scion and GNS, as well as some very productive students at the University of Waikato, and supported by Te Arawa Lakes Trust, Bay of Plenty Regional Council, and the Rotorua District Council.

Thank You.

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## CHANGE A CATCHMENT TO GROW THE CITY

**Mayor Bo Frank**  
Vaxjo, Sweden  
Bo.Frank@vaxjo.se

*Bo Frank grew up in Växjö, Sweden, where he was educated and graduated in political science, social science, ecology, economics and administration at the University of Lund. At a young age he became a member of the Health and Environment Board and the Växjö City Council. He had a variety of part time employments at the same time, including hospital planning. From 1982 he has been a full time politician with various municipal assignments, Member of the Swedish Parliament (1991), Mayor or Vice Mayor of the City of Växjö since 1992 and Vice Chair of the Regional Council of Southern Småland since 2007. He has also been involved with various boards such as Euregion Baltic, Småland Airport and Regional Board for Conservatives, Sydsam, and Almi.*

*He is often invited as speaker at international conferences and workshops regarding environmental issues such as sustainable development and fossil fuel free Växjö.*

### **ABSTRACT**

Växjö with its 80,000 inhabitants is a regional centre in the southeast part of Sweden. The city has a long history as an educational town and the Linneaus University, with its 25,000 students, is among the largest in Sweden. Because of its geographical location, surrounded by lakes, Växjö was described as the city by the lake where the roads meet. Until some decades ago, the lakes were severely polluted, but after massive restoration work, the City of Växjö has now integrated the lakes in the townscape again. In 1970 Växjö started collaboration with the University of Lund. The aim was to restore Lake Trummen. The project was internationally ground-breaking and was followed in the 1980s by the restoration of two other lakes near the city - Lake Växjö and Lake Södra Bergunda.

In the 1990s the municipality carried through a strategy to solve the problems in the city caused by storm water. By combining technical solutions with landscaping the city of Växjö created a number of attractive and popular public areas and walkways which has enhanced the cityscape and outdoor areas. In 2002 the city received the Association of Swedish Architects award for its efforts. The strategy of integrating the city with its lakes continues and is enhanced even further in the new city master plan.

The City of Växjö is an internationally recognized frontrunner in the fight against pollution and climate change and has undertaken an ambitious programme designed to protect and enhance its local environment. Växjö has made a shift from fossil fuels to bioenergy in the heating and transport sectors. Access to the many forests and municipal nature reserves is the basis for the climate politics of Växjö with the municipality situated in the middle of the woodshed - the source of bioenergy.

Politicians, NGO's, businesses and inhabitants have successfully participated with wide knowledge about the environment and the ability to see solutions instead of problems. To ensure environmental improvement and efficient work, we use the environmental management system eco-BUDGET. Through this system we can control the environmental resources in the municipality and follow up goals in the Environmental Programme.

Through the years the city has received a number of international rewards for its climate strategy and Växjö has been given the epithet 'The Greenest City in Europe' by BBC

London and ICLEI, Local Governments for Sustainability. Växjö can be a role model and inspire other cities in their environmental work. During the last decade, individuals and groups from all over the world visit Växjö to learn about Fossil Fuel Free Växjö and how the city manages sustainable development, bioenergy, forestry, elderly care and gender issues. In order to make best use of these visits Sustainable Smaland was formed in January 2011. Its aim is to turn the municipality contacts into new business contracts for local and regional companies with climate focus and profile.

## TRANSCRIPT

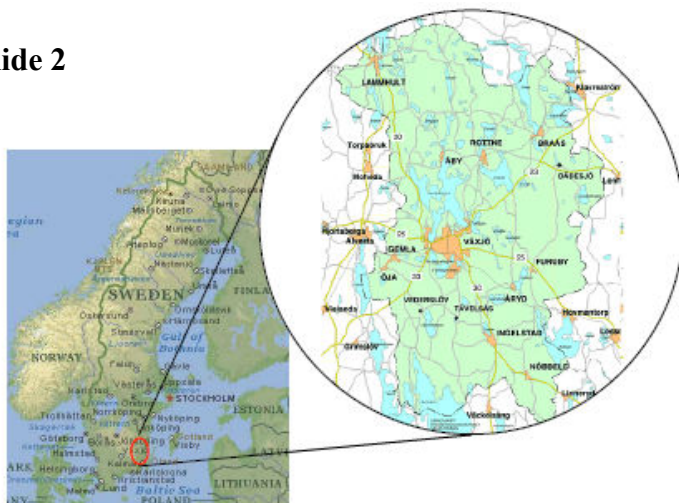
Distinguished Guests, Mr Chairman, Friends – I am very pleased and honoured to be invited to this very important Symposium to talk about my favourite subjects - How to Work with Environmental Issues.

I am the proud Mayor of the greenest city in Europe, but most importantly I am the President of the local Beatles Club. I will come back to this issue later. We were picked up by English BBC to be the greenest city in Europe in 2007, but our environmental work started in the sixties when we began restoring our polluted lakes. In 1996 we made a unanimous decision with all political parties in the City Council to be the first city in the world to be fossil fuel free. The target was to reduce our emissions by 50% per capita by the year 2010, and at least 70% by the year 2025, compared to 1993. I will come back to the question of whether we have succeeded or not.

We have eight parties in the City Council. I have been a City Councillor since I was twenty, in 1976, and Mayor more or less since 1991. Yes we have democracy. Democracy in our city means that the Mayor is re-elected every election. I think it is very nice. So the Mayor's job is easier in Växjö than in New Zealand, because you vote for the party and you always have a stable majority behind you. One of the reasons for our success being the greenest city in Europe is that all political parties have agreed on all environmental issues for the last forty years. We disagree on many issues but not when it comes to the environmental issues and the green approach.

All political parties in Sweden are extremely mainstreamed when it comes to environmental issues, gender and equal opportunity. For young people taking part in their first election it is impossible for them to find a difference between the political parties when you discuss environments, the green issues, gender equal opportunities and the welfare of states.

## Slide 2



## This is Växjö, Sweden

## Municipal profile

- Population 83 000 (2010)  
60 000 in the city
- Forests and 200 lakes
- Centre of glass, furniture, SMEs,  
bio energy and education
- 8 000 SME-companies
- Linnæus University
- Political majority, right wing:  
M. C. FP KD

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**Slide 2:** Welcome to the magical mystery tour to the greenest city in Europe. We are a small university city in the southern part of Sweden with 85,000 people; 60,000 in the city centre and 85,000 people in the municipality. We are a centre of the Kingdom of Crystal, but also the centre of entrepreneurship in Sweden. Out of a population of 85,000 we have 8,000 small companies in the city. We have a lot of entrepreneurs, and many who want to start their business in the greenest city in Europe. We are bringing more and more tourists to our part of Sweden because we are regarded as the greenest city in Europe with a lot of lakes. In the municipality we have 200 lakes. 198 lakes have clean fresh water where you can swim and almost drink the water. In the city centre we have seven lakes, and my ambition and vision for the citizens is that there should be walking distance to a nice lake where one can swim. That is a very good vision.

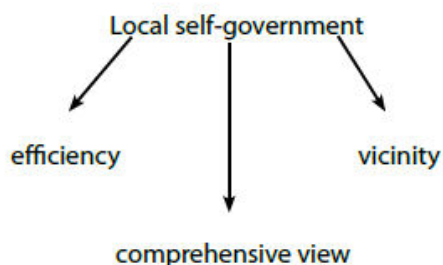
We have a small university, Linnaeus, which is growing quite fast. The Scientist called Linnaeus was born and raised in Växjö, so the University is named after Linnaeus who gave name to all the flowers. We celebrated his 300th anniversary two years ago.

There is a stable majority of four parties in the City Council, so I know in advance when I propose the budget it will be passed by the City Council, because I have a majority. It is very easy to be Mayor in Sweden. You can go abroad for many weeks per month. Well its big news in Sweden if the Mayor stays at home for a week. It is not in the news if I travel, and I like to travel quite a lot. This week, for example, seven or eight City Councillors are away in different parts of the world talking about and marketing the greenest city in Europe. Southern parts of Sweden are only two hours by train to Copenhagen in Denmark.

**Slide 3:** To know why almost everything is possible in Sweden you must understand that we are the most decentralised country in the world. There is so much power at the local level, which came from the constitution established 150 years ago. Everyone pays 30% of their income tax directly to the city. Can you imagine? An awful lot of money. 70% of our budget is about \$800 million and comes from the local tax payers and 15% fees from citizens that pay for waste and fresh water, etc., and 15% from the national government. We can only make a loss at two levels in Sweden, the national and local level. There are 290 cities or municipalities.

## The Local Government Act

Strong local self-government;  
for example the power of taxation



We could, for example, decide at the local level that all new homes must be wooden passive houses. We can decide that all buildings must have three glass windows, which has been standard in Sweden for the last twenty years. Buildings are very well insulated.

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The coldest temperature in Sweden this winter was minus 47 degrees, and the passive house technique with good insulation works even if it is cold and you do not have external heating.

The entire city is heated by bio energy, a plant owned by the city, and we also produce electricity. 58% of all consumed energy in the city or in the municipality is from renewables. That is quite amazing. We also have a special local law saying that if you build a new house you must connect to the grid, the bio fuel plant, and we set the limit per square metre for how many kilowatts a new building uses. Passive houses all connect to the bio energy plant.



**Slide 6**

We started our first environmental programme in the fifties and we renew it every fourth year, after each election. We focus on consumption, bio diversity, and also on nature and our water resources. We have nature reserves close to the city centre. Each citizen has access to a park or nature reservation that we have created.

**Slide 6:** We have a reduction of bees all over Europe; so close to our wetlands we have created paradises for bees with special flowers.

**Slide 7:** To take care of storm water we have natural infiltration which is very important. We have a lot of asphalt and

many flat pieces in the city. Private companies have developed a technique for green roofs and these are taking care of the storm water which compliments the wetlands.

**Slide 7**



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Slide 8



**Slide 8:** All over Sweden we have Water Protection Associations. Each river, each lake has one. Land owners belong there, companies and also municipalities and cities. It is a way to measure and treat water facilities, because the aim is to protect all Council water in Sweden. The Water Protection Associations are very important and they get money from the government and local government.

The city budget for sustainability has eleven indicators.

- Climate
- Sustainable growth
- Income (women's income compared with men's)
- Level of education
- State of Health
- Segregation
- Unemployed/Employed
- Waste
- Quality of water
- Risk of Poverty/Social allowance
- Creativity index

Three indicators are related to environment – climate, waste and quality of water. Every year we measure the quality of water, waste, climate and emissions, and the city budget is to help all the indicators, to show we are on the right track. We talk about sustainability, but it is also about democracy, social sustainability, gender, equal opportunities, poetry, and creativity. We like to have many Bohemian people, artists, entrepreneurs, because if you have them you encourage new enterprise. We measure and compare and benchmark, something we do a lot in Sweden. Every single issue is benchmarked with other cities and municipalities and we always try to be Number 1 in Sweden. The competition is very tough between municipalities and the cities of Sweden.

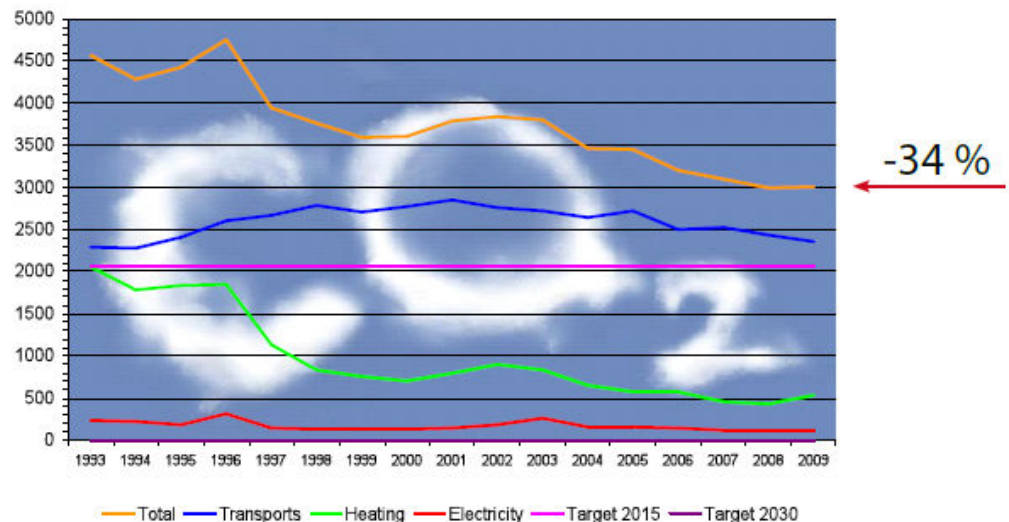
Next year we start a new plant for the local production of bio gas. We recycle a lot; every week we go to the recycling station with white glass, green glass, batteries, cans, papers, whatever. Now our citizens have to put all organic waste in a separate box which will be used to produce local bio gas. All public transport will be fuelled by locally produced bio gas. The city only owns environmental cars - electrical, hybrid, ethanol and bio gas cars.

There is a competition each year between companies, citizens and the city to increase the amount of environmental cars in Sweden. 40% of all new cars sold are environmental cars and more and more cities produce bio gas at the local level.

**Slide 10:** Since we began measuring we have cut our emissions by 34%. President Obama is talking about cutting emissions by 20% by 2020. Our example, as many other cities in Sweden, shows that it is possible at the local level to considerably reduce emissions.

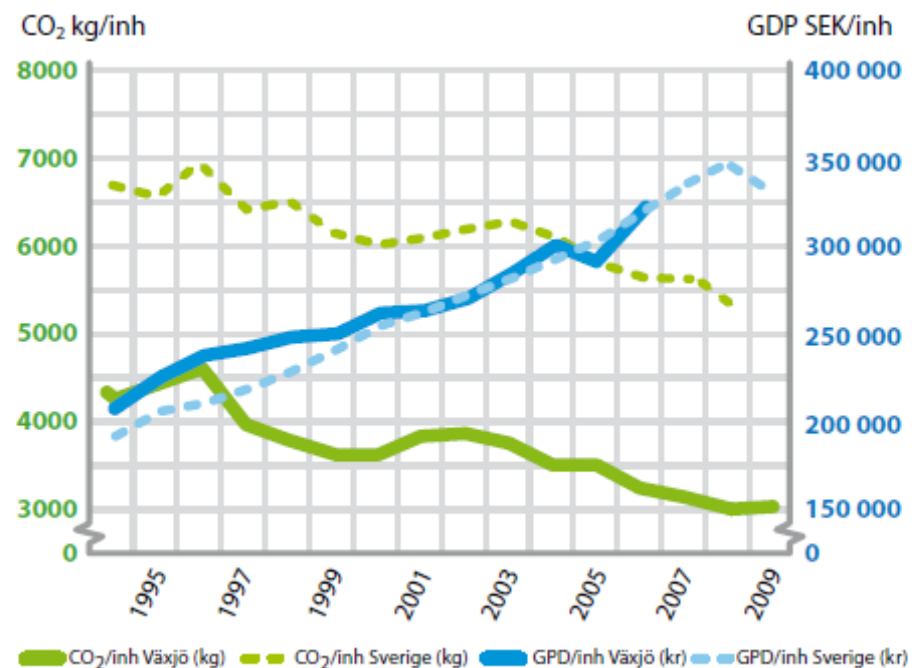
## Co<sub>2</sub>/person Våxjö, kg

Slide 10



**Slide 11:** At the same time the local growth is higher in our city than the national level. It means that you can save energy, cut the amount of fossil fuels and still increase local business life, because when you turn to renewable energy, new companies are attracted.

Slide 11

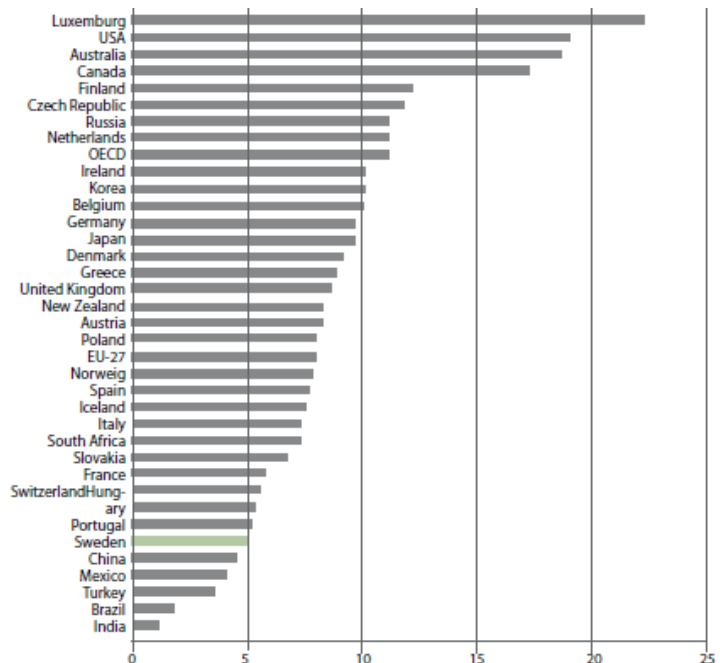


**Slide 12** shows there are big differences between emissions in different countries. I think in New Zealand you are doing quite well, but the United States and Australia are not. For example, Sweden has 5 tonnes of emission per capita every year and in our city we have 2.5 tonnes. That is why we are quite successful.

## Slide 12

### Carbon dioxin emissions per capita

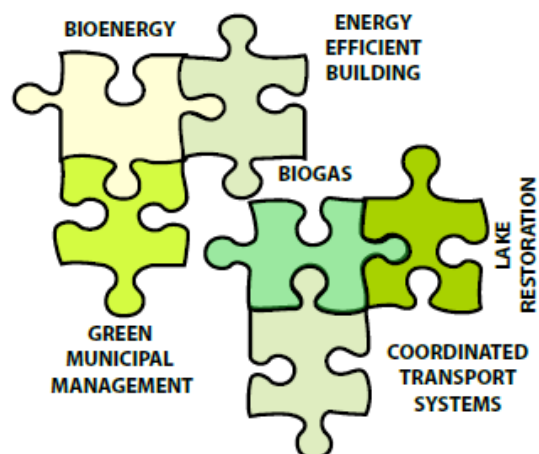
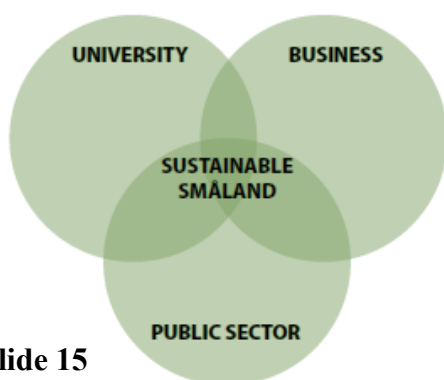
Ton per capita 2007



We have about one hundred and thirty foreign technical visitors coming to Sweden every year to see how we work with environmental issues and many hundreds of visitors from different parts of Sweden. Journalists come from all over the world. All major American companies, news broadcasting companies, ABS, CNN etc. come frequently to our city, which is very important for us.

**Slide 15** is about a new company we created, together with the University, in which we sell our knowledge. At the Linnaeus University we have about thirty five professors

### Sustainable Smaland



## Slide 15

Our offer  
Technical Visits  
Training & Capacity Building  
Construction & Equipment

Pre-studies  
Feasibility studies  
Optimizing, Service & Maintenance



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working with forestry, bio energy, and how to use our forests in a better way. We have plenty of forests in Sweden; we cut about 75% of the annual growth, so we have never had so much forest as we have today. But if you cut one tree, you are obliged to plant another which is the reason for our Programme for Climate Compensation to plant new trees. We are selling the knowledge from our University, from the green governance in the city and from companies. We work together with a cluster of green technical companies which is very important. We also earn a lot of money from our knowledge about energy saving, bio energy, logistics, etc.

## Bergaåsen amazing gravel formation

Slide 16



Slide 17

### Bergaåsen

- 16 raw water wells
- 18 production wells
- 8 infiltration ponds
- 200 litre/second
- ca 70 000 persons



**Slides 16-17:** We have the second best drinking water in Sweden. We take water with natural infiltration 60 kilometres away from our city, and that fresh water is outstanding. Of

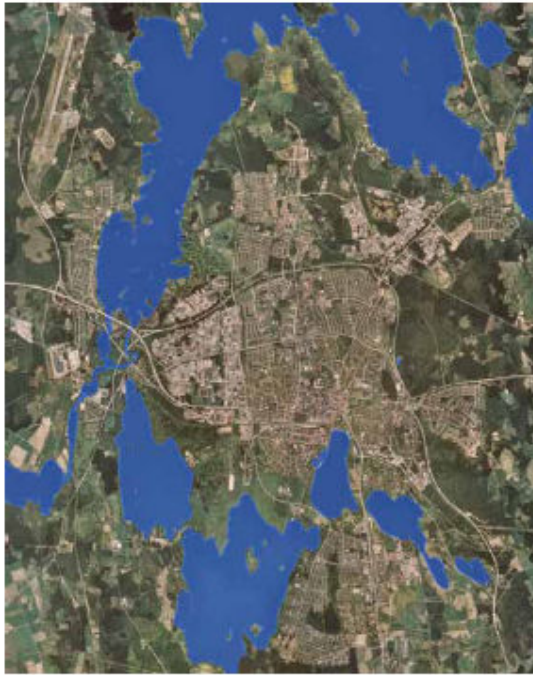
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course we could take water from almost any lake as drinking water, but we prefer the best. It is transferred by pipes to the city of Växjö.

Water is an important element of city development. Restoring the lakes started in the mid-sixties, and your Professor Hamilton knows a lot about our restoration programme. Most of our lakes are smaller than yours so our technique is not possible here because it would be too expensive.

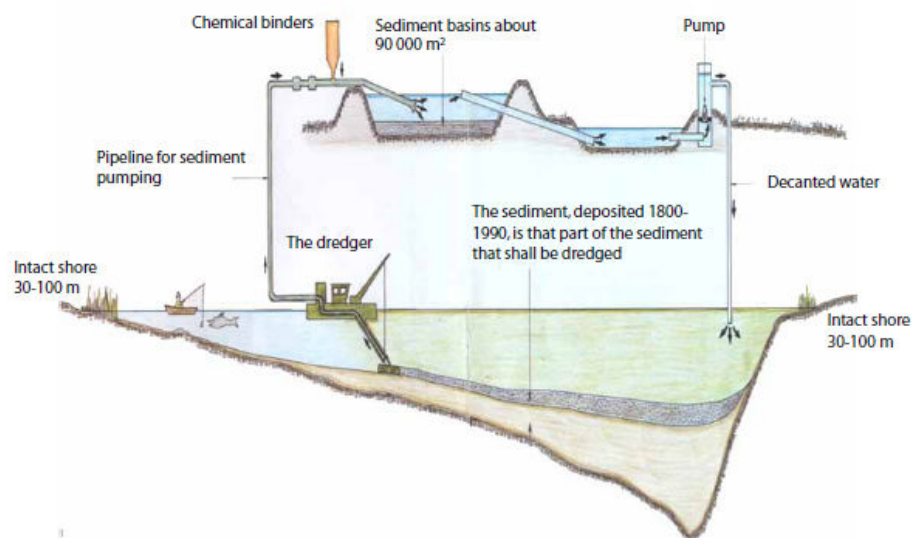
#### Slide 20

### Lake restoration



#### Slide 21

### Principal sketch for Växjösjöns restoration



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**Slide 20** shows what the lake looked like in the sixties before restoration, and how it looks now. We only have to do this restoration one time, because now there is only fresh water coming into the lake. The name Växjö means the lake where the roads meet. *Road* is Vär and *lake* is sjö. The water coming out from the waste water plant today is fresh and clean and does not pollute. It is almost drinkable.

**Slide 21** is a simple sketch of how they achieved the restoration of the lake. The techniques we used for restoration was taking away sediment from the bottom and stopping all dirty water polluting the lakes, with different methods such as wetlands, etc. Some sediment has been used for landfilling, roads and farming, depending on how much heavy metal is in the sediment.

**Slide 23**



**Slide 23:** We started with restoration in the lakes around the city centre where the University Campus is. First it was Lake Växjö, then Södra Bergundasjön and today Norra Bergundasjön. The first two lakes have been restored and a wonderful resource in the city centre.

**Slide 24**



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How have we shared the costs for restoration? Tax payers have paid about 30%, and people connected to the waste water plant paid about 30%. When we explore and build new areas for housing the cost of restoration is included. The costs are divided between different interests, and people like to pay tax for lake restoration because everyone wants to have a clean lake close to the city centre. We also attract more people to come to our city, the fastest growing city in Sweden according to our size. More than one thousand people come to live in our city every year because the business life is very attractive.

**Slide 24** shows how storm water is collected and sedimentation taken away. To start with we had different bases where we laid the sediment and we also had to take away all the fish in the lakes, because too many fish are not good for the quality of the lakes. With all three lakes we took the fish out to get a good balance in the water. Once again we have fish in the city lakes, crayfish, trout, salmon, and different kinds of fish. Fishing in the city centre is unique even for Sweden.

**Slide 27-28:** Storm water is another problem because of global warming. We are getting more and more rain in Sweden so have to take care of storm water in different ways. We have built open flood bases in different parts of the city. The storm water does not go to the waste water plant, we use natural infiltration, green roofs, and basins to take care of flood water as locally as possible. Flood bases can be underground or in the form of different kinds of wetlands.

#### Slide 27

### Open flood basins – takes care of excess water



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Slide 28

## Built in flood basins



**Slide 30:** We have now built this Linnaeus canal and other canals in the city centre to take care of the flood water. We built the canals so that the bases could clean the water before it came to the different lakes and this technique is working really well.

Slide 30



Linnaeus Canal

**Slide 32:** Lake Väjö is in the middle of the city centre and a big tourist attraction. More and more restaurants are being built around the lake. It is used for sports purposes, and for example, I take a jog every morning around this lake for health reasons. This winter we have had one metre of ice, but because of all the snow we could not ice skate on the lake.

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The lake is used for many activities year round and also attracts many people to Växjö. Motor boats are not allowed, but you can canoe. We try to create new attractions around the lake every year for people, both residents and tourists, to come back to.

**Slide 32**



**Slides 35:** We have a programme called Lake Växjö Art Site, an annual competition, to have a new piece of art at the shore of the lake. We invite three or four artists to make a model. Then we have a referendum where all citizens vote for the best sculpture which is then erected. We had a big debate on the globe. I do not know the English name but in all discothèques you have this kind of globe in the roof. I was close to losing the election because I was the only politician who defended this sculpture, but you must be brave sometimes. Now 90% of the people liked it once it was built. That is why democracy must be slow sometimes, people must get used to what politicians are doing.

**Lake Växjö – Växjö Art Site**

**Slide 35**



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We have an international competition with our eleven sister cities all around the world, and work together with regions in at least six or seven different continents. We are members of a lot of international networks. We are discussing the idea of an International Art Competition to bring pieces of art from our sister cities to our lake shore.

Twice a year we have a day and night cultural festival. People vote for a new piece of art or sculpture. Every year we build a new sculpture for a sculpture park around Lake Väckjö. People choose from three different alternatives. 40% of all people out that night vote. For interest, approximately 85% vote in a general election.

**Slide 36** is Trummen Lake at the university campus with the Linnaeus Garden using Linnaeus's favourite flowers in a geometrical park created by the university. There is also a programme here for creating new pieces of art and we work together with the university. The vision for the future is a sculpture park around all lakes in the city centre, a few new installations every year, which is a nice way to bring more tourists interested in art and art exhibitions.

### Slide 36

## Lake Trummen – Växjö Land Art Site



We have to compete because we are in the middle of the south of Sweden, not by the seaside. Most citizens, like me, go to the seaside in summer time. It is difficult for an inland city to attract tourists and that is one of the reasons we have this kind of programme.

We also have connected nature and public health and encourage different kinds of sports activities around the lakes such as a marathon and other kinds of competition. We are in discussion with doctors at the hospital suggesting they prescribe taking part in a jogging programme instead of giving people a lot of pills. Art and sports are becoming more and more important in medicine.

**Slide 39:** To be re-elected as a Mayor or a Councillor in Sweden you must have an environmental car and set a good example. This is my bio gas Saab. At work I use a

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Toyota hybrid car. We count all environmental costs every year. As the Mayor you have to give some kind of private climate promise. So my promise for the last five years has been to continue driving an environmental car and pay climate compensation when flying personally. We are one of the few cities in Sweden to pay climate compensation for flying and encourage all private citizens and companies to pay it too.

Slide 39

**Thank you for listening!**



To be able to reduce the CO<sub>2</sub> emissions in the city, the Mayor has to lead the environmental work personally

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The local airport is green. It only allows environmental cars and taxis to connect to the airport. Because we have a lot of snow and ice we use chemicals to spray on the wings before planes can leave. We recycle it all to prevent it going into the lake. We have an environment programme for the airport to become the greenest airport.

I have also promised myself to save electricity, for example, to turn off all stand-by equipment in the house which uses a lot of energy. We have energy competitions

Slide 40



*"The love you take is equal to the love you make"*

"The End" by Paul Mc Cartney

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between citizens and companies. Last year there was one between two companies and two schools comparing one week to the week in the previous year. They saved 25% more energy. It is very easy to save energy and the best way to reduce emissions.

**Slide 40:** My last picture – *Summer of Love 1967*, my favourite picture as the President of the local Beatles Society. It was in fact John Lennon who coined the phrase '*Think Globally, Act Locally*', and that is what we are doing in Växjö; we try to act very locally. The Beatles are helping me because I feel fine when I listen to Beatles music. A Muslim goes to Mecca once a year, I go to Liverpool.

Thank you so much for your attention.

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## DISCUSSION PANEL - QUESTIONS

**John Green, Chair:** Bo, you gave a presentation last night at the Mayoral reception and today you did not touch on the bio fuels, the generation of electricity and what you do in your city. We think there is also a great opportunity for Rotorua to capture the heat that sits under the ground through geothermal and we have lots of trees. How do you use your natural resources around the city to benefit the community? Do you think you could just touch on that a bit please?

**Bo Frank, Mayor of Växjö:** Twenty years from now you will be ahead of us because you have more possibilities. You have all the hot water and you have forestry. It is just a matter of vision and go for gold. It would be very easy because you have better opportunities than we have. We use a lot of bio energy to produce 58% of our electricity all from renewables and that is quite a lot. They are discussing in the European Union having 20% renewables by 2020 and a 20% reduction. That is not enough.

We have taken care of our possibilities in a nice way and the only bad thing about our city is that many cities are ahead of us when it comes to local production of bio gas. There will be enough forests in Sweden for timber, bio mass and fuel from our bio plants because we do not use the roots. There is more energy under the tree than above the tree and we have started to use the technique for using the roots also. There will be enough bio energy in Sweden to fuel all the plants so heating is not the problem anymore.

The problem is the emission from transport. We are doing research together with the University and private companies to develop the gasification of biomass. When we can build that kind of plant we could reduce the amount of diesel for trucks and buses. We have many possibilities and solutions and there is a strong will in Sweden because the environmental issues are the second most important issue after the economy and creating new jobs.

**Nick Zaman, Bay of Plenty Regional Council:** The word you were looking for was 'glitter ball' for your sculpture, but the question is - could you tell us more about the land use you have around your lakes?

**Bo Frank:** The land is used for building new homes because our population is increasing by a thousand people every year. We have a technique to build close to the water without interfering with the water through natural infiltration, for example. The land is used mainly for new dwellings and we try to make a dense city because it is more energy efficient and there are better efficiencies for public transport and cycle paths.

**Nick Zaman:** I was thinking more in the lake catchment. Is it mainly forestry or pastoral land use, in terms of the issues that you had with water quality, or is it mainly from municipal inputs?

**Bo Frank:** I do not understand your question correctly but we work a lot together with business and the University when we discuss all council issues.

**Nick Zaman:** Sorry, in the catchment do you have more farming, or mainly forestry, around your lakes?

**Bo Frank:** We do not have many nutrients because farming has reduced. We used to have a lot but now we have very tough regulations for farming. You are not allowed, for example, to export any waste from farming in the winter because it is icy and the nutrients

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will not infiltrate into the grass. It goes directly out to the lake. Farming is heavily restricted in the way you use the waste from farming.

**Scott Gray, Bush Skills Trust:** Mayor Frank I am wondering – have you seen the lily sculpture in Virginia Lake, Wanganui?

**Bo Frank:** No.

**Scott Gray:** You must see it while you are in the country, mate, it will blow you away.

**Scott Gray:** I am now promoting Rotorua but I was born in Wanganui. You know how beautiful Rotorua is. We have eighteen lakes within twenty miles of here, so make sure you see some or most of them if possible.

**Liz Yoder, Earlham College:** I am from the United States. I have a question for Professor Hamilton. You were talking about the middle layer of the lakes, called the metalimnion, which contributes to the stability of the lakes and I was interested in how?

**David Hamilton:** The stability is contributed physically by warm water sitting above cooler water and it is also contributed by the nutrients going into the lake. As long as the nutrients are low enough that they allow light to penetrate into that deeper layer, the metalimnion, that middle layer, then the algal layer will stay there and take up nutrients, effectively preventing them from getting to the surface where they contribute to reduced water clarity. It is a self-perpetuating mechanism that as the nutrients increase, there is more algal growth and it shuts down the light to the deeper layer. On the other hand as long as that deeper layer exists it will tend to take up nutrients from the bottom and stop them reaching the surface and therefore enhance the water clarity.

**Luke Tierney, Earlham College:** I have a question for Mayor Frank. You said that your city's population is growing, and you seem very proud of that fact, and I was wondering if you see your city being as energy efficient and as sustainable with a steadily growing population.

**Bo Frank:** Yes because we are building more and more densely so then we can have more public transport, for example, and all the new dwellings are more energy efficient than the previous buildings. An increase in the population is not a problem, it gives us opportunities instead.

**Luke Tierney:** Thank you, just one more question. What is your favourite Beatles album?

**Bo Frank:** The favourite song is a *Day in My Life* from Salt and Pepper. It was also listed by the magazine, Rolling Stone, as being the best Beatles one. Number two is *Strawberry Fields*.

**Paul Scholes, Bay of Plenty Regional Council:** I enjoyed your talk very much Mayor Frank. Just a question for you – you mentioned water protection associations and I wonder how they actually work? What is the framework with their aim, and how do they bring stake holders together?

**Bo Frank:** The Water Protection Organisations are NGOs. They work voluntarily but they get a lot of financial support from the government and also from the city. Like any organisation, they meet once to choose the board and chairman and they measure their quality of water every year, make reports and proposals to the city council and to the government.

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**Katie Rose Taulbee, Earlham College:** I have a question for Mayor Frank - thinking back to your sustainability indicators for your town, how do you measure the creativity index?

**Bo Frank:** In Sweden we have statistics about everything, we are not North Korea, but we know everything about people. We know, for example, how many chickens are dying every year in thunder storms. We measure people working in different occupations, e.g. how many web designers, artists, musicians and people working with events. So there is a statistical way of measuring the people working in creative occupations.

**Peter Guerin, Rotorua District Council:** Mayor Franks, towards the end of your speech you talked about climate charges and that you use them to make your airport green. Can you talk about the process and tools that you used to get to that state?

**Bo Frank:** The process for the airport becoming green? It started with a political initiative. Airports are feeling like bad guys because of the emissions from flying. Sweden has 1% of the emissions in the world, and less than 1% comes from flying, but still per capita that is a lot of emission. The local airport is owned by the city because the Federal Government did not want us to have an airport. What did we do, we built one ourselves because we are in the entrepreneurial part of Sweden.

To compete with other airports we have the approach of being green. The companies flying into our airport have a green profile and the newest planes, using less fuel. We have developed a system for recycling everything from the planes. We introduced green environmental taxis to go to airports and cheaper parking for environmental cars. The tax payers complained to begin with!

**John Green, Chair:** I think that was music to Peter's ears because Rotorua District Council also owns the airport and you have a lot of messages and ideas to share with them.

**Peter Skelton, Environment Canterbury:** I must say, Mayor Frank, as a recent participant in local Government I would love to have 30% of my constituents' taxes. The question I ask is this – in New Zealand water is a common, in other words nobody owns it, and we have a regulatory system of control, which is at the regional level, although central government has a function to play as well. I would be interested to know what kind of regulatory control you have in Sweden, and particularly in your city, with regards to water resources and how is that administered?

**Bo Frank:** Each city is obliged by the government to have a special plan for how to treat the water resources, and that report has to be done every year. What I have not mentioned is that we do not have a lot of problems with nitrogen and phosphorus, etc., but in the 60s to 80s we had problems with acid rain coming mainly from abroad. 70% of the acid rain comes from Poland, England and Germany, but now it is not so difficult. We had a special programme where we used limestone to improve the PH in our lakes. We have to make a report on this also to the central government every year.

**Peter Skelton:** Thank you for that. Do you have a permitting or consenting process for discharges to water and for the use of water other than at the local level, or is it all done by central government?

**Bo Frank:** You must connect to the waste water plant in the city as a citizen, in all dwellings in the city centre. If you live in the countryside you are obliged to have some

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kind of septic tank or something to secure infiltration far away from the lake. It is very difficult to build a new house without taking care of the waste.

**Peter Skelton:** Yes I understand that, thank you, but does your municipality exercise a regulatory function with regard to the use of water in your city?

**Bo Frank:** Yes of course, it is not part of income tax but each consumer pays individually for water consumption and waste water. The city is not allowed to charge more than what it costs so all cities charge 100% of the cost to each individual using fresh water and are connected to the waste water plant.

**Peter Skelton:** Who authorises the discharges of treated effluent? You talked about one of your lakes still receiving discharges and you are going to clean that up. Who authorised those discharges?

**Bo Frank:** The city is responsible.

**David Hamilton:** Could I mention too there is an overarching driver for some of the environmental management of water in Europe and that is the European Water Framework Directive which has very strict goals around maintaining or improving water quality by set dates. It has been the driver of many of the changes that have occurred in water management in Europe over the past few years.

**John Green, Chair:** David, could you give a brief explanation as to how it is different for us?

**David Hamilton:** It is an international organisation, for a start, throughout Europe. Essentially the European Union has got together and provided the goals for countries and then they have been delegated down to individual authorities or cities to be attained by set dates so no further deterioration shall occur by a certain date.

**John Green:** Compared to Sweden, New Zealand is very liberal with its water management rules?

**David Hamilton:** I would say that we are working towards setting some of those goals, but their collective goals have been agreed upon by consensus some time ago, and now form the basis to which everybody has agreed essentially to work towards.

**John Green:** Yes, I was watching Bo's reaction to Peter's question and it is obvious the water management issues with control, and who exercises the authority, have been in existence for a long time in Sweden, while it is still new fields here in New Zealand.

**Matthias Schellhorn, University of Canterbury:** I am here with the American contingent from Earlham College. At the moment we have taken refuge up here in the North Island. I have a question for Mayor Bo Frank - I am interested in how you have achieved this vision of being the greenest city in Europe. That must have been a vision for quite a long time. You talked about different aspects of getting there, one is certainly the rating base of 30% of your tax paying money going directly to the city. Another element you talk about is the regulatory environment and the fact that you have strong regulation. A third element is the civil society and the input that came from interest groups, like the LakesWater Quality Society. What I would like to challenge you with is, if you could pinpoint the most important input into achieving this vision, where did it come from?

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**Bo Frank:** It is very easy to explain. When I became Mayor first time in 1991, I took the executive committee in the city council abroad for a week to discuss what issues we agreed on and what issues we do not. We defined environmental issues as top priority to be the best city in Sweden. The second issue was to develop the university campus and then culture and sports. We made an agreement a long time ago to co-operate on all those issues even if we are eight different parties in the city council.

That was the first decision we took. Then we employed some clever civil servants for the city and the atmosphere in the city council is very informal between the civil service and politicians. Each person employed by the city comes to my office every day and says, "Bo you have to do this, you shouldn't do that".

We agreed very very early to have co-operation with businesses and the university and that has been very useful. We also have co-operation with different NGOs working for environmental issues. We had a lot of environmental .... at that time in the seventies and the eighties. We do not have so many organisations of that kind today because politicians are green and the environmental issues are mainstreamed inside political parties. The pressure groups have decreased a lot. So set your target, and all politicians go for it.

**Matthias Schellhorn:** As the chairman mentioned before, the key element in achieving this vision was to reach some societal consensus and it appears to me that that involves bringing together different stakeholders with different interests and values and obviously sometimes conflicting interests. Bringing that back to our situation in Rotorua, and the fact that we are here sitting in a Symposium which brings together people with quite diverse interests from all sorts of different economic backgrounds, industries, public service, local government and regional government, we should be in a good position to embark on a similar track as your city has achieved. That gives me a lot of confidence in what we could achieve here. Thank you.

**Bo Frank:** I think you are right. Thank you.

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## ***Session Two - Action By Authorities***

**SESSION CHAIR: Mayor Kevin Winters, Rotorua District Council**

### **SLAYING THE MONSTER : MEETING THE CHALLENGE OF FIXING LAKE ROTORUA**

**Bill Bayfield**

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*Bill Bayfield began a career in resource management in New Zealand local government in Taranaki in 1980. In 2002 he took up a position in central government for the Ministry for the Environment as Group Leader in charge of Sustainable Industry and Climate Change. In 2006 he left Wellington to take up the challenge of Chief Executive Officer at Bay of Plenty Regional Council. The Bay of Plenty is the fastest growing region in New Zealand and contains in the Rotorua Lakes, one of the country's most challenging water quality issues. The Council is also working on the challenges facing Tauranga Harbour, using methods such as catchment plans, whole-of-catchment stormwater consents and mechanical mangrove removal. Water allocation and the sustainability of flooding defence infrastructure are among the many other challenges that are part of actively promoting sustainable development on many fronts in the Bay of Plenty.*

#### **ABSTRACT**

The Rotorua Lakes Protection and Restoration Programme covers planning and actions over twelve lakes in the Rotorua District. Initial progress on cleaning up the smaller lakes has been spectacular, but Lake Rotorua – the largest – is a challenge that needs ideas, imagination, innovation and leadership to resolve. Our experience has shown we can stop lakes degrading. The success of our interventions on the thirty hectare Lake Ōkaro is the proof that our methods work on this scale.

So far, our interventions have significantly improved Lake Rotoiti's water quality, and all the actions in the Lake Ōkaro action plan are complete. For Lake Ōkāreka interventions are nearly complete, including reticulating community sewage, treating the sediments, creating wetlands and retiring 100 hectares of pasture and planting the land with trees.

However, for the 50,000 hectare Lake Rotorua, even with the best environmental agricultural practices, the nutrient reductions required cannot be achieved without some land changing out of highly profitable and highly leaching agricultural practices.

This will create community tensions between the environment and economics. Our leaders and politicians will need to make some tough decisions to achieve land use targets required for real water quality improvement. They will not only need to consider a range of tools – including regulation, identification of alternative high value land use practices and implementation of research that identifies low leaching farming techniques – but understand how to motivate the community to action.

The challenges in restoring Lake Rotorua are a whole new issue. With the experience we have gained dealing with other lakes we understand and realise that an all-encompassing

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vision is needed to engage with the whole community and find solutions that will provide economic opportunities while addressing environmental issues.

## **TRANSCRIPT**

When I spoke to this Symposium in 2008 I told you that Lake Rotorua was a monster. I also said that I was convinced that in the next decade we could tackle the challenges on eleven out of the twelve lakes, trends heading in the right direction, lakes achieving their TLI goals by the end of the decade. Three years on and I think time is proving me right, but there is still an awful long way to go, Rotorua is still a monster. We are making some excellent progress though and I want to run you through some of that.

### **We are making excellent progress**

We have significantly improved the water quality of Lake Rotoiti; everybody recognises that. All the actions in Lake Ōkaro's plan are now complete and the lake is looking much better. The actions for Lake Ōkāreka are now almost complete. Lake Tikitapu's actions might amazingly be completed before the action plan is even finalised. Rotorua District Council is forging ahead with sewerage reticulation. We have successfully harvested weed out of Lake Rotoehu, more on that later. We have successfully trialled floating wetlands on Lake Rotoiti. We have successfully stopped an algal bloom in mid-stream in its early stages on Lake Rotoiti. All good stuff.

We are learning, with a community, to manage and improve these lakes. We have learnt what works, and sometimes what does not, and we can adapt what we have learnt to address the bigger challenges. In other words, for the first time in three years I stand before you believing that monsters can be slain. For Lake Rotorua we are going to need innovation, to think outside the box. We need to come to terms with the fact that even with the implementation of the best agricultural practises in the world, and we need those in our catchment, we cannot achieve the reductions we need in nutrient loads for Lake Rotorua without some land use changing. We will need regulation to underpin initiatives for this to happen, and inevitably we will need financial support for the land owners to achieve it.

Changes in land management practices, and indeed changes in land use, will take years, even decades, to have a visible effect on Lake Rotorua. Some of the technologies we are using now, like phosphate locking, will show more rapid results, and indeed they are, but it will in general be a slow haul. We have to believe that doing it is right even if we do not see the full extents of the changes in our lifetime, particularly on Lake Rotorua.

### **How far we have come**

Since we signed the strategy for the lakes of the Rotorua district in 2000 the Council, with its partners, has embarked on an extensive work programme on all twelve lakes. This is a \$200million project and we are working in a partnership with firstly, Te Arawa Lakes Trust, secondly, Rotorua District Council and thirdly and importantly MFE representing Central Government, who of course give us substantial funding to tackle the four priority lakes – **Rotorua, Rotoiti, Rotoehu and Ōkāreka**. They are the partners on the Rotorua Lakes Strategy Group, and many of you represent partners that are with us in one way or another as we take this journey.

Lake Ōkaro remains the most degraded lake, but it is here we have been able to make most progress so far. It is our practise pond and the work we are doing here will tell us

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more about what we can do as we tackle the bigger ponds. Ōkaro is proof that our methods are actually working. It is on a very small scale but we know that we can significantly improve water quality because we have done it.

### **What we have achieved at Ōkaro**

Lake Ōkaro is 31 hectares and has a catchment of 367 hectares around it, surrounded by farms about 90% in pasture. It is very popular with water skiers and it is in a poor state. It has had significant algal problems due to the levels of nitrogen and phosphorus that have increased over the decades. We regularly monitor the lake and can tell you that overall it is an excellent place to swim, it has good bacterial quality, but health warnings are common over summer due to potentially toxic algae. Indeed we had one of those toxic algae blooms in November last year. Ōkaro's trophic level index, which is the measure we use of overall lake health, has been around 5.3, and that has been regularly above our target of 5.0. So in 2006 the Rotorua Te Arawa Lakes Strategy Group agreed a long term action plan, our first to tackle a lake. The action plan estimated that the reductions that were needed to achieve a TLI of 5 were to get about one tonne of nitrogen out of the lake a year and twenty kilos of phosphorus. To have those targets is vital, it is one of the lessons we have learned. To know what you are aiming for. We have now implemented all those actions under that action plan.

- **We have capped the lake bed** - and learnt a lot in doing it. We applied zeolite, a phosphorous-absorbing cap or mineral layer on the lakebed to limit the release of phosphorous from sediment. This was applied by barge in 2007 and 2009, and we are monitoring to see how successful it is in locking up phosphorous.
- **We built a wetland** on council land and private farmland which we have been monitoring for a couple of years. It has taken out about 50% of the phosphorus and nitrogen flowing from the two main streams entering the lake.
- **We have created buffer zones** - This year will see the last of the fencing and planting of riparian strips along all the streams in the Ōkaro catchment.
- **We have reduced nutrients** with herd homes, thanks to the Birchall Family, and we are monitoring their results. Farmers are working on a Sustainable Farming Fund project to account for and minimise nutrient losses.
- **We monitor all these interventions** very closely to be able to adapt what we do and change if it is not working.
- **We have regulated.** Ōkaro is regulated under Rule 11 in the Regional Council's Water and Land Plan. Rule 11 is a powerful tool which caps existing nitrogen and phosphorus loss from land use. It means no more dairy conversions and no intensification of land use with higher nitrogen loss.

It is a package and it is working. This year Lake Ōkaro showed significant improvement. The annual TLI is now 4.7, **below our target by a considerable amount**. That is what we have been able to do on the smallest of our lakes, we need to celebrate that and recognise that these techniques have worked, but also remember that the larger foe we still have to deal with is likely to pose different and more complex challenges.

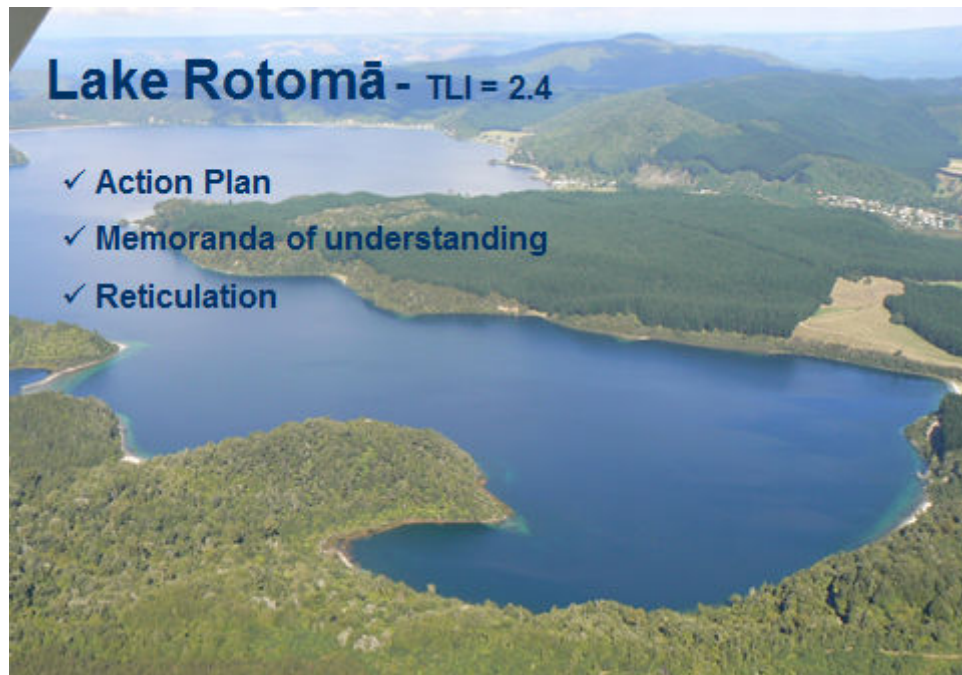
### **What about our cleanest lakes?**

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We need to be very vigilant in protecting our best lakes as well as clean up our worst. Some of our most pristine lakes are showing signs of decline. Most are still very clean by any standards with no algal blooms, but we need to make sure they stay this way.

Our four cleanest, oligotrophic lakes are **Rotoma, Okataina, Tarawera and Tikitapu**.

This year the Strategic partners approved an action plan for Lake **Rotomā** and we have two memorandums of understanding with the largest agricultural landowners, and sewerage reticulation is going ahead. We are not far from completing the action within that action plan.



My learning from Rotomā is to question whether memorandums of understanding are sufficient commitment for the broader community to be sure that land use changes are controlled and managed to ensure that investments that the community make in other actions are supported. I guess it is fair for me to say that I believe that Rule 11, our rule that caps intensification or increased loss of nutrients on land, should apply to all the twelve lakes. It does not suggest the lack of trust; it is simply that we all need certainty.

We have started work on the actions for **Tikitapu** before we have even signed off the action plan. We have had such support for the action plan that we have been able to move straight into the actions. Luckily the sewerage reticulation system that addresses Lake Ōkāreka goes right past Tikitapu and hence largely addresses that lake too. What a marvellous win. However a word of caution on that beautiful lake. The recreational use of Tikitapu is at times incredibly intense and we are collectively going to have to monitor the impact on the lake of that recreational use.

**Tarawera** is next on the list for preparation of an action plan. I understand it will be started the minute Tikitapu is finished and **Okataina**, which is the most protected catchment, will be addressed next. It is very important these oligotrophic gems of water quality remain so, and I now have faith that they will.

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**Tikitapu** - TLI 3.0



**Tarawera** - TLI 2.8



**Ōkataina** - TLI 2.8



Then there are the odd ones - **Rotomahana**, **Rotokakihi** and **Rerewhakaaitu**.

**Rotomahana** - TLI 4.0



**Rotokakahi** - TLI 4.8



The most exciting thing about **Rotomahana** this year is nothing to do with water quality; it is the discovery of the pink terraces below. I am sure like me you are all fascinated by that footage and to see those famous terraces back. But we have a twist, the lake is actually remarkably stable in terms of its TLI at 4, its goal is 3.9, so we are reasonably comfortable with it. But all of a sudden we have a weed invasion which is causing concern and we will be watching and monitoring it. Luckily through other lakes we have some experience.

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**Rotokakahi**, which is privately owned by Iwi, has some very odd signs and deteriorating water quality. We need to engage better with the Maori land owners around that lake and will be looking to do that through our partners Te Arawa Lakes Trust. We need to find out what is going on. Tai Eru tells me they are still catching superb trout. Sorry Tai, that was supposed to be a secret, I withdraw that comment.

**Rerewhakaaitu** is a lake that has gone up and down in quality over the last twenty years, quite strange because we do not understand the reasons why. Some of the beauty of working with these lakes is you do not always understand everything. But it is a special lake for us as we hope that we can demonstrate, with good land use and best farming practice, we can fix a lake while only needing regulation as back stop. I am very impressed with the farmers of the Rerewhakaaitu catchment in the five years I have been working with them. They are developing their own catchment action plan. Farmers have joined forces to work out how they need to change their farming methods to improve their lake. They are starting to make the changes in their farming operations, reviewing their actions and looking at what has been done on their farms and how it links to that lake. Time will tell whether their actions are enough. We will support them all the way, but if we do not see action on the ground and changes occurring in farming practice then we will have no choice but to move to regulation. I implore the farmers of Rerewhakaaitu catchment to prove the sceptics wrong and demonstrate that land owners in New Zealand can stand up, take ownership for their own external effects and actually do the job.

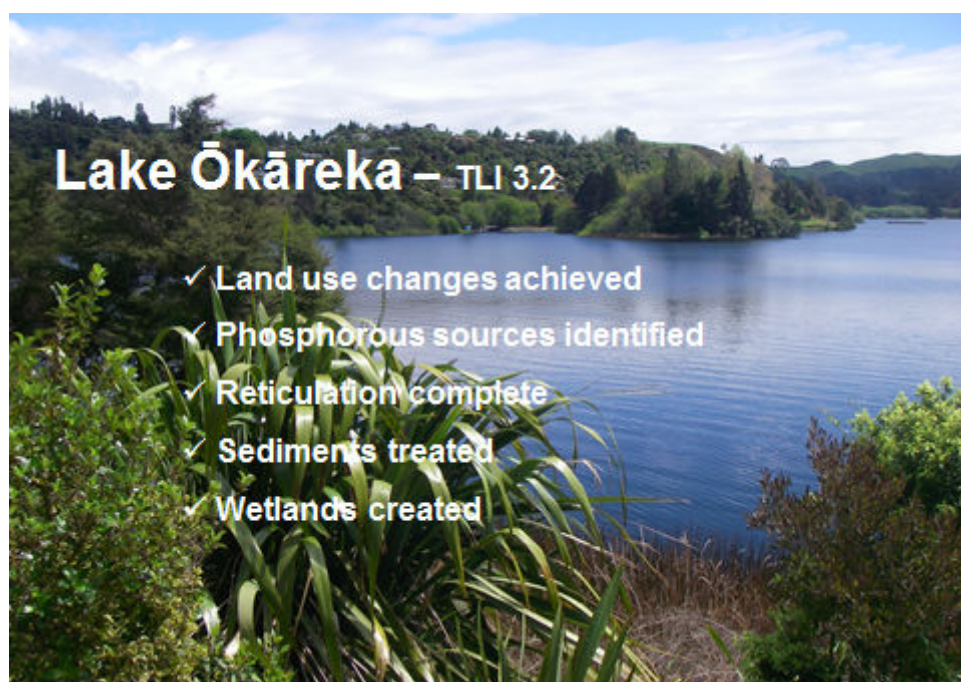


### **Then there are our four priority lakes**

The Lake **Ōkāreka** action plan is done. We have largely taken the actions and now we monitor.

- About 60% of the land use change we sought in the catchment has been agreed voluntarily, and is secured, not through MOU's, but by binding contractual arrangements
- Critical sources of phosphorus have been identified and the work to install the detention and retention structures is underway

- The sewerage reticulation is complete and my congratulations to RDC, its engineers and contractors, for doing an excellent job
- Sediments have been treated
- Wetlands have been created

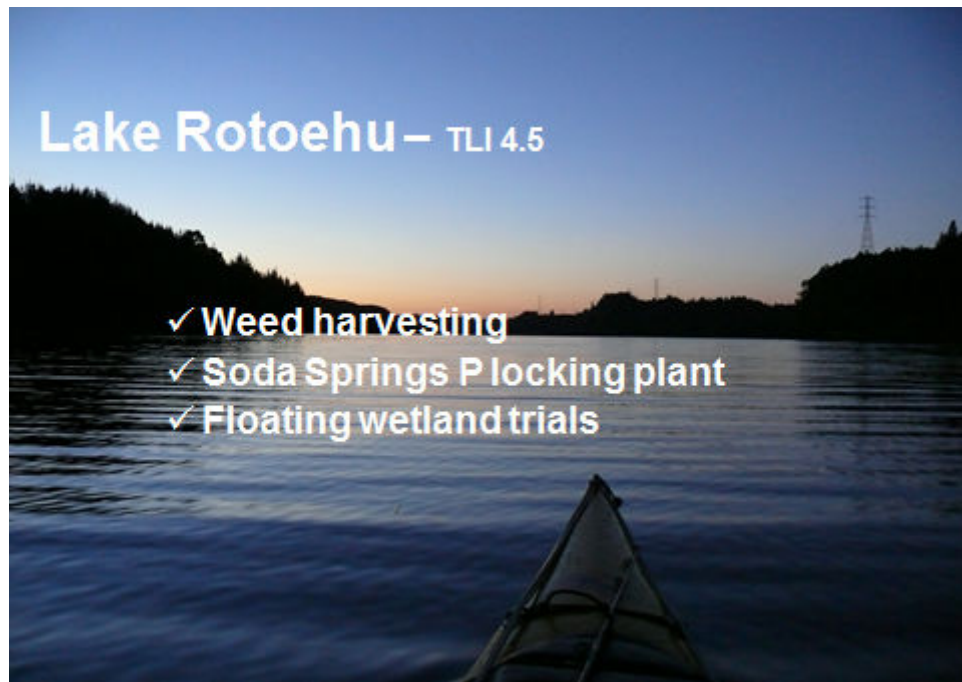


I have faith that the landowner Kipa Royal's land retirement and Rotorua District Council's sewerage scheme will prove effective on this lake. In fact we need to monitor the lake and watch the changes occur. Anecdotal information at this stage is that the lake is responding to the sewerage scheme already, much as we saw when the Okawa Bay Scheme went in at Lake Rotoiti.

I believe that those actions will be enough to fix the lake. It is important when you take a series of major actions like we are at Ōkāreka, that you actually stop for a while and monitor, and work out whether or not you need to take the next steps. If you need to take the next steps there are future land improvements and land management options available in Ōkāreka. But right now it is time to sit and wait and see what goes down. Hopefully it is the TLI.

On **Rotoehu** the action plan is done and the actions are now underway on Lake Rotoehu. They form two parts on Rotoehu and I want to cover both. First of all aquatic weed harvesting last year removed 8½ tonnes of nitrogen and 1½ tonnes of phosphorus from the lake, exceeding our annual targets for nutrient removal. That weed harvesting operation, the first time we had ever done it, removed the whole year's nutrients in one hit. It is more successful than we dreamed it could be and out of it a new tool emerged, one that we will use again and learn how frequently it should be used and also how it might enhance amenity values across the lakes.

A phosphorus locking plant at Soda Springs has now been commissioned. The plant is based on our successful plants at Utuhina and Poranga Streams off Lake Rotorua, and will remove about 700 kilos of phosphorus from the inflow into the lake, meeting the whole lake target for phosphorus. Floating wetlands have been trialled on Rotoehu and shown that they can remove four times as much nitrogen by de-nitrification compared with land



based wetlands of the same size. They are also incredibly fantastic for enhancing the koura resources, our native fresh water crayfish. If you could see those little crayfish hanging on the bottom of that floating wetland you start to wonder whether or not the thing will sink.

We have almost completed a 200 square metre wetland which will be launched soon. For those who saw the smaller wetland on Rotoiti get paddled out by two Waka, a 200 square metre wetland getting paddled out should be some event.

Those are immediate stop gap measures – weed, wetlands and the dosing plant. They are doing the job on Rotoehu now, but the best news for me on Lake Rotoehu is the relationship that we have steadily built up with the land owners in the catchment. I believe those land owners, driven by their values of land ownership and stewardship that automatically encompasses responsibility for the lake, will see us making very significant land use and land management changes in that catchment very shortly. Effectively we will nail our targets for Lake Rotoehu in quite a short time.

Lake **Rotoiti** water quality has improved. The lake is now meso trophic or average, instead of eutrophic - poor. The TLI has shifted dramatically from 4.5 in 2005 to 4 in 2008 and last year it reached 3.9. We have a way to go to the target of 3.5 but the trends are alright. Rotorua District Council sewage reticulation is continuing in the communities around the lake and that will assist us to get to that target. But the bottom line is that I doubt we will hit it for a while, because Lake Rotoiti is greatly affected by what happens in Lake Rotorua, linked through the Ohau Channel, as David Hamilton showed you. What we do in Lake Rotorua will in the end solve Lake Rotoiti.

In July 2008 the diversion wall was completed and prevents water with high nutrient load flowing directly into Rotoiti. Now more than 70% of the nutrients, which used to flow into Rotoiti and then down the Kaituna River, are now diverted and bypass the lake. Monitoring has been done and you saw some of the examples to determine the performance of the wall as well as any potential effect on local ecology in the Kaituna River. I am very pleased to say that we have found no significant problems, the wall is working and the Kaituna River is not measurably impacted. But we still have issues in

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Rotoiti, particularly in the Okere arm, and no one is suggesting that the diversion of those Rotorua lake waters and their current condition through the arm, or down the Kaituna River is acceptable. It is not. But when we slay the monster both will be resolved.



Before I move to Rotorua I want to remind you that this business is not an exact science. Just when we thought we had fixed Ōkaro it had an algal bloom with a species we had not even recorded before. We do not really understand what is going on in Lake Rerewhakaaitu, why its water quality goes up and down. This process is all about learning and all about adaptive management. Not about working with blueprints and fixed minds. At Rotoiti this summer our scientist spotted the beginnings of an algal bloom and a dose of zeolite locked up the phosphorus and took the bloom out quickly before it really got going. Something never been done before, and something that on the basis of their work with Ōkaro they were brave enough to try, and they nailed it. A tremendous success story.

For me it is all about learning and adaptive management and all that we learn from our lakes and those overseas, including Sweden, comes to bear on the monster – Rotorua.

### **Why is this one so different?**

**Rotorua** has a growing city around it, not just a few baches and not just a few farms. We need to deal with 40,000 people and 2,000 rural owners. By comparison Ōkāreka has a dozen rural land owners and Rotoehu only three. In terms of size Ōkāreka is 367 hectares, Rotoehu 4,700 hectares, but Rotorua is ten times that size, 50,000 hectares. The size of the catchment means the travel times and nutrients in ground water can be measured in decades.

Rotorua has intensive land use, dairying, dairy grazing and cropping. Rotoehu has one dairy farm. At Ōkāreka voluntary land use change looks as if it will work because there are just twelve rural land owners. All of them see the lake; all of them use the lake. By Rotorua some of the land owners are a long way away from the lake. They do not necessarily connect with it. It is a challenge to get those people to buy into the solutions.

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They are not directly engaged and they do not see it as benefit for themselves. Some of them actually see real challenge to their livelihoods from our actions.

We know now that the best agricultural practices are required in the catchment of Rotorua. The very best in the world, and we know that even with that it is not going to cut the mustard as we know it will for Ōkāreka, Rotomā and Rerewhakaaitu. We will need land use change. We will not get long term gains necessary by voluntary means. We need to take some strong measures and make some tough decisions, good policy and good regulation under-pinning actions.



If I sound too tough I am going to ease up now and tell you some good news about Rotorua.

- **Partnership** - the partnership between the Rotorua Te Arawa Lakes Strategy Group, the Te Arawa Lakes Trust, the District Council, Ministry for the Environment and the Regional Council is nothing short of excellent and is making demonstrable progress. I have got to tell you bluntly, it is great to work on it.
- **Targets** - When I spoke to you three years ago the targets were still in dispute. Nobody is really disputing the targets the way they were. We recognise that a limit of 435 tonnes a year of nitrogen discharging into Lake Rotorua is about right. Daunting yes, it is a reduction of 300 tonnes from where we are now, but it is about right.
- **Science** - One of the contributors to those targets is the science around the lakes which is growing and now a considerable body of information. The lakes issues are carefully studied by a bunch of incredibly intelligent, smart people who are bringing up solutions all the time. Professor David Hamilton of the University of Waikato, and the team he collects, deserve accolades here. We have a sound knowledge base from which to make decisions and I note that not all that knowledge is necessarily western science based.

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- **Collaboration** and innovation are breaking out all round Lake Rotorua and the key one for me at the moment is the dairy farm collective currently being proposed. It represents an exciting collaborative venture by which the lake's dairy farmers collectively approach their share of the reduction required on their properties. Tanira Kingi is leading the formation of that collective and it looks and sounds smart and you will hear more about it later.
  - **Technologies** - As we learn from the actions on other lakes, we find that techniques are refined and new techniques emerge, from weed harvesting to floating wetlands. We learn, for instance, that there are concerns about all techniques that we use, but we seem to be able to talk through them and trial. Trialling is incredibly important. Iwi have expressed a concern over the dosing techniques using alum or zeolite on the basis that they do not like material or other products being introduced to their lakes. But I have to say the clever dosing of the algal bloom in Lake Rotoiti tells me that even that technique has its place, right time, right place, and I look forward to working with Iwi through those issues. Perhaps the most exciting technology to emerge at the moment is aeration. It means mixing the lake water to stop blooms. You will note how much David Hamilton's address depended on different stratification. Aeration does not add any product; it is used when there is a need to de-stratify the lake. It is exciting and might cost less and be more effective than sediment capping.
  - **Regulatory Framework** - Our proposed Regional Policy Statement was notified late last year and is now at the further submission stage. It identifies all the Rotorua Te Arawa lakes' catchments at risk. The policies for these catchments are to be given affect through rule changes to our Regional Water and Land Plan, and indeed changes to the rules of the Rotorua District Plan. Those rule changes will follow the RPS and will effectively operationalize the RPS.

The proposed RPS limits the contaminants that can be discharged in at-risk catchments. A limit of 435 tonnes a year of nitrogen for Lake Rotorua is stated. Currently discharges are capped under Rule 11 - they may not be increased. Our proposed RPS goes further and sets the policies out that will drive the reduction of those discharges to meet the target. It is a big change.

Resource consents will be needed for any change in land use likely to increase the discharge of contaminants. When dealing with land use change, BOPRC and the District Council can regard positively significant reductions in discharges when weighing up resource consent applications.

Council will hear submissions on the proposed RPS later this year. But I have to say after taking a preliminary look at the submissions we received to date, we are on the right track.

We are getting our act together in terms of a regulatory framework. We have to face facts; voluntary change cannot work in Rotorua, the problem is too big and too complex, and therefore the solution must be underpinned by good policy and regulation.

- **Incentives** - We know policy and regulation will not work on its own. All parties are partners in the rehabilitation of Rotorua and we have to have some carrots to facilitate and encourage change. There should be no finger pointing. Every element of society in this catchment has to contribute to this change, from urban dwellers to sheep and beef farmers. Pointing at dairy is just too easy. It does not

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recognise the breadth of the problem we face. Everyone has to go a step further; it is just that dairy farmers have to go five steps further. As a Council we will be helping them all the way. We are working with experts to develop at least three packages of actions to reduce nutrients and we will be engaging with the Rotorua community on those over the next couple of months. The first off the blocks is a Nutrient Reduction Fund, a pilot programme aimed at making funding available for land based nutrient reductions for Rotorua land owners. Watch that space.

## **Conclusion**

The Bay of Plenty Regional Council and its partners are absolutely committed to rehabilitating these lakes, Lake Rotorua in particular. While I stand before you pleased with the progress over the last five years that I have led the Regional Council, I feel like celebrating some not insignificant successes and recognising that many of the trends are going in the right way, while at the same time acknowledging there is a long way to go.

On Rotorua in particular I just want to note that the Strategy partnership is great and I am sure in the near future it will be extended for instance on Lake Rotorua to include Ngati Rangiwewehi and Ngati Rangiteaorere.

The targets are daunting. They are hard, but we know, and we are good at this and will tackle them. The science is superb and the ability to model different interventions and see what they can do provides us with a real crunch tool. Technologies – just remember aeration. Collaboration – good luck to Tanira Kingi and all our support will be with the dairy community as they try to tackle their share of that reduction.

The regulatory framework, I believe is necessary. The time has come, particularly around Lake Rotorua, when voluntary approaches just will not cut the mustard. So therefore it is inherent on us to drive good policy and provide good regulation and back it up with packages of incentives to target good change.

I regret that I will not be here when you slay this monster because I know you will. I believe that the work that we have already collectively done shows that the tools and the pathway will enable us to slay the beast. No blueprint, monsters can be very cunning and very tricky. You need to be agile and innovative along the way to slay them. Agile and innovative includes the Lakes Water Quality Society, you are fantastic. I believe in the last Symposium I said that you were so good that if you did not exist we would have to invent you and if we tried to invent you we would get it wrong. I take my hat off to you guys and I am absolutely sure that you are going to be here for the death scene when the monster is slain.

The good part about slaying monsters that is written into all the fairy tales that I ever read my kids, is that when the monster is slain the kingdom prospers and everyone lives happily ever after. I believe that the tools and the pathway ahead are not only doable, they are affordable, and will create a platform for making this part of our kingdom an icon of sustainable living and a community of considerable wealth.

I wish you all the best. I will watch closely from the South Island and it has been a pleasure to work with you. Thank you.

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## HOW WILL THE DISTRICT PLAN IMPROVE WATER QUALITY AND GROW THE CITY?

**Peter Guerin**

Chief Executive, Rotorua District Council  
peter.guerin@rdc.govt.nz

*Peter Guerin has been Chief Executive of the Rotorua District Council for about eight years. He came from Opotiki District Council.*

### ABSTRACT

The district council is well placed to play a significant role in improving lake water quality and growing the city. The district plan is one of the principal documents council uses to manage land use and the first generation plan, made operative in 1996, is going through a process of review. The community identified lake water quality as the top issue the next district plan needs to address. Improving lake water quality is an objective of the current district plan, but it falls short on the standards and rules needed to achieve the outcome. One of the challenges of the plan review has been to address this gap. The district council sees it has a major role to play in enabling the move from one land use to another, where the current use has a high nutrient output.

A broad range of options have been canvassed, with a number of these to feature in the draft district plan. The provision of additional development or subdivision rights if a significant reduction in nutrient output can be demonstrated is one such feature. There are no silver bullets to improving lake water quality, and the district council is very aware of the need to work together with central government, regional councils, the Te Arawa Lakes Trust and the broader community. The paper provides a brief overview of the legal context and plan review process, and focuses on the range of options that have been considered. Improving lake water quality and growing the city goes beyond the district plan, and other district council measures are also discussed.

### TRANSCRIPT

Kai ora and good morning to Tai Eru and Toby Curtis - Te Arawa Kaumatua, Chairman John Green, Chairman John Cronin, Mayor Kevin and the organisers of this very prestigious Symposium and other guests and delegates.

I was at a Conference recently when the guest speaker was introduced as an Australian gentleman, and where the speaker then wondered whether that reference to an Australian gentleman was an oxymoron, which went down well at the Conference.

But some may say that about local government and fixing the lakes, and nothing can be further from the truth. You have just heard from Bill Bayfield, CEO of Bay of Plenty Regional Council, there is an enormous amount of work being undertaken directly by local government in collaboration and partnership with central government and with a wide range of other groups and individuals.

I would like to take this opportunity to acknowledge the significant leadership of Rick Vallance, in all the senses of that word 'leadership' for his role as Chair of the Land Use Futures Board until his untimely death last year. Bill Cleghorn has since taken up that role with the same sense of urgency.

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Rick always used to talk about the 'elephant in the room' when referring to Lake Rotorua. Bill Bayfield talked today about 'slaying the monster'. Whatever you call it, we will need a considerable effort from everybody to reach the levels of expectation that the wider community have for all of our lakes, but particularly for Lake Rotorua. Improving lake water quality and economic growth are two of the major challenges facing our district and in my view closely related. I am absolutely convinced that one cannot be achieved without success in the other. I also believe the District Plan can play a vital role in supporting economic growth and improving lakes water quality in a sustainable manner.

As you know Rotorua District Council is a sponsor of this prestigious Symposium. One of the reasons for that support is to ensure that we are able to glean some of the new thinking that will come out of these two days, particularly that which we should be considering for inclusion in our proposed District Plan. The question that I have repeatedly asked of various groups, including the external Draft District Plan Technical Review Group that reviewed one of the later drafts, is:

***Is there anything else we should be including in the proposed District Plan that will make a contribution to improving lake water quality that is not already in the draft?***

To date the responses have been – we think we have got everything in there. But I would like to think that in 2011 there is a lot more innovation than there was five years ago when we started this process and there are some new opportunities that we can use the District Plan for.

### **Rotorua District Council**

I would like to talk about the Rotorua District Council to give you a feel for the fact that we are shaping ourselves to ensure that we are able to provide the very best support for growing the economy and improving lake water quality. We provide a large range of services which the market may not, but also services where there is a competitive market. These services have been determined over a long period of time through -

- community consultation
- the establishment of community outcomes
- the preparation of a multitude of documents and strategies

But more recently there has been a strong call from the business community and others for Rotorua District Council to take a greater role in encouraging economic growth and development. To that end, the Council has supported the development of a vision for the district. The vision is –

**“Rotorua, Living the Dream, World Class in Every Way”**

For the people from Rotorua or the Bay of Plenty, who has heard of a website called [www.myrotorua.com](http://www.myrotorua.com)? It is worth a visit to see the work that went on to come up with this vision which is still in its draft stage.

**Living the dream** suggests lifestyle, prosperity, sustainability and vibrancy that encompasses a wide variety of issues into a concise slogan describing aspirations for an ideal community, environment, economy and infrastructure.

**World class** sets a bench mark for all businesses and organisations to strive towards. It builds on Rotorua's reputation of already having a world class tourism sector and forestry,

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and challenges stakeholders to set the same standards. We are working with a reference group of business leaders to realign an economic growth strategy for Rotorua. Running in parallel with this is the establishment of a Tourism Committee who are well advanced on a new strategy for growing tourism in Rotorua and the wider Central Park New Zealand.

Structure should follow form and form should follow function. We have looked at the way we work and last year we restructured the management team to ensure that there was complete alignment and clarity around Rotorua District Council's economic growth roles and its regulatory responsibilities. To this end we established three groups -

- Corporate and Customer Services
- Infrastructure Services
- Economic and Regulatory Services

Infrastructure services includes Parks and Reserves so you can imagine an engineer who is used to running the hard infrastructure being involved in parks and reserves, but it has produced some interesting and very positive synergies immediately. It is an unusual structure to have three groups for a local authority of our size, normally there would be four or five, and combining economic and regulatory activities is unusual. But I think that it shows we want to make sure that the regulatory part of our organisation aligns well with the economic development and growth parts of our organisation so they both move forward in a sustainable way.

Regularly there are cries that local government's regulatory responsibilities are a handbrake on the economy. It is completely unfounded, in my view, as a claim against Rotorua District Council. But this structure is designed to assist dispelling that myth. It gives you an idea that water quality in our lakes is a critical part of the business at Rotorua District Council and our wider community.

As part of the economic alignment strategy process, the key drivers that have been identified so far are -

- Iwi and Maori land
- Forestry and wood processing
- Geothermal
- Lakes environment
- Central location
- Tourism product and infrastructure
- Agriculture
- Education
- Scion – a very important part of our economic drivers
- Rotorua as a regional city

It gives you a feel for what the strategy shape may look like going forward. As Mayor Kevin said we are bound by a range of planning documents and this year we have commenced the review and preparation of what is now called the 2012 - 2022 Long Term Plan.

Parallel with this Long Term Plan process are a number of other documents that need to be reviewed including the direction that has been established through the Auckland Council of spatial planning and we are looking forward to that as a sophisticated tool to help with decision-making.

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I will finish this section by talking about lean thinking. Can I have a show of hands – who has heard of lean thinking? Lean thinking comes out of the Toyota way, and it is about having a fanatical focus on customer service. The things that describe it are - *better, faster, cheaper* and *easier* in a safe environment. It is a method of continuous improvement. Rotorua District Council has taken about seven months to condition the organisation to be ready, and it will make substantial changes to the way we do services and the money that is available to support those new discretionary areas of expenditure, including potentially more ratepayer funding going into lake water quality.

## **The District Plan**

The District Plan sits alongside the Long Term Plan and is the main document directing land use and subdivision. The current District Plan was one of the first to become operative after the Resource Management Act was introduced in 1991. In hindsight perhaps we were a bit quick off the blocks. For the purposes of today, the points to note for the current plan are -

- lake water quality is identified as a significant management issue and even in 1996 it was important
- water quality issues are backed up with a strong set of objectives and policies around improving lake water quality in the rural zone and in the subdivision chapter
- sadly there is no strong follow through from these policies to water quality rules. For example, where we did not do it well, and we are proposing to improve, that in the rural zone provides where no structures or sewerage disposal fields can be built within 25 metres of a lake edge or water course. But on the other hand agriculture, including dairy, is a permitted activity, so we have got to get these things aligned.

## **How the District Plan Fits With Other Plans and Strategies?**

In preparing the next District Plan we have given effect to the National Policy Statement and the Regional Policy Statement. At a national level there is good guidance from the National Policy Statement for fresh water and biodiversity.

The proposed Bay of Plenty Regional Council Regional Policy Statement makes it clear that there is a need for change across a wide range of areas that are absolutely critical if we are to improve lake water quality.

Rotorua District Council clearly understands the Regional Council is the major player in controlling the effects on water quality. We do not want to see any duplication in our roles there. However, the Community is in no doubt that the District Plan could and should be used to assist in improving lake water quality. A significant amount of time has been spent during the review phase of the District Plan to develop solutions that respond to those needs.

Bill Bayfield has given you a comprehensive overview of the in-lake treatments being used. We see the District Plan as an important tool for guiding what happens beyond the lake edge that can be a major influence on nutrients entering the lake. However, and I am just repeating Bill's comment, and I am sure it comes through time and time again, there are no silver bullets. No single planning document, organisation or person can fix this problem. It will take a monumental team effort.

## **District Plan Review**

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Kevin Winters has explained that the District Plan review is underway. In preparing the next plan a lot of time was spent talking with the community to identify what they think the major environmental issues are. Lake water quality was by far the most frequently raised issue.

Other issues were -

- CBD revitalisation
- the need for economic growth
- maintenance of the rural and urban amenity values
- providing a better way for the development of multiple-owned Maori land

The common theme or thread running through these issues was our 'beautiful lakes'. Rotorua District Council staff have worked very closely with Environment Bay of Plenty Regional Council and the Te Arawa Lakes Trust to explore the roles of the next District Plan in managing land use around our lakes.

There have also been discussions with a broader range of groups, and I am trying to make you aware that the solutions we are proposing are the result of a discussion that has taken place over a number of years with -

- Iwi and Hapu
- LakesWater Quality Society
- Federated Farmers
- Land Use Futures Board
- Residents
- Ratepayers
- Individual land owners.

The discussion has advanced through these meetings on the understanding that -

- The District Plan is not the principal method for achieving improvement to lake water quality. It has a role but it is only one of many regulatory and non-regulatory tools available
- Land use change will be necessary in some catchments and Bill has made that point pretty forcefully this morning
- Community trade-offs will be needed, and again that is another discussion that needs to be had with the community once we identify those who are affected
- the District Plan and regional planning documents must work in tandem to produce complimentary results

For example, Bill spoke of experimental applications carried out in some of the lakes. Rotorua District Council plays its role by not requiring land use consents for these activities which is provided for in the District Plan. This approach will continue in the new District Plan.

Before going into some of the specific features of our next District Plan, I would like to emphasise two points -

- the current District Plan has strong water quality objectives, but falls well short in translating these into meaningful rules

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- Bill Bayfield and I are in total agreement that the land use change is essential if major positive changes are to be achieved going forward

### **How can the District Plan Achieve Lake Water Quality Improvements?**

What are the tools that are available through the District Plan for improving lake water quality? There are really three main tools available -

- zoning
- activity rules that manage land use and affects
- subdivisions provisions

All the options discussed have been presented to the Rotorua District Council's elected members, Bay of Plenty Regional Council, Te Arawa Lakes Trust and the Rotorua Te Arawa Lakes Strategy Group. Kevin made reference to forty workshops, an enormous amount of effort because there are some very important trade-offs that need to be made through this process. Unfortunately, or fortunately, we have almost the final draft of the plan which, as you can imagine, is about this thick. It was their Christmas reading and they all dutifully did. I think as a result we have got a Draft that is going to be pretty well received, but there are some decisions in there.

The main zone surrounding most of the Rotorua lakes is the Rural General Zone. An option explored was a new zone for a number of Bay of Plenty/Waikato catchments with objectives and policies for achieving improved lakes water quality. This zone during the discussion phase was referred to as the Rural Enhancement zone, and had particular application for the Lake Rotorua catchment where there are a number of dairying operations. After discussion it was decided to stay with the district-wide approach on the basis that it was a fairer and more equitable application across the entire district.

We will be guided by the Community to some extent through feedback on the Draft District Plan as to whether there is more support for a broad brush or targeted approach.

I should just stop for a minute and explain what we are doing with the planning processes. We are going with a Draft District Plan next week and that has no statutory backing whatsoever. It is a chance for us to test what we have done with the planning process. The leadership that has been provided by the Mayor and Rotorua District Council, support from Environment Bay of Plenty and Te Arawa Lakes Trust, and that is a relatively short process. Then that will feed into a proposed District Plan and depending on various planning timetables that becomes the beginning of the statutory process. So in part I am talking about the Draft District Plan, and in part I am talking about a Proposed Plan depending on what happens to that second step.

Activity rules are another approach used to manage land use and stop activities happening, or they can encourage activities to happen. An activity rule can be used to target land use change. This concept is based on a public/private sector approach to the development of sustainable land use options on strategic properties, where there is a property owner willingness to develop a way forward that produces sustainable lake water quality improvements.

This requires the development of a 'concept plan' sponsored, and Bill and I have yet to talk about how we fund this, but sponsored by Rotorua District Council or the Bay of Plenty Regional Council. The property owner is required to agree with the concept plan and the outcomes that include changes to land use, options far beyond the normal subdivision lifestyle lots, such as forestry, tourism lodges, golf courses, farm parks, etc.

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These are the sorts of things that might lead to significant reductions in nutrients entering our lakes.

The concept plans are included in the District Plan and if the land owner wishes to develop in accordance with the concept plan then the activity would become a controlled activity, meaning that the Council must approve the application, subject to conditions demonstrating a decrease in nutrients. Obviously development contrary to the concept plan would not be a controlled activity. That is a big step forward for this Council to encourage and incentivise people to change land use. There is hope that at least one test case concept plan can be included in the proposed District Plan. We are also hoping that land owners will be encouraged to make submissions to our draft District Plan on this proposal.

Other opportunities under the Activity Rules are consents for high nutrient outputs and the existing District Plan, as I have already said, is very permissive in regard to the number and types of activities that exist in the rural zone. A rule requiring high nutrient output activities to require a resource consent is a quantum leap for this District Council and our District Plan and the draft includes such a rule.

The objectives and outcomes of regional planning documents should be reflected as companion rules in the District Plan. If the regional planning documents were to include rules that managed specific land use activities within a catchment, then it is logical that the provision of the District Plan reflected the same.

Subdivision management as another major tool and these are things that have been discussed and debated at length through the Land Use Futures Board, the Rotorua Te Arawa Lake Strategy Groups and the LakesWater Quality Society. I will not spend too much time on it except to say that we think that there are some pretty exciting, enabling and incentivising provisions that might see some progress there.

Transferrable development rights are to protect environmental values that might otherwise be threatened, to allow the development right for that property to be transferred to a new property. Those Councils that do already have transferrable development rights advise caution, because of the complexity, cost and uncertainty for land owners. We need to have a much more comprehensive understanding of the entire rural area to determine the receiving environments, which probably does not exist to the extent needed to get the certainty that land owners require. So because of the warnings from other local authorities we have decided not to include that in our District Plan at this stage, but again it is at draft stage and we are looking for submissions to get support or otherwise for that.

An integrated site concept plan is a concept for the subdivision equivalent of targeted land use change discussed under activity rules. This approach provides incentive for subdivision where improved water quality outcomes can be achieved.

Balancing the alternatives has been, and will continue to be, a major challenge for Council. The preference is to have an inclusive, enabling, incentive-based approach, but to be aware of all of the options and give them equal, proper consideration. Rotorua Lakes are a critical part of our district, region and national taonga.

The above options have required elected members to consider to what extent ratepayers should bear the cost of implementation. Budget provisions will be considered as part of the development of the 2012 – 2022 Long Term Plan preparation later this year. One thing is certain, a stronger economy will help the incentives, but either way there must be community support for the District Plan.

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## **Other Matters**

I thought of two other matters that I should cover off. One is the Lakes A Zone, not included in this review, and that has been a disappointment to some people. But the main reason is that at the time Council commenced the review of the District Plan the Lakes A Zone had only recently become operative, in December 2005. It was not thought appropriate, and possibly frowned upon by the Courts if Council were to commence a review so soon after that zone becoming operative.

In addition, Council believes that the Lakes A Zone generally reflects the aspirations of the Community, particularly Tarawera and Okareka. However there are some areas that do need attention and some of you may recall the challenges and difficulties of the Ngati Whakaue Tribal Lands consent applications for Crater Lake and we appreciate that we do need to make provision for that.

Council has asked staff to review the key issues of the Lakes A Zone once the proposed District Plan is notified. What we are saying is - let us get this part of the Plan on track and moving forward and then we will go back and start a review for the Lakes A Zone.

Mark Rawson, as our Group Manager of Economic and Regulatory Services, will engage advisors to undertake an economic impact analysis to identify the impact of the District Plan on economic growth and any constraint factors that will affect economic growth.

## **The Way Forward**

The draft District Plan is packing a punch bigger than the previous Plan did, and it delivers meaningful outcomes for lake water quality. It sends a strong signal that high nutrient activities will be subject to land use consent processes, but it sends an equally strong signal that property owners and occupiers wanting to move to low nutrient activities will be enabled.

The draft District Plan will be released next week as I said; the community has some major decisions to make. A strong but incentive-based regulatory approach has been brought forward to accompany a suite of measures already in place. The community needs to decide whether it will support these major changes across the District, particularly in terms of zones for the District or in targeted areas. It will also need to have a view on the effect of this Plan and changing landscapes - rural and urban.

I conclude by saying this is a chance for everybody to have a role in shaping Rotorua and we look forward to your submission and I finish with the question I started with – Is there anything else we should be including in the proposed District Plan that will make a contribution to improving lake water quality?

Thank you very much.

A copy of the Draft District Plan is available on the RDC website [www.rdc.govt.nz](http://www.rdc.govt.nz)

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## CAN YOU OPEN THE GATE AND STILL HAVE A PLAN?

**Frank Boffa**

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*A founding principal of Boffa Miskell, Frank has practiced as a landscape architect/landscape planner for thirty five years and worked on a wide range of landscape planning, design and development projects throughout New Zealand, South East Asia, and the Pacific. His work involves the assessment of landscapes and the formulation of landscape strategies and policies for the protection, management and development of a range of landscapes and developments in sensitive environments.*

*Frank's landscape design work includes numerous commercial, industrial, tourism and public open space projects in urban, rural and coastal environments. Frank is often engaged as an expert witness on a range of environmental planning and development projects. He has also acted as a Commissioner for territorial local authorities on applications where landscape and/or visual issues have been important considerations. Frank was a founding member of the New Zealand Institute of Landscape Architects and currently chairs the Institute's Education Foundation and the Accreditation Review Panel.*

### ABSTRACT

In July 2008 Frank Boffa made a presentation to the Rotorua Land Use Futures Board outlining how rural residential and lifestyle developments might be promoted and developed within the Rotorua catchment. This presentation expands the rural residential options and looks at the wider opportunities for innovative land use activities and developments that could optimise environmental, social and economic benefits to the District and the Region. Building on the 2007 Landscape Assessment Studies carried out for the Rotorua District Council and the unique and distinctive characteristics of the Rotorua area, Frank offers suggestions as to what form new land use opportunities might take and how these might be developed. The initiatives and framework that needs to be in place to ensure these opportunities are realised is also discussed as is the timing and the drivers for success.

### TRANSCRIPT

Thank you Mayor Winters. I was assigned this particular topic – **Can You Open the Gate and Still Have a Plan?** I will not give you the short answer until part way through this presentation. My involvement with Lake Rotorua, and in fact this area, is not great. I am an outsider; I am from the Kapiti Coast where our water problem has to do with quantity, rather than quality, and quantity being the lack of it.

Several years ago I was invited here by the Land Use Futures Board to talk about alternative uses in the lakes catchments, particularly as there were proposals to retire land and the Land Futures Board were considering alternative land uses that might be appropriate. That address really focussed on opportunities in the area of rural residential and lifestyle developments, as that was seen at the time as being an option that would be quite useful.

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I am not going to re-run that particular talk but I will cover it briefly with a couple of the examples I gave. I talked about some of the farm park concepts and the many ways of creating farm parks and resolving land ownership and wider land use matters within the farm park. The concept involved the allocation of some rural residential lots, re-forestation, returning some of the land to native vegetation and leaving some of it as farm land.

#### Slide 4



**Slide 4** is a site in the Bay of Islands, not too far from Kerikeri, where the agricultural use was no longer viable. That particular site was also classified as an outstanding natural landscape and there was some incentive to revert the site back into native vegetation in harmony with the rest of the outstanding landscape. In order to achieve this, some subdivision was permitted. There were sixteen lots and the balance of the land converted into native vegetation. That occurred about five years ago and already most of the pasture is no longer evident. It has been quite successful and a very expensive subdivision, as you could imagine in that particular location.

I talked about other developments alluded to by two previous speakers, Bill Bayfield and Peter Guerin, developments like golf courses and other development either with a resort flavour or even retirement villages. I see these as having opportunities for some land use change in this particular district. I will talk more about this later on. **Slide 5** is the Clearwater Development in Christchurch with residential lots, a hotel, provision for more intensive development and another hotel.

So development, whether it be rural or residential, or whether it be lifestyle, can come in many shapes and sizes. It does not have to be the traditional form of development.

#### The Problem

**Slide 6:** Being a landscape architect I think spatially, so I will go through what I see as the problem here, what the issues are, and what some of the solutions, or the way forward might be.

## Slide 5



## Slide 6

Rotorua Catchment		
Land Use	Area	Nutrient Output
Native Bush	24%	6%
Exotic Forest	21%	4%
Pasture	46%	79%
Cropping	1%	2%
Urban / Lifestyle	8%	9%

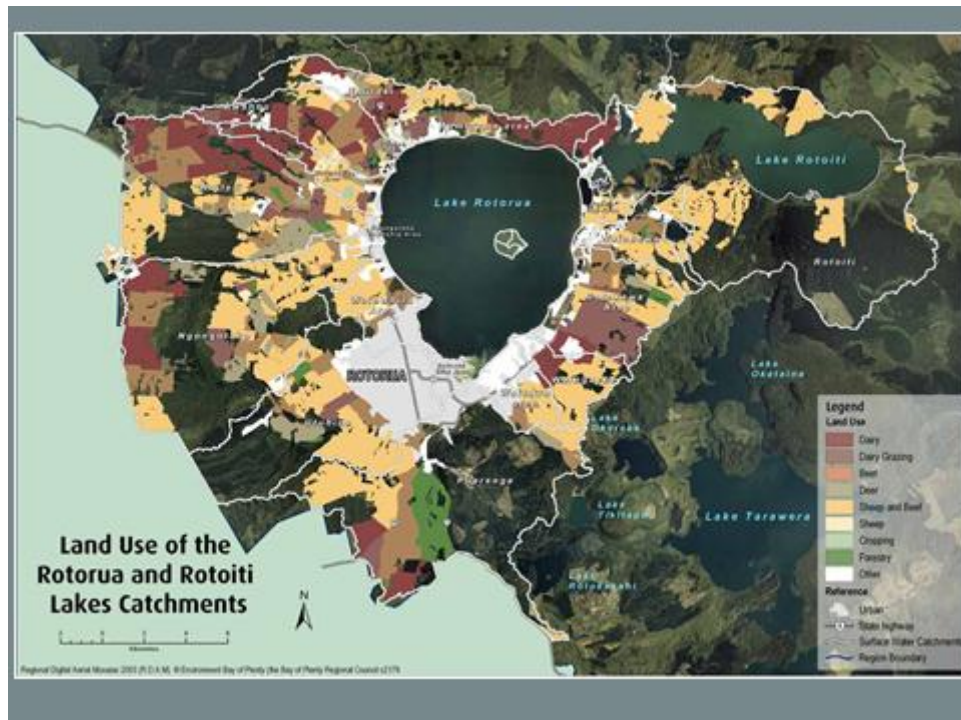
In addition to all the other measures that one might take, such as riparian planting, better farming practices and so on, there is still 30% of the pastoral area of the catchment that is likely to be retired and this equates to about 6,750 hectares, which is not an inconsiderable amount of land.

**Slide 7** identifies spatially the four or five top classifications indicated in the brown colours which show the extent of the pastoral land within the Rotorua catchment. As you can see it occurs fairly extensively throughout, except in the southern area where the urban area of Lake Rotorua is located.

### Possible Solutions

Now some of the possible solutions put forward by others which are very much tied to initiatives and various incentives that would encourage people to subdivide rural land either into lifestyle blocks or perhaps even into larger integrated developments have been:-

## Slide 7



**LWQS** - Subdivision of 600 – 850 rural residential/lifestyle lots over a 10 year period

- 600 lots @ 11 ha
- 850 lots @ 8 ha, or
- 3,375 lots @ 2 ha

I am intrigued by the LakesWater Quality Society suggestion of 600 to 850 rural residential lots. Simplistically if you just divide that into 6,750ha you are talking about 600, 11 hectare lots which are probably not too much use to anyone and not in great demand. In my experience people are looking at lots of 1 hectare and even less in the lifestyle rural type environment.

**NIWA** - Subdivision of 1,553 new rural lifestyle lots with the balance area into forestry. This could equate to -

- 776 lots @ 2 ha
- 1,553 lots @ 1 ha

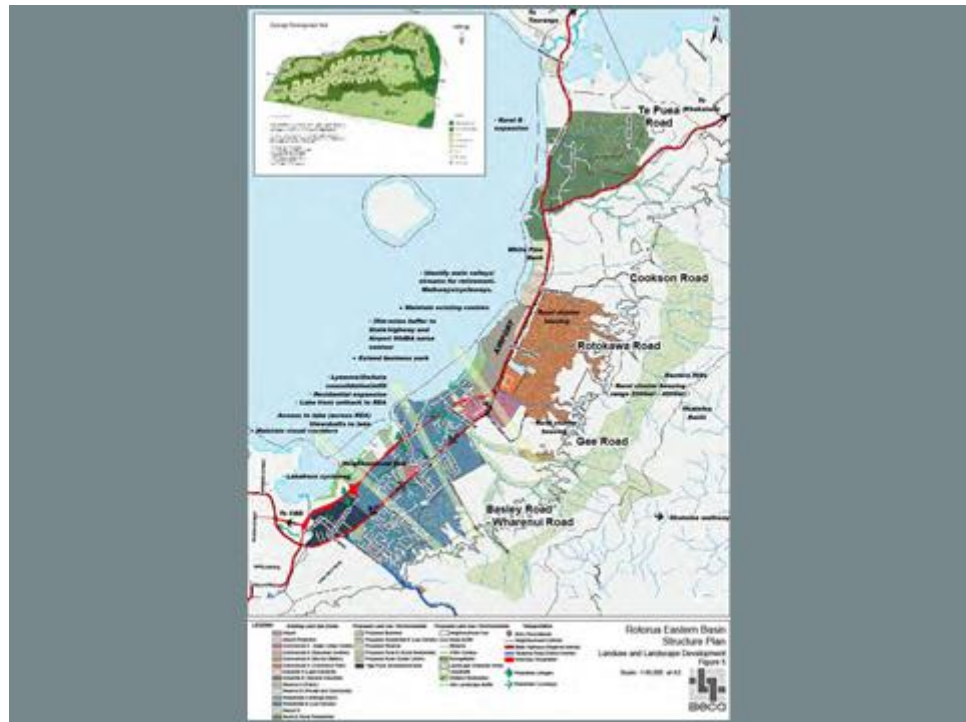
NIWA and their work have talked about quite a bit of forestry and also subdivision of 1,553 lots. I am not quite sure where that magic number came from, but nevertheless in my simple terms that equates to 776, 2 hectare lots, or 1,553, 1 hectare rural residential lots. I presume we are talking in the time frame of ten years, so that too is a lot of rural residential or lifestyle lots.

### Rotorua District Council Structure Plans

- |                                |                         |
|--------------------------------|-------------------------|
| • Eastern Basin Structure Plan | 1,750 households        |
| • Western Basin Structure Plan | 1,600 households        |
| <b>Total</b>                   | <b>3,350 households</b> |

**Slide 9:** As part of the District Plan, the Rotorua District Council recently carried out several structure plan studies, one on the eastern side of the lake, and one on the western side looking at projected and traditional growth, and how much land would be needed to

## Slide 9



allocated for various land use activities in the next forty years up to 2051. I looked closely at the Eastern Structure Plan and in the forty year period that will consume 590 hectares of additional land. A lot of that growth is going to be urban infilling and some rural residential and so on. That is not going to go a long way in terms of solving the land use problem in terms of the 7,650 hectares that needs to be retired.

### Headway Limited

- Eastern Structure Plan
- Ngati Whakaue Master Plan
- Western Structure Plan
- Market demand for lifestyle lots

I do not know much about the Headway proposal, but they were talking about 2,400 hectares of rural residential development.

### The Issues

I will not go into these scenarios any further, except to say to what extent will the desired outcomes be achieved by rural residential/lifestyle developments and/or native bush or commercial forestry, and/or structure plan growth? I am not so sure that the 30% target of conversion into alternative land uses, other than planting quite a lot of trees, has been really thought through.

So I ask the question – What are realistic and marketable rural residential or lifestyle lot sizes? In my view it is an average of about a hectare for rural residential or lifestyle lots.

The next question is – Is there a market out there for the uptake of 600 - 3,500 lots? I do not think there is.

Then I ask the question – Will these initiatives “*fix the lake and grow the city?*”

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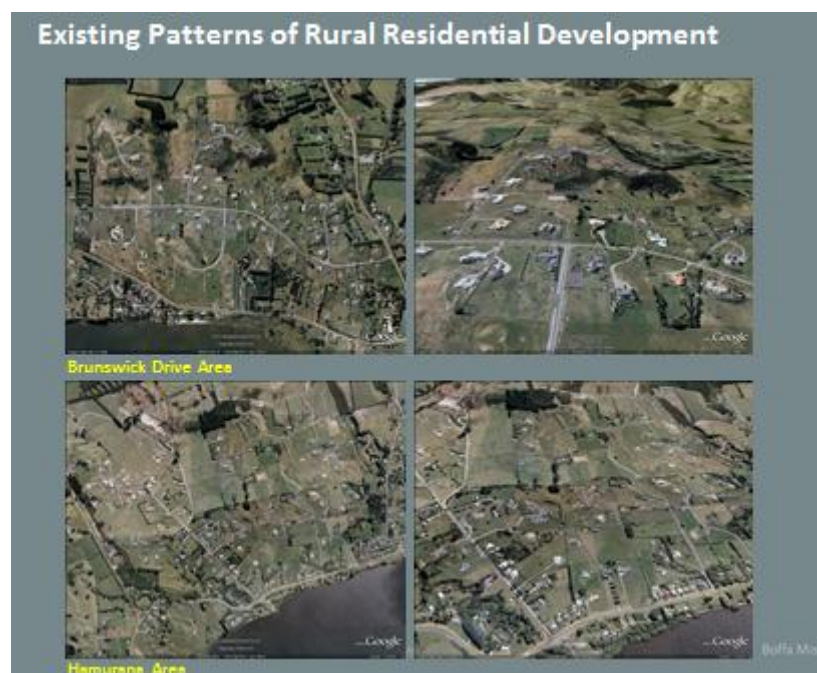
**Slide 12:** I also ask – Are there better and more appropriate development options to some of the large scale “*real estate farming*” which I call this large scale rural subdivision or are there other options? I am certainly not putting this forward as an option. I am not sure where it comes from, I do not think it is Sweden, Mayor Frank, but I suspect it is the Netherlands or somewhere over there. This has to be the ultimate in rural residential development! We do not need to go there.

**Slide 12**



**Slide 13** shows the type of rural residential development that is occurring in Rotorua out in the Brunswick Drive area and near Hamurana. These developments are typical of the standard rural residential subdivisions throughout the country, rural/residential subdivision on a larger lot scale. Some of it is quite nice but I do not think Rotorua wants to have thousands of acres of rural residential subdivision and plantations of trees to break it up here and there on the steeper country. There are better ways of solving the problem.

**Slide 13**



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## The way forward

The scientists have identified and quantified the problem and the possible solutions - i.e. what is required to fix the lake. There is no arguing about that. There is a need to move now into a creative phase driven by opportunities, innovation and entrepreneurial flair. I mean that in a sense of getting the development community involved, getting financiers involved, getting dreamers who have vision, people who will look and just come up with all sorts of ideas. The time is right to have a good think tank and explore the opportunities. The focus needs to be on **growing the city to fix the lake**. I do not think that fixing the lake is going to grow the city.

### Can You Open the Gates and Still Have a Plan?

We now get to the question that the LakesWater Quality Society posed to me. The way I interpret that question, or rephrase it, is perhaps better explained as -

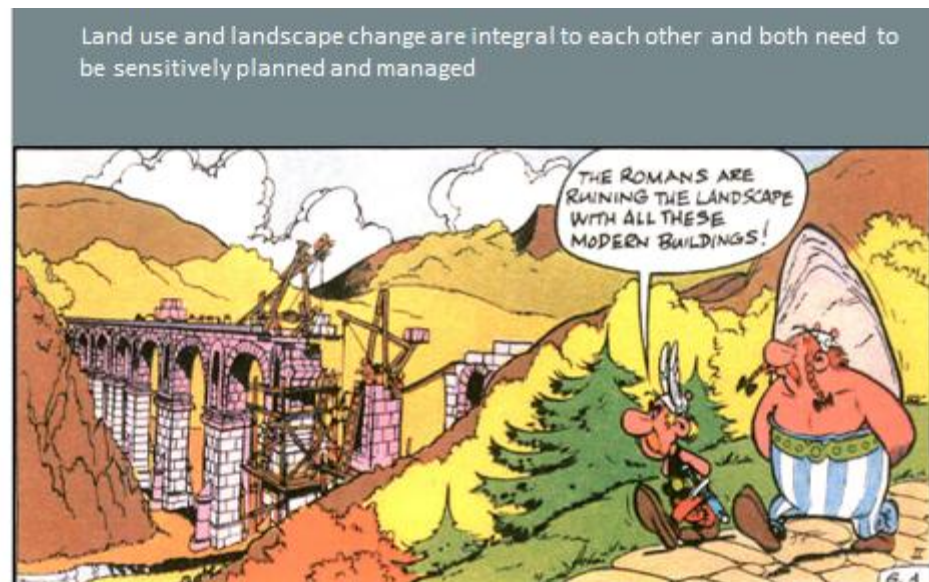
### Can you open up the rural zone to wide spread development and maintain the integrity of the District Plan?

I guess retired Environment Court Judge Peter Skelton would say “no”, but I would certainly have said “probably not”, we would have chaos. I have therefore rephrased the question again and suggest,

### “Can you have a District Plan that encourages and facilitates opportunities for rural land use change and development in the rural zone?”

I think you can, and I think that is what Peter Guerin (RDC’s Chief Executive) is looking for. That is the way to approach it and the answer is, “yes”.

#### Slide 16



**Slide 16:** Change is what it is all about and occurring extremely rapidly. Land use and landscape change go hand in hand. Look 50 kms from here towards Wairakei where vast areas of forest are now being converted into dairy production. In Rotorua you are talking about dairy back into forest. These things can happen very rapidly. I have worked in Marlborough in the last ten years and every time I go, there are kilometres more grapes up the Wairau Valley where they get frosts. Mind you, a lot are on the market now; they have probably over done it!

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Land use changes are occurring rapidly and councils and others need to be proactive in how they can influence or manage change. How you manage change in a way that is not trying to put in practice rules when the horse has already bolted requires a large degree of forward thinking. Wind farms are another example which has caught everybody by surprise.

**Slide 17**



**Slide 17** is a small development close to where I live which has occurred in the last few years where the farm was no longer economic. They looked at a multipurpose land use concept incorporating rural residential and growing grapes, wetland enhancement, riparian planting and retaining existing native forest in the centre of the development. The interesting thing is that they went for grapes, and on the Kapiti Coast you would not think that grapes would grow very well. The Ohau Gravels wine has scooped several awards for sauvignon blanc. It is that kind of thinking we need. I am not suggesting you grow grapes or lavender all over the hills here but there are opportunities you need to explore, rather than houses and trees. They are an important part of the solution, but there are other opportunities.

**Grow the District to Fix the Lake**

How do you grow the district and fix the lake? You will notice I have subtly changed 'city' to 'district' because it is bigger than just the city.

It needs a **strong planning focus**, a framework that encourages and facilitates appropriate land use change in the rural zone:

- visionary and innovative planning
- focus on outcomes that achieve environmental goals
- leadership at all levels
- public support and commitment
- greater flexibility and certainty in regional and district plans
- simplification of consent procedures and processes
- innovative economic incentives and funding, an important one in this instance

It needs a **development focus** adopting a visionary and more expansive approach to land use and landscape change in the entire Rotorua catchment focussing on new opportunities for development and growth.

- |                                      |                         |
|--------------------------------------|-------------------------|
| • Is there something to sell?        | A good product          |
| • Is it commercially viable?         | Profitable and bankable |
| • Is there a market for the product? | Investors and buyers    |
| • Is it consentable?                 | RMA processes           |
| • Is it sustainable?                 | Short and long term     |

It is important and easy to say but you need a product to sell and it has to be good. I do not think there is anything wrong with aiming for the top end of the market, whether its tourism or whatever. Put the 'Rotovegas' image aside and look to, as Rick Vallance once said, "Create wealth in the land use change".

There has to be a market for the product, and I dare say one can create a market if you have a good product. Rotorua has everything going for it so I see no problem there. It has to be consentable and that is where the District Plan comes in, and Peter Guerin has put it out there, get amongst it, make some submissions, and ensure that the plan is more permissive.

## Slide 20



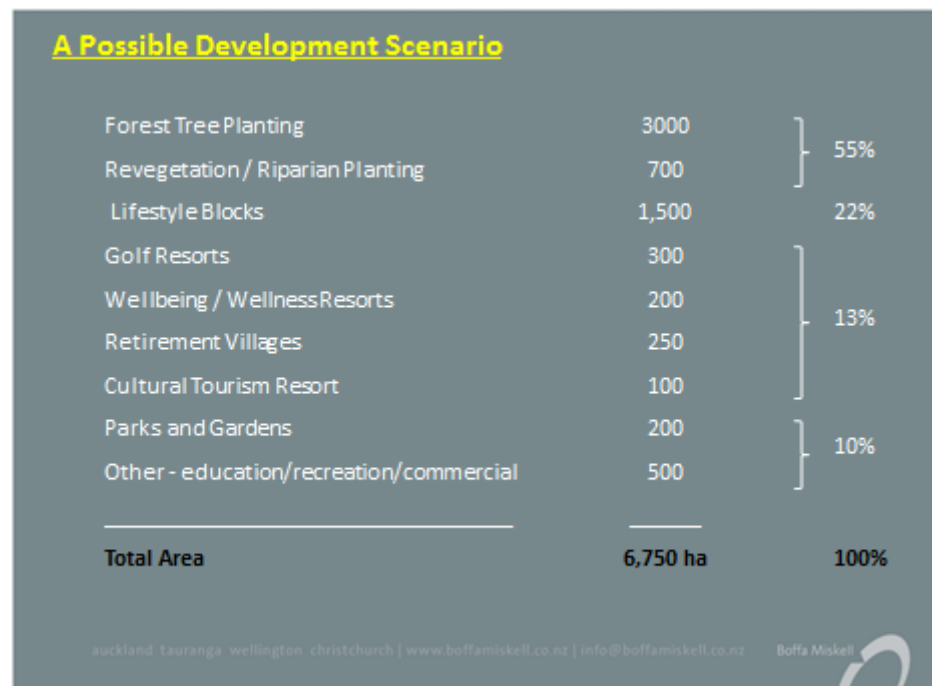
**Slide 20:** When I spoke to the Land Use Futures Board a few years ago I put this sketch up as a brain teaser to say there are many things we could be thinking about in addition to rural residential or planting trees. I notice that some of these topics will come up in the

Symposium so people will be talking about these opportunities. But I want to focus on resorts because Rotorua has always been known as a resort town. Its steeped in cultural history, got the thermal activity, and location, location and location. One should not be reinventing those things, but re-marketing, re-packaging and targeting the higher end of the market. There are people out there who want to be pampered and spend money. Most of them are off shore visitors who would love to spend their money in Rotorua.

## A Possible Development Scenario

**Slide 21** is a 'what if' development scenario. Planting trees is important and we get a good bang for bucks quickly. If half of the 6,750 hectares went into forestry planting and 700 hectares was re-vegetation and riparian planting, we could market 1,500 rural residential blocks in ten years, some of which could be incorporated within golf resorts, wellbeing and wellness resorts. These seem to be all the rage overseas and there is no reason why Rotorua cannot capitalise too. People pay thousands of dollars to plaster their body with mud, so there is a market. I do not mean do it in a crass way, but do it in a very sophisticated and profitable way. It is a way of growing the district; it creates jobs and opportunities.

### Slide 21

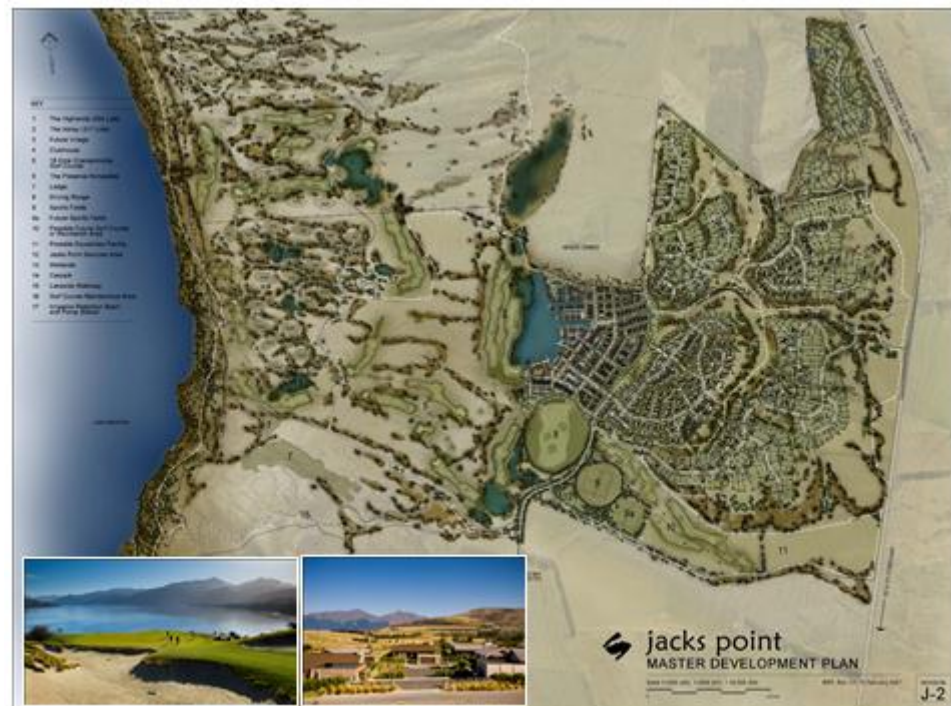


We are all getting old and there has to be opportunity for quality retirement villages. It is a great way to live, play golf, go down to the spa and enjoy life. There are also lots of opportunities for parks and gardens and I am thinking here in the commercial sense. You could have medicinal plants featured in gardens or flax gardens. You could extend cultural tourism in a tasteful way and give people real experiences and integrate that into the developments. Do not read too much into the numbers on this slide but it is the kind of thing that needs to be explored rather than saying, "Where are we going to put all these rural residential properties?"

**Slide 22** is the Jacks Point Development in Queenstown. It is a tourist place on a lake and it is quite different to Rotorua. But Jacks Point is a good example of an integrated development. I do not think you would necessarily pick up a Jacks Point and put it here because it is targeted at a different tourist market. But it shows what can be done on a

scale where you integrate developments. You can have a golf course, a wellbeing resort, rural residential, service housing for the locals; you can have a lot of things in these developments which are integrated.

## Slide 22



**Slide 23** shows the Pink and White Terraces and something similar at Pamukkale in Turkey. Someone has talked about recreating the Pink and White Terraces, and I say, “Why not?” Do not pretend it is the original, but do it in a very meaningful way where people experience the beautiful natural environment rather than a hot pool just up the road. We can do lots of things, and if we do them well it will bring the tourists and it will grow the city. Again it is this blue skies thinking, maybe it is a stupid idea, I do not know, but it seems to me, “Why not?”

## Slide 23



**Slide 24:** Rotorua has to capitalise on the spa and health phenomena. We have Queen Elizabeth Hospital down on the lake shore. For other reasons it would be better out in the rural environment where people can enjoy the experience and be pampered and they can play golf and do other things. There has to be a big market here.

## Slide 24

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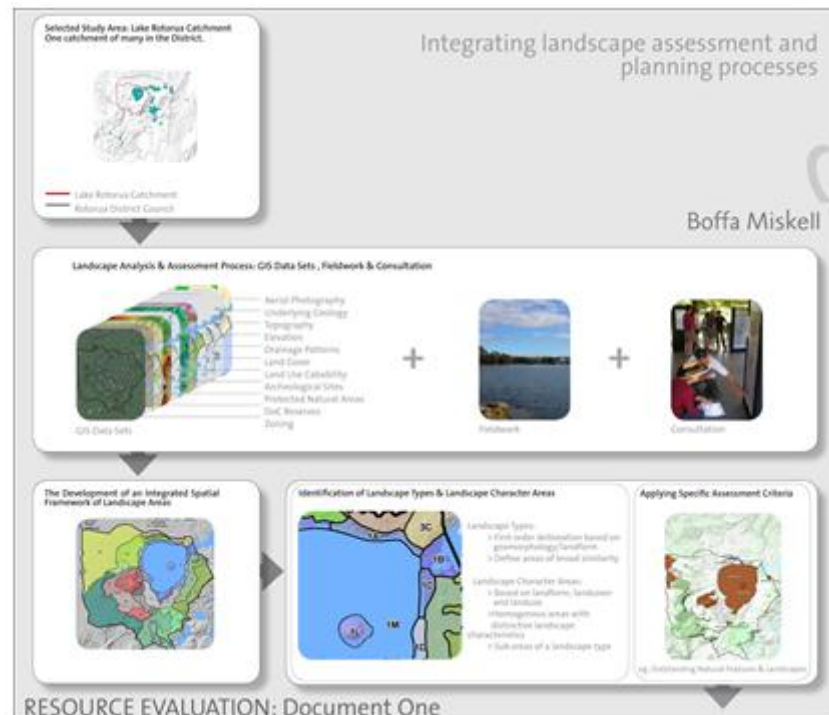
## Grow the District to Fix the Lake

How and where do we start? The district is in a very favoured position to take advantage of the challenges and opportunities available, particularly in terms of the **district's distinctive and unique cultural and natural environment**. There is no disputing that. Plus there is thermal activity as well. There are all those attributes here and nobody can take them away.

The District Plan is currently under review and a huge opportunity. It is not too late to influence and shape it to be more permissive and encourage innovative thinking and different types of land use, rather than making it easier to subdivide into rural residential lots. There has been a comprehensive landscape assessment recently completed for the entire district, and particularly the Rotorua Lake catchment which I am going to speak a little more about in a minute. The integration of these documents will provide an 'outcome based' framework which will positively assist and guide land use and landscape change in the Rotorua Lakes area. Everything has come together at this point and it seems to me if you do not grab the advantage now with the District Plan in the review process then maybe you might miss the boat and carry on and end up with lots of trees and rural residential. It may solve the problem, but I do not think it will do justice to Rotorua and grow the city and district as perhaps it could, and should.

New land use opportunities in many respects will follow and be limited only by people's imagination and initiative. Provided there is an achievable and flexible framework which encourages innovation and creativity, possibly with meaningful incentives, the Strategic Vision for the Rotorua Lakes area can be realised.

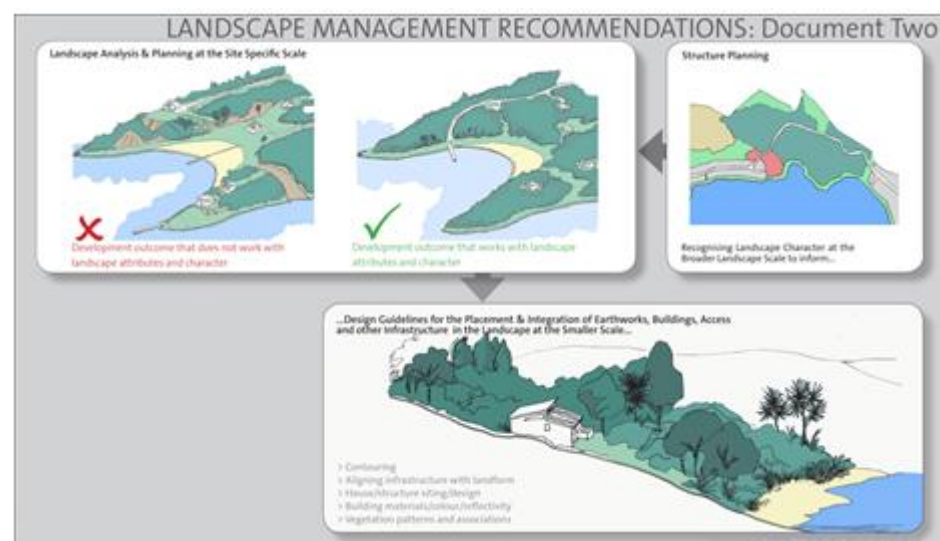
## Slide 27



**Slide 27:** The landscape assessment which was completed for the Rotorua district in 2007 was carried out at a high level. One of the drivers was to identify outstanding natural landscapes and landscape features, which is a Resource Management Act requirement for all districts. Nevertheless, in achieving that objective, the assessment also provided very useful information on which to build a land use framework for future development in terms of where the best sites for certain developments are. How can you accommodate them? What are the opportunities for development?

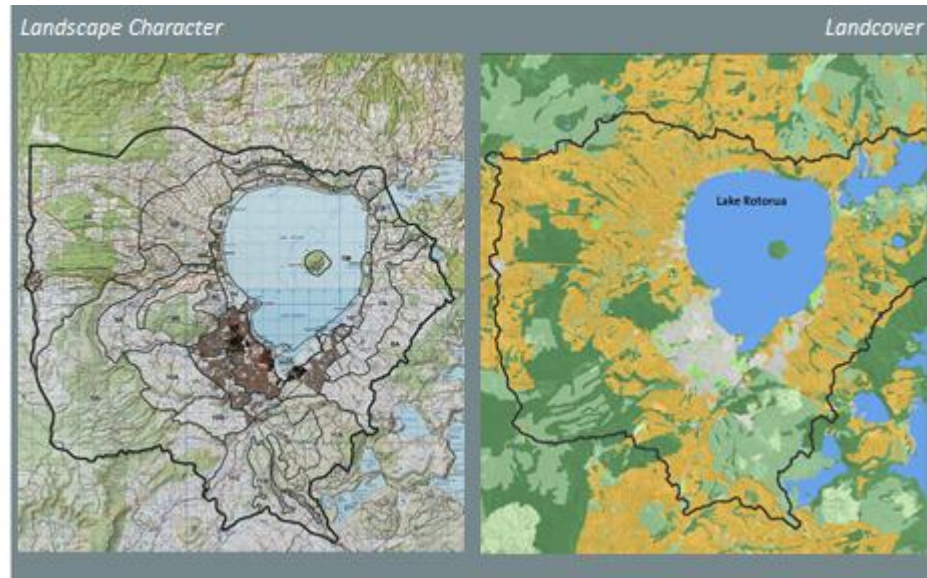
There were five areas within the district that were studied. The studies looked at all the layers of landscape information, put them together, and with further field work and consultation carried out, and then the areas were mapped in terms of the landscape types

## Slide 28



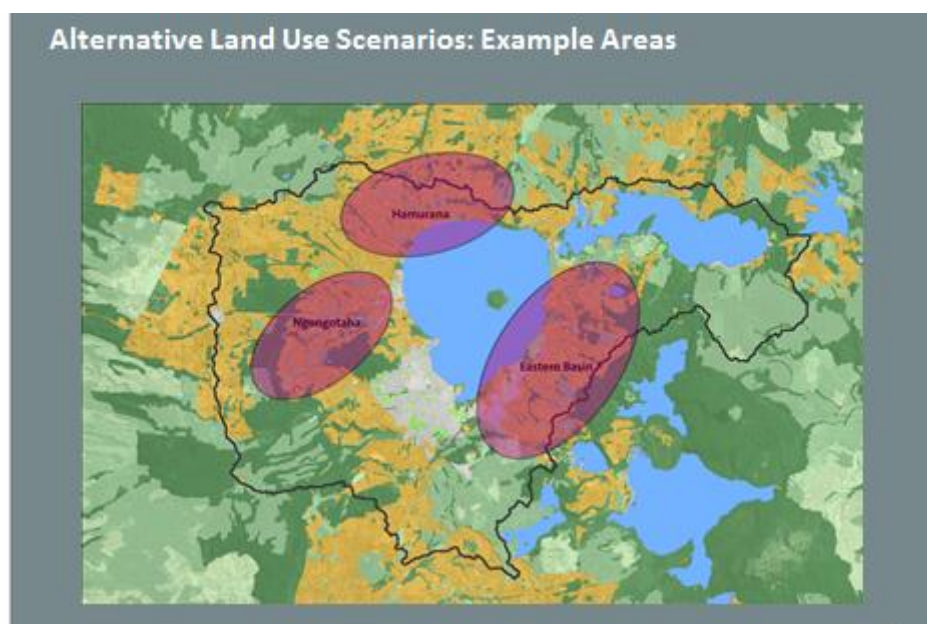
and character areas. They looked at what makes this particular area more distinctive than another? What are the features and characteristics of this particular area that make it special? Not more beautiful but special. From that, one can develop policies for managing a landscape for protection purposes or enhancement if it was a degraded landscape. All that information exists and it comes at a large scale down quite detailed scales in some areas.

**Slide 29**



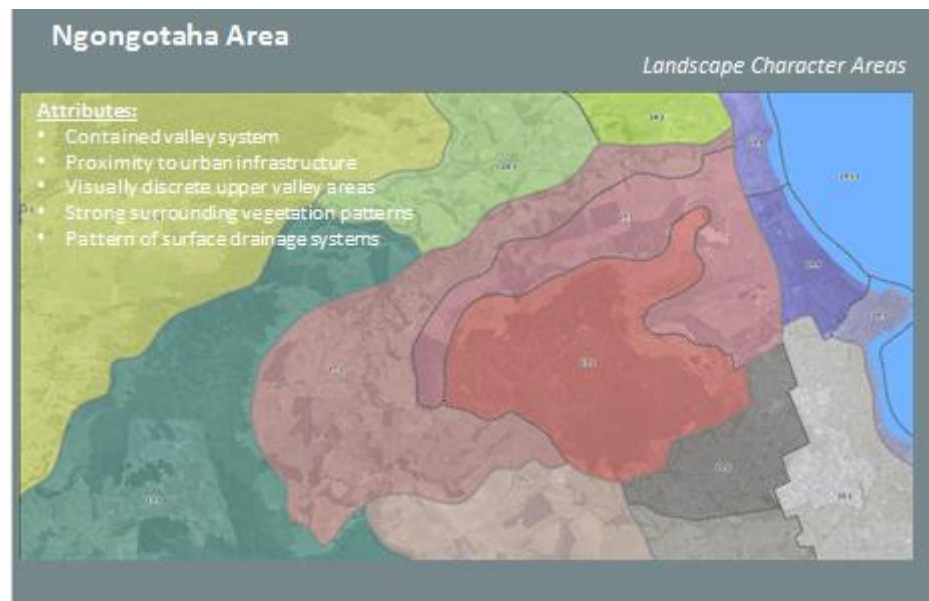
**Slides 28-29:** While the primary objective was to identify the outstanding natural features and landscapes in the area, it also indicated in very general terms some guidelines which said how you might develop an area like this; would it be better to develop this way than that way? It talked about the need for structure planning. Peter Guerin talked about concept planning, which is an interesting idea that takes it a little further. The plan promulgated some design guides but it did not go so far as to identify particular sites for development. Nor did it work with entrepreneurs and developers or land owners about their aspirations for development. It would be very easy at this point to take that step forward now. That information is all there. Rotorua district has paid for it and it has no doubt been used in the District Plan, but I think it can be taken another step forward.

**Slide 30**



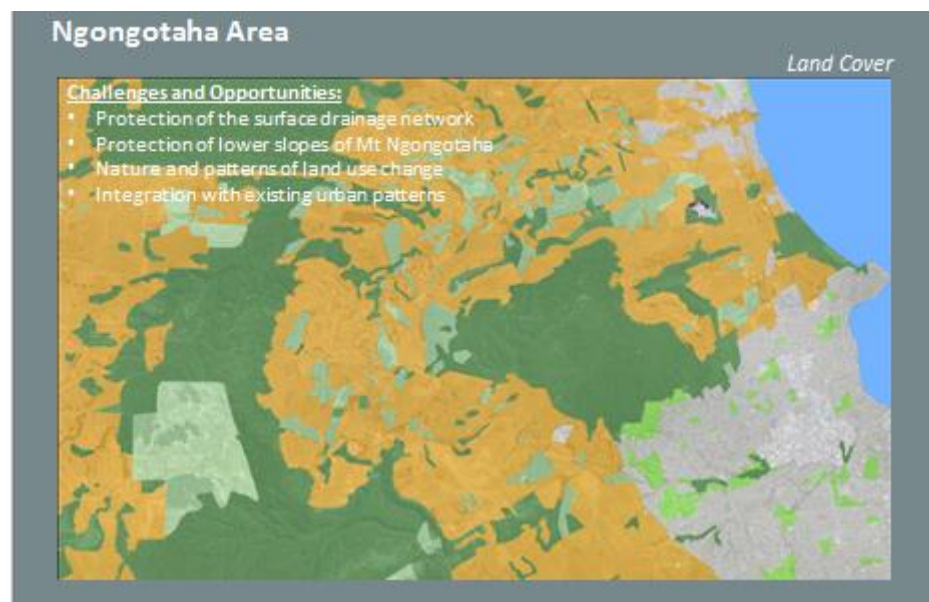
**Slide 30:** I want to get you all excited about what the possibilities might be. On this plan shown as yellow, is all the land in pasture in the catchment. I am going to look very briefly and in a very broad brush way at those three areas and how you might go about approaching developing these areas.

**Slide 31**



**Slide 31:** In the Ngongotaha area some attributes were identified in the Landscape Assessment Study as very broad brush, high level attributes. It is quite easy to list these attributes and get out of the landscape assessment work the ability to drill down further into more detail. You can look at what the challenges and opportunities might be. What are the issues? What have we got to protect? What have we got to do? Look at the opportunities? Where might there be opportunity for a golf resort or rural residential development or a farm park development.

**Slide 32**

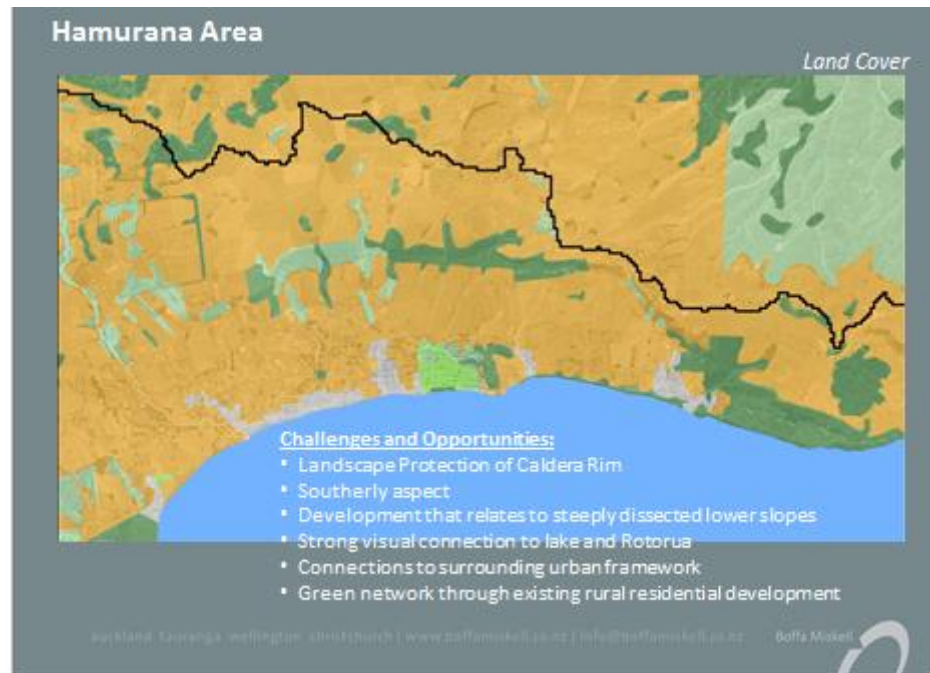


**Slide 32-33:** The framework exists where you can get onto it smartly and, as I have said a little tongue in cheek, “this is the kind of thinking that needs to be done with some visionary think tank group of locals, entrepreneurs, developers, people who want to invest some money, land owners, and start thinking where spatially we put some of these? How

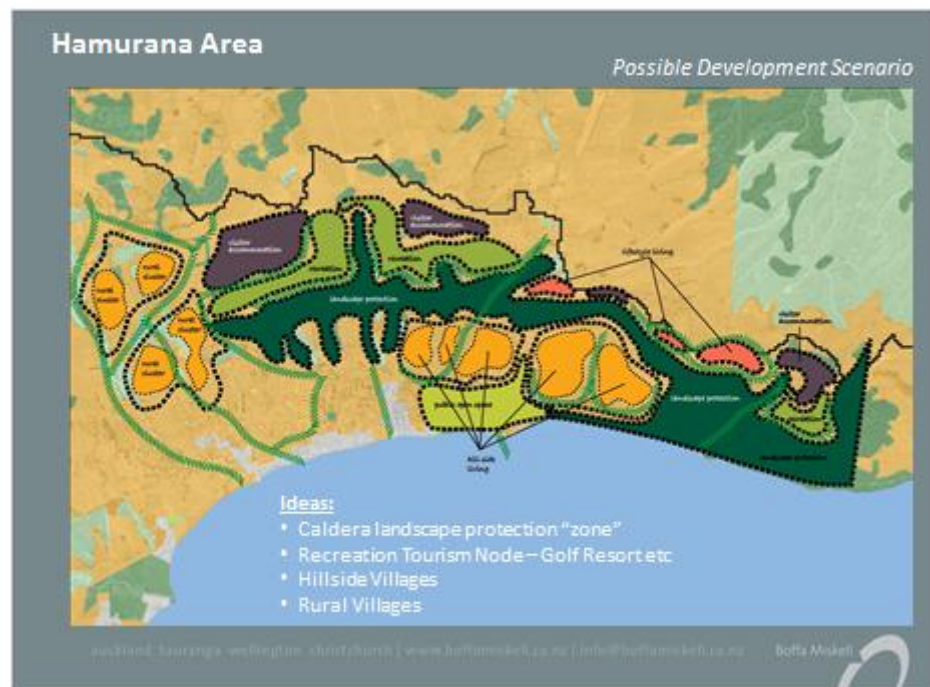


- landscape protection of the Caldera Rim
- southerly aspect
- steeply dissected slopes
- strong visual connections to the lake that could be exploited because there are a lot of areas around the lake without those connections
- connections to surrounding urban framework
- green network through existing rural residential development

**Slide 35**



**Slide 36**



**Slide 36:** Start thinking conceptually and what could we do? It is more than just drawing bubbles. One must be quite confident that it can develop into something. How does it

relate to the landscape protection zone? How does it relate to existing development? A lot of this blue skies type exercise needs to be done and applied to see the opportunities. Because one may lose those opportunities if the incentives allow someone to carve up fifty rural residential lifestyle blocks in an area that could be developed much more effectively in a way that creates more wealth and growth for the district. It is a chance to seize the opportunities.

### Slide 37



**Slide 37:** Over on the eastern basin area, it possibly has the greatest potential with a north-westerly aspect. The contours are good and it is handy to existing infrastructure, on the main road to Whakatane and Tauranga and the airport. There is also geothermal activity there. There is opportunity to focus in that area now and the district has already done a structure plan looking at infilling and so on. Expand that out to accommodate the needs of changing the land use of 30% of the land.

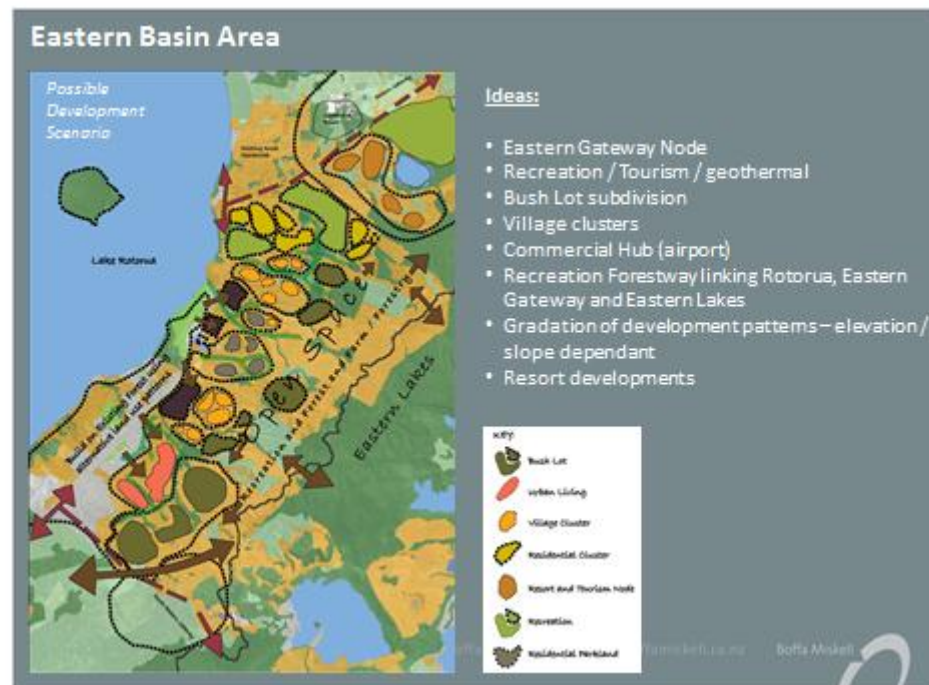
### Slide 38



**Slide 38** shows the yellow land that is in pasture, so in theory that land is all available.

**Slide 39** is the old bubble diagram again and notice quite a bit of resort type development in this area towards the turn off to Whakatane mainly because there is geothermal resource there. It is also an outstanding landscape and seems like there could be some opportunities to really do something interesting now.

**Slide 39**



**Slide 40:** I do not know if it is feasible, all I know is why not look and see and generally this is how it might look.

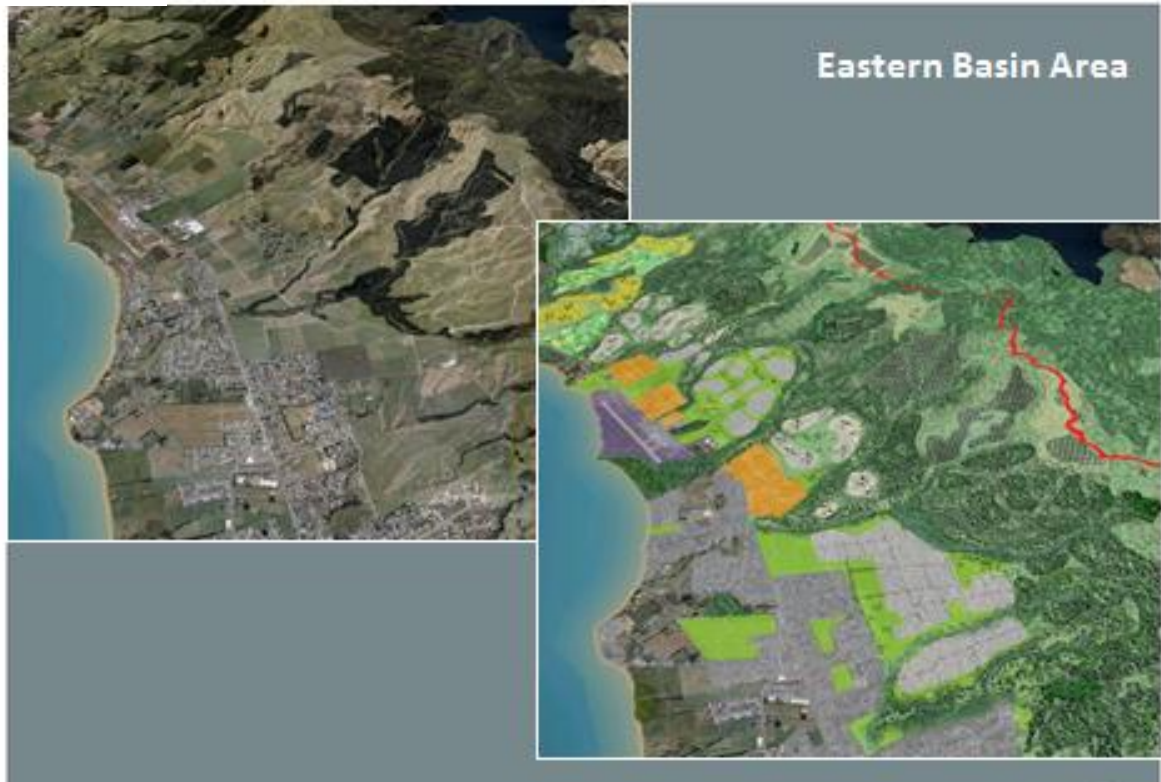
**Slide 40**



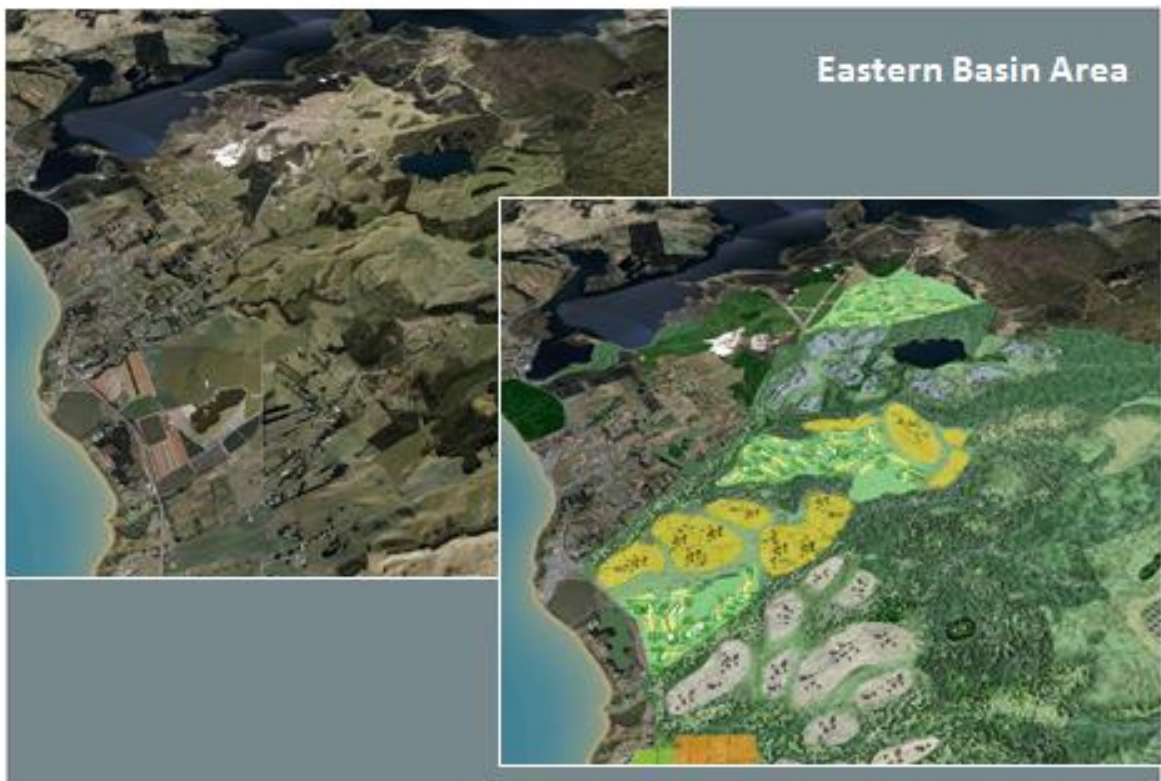
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**Slides 41, 42, 43** are very indicative showing some images of what is there now, and in a very conceptual sense how it might look in the future. I do think that side of the lake has a lot of opportunity because of so many things going for it. In the top corner there might be a good focus for some major tourism activity.

**Slide 41**

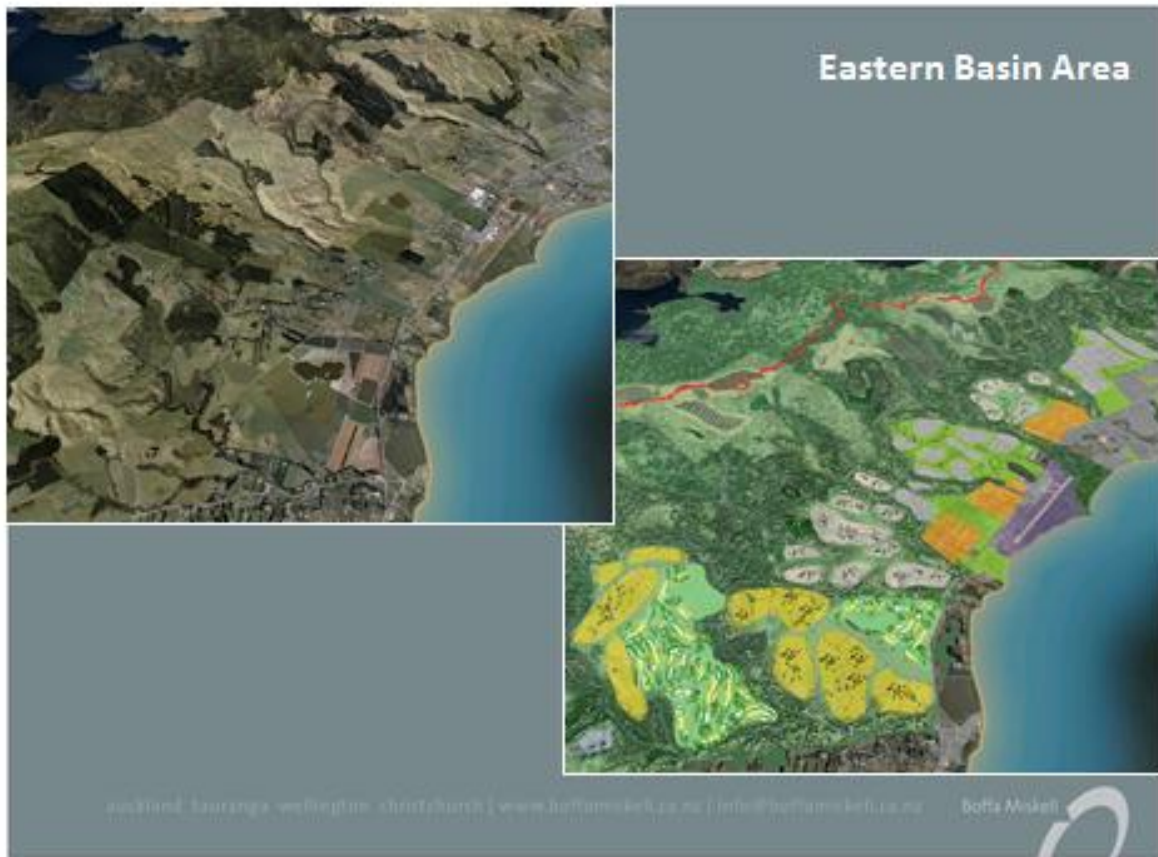


**Slide 42**



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## Slide 43



## Conclusion

In conclusion, the focus needs to be on growing the district to fix the lake, rather than fix the lake and grow the district or the city. You have to develop innovative and entrepreneurial opportunities for growth and development, and that is extremely important. What is needed right now is innovation and flare and 'what ifs', some vision. Build on the existing landscape framework and the studies that have been done, and provide a planning framework that encourages and facilitates rural land use change. I believe that is what the District Plan is seeking to do. If you can bring all those things together then maybe you might achieve that ten year target of changing the land use and 30% of the catchment.

Thank you.

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## ***Session Three - Land Use Change***

**SESSION CHAIR: Emeritus Professor Warwick Silvester, University of Waikato**

### **THE ROLE OF MAORI AND THEIR LAND IN THE RESTORATION OF LAKE ROTORUA**

**Hon Sir Edward Durie**  
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*Sir Edward is a former Chief Judge of the Maori Land Court and later High Court judge. For 20 years he was also chairperson of the Waitangi Tribunal which he took to prominence in New Zealand jurisprudence. He also served as a member of the New Zealand Law Commission. He has Honorary Doctorates from Victoria, Massey and Waikato Universities.*

*Following his recent retirement he has retained an interest in legal issues and justice and has pursued interests in Maori education, children and family violence and the management of crime. He is also closely involved with hapu and iwi development amongst his own people of Manawatu-Horowhenua.*

#### **ABSTRACT**

Rotorua Iwi are famous among the New Zealand tribes for their association with magnificent lakes and hot and cold water springs. This address considers the significance of fresh-water regimes in Maori economies and the impact of Maori values in relation to water on environmental planning. The Rotorua lakes are also surrounded by a larger proportion of Maori land than most others in New Zealand. The address will examine the impact this has on development and environmental management and the options for managing the constraints.

#### **TRANSCRIPT**

Thank you for the introduction, it is so good to know that I might have some thoughts on the Maori land question. Most of my working life it tended to elude me. It is good to know that I might actually have some solutions. But today I want to talk about water and about land from a Maori perspective and in the context of strategic planning. How do we manage the issues?

With water, very briefly, the problem is different cultural views. One is a deeply metaphysical and spiritual view about its use. The other a very secular, rational and scientific approach to the same. How do we manage those different objectives?

On land it is the same thing. The problem is that it is pretty much unusable in an economic sense, having regard to certain problems about its multiple ownership and absentee owners. Here again the problem is a cultural one.

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What is our approach to be? Do we say this is a huge problem and see if we can bypass it, overlook it, or get rid of it? Or do we seek that which provides for both the general public perspective and the Maori perspective so that we can move forward together?

I want to begin with water. It is a very difficult thing to try and explain a deeply religious world view in a few sentences, so one can only hope to use a few illustrations. Basically I need to emphasize the place of water in the customary Maori economy. The general thought in New Zealand is that Maori were predominantly interested in the land. Not so, the predominant interest was in the water. Why was that so? Because there were no animals here and very few crops. The food resources came predominantly from fish and water fowl.

The great focus that Maori people have is not so much on land, but upon lakes, rivers, streams and particularly swamps. These were the primary sources of food. If you wonder why there is all the fuss about the foreshore and seabed? The answer is, for Maori, because it was the primary source of food for those who lived along the coast. While we think of land, and our land tenure system has been subdivided off for particular use in the Maori legal system, it was the sea and the water areas that were divided off for particular use. We see the great focus in this district upon the lakes to the extent that there are some twenty five marae bordering around the shores of Lake Rotorua alone.

Leaving that to one side, let us turn to the water in the Maori psyche. What did they think of it? Well the interesting thing about the way Maori think about water is that it was not just a consumable, like food. They are in different categories. Food is not sacred, water is. That is the difference with Maori. Fresh water is seen as the life giving gift of the Gods. It is used to bless, to heal and seen to have a life force, or mauri, in the same way as human beings have their own life force. This particular world view produces some rather extraordinary results when you think that living here a couple of hundred years ago were people with vast water resources, and who were very few in comparison with what we have around the lake today.

One would have thought these people would have no thought or concern whatsoever for the maintenance of pure water regimes. In fact, the opposite; they had extraordinarily strict regimes to the extent that different water streams were used for cooking, for drinking, for washing clothes and cleaning bodies. Pretty unusual, but such was the concern for the defilement of water. Waste is discharged, of course, to land, not to water. Where waste is discharged, the spiritual quality of the water is defiled. The Maori way of thinking is no gutting of fish even near the water's edge. The defilement of water was a serious spiritual offence that would be seen to carry an almost certain bad consequence for the people as a whole.

Now what is a place of such metaphysical beliefs in the modern political and legal system? Do we have a situation of the religious view versus secularism? No, I do not think so. Whatever the strengths and weaknesses the Maori view may have, in your opinion, what we can see at least is a very strong metaphysical injunction to achieve the very same objectives that we try to achieve by scientific means. It is the metaphorical injunction that serves to maintain water purity for Maori.

The focus then is on cultural difference, not on religious versus secular. This was borne home to me by Professor James Ritchie of Waikato University in 1985 in speaking to the Waitangi Tribunal on the pollution of the Manukau Harbour. He compared how Maori beliefs align very closely with those of the Jews and Islam, pointing out, for example, that in Israel rabbinical law requires that effluent from human wastes, however purified, be returned to the land. Recycling by irrigation is practised in much the same way in Muslim

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contexts. Now secularists might decry the religious basis of such practices. Sir Ahmed Salman Rushdie at least helped us to appreciate more that the belittlement of the sacred beliefs of others is not the best way to win friends and influence people. Nor does it help to conveniently overlook the influence of religion upon the development of our own laws and value systems.

So that is the background, but what then is the place for all of this within our political and legal regime? The answers are very simple. Cultural rights are protected by the United Nations Conventions and by now the United Nations Declaration and the Rights of Indigenous Peoples. In New Zealand they are protected to a larger or lesser extent depending upon the statute concerned of the Treaty of Waitangi. They are also provided for in domestic law and the Resource Management Act and they have also got into the Common Law where the High Court held that the metaphysical beliefs were relevant to the water management issues.

Now just how real is that sort of protection of the cultural belief? Well it was a long long time ago but in the very early 1980's when we had the 'Think Big' projects running in Taranaki, there was no legal protection for cultural rights. Nonetheless a group of people who complained about the gas to gasoline project in Taranaki, and its impact upon the pollution and spiritual defilement of the reefs used for collecting food, were successful in requiring the Government to renegotiate its overseas contracts for the funding of the "Think Big" projects to take account of those very elements. In Rotorua we saw much the same soon after, with the Kaituna River claim and the discharge of waste to water in that river and the consequence of a shift to land based disposal.

My point is not that it was a good change; some people question the application of waste to land in large quantities and the impact on the lakes and the forest. My point is that we cannot ignore these beliefs and practices because they do impact.

So what then is to be gained from that Maori world view? The alternative approach is that so much more is to be gained simply by respecting cultural difference and from understanding that when it comes to promoting clean water regimes the LakesWater Quality Society and Maori leadership are expecting precisely the same. That is what we need to pursue.

That takes me to the land. The same is going to apply but for different reasons. A similar complex set of spiritual beliefs applies to land, but that is not the problem in the land case. The problem is not simply that of multiple and absentee ownership and the consequential return to owners. The real problem in terms of Maori tradition is that the land does not provide a return for the tribe. For by Maori customary law the land was held by the tribe to sustain the tribe as an on-going political entity.

That was its purpose. In translating that principle into today's terms one would say that the land should be meeting the cost of maintaining tribal identity for the benefit of future generations in Rotorua. But is it? It is not, and the problem does not come from Maori custom. The problem comes from the fact that in 1860 the government decided that the land should be shifted from tribal control to individual ownership. We really must appreciate this fact. This problem that we constantly talk about of multiple and absentee ownership is a problem brought about, not by the nature of Maori land, but by an attempt to impose one cultural set of rules upon another culture for which those rules did not truly apply. There was no such concept as absentee ownership in Maori customary law. If you left the tribe you left the benefits that came from it.

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But what do we have in New Zealand? We have a situation where the income from the use of land goes primarily to Australia. We have this extraordinary situation amongst our Polynesian cousins that amongst them remittance money goes from the new land back to the home people. For Maori it is the reverse. The people have all gone to Australia and we are paying them from here. It is hardly an incentive for tribal leaders to get around and see to the development of the land when the people who add nothing to maintaining tribal standards are the ones who get the benefit. That was the concept of absentee ownership unknown in customary law.

We do know that incorporations have been set up, and most of the land around Lake Rotorua is owned by two. It has proved one thing, that you can overcome the problem in terms of land management if you have a sufficient aggregation of land. It solves the problem about productive use, but it does not solve the problem of the dissipation of benefits to those who contribute nothing to the maintenance of tribal functions. In addition we are also left with a large number of dispirit and largely uneconomic blocks lying idle and producing only gorse which, as we all know, has very bad consequences for lake water purity, and which is also pretty much inalienable.

How do we manage this problem because it is not working for the city and it is not working for Maori? One approach is to get rid of Maori land, to loosen up the laws on alienation to enable free trade. The trouble is that is the whole history of New Zealand. That is precisely what was done and it did not work. The flaw in it is, if you wish to inherit the very response that Rushdie had from the Islamics then I would recommend that that is the course you should be proposing. Another course is to look for how the objective to clean a lake and to grow a city can serve not just the objectives of the general population, but incorporate as well the Maori objective of maintaining tribal or hapu identity. It is entirely feasible to do so.

First you must look to restoring the tribal interest in the land. We have one great factor in our favour in the capacity of human populations to expand in geometric progression. The ownership becomes so large if you allow all successors to come in there must come a point when those shares fall below a minimum economic unit and drop into the box for general tribal benefit. Time alone will cure it if we have the structures in the right way.

The other dire need is to restore tribal lands to tribal management so we can aggregate many of these dispirit blocks. What does that mean? It means an end to the Maori Land Court. Now I am a former Chief Judge of that Court and I am not in the habit of treasonable statements, but the reality of the matter is it served well a long time ago. But it is time to ask – is it really serving well today? Is it in fact thwarting Maori objectives? Although I hate to say it with the Maori trustee here, is it the best result to have lands in the hand of a trustee who by law is obliged to achieve the best economic result for the Maori trustee as an institution when all the trust law screams at us to say the trustees should operate only for the benefit of their beneficiaries? We have set up a perfect complex situation. That too must pass and we must be looking more to tribal management of these dispirit tribal lands.

The real question then is – how do we provide an endowment to meet the cost of maintaining tribal identity in the future which is the real and customary purpose of Maori land? We have this problem of alienability. It is a very blunt instrument for achieving the sort of objective that is required. Are there other options that can be looked at? Leasehold tenure is one. We have tried it in Rotorua and it has had its problems. It has been tried amongst colleges and church institutions in Auckland and it has worked rather well. Is it an option for the future to enable a city to grow while yet ensuring a base for the Maori cultural objective and endowment for maintaining Maori identity into the future?

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If that is not a feasible option is there some other form of investment from the proceeds of a sale. This is almost like heresy in the Maori world, I am conscience of that, but are there other forms that would present a far better economic return with the same degree of safety and serve the cultural objective. That is the real challenge that we are facing. With a bit of wit we can provide the structures.

If we were to go to Government and say, "Maori land should be more open to alienation", there would be an outcry. Forget it; it is just not worth going there. But if we can go to Government and say, "We have set up the structures, we've set up the tribal management systems and there is a way in which we can alienate land for housing in our areas while providing some other form of economic base to meet the tribal objective", then I think we would end up with a far better return for many of our people. What would it mean? I think it would mean that it is entirely feasible to achieve twin objectives. The one of fixing a lake to grow a city and the other of fixing a lake and maintaining a place for the people.

Tena Koutou.

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## **CAN REDUCTIONS IN NUTRIENT OUTFLOW FROM FARMS BE ENTIRELY VOLUNTARY?**

**Hon Professor Peter Skelton**

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*Hon Professor Peter Skelton CNZM is a former Environment Court Judge and Associate Professor of Resource Management Law at Lincoln University. He presided as an Independent Commissioner over the hearings by Environment Waikato into Variation 5 to the Waikato Regional Plan concerning the control of nitrates entering Lake Taupo and, as an Independent Commissioner appointed by Environment Canterbury, has been completing a series of decisions on Lower Waitaki Catchment water applications.*

*With more than 20 years as a Judge of the Environment Court, and having presided over the Lower Waitaki hearings, Professor Skelton brings the depth of knowledge and experience required for the Commission to fulfill its role in Water Conservation Order matters and the development of water management plans for Canterbury.*

### **ABSTRACT**

This presentation commences with a description of the social, economic and environmental context in which the problem of nutrient inflows exists. This is followed by a discussion of the Lake Taupo water quality issue and the policy responses both regulatory and non-regulatory that were developed to deal with that issue. The conclusion reached is that the effectiveness of entirely voluntary reductions in nutrient inflows needs to be assessed on a catchment by catchment basis but the likelihood is that the answer to the question posed will be “no”.

### **TRANSCRIPT**

Ladies and Gentlemen thank you very much for inviting me to address this very important Symposium this afternoon. It gives me and my wife a little time away from the daily visitations of aftershocks and it is a pleasure to be here. I bring you greetings from a resilient Christchurch, we will rise again. There is a huge move afoot in that city to make good the damage that we have suffered and to become once again the proud city that we always have been and that is great to see.

I bring you greetings also from my colleagues, the Environment Canterbury Commissioners, who were appointed just about this time last year to take over the operations of Environment Canterbury. We did not reckon on earthquakes when we took up those appointments and for those of you who are in local government in this part of New Zealand I give you a promise now – we are going to look after Bill Bayfield very well indeed. We recognise him as a jewel and we are very lucky to have him.

I am going to talk with you today about my experience with the Lake Taupo case. Preparation of this has been assisted by two of the Council who were involved in the Environment Court hearings, Simon Berry and Craig Malin, Environmental Council in Auckland and want to acknowledge the assistance that they have given me in this presentation.

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A little bit of environmental context first of all, and I hardly need to say to this audience that both diffuse and point source discharges of nutrients from farming activities need to be addressed. You have spent some years doing that and will continue to do so. But it is interesting that tens of thousands, probably hundreds of thousands, of people in our country do not yet understand and appreciate that fairly straightforward concept. There are a lot of people for whom that really does not mean a great deal, so it needs to be said time and time again so that the message continues to get through.

The social and economic context is also important because putting constraints on the activities that have led, or lead to, diffuse and point source discharges of nutrients have their social and economic consequences, again for all of us. Where would we be right now in economic terms were it not for the dairy industry? We are in big enough trouble now, but we would be in a lot bigger trouble if we did not have the dairy industry right now, or the sheep and beef industry, all of whom are contributing to our way of life and our economic wellbeing. There are balances to be struck when you start putting the brakes on those kinds of activities, as I found out when doing the Lake Taupo case. A number of farmers came to tell me how difficult it would be for them to continue their farming activities.

**Key issue - financial implications for farmers associated with voluntarily reducing nutrient discharges**

- **Economic and social effects on farmers (for example, reduced stock numbers and resulting loss of income)**
- **Flow on economic and social effects on communities that rely on farming**

This brings me to reducing discharges to Lake Taupo and the Waikato Regional Plan Variation Number 5. One of the important things to note right up front about that variation is that it did not impose the reduction on the farming community. There were reasons for that which I will come back to. My talk is about voluntary versus regulatory. But Variation 5 did not impose on the farmers a responsibility to reduce their nutrients; it imposed on them a cap as it did on the whole of the Taupo catchment to their then existing levels. The way in which that worked I will discuss shortly.

In Lake Taupo we looked at the discharges to ground water which ultimately lead to the lake, the nitrogen inputs to the lake from the natural background. I am no scientist but even I can appreciate that within nature there are nutrient enrichment processes going on. So it is in these lakes in Rotorua and so it is in Taupo. Then we looked at the policy response to the problem that was faced in Taupo and the means by which that was to be achieved, and some of the lessons that have been learnt.

Most of the farming in Lake Taupo catchment is on the western side and a lot of forestry on the eastern side. The discharges enter the ground water and the lake via streams and one of the big problems facing us was the time lag. The nitrogen that entered groundwater decades ago is yet to reach the lake. There were some differences of opinion amongst the scientists about how long it was going to take the nutrients to get to the lake – was it thirty five, forty years? How long was it? Having capped the nutrients, what target did we have to have for reducing the nutrients yet to come, and over what period of time? I found that, in legal terms, quite a difficult concept to come to grips with. But we did it in Variation 5 taking account of the nitrogen load yet to come.

Nobody doubts that Lake Taupo has outstanding water quality, probably on a world scale, although it is not recognised in any statutory instrument in that way. It probably ought to be. It certainly is at a regional level and everybody in New Zealand would accept that that is the case.

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In the late 1990s the Waikato Regional Council became aware of the threats to that quality, primarily from nitrogen, and mainly as a result of intensification of land use in the Lake Taupo catchment which had begun decades before. Some of you here may remember or know that a lot of that land was settled post Second World War, specifically for farming purposes. That was one of the problems we faced because the farmers had been encouraged for decades to produce, produce, produce. Put the nitrogen on, increase your farming activities. Suddenly at the end of the 1990's they are told – you are polluting Lake Taupo. That is difficult for people to take. I experienced the anxiety those farmers had about their situation when they came to the Taupo hearings and talked to us.

There are now about 1,200 tonnes of nitrogen entering the lake and prior to development there were about 650 tonnes. The human generated load is around 550 tonnes per annum. 92% of it comes from pastoral farming activities, primarily sheep and beef farming. The next biggest percentage comes from waste water disposal in the number of townships and villages around the lake where there are still some inadequate sewage disposal facilities. There is a bit from run off activities, subdivision run offs and that kind of thing. There was also at that time a high risk of dairy conversion in the Lake Taupo catchment and this is what in the end prompted the Waikato Regional Council to move, because if no action was taken things were going to get a whole lot worse.

The Council embarked upon a lengthy five year period of consultation with key stakeholders - the Crown, Taupo District Council, Tuwharetoa Maori Trust Board, Lakes and Waterways Action Group, farmers and forestry interests. That is a lengthy period of consultation. I am making this comment for the benefit of Guy Salmon, whom I know is a devotee of the consultation process, and no doubt will say something about it later. I like the idea myself too. I do have some difficulties though because as a judge you are used to having parties fighting something out between themselves and then you make a decision. I am coming to the idea of consultation and collaborative approaches much more in my present role as an Environment Canterbury Commissioner with the Canterbury Water Management Strategy that we are attempting to implement, which is a collaborative approach.

The point of my diversion is to say that after all that was done, and it had been accepted that the community generally favoured maintaining Taupo at its current water quality levels, the Regional Council was sufficiently encouraged to embark upon promoting Variation 5 as part of the policy response. They got 168 submissions opposing Variation 5 in various ways, or seeking significant changes, and I got one submission in support after five years. That submission came from Fonterra who told us at the hearings that they no longer had any interest in dairy farming in the Lake Taupo catchment and very happy to see Variation 5 proceed. We took that at face value as evidence and we went on with all the other submissions opposing it in various ways. When the matter went to appeal in the Environment Court one of the leading proponents seeking to oppose Variation 5 was Fonterra. Difficult to understand, never mind. Fonterra is doing good things in other ways, particularly in Canterbury. I think we still have a long way to go with collaborative approaches in this country.

Now Variation 5 is part of the policy response. It is not the whole policy response because there is a fund set up as well. As many of you will know when you embark upon an RMA statutory process, you are required to do a Section 32 cost/benefit analysis and evaluation of alternatives. It showed up the need for both a regulatory and non-regulatory approach to solving the problem by controlling the use of land to their existing levels with regard to nutrient discharges, and by seeking to reduce discharges for the future, i.e. those loads yet to come, by 20% via a public non-regulatory fund. At the end of the day in 2080, when

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most of us will not be here, we will have a Lake Taupo that looks like it does today. That fundamentally is the two pronged regulatory and non-regulatory approach.

### **What does RPV5 do?**

All low nitrogen leaching domestic, forestry and farming activities are treated as permitted activities provided they comply with various standards. High leaching farming activities are required to gain consent as controlled activities. As part of that process they are benchmarked at existing levels, via Overseer, to provide a nitrogen discharge allowance which becomes the mechanism by which their farming is controlled for the future.

It is important to understand that all activities in the Lake Taupo catchment are in some way or another controlled. In other words, although farming is the major one it is indeed a community commitment. Even putting fertiliser on your lawn at home is controlled in this plan, by way of a permitted activity, and you are required to use no more than the manufacturer's specifications. In a sense everybody shares to maintain the overall catchment cap. If that cap ever goes then everything that has been set up to make this thing work will go with it.

The high nitrogen farming activities were benchmarked initially based on an average over the previous three years before the Variation to the Plan was publicly notified. But on appeal the farmers managed to persuade the Court that they should have their highest nitrogen discharge year over the previous five, which unfortunately in a way has raised the target now to be achieved.

Farmers have to demonstrate compliance with their nitrogen discharge allowance through a management plan process. That management plan is tied to their controlled activity resource consent. If they breach that they are in breach of their consent. The whole thing depends not only on the willingness of farmers to comply, but on the ability of the Regional Council as the regulator to monitor the performance. I am not at all sure how well that is going and may need some refinements because not all farmers are playing the game.

There is potential for trading of nitrogen discharge allowances on a one for one basis, and the plan does make provision for that also as a controlled activity. But there is not a nitrogen market as such. People suggested that but we drew away from it, but enabled people to purchase other farmers nitrogen who may be going out of production and by that means increase their own, so long as the cap is maintained. The overall effect of the farming/land use activity rules was to retain the status quo for the lake and there was no nitrogen reduction imposed on the farmers.

### **Rationale for not imposing nitrogen reductions on farmers**

This brings me back to the point I made earlier about farmers being blamed for polluting Lake Taupo. This is one of the reasons why the Variation does not impose on them the requirement to reduce, because it is intended to be a no blame situation. We had to take account of the economic viability of farmers and what it would mean to them. It would put a lot out of business straight away if they had to reduce their nitrogen discharge allowances. As it is, a number have gone even without that being imposed.

Economic viability was a key consideration -

- New practices (herd homes, feed pads, etc.) are very costly

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- Nitrogen leaching inhibitors have associated costs and technology was at an early stage of development
  - The ability of farmers to comply with reductions was likely to vary from farm to farm (variables re mortgages, type of farm, etc.)
  - Modelling of profitability and nitrogen leaching for various farm systems was at the very early stage of development

The nitrogen reduction mechanism set up was a public fund of about \$81million which was contributed to by the Waikato Regional Council, the Taupo District Council and Central Government to achieve a 20% reduction in manageable nitrogen inputs to the lake. That fund is administered by the Lake Taupo Protection Trust which is a council controlled organisation, and although it is recognised in the Variation, it is set up quite separately. The Trust administers the fund and receives requests from people wanting to either sell their land or change their land uses for funding accordingly. It is the non-regulatory part of the process.

This brings me to the point where I am saying we need regulation. Voluntary reductions will not cut it.

The key reasons for rejecting this option included that:

- *“The scale of the on-farm changes required and impacts on farm businesses is so large that it would be contrary to any individual’s business viability to reduce nitrogen in the timeframe required unless equivalent or greater financial incentives were offered.”*
- *“An action that results in no easily identifiable individual benefits to the landowner is likely to invoke a free-rider mentality where landowners hope that others will act so that they will not have to themselves.”*

#### Section 32 analysis for Variation 5

It is all to do with what is it going to cost, farmers in particular, to reduce their nitrogen outputs and the costs are so high that it is extremely unlikely that they would do it voluntarily. Regulation for that reason is required as Bill Bayfield acknowledged this morning.

#### **Voluntary management practices that could reduce nitrogen discharges**

*“While there are a range of management practices available that have the potential to reduce N leaching on farms, few of them can be implemented at little or negligible net cost to farmers. Moderate to large reductions in N leaching can be obtained from some practices such as the use of winter grazing off or winter feed pads for cattle, and nitrification inhibitors, but the costs of implementing them on sheep and beef farms are high.*

*Reliance solely on the use of management practices to control N discharges from pastoral land is not likely to be successful because reductions in N leaching will be countered by increased losses from greater use of inputs such as N fertiliser and the general intensification that is on-going on farms throughout New Zealand. This approach would also not limit dairy conversions on large areas of suitable land in the Taupo catchment and N*

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*leaching from dairy farms, even with a suite of N mitigation practices, will still exceed that from sheep and beef farms.”*

Source: Evidence in chief of Dr Stewart Ledgard to the Environment Court in the 2007 hearing of the appeals against RPV5

### **Can it be entirely voluntary?**

My answer is – not in the Taupo catchment primarily due to the significant costs to farmers and the nature of the farms, mainly sheep and beef farmers. Whether it can be entirely voluntary in other catchments depends very much on the catchment itself and whether farmers can absorb them and remain economically viable. You heard this morning about one small catchment with twelve farms where they are hoping to achieve at least a consensus. The greater the cost, the less likely it can be achieved by voluntary action. One has to guard against the free rider mentality and there is also ever present the high risk of conversion from sheep and beef farming to dairy farming due to higher returns and higher nitrogen discharges. The voluntary approach would not prevent dairy conversions.

### **Some variable involved in determining the significance of costs to farmers**

- The size of the reduction required
- The time frame over which the reduction is to be achieved
- How the reduction is to be achieved – destocking, changed farming practices (herd homes, feed pads, etc.), use of nitrogen inhibitors, etc.
- The type of farming operation (sheep and beef, dairying, etc.)
- The income of farmers – higher returns for dairying versus sheep and beef
- The debt being carried by farmers – mortgages, etc.
- The overheads and outgoings of farmers
- The state of the global economy from year to year - demand for NZ farm produce and Fonterra's returns

In conclusion, whether it can be voluntary needs to be looked at on a catchment by catchment basis. The greater the cost to farmers, the less likely it is that a voluntary approach will be sufficient, particularly if an uneconomic farm would be the end result. The huge range of variables that need to be assessed but my overall conclusion, and certainly the way we are heading in Canterbury, is to have some regulatory bottom lines to which farming will have to adhere.

Thank you very much.

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## MODELLING THE EFFECTS OF LAND USE CHANGE ON NITROGEN LOADS TO LAKE ROTORUA

**Kit Rutherford**

Chris Palliser

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k.rutherford@niwa.co.nz

*Kit is an engineer with a PhD from Auckland University. He has thirty years of experience in research and consulting on the prediction of water quality in rivers, lakes and estuaries. His main interest is in developing mathematical models to address water quality issues such as dispersion, water temperature, dissolved oxygen depletion, nutrients and plant growth, and ecosystem structure and function. More recently this work has been extended to catchment scale modelling of nutrient runoff and nutrient transformations that occur in the riparian zone and the stream channel. Kit has used models to address water quality problems in rivers, lakes and estuaries, mostly in New Zealand and Australia, for a range of clients. He has been involved with Lakes Rotorua and Taupo since the early 1970s with the Ministry of Works & Development, DSIR, CSIRO and NIWA and has published widely on mathematical modelling, trend analysis and mixing as it affects water quality.*

### ABSTRACT

NIWA recently completed the third in a series of reports for Bay of Plenty Regional Council which describes predictions of the nitrogen load to Lake Rotorua made using the ROTAN model.

New input data was introduced and slight adjustments were made to the model which has improved its fit to available observations. The model has been calibrated using:

- (1) historic land use or land cover maps
- (2) historic agricultural stocking rates
- (3) Overseer® predictions of nitrogen export rates
- (4) groundwater mean residence times measured by GNS-Science using bomb tritium
- (5) historic measured stream nitrogen concentrations

Problems remain predicting stream and groundwater nitrogen loads because of uncertainties in aquifer boundaries, groundwater mean residence time, historic land use patterns, and historic nitrogen export rates. However, the model fit is sufficiently close for scenario modelling.

The target for the lake load has been set by BoPRC at 405 tN/yr from the catchment plus 30 tN/yr in rainfall. ROTAN simulations indicate that if the total nitrogen export remains constant at the current level of 725 tN/yr, lake load is likely to increase slowly over the next sixty five years and to approach a steady state of 725 tN/yr by about 2080. ROTAN simulations also indicate that if total nitrogen exports were to be reduced by about 320 tN/yr and held constant then the lake load is likely to decrease quite quickly and to approach the target of 435 tN/yr within about 35 years. There is uncertainty about these response times which arises from uncertainties in groundwater mean residence time and the behaviour of the groundwater. Nevertheless, the calibrated ROTAN model is considered to be sufficiently reliable to help inform policy.

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The actual recovery rate is likely to be slower than about 35 years for two reasons. First, in ROTAN the nitrogen export rate changes immediately there is a land use change. In practice it may take 5-10 years for nitrogen stores in the soil to be depleted and for the nitrogen export to decrease to a new steady state value after a land use change. Second, the scenarios assume a step change in land use in 2015 but in practice land change is likely to occur gradually.

The predicted recovery time of about 35 years is a faster than expected, but there is a plausible explanation. It has been estimated that about 50% of total nitrogen export travels via shallow groundwater and reaches the lake within months-years. Nitrogen concentrations in shallow groundwater respond quickly to land use change. The remaining 50% of total nitrogen export travels via deep groundwater and reaches the lake after 'lags' of the order 10-100 years.

In catchments with a very long lag time (e.g., Waingaehe), groundwater concentration was predicted by ROTAN to increase only very slowly when land use intensified from 1960-2010, because of the large volume of groundwater in that catchment and the assumption that the groundwater is well-mixed. When land use intensity decreased in 2015, predicted groundwater concentration remained largely unchanged. Consequently, total nitrogen load decreased quickly – shallow groundwater load decreased quickly (as in all catchments) while deep groundwater load was already low and remained so.

In catchments with a short lag time (e.g., Ngongotaha), predicted groundwater increased quickly when land use intensified from 1960-2010 because of the small volume of groundwater in the catchment. When land use intensity decreased in 2015, groundwater concentration was near the steady state value for the historic intensive land use. Subsequently, groundwater concentration was predicted to decrease fairly quickly and, as in all catchments, shallow groundwater load decreased very quickly. Consequently, the total load decreased at a similar rate to the Waingaehe catchment.

The Hamurana was unusual in that its surface catchment is very small and shallow groundwater flows are minimal. It receives deep groundwater from other catchments and has a long groundwater lag time. Simulations suggest that its load will take >85 years to approach steady state following land use change.

One might argue that the quickest way to reduce lake load would be to reduce nitrogen exports from catchments with short lag times. Simulations indicate that export reductions in catchments with widely differing lag times (Waingaehe and Ngongotaha) result in significant load reductions within a similar period of about 35 years. Hence, it may not be sensible to try and 'optimise' land use change based solely on groundwater mean residence time but rather by identifying properties where for economic or social reasons it is possible to reduce nitrogen exports, regardless of where these lie in the catchment.

## **TRANSCRIPT**

Good afternoon everybody. The first thing I would like to do is thank the Society for the invitation to present. I have been coming to their symposia off and on for a number of years and I would have to say that they have grown in stature to the point, not only where they are leading decision making in Rotorua, but where they are making a significant contribution nationally.

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The second thing I would like to say is that it is pretty daunting to take the stand after two such eminent jurists as Sir Edward Durie and Professor Peter Skelton. I am just an engineer.

I am going to talk today about the nuts and bolts, and in particular, one modelling approach which involves ROTAN, my baby, but also involves LakeDC, the University of Waikato's lake water quality model. I would like to acknowledge the major contribution made by my colleague Chris Palliser who has taken over much of the day to day operations of the ROTAN model.

We all know that a target has been set for the lake which is a trophic lake index of 4.2. It is now the responsibility of LakeDC and the University of Waikato to deal with lake water quality. At the time the TLI target was suggested there was consensus that it would likely be attained if the nitrogen load reaching the lake was 435 tonnes N/y. That excludes the sewage, rain fall and these mysterious ground water direct contributions to the lake which are hard to see. Water quality was worrying in the 1960s even before there was widespread concern about algal blooms, there were concerns about aquatic weeds

Where did that number come from? It was first talked about by the Lake Rotorua Scientific Co-ordinating Committee (1989) which had such giants on it as Rob McColl and Eddie White. It was adopted by the Regional Council and has been endorsed a number of times since. In context with that 435 target, the current load is about 650 tN/yr, and the current exports i.e. that which is leaving the land, is about 750 tN/yr. The reason for the difference between the 650 and the 750 is what is coming through the ground water, which has yet to reach the lake.

We use a combination of measurements, models and anecdotal information to reach that target. There are also a number of models -

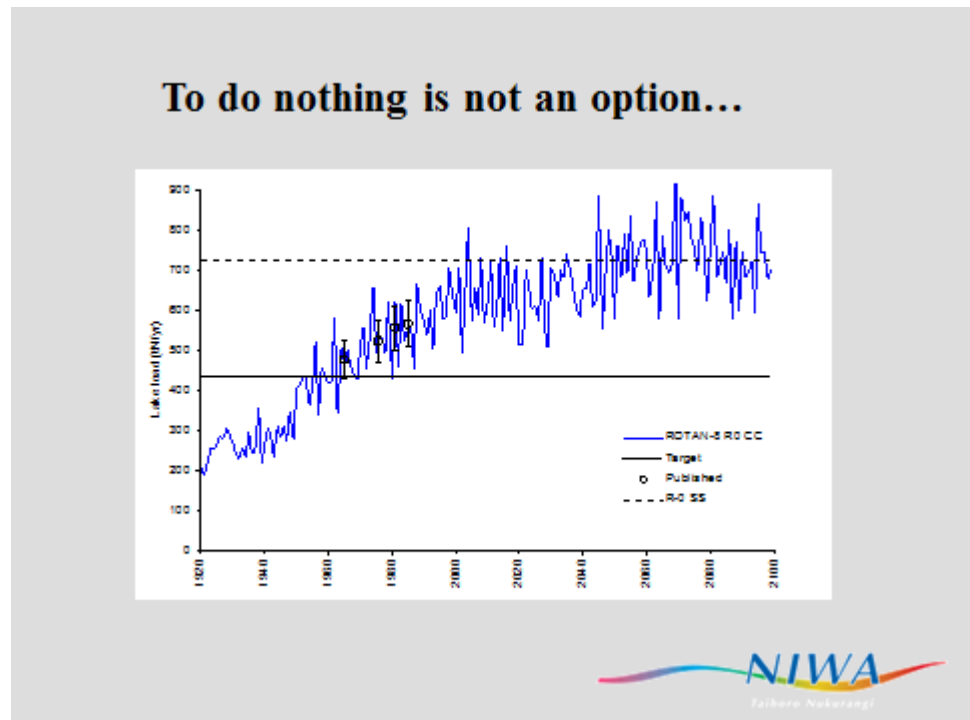
- Overseer - AgResearch - predicts the amount of nitrogen leaving the farm
- Tritium Model, Uwe Morgenstern, Geological and Nuclear Sciences (GNS) has done some excellent work on quantifying ground water age by measuring tritium and using a mixing model.
- GNS are also engaged in doing some complicated modelling using FEWater. Chris Daughney is leading that and it is still a work in progress
- LakeDC, University of Waikato - lake water quality
- ROTAN - catchment - sensitivity analysis

We have been doing some sensitivity analysis recently using ROTAN and discussed how it informs the policy debate. We have very carefully gone back to look at how well ROTAN reproduces what we have seen in the past, because that is a key to understanding the future.

**To do nothing is not an option.**

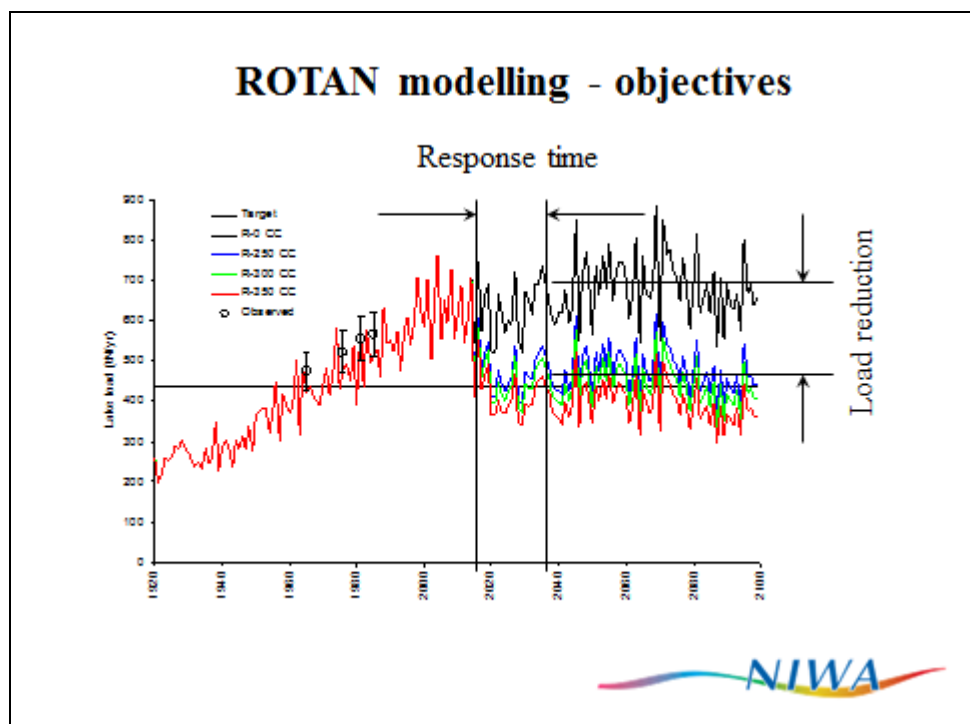
**Slide 4:** These are measured lake loads, were we to do nothing the lake load would continue to go up. This is ROTAN's simulations but the Morgenstern model, which I just mentioned, makes very similar predictions.

Slide 4



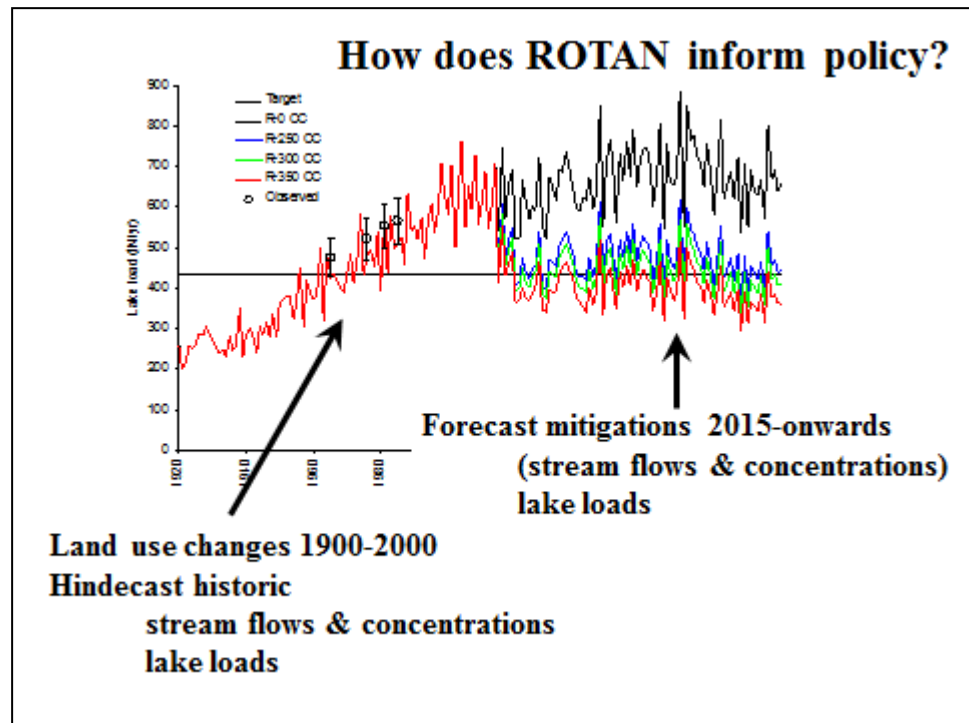
**Slide 5** shows the objectives of the ROTAN modelling, a sneak preview of the results, and a number of possible scenarios of land use change and the interchange in lake load. We have used the model to address two questions. What sort of load reductions could you get with various scenarios of land use change? I will say now that, of the two questions, that is the easier one to answer. The second one is how quickly would we see any response? That is a more difficult question and more contentious, but nevertheless a good question to ask.

Slide 5



**Slide 6:** How have Chris and I gone about it? We have looked very carefully at what has happened in the past and how the model is able to reproduce. The open circles are published estimates of the nitrogen load to the lake. Some stem from Geoff Fish's work in the early 1970s and Ray Hoare's very detailed work in the late 1970s and then subsequent monitoring.

**Slide 6**



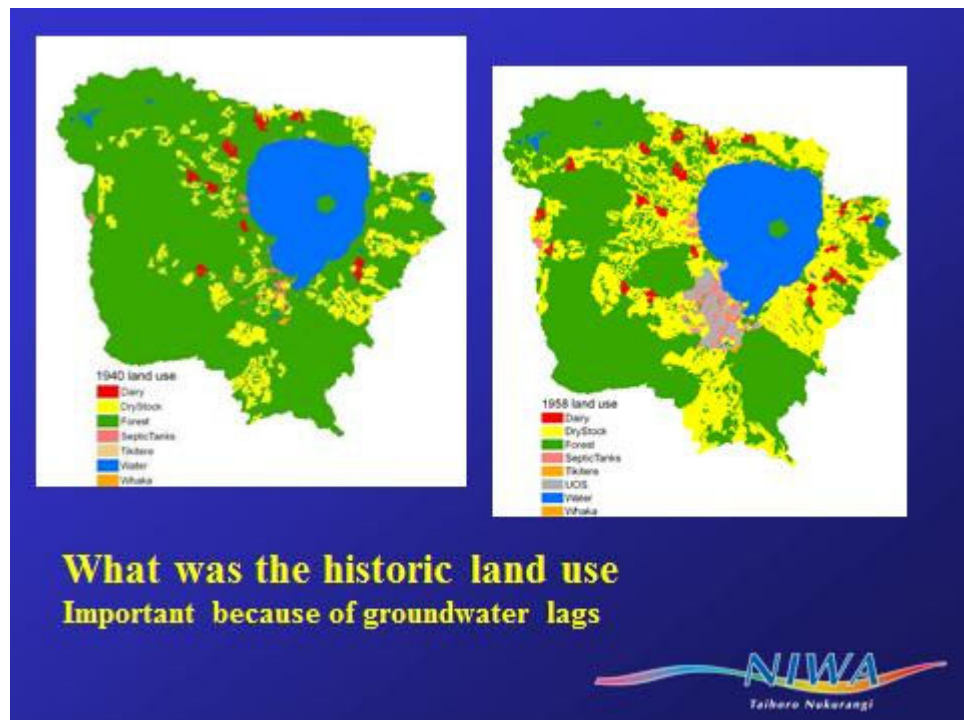
If we can model what has happened in the past then we are able to use it with some confidence to predict what is going to happen in the future. That sounds reasonably straight forward, but of course it is not. There are gaps in the existing data. Agricultural statistics have not been collected in the catchment itself in any detail although they have been collected at county level. Some things are very hard to measure. There is a good array of rain gauges around the catchment but it is very difficult to resurrect the daily rainfall pattern on an individual farm. All measurements such as stream flow and stream concentration have uncertainty, errors and omissions. Where that leaves us modellers is a problem of uniqueness. We can train the model to the data but we can get several combinations of model co-efficients that give an equally good fit to our observations. However to wait until there is no uncertainty is not an option either.

We have recently developed nine different versions of ROTAN which is the same approach taken by the people modelling climate change. We then look at the spread of simulations and see whether they give the same general information. If they do then there is a measure of comfort. If one is diametrically opposed to the others then we sit and think about it a bit more. I am happy to say that the nine different models are all pointing in a similar direction. They also tell us where the major certainties and uncertainties lie. Clearly it is very important to know how land use has changed over time and what the spatial pattern of that land use has been which will then give ground water lags.

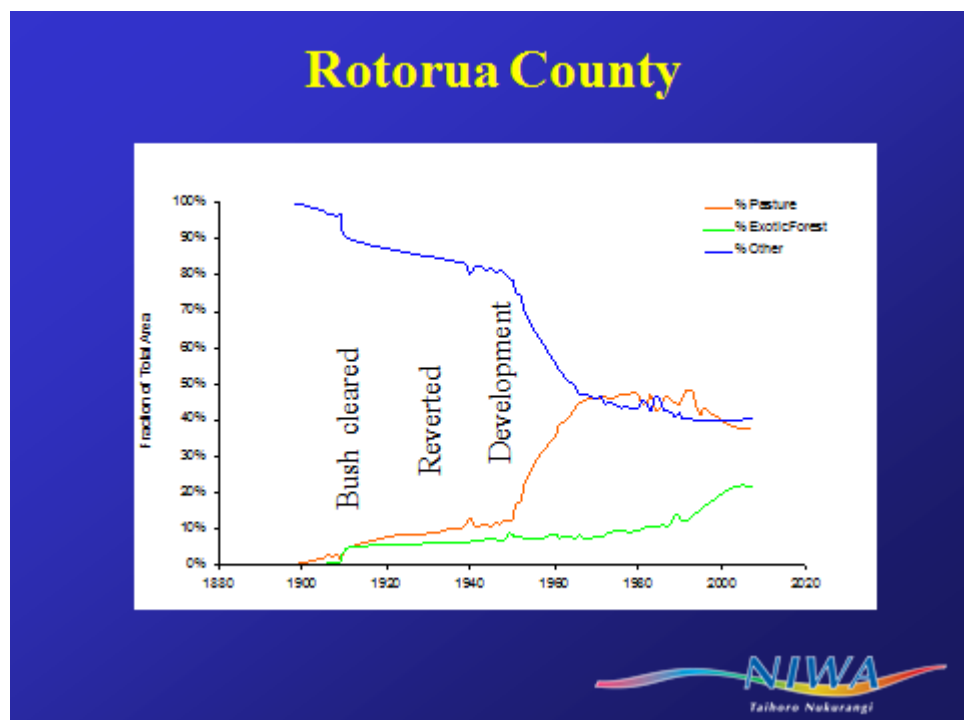
**Slides 8-9:** In terms of changes over time, what has emerged very recently is anecdotal evidence to suggest that a lot of the bush was cleared off the catchment in the early 1900's, but was not turned into pasture. It reverted in the 1930s as gorse and broom moved in and grew on that land that had previously been cleared; both of them are

nitrogen fixers. Work has been done on the amount of nitrogen that leaches from gorse. We have now included in the ROTAN model the fact that after the war a lot of this land was developed for pasture. It was developed from gorse and broom and there could well have been a large pulse of nitrogen released at that time.

## Slide 8



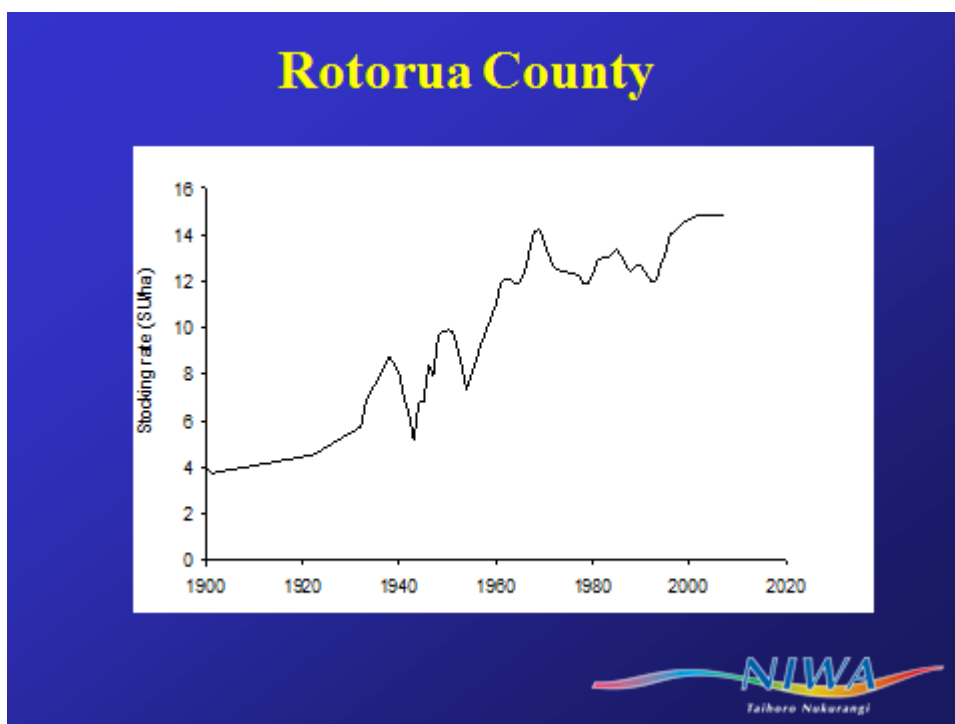
## Slide 9



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**Slide 10:** What we know too is that stocking rates have increased. Again this is at county level but it is reasonable to extrapolate it to the whole of the catchment. So there are more, and bigger, animals in the catchment which have obvious implications for nitrogen leaching.

**Slide 10**



Overseer is our model of choice for predicting how much nitrogen leaves the land. The big break through we have had recently is to realise that Overseer predicts a long-term average model. It is very good at predicting that a dairy farm that has been there for thirty to forty years will leach 50 kilograms per hectare per year. What it is not very good at telling is, if new land is broken in, how quickly does it get to that 50? Conversely, if land is retired and planted in pine trees how quickly will it go from 50 to 4? We have not necessarily got it right but we have now included in ROTAN a development pulse in the 1940s of 100 kilograms, which has improved the fit to the model.

**Slide 12** is Uwe Morgenstern's work using tritium which says that the Awahou Stream has a mean residence time of sixty one years. Ngongotaha, by comparison, the shortest is sixteen years. The Waingaehe is the oldest ground water in the catchment.

**Slide 13:** We are not hydro-geologists so we depend on GNS to provide us with the information about ground water lag times. This is a bit technical but it raises an issue still being debated. What do these mean residence times of Uwe's actually mean? Uwe has measured the mean residence time using bomb tritium. During the atmospheric tests there was a lot of tritium, an isotope of hydrogen in the rain. It has been measured continuously in Wellington. Claude Taylor and then Mike Stewart and Uwe Morgenstern have measured concentrations in various springs around Rotorua and used a simple model to estimate that the mean residence time of the Awahou, for example, is sixty one years.

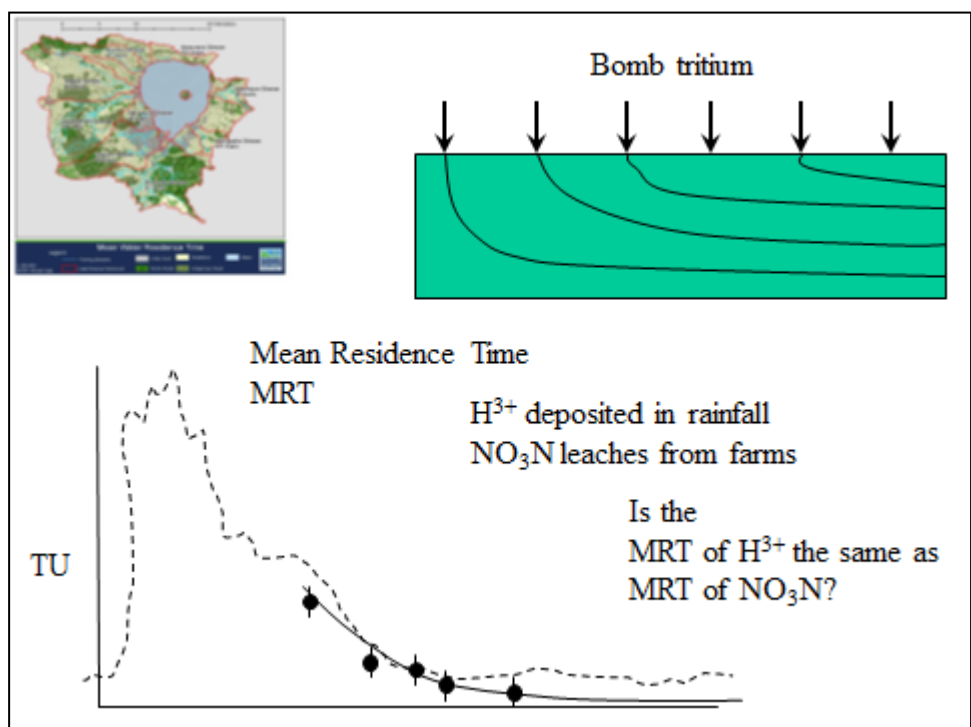
An issue that I grapple with is that tritium in rainfall is assumed to be deposited uniformly across the catchment. However, the tritium input may possibly not uniform because it rains more in some parts of the catchment than in others. If anything, tritium is

preferentially deposited at the top of the catchment. If all the farms are down by the lake then the nitrogen is deposited at the bottom of the catchment.

Slide 12



Slide 13

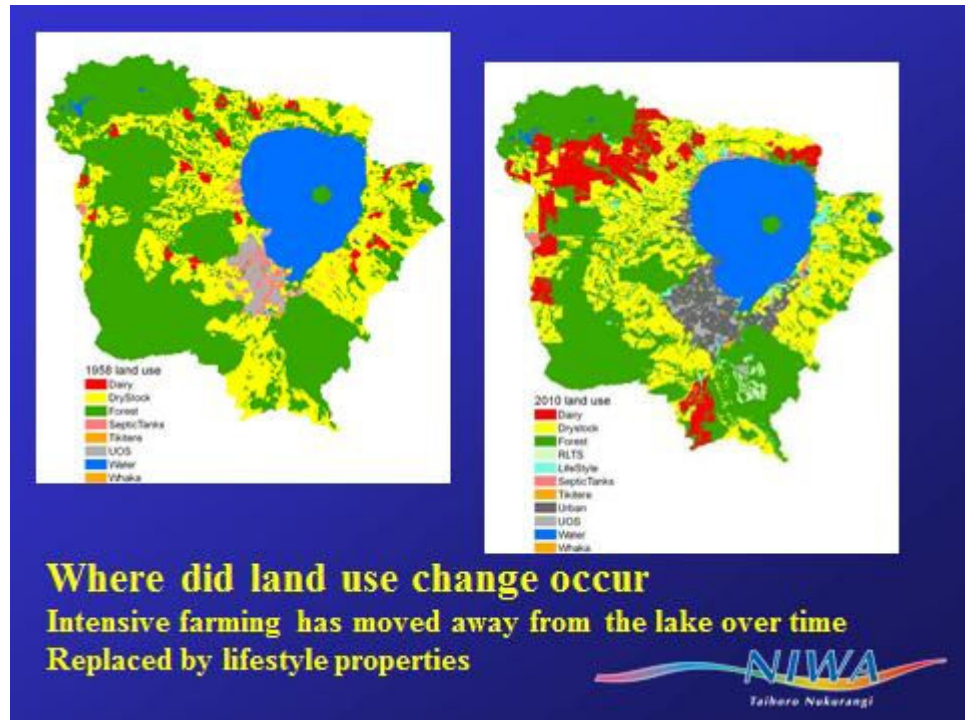


So for me the question remains – is the mean residence time for tritium the same as the mean residence time for nitrate?

The answer is probably that it depends which catchment you are in. Sometimes it is a very good indicator and other times it is less so.

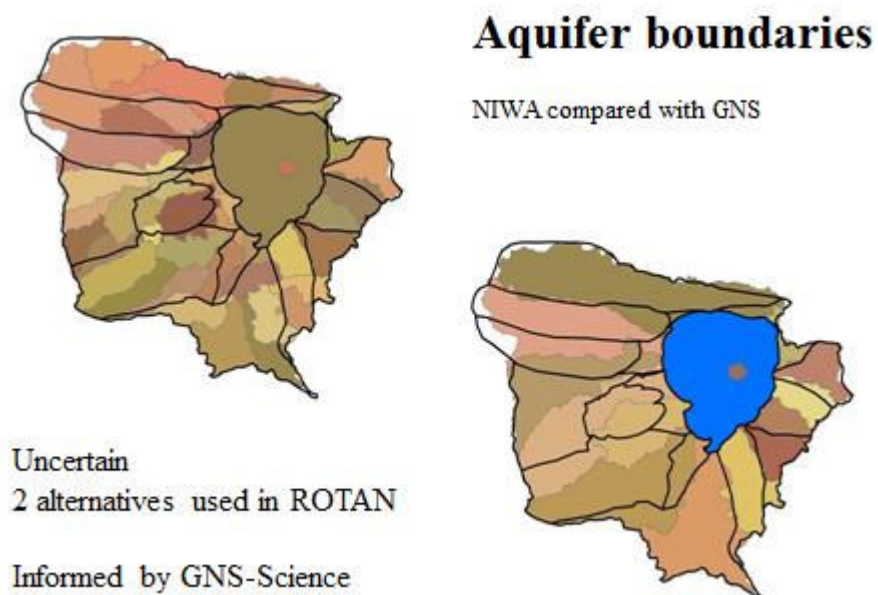
**Slide 14:** Another interesting point that emerges from the land use maps is that in the early days the agriculture, unsurprisingly, dairy tended to be closer to the lake. Nowadays a lot of the dairying is up in the top parts of the catchment. That affects the way in which we match historic concentrations in the streams.

**Slide 14**



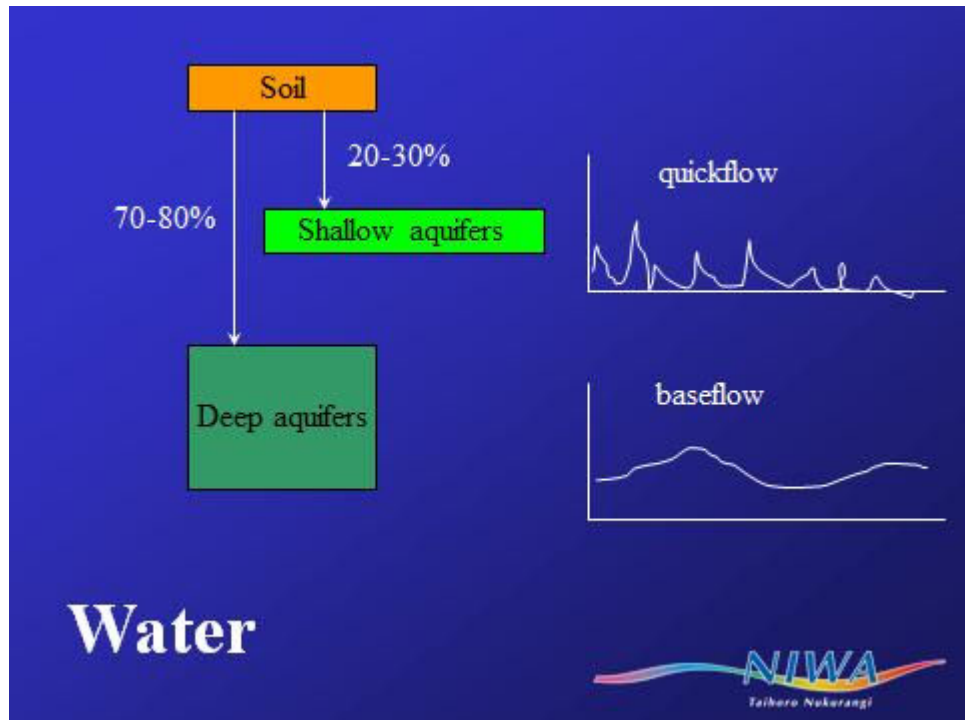
**Slide 15:** ROTAN models aquifers and we rely on GNS to help us find those aquifers. The black lines are aquifer boundaries drawn up by GNS and the colours underneath are two of our ROTAN models. It shows that there is a measure of agreement between the various catchments. We use slightly different rainfall than GNS use to size their catchments and have adjusted accordingly.

**Slide 15**



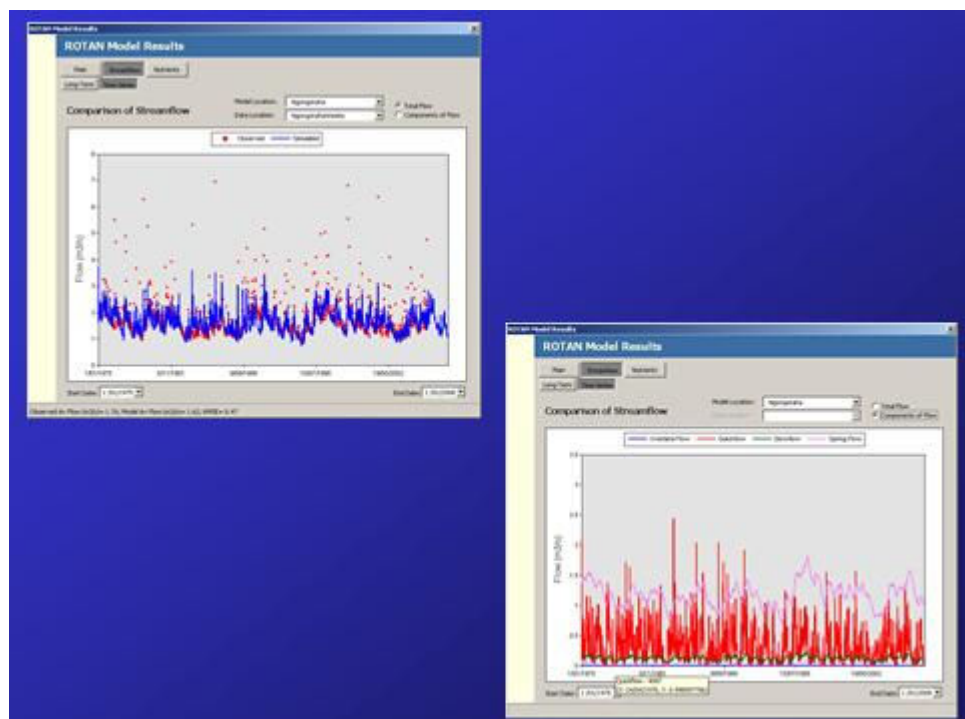
**Slide 16:** There are two things that are important but a little technical, so bear with me. One which is not immediately obvious to anybody is how much of the water that infiltrates goes into deep aquifers and how much into shallow aquifers? We know how much water infiltrates, about 50% of the rainfall. We know that eventually it turns up in streams, often via springs, but it makes a lot of difference. The modelling indicates the likely ranges of how much goes into deep and shallow aquifers.

**Slide 16**



**Slide 17:** The way in which we derive those numbers is by looking at the blue lines which are predicted weekly average flows. The red spots are measured weekly average flows. Remember, the more we put into the shallow aquifers the higher is the variability week to week, which makes sense.

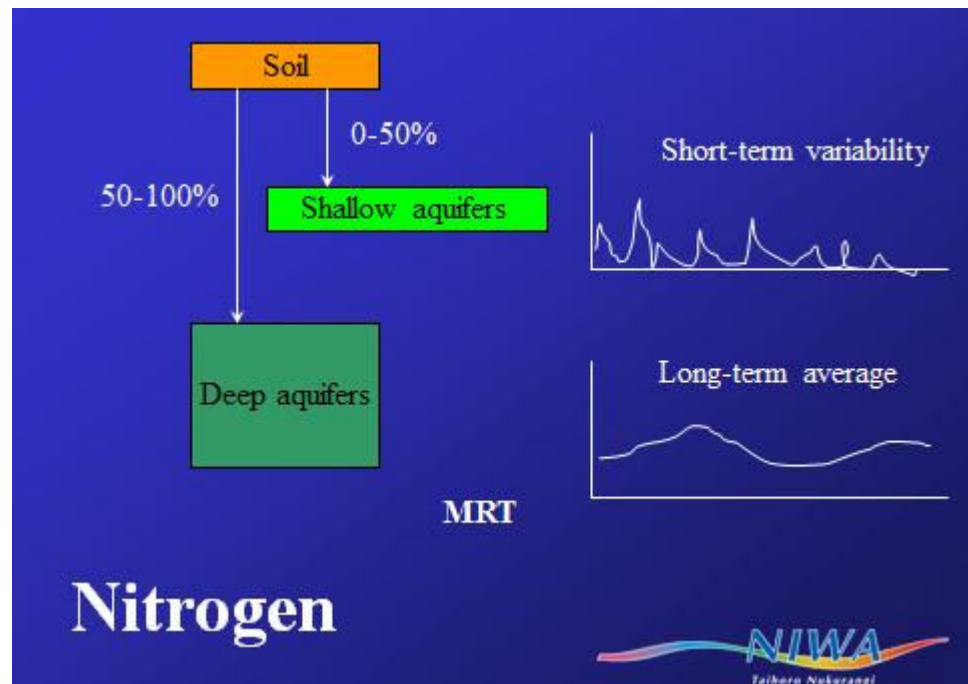
**Slide 17**



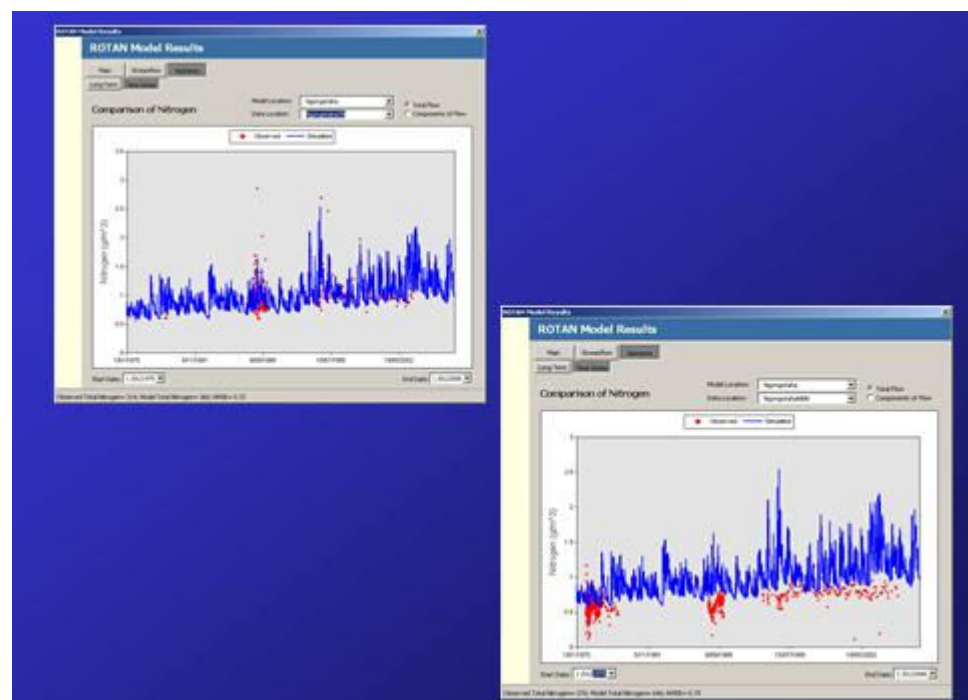
Were we to put all the water into the deep aquifers this blue line would just go up and down very slowly. We are able to say that on the basis of flows about 20 to 30% of the water goes into shallow aquifers and 70% to 80% into deep aquifers.

**Slides 18 and 19:** When we come to nitrogen we have the same sort of choice to make. Where is the nitrogen generated? What is the flow pathway that the nitrogen follows? Here there is much less information available to us so we run a range of simulations putting 50% to 100% into the deep ground water and the balance into shallow ground water. We look to see how well we can mimic the observed week to week variations in concentration in the rivers.

#### Slide 18

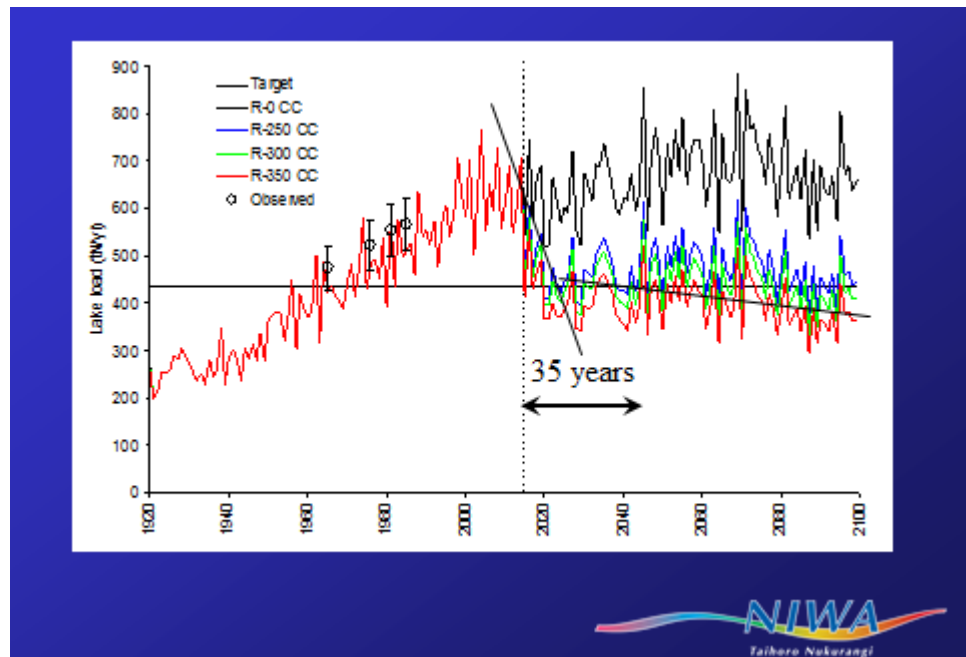


#### Slide 19



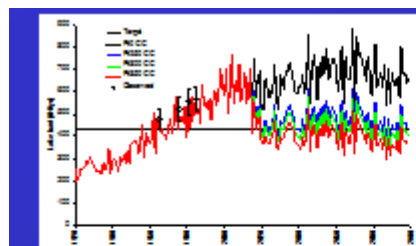
**Slide 20:** There are three scenarios of land use change. There is also the 'do nothing scenario', in other words, not reduce the nutrient load at all. The model predicts that for the 'do nothing' scenario the load will continue to increase and it will eventually get up to a long term average of 735 tN/y. Remember our target is 435 tN/y. The other three lines involve reducing the current load by 250, 300 and 350 tN/y. The horizontal line is our target. If we look at what happens out here in the year 2100, the R350 scenario more than meets the lake target. If you extrapolate between the 300 and 350 tN/y lines, then the modelling is saying that in order to reach the target long term you would need to reduce the nitrogen load coming from the agricultural part of the catchment by about 320 tonnes per year. That is the easy bit.

**Slide 20**



The next issue is this prediction that suggests you would get a very rapid response – within about four or five years – if you were to change the land use in 2015. When we first saw this prediction, we thought the model must be wrong because Uwe's map talks about residence times of 60 years, 127 years and 16 years. So how can this be?

**Slide 21**



**Step change in land use in 2015**

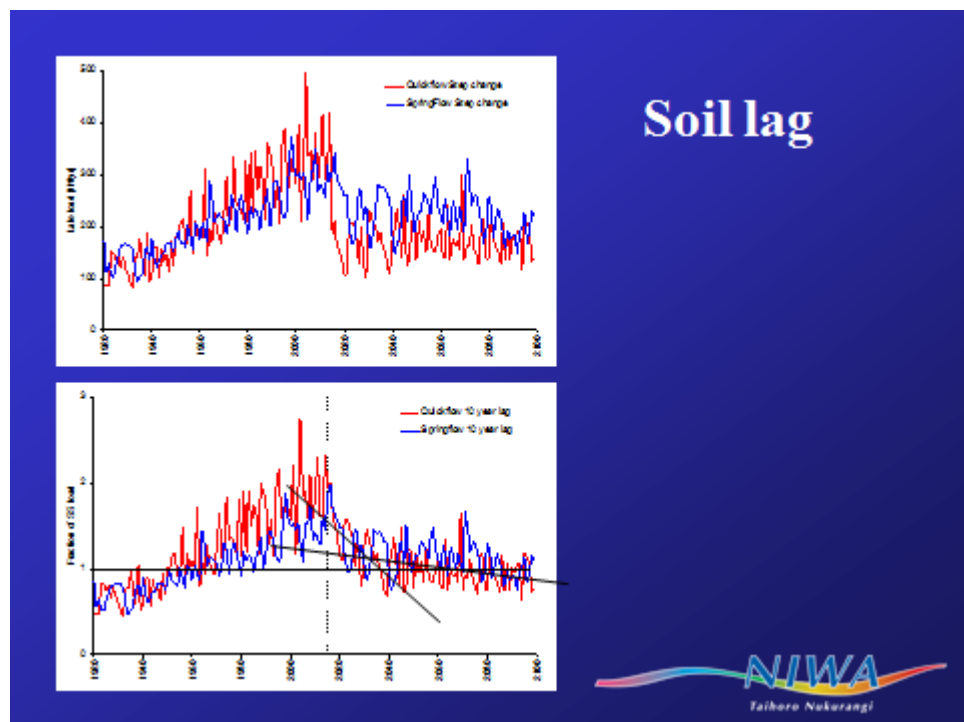
**No 'soil lags' (eg Dairy at 56 kgN/ha/yr to Forestry at 4 kgN/ha/yr – in the year the land use change occurs)**

**Dry period 2020-2030 – by chance**

**Slide 21:** Firstly, note that the model assumes a step change in land use in 2015. Clearly that is unrealistic as it is not all going to happen in 2015. I do not apologise for that. We use the model to determine that, if there were a step change in land use, what would be the response time of the lake? It is still surprising that it turns out as quick as it is. If you want to model a more gradual land use change, it can be done but what the model says is that for every change in the land use, the lake load will respond within about thirty five years.

**Slide 22:** Another issue stems from what Overseer does. Overseer does not have soil lags so we cannot use it to tell us the answer to the question: if we go from a dairy farming, (which Overseer says leaches 50 kgN/ha/y) to forestry (which Overseer says leaches 4 kgN/ha/y), over how many years will it take for the leaching to come down from 50 to 4? We originally assumed that it happens the year following land use change. That is clearly unrealistic. We have done a bit of work assuming that these changes occur over ten years. At the top is a step change and the blue line is the load coming through in the spring flow. This is the load that has gone through the deep aquifers. That does not change between the two simulations. At the top we assume that you get an instantaneous reduction from 50 to 4 kgN/ha/y if you convert dairy to forestry. At the bottom we assume there is a ten year lag, a slightly more realistic simulation and a slightly slower response. But, and it is a big but, we are still predicting a significant change in lake load over a period of thirty five years or so. The lake load is not at steady state after 35 years, there is still a gradual decline.

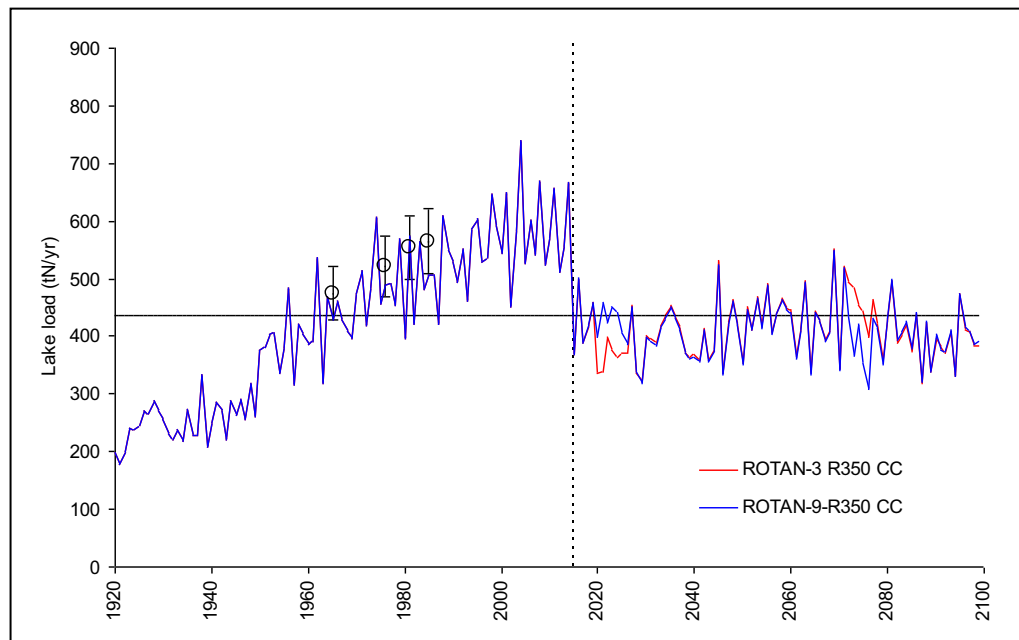
**Slide 22**



How can this be? Remember that I said that some of the nitrogen is going into shallow aquifers and some into the deep aquifers. Part of the answer is that a lot of the nitrogen is going into the shallow aquifers and they respond very quickly.

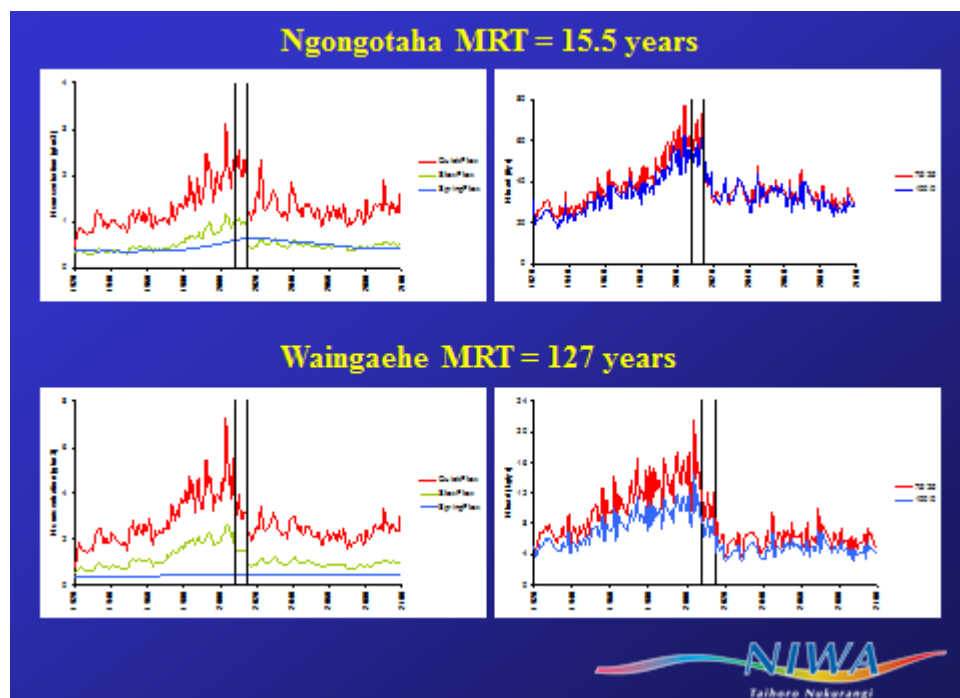
**Slide 23:** If you look carefully, it appears that for the 'do nothing' scenario the lake load remains stable, or even drops after 2015 because it is a dry period. We ran a simulation where we assumed both wet and dry periods immediately after the land use change. We swapped climate data from the period which was very dry with data from a period which was very wet. It makes a little bit of difference but it can't explain the 35 year response time.

**Slide 23**



**Slide 24** is a complicated slide. These are predictions for the Ngongotaha, which has a mean residence time of 15 years, and the Waingaehe which has a mean residence time of 127 years. At the top the nitrogen concentrations are split between the various components. This is the nitrogen concentration in the deep ground water. In the Ngongotaha development started just after WWII, a major intensification during this period, the concentrations in that ground water are predicted to increase quite significantly. They almost reach steady state with the existing land use.

**Slide 24**



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In the Waingaehe the bucket is so large that the nitrogen which goes into it hardly changes the concentration at all. There is a little change there but compare the two. The concentration of nitrogen in the really deep ground waters does not respond to land use change which, remember, has only occurred since the war. What this suggests is that we do not have to deal with high concentrations of nitrogen in the ground water in the Waingaehe, whereas in the Ngongotaha we do. When you change the land use in the Ngongotaha, ground water concentrations come down with a time scale of fifteen years, but they have to come down from the high concentrations.

These are the two shallow aquifers that we are modelling; we know they have response times of only a few years so they come down quite quickly. In the Waingaehe the nitrogen concentration in the ground water is already low and so it will gradually come back down again, but effectively it will not change. The net result is that the load coming out of those two catchments both respond moderately quickly to a step change in land use. That was a surprise to us.

There is good news and bad news in the conclusion. Firstly, the bad news is that in order to achieve the target, the nitrogen load to the lake is going to have to be reduced by about 320 tonnes of nitrogen per year. This is different from the situation in Taupo which Peter Skelton talked about, where they talk about 'holding the line'. We are talking about major reductions here. The current average leaching rate is about 18 kgN/ha/y and it needs to get down to 10 kgN/ha/y. We all know that dairy farms leach in the order of 50 kgN/ha/y. The best dairy farms, Stuart Ledgard will tell you, are between 30 and 40 kgN/ha/y. Current dry stocks are 16 - 18 kgN/ha/y and forestry is 4 kgN/ha/y.

I can see people are already doing back of the fag packet calculations of how much dairy you can have in the catchment, if all the rest is forestry. We did those calculations and estimate that you could have about 16% of the land in dairying if all of the rest of the catchment were in forestry and you would just meet the targets, or 13% in sheep and beef and 13% in dairy. You can play those games. The point is that all of these options require significant export reductions.

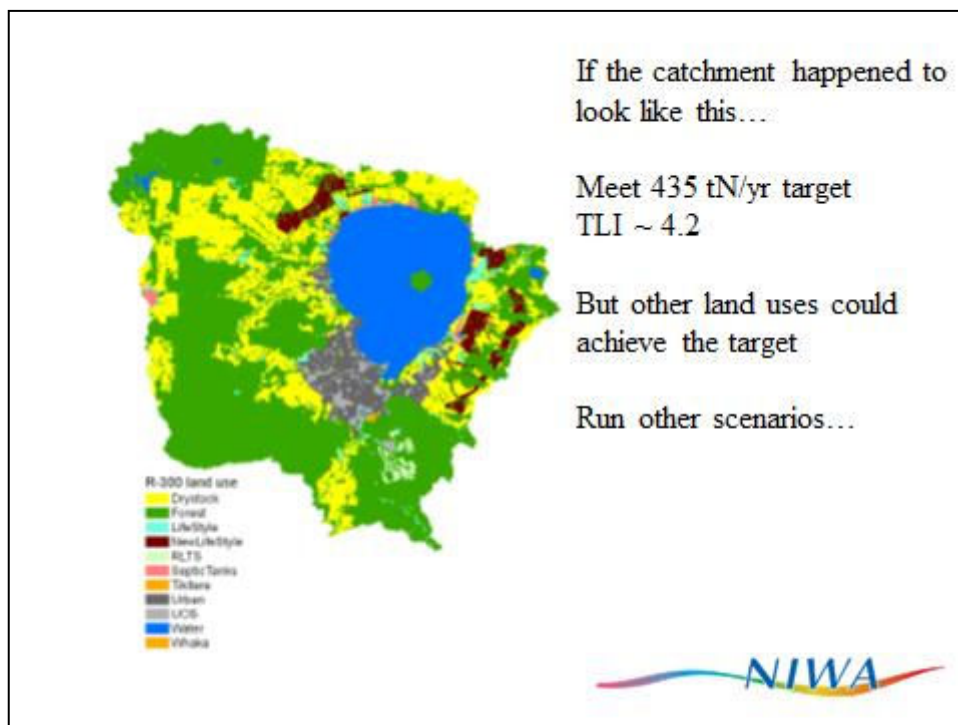
The good news, if there is any, is that ROTAN indicates that the response time, regardless of the catchment, is moderately rapid – much more rapid than we expected from just quick reading of Uwe's groundwater mean residence time map.

What is the implication for that? It may not be critical to target intensive land use in short residence time catchments. It could be that it does not matter where you target your reductions - you are still going to see benefits occurring in the catchment.

The one exception is the Hamurana catchment which is a bit of an odd ball, because it has a pocket handkerchief surface catchment and is fed by deep ground water from up in the hills. We have got to do more thinking about the Hamurana, and comparing it with the Waingaehe and the Ngongotaha.

**Slide 27:** If the catchment happened to look like this, with these land uses, ROTAN says the target of 435 tN/y would be met. Plug that into Lake DC and, as you heard from Professor David Hamilton this morning, it will meet the TLI target of 4.2. Picking up from Frank Boffa's talk, there are many other scenarios of land use that will meet the same target. We have put in dry stock and lifestyle. I am not suggesting that this has to be what the catchment looks like in twenty years' time, we can run other land use scenarios that people come up with.

Slide 27



Thank you.

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## ***Session Four - In-Catchment and In-Lake***

**SESSION CHAIR: Graeme Fleming, Lake Taupo Protection Trust**

### **HOW THE ETS CAN HELP IN THE ROTORUA CATCHMENT**

**William Oliver**  
Farmer, Taupo  
william.karen@xtra.co.nz

*William gained a Certificate of Agriculture and graduated with a BCom at Otago University, majoring in Economics. He worked in the Ministry of Commerce as an advisor on Tariff policy. He and his wife have been farming Waerenga Station at Rangitoto, near Taupo, since 1995. It is 774ha and runs 10,000 stock units, sheep, cattle and deer. He also runs Motere Land Ltd, 364ha, with 32,000 stock units of sheep, cattle and deer.*

*He is the guiding board member of the Waerenga Trust which owns five farms of 9500ha. 1100ha is on short term lease from the Lake Taupo Protection Trust and there are two other Maori trust farms in a long term very successful lease based agreement. It also owns 200ha of native bush under a Queen Elizabeth 11 Covenant and 450ha of radiata pine forest.*

*William sees his role as developing a business structure for an intergenerational family business and being innovative in farming in the Lake Taupo catchment.*

### **ABSTRACT**

I am that farmer that farms and lives with water quality and soil conservation restrictions. The Lake Taupo catchment is the first place in New Zealand where farming is a restricted activity and you need resource consent to farm. As the public rightfully demands cleaner water ways, an end to water degradation and soil erosion, the business of farming and the associated communities will have to rise to the challenge of change. Policy around the environment, I believe, is successful only if businesses, farms and communities can still be profitable and viable.

This is our story of how we have adapted to environmental legislation and taken up a policy of best land use producing food on our best land whilst reducing nitrate leaching, planting carbon forests on our erosion prone land while still providing jobs and helping to keep things alive around the existing life style blocks, community, clubs and schools.

### **TRANSCRIPT**

Hello. I was lucky enough to attend this Executive Development Programme run by Rabo bank in Sydney. This kind of further education is instrumental in promoting the thinking needed to create strategies and understanding in what we are doing. Scholarships and grants are very important to encourage farmers to participate in these programmes.

**(Slide 1)**

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## Slide 1

### Executive Development Program (EDP)



- Unique business management program for progressive farm owners/operators
- Designed to enhance commercial management skills, explore growth opportunities and develop strategies for the business
- Brings together 36 leading primary producers from across Australia and New Zealand
- Residential program, divided into two week-long modules
- Led by Program Director, Dr John Morris incorporating sessions run by leading industry experts

#### Who Am I?

I am foremost a husband and father which provides me with motivation. I am a member of a large farming family, farming in excess of 10,000 ha of land, 1,500 ha of forestry and 500 ha of native bush that we conserve with the help from the QEII covenants. I am an employer and a businessman. I am proud to have goals around inter-generational succession, sustainability, return on investment and profit. These are the key pillars to our business innovation in a changing environment. I live it and have skin in the farm/environmental sustainability game.

This is a story about Motere, a farm I own with my brother Mark, and his wife Buffi, and my wife Karen. It is a story of how we used the proceeds from the sale of a dairy conversion, leveraged off environmental legislation, to now farm three times as many stock units with higher earning potential and in a 50:50 JV in 1,100 ha carbon forest.

**Slide 4:** Motere is in the Lake Taupo catchment, the first place in New Zealand where you need resource consent to farm. Other farmers saw this as a barrier to entry and those in the catchment wanted to exit.

We believe that public perception around water quality and environmental sustainability means government will have no choice but to make resource consent, in some form, a requirement for all farms. To back up our thinking we took note of these quotes from presentations to MPs in the *Waikato Times* and the *Dominion Post*, 5 July 2010:-

- *"Questions need to be asked how New Zealand's rivers will be cleaned up."*

Dr Jan Wright - Parliamentary Commissioner for the Environment

- *"Over-fertilization of pasture land continues to increase, clarity is needed about what needs to be achieved, to balance economic effect vs. environmental effect."*

Dr Peter Singleton - Chief Scientist, Environment Waikato

#### Slide 4



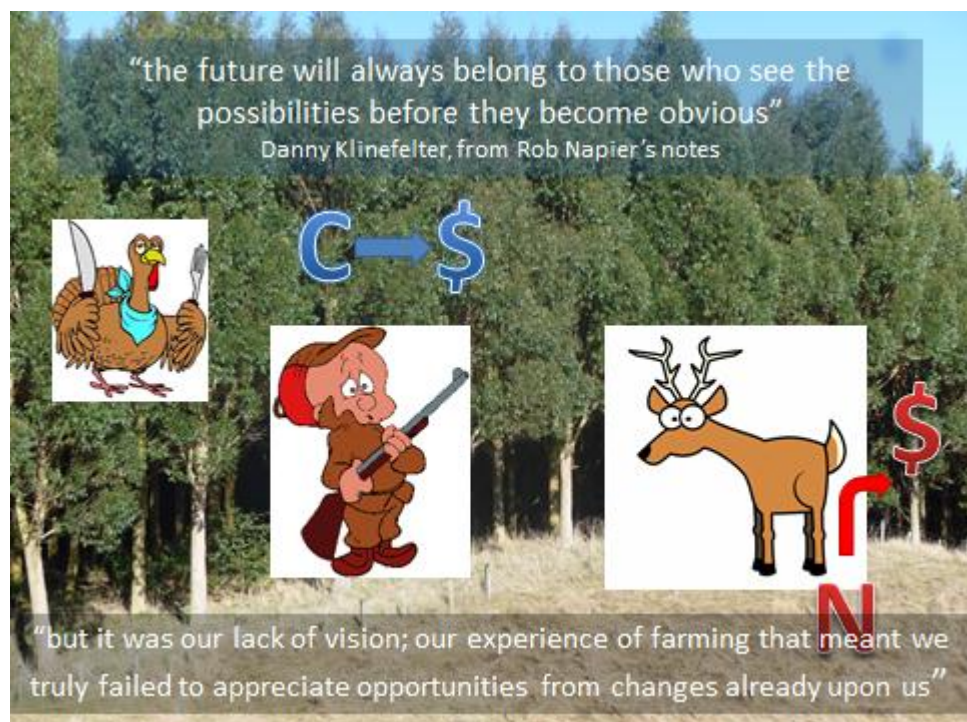
#### Why did we move to Taupo?

Our goals were to:

- Increase return on investment
- Capture capital gain from premiums for land being targeted for dairy conversion

So three years ago we sold Shalimar, 860 ha, 12,000su fattening bulls and lambs and bought Motere, 2,783 ha, 25,000su breeding and fattening sheep, beef and deer.

#### Slide 8



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**Slide 8:** When looking for a farm to buy, we met what we thought to be a rather eccentric character who showed us several farms in the Taupo catchment.

He said, "This is the kind of land you guys need to buy. Buy this farm, sell the nitrate, grow eucalypt forests and sell carbon on the ETS."

At this stage we are starting to think, he is bonkers.

"You release turkeys and deer into the forest and sell hunting to Americans."

We are thinking at this stage, "There's only one turkey in the car here."

But it was really our lack of vision and experience of farming that meant we did not appreciate the opportunities that were upon us. It was because of this guy that when we did our due diligence on Motere we had a whole new focus about the way we looked at things and it was on best land use.

We knew where to look and where to go in terms of understanding legislation, how Variation 5 was going to work. Who is going to govern and police it and drive this whole thing along? I would like to acknowledge the Environment Waikato Taupo office because they helped to provide solutions for us. We dropped the problems on their table and they helped us through the process. It is so important to have people who are going to work with farmers and give solutions.

Opportunities like carbon farming, taking advantage of trading nitrate, the manuka high value honey production which is slowly moving ahead, buying more land in the catchment, growing our deer farm for higher returns, tourism, hunting/fishing and the Taupo Cycle Way, which was supposed to cross our farm in two places, but is being held up at the moment by a Maori Trust but hopefully it will happen. These all became probabilities.

It was decided in 2000 by the Government that Taupo is an iconic part of New Zealand's clean green image for tourism. To conserve and improve the quality of the lake water runoff and nutrients entering the lake had to be managed. But to cut to the chase, agriculture is the greatest source of controllable nitrate, and controllable is the key word here, and that is how Variation 5 was passed to regulate, control and reduce the controllable nitrate in the catchment.

To measure the nitrate leached, all farms were benchmarked from 2000-2005 with Overseer which is a computer programme written by AgResearch and fertiliser scientists. Interestingly, it was initially designed to give production outcomes for given fertilizer inputs, stock and crop policies - put on more fertiliser, grow more grass, get more milk, etc. One of the outputs it models is nitrate leaching which is about stocking concentration, not fertilizer.

Farms were allocated a Nitrate Discharge Allowance (NDA) and to gain consent to farm a nutrient management plan, which is basically a business plan, it must not exceed the NDA. A pretty basic concept when you get your head around it.

### **Where did we perceive value in this?**

We could adapt our farming policy in terms of improving our Overseer outcome. Sit down with the computer programme, bang numbers through and come up with better ways to utilise the nitrate. Nitrate is a tradable management asset. We have one dairy farmer in the catchment who has brought more N to grow and intensify his farm.

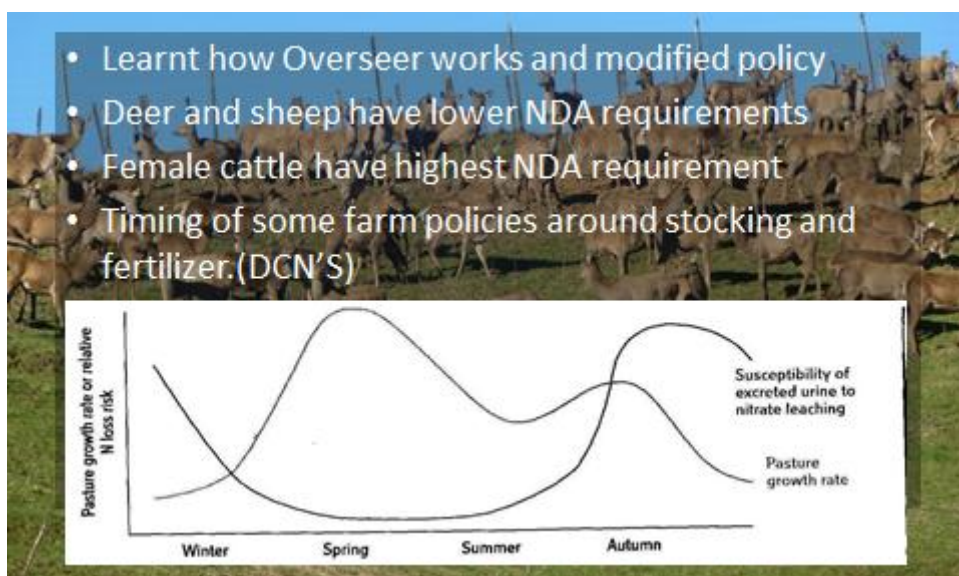
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The Government established the Lake Taupo Protection Trust (LTPT) and funded it with money. That \$81.5 million secured our capital gain from the farm we sold, because we could sell our nitrate back to the Lake Taupo Protection Trust to get back our capital.

The Lake Taupo Protection Trust mandate to reduce controllable nitrate by 20% (174 tonnes) has been covered but there are a couple of interesting things. They also facilitate research and development, trying to teach farmers how to use their nitrate more effectively. Instead of thinking about production per hectare or per sheep, it is \$/kg of nitrate, and obviously facilitating land use change. Heat your home with Mighty River Power electricity and save the lakes that is where the Lake Taupo Protection Trust helped us a lot, in facilitating our land use change.

### Which ideas did we pursue?

#### Slide 13



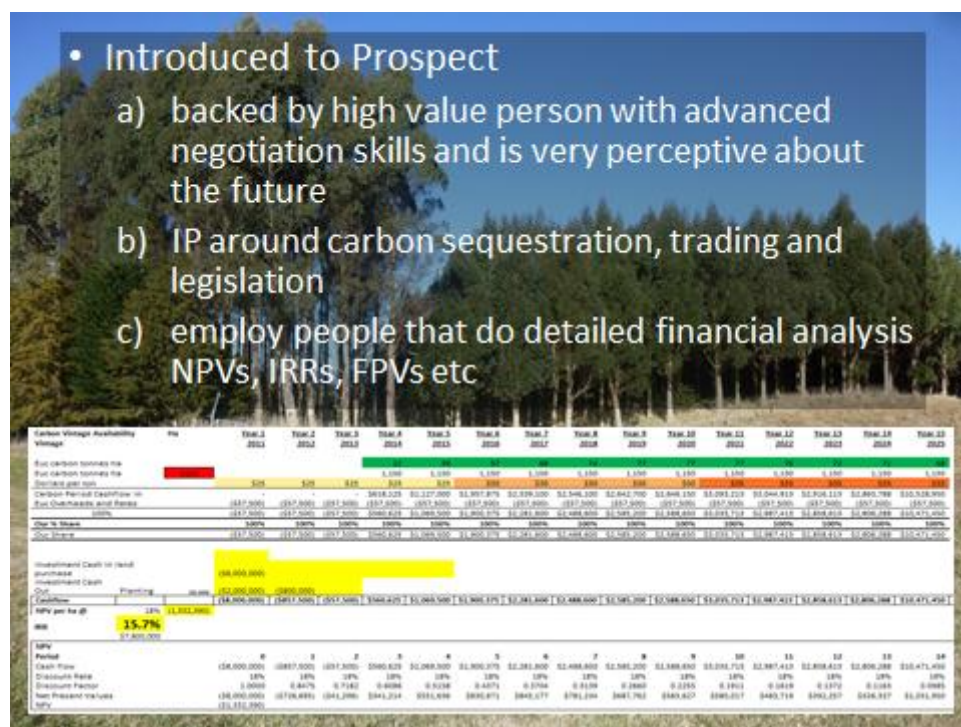
**Slide 13:** This showed us the importance of timing around stocking and the use of DCNs. At certain times the pasture growth rates diminishes because pasture is not growing as fast and cannot soak up the nitrate in the soil. There are things you can do with your farm that drive your NDA down.

We leased 1,100ha of land from next door on short term which is going to be about 500 - 600ha by the end of the winter. We trialled manuka. We purchased a further three neighbouring farms of 684ha with an average NDA of 26 which is very high. We managed to sell capital out of the land, making that land cheaper.

Our most important purchase was 174ha from the LTPT which came with a 300ha long term carbon contract. New Zealand has an Emissions Trading Scheme (ETS) whether we like it or not. It started for forestry in 1990 and for stationary emitters first 1<sup>st</sup> July 2010. Carbon credits are traded every day.

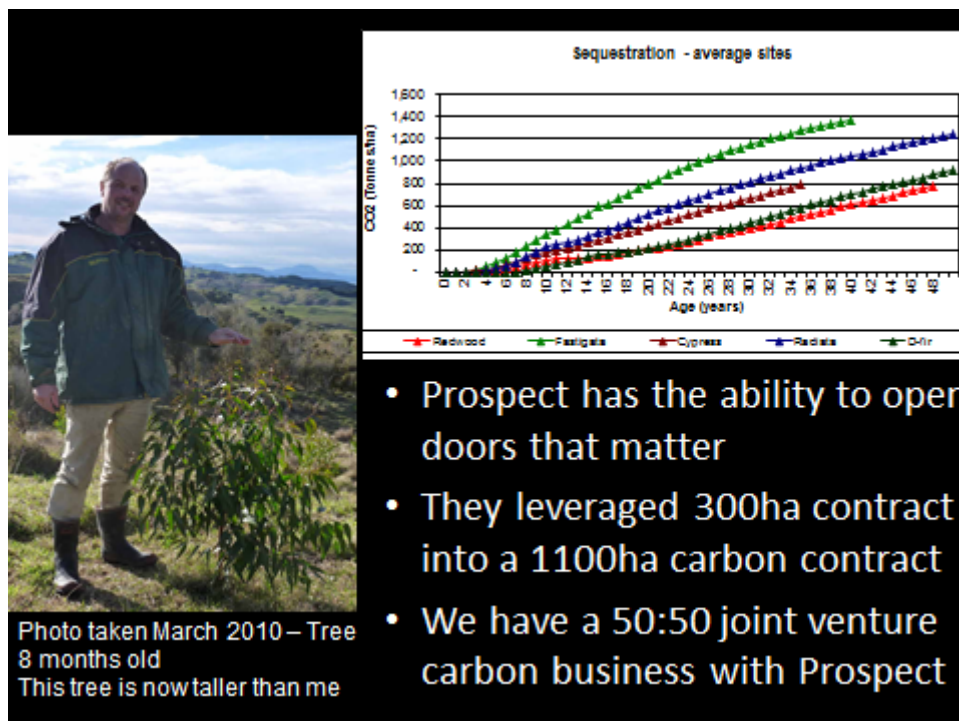
Being global warming sceptics, carbon sinks were something we struggled with but the LTPT introduced us to Prospect. We needed to mitigate our risk on a scheme where New Zealand is out on its own, especially with our trading partners. ETS reviews are occurring in 2011 and 2013. It was something we have very little knowledge about.

## Slide 17



**Slide 17:** Prospect is backed by a high value, very wealthy person with excellent negotiation skills and very perceptive about the future. When Kyoto was signed he went and gathered a lot of IP around carbon sequestration, trading and the legislation that drives it and how it all works. He employs people that do detailed financial analysis to enable him to drive the business to maximise income.

## Slide 18



**Slide 18:** We have planted *Eucalypt Fastigata* and you can see the sequestration rates on the graph. The forests we are growing are about carbon not production. Going forward there will be bio fuels or other opportunities.

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Prospect has the ability to open doors that matter. They know the people driving the companies that want to buy carbon. They leveraged our carbon contract considerably out from 300ha to 1,100ha and we have a 50/50 JB with Prospect.

### How did we leverage off this?

#### Slide 19



**Slide 19** is an aerial photo of the farm showing Waihaha Bay and State Highway 32. We have planted our poorer land and sold the NDA, or nitrate, back to the Lake Taupo Protection Trust. Farming this poor land required a NDA of about 14, whereas a forest requires 3. Selling this NDA released capital. Our other major cost was the legal fees. We were writing contracts that had no legal precedent and a lot of work in terms of tying all the covenants, etc.

Our net share of the net annual income from year three will be between \$700 to \$900 per annum. When we started the returns from carbon farming were about two or three times higher than what we achieved farming stock per hectare on poor land. They are now about one and a half times. There is a lower cost because we have little capital in that land and also a lower management cost once the forest is up and going. I can move to the Sunshine Coast and it would keep pumping income, so not a bad option.

We could only get a 1,100ha carbon contract, however I still believe that food is a need and carbon a want. If that economic factor is true, income derived from food will exceed that of carbon over time. Recent modelling by AgResearch shows that farmers are better off to farm harder than plant to mitigate ETS liability. However, I still believe in best land use. If it is poor land, has erosion or too steep, plant it.

### Now and next year, where are we at?

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## Slide 21



**Slide 21:** Motere is about 3,640ha and we have 1,100ha of short term lease. That land has been sold to an American superannuation fund and they were going to plant about half this year and we will lose it. We have more land of our own to plant as well. Over the next year our current stock will decrease which means so will our labour. This land used to support about 14 families before this whole job started. Next year there will be five single men and one married couple.

Besides supporting those families, there were on-going jobs for shearers, a presser, a rousie, stock agents, truck drivers, the agricultural contractors, the guys that make the hay, the guys that cultivate the land, meat workers, as it probably kept a meat plant going for two or three days, and all the other service industries that farmers generally operate with. The multiplier effect for farming is between five and six to local communities.

I am involved with a couple of forestry blocks that have been harvested in Te Kuiti, Otorohanga, where I live. The contractors that organise the haulers etc. drive from Tokoroa, and some come from Rotorua every day, so there is not really much benefit for the local community with people doing that. The three or four trucks that turn up every day come from Mt Maunganui, 80 to 90% of the logs going directly to the port at Tauranga with very little further processing in New Zealand. I struggle to see how blanket forestry is a good option going forward.

There are currently six lifestyle blocks, three of which are for sale, attached to, or very close to our farm. Four more will soon be on the market with buildings attached. With land going into forestry there is little prospect of jobs in the area and it is uneconomical to travel to Taupo and Turangi. The people who own these lifestyle blocks now – one drives a fertilizer truck, one does a lot of contract fencing, or scanning of pregnant stock. One is a qualified builder who gave up travelling to Taupo because he could not afford it anymore.

There are also issues around local body rates. As soon as we convert our land to forestry our rates are reduced so someone else has to pick that up. A recent Waikato River Independent Scoping Study suggested that 68,000 hectares, mostly in the Waipa

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Catchment, would be planted. I struggle with the economics of all that and where we are going. Are there other ways?

### **What have we been doing?**

We have been doing alright out of this in spite of those depressing thoughts. We have been preparing land for planting destocking. We are fixing and developing infrastructure for efficiency and incorporating new farms. We have 40 km of new deer fencing and 5 km of sheep fence. There has been pasture development with fertilizer and crop rotation. The farms we have are very good and the production, especially over the summer months, exceed my farm in Te Kuiti which is surrounded by dairy farms and also considered a very good farm.

My job is mainly around governance and strategy, communication with management and setting new levels of responsibility and goal setting.

In conclusion, we have personally achieved our own basic goals around best land use and a balance that should be looked for. We have increased our internal rate of return and captured and retained our unsustainable capital gain.

We have learned how Overseer worked and altered policy to benefit. I have the carbon farming JV with Prospect, a long term contract mitigating risk. We have sold NDA which released capital and was used as a means of exchange. We bought 55.5 tonne and sold 11 tonnes to LTPT, almost 10% of what they have bought so far.

We have bought more land. The Taupo Cycle Way which has government funding is crossing our land. We are hoping that this will create a few more jobs. We have spoken to meat companies and Mike Barton, a local farmer, has been doing a lot of good work trying to create local markets for products grown in the Taupo catchment and trying to leverage off the value of eco-friendly carbon free products.

### **A New Day**

What do I see going forward? Community jobs, food production, lifestyle, water and soil conversation. It is true that the cost of food is only going to go up, and lambs I sold for \$80 last year are \$130 - \$135 this year. If there is less and less food production the price is only going to go up so we have to get a balance. We can farm dry stock, whilst lowering our nutrient leaching, and improve soil conservation with the available IP, fencing and planting, but we need governance that gives clarity of direction, balance and assistance. The price of food will need to increase to cover all this. Food is one of the world's big issues!

The model we have in Taupo is transparent. There was talk about having different policies for different lakes. If I was a farmer coming to buy land in the Rotorua catchments and saw a whole lot of different rules, I would think, "You know what, this is a dog's breakfast, I don't want to buy land here." If you have one rule for everybody, as an investor it would make far more sense for me.

**Slide 28:** I am not a dairy farmer and certainly would not tell dairy farmers what to do. But I did a course with a farmer who has a herd home and he said he had the happiest cows in Southland. They produced 635 milk solids a cow last year. The New Zealand average is 340. This farm leaches about 25 kgs of nitrate per hectare per year and for the stocking rate, fertiliser, etc., he could expect well in excess of 45 kgs in a normal New Zealand

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system. The herd home is not only helping with the nitrate but means less soil erosion. Whenever there is rain or snow down there the cows just come and go as they like.

**Slide 28**



**Dairying**  
**(the happiest cows in southland)**

- These cows produce 635ms/cow/yr. NZ av 340
- This farm leaches approx 25kg/N/ha/yr
- Would expect 45+ kg/N/ha/yr with the stocking rate etc
- The herd home means reduced soil erosion.
- The IP for balanced feeding of ruminants to achieve higher production and better environmental outcomes is available. (Sue Macky, DPS)
- Dairy or farm free areas is a bad precedent.

The IP, or Intellectual Property, for balanced feeding of ruminants to achieve higher production and better environmental outcomes is already available. Mrs Sue Mackie from Dairy Production Systems, in Hamilton, said they know how to balance the cows' rumen by balancing the feed. The feed of straight grass is not very efficient and they produce more nitrates which have to be excreted. Obviously that is then excreted into the ground. She also said that if you believe in man-made global warming they can reduce the amount of nitrous oxide being excreted as well. This information is already here. What farmers need is more governance and clarity about what you want us to do, and then we need to move forward.

I saw recently in a local farming magazine a suggestion of farm-free areas. One morning we might wake up to the people of Christchurch deciding that they do not want dairy farms on the Canterbury Plains. Or the people in Auckland may decide that the Hauraki Gulf are a bit messy and there should be no dairy farming on the Hauraki Plains. I believe precedents like that are really bad ideas.

In conclusion I guess by accepting the inevitability of change and adopting best land use, we have realised the opportunities of the future, for the kids and policy going forward. I believe policy for environmental sustainability will be successful only if the associated communities, businesses, farms and clubs, basically the New Zealand farmer's habitat, are profitable and viable.

Thanks very much.

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## CAN FARMERS REDUCE THEIR NUTRIENT OUTFLOWS AND REMAIN VIABLE?

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*Alison trained and practised as a large animal veterinarian – EBOP and Waikato. She dairy farmed in both New Zealand and Australia for twenty five years. While farming in Australia with her family, she assisted in the design and implementation of the “On Farm Quality Assurance Schemes” for Nestle, and then managed the establishment of Intelact Agribusiness Consultancy in Australia before joining Commonwealth Bank of Australia in 2007.*

*Since returning to New Zealand at the end of 2009, she has undertaken post graduate study in Freshwater Ecology and Nutrient Management in Agriculture. She is presently working with Raukawa Settlement Trust as a Sustainable Land Use Advisor, and consults on Strategic & Whole Farm Planning and a variety of projects associated with improving nutrient efficiency in agriculture in sensitive catchments.*

### ABSTRACT

The **viability** of a business is measured by its long-term survival, and its ability to have sustainable profits over a period of time. Many of our farm businesses are feeling the pressure to re align their focus, in response to some fundamental shifts in a global re pricing of risk in the past 3 years.

A result of this shift has meant a decline in “lending for growth’ in the NZ dairy industry, and a requirement by banks for real profits and not speculative capital gains. Returns prior to 2009 were largely driven by intensification on farm, leverage against that increased production, and subsequent procurement of new land and dairy assets.

This drive has been fuelled by capital gains and unfortunately has resulted in a tardy approach in many cases, at farm level to ensure businesses are driven by the essential drivers – that of deriving a profit, managing risk and adaptation by the business from year to year.

Along with the financial pressure is strong public pressure at the same time for the industry to manage and reduce its nutrient and environmental footprint. Many farmers are overwhelmed by the prospects of change on a number of fronts. Professional capacity to support both improved financial and environmental literacy at farm level is also thin.

The news is not all bad. In every demographic profile there are “landscapers and leaders”, and this is coupled with the emerging science and tools that they have at their disposal. We know there are opportunities in many cases for improved nutrient efficiency at farm level. We also know that some farms are able to couple profitability along with a lower than average impact to the receiving environment from their activity. We will explore some of those case studies.

The business is changing. The “landscapers” within the industry are seeking their information in different ways. They can see the opportunity to couple resource use efficiency with improved profitability and are making a conscious decision to design their

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farm systems for the future. With an aging population of dairy farm owners, the exit strategy for many is a high priority. Hence demonstrating that their business is profitable, compliant and resilient for the next

## **TRANSCRIPT**

I am a bit overwhelmed with all these very famous speakers in such a great Symposium. It is wonderful to be here and thank you very much. I have been very fortunate as well this morning to speak at the Large Herd's Conference in Reporoa, so was able to talk about case studies with farmers to my farming colleagues, who were quite open to listening. I was pinching myself thinking, "We're really moving forward in this area because it's great to be talking about whole of catchment management with 250 farmers". That was a great talk just before, William, and I am just going to endorse a lot of what you have said.

So can farmers reduce their nutrient outflows and still be viable? A big question? It is the challenge of economy and environment. I am going to go through a bit of a background, where we are at the moment in terms of what was happening prior to 2008, and how we are in a changing world in a whole range of areas. The emerging science and what is happening in terms of extension patterns and look at how healthy our businesses are. What we can do to reduce nitrogen losses in order to have healthier catchments and look at a few case study farms that I am really fortunate to be working with.

What can we do moving forward also, in terms of reducing footprints, but at the same time optimise profits? I know this is a play on words and you would have seen this in the media.

We sold our farm in 2008 in Australia and got out in time. We were a bit naughty in the nineties and in the 'noughties' we followed capital gains as well. What was happening in New Zealand was really quite a New Zealand phenomenon. Our dairy farmers were intensifying their farm businesses, leveraging against more cows, more shares, and rising land values. A bit of a dangerous business in hindsight, growing and expanding business with really strong bank support. The driver was return on assets and capital gains and in New Zealand it appeared that bankers and generalist consultants were the key advisors to the business. There was negligible accounting of environmental risks and effects.

It all came to a bit of an end in 2008/2009 and some people did see this coming. I was working at the time in the Commonwealth Bank of Australia and some of my colleagues were concerned, in late 2008 saying, "There's something happening out there and we are not sure how we are going to control this, it is global re-pricing of risk." All our swaps were very volatile, the margins on the long term loans we thought were fixed, did not appear to be. All of a sudden in New Zealand there was a real change. Our farmers had to focus on protection of the assets, rather than growth in the assets, and that had to happen.

We had capital gains in the good times, but there has been a huge wealth adjustment and up to 30% decline in land values in those higher risk land areas. The high risk business model crashed and at the same time a crescendo of negative media and public concern. Now we are in a different business operating environment, cash is king and returns must equal the cost of borrowed money. I can see you thinking they need to be more than that too if you are dairy farming, more than 8%. The performance is certainly scrutinised by a more informed public, people like you.

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I read the Listener when I came back from Australia and kept opening up all these articles thinking what is going on in this country where dairy farming was supposed to have a nice habitat? The public was saying, “The bullish dairy industry is continuing to drive the country’s economy but at an increasingly high environmental cost.” They really have run out of patience.

**Slide 6**



**Slide 6:** I am a third generation dairy farmer as well. My grandfather and his brothers cleared about 3,000 acres in the Upper Waikato and for the last fifty years it has been ok to do all the sorts of things in this slide and we did not really know what we were doing.

**Slide 7:** But the public is saying, “No longer is it business as usual, guys.” We do know how to fix some of these things. The Iwi are saying the same. They want catchments to look a bit different and the people that are speaking out, people like you, are saying, “We

**Slide 7**

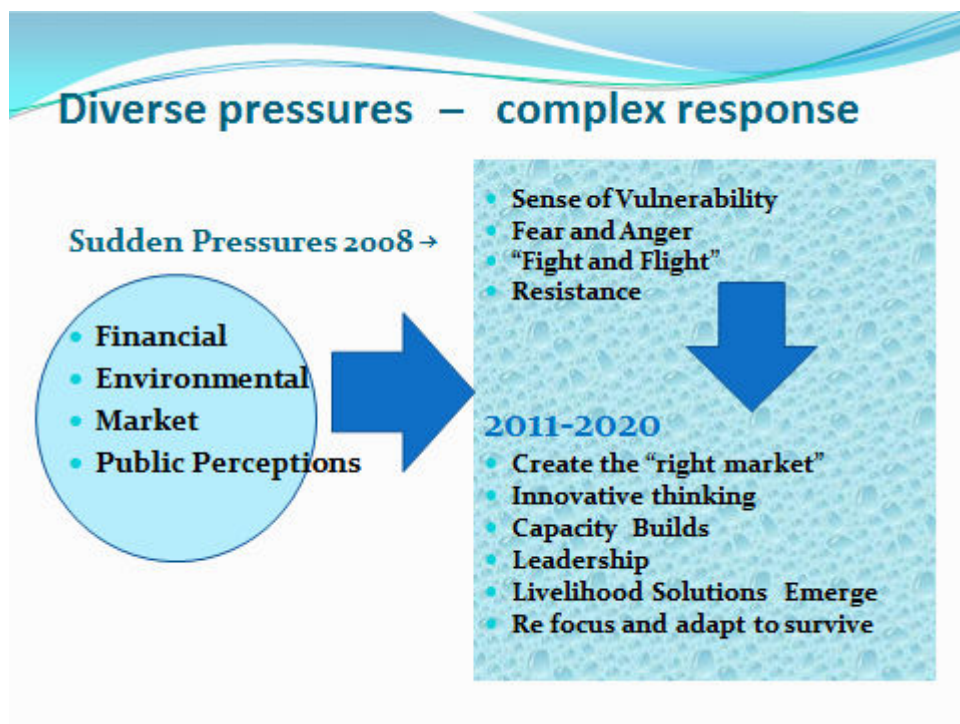


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can do things differently, we all want to live in these catchments together.”

**Slide 8:** Now down on the farm, sitting round the kitchen table, we have had all these pressures come together all at once, like a perfect storm. In the last three years there has been a huge sense of vulnerability down on the farm. Fear and anger has emerged and there is almost a catatonic state. People are going, “I don’t know what to do, this is all too much.”

**Slide 8**



But moving forward I am starting to feel really positive, I did not expect to be up here talking about this only two years after coming back from Australia. We are starting to see the right market created in different catchments and getting innovative thinking amongst farmers and private businesses. We are getting ‘capacity building’- increasing knowledge, amongst our agri-professionals.

I have heard out there, “There are not enough consultants to do whole farm plans.”  
“How are we going to do this? Are we going to roll out a whole heap of nutrient budgets and tick boxes?”

We can do better than that. We are getting leadership, we have fantastic farmers already doing a great job, and there are solutions emerging that say we can do this profitably and with a lower footprint.

There is a whole lot happening at the moment. AgResearch is providing research and supporting the industry with tools such as Overseer and updating that all the time. Dairy NZ has now got a sustainability team with CO’s trained in nutrient efficiency and profitability advice. Both Dairy NZ and Fert Research have got an initiative underway to collate a benchmarking database of all the Overseer files to understand what low leaching farms are doing and how they are doing it. That is a huge step forward, we do not have the data at this point. Fonterra is checking every farm every year that all effluent systems are compliant.

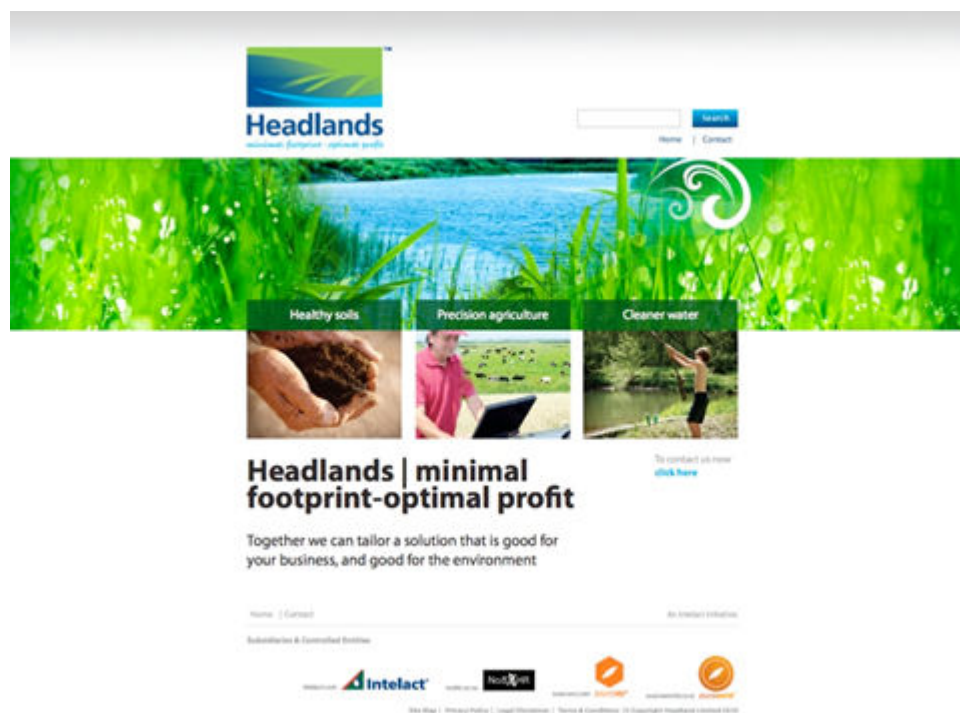
The Ministry of Agriculture and Forestry’s Sustainable Farming Fund (SFF) projects are everywhere in this catchment. Rerewhakaaitu, one in the Upper Waikato, Rotorua and

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one in Reporoa<sup>1</sup>. Regional Councils are providing educational initiatives and private consultancy firms are saying, “If we don’t help our leading farmers change, we’re not going to be in business long-term either”.

**Slide 10:** I am doing work too. I managed Intelact Agribusiness Consultancy in Australia when farmers lost their water in the case of droughts and we had to help them adapt. Since being back Intelact asked me to help with a group of twenty consultants throughout the country here. They are all skilled in farm systems modelling now in training in whole-farm planning because they want farmers to understand there is an opportunity in this change and it is not all about risk.

**Slide 10**



**What’s happening with business health?**

**Slide 12:** I am a vet. I always talk about health and I am talking about business health now. This is Red Sky dairy farm’s benchmark for the last three years. I do not get too hung up on all numbers but return on capital, return on total assets not including capital gain for the three years is sitting around 4% average, or 2 - 6% depending on the milk price. The top was 10% which is a bit of a difference. Good operators are always good operators. So a top of 10% is doing something better than the average and it is not one system. It is not about a low input system or a high input system, they are just very good at all facets of their business.

**Slide 13:** If we look at the cost of production per kilo of milk solids, the average for those three years is around \$4. As we know, the banks get nervous when equity drops, they want their finance costs met and principle repayments. The average farmer needs about \$7 milk solids to tread water, but the good guys are making a profit at \$7.

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<sup>1</sup>“Tomorrows Farms Today” is a project aimed at helping farmers position their businesses for the future and to maximise farming profitability while measuring and reducing the farm environmental footprint. The farmers wish to explore a range of farming systems.

Slide 12

<b>Red Sky 2009 Dairy Benchmarks</b>						
	2007 Avg	2008 Avg	2009 Avg	2007 T10%	2008 T10%	2009 T10%
<b>Return on Cap</b>	2.4%	6.4 %	2.2 %	5.1 %	10.1 %	4.2 %
<b>Profit per Ha</b>	\$1,063	\$3,650	\$1,143	\$2,431	\$6,154	\$2,667
<b>Profit Margin</b>	19 %	40 %	18 %	35 %	53 %	32 %
<b>Pasture Harvest</b>	11.9	11.4	12.4	14.5	14.0	14.6
<b>Cows / FTE</b>	126	138	139	158	171	173
<b>Core / Cow</b>	\$ 466	\$ 546	\$ 581	\$ 387	\$ 466	\$ 507

Slide 13

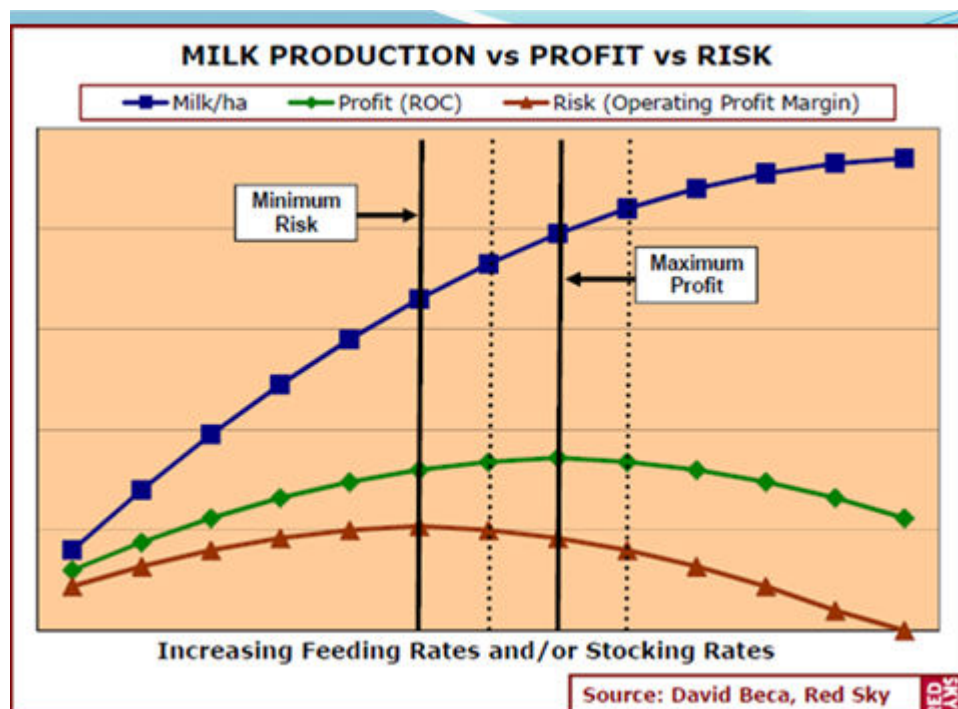
<b>NZ Red Sky Dairy Benchmarks</b>						
Per kgMS	2007 Avg	2008 Avg	2009 Avg	2007 T10%	2008 T10%	2009 T10%
<b>Cost of Prod'n</b>	\$ 3.47	\$ 4.19	\$ 4.20	\$ 2.71	\$ 3.19	\$ 3.38
<b>Finance Costs</b>	\$ 1.84	\$ 1.95	\$ 1.76	\$ 1.30	\$ 1.57	\$ 1.43
<b>Total</b>	\$ 5.31	\$ 6.14	\$ 5.96	\$ 4.01	\$ 4.76	\$ 4.81
<b>Princ Repay</b>	\$ 0.72	\$ 0.76	\$ 0.76	\$ 0.51	\$ 0.61	\$ 0.61
<b>Total</b>	\$ 6.05	\$ 6.90	\$ 6.72	\$ 4.52	\$ 5.37	\$ 5.42

How healthy were we anyway? Yes it is tough and there are lots of pressures, but life is not that easy is it? We have always got pressures. We understand there are challenges for our farmers and the best thing we can do is help them understand their business performance now. Part of that is whole farm planning.

**Slide 14** is from the Red Sky data. The blue line is milk solids per hectare. You would think by increasing milk solids per hectare and feeding or stocking rates, it would follow on a straight line of increasing return on assets. No. It comes up to a sweet spot and then

starts going down again, because of increased risk in the business. One size does not fit all. Every farmer is different and a mix of unique social capability, bio physical factors and risks and a couple of biological systems. We have animals, pastures and a whole raft of things which is really complex. We need to understand our businesses better on a historical basis and then find where that 'sweet spot' is.

#### Slide 14



#### What are the challenges ahead?

They are massive, but they are not insurmountable. We have climatic volatility, just like Australia. I left Australia where we grew grass and then we did not, we had a drought and we lost our water. I came back to New Zealand – same thing. We have had the pasture harvest drop by about 2 to 3 tonnes per hectare in the last couple of years.

The public wants to see stewardship. We have to increase resilience in our businesses in a whole range of areas. At the moment dairy farms are depending on 600 kilos of palm kernel a cow. How do we know that is there for the long term, to keep feeding our cow and getting us out of trouble? In other words, reduce our business risk. We must plan for optimal profit with a lower footprint and pre-prepare for change so we cope with business shocks when or if some regulation comes in.

It is the blend of mitigation, I would argue, which needs to be a whole farm system approach. That is not just a straight forward nutrient management plan which does not take into account the whole farm system. We cannot look at this through a reductionist lens, it gets back to that argument of reductionist versus holism.

#### Options to reduce nitrogen leaching

**Slide 17:** There is a whole range. If we **remove winter nitrogen use**, which is high risk on saturated soils, or lower the overall nitrogen use, and use it strategically at the best times of the year, not only can it be slightly more profitable, but we can reduce nitrogen

leaching by 10 to 20%. This is about mixing it with the whole thing. Like having the stocking rate right and understanding what is happening with the whole farm system.

Slide 17

Tools to Lower N loss - farm system		
Tool	System Changes	N Loss Reduction Modelled
<b>Lower Overall, or no winter N use</b>	Change to high growth times of year. Lower overall & more strategic usage.	↓10-20%
<b>Better Effluent Capture and Recirculation.</b>	(up to 50+% of farm area) Collected from feed pads, stored & use on summer re graze-able crops such as chicory, plantain & over sown with winter ryegrasses. <b>no mineralization period</b> ↓N & P use, ↓Costs.	↓10-15%
<b>"Right" Stocking Rate</b>	Following self analysis of historical data, match cow requirements to pasture harvested. Aim for improved intakes, productivity similar. Best tool to use when Stocking Rate is "above optimum" for farm. (↓10-15%)	↓3-20%

**Better effluent capture and recirculation** - the rules at the moment are to irrigate about 10% of your farm. It is more beneficial to irrigate up to 50% of your farm if you can, and store effluent and put it on at the best times of the year. Use it on crops that are going to give you more growth for that effluent use, and gain 10 to 15% reduction.

I talked about the sweet spot of a business and that is about understanding what you are harvesting and **the right stocking rate** for the farm. Too low is not good, neither is too high, but cows eating about 3½ to 4 tonnes of dry matter per cow from home grown feeds is optimum. Many people at present are only achieving about 2 to 2 ½ tonnes of DM eaten per cow because we have lower pasture harvest occurring combined with the same old stocking rate. Again 3 to 20% reduction in end loss.

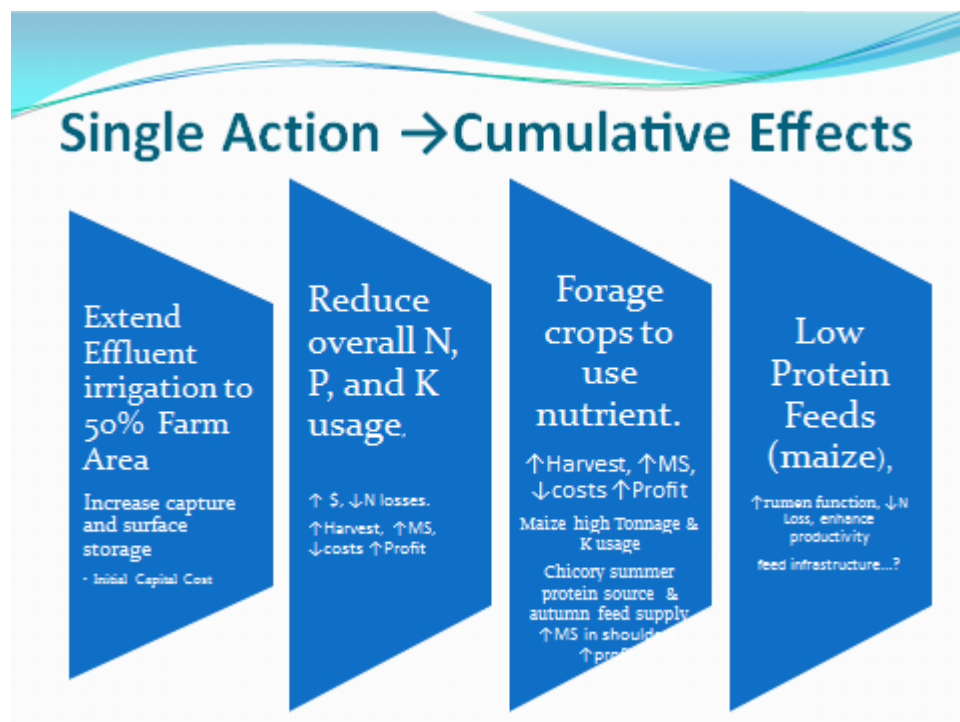
**DCD** – a lot of hope is being pinned on this nitrification inhibitor. We are not sure if it is going to work in the North Island because of the intricacies of when it needs to be applied and what the temperatures are in the North Island. It seems to be effective in the South Island. At the moment I cannot recommend it for this region. It is also quite a high cost for what it does. But there is a lot of emerging science so it cannot be written off.

**Winter grazing off** – fine, but I am not sure you guys from Rotorua can send your cows to the Upper Waikato or down to Taupo anymore. So what are our choices? What catchment is not sensitive? It is a very profitable option and gives a good bang for your buck, 15 to 25% reduction in end losses, but not a choice that you can always use.

**Infrastructure improvements** are anything from feed pads, wintering pads, standing cows off in autumn and winter, and this assumes the effluent is captured and reused at optimal times. Or go to the Rolls Royce of the herd home and have 3 to 15% reduction in end loss.

Another option is **higher per cow production** using low protein supplements or alternative feeding strategies. Having that stocking rate right, getting the rumen functioning appropriately without this high load of nitrogen or protein, and getting it all sorted so our cows do not have a huge load of urea in their urine cascading it out into the environment like it is at the moment. If we reduce protein in the diet back to about 16 to 17% all year, rather than 26%, our cows function a whole lot better.

# Slide 19



**Slide 19:** A single action can have cumulative effects, but it is not about simple recipes. It is about farm systems approaches and that is why I advocate whole farm plans because it takes into account the business health of the complete farm system. If we extend the effluent for 50% of the farm area we end up reducing the overall N, P and K usage. Farmers can use forage crops on those areas and get better growth by using maize, chicory and regrowth crops. Then if they do grow maize it goes back to the cows and there is more efficiency there. Cumulative effects.


**Slide 21:** I would like to take you through examples of farms that I am lucky enough to work with. Andy and Jenny Hayes at Lakeland Farms are around two lakes, Kaituna and Komakarau, at Horsham Downs. It is all organic peat soils with sedimentary clay soils on about 30% of the farm. 90% of the farm is irrigated with effluent. The average harvest for the Waikato is about 11.2 tonne dry matter per hectare. They are harvesting 13½. They bring 25% of the cow diet in as low protein feeds and stocking rate is above average. What is going on?

Stocking rate in the Waikato is typically about 3.2; Andrew has 3.4 cows a hectare. Above average milk solids production 1,360 averages about 900 to 1000 using 55 kilos a hectare of nitrogen, the average is 140 – 160 from what we know. No wintering off, so no easy runs here. Targeting 23 kilos of nitrogen leached per hectare this year. Now if I put the average dairy farm system from Dairy NZ data into Overseer and put an organic soil in there it would leach 45 to 50.

Slide 21

## Lakeland farms- Peat soils/priority lake

Andy & Jenny Hayes



90% irrigated with effluent  
 13.5 T DM pasture harvest  
 25% low protein feed imported.  
 3.4 cows/ha  
 1360 kg MS/Ha  
 Soluble N use <55 kg N/ha  
 No wintering off.  
 Targeting 23 kg N leached 2011  
 using changes to diet.

ROA > 6 % .  
 28 kg N leached.  
 Focus on ↑ROA ↓ Footprint.

**Slide 22:** This guy is breaking the rules, he is getting it right. We did not think he could do this. Return on Assets at \$6.50 MS – above average 6%. In the two years leaching has been about 28. Milk solids per hectare have gone up in the last three years and this next year he is hoping for a bit more.

Slide 22

LAKELAND FARMS	2008/09	2009/10	2010/11	2012 budget	Ave Waikato *
\$6.50/kg MS					
Milksolids/Ha	1193	1229	1363	1408	1062
Total Cows	300	305	311	300	324
Stocking Rate	3.2	3.4	3.5	3.2	3.12
Milksolids/Cow	350	371	405	434	328
TDM/Harvsted/Ha	14	13.5	13.5	13.5	11.2
Soluble N use/Ha	57	40	30	25	144
Soluble P use/Ha	35	0	0	0	52
OP Profit/Ha	\$3752	\$3786	\$4004	\$4135	\$2490
Return on Assets	5.9%	6%	6.3%	6.5%	4.4%
N Leached/Ha	28	28	28	23	45
N Conv.Efficiency	37	37	36	43	25


**Milk solids a cow going up. Soluble end use per hectare going down.** Soluble P use was up at about 35 to 40 and he has decided to cut that out completely which is way better for the environment. He is monitoring trends there very carefully and making sure that his Olsen P's do not drop back down below an optimum level. Operating profit is at a \$6.50 milk price, which is excellent compared with the average. In the last couple of years

N leached seems to be sitting at 28. We are hoping to change to more low protein feeds than palm kernel and get that down to 23 with better dietary management.

## Slide 23

### Reporoa – 26 kg leached. (Pumice)

**Bellvue Farms**



- 3.2 cows/ha
- 45% imported feed- cereals
- 1400 kg MS/Ha
- High degree of feed infrastructure and standing cows off 3-5 hours per day
- Effluent over 30% of farm.
- Low soluble N use (55 kg N/ha)
- No P use, but monitors trends.
- Targeting a lower risk, higher profit system.

**Slide 23** is Bellvue Farms in Reporoa with pumice and they have achieved 26 kgs leached in the last two years. When I first started working with Ian he was in the Upper Waikato study and leaching 31 kgs. It was still a really good result and that is just on the milking platform. 3.2 cows a hectare, 45% brought in feeds as cereal. We have got a high degree of feed infrastructure and high nitrogen conversion efficiency happening here. 1,400 kilos of milk solids per hectare. He is a System 5 in terms of dairy farm systems, intensive, but he has spent the money to get the infrastructure right. He has not got on-going costs for infrastructure improvement and he can run a system that he likes, year in and year out.

## Slide 24

Bellvue Farms – Environmental			
	Bellvue 2009-10	Bellvue 2010-11	Upper Waikato Average (modelled)*
Effluent Irrigation Area (Ha)	60	80 (30% of milking area)	8-10% of milking area
Nitrogen Use kg/Ha	65	55	120-140
Nitrogen leached kg/ha/yr	28	26	50-52 *
N. Conversion Efficiency	36%	38%	27%
Nitrogen Surplus kg/Ha/yr	124	116	185
Phosphorus Surplus kg/Ha/yr	23	23	52

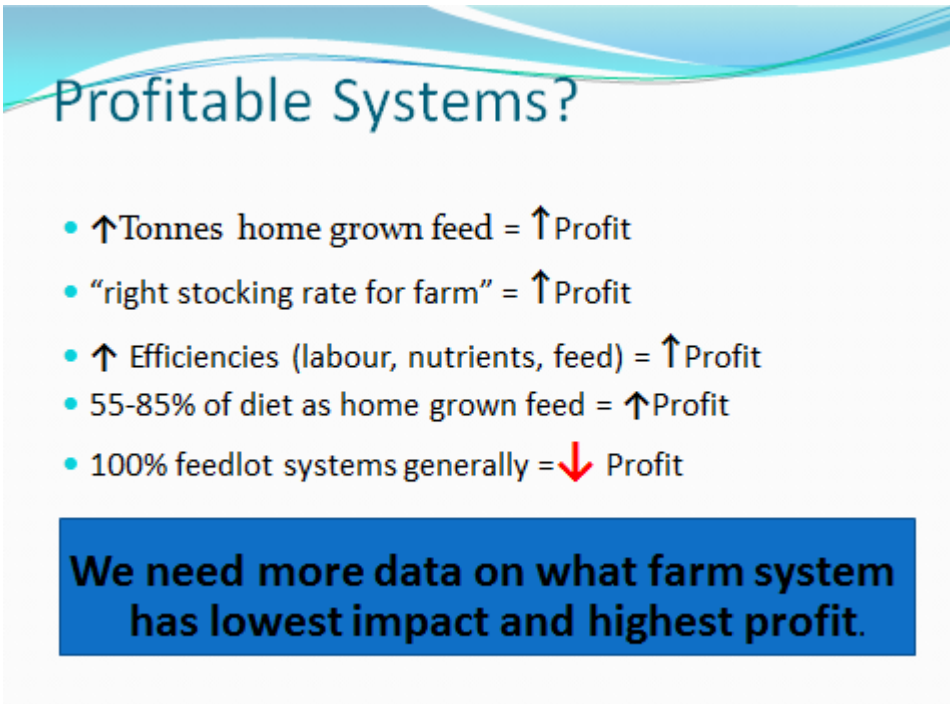
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Effluent use – he continues to spread that over the farm and now up to 30% but going to 40 – 40%. He is not using a huge amount of nitrogen and no P use because the bought in feeds and the recirculation is keeping his soil phosphate at a good level. He wants to do more farm analysis of where his business is and its performance at different milk and feed prices and target a lower risk system but at the same time chase higher profit.

**Slide 24:** The nitrogen use per hectare has been declining and the average for the upper Waikato area as we understand is about 140. Nitrogen conversion efficiency is up at 38%, the average is about 27 and clearly all the other indicators are well below the average. As William mentioned before, you can get a kick in terms of helping the global warming scenario as well. Low greenhouse gas emissions per kilo of milk solids because he achieved higher rumenal efficiency in his cows.

### What do profitable systems look like?

#### Slide 25



**Profitable Systems?**

- ↑ Tonnes home grown feed = ↑ Profit
- “right stocking rate for farm” = ↑ Profit
- ↑ Efficiencies (labour, nutrients, feed) = ↑ Profit
- 55-85% of diet as home grown feed = ↑ Profit
- 100% feedlot systems generally = ↓ Profit

**We need more data on what farm system has lowest impact and highest profit.**

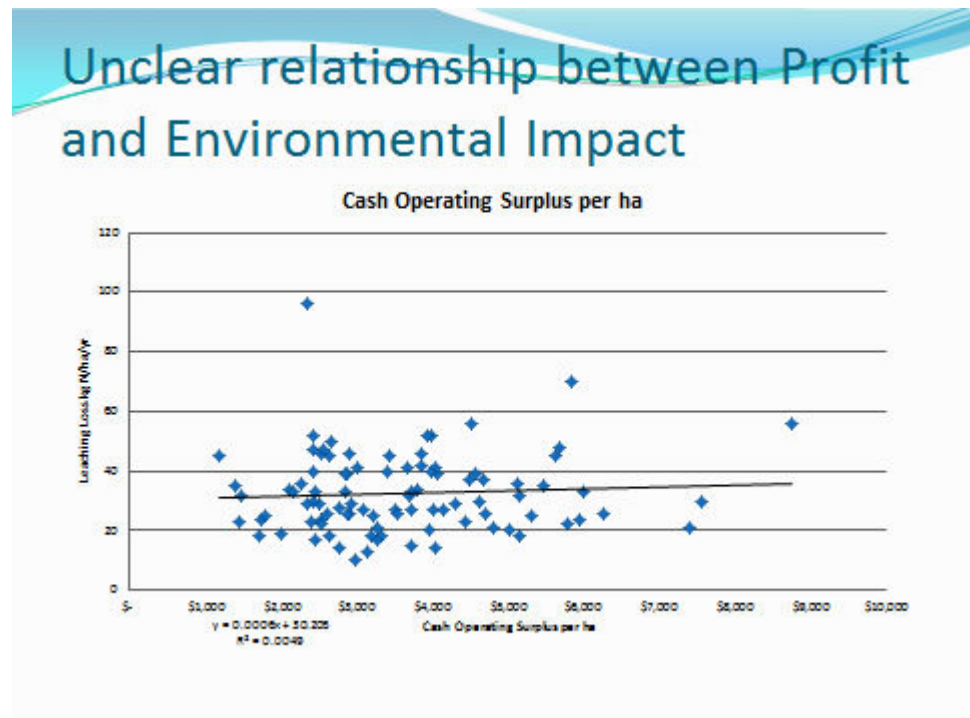
**Slide 25:** There are all kinds of horses for courses but we do know that in a pasture based industry we need to have maximum tonnes of home grown feed to generate high profits. We also need to get the stocking rate right for the farm and follow historical analysis of what that farms does, what has been harvested and what the optimum level of pasture intake is per cow. It is not a one size fits all recipe. High levels of efficiency in labour, nutrients and feeds, and growing as much home grown feed as possible from the nutrients recycling in that system.

There is no doubt that we need more data on what farm system has the lowest impact and highest profit but the good thing is there are some gems amongst our farmers doing an excellent job. We need to better understand what these top guys are doing and that will unlock the secrets for dropping leaching down by 30 to 40%.

**Slide 26:** When I came back from Australia, in between reading the Listener and all this other stuff, I was part of a project for AgResearch and MAF and we analysed 150 Overseer files and looked at the relationship of a number of things. One was the leaching loss in kilos per hectare in relation to the operating surplus and there was no correlation at all. Probably one would not expect there to be but the industry was saying if you constrain

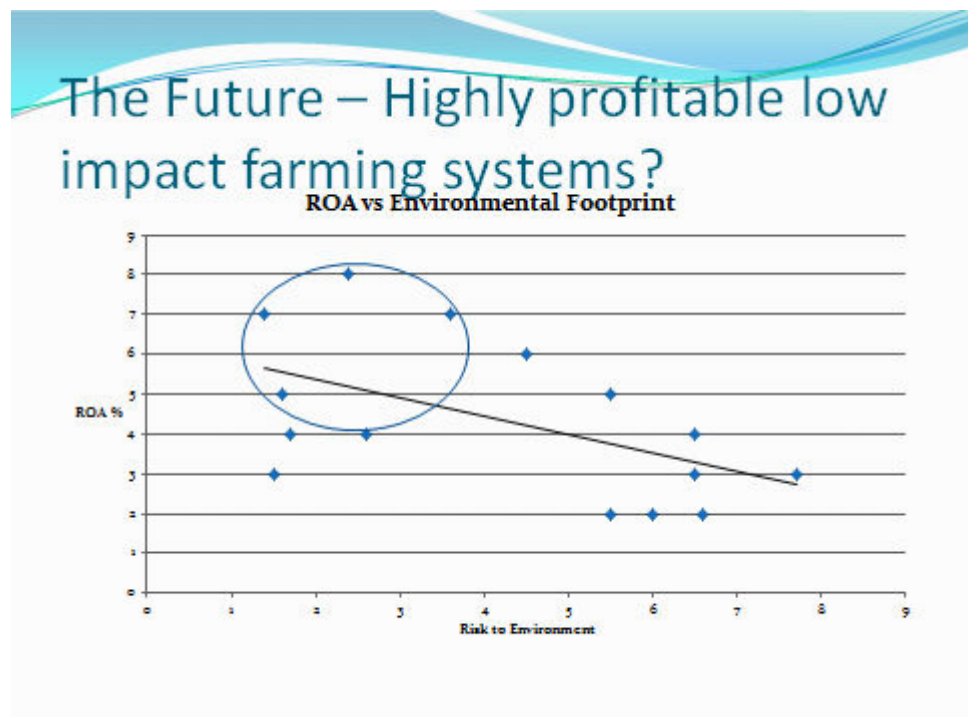
us, in terms of our nitrogen leaching we are not going to be profitable. But maybe there are solutions, we have to work out how to do it and be clearer on who is doing what.

Slide 26



**Slide 27:** The future I believe is that to have high returns we need to be up 9, 10, 12% return on assets. It would be really good to get there but it would be nice to see some more up at 8 and 9% with a low overall risk to the environment. We need to work out how to change and adapt to survive for the future, **because everyone wants to sell or transfer their farm someday.**

Slide 27



*"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change."*

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Thank you.

Three further slides not presented by Alison but in her PowerPoint may be of interest to readers.

### Slides 30, 31, 32

These slides represent the increase in knowledge, and the extension process that is associated with nutrient use efficiency at farm level. Nutrient budgets are the most basic format of the farms nutrient flows. Nutrient plans take into account nutrient flows, but not whole of farm system approaches.

#### Slide 30

Slide 30 is titled "How do lower protein feeds work?". It features two colored boxes. The left box is light blue and contains the text: "The use of lower protein feeds – to better match cow requirements. For Example – cereal based feeds, molasses or tapioca." The right box is light green and contains the text: "100% grass diet provides around 25% crude protein all year round. Cows only require around 16-17% crude protein all year round."

As extension providers, and practitioners, we have realised that if we are to manipulate nutrient usage at farm level, to do it properly, economically and give robust advice, we must take into account – the whole of farm system.

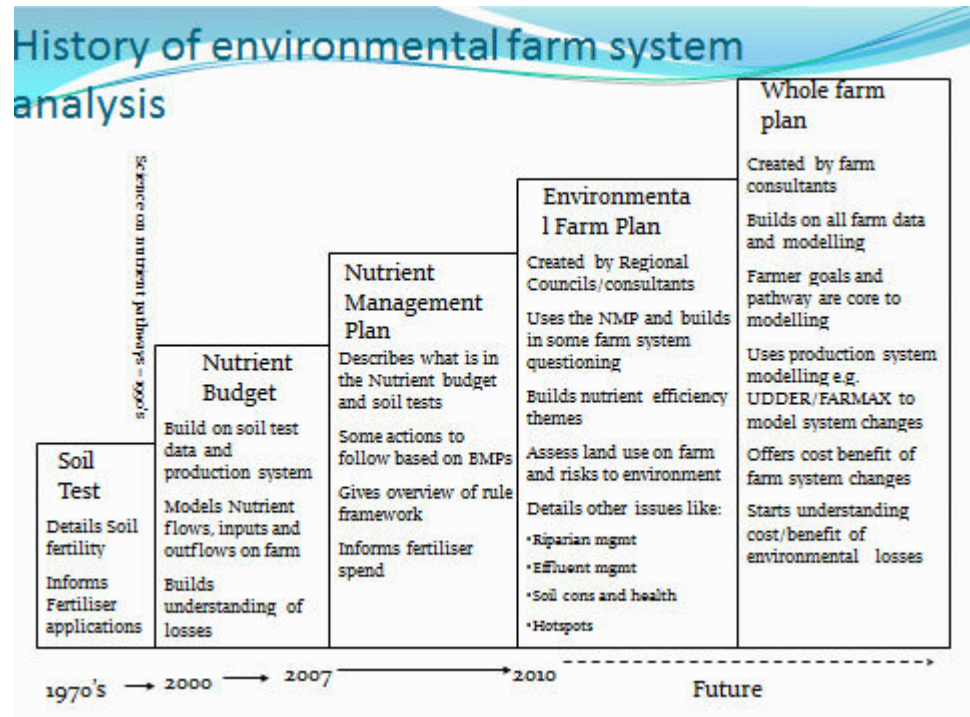
#### Slide 31

Slide 31 is titled "Urinary N excretion in NZ dairy COWS" with a subtitle "(ref. J Burke Massey 2009)". It contains a table comparing four feeding regimes: Pasture, Pasture Only Diet, Pasture + 25% maize silage, and Pasture + 45% maize silage. The table lists four metrics: Mean dietary protein, Dietary N intake (g/day), Urine N(g) excreted per day, and Energy cost in managing extra urea (litres lost per cow per day).

Pasture	Pasture Only Diet	Pasture + 25% maize silage	Pasture + 45% maize silage
Mean dietary protein	26%	22%	17.5%
Dietary N intake (g/day)	711	594	478
Urine N(g) excreted per day	403	294	179
Energy cost in managing extra urea (litres lost per cow per day)	9.8 Megajoules (2 litres milk lost)	5.9 MJ (1 litre milk lost)	2 MJ (0.5 litre)

If we tweak nitrogen applied in the farm system for example, it is likely we are tinkering with the farm's feed supply, hence this becomes a values, economic, and farm system decision on alternative choices.

Slide 32



Farmers may need to take on the services of a specialised consultant, in order to get the most appropriate advice, for their business in the future.

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## THE PASTORAL SECTOR'S CONTRIBUTION TO WATER QUALITY IMPROVEMENT IN LAKE ROTORUA

**Dr Tanira Kingi**

Rotorua Primary Sector Collective  
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*Tanira Kingi is a Science Advisor with AgResearch Ltd, based in Palmerston North. He has PhD in agricultural economics and development from the Australian National University and is currently managing a number of research programmes around the country looking into land use change, environmental impacts from the pastoral agriculture and vertical integration in the agribusiness sector. Prior to his appointment with AgResearch, Tanira was with Massey University's Agricultural Systems Management group from 1995 and has published widely on Māori land tenure and Māori agricultural development. Tanira is from Rotorua and is affiliated to Ngati Whakaue, Ngati Uenukukopako, Ngati Parua and other Te Arawa hapu that surround Lake Rotorua. He grew up in Ohinemutu, on the shores of Lake Rotorua and worked in Rotorua's forestry and sawmilling sectors in the late 1970s and managed a kiwifruit orchard on the eastern shores of Lake Rotorua in the 1980s before starting work with MAF Agriculture NZ in Palmerston North as a policy consultant in the early 1990s.*

*Tanira currently holds directorships with Agriculture ITO and the NZ Qualifications Authority and is currently the chair of Waerenga-Pukahukiwi Ltd, the largest dairy farm in the Rotorua Lake's catchment. He has recently been appointed Chair of the Rotorua Dairy Collective.*

### ABSTRACT

The Rotorua Dairy Collective has twenty two dairy farmer members and is currently in discussions with dry stock farmers and Māori landowners within the Lake Rotorua catchment to develop a collaborative arrangement to find common solutions that will reduce nutrient discharge rates from the pastoral sector into Lake Rotorua. The Collective, in collaboration with DairyNZ, AgResearch, Federated Farmers and the Māori Trustee, are working closely with the Bay of Plenty Regional Council to develop a research and development programme over the next few years. This programme will result in reduced N from farmers while maintaining the viability of the catchment's primary industry sector's contribution to Rotorua's economy. Tanira will outline the programme in his presentation.

### TRANSCRIPT

Thanks Graham, and I also want to thank John and the rest of the LakesWater Quality Society for inviting me here today. There has been a change in the title of the paper from the Dairy Collective to the Pastoral Sector Collective. This has largely been the result of discussions over the last few months bringing other land owners in the catchment into the Rotorua Collective, which is being formed, hopefully by the end of this month. These discussions started early last year, mainly among dairy farmers, but have now extended through to dry stock farmers.

There are twenty two dairy farmers in the catchment and roughly 59 dry stock farmers with over 50 hectares. That number is a little uncertain, I have a different number from the Regional Council but 59 over 50 hectares came from Federated Farmers. There is also the Maori Trustee who administer 3,000 hectares.

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**Slide 2:** The intention was to put together a group with wider interests in the catchment looking at a collective response across land use practise and land use change. The collective is supported by AgResearch, DairyNZ, a major funder in its activities, the Maori Trustee and Federated Farmers. I have been involved in the collective since late 2010.

**Slide 2**

## Rotorua Pastoral Sector Collective (RPSC)

- Dairy farmers: 22
- Drystock farmers: 59
- Maori Trustee: 3,000ha



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DairyNZ

MĀORI TRUSTEE

FEDERATED  
FARMERS  
OF NEW ZEALAND (INC)

The purpose of the Collective was to establish collaborative relationships between farmers, land owners, industry organisations, research institutes, the Rotorua community and Regional and District Councils, to ensure that land use practises and land use change met water quality expectations while maintaining the viability of the catchment's primary sector producers.

That is a big ask and quite a challenge. There is agreement among the Collective Governance Group that to achieve enduring change, in addition to forming the partnerships, it needs to be underpinned by two things. One is a focus on common outcomes and not single solutions which cause views to become entrenched and breakdowns in communication. The focus then is on common outcomes. The second point is to agree on processes to define the problems, prioritise the actions and allocate resources to produce information and mechanisms that can result in enduring solutions or solutions that work. I will talk more about the information and the mechanisms later.

Although the Collective has not formally been established it has already got a few things ticked off. One is that last year there was 100% dairy farmer compliance with Regional Council's environmental nutrient management requirements for 2010. All dairy farmers in the Collective elected permitted activities and now comply. They have clear ceilings to work towards getting their key indicators moving in the right direction.

The benchmarking process based on the 2001/2004 data is underway in an agreement with the Regional Council. That process includes the collection of data, how it is collected and stored, the Overseer runs and the nutrient emission targets. This process allows the Regional Council to hand out permitted activities and benchmarks for those farmers.

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There are also discussions underway within the Collective members on the group consent process.

**Slide 3:** These are photographs of the Kaipara Harbour, the Manawatu River with cows walking in it and the Waipa River. One of the advantages of the Collective is its linkages with DairyNZ and AgResearch and other research programmes. One particular programme, Clean Water Productive Land, started last year in collaboration between AgResearch, Landcare Research, NIWA and ESR looks at predicting the concentration loads of water quality contaminants including nutrients and other nasty's into fresh water.

**Slide 3**

## Advantages of the Collective

□ Links with other research programmes:

- Kaipara Harbour
- Maniapoto (Waipa River)
- Manawatu River
- Hurunui River



One of the useful tools being developed is the stock movement models to identify 'hot spots' on farms and when applying nitrogen inhibitors like DCD's, they can be targeted to reduce the cost and increase their effectiveness.

I want to go through our work programme for the Collective. There were two broad categories. One is reducing N leaching through management practice change, and these include reducing N fertiliser, increasing wintering off, reducing stocking rates and increasing production efficiencies.

*"...it is noted that to enable sound and transparent decisions to be made by farmers and policy makers, it is desirable to have more reliable estimates for farm profitability and nitrogen losses associated with the adoption of nutrient mitigation options."*

Quoted from Amy Taylor and Simon Parker on the cost-effectiveness analysis of grazing management options for Rotorua dairy farms. Environment Bay of Plenty (2007/7)

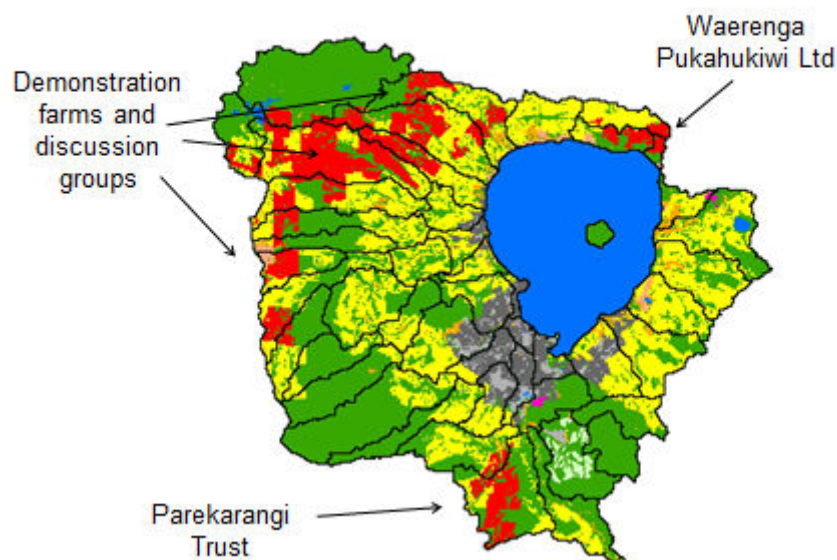
It is about the role information plays to enable farmers and policy makers to make reliable estimates for farm profitability and nitrogen losses.

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What has struck me in the last couple of years is the volume of information that has been produced on Rotorua. There is no issue about the quality and quantity of the information. Where things do break down is in the reliability and accuracy of that information and its relevance to farmers and the ability of farmers to be able to test and trial the recommendations that come out of those reports. An important role of the collective is to be able to work with farmers to do just that.

**Slide 6:** I want to acknowledge Kit Rutherford and Chris Palliser for this slide. It comes out of the ROTAN model and shows (in red) where the dairy farms are in the Rotorua catchment. Waerenga Pukahukiwi Ltd is the incorporation, or joint venture between two incorporations, that I chair. It is the largest dairy farm in the catchment, milking 1,200 cows. The second largest incorporation is Parekarangi Trust which is 9 kms south of Rotorua, but connected to the lake through a stream. They milk about 800 cows. The bulk of the other farms in the catchment are off to the west of Lake Rotorua.

### Slide 6



The Collective is doing three things. One is to establish a monitor farm on Parekarangi Trust, led by Dr Stewart Ledgard's team from AgResearch. Field trials will be set up to measure the biophysical responses to intervention strategies and also critical management changes, i.e. pasture response rates to reducing N applications. We need more information to improve our Overseer runs.

The second part is to model these farms. There are a couple of stages to that; one is to do base models of the farms. The farms have been modelled in Overseer but they have not been put into a farm simulation package where we can look at options for reconfiguring the farm and looking at the impacts on farm profitability and productivity. The third part of the work programme is establishing discussion groups which I will get to a little later.

**Slide 7** is a fictitious farm. We have modelled the dairy farms in the Collective using a linear programme. It optimises the farm for different constraints you want to put, either productivity or maximising productivity and minimising nutrient loss. This data was based on an actual farm but I have doctored the figures which are indications of trends of

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**Slide 7****A FICTICIOUS DAIRY FARM**

	BASE FARM	OPTIMISED	CHANGE
Cows	460	400	-13%
Milk Solids/cow (kg)	380	380	N/C
N applied per hectare	160	45	- 70%
Supplements made (tons)	0	50	+ 50
Supplements bought (tons)	250	60	- 75%
Total MS/ha (kg)	175,000	150,000	- 15%
Income	1,150,000	980,000	- 15%
Costs	650,000	500,000	- 25%
<b>Surplus (\$)</b>	<b>500,000</b>	<b>480,000</b>	- 4%
<b>N leached (KgN/ha)</b>	<b>50</b>	<b>30</b>	- 40%

movement. There is a reduction in cow numbers by 30%. The milk solids per cow stay the same so productivity per cow is kept constant. N application per hectare drops from 160 to 45. There is a shift to making maize silage and a reduction in buying in supplements and a lot of that was Palm Kernel Expeller. The total milk solids per hectare show a reduction of 15% and a reduction in income of 15%. However, there is also a reduction in the costs associated with lower cow numbers, but the surplus is lower than \$20,000 per hectare, or a drop of 4%. In some ways there is a neutral outcome, with a slight decrease in profitability. But the major change was a 40% reduction in nitrogen leached.

**The question is – Is it achievable?**

This is a model. It is based on an actual farm which we are reconfiguring. It has come out with quite a dramatic drop in N leaching, but what the farmers need at this point are management plans so they can test these scenarios. We will be doing that by running the outputs of the linear programme models into farm charts and then apply Overseer to put together farm plans to think and work through to understand what is involved and the associated risks.

One is that the reduction in cow numbers requires a higher capability in management to monitor feed surplus. You must keep the pressure on pastures to maintain quality so management expertise needs to improve. The reduction in N needs to be better targeted and this is why we are doing biophysical tests with Stuart Ledgard on the monitor farm. The soil type is different within the catchment and we have seen a reduction in the aggregate N leaching across the 22 farms by adjusting the soil types, for example, yellow brown loam or Mamaku pod soils reduce N leaching by 3 to 4 kilos a hectare compared to some of the ash soils.

If you adjust the model to the local situation and put the correct soil types in there is a more accurate figure. The important point here is the need for base line information to be tested out in the field.

This is where **discussion groups** are important. We are setting up two or three within the catchment to test the tools and efficiency of the technologies and their effectiveness. A key part of this is building the capability of farmers collectively to test out these ideas and see if the practice works to bring about change.

**Slide 9:** The second area of options is **system reconfiguration**. This requires investments in infrastructure - feed pads, stand off or wintering pads, herd homes and a reduction in part of the farm. It also includes expansion of effluent storage.

Slide 9

## Options for reducing N leaching

### 2. System reconfiguration

Investment in:

- Feed pads
- Stand off or wintering pads
- Herd homes
- Reduce/retire part of farm



Source: Taylor and Park (2007)

agresearch

DairyNZ

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FEDERATED FARMERS OF NEW ZEALAND UNIO

In the Collective now approximately 30% of the dairy farmers have invested in extensive effluent storage and feed pads. That is a large number of farmers within this catchment digging into their own pockets to make sure they are increasing the feed efficiency of the system, but also doing their best to reduce N loss. On the farm I chair, over the next two years, we are looking at spending around \$300,000 on effluent storage and a feed pad.

I want to finish off with a quote from Dave Clark of DairyNZ in the presentation he did around the country about “Reducing the environmental impact and increasing the economic contribution of dairy farming” -

*“The only current and medium term option to achieve targets is ‘**system redesign**’ - an integrated change in many factors that constitute a dairy farm”.*

For those farmers that can get down from 50 to 40, or 50 to 35 through practice change and doing things better and smarter, that may be the limit. To go further and get an extra drop may mean in some cases a complete system redesign and a significant investment in infrastructure.

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**Slide 11:** The Governance Group.

**Slide 11**

## Establishment Governance Group

- Tanira Kingi (dairy farmer/AgResearch - chair)
- Giselle Swiezer (dairy farmer)
- Robbie Moore (dairy farmer)
- Lachlan Mackenzie (dairy farmer/Fed Farmers)
- Stuart Morrison (dairy farmer/Fed Farmers)
- Neil Heather (drystock farmer/Fed Farmers)
- Tina Ngatai (Maori Trustee)
- Hera Naera (Maori Trustee)
- Denis Collins (DairyNZ)
- Mike Scarsbrook (DairyNZ)



Thanks very much.

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## LAKE ROTORUA RESTORATION: RESULTS IN THIS GENERATION

### Andy Bruere

Lake Operations Manager, Bay of Plenty Regional Council  
Rotorua  
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*Andy Bruere is BOPRC Lake Operations Manager. In the role he is responsible for managing the implementation of all in-stream and lake projects to protect and restore the twelve lakes within the Rotorua Lakes Programme. This includes obtaining resource consent for many projects as well as developing relationships with key people and groups within the community. In this role he is supported by a team of scientist from the council as well as the University of Waikato and other CRI's including NIWA and GNS.*

### ABSTRACT

Bay of Plenty Regional Council is a partner with Te Arawa Lakes Trust and Rotorua District Council in implementing the Strategy for the Lakes of the Rotorua District. The partners have been working together for over ten years to sequentially develop and implement actions to protect and restore twelve lakes within the district. A number of these lakes have progressively become eutrophic while others are at risk of declining water quality due to inputs from land and human waste water in their surrounding catchments. The programme is underpinned by a significant science and research effort, which includes the University of Waikato and other Crown Research institutes.

A key feature of the programme is that each of the twelve lakes has different individual water quality targets based on natural influences and community aspirations. These targets are written into Regional Planning documents and form the basis for research and protection and restoration actions.

The programme is well progressed into the implementation stage and the results of research and actions are becoming apparent. The level of complexity in meeting community water quality standards for each lake is dependent on the features of individual lakes and how they have been impacted by human activities in the past. Some interventions will take a significant time, perhaps 10 to over 100 years to be reflected in improved lake water quality due to ground water time lags. A number of interventions are designed specifically to provide a more rapid response in water quality. The presentation will focus more specifically on the short to medium term interventions and how these are starting to improve water quality.

### TRANSCRIPT

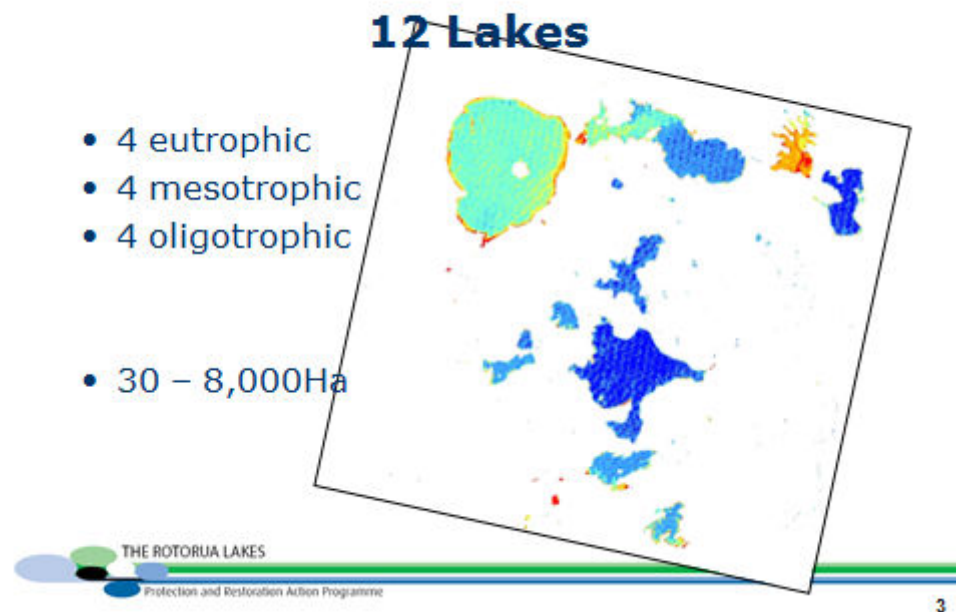
Tena Koutou Katoa, thank you Graham for those kind words. I understand being the last speaker today I better get a move along because we will be cutting into drinking time. A lot of things in my presentation have actually already been said today by some of the scientists that came before me. It is not surprising that they have already covered these things before me because they are advisors to our programme. We are using their science information to make decisions and get direction on what projects we should be implementing on our lakes programme.

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The title of my presentation is 'Results in This Generation' and that relates to this generation paying for restorative measures at the moment. They are going to be a little bit disappointed if it takes another one hundred years before we see our lakes improve. Bill Bayfield said this morning eleven of those twelve lakes are not that complicated. We know the interventions that we need to take water quality in the right direction. In a number of them we have already proven that we can do it. The really challenging lake is Rotorua and I will show you what we are doing to get results in this generation.

By way of introduction my presentation will give background information on the state of our lakes. Where those nutrients come from for Lake Rotorua, and then we will talk about the short and long term interventions, particularly what has already been achieved and our next phase.

### Slide 3



**Slide 3:** Our programme is around twelve lakes in the Rotorua district. We started with four eutrophic lakes, four mesotrophic and four oligotrophic. It has changed slightly with improvements to Lake Rotoiti, but I would like to point out that there is a range of different water qualities in the lakes. Our objectives in terms of improving those lakes are still to be achieved. They will not all be pristine oligotrophic lakes when we finish. Some will be and we are trying to protect them. Some will remain as mesotrophic lakes and there will be at least one eutrophic lake if it meets the objective of the land and water plan.

The little red dot at the bottom is Lake Okaro, our smallest lake of 30 hectares. There is a range of lake sizes right through to Lake Rotorua which is 8,000 hectares. It means that experiments can be made with smaller lakes, scale them up to medium sized lakes, and eventually apply those techniques to large lakes like Lake Rotorua of 8,000 hectares.

### What is the problem?

**Slide 4:** Essentially this is the problem. We do not want a whole lot of lakes that look like Lake Rotoiti in 2003 and the problem was too many nutrients in the lake causing a terrible algal bloom.

#### Slide 4

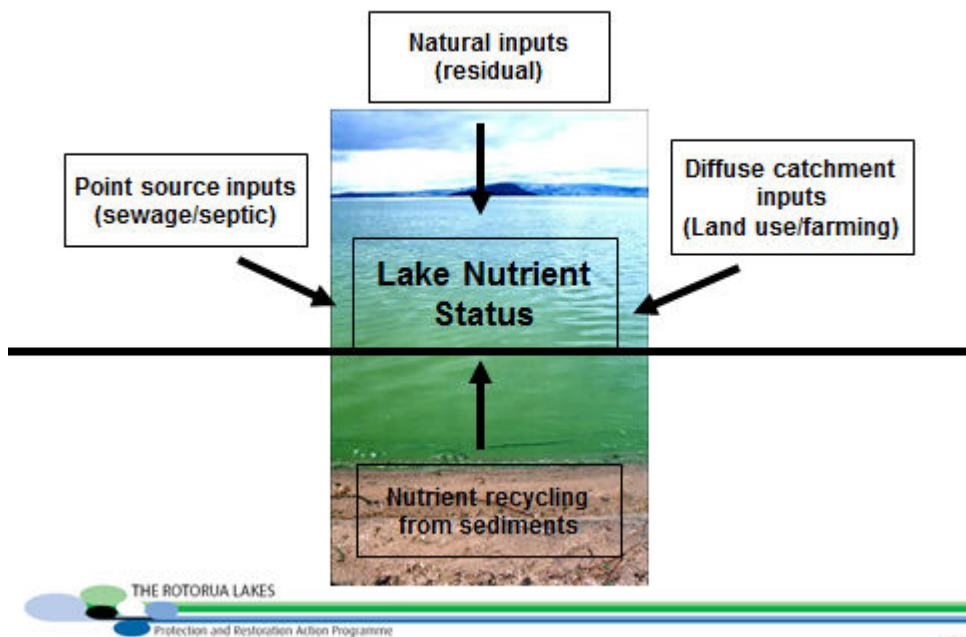


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#### Where do the nutrients come from?

**Slide 5:** When you talk to the community they all know where nutrients come from. They come from sewage and farming. Not many people recognise that there are a lot of natural inputs to our lakes and even fewer people realise that there are a lot of nutrients recycling out of the lake bottom. Things that have happened for the last one hundred years have ended up at the bottom of the lake and these recycle back into the water column and cause problems today.

#### Slide 5



5

**Slide 6** shows where nitrogen and phosphorus in Lake Rotorua come from. Peter Skelton talked about Taupo and nitrogen. In the northern hemisphere people do not talk about nitrogen in lakes, they talk about phosphorus. One school of thought says we should be addressing phosphorus inputs. In Taupo they address nitrogen inputs, but the technical advice for our programme is that we need to address both nitrogen and phosphorus. There are different ways of approaching eutrophication in lakes around New Zealand and the rest of the world.

## Lake Rotorua Inputs

**Slide 6**

	Nitrogen inputs t/yr	% of nitrogen inputs	Phosphorus input t/yr	% of phosphorus input
Forest and bush	70.5	9	2.26	6
Pasture	580	74	17.49	44
Lifestyle and urban	61	8	4.32	11
Springs and geothermal input	42	5	14.4	36
Rainfall	29.2	4	1.33	3
Sediment releases	360	NA	36	NA



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74% of nitrogen is coming from our pasture catchment and 44% of our phosphorus. When talking to our city slickers they say, "Well why don't you just go out and sort it out, get it out of there straight away".

I will explain why in a moment with the graph, but I think Kit Rutherford has probably explained that satisfactorily too. It is not as simple as being able to 'get it out straight away'. In the meantime there are other significant sources of nutrients such as 36% coming from geothermal and springs.

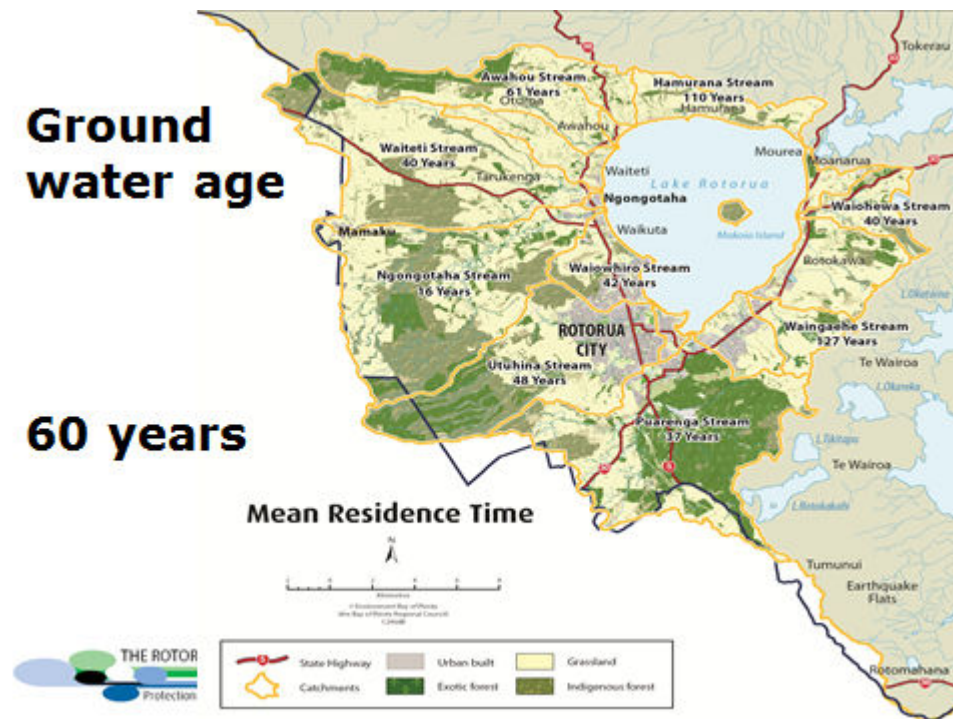
We can also point the finger at lifestyle and urban blocks but they are relatively low. It does not mean we do nothing there; in fact we are working on reticulation of urban sewage from satellite parts of Lake Rotorua and other communities around the lakes. Even if you convert to forestry or bush there is still going to be nitrogen and phosphorus residual input.

The bottom line is the sediment releases. I have not put a percentage because it is not an input from the catchment. Professor Hamilton described the release of nutrients from the bottom sediments this morning as lakes become anoxic in the bottom waters. In Lake Rotorua we could be releasing up to 360 tonnes per year of nitrogen and 36 tonnes per year of phosphorus, which is equivalent to all the phosphorus coming from the catchment.

**Slide 7** is a diagram that Kit Rutherford used this afternoon. We often thought that some of these catchments with younger ground water, say sixteen years, were the ones we should be targeting, but Kit explained perhaps why we should not be targeting them. He

mentioned Waingaehe Stream with 127 years ground water age, pretty old ground water. In fact, from what he has described, the beauty is that it gives us some breathing space. It means that the freight train of nitrogen is not coming as fast as we were expecting, and there is a chance that we can make these improvements through land use change quicker than we were initially predicting or expecting.

Slide 7



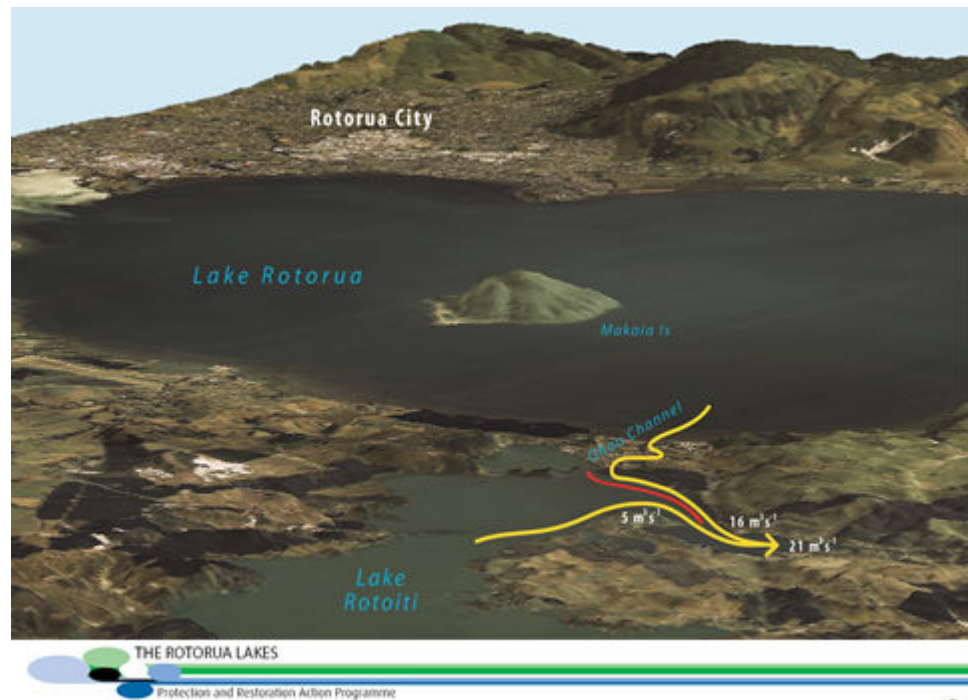
**Slide 8:** One of the first interventions we undertook is the diversion wall on Lake Rotoiti. We put this 1.3 km wall in because Lake Rotorua (**Slide 9**) has a significant issue around land use with large amounts of nutrients flowing through the outlet of Ohau Channel. Prior to the diversion wall it all flowed into Lake Rotoiti. That carried about 80% of the nutrients into Lake Rotoiti and caused the eutrophication problems shown in **Slide 2**.

The diversion wall is now taking that nutrient down the Kaituna River. People criticize us, watching the impact down the Kaituna River. You would be hard pressed to disagree; it is not a satisfactory long term solution because the diversion wall will last fifty to one hundred years and is only a temporary solution. But it does give us some breathing space to protect Lake Rotoiti while we address the issues around Lake Rotorua.



*Rotorua Lakes 2011*

## Slide 9



### What are we doing to address the issues on Lake Rotorua on the short term?

**Slide 10:** We have undertaken the construction of two phosphorus locking plants. These are plants which dose alum into streams carrying relatively high phosphorus loads, removing two tonnes of phosphorus per year out of the Puranga and Utuhina Streams. It is simply an alum storage tank with all the appropriate bunding requirements. Inside is a metering mechanism for pumping alum down a line carrying water through to the Puarenga Stream over the back of the Rotorua sewage treatment plant.

## Slide 10

### P locking plants

- Alum dosing
- In-stream
- 2 T per year P removal
- \$250K capital
- Puarenga/  
Utuhina



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They are relatively cheap plants to build, around \$250,000 capital, but are relatively expensive to run at around \$400,000 to \$500,000 a year in chemicals. However alum seems to be the only product that you can buy now that is reducing in price. It was over \$400 per tonne last year, now \$330 per tonne this year, so good news for our programme. Alum is a very common lake treatment chemical overseas, particularly in North America and Europe. In a lot of locations it is dosed directly into the lake water to lock up phosphorus in the water column and assist in locking up phosphorus released from lake bed sediments.

**Slide 11:** Tikitere is an interesting situation. There is a geothermal input which flows down the Waiohewa stream and into Lake Rotorua. It carries about 30 tonnes of nitrogen per year in a relatively small flow. In terms of the target, 30 tonnes of nitrogen out of the catchment is worthwhile because it is about 10%.

### Slide 11

**Tikitere**

- Geothermal N input
- 30 T N per year
- Pilot plant
- Off-stream de-nitrification
- Long term treatment design



THE ROTORUA LAKES  
Protection and Restoration Action Programme

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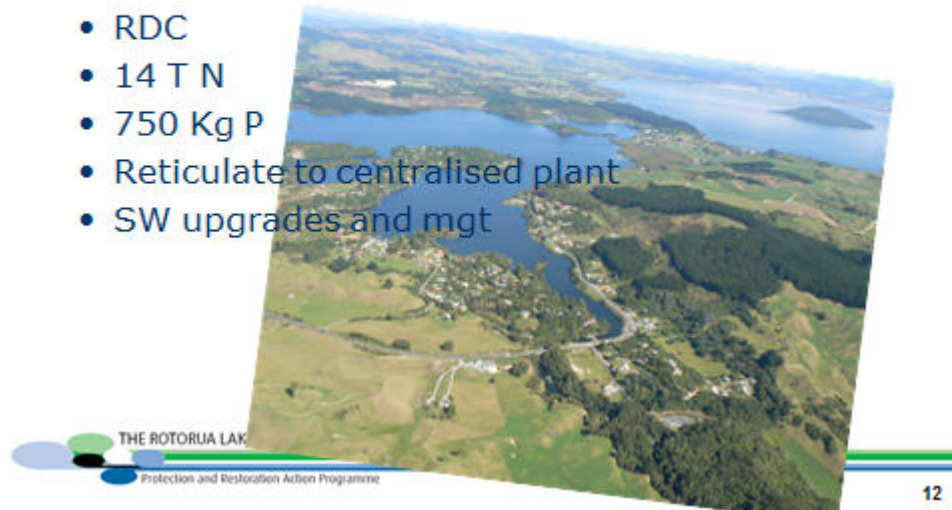
We have commissioned a pilot plant and are optimising the performance to see how to use off-stream de-nitrification as a long term treatment and develop the design parameters for a long term treatment plant in that location. The processes are nitrification, pH balancing and then de-nitrification through a wood chip bed. The wood chip is a carbon source to drive the chemical process.

### Sewerage reticulation and urban storm water

**Slide 12:** Sewerage reticulation and storm water treatment is managed by the Rotorua District Council. They are a partner in our programme of lake restoration along with Te Arawa Lakes Trust. Around Lake Rotorua itself reticulation and improvement in storm water handling has got the potential to remove about 14 tonnes of nitrogen and about 750 kilograms of phosphorus. That is reticulated to a central sewerage treatment plant. This slide is Lake Rotoiti and the Okere arm and these types of communities will be reticulated into the central plant in town and treated before discharge into the forest.

## Sewage Reticulation and Urban Stormwater

- RDC
- 14 T N
- 750 Kg P
- Reticulate to centralised plant
- SW upgrades and mgt



There has been an upgrade of storm water as well as changes to management in terms of street sweeping and road cesspit management. Another proposal in our Ten Year Plan, and within the government funding deed for our programme, is the diversion of a high nutrient flow. The Hamurana stream has been identified which is spring fed. It is in a very small surface catchment and you would think the clear, cold water was pollution free. However that stream carries about 60 tonnes of nitrogen per year into Lake Rotorua and this is going to increase to over 100 tonnes within the next fifty to one hundred years. It also carries about 6 tonnes of phosphorus. There has been a proposal to divert this stream directly into the Ohau Channel and get that amount of nutrient out of the lake.

There are clearly going to be cultural and community issues to get resource consent to undertake such a project and we are looking very carefully at the science before we embark on any such discussion. Professor Hamilton has undertaken modelling work to look at the effect of that, alongside other interventions, to see the benefits. I would mention here that a diversion like that has the benefit of removing these nutrients, but when you undertake a diversion you also take away the beneficial effects that water may have brought to Lake Rotorua. Professor Hamilton has advised us that by taking away the Hamurana stream water you may be taking away well oxygenated, colder water which travels along the bottom of the lake and assists in preventing part of the lake becoming deoxygenated. Therefore more nutrients may be released from the bottom of the lake as a result. So the jury is still out on that one before we make any decisions to go ahead with that proposal or not.

**Slide 14** is here because I was sure there would be some accountants in the audience and it has numbers in it, but just in case you are not accountants it has colours and smiley faces. This is the relative cost of interventions per kilogram of phosphorus and nitrogen for what we have already undertaken. The Ohau diversion wall is very high value in terms of achieving reductions of nutrients at a low cost and deserves a smiley face. The other two green ones, de-nitrification, if it works out as we expected, and weed harvesting for removal of nutrients, also both get a smiley face.

Slide 14

## Relative cost of interventions

Project	Nutrient	P \$per kg	N \$ per Kg	
Ohau Wall	N + P	65	8	☺
Alum dosing	P	210	NA	☺
Sewage	N + P	2000+	553	☹
De-nite	N	NA	19	☺
Weed harvest	N + P	130	20	☺
Hamurana	N + P	330	15-33	



14

Alum dosing gets a smiley face but is a little more costly and only addresses phosphorus. I do not have anything beside the Hamurana diversion because I do not want to get too excited at the moment until we see the science. Sewage is there in red and I did not want a sad face beside it is a very important component of improving lake water quality. When people see numbers that say how effective something is per kilogram they want us to do all of that and nothing else because it is the cheapest way of doing everything. But the reality is the whole restoration programme will rely on a combination of a lot of different things, because we cannot do all diversions or all alum dosing. These things need to dovetail together a little bit.

I would like to point out that if you get too fixated on the lowest cost and do not try something a little more costly you can miss out on recognising the co-benefits of a certain intervention. I will tell you about that on a slide further along.

Slide 15

## Nutrient from sediments

- Capping
- Aeration
- Dredging



15

**Slide 15:** The next thing to do, looking towards the future, is to address nutrient releases from sediments. In this diagram of Lake Rotorua the red colour depicts the area of the lake greater than fifteen metres deep where most of the nutrients are released from when the lake stratifies for short periods during the summer. David Hamilton spoke about stratification so fortunately I do not have to explain that.

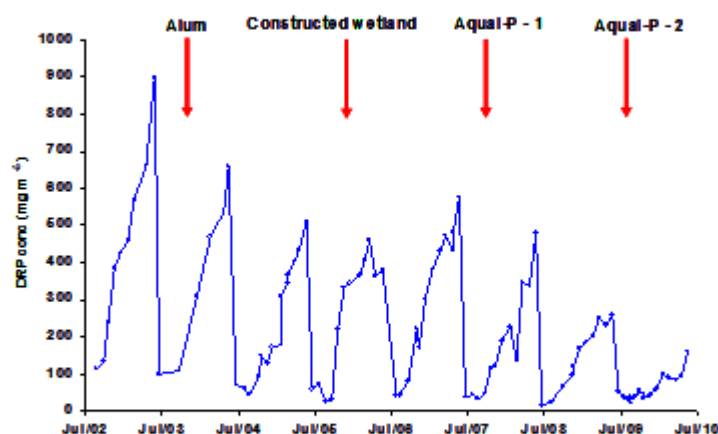
This is the area of the lake that we would treat if we were trying to address nutrient releases coming from the sediments. The obvious options to test out are capping, aeration and dredging. I will explain capping shortly. Mayor Frank talked about dredging lakes in Sweden, and it is feasible but costly. It is likely to be most useful on very small lakes because there are problems with the logistics of the dredging exercise itself, the cost and then dealing with the material taken out of the lake.

We have done a lot of work on sediment capping and chemical treatments to try and stop nutrients coming out of the bottom of the lake. In 2009 on Lake Okaro we applied a modified zeolite by barge, and the objective was to collect phosphorus in the water column as well as settle to the bottom and stop phosphorus from releasing nutrients and the sediments mixing in the water column.

**Slide 17:** That has been pretty successful. The graph shows dissolved phosphorus concentrations in the bottom waters of Lake Okaro over time. Starting in 2003 we did a small alum dose and then two Aqua P doses in 2007 and 2009. The phosphorus levels start almost immediately to drop down. Last season was the first year we had no algal bloom in Lake Okaro for about twenty years. However we had an algal bloom in Lake Okaro at the beginning of this summer so we are interested in what is going to happen next year and subsequent years. Have we done enough or do we need to add more sediment locking agents to continue trapping phosphorus?

## Slide 17

### Field application results: P release from sediments

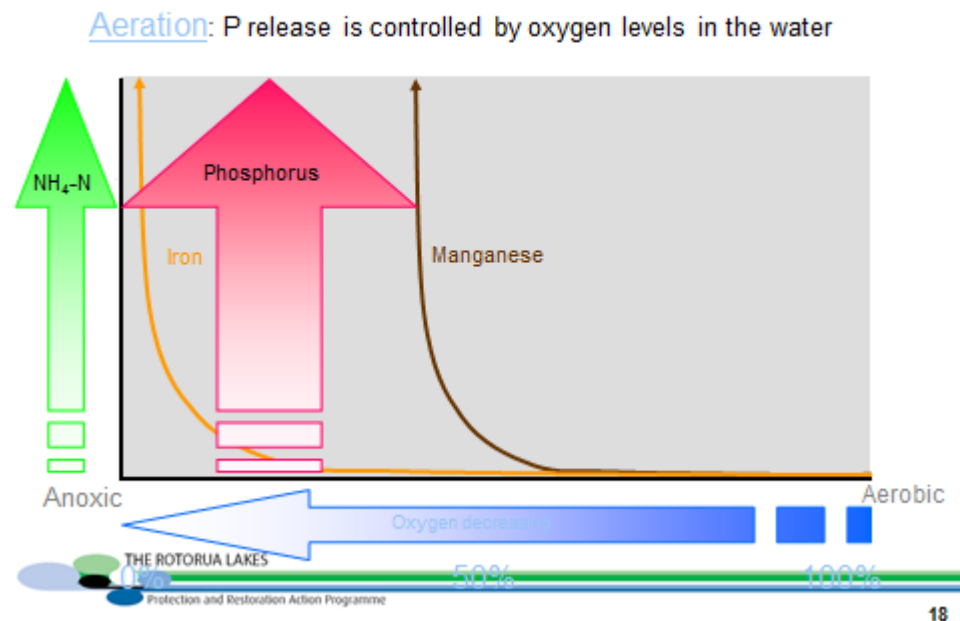


Lake Okaro data from EBoP  
THE ROTORUA LAKES  
Protection and Restoration Action Programme

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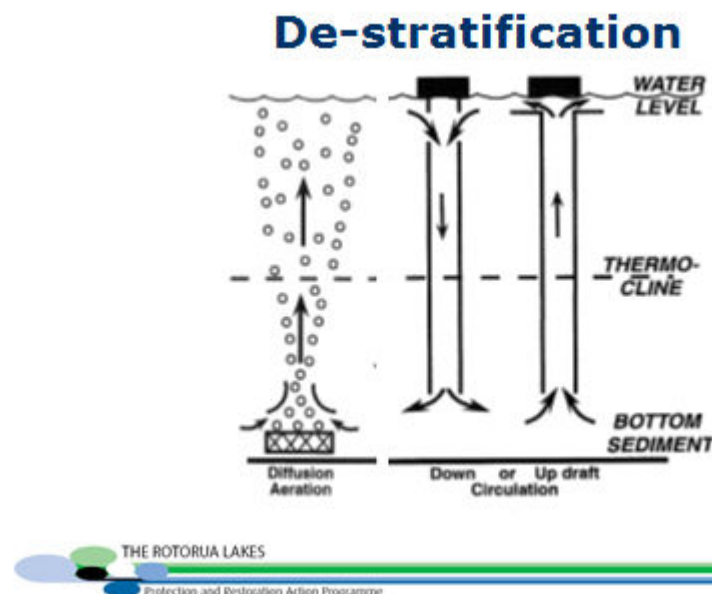
**Slide 18** is another process looking at aeration of lakes. As a lake loses its oxygen it starts to release nutrients. When the lake oxygen concentration gets to about 50% of saturation it starts to release phosphorus associated with manganese and then further down, around about 2 or 3 parts per million dissolved oxygen, iron starts to lose its phosphorus. So the secret to all this is to never let the bed of a lake become anoxic and then you have no problem with releases of nutrients from the sediments.

## Slide 18



**Slide 19**: We have looked at reversing the process of stratification for shallow lakes like Rotoehu or Rotorua. It is not a process recommended for deep lakes like Rotoma or Tarawera. There are a few different techniques of de-stratification. You can pump in air at the bottom of the lake through a diffuser and air travelling up through the water column will mix the water and bring the colder water from the bottom to the surface starting a rotation of water in the lake, bringing aerated water into the areas which are deoxygenated. You can also do this with machines that pump water up and down with a fan device.

## Slide 19



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We are looking at undertaking this project on Lake Rotoehu, a shallow lake which behaves similarly to Lake Rotorua where it is mostly totally mixed throughout the year apart from short periods of time in summer when the climate is still and warm. Then the bottom waters of the lake stratify and for perhaps a week or two and do not mix with the surface waters. In that period there is a release of phosphorus which mixes again when the wind comes up and temperature drops and there is enough phosphorus to drive significant algal blooms on the surface of the lake.

If we can apply this de-stratification technique to Lake Rotoehu and make it work there, it is possible we could transfer that to Lake Rotorua. The big advantage is there is no need for chemicals in the lake if de-stratification works. It is a process which a lot of the community are very supportive of, particularly our Iwi community.

Lake Rotoehu is about 800 hectares and a reasonable size to pump and mix the water of the lake. When looking at new projects I often look on the internet or through the literature and see if somewhere around the world this technique has been undertaken in a lake the size of what we are trying to do. I found something pretty interesting the other day. There is a lake called Waco in Texas and I thought everybody would recognise that name. It is about 2,900 hectares, about four times the size of Lake Rotoehu and they have tried this de-stratification technique and it has been successful. I am a little more relaxed that we have been able to identify an application the size of the Waco project that indicates we can apply this technique at the proposed scale.

**Slide 21:** This is a floating wetland on Lake Rotoehu. It is a technique that our scientists came up with three or four years ago. Wetlands have the ability to strip nitrogen through the de-nitrification process and they take out some phosphorus too. We put in a significant sized terrestrial wetland at Lake Okaro which has been very successful, and we are considering doing the same thing in other locations. However, sometimes it is difficult to find locations that are totally suitable for construction of wetlands for various reasons and our scientists came up with this idea, originally from the United States. We did some trial work and found how effective they were in getting rid of nitrogen; something like four times the de-nitrification capacity of a terrestrial wetland per unit area.

## Slide 21



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We put one in Lake Rotoiti at the end of last year. We had difficulty with this floating wetland because initially it came apart at the joints which was not a good look. We wanted it to be more stable than that. The contractors removed it again, and they found after two to three months there was a significant number of small koura, about the size of a thumb nail, underneath the wetland, in the matrix. It was a side benefit of the floating wetlands and suddenly we realised there were more benefits to floating wetlands than just getting rid of nitrogen. There are ecological benefits in having these floating wetlands in different locations.

It has been a useful thing for us because, in terms of engagement with Iwi, the floating wetlands have been fantastic and we have had a lot of support. The project required resource consent and we now hold resource consents for floating wetlands on eleven lakes. It was a neat initiative working with Iwi and we are interested in doing more research around koura and how wetlands may benefit the enhancement of koura within our lakes.

It led us to other conclusions, and returning to the slide with the smiley faces, it showed there are co-benefits like this which are not recognised at the outset of a project. It is important that you test different things to ensure opportunities are not being missed out that may assist the programme.

So I will finish off there and give a list of acknowledgements because I have taken quite a few slides from other people's PowerPoint presentations and thank them for their input.

- Prof David Hamilton, University of Waikato
- Dr Max Gibbs, NIWA,
- Mat Allen, University of Waikato
- Paul White, GNS
- Ian Kusabs

Thank you.

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## DISCUSSION PANEL - QUESTIONS

**Nick Miller, Lakes Water Quality Society:** A question for Andy Bruere which was asked by someone else but I am passing it on. What material are your floating wetlands made from please?

**Andy Bruere:** The floating wetlands are interesting and I should have told you that. The wetlands at Rotoehu are 2,800 square metres which is about three quarter acre sections. They are made of recycled coke bottles. This non-woven mat is imported by Kauri Park Nurseries in Kaiwaka from Georgia. There are 364,000 recycled coke bottles in the wetland. The photograph on the slide is about a third of the size of it. I have not spoken to Coca Cola yet, but I am sure we are going to get some sponsorship.

**Mike Barton, Farmer, Taupo:** The question is to Peter Skelton. Peter, as a farmer in the catchment, I want to acknowledge in front of the audience the way you handled the hearing. The farmers much appreciated the fact that you gave us a fair hearing and we were very well received. The question is - what have you learnt from that exercise and what you are doing in Environment Canterbury? If you had a clean slate to start the process again in Taupo, what would you do?

**Graham Fleming, Chair:** The short version!

**Peter Skelton:** When I came to do the Taupo case the lake was not quite clean but as I got into Variation 5 I became more and more confident about it. One of the things I feel, and I am not sure whether this is answering your question, is that fundamentally it is a good idea and I am convinced that there has to be some controls on agricultural and horticultural activities. In the Taupo situation I thought we might have a gap but I do not think this has eventuated. It is to do with having controlled activities for farming, and associated with that there is a permitted activity for the actual discharge, because that is the way the RMA works, land use and discharge.

When it came to the question of what would happen if you wanted to go beyond that, what kind of a consent would you need? It ended up being a consent for a non-complying activity. This means somebody could still apply in the Taupo catchment to breach the cap and there would be no guarantee that the cap would not be breached. As we all know consents for non-complying activities can be granted. It was argued in front of us that it should be a prohibited activity and we ruled against that at the time because we were not sure about the legal consequences. I am far more confident now, since the Court of Appeal has ruled on that subject, to imposing such a constraint. For a cap and trade situation in Taupo, I would make everything, other than complying with that, a prohibited activity. There would be no room to go beyond that cap under any circumstances.

I do not know if that answers your question at all but it has given me an opportunity to say something because it is a pet hobby of mine, the same sort of situation is arising in Canterbury where we are limiting allocations of water. There is no point in having an allocation of water and letting people apply for consent to go beyond it. Apart from that I am happy with the way the Taupo situation developed, and gather from talking to people like John Kneebone today that it is working quite well.

**Graham Fleming, Chair:** Can I ask farming experts here, what is your opinion on this voluntary versus regulation?

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**William Oliver:** I personally do not think that voluntary will work because there are free riders in the community and that is human nature. I think you should have regulation.

**Tanira Kingi:** We will wait and see. The Rotorua Dairy Collective is involved in a process right now based on voluntary and underpinned by a number of organisations that are backing that. But it does come down to what farmers can do, both individually and as a collective. It also depends on what resources are available from the regional council and others to support those changes.

The farmers have got targets. Some of those targets mean that farmers have sleepless nights worrying about how they are going to survive, because the targets are ambitious. They have looked at practice changes and cannot quite get their head around how they are going to do it. They realise they may need to go further and that impacts on the bottom line. The targets have provided a boundary, a clear ceiling for farmers to work within.

The voluntary system in Rotorua is driving a whole lot of things now. I am interested in seeing if that can be generalised to other regions around the country. There is a unique mix going on in Rotorua. I was on the Incorporation in 2000 when Rule 11 came out and it created a lot of excitement among farmers. Three years later our Incorporation decided to pull out of dairying, which has improved the situation within the catchment, but there are still huge challenges for those farmers that are left. So we will wait and see.

**Graham Fleming, Chair:** Alison, I am interested in a lot of your theses, the fact that you can provide economic advantage with that much reduction in pollutants. Is that strong enough to tie with reductions in a long term issue of sustainability? What about changing farm ownership?

**Alison Dewes:** We still do not know enough. We have great examples out there, but need more data. I have been quite surprised, coming back to New Zealand, seeing the lack of financial and environmental literacy on farms when we have such big issues. We have not got particularly healthy businesses on farms, and nor do we seem to understand what is happening with our environmental impact.

I personally have been a farmer for twenty five years, but not farming currently apart from two acres. If I was buying a farm now I would want certainty. I like to back myself as any farmer speculating would do, because it is a high risk industry. When we enter any business we want to have an exit strategy. We have to know our asset is saleable at the end of the period, which might be five or ten years, and we also need to know it is going to be compliant.

It is about business certainty and investment so therefore regulation is important. The landscapers in the industry will look for opportunities and change anyway. But to help that change, a compulsory educational undertaking of self-analysis, whether that be in whole farm plans or some sort of self-analysis to understand how their business is currently performing, and how it can perform better with a lower footprint, has got to be the pathway forward.

**Gisele Schweizer, Rotorua dairy farmer and member of the Collective Governance Group:** I have a question for William Oliver and aimed at discovering how transportable your success story from Taupo is to our situation in Rotorua. If you had to do it all again now, how reliant were you on the timing to make use of that massive capital gain achieved from the selling and buying, prior to, or during, the recession. Clearly that would not be

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around now. How reliant were you on the NDA, and if that was not available in Rotorua, how would that affect what you did, and how can we implement it here?

**William Oliver:** Timing is everything in business so it was a very conscious decision made by us when we sold our farm. We could not get our heads around where the values of farms were and went looking for other opportunities. We were lucky that we came across another farm. Our first farm was the same size but it was outside the catchment and it sold for twice as much as what we paid for Motere. We would not have been able to afford Motere Station if we had not got the timing right on the sale of Shalimar.

In terms of the sale of the NDA with the carbon, we probably valued the poor land that we planted into forest at about \$5,000 - \$6,000 hectare at the best, and we have sold over \$4,500 worth of capital out of that land. Our capital input in that carbon forest is only about \$1000 per hectare. We are going to make quite a good return on capital. The sale of that nitrate was very important. But going forward for all other catchments I do not think New Zealand is in the position to be able to afford to come up with the sort of money they did for the Taupo catchment, (\$81 million). We are already, as a country, losing \$300 million a week so I do not think we can afford that.

**Sue Cumberworth, Agribusiness Group, Canterbury:** I have a question for Alison and thanks for your presentation. I really enjoyed it. It is a practical question about dairy farming and feed for all ruminants. You talked about reducing the protein and trying to grow feed on your farm, which of course is the most efficient way to go. This can be very high in protein and bringing feed in from off-farm which would be low protein. Have you got any information about pasture mixes, types of feeds that would be practical for farmers to reduce their nitrogen output?

**Alison Dewes:** There are two questions in there. One is growing more feed, and there is no doubt that, if we got out of our mind set of 100% pasture in these systems, and went instead to alternative forages such as regrowth crops where we have not got a mineralisation period, it would be better. No bare soil, but direct drilling in crops that are constantly regrowing, such as chicory, plantain, and then going straight into a winter rye grass so there is a constant forage happening. Unfortunately I am talking about high protein ones, answering your question about getting more forage. That would be lifting it from say, 11 tonnes to a 22 tonne harvest, if we get it all right and the planets line up. They do not always do so in farming.

The other alternative is low protein feeds, as you said, we can halve the nitrogen excretion in the urine by getting that overall protein in the diet back to 16% from 26%, which is where it is with pasture. Growing maize or cereal silages on that area and getting the planets lined so everything goes right, to get a 10 tonne harvest of cereal silage, which has got a protein content of 8% versus 26% in those other high protein feeds. You can get those blends as well and have your cake and eat it too. But you have to be a very good manager.

**Derek Ryan, Environment Waikato, Taupo:** I would like to ask the panel, Alison or William in particular, do you find it disturbing that there are not enough extension offices out there trying to promote sustainability, environmental concerns and profitability, especially when it comes to nutrient management?

**Alison Dewes:** Yes it is a concern and I have been lucky enough to be funded to do whole farm plans for people like Andrew Hayes and several other farmers. The cost of going through all that farm system modelling, coming up with scenarios and a road map and then revisits, has been paid for by people with other interests, such as DOC and

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Landcare Research. When a farmer has that opportunity it is like a light goes on and they say, "I didn't realise we could do all this modelling and then understand that we can change our farm system in this way." I have worked with them for two years and helped them through it.

My issue is that the market has not been created so we have got other things happening. I spoke about the group of private consultants that chase higher productivity and higher profitability, but they are now saying, "Actually if we do nutrient efficiency as well we can lead our farmers to better profitability through better resource use as well." It would be nice to have the market but it is not there yet unfortunately.

In Taupo, and William can back me up here, once the rules were made certain, the entrepreneurs stepped in and saw opportunities. The whole mind set of the catchment changed. I think in the Rotorua situation regulation is the only way to go. What concerns me is that as other regional councils start to consider nutrient management there are no extension offices out there. Private consultants do not seem to grasp the sustainability yet. Is that a fair comment, Will?

**William Oliver:** You certainly need people out there that give farmers solutions, not a whole lot more problems. There is a lack of people like Alison and Graeme Fleming and people like you in Taupo out there. The farmer I referred to from Southland used someone from Hamilton because that is where he had to go to find someone with those skills. The consultants out there are production based, or managing people for the banks.

**Alison Dewes:** I want to comment also that that is why I am currently training a group of twenty of the old production/profits/focus consultants to a new way of thinking. We expect it will probably take eighteen months of full training. But we also expect it is going to be easily that before the market is created. There is a lot of really good stuff happening out there and people are starting to move.

**Tanira Kingi:** I want to add that there is a problem with numbers of consultants and those entering in the industry. It has been with us for a couple of decades at least. But there is also a gap in the skill base of consultants and this is adding on to what Alison said. The questions coming from farmers now are more complex. The solutions are unknown, the skill level needs lifting and in some cases it is not just the consultancy fraternity or business that should have the answer. In the mix too are science institutions. We get requests all the time to go out onto farms to help fix problems. There is a need to link science with the consultancy business. It is important to develop long term discussion groups where farmers can learn from each other and do better with the information to build on that local knowledge that many farmers have had for decades in their regions.

**Jocelyn Reeve, Farmer, Taupo:** I am thinking about the consumption of our products or whatever we do. We cannot regulate consumption so how do we promote our consumption? I am not sure if you understand what I am talking about?

**Graham Fleming, Chair:** I guess the question is – how do you effectively market your products from environmentally sensitive areas?

**Jocelyn Reeve:** Yes

**Graham Fleming:** Anyone want to have a go at that one? Any marketers here?

**Tanira Kingi:** I am not too sure if I understand the question. Are you asking about marketing of alternative products?

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**Graham Fleming:** I think I understand the question. The question is about, for instance, if Rotorua becomes a good place to farm and it is a sensitive environment and everything is working well, how do go about marketing that to either the world or the rest of New Zealand?

**Tanira Kingi:** I think one part to your question is the potential for diversification within a landscape like Rotorua; it is predominantly pastoral and forestry. The question is how do you promote alternatives, and they need to be tied in with markets. There has got to be a value chain approach to getting products to people that want to buy them. Alternative markets take a while to develop. Current markets in terms of the dairy sector consist of Fonterra but there are also alternatives coming on stream as with the meat industry.

**Mary Stanton, LakesWater Quality Society:** Kia Ora, I would like to ask two questions. My first question is, I was born on the Ohau Channel and we had farming right down to the Ohau Channel for years. Our people were farmers, however because we wanted to look after the water quality we took precautions. I now look at the land along the Ohau Channel and a lot of that land has opened up to different things which could affect the environment.

My concern is - what do we do with the black swans? What do we do with the Canadian Geese? What do we do with the Roman Geese? We have never had this sort of thing on the Ohau Channel. They are new, they are not birds I saw when I was a child. Has anybody got anything to explain to us what do we do about the bird life? I welcome native birds but we are losing them. Can somebody tell me what to do with these new bird species because there is a mass of them and they are overtaking our buildings? Can anybody answer my question please?

**Andy Bruere:** Mary, I am not sure I can answer your question but I can shed some light on it. That is an issue that a lot of the community are concerned about in a number of lakes. It is one which we have discussed and done research with Fish and Game around some of our action plans. In terms of water quality, the advice they have given is that they are not really causing a great concern with respect to bringing nutrients into the lakes. So it becomes just a nuisance issue and something that needs to be approached through the body that has the responsibility to look after game birds. I cannot answer it further than that, Mary, sorry.

**Mary Stanton:** Thank you, I believe it is part of our environment and we have to think about bird life. My final question is the people. People have to find happiness otherwise they sell up and move out. Tangitawhenua and Iwi remain on our land for many reasons; because of our urupa, our maraes and this is where we were born. Mourea was the first to have sewerage and now I am looking at the costing of other sewerage systems further down the line. I believe that the costing is unbelievable and it could chase our people away. I feel that there is not enough effort to reduce these costings. People have to be happy and a lot of our people are very very sad at the moment because they look at what they can afford, what the bank is going to do to them and where they are going to go. Our young are shifting over to Australia and say, "You can have your land, you can have this, you can have that, we're gone." Think about the cost. I want our people to be happy and to remain here in Rotorua. Kia Ora.

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## ***Session Five – Grow the City***

**SESSION CHAIR:** Roger Gordon, Chief Executive, Rotorua Chambers of Commerce

### **HARNESSING ECONOMIC GROWTH – PROCESS**

**Murray McCaw**

Wellington Regional Strategy Forum

Director of Cormilligan Group

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*Murray is a Director of Cormilligan Group – a privately owned consulting company established in 1998 to provide governance skills and strategy advice to New Zealand and Pacific based businesses. Prior to taking up the role as Chair of Grow Wellington in 2007, Murray had chaired the Wellington Regional Strategy Forum for three years. The Forum developed the Wellington Regional Strategy. He is a graduate of Harvard Business School and is also a Director of Bay of Many Coves Resort Ltd, BOMC Properties Ltd and Mitsubishi Motors NZ Ltd and a Trustee of Sport Wellington Region and Hawke's Bay Sports Park Trust.*

### **ABSTRACT**

A great place to live, a great place to work in a vibrant economy, a shared region wide vision and an integrated development framework are the keys to sustainable economic growth.

The Wellington Region (The Lower North Island, south of Otaki and Masterton) came to this understanding during a four year process that led to the adoption of the Wellington regional strategy. Importantly this regional strategy was developed on factual information rather than emotional opinion which allowed much of the politics to be taken away with rational strategic thinking prevailing. In addition to community and business leader workshops two major research projects were undertaken amongst 1,000 people in the community – both businesses and residents. The survey provided critical input when it highlighted the most important statement researched as being 'It is really important to look after the natural environment in our region'.

Critical also was the realisation that for the region to be successful each of the cities and rural communities had to play their discrete roles in an optimal manner within the context of the shared vision. As a consequence of this, four years' analysis of the Wellington regional strategy was launched in 2006 with three key pillars of investment:

- Investment in effective leadership and partnerships – our research showed that successful regions of the world have proactive and innovative leadership
- Investment in growing our economy – especially from exports
- Investment in good regional form – creating the great place to live

Rotorua has the opportunity to leverage off the foundational work undertaken in the Wellington Region, particularly in developing appropriate processes, to create something very special for New Zealand.

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## TRANSCRIPT

Good morning everyone. Can I start with a thank you for the opportunity to mix with you all last night, and to attend this Symposium and share a bit about the Wellington experience. Can I make the observation that what works in one place is not necessarily going to work in another, and in particular, what works in Wellington may not work here in Rotorua. I am not going to tell you how to do it; I am going to give you what I think were the successes and some of the challenges we faced in Wellington as we developed our economic strategy.

Let me start off with a quote from 1909 which was delivered to the Fort Wayne Civic Association: *"It is no small matter to recast a city, readjusting it to its higher density and shaping for a greater trade in industry and larger population than had been foreseen. But the very deed of doing so is inspiring and calculated to give courage and today in competition of cities for wholesomer living, the city that dares is the city that wins."*

Nothing much changes really in 100 years, does it? The key words for me in that quote are *courage* and *wholesomer living*.

It is critical when moving forward with a growth strategy to have a perception of what success looks like. I am not talking about having a vision or some sort of great theoretical statement. It is about saying: *"What is it that we want to achieve?"* For the All Blacks this year there is only one thing, I hope.

In Wellington, we asked MacroPlan, Australia, to research what success looked like around the world, particularly looking at regions rather than just cities. They provided the following:

- Increasing economic output/GDP per capita
- An economy that is supported by a diverse industry mix with opportunities for new business and relatively low business costs
- Good quality and affordable health and education services
- Affordable housing for low and middle income earners
- Availability of recreational and sporting activities
- Community interaction and a spirit of volunteering
- Good quality air and drinking water
- Growth on real family income and a low poverty level
- A high level of social cohesion and safety

It was interesting that Mayor Bo Frank highlighted eight bullet points of what he thought success looked like for him in Sweden. There was not much difference, and that is great. But I think you need to understand what these things are, because if you do not understand them at a fundamental level, then you do not know where you are going and what sort of form to have: i.e. what structures to put in place to deliver the outcomes that you are looking for. Moreover, each one must be measureable at the end of it. It is not sufficient in my view to simply list the features of success. In Wellington, after having defined them, we looked at what they meant and made sure that this was incorporated within our strategy, including;

- Each successful city/region has a clear shared vision and strategy where there is a clear understanding of the integrated roles played by local and central government
- It is possible for a medium sized international city/region to be economically, socially and environmentally competitive on an

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international scale – and to display the hallmarks of being a great place to live

- Climate and relative isolation from major population centres is not necessarily a significant constraint
- They take advantage of adjacent trading partners and build a solid wealthy population base with strengths in high value added industries
- There is strategic urban spatial planning, that is long term and places emphasis on effective land use policies and provision of transport infrastructure – mobility and accessibility are critical for industry and residents alike
- A triple bottom line approach is taken to governance – economic, social and environmental

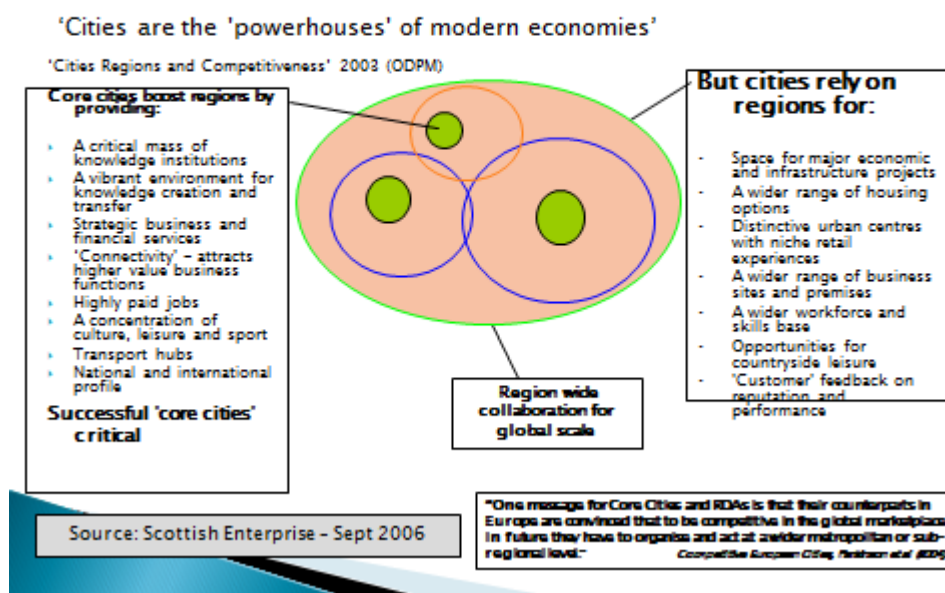
Another challenge in Wellington, which came from all parts of the community – the business sector, private Joe citizen, people in NGOs, even the government sector - was the question: *“Could the Wellington region be internationally competitive?”*

A challenge from central government said, *“We can only have one internationally competitive city in New Zealand and that is Auckland”*. Now the reality is that New Zealand can have a number of internationally competitive cities. It does not matter whether it is Rotorua, Christchurch, Dunedin, Hamilton, Tauranga or wherever; each can be internationally competitive on its own terms.

But what does it mean to be successful? Clearly, you must have a shared vision, a strategy out in the public, and an understanding of what success looks like. A medium sized city or region can be successful, but has to leverage off what is unique to it. I will come back to that a little later. The key is it is a great place to live. Climate and isolation do not matter. What you are doing in your Lakes Project with Professor Hamilton is leveraging off a close-by piece of expertise that you can grow from. We heard yesterday about the need for spatial planning and this is what LakesWater Quality Society is all about. Critically, governance has a triple bottom line.

Slide 6

## Region Wide co-operation is critical



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**Slide 6:** Cities cannot do it alone; they need region-wide cooperation. The model the Scots identified has been very successful. The key to success is that each entity has to define its role. If Rotorua is part of a wider region, what role does Rotorua have? With role clarity, all the partners within the region understand where they are, what their place is, and what role they will play. It is collaboration that works.

You may well take a role on an international stage. You might say to yourselves, *“We’re going to leverage off the fact that we have huge skills and a natural advantage from our cleaned up lakes. How can we leverage off that internationally? How can we grow a presence so that we become the focus in the world on how to clean up lakes?”* Grow a business and grow your economy.

**Slide 8** looks specifically at the Wellington Regional strategy. At its core was a desire to have an internationally competitive Wellington. There are eight territorial local authorities essentially from Eketahuna and Otaki south, eight Mayors and a Chair of the Regional Council. It is a big area, very diverse, with challenges in the geography of the region split many ways.

Slide 8



The goal, when the project was put together by five of the Mayors, was to work together to create an internationally competitive Wellington by developing a vision for an integrated framework to achieve sustainable growth for the whole region.

Frankly, the Wellington economy was standing on a burning bridge. It was slowing. We had a reduced share of migrants, a huge loss of people and jobs offshore. In our view, our back would be severely against the wall in fifteen to twenty years. If the local economy is not growing and the population shrinking, it will ultimately not be possible to fund what you want to do: to ensure that the region is a great place to live in. That is the challenge for us all.

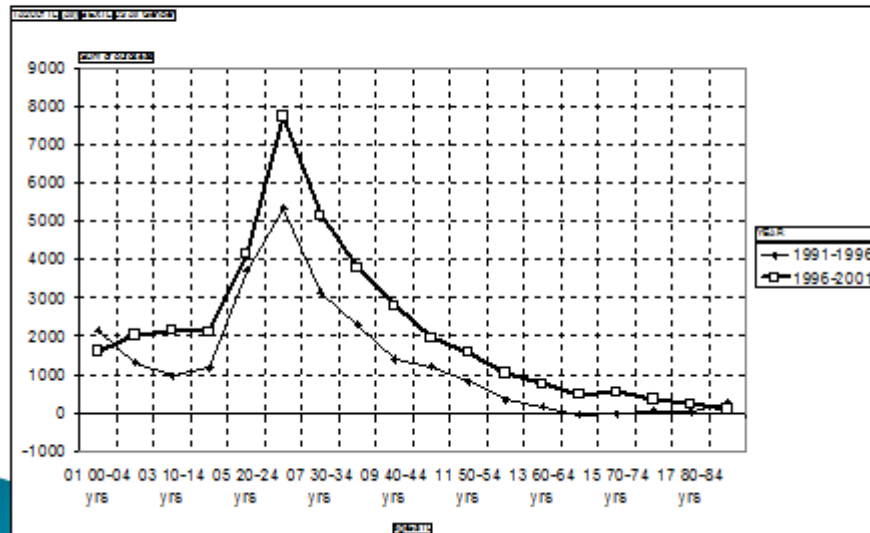
**Slide 11** reinforces this point: we are losing our youth in Wellington from around twenty two. They go to University in Wellington, and we have a growing population in the

University area, but between twenty two and thirty five we lose a whole lot of people, a significant loss.

# Slide 11



## We are losing our youth?

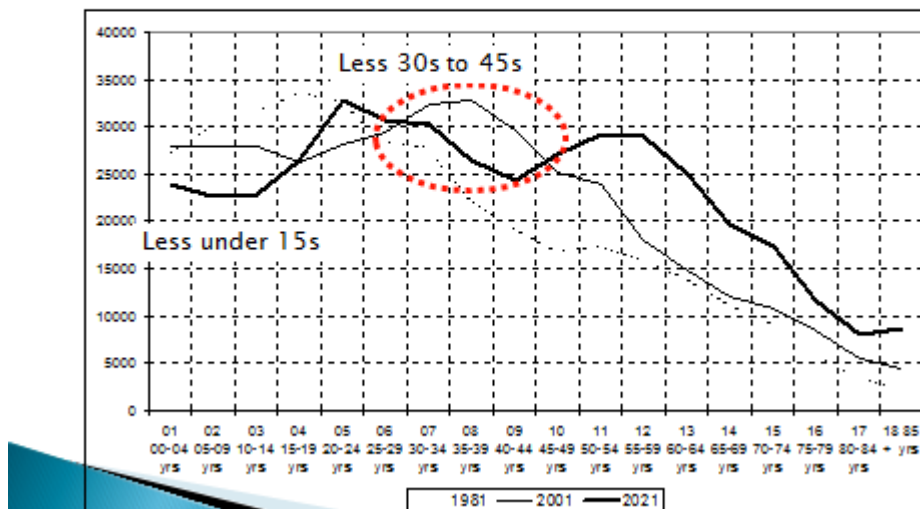


Slide 12 extrapolates that to 2021, when we will have 38,000 less people in that age group. That is all the leaders and breeders. It does not bode well. This is what we were faced with and we had to do something about addressing it.

# Slide 12



In 15 years we will have 38,000 less 'breed and leaders' than we have today.



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A comprehensive approach was taken in the project. In 2002, the five Mayors agreed that they needed to do something. You probably do not understand it here, but when five parochial Mayors got together, let alone with a Regional Council, they could not agree on where they should be going or doing. They asked me in late 2002 if I would be prepared to be the independent Chair. We widened the representation on what we call the WRS Committee (the Wellington Regional Strategy Committee) to have eight Mayors, the Regional Council Chair, two representatives of Iwi and me. I spent three and a half years being a referee: cajoling and challenged by all sorts of behaviour that you could only guess about. The point is, we got there, but because it was hard and everybody knew it, I believe it will be sustained.

#### **Wellington Regional Strategy Committee:**

- 8 Mayors
- 1 Regional Council Chair
- 2 Iwi representatives
- An independent Chair
  
- The Strategic Partners Forum – 53 people from small and large business, Social Agencies, Central Government, NGOs etc.
- Always met with a purpose
- Widespread consultation – including research
- Involved ‘specialists’ on aspects of the project
- Fact based.
- Nothing was ‘out of scope’

We decided to embrace the community. I do not know what happens here, but in Wellington we have a very poor participation in local body elections – 29%. We knew we were not going to get involvement by normal forms of consultation. We decided to get fifty three people. There was no magic in that number, simply the key movers and shakers in the region from small and large business, central government and NGOs. We met probably ten or a dozen times during the three and a half years. The point I want to make in terms of process is we only got together when there was a need and when they could make a useful contribution and see an impact.

Too often we say, “*Oh let’s get community leaders together and see what they think.*” We get them together, see what they think and say, “*tick that box we have done the consultation*”. That is not how to get best value out of people. Best value is when they believe they are making a contribution. We undertook widespread consultation using the web, holding community meetings and being out and about all the time.

#### **A fact based approach was agreed**

- Research – before, during and after
- Significant number of technical working papers:
  - Regional Stocktake – Context, Quality of Life, Regional Systems, Economy)
  - Regional Community Outcomes
  - Successful Cities
  - Economic Outlook
  - Global Trends and Uncertainties
  - Demographic projections

- Housing
  - Human Capital
  - Business Retail
  - Wairarapa Issues
  - Wairarapa Economic Development Strategy
  - Environmental Constraints and Opportunities
  - Growth Framework
  - Good Regional Form
  - Wellington Regional Labour Market Strategy
  - Wellington Regional Labour Market Implementation Strategy
- 6 International Consultants – their recommendations – interactive forum with challenges – all consultants involved
  - Specific working parties from sectors

We involved specialists on aspects of the project, and I will come back to that again. One of the critical things the Mayors agreed to was fact based outcomes - **no opinion, no emotion, fact based outcomes**. It was just as you are doing with the science in the lakes. Nothing was out of scope. It was not just an economic strategy, but a regional strategy for Wellington.

What is a fact based approach? We did significant market research, samples of over 1,000, before, during and after the research. We had a significant number of technical working papers, which are now all on the website. <http://www.wrs.govt.nz>. There were some fascinating papers particularly on global trends and uncertainties, if you really want to scare yourselves.

With all the papers together, we sent them to six consultants, two off-shore, and said, “*We want your view on how you do this. What do we have to do to make Wellington internationally competitive?*” They presented their findings to each other and the committee and then we had a debate and ended up coming to some form of consensus.

## Slide 16

### Submissions and Research from the Growth Framework consultation reinforced the need for a balanced approach to economic development.

#### Ten most popular statements



#### Average responses to statements in resident survey agreement order

	Resident survey	Business survey	Sub-mission	Average (unwtd)
1 It is really important to look after the natural environment in our Region.	4.44	4.28	4.43	4.38
2 In planning major roads, the effects on local communities should be considered.	4.34	4.2	4.34	4.29
3 Successful economic development doesn't just mean higher incomes - quality of life is important too.	4.23	4.18	4.38	4.27
4 Councils in the Region need to work together to develop more consistent policies and services.	4.16	4.2	4.36	4.24
5 There should be natural green space in or near all built-up areas.	4.15	3.97	4.24	4.12
6 The different historical and cultural characters of different places are important and should be preserved.	4.14	4.06	4.31	4.17
7 There should be actions taken to encourage skilled people to remain in the Region.	4.11	4.10	4.06	4.09
8 It is important to have a strong and prosperous Wellington City CBD.	4.09	4.20	4.17	4.15
9 Councils should get together to make strategic land use decisions on a Region-wide basis.	4.06	4.15	4.25	4.15
10 Decisions about transport should promote more walking, cycling and public transport.	4.02	3.92	4.06	4.00

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We had working parties in particular sectors. I chaired a small group of four CEOs that looked at parts of Wellington.

We published two key consultation documents, one outlining a grow framework and the second a draft strategy: significant booklets that had all the rationale and detail. Then we did our research. A requirement was that at the end of the day we needed approval from every individual council. The nine councils (eight TLAs and a regional council), all endorsed it unanimously which was a tribute to the process.

**Slide 16** shows the results of our research which we sent out and then went out to talk about it. It was an informed audience who responded to our questionnaire. Interestingly in the research was the answer to the question: *“What is the most critical thing if we are going to get growth?”* The answer was: *“It is really important to look after the natural environment in our region.”* This was number one when doing a growth strategy. Would it be any different here?

It was critical to use **our natural advantages**; our natural, not competitive advantages. What unique things do you have to leverage off? For example, in Wellington we identified the deep water in Cook Strait as being a key crucial natural advantage and one that even today we are working on with a twenty year plan as to how we can leverage it. **Sustainability is important** and the Wellington region had to be **a great place to live, a great place to work**. Both components are critical. My wife, who works in executive search involved in looking for chief executives for national companies and central government, says, *“When you bring someone from off-shore here for a job interview they spend two hours being interviewed in the job, and spend two days interviewing the region as a place to work.”* That is the relative importance that you need to think about.

## **Wellington Regional Strategy**

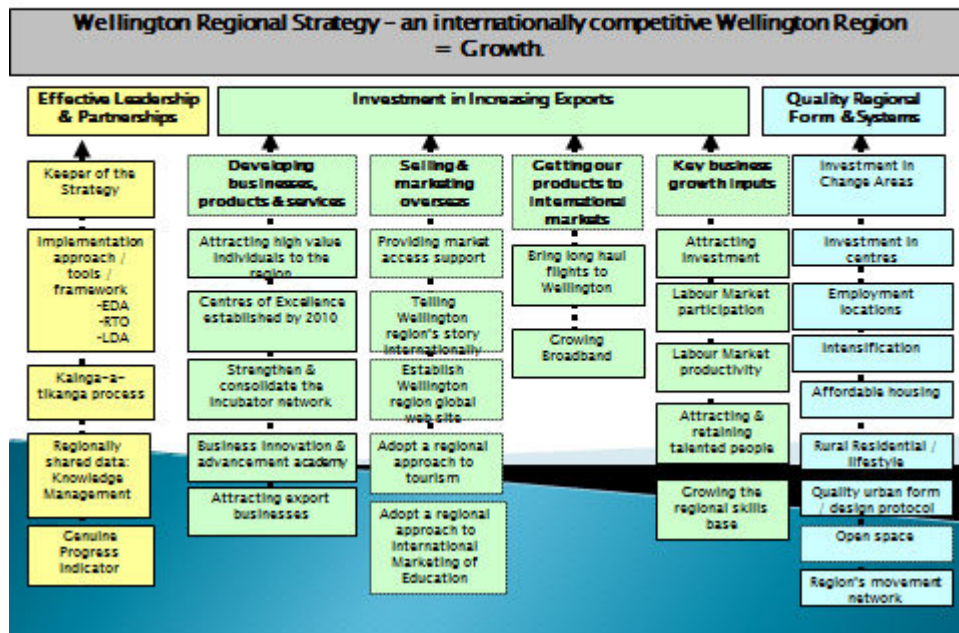
We developed an all-encompassing vision.

*“In 2025 the Wellington region’s competitive advantage will be based around its capital status, global links and local geography. The two main corridors running the length of the area will create a feeling of free movement and intimacy in the region. You’ll never feel far from the bush, the sea, work or home. A thriving entrepreneurial spirit of new ideas will be encouraged and drive the economy. People will live in safe, clean communities that celebrate the coming together of different cultures. Everyone will enjoy access to an environmentally friendly outdoors and to thriving, cosmopolitan arts and entertainment.”*

**Slide 20** focuses on what is in the strategy. There are three key core elements and working parties look at all factors. You cannot have economic growth without a great place to live. One core element, in terms of creating a great place to live, was the quality regional form and systems.

We believed that to have economic growth it must be export based, and there are four key elements. Developing business products and services, selling and marketing our product overseas: how do you get it to market once you have got it? What were the key business growth inputs needed? That has been a challenge. Not everybody has accepted that Grow Wellington, which I have chaired since its inception, is only about growing exports. That is our single focus and whilst it upsets people now and then, the reality is we will not make a difference unless we have that focus.

Slide 20

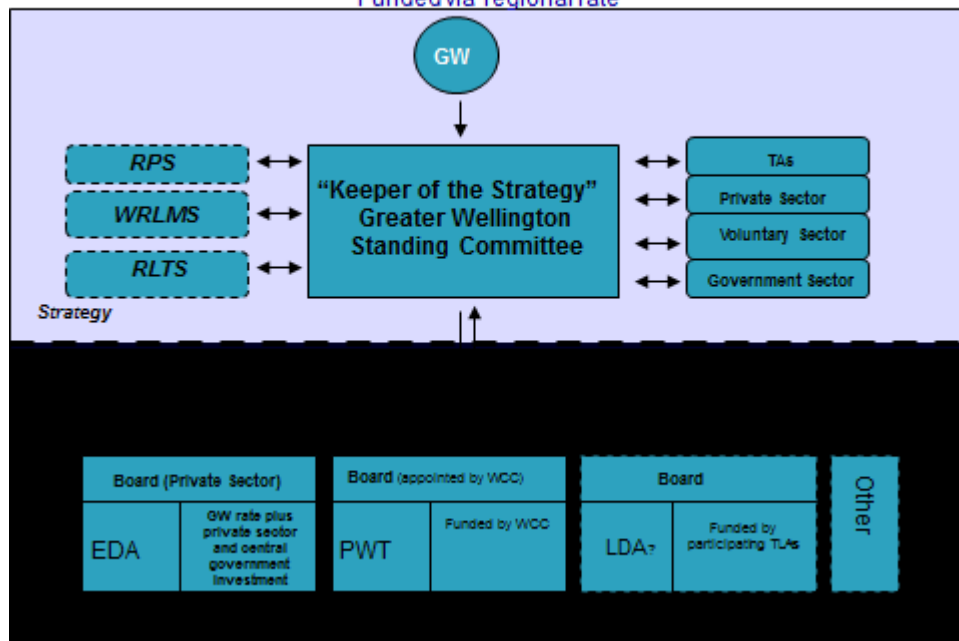


The third, and I believe absolutely key element, is to have effective leadership and partnerships within the region. We set up a strong structure, with a knowledge base to leverage off and ensure we were going forward.

Slide 21 shows the way it is structured today, funded by a regional rate, and the Wellington Regional Strategy Committee, chaired by Sir John Anderson, and four other eminent Wellingtonians who are not local body politicians. It has five Mayors and the Chair of the Regional Council. That group oversees everything that is going on in the region.

Slide 21

**Standing Committee Of Greater Wellington**   
Funded via regional rate



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Frankly I think there should be a region wide district plan which would be a key element in making this work better. The economic development agency, Grow Wellington, gets a significant amount of money from the Wellington Regional Strategy Committee and then leverages that money up. We get around \$4 million and spend about \$7.5 million. The rest of that money comes from our own activities, fundraising and leveraging. The board of Grow Wellington is wholly independent. There are no local government politicians. It worries me that this might change, but in my view it is absolutely vital to making progress. The board has a focus on one thing only – exports, and on the customer, being export and export potential businesses.

Why is that important? We had a programme called Bright Ideas, and I encourage you to have a look at this. We asked people to come in: “*Show us your bright idea and how can it be exported?*” We had 1,200 bright ideas. 100 legitimate, big time ideas. We have invested \$100,000 into them and the business community of the Wellington region have put in \$500,000 worth of services to support them.

Possibly Wellington Tourism is outside our orbit, although we look after tourism as a regional strategy component. It was also agreed that if there was to be a land development agency, it would come in under the WRS Committee. This is currently up for review and there are consultants out there wandering around deciding what they are going to do now.

The key thing is we got there. It is nine years since the project was started, of which I have been involved for eight. We are truly making a difference in all sorts of areas. Some bits could be done better; there is no question about that. There is parochialism regarding areas that are more emotional: e.g. in terms of land use, etc. There are still hairy old things that need to be dealt to. But the critical thing is that we are not doing it for ourselves. We have to keep reminding ourselves about this, **you have got to be in it for the long term**. We are doing it, not for ourselves, probably not even for our children, but for our children’s children, and we owe them that.

Thank you.

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## VISIONS FOR ROTORUA : A CASE STUDY

### John Sax

Chief Executive of Southpark Group of Companies  
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*John was the founder of the Southpark Group of Companies, and has acted as CEO or Executive Director of all companies since. His more recent acquisition of Kensington Park in Orewa, has seen development evolve around lifestyle and communities. Southpark has been a leader in the redevelopment of much of the former "smoke stack industries" within Auckland such as Southdown Freezing Works - formerly owned by Affco, Hellaby Works, Shortland Works, Taniwha Works, Pikes Point, Roscommon Quarries and others.*

*John is the founder and Chairman of the 'For the Sake of Our Children Trust'. He is a promoter and a champion of caring communities. John is also a Founder, Chairman and Director of numerous community and social action initiatives. John is the creator of Treetops Lodge & Wilderness Park in Rotorua, an internationally acclaimed wilderness retreat. He is married to Alma and they have two children, James and Natasha.*

## TRANSCRIPT

Good Morning all. It is great to be with you and what a wonderful opportunity to dream a little. The topic of *Fix A Lake and Grow a City* seemed to be an interesting statement to me so I am going to have some fun defining what that could mean. To do that I would like to take you back to basics because I did not ask for any good explanation.

To me it is about a love story. The love story may be perceived differently by all of us. For many it might be the love of your lakes, and indeed, I am sure the great motivating factor of the wonderful people that have assembled at this gathering, and the people that went before, is about that. For me, a love story is always about people, so we cannot love lakes by ourselves or without our people. If I asked the people of Rotorua what is one of the statements that they would think, they would say 'Feel the Spirit'. Now once again I have not had a good definition of what that is, but people are influenced by other people. We are influenced by the place and we are influenced by the environment.

When I was coming over the Mamakus last night I looked at the catch phrase of Rotorua 'Feel the Spirit'. I do not know who invented this as a marketing statement, but I would say to you that we need to 'Become the Spirit'. We need to 'Live the Spirit', and remembering those that went before you in your lakes restoration programme, when we pass on we want to 'Leave the Spirit'. I think that Spirit is a 'Spirit of Love'.

Now we have defined that, let us talk about the subject I have been asked to speak: being a dreamer. It is actually called vision; being visionary starts with being a dreamer. I have got to confess I think I would be classified as a dreamer.

A lady who is a hero of mine, Baroness Caroline Cox, agreed to do the foreword of a little book we wrote – *Tree Tops, A Place of Dreams*. Caroline stayed with us a number of times. She was Deputy Chair of the House of Lords for many years, and one of those people that rode into Warsaw on the tank. She went into Sudan thirty four times, crossing the border illegally, and sentenced to death in absentia in that country. She is campaigning worldwide for the twenty seven million women she estimates have been sold into sexual slavery. She is a wonderful person. She said:

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*“Tree Tops Lodge is an example of one of John’s dreams. He wanted to not just build a world class wilderness lodge, but also designed it so those who visit will find it a place of inspiration, rejuvenation and reflection. John envisaged Tree Tops as a place to dream, and more importantly a place where dreams can be born, and can be transformed into reality: a reality which can make a difference for the good of the world in which we live, and for the good of those that will follow.”*

**Slide 5**



**Slide 5** is about creating a 'Dream Team' and seeking the wider picture of what this means in terms of economics. It is a matter of getting the right team. What does the right team look like? There are dreamers in the world that just remain dreamers or visionaries, but we need visionaries that have wisdom. There are many foolish visionaries, but we want visionaries that have wisdom. If they do not have passion they do nothing but become day dreamers.

The team that will transform this region will be a team of dreamers that are wise and have heaps of passion. We need to create a 'can do' environment and every one of us is responsible for that, particularly district and regional councils. One of the greatest impediments to dreamers is the statement – *you can't do it*. Entrepreneurs detest sitting for years and years waiting for an answer which should have been yes almost immediately. It is vital to have a 'can do' attitude, do not underestimate the difference it makes to delivery in your communities.

I know it became untrendy under the Rogernomics regime, but the team needs to incentivise. It is remarkable what people will do, how many hours they will lie awake at night dreaming when they have got an incentive. Look at ways of providing constructive incentives in your strategies and then encourage them to go and do it.

**Slide 6:** What might a Dream Team come up with? Since this is the question I have been asked to talk on as a vision for Rotorua, I will keep it at a very high level. We need to be talking about 'a place of inspiration', 'a place of inspiration', 'a place of rejuvenation'. The

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world has become a pretty frantic place for many, so a place for people to relax and rejuvenate is a great place.

**Slide 6**



These words - a place of 'love, joy and peace' - what does that all mean. It sounds fluffy stuff. No, not at all. We tell our staff at *Tree Tops* that the place is about you. 30% of it is about great buildings and a great environment, but the real environment that matters is the software, not the hardware. That's the 70% which is the people. If people are not loving, caring, serving, bringing joy to a place, it is a pretty dull place. There are wonderful places all around the world that fail because of the people. Do not ever underestimate the importance of people, as we all know. If this region is a great place it will be a place of memories: that is what we want people to leave with, and the world to understand.

**Slide 7**



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**Slide 7:** Let us dream for a minute. What might some of the things be that you could do in this region? Some fantastic lakes. I have hiked at the back of the Rotoehu forest, and Rotoma, through and behind Okataina to the saddles above Mount Tarawera, through and behind Rotomahana, through and behind the Green and Blue Lakes, and down through the Redwood Forest. It is magnificent. Is there a magnificent trail where people from round the world can say: *this is one of the world's seven best lake trails on the planet?* Not yet, but can you do it? Of course you can. What will the world say about that when you do deliver?

There is a new phrase called *Glamping*, which is glamour camping. Normally it is under tents, but luxury tents that can be on those trails. This is a fantastic region of natural resources that I do not think we are using particularly well. Where are the great glamour tramping trails of the world? I could tell you, there are about two and that is it. What you have here is world class already and it can be done with ease.

What about the greatest mountain biking trail in the world? When you come over the Mamakus there is a fabulous forest. Heading across the Plateau are spectacular streams that have no tracks or access, unless you are an avid hunter. Further down to the lower Kaimais and the coast 1,850 feet below (or whatever that is in metres), there are fantastic little uninhabited sandy bays in behind Waihi. Why not have the greatest bike riding trail on the planet, in some of the most spectacular terrain on the planet? Can you do it? Of course you can do it. Would you want to do it if it was there? I bet you would, because I would.

What about eco trekking? One of the wonderful things about most people passionate about the environment is that they are just passionate. When you talk to David Attenborough or David Bellamy you get excited even by amoeba. They make amoeba sound sexy because they are passionate about their subject. So with eco trails we need the best eco guides that we can deliver to be along those trails. Would people pay for it? You bet they would. People love learning. I love learning. We love hearing the passion of others that has been delivered and leaves a memory. Remember what I said earlier – a place of memories.

**Slide 8**



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**Slide 8:** We need to be world class. Spas are a natural and we have them here already, but can we take them up a number of notches to where they are truly world class? We have a lake front with which an awful lot can be yet done. Great work was done by the Rotorua District Council some years ago, which started a lot of the centre development of this town and is magnificent. Can it go to another level? Absolutely. Are there unique features of your lake front? Yes there are. If you walked out behind here there is steam rising, quite an eerie feeling this morning as you go past there. Could you create walkways hovering about that steam? Could you recreate the pink and white terraces by pumping the mineral waters over concrete formations that looked like terraces? These would be unique experiences for visitors walking along your lake fronts? Yes you can.

What about taking our culture to another level? Increasingly the world is becoming fascinated by, and interested in, culture. It is not just the shows, but real culture, real experiences. I think we can do a lot more.

You have a wonderful geothermal wonderland in the area. People love geology too. Where are the great geologists who will share the story about what the earth's crust is doing and explaining it, in meaningful and exciting ways.

**Slide 9**



**Slide 9:** Look at some other things we can do. We see great energy stories. The world is looking for more answers in energy. This region led the world once back in the fifties, with Wairakei. After that, little was done for a long time, but now there is a lot being done. There are fascinating and interesting stories there. As for hydro, we have hydro in this region, and micro-hydro is increasingly being looked at. Opportunities with micro-hydro arise because of the number of streams that flow out of these catchments. What can we do?

We also talk about bio farming. When you look at the nutrients that flow into your lakes, you see them as a menace - a costly menace - but in actual fact they are not. Every kilo of nitrogen is valuable; it is a great asset, as is every kilo of phosphate. How can we convert those away from where they are going and into bio farming? Look at even simple little things like duck weed. You would not believe how fast duck weed grows if you put it

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into shallow lakes. Sunlight and photosynthesis convert it into energy, wonderful proteins and nutrients for stock and animals. So thinking laterally, thinking creatively, let us use the best of our science, to think about converting what is a nuisance into economic and social gain. Those are the sort of things that help write great stories for this region.

What about the world's great living communities? Well designed communities are energy efficient. They are great places to live, with great design, and efficient use of resources: water, waste processing, electricity etc. I will talk a little more about that regarding Kensington when we get to it.

Architecture is a great expression of man's creativity, with so much that we can do with architecture. Years ago I walked for the first time along Lake Lagonia, Lake Como, Lake Geneva and so on. A lot of those lake fronts are absolutely stunning. Now can we do it? Yes of course we can. Do we have a dream? Do we have the vision? Do we have the desire to do it? Yes I believe we have. But it all comes back to money. These are the ideas in a macro picture that I am talking about: those which actually make money, that are physically sustainable, that will work.

**Slide 11** shows a few examples of being a dreamer. I call myself a dreamer. Never underestimate what grows a dream. I will share two stories with you, but I want you to reflect on your own, because we all have our own stories.

It is not a surprise that when you walk in across a stream at the *Tree Tops Lodge* there are trout swimming backwards and forwards under the lodge and under the steps which you walk. Where did that come from? As a four year old my family unwittingly took me to the Fairy Springs (as they were then) and when I saw the trout I drove my parents absolutely stark raving mad. I hounded them every day to take me back with a fishing rod to go and get some of those trout. The little picture of trout there left an impression.

Look at *Tree Tops Lodge*, where did that dream come from? It came from a nine year old boy. I used to hunt with my Dad - duck shooting. We would get up nice and early in the mornings which I used to love doing. But he lost his desire to hunt when all our remaining

**Slide 11**



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wetland habitat areas were drained, and the last of our wood lots were all cut down. That was a sad day for a nine year old. I repeat, as a nine year old, it does not have to be like this. One day perhaps we can buy some wilderness environment and preserve it for future generations. There can be other land uses: you do not have to make money just out of dairy cows. Dad was a great dairy farmer, one of the best, but every last square metre did not have to go into grass with seven wire barbed-wire fences. Other land uses can give returns and leave something for future generations as well. So a little dream as a nine year old is translated into what is there today.

When we look at that dream – is it a successful dream? Yes it is. How does the world see that dream? That is quite humbling because when you have a dream you do not necessarily say, “You’re going to like this”, or “We expect you to”. One of the most pre-eminent magazines on travel is *Condé Nast* magazine in America and the last few years *Tree Tops* has been voted in their readers’ survey as the top lodge in New Zealand, which I think is extraordinary. It is fabulous that people enjoy the things and elements that I have talked about in that dream. More extraordinary is what happened with another magazine, probably the second most prominent magazine in America, called *Travel and Leisure*. In the last few years they have undertaken reader surveys to ask - *what are the 100 top destinations to visit in the world?* This is not accommodation, but it is the Taj Mahal, the pyramids etc. *Tree Tops* has been voted in the top 100 and in fact ranked 25<sup>th</sup> in the top 100 in the world of destinations to visit. It is actually the only destination in New Zealand to rank.

Marketing boffins these days calculate the value of destinations, of articles bought, of town and country travel, leisure and so on. They have estimated the value that *Tree Tops* brought to New Zealand at about \$55 million, not far off the total New Zealand tourism value.

In the little photos across the top is an example of a \$500 million estate we are building in Auckland called Kensington. Again this employs state of the art technologies: in terms of energy, recycling processors, sewage processors, its own water supply, its treatment of storm water and so on. Kensington is created as a living community environment. It has very high density, one of the highest densities in Auckland. But in those photos, where David Bellamy is sitting looking at a new wood lot that we have established, it does not look like high density. There are lots of open spaces but we have paid attention to the things that we think are important to people. It has been voted the top development in the Asia Pacific. Yes, with dreams you can translate them into fabulous things. Get the principles right and then make it happen.

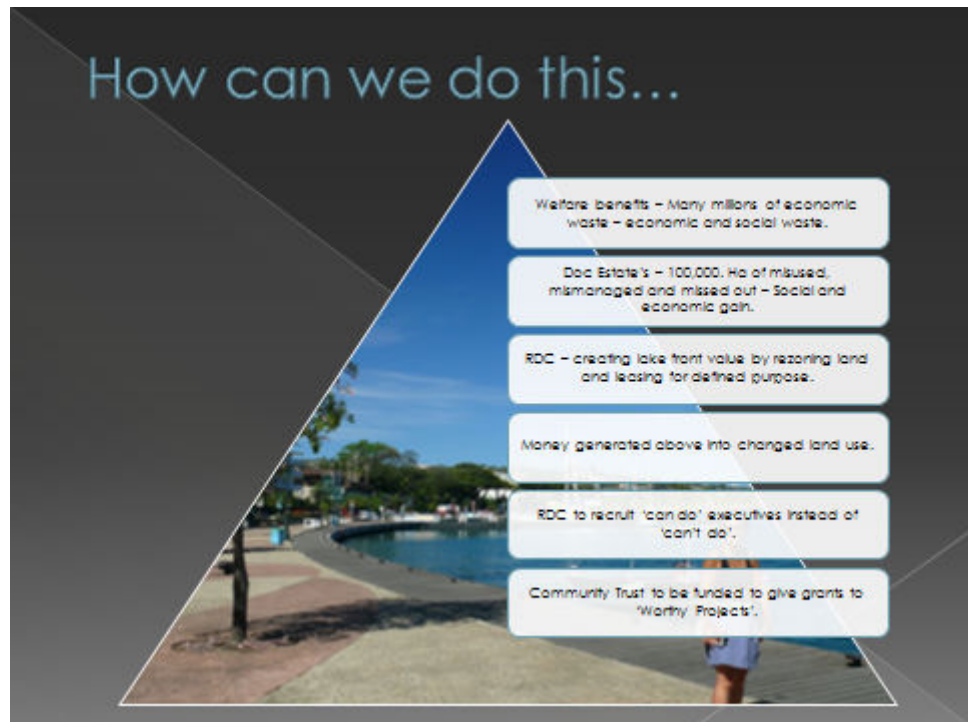
**Slide 12** is about the economics. How do we do all of this and what can we do? You may find some of the comments offensive, and I apologise in advance if that is the case. But let us look at the situation. We spend hundreds of millions of dollars in this community on what I call welfare waste. We pay people not to work. I promise you that in these dreams there will be no such thing as a child ever born in Rotorua who will not have a meaningful job, and something meaningful they can contribute to this community. Looking at just a few of those ideas (and there will be hundreds of others), there are many, many very worthwhile things that people can do and get great joy from doing.

When we look at some of our policies, we have an awful lot of people in this community that pretend to be sick, and act sick, but who really are not. We will have wellness policies which will ensure that there are worthwhile things that they can contribute to. In the DOC estate, there are probably 100,000 hectares which can be managed far, far better. My comments of *misused*, *mismanaged* and *missed out* mean this: are our resources being well used? Are there better ways of using them? Are there people in the

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community that can maintain the environmental objectives but use the resources better, manage them better, and get an economic return?

**Slide 12**



How do we get value from Councils? Councils can do a lot, but how can they create value? Perhaps it is tracts of land along the waterfront. Perhaps it is tracts of land of high density housing which they own, and which they could lease back on ninety-nine year leases, so there is equity there. They can incentivise the right sort of people to come, bringing capital, resources, and skills. It is a win/win for the community. Entrepreneurs hate sitting for years and years and years where the answer might be no. When councils are proactive in sharing in those dreams and facilitate those processes you would not believe what difference that makes.

I will share a little story: a number of years ago we looked at building a major centre offshore. It took rezoning and quite a few things needed to happen. It all looked too hard, with motorway on and off ramps, etc. We met with the council and the reply was, "*Of course we can do this. Come back in six weeks' time and we'll have the answer in principle.*" You would not believe the difference that makes, instead of saying come back in two years and we might have an answer.

Well, my question is – 'do you feel the Spirit?' It is my hope that a new wave of aspiration will emerge for our children, and that every child is born into wedlock will be loved and nurtured and grow into a great Kiwi. Why do I say that? The statistical outcomes are 1,600% worse, not 16, 1,600% worse for every child that is bought up out of wedlock. Those ugly outcomes are child abuse: it is sexual abuse, it is incarceration in later life, it is diagnosed psychiatric disorders and suicide.

We want to be aspirational and want to build great families; we want to build great communities. Why? Because if we love our children we will take care of the world we leave them.

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In summary, I come back to the original question posed. It is my hope that one day our children or grandchildren (as Murray said) will ask, "Where did this great city come from?" You will be able to say – "It grew out of the lakes".

Thank you.

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## FARMING PEOPLE VERSUS FARMING COWS : EXURBAN DEVELOPMENT

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*Elena Irwin's area of specialization is regional and community economics. Her primary research interests focus on the causes and consequences of growth in local and regional areas, including changes in settlement patterns in suburban, exurban and rural areas; the life-cycle and policy factors that influence households' residential location decisions; the value of open space and open space preservation policies; and the linkages among land use change, environmental amenities, and water quality. Her research applies theory and modelling techniques from the fields of spatial and regional economics, including the application of spatial econometrics and geographic information systems. Irwin's extension outreach activities provide Ohio State personnel, local and state policymakers, and community leaders with technical information and analysis of population, land use, economic, and other growth-related changes in Ohio communities.*

### ABSTRACT

Urban development in seemingly rural areas is an increasingly common form of new development that is characterized by the merging of rural landscapes with urban economic functions. Examples include natural amenity-rich rural places that attract urban-based businesses and large expanses of low density exurban development in which a large proportion of residents commute to proximate suburban or urban employment locations. Such places are neither fully urban nor fully rural, but rather a blend of rural form with some degree of urban function. Changing economic conditions, including waning transportation and communication costs, technological change and economic restructuring, rising real incomes and changing tastes for natural amenities, have led to these new forms of urban-rural interdependence. This presentation provides an overview of the recent research on the causes of exurban and amenity-led rural growth and the economic and environmental impacts of this growth at local and regional scales, drawing primarily on applied economics research that has been conducted in the U.S. The policy implications of this research, in terms of attracting and managing this growth, are also discussed.

### TRANSCRIPT

Thank you for the invitation to speak this morning, or this afternoon for me. I am very excited to be speaking and regret that I could not be there in person, because I have heard so many wonderful things about how beautiful New Zealand is.

I want to start with a description of the features of rural growth in the United States and then talk about the causes of rural growth and some of the implications for planning and managing rural growth, and what the implications of this are for regions. We can think of the city, the suburbs and the rural areas as comprising a region. I talk in the context of the United States as it is what I have studied, but my comments are general enough to be able to glean something in the New Zealand context.

**Slide 3:** There are two types of rural growth that have some commonalities and also some differences –



- **Exurbia**, or exurban development, which are regions on the outskirts of urban and suburban areas but within the commutershed of a metropolitan area

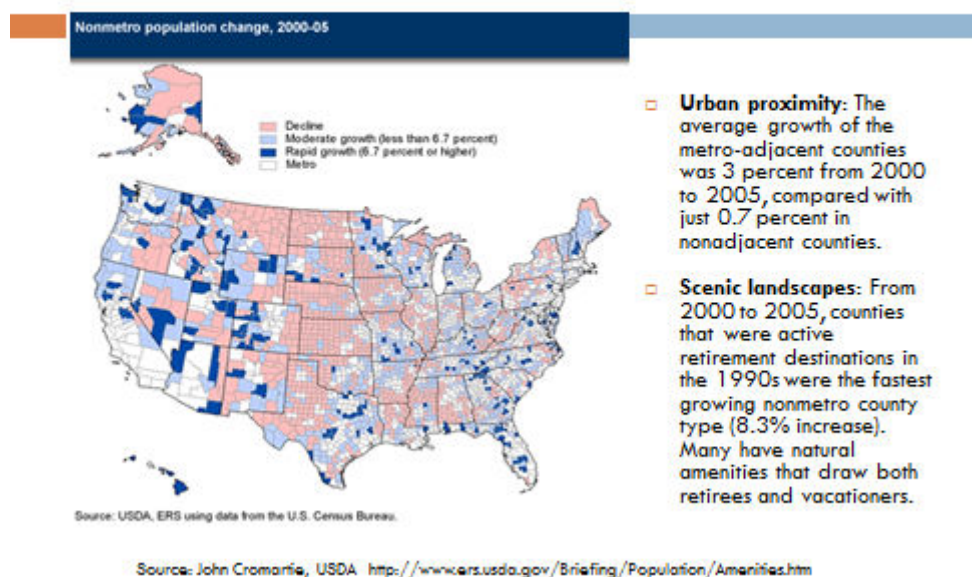


- **Rurbia**, which is a combination of rural, urban and suburban, located in places with high quality environmental or rural amenities, not next to, or adjacent to, an urban area. It could perhaps be the revival of a rural town or region, 'located far away from urban and suburban development'.

**Slide 4** is a map of the United States Population Growth and indicates pink areas that have declined in population between 2000 and 2005, and the darker the blue shows higher the increase in population growth. This map indicates that growth is definitely systematic with a pattern. The mid-central, mid-west area has predominantly seen population losses and growth in rural areas. This is highlighting just the growth in rural areas, not in urban areas, but the growth in rural areas has occurred predominately in the mountain west, the far west, the south west, as well as in the south east, and to the lesser extent to the north mid-west around the Great Lakes region and a little in the north east area as well. An overlay of a map of natural amenities in the United States, showing mountains, lakes and coast line, would show a large correspondence between the location of these natural amenities and the location of rural population growth.

**Slide 4**

## U.S. rural population growth



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There are two systematic features that characterise rural growth – one is rural growth that is proximate to urban areas, but the other is rural growth that is occurring exactly where these scenic amenities are – mountains, lakes, coastlines and other places of natural beauty.

**Slide 5** is a list of the location of the fastest growing, in terms of population, counties in the United States between 2004 and 2005. The last column giving distance to the closest large urban area indicates that many of these are located far from urban areas. Rockwall, Texas, is located twenty miles from Dallas, but some are located over 100, even over 200 miles, away from the nearest urban city. This emphasises the role that rural growth is playing in the redistribution and population growth in the United States.

## Slide 5

### The location of fastest population growth by U.S. county

Rank/county	Growth	Distance
1. Flagler, Fla.	10.70%	25 miles to Daytona Beach
2. Lyon, Nev.	9.60%	80 miles to Reno
3. Kendall, Ill.	9.40%	50 miles to Chicago
4. Rockwall, Texas	7.70%	20 miles to Dallas
5. Washington, Utah	7.70%	120 miles to Las Vegas
6. Nye, Nev.	7.40%	210 miles to Las Vegas
7. Pinal, Ariz.	6.90%	60 miles to Phoenix
8. Loudoun, Va.	6.80%	35 miles to Washington
9. King George, Va.	6.70%	60 miles to Richmond
10. Caroline, Va.	6.50%	40 miles to Richmond

The USA's fastest-growing counties with populations greater than 10,000 in 2004-05, with their percentage of population growth and the driving distance from the county

Sources: Census Bureau, USA TODAY research  
[http://www.usatoday.com/news/nation/census/2006-03-15-census-growth\\_x.htm?POE=NEWISVA#](http://www.usatoday.com/news/nation/census/2006-03-15-census-growth_x.htm?POE=NEWISVA#)

## Features of Exurbia

Exurbia is the suburbs of the suburbs. It exists in every metropolitan area of the United States within some commutershed, which is the distance from which people are willing to commute from a rural area into the suburban or urban employment district –

- 10 to 50 miles from urban centres of approximately 500,000
- 5 to 30 miles from a city of at least 50,000

Exurbia is ubiquitous in the United States and most parts of developed countries. It will vary depending on the size of the urban city, the location, or the suburbs, depending on the growth rate of that city. But it is predictable in the sense that exurban development is found around all urban areas. It is largely residential land use, over 90% is typically comprised by housing of some type, much of it single family. It is not just a contiguous swath of residential, rather a scattered mixture of residential inter-mingled with agriculture, and other non-urban uses. There is some commercial and retail development to service the residential areas.

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## Features of Rurbia

Rurbia happens only in selected rural areas and is development located in faraway rural areas, but not every rural area. There are many rural areas in the United States that are in decline. They have lost their natural resource production base and declining in terms of population area. Rurbia is the opposite; regions or towns that may have been in decline, because of the loss of natural resource base, but in more recent decades has seen a revitalisation of their economies due to an influx of people coming into their region. They are all landscapes of scenic beauty, concentrated in mountains, lakes, coastal areas, or other such natural amenities. They are either scenic or natural amenities.

This growth is not fuelled by people that are connected to any kind of employment in an urban area, rather people who are footloose and fancy free. Retirees make up a large component of the growth in these areas. For example, of the eighty fastest growing retirement destinations in the United States, 74% contain some type of natural forest land. Who knew back in the 1930's, when we were creating our natural forest that they would serve as a magnet of growth as in more recent decades.

The other thing that makes rurbia different from exurbia is the kind of development that occurs. Rurbia is attracting a lot of residential upscale development, often second homes, not primary homes that get developed. Along with this kind of development comes the service to create the playground for wealthy families moving into these areas. Rural landscapes include golf courses, health and wellness spas, wineries etc. This rural landscape is not as ubiquitously developed as exurban areas, but is developed with this hidden upscale development. It looks very rural but has hidden away in it much of the upscale development needs. In addition, the towns themselves have become very upscale containing very expensive retail and restaurants.

The next 'hot spot' is hard to predict. Rurbia happens in the middle of 'nowhere' and the hidden 'upscale attributes' are ready to be discovered. This is another thing that distinguishes it from exurban areas.

### Slide 8

## Rural growth is a process of economic transformation

Variable	Before	Exurbia	Rurbia
Primary economic activities	Natural resource industries (agriculture, logging, mining)	Service industries (retail, commercial services, higher order businesses), Construction, some hobby farms	Service industries (tourism, recreation, health care and wellness, retail), Construction, some hobby farms
Land Use	Agriculture, forest, natural	Residential (over 90% of urban land) and rural land uses; some clustering, some scattering	Mix of residential, retail, services, recreation, rural; highly scattered
Population	Farmers or residents of small towns	Influx of families – seeking safety and good public services  Commute to urban or suburban employment	Influx of young and hip, retirees seeking specific lifestyles  Retired, wealthy or work in local service industry

Elena G. Irwin, Lakes/Water Quality Society Symposium April 8, 2011

**Slide 8** shows a table that distinguishes between the different kinds of economic processes that go on in exurban and rural development. In either case both kinds of rural growth are a process of economic transformation. This is one of the main points that I want to communicate to you today. One can look at what the economic base was before the growth occurred. The primary economic activities before, in either one of these areas, were things such as agriculture, logging, mining, essentially natural resource, or what we call primary resource industries. In exurbia once this growth has occurred we have transformation of the economic activities to primarily service industries. This is also true for the rural development in rurbia. We also have a transformation of the economy into service industries but the components of the service industries are somewhat different. In exurbia there are largely retail and commercial services and sometimes higher order businesses, such as law or finance firms. Rurbia focus on the idea of more tourism and recreation, healthcare and wellness, and of course, upscale retail as well.

Population looks at the types of people moving into exurbia and rurbia. In both cases we are going from a rural population that was largely land based, largely farmers, or engaged in other sorts of primary resource activity, to a population that becomes much more mixed. In the exurban case we have an influx of families coming largely from more urban or suburban locations, seeking safety and good public services. In many cases they are fleeing or escaping what they perceive to be the disamenities or the blight of the more urban areas. In terms of employment this population is tied to the urban or suburban centres.

In contrast, rurbia attracts footloose people, would-be retirees or young hip people looking for a specific lifestyle choice. They may be independently wealthy, or in other cases young but not independently wealthy, willing to work in the local service industry for little pay. For example the Mountain West is littered with young people who are working at ski resorts loving the lifestyle. That is why they are there, not for the pay.

## Slide 9

### Rural growth is a process of economic transformation -- continued

Variable	Before	Exurbia	Rurbia
<b>Income distribution</b>	Low to moderate income base	Influx of moderate to upper income households; widening income gap between old and new residents	Influx of new wealth; widening income gap; income may rise but purchasing power of old residents falls (because of cost of living increases)
<b>Public finances</b>	Little demand for public services	Increasing local tax base, large increase in public service costs (schools, roads, health care, fire, police)	Increasing local tax base, moderate increase in public service costs
<b>Nature</b>	Natural resources as inputs into production processes	Open space amenities as an attractor of growth	Natural amenities as basis of economic growth

Elena G. Irwin, LakesWater Quality Society Symposium April 8, 2011

**Slide 9** continues the table with other aspects of this economic transformation in terms of income distribution. Before the growth occurs we typically have, in these mainly agriculture or primary resource based regions, low to moderate income base. This

changes with the influx of new people coming in. In exurbia the influx of income is heterogeneous in the sense that it is not all necessarily wealthy people immigrating to the areas. One of the reasons that people come to the exurbs is because they perceive they can get a deal, in terms of a larger house with a larger yard and without paying the same per square foot expenses that they might in the suburban or urban area. This creates a division between the existing residents, the old residents and the new, but it is not as large as in rurbia which has an influx of new wealth coming from outside the region and a stark division between the existing and new residents in terms of income.

In terms of public services both exurbia and rurbia development demand a lot more in public services, but this is particularly true in the exurbs. The reason is the influx of residential families. Families are the most expensive group to serve in terms of schools and other public services demanded. Exurbs struggle with this cost of community services and footing the bill for the large residential development created. In contrast rurbia attracts retirees, which in some cases come with greater cost for health care, but on the other hand they do not have children so less burdensome on local tax payers.

The last point in this economic transformation is how nature is transformed in these areas. Nature starts out before the growth happens as an input in the production process. For example, trees are logged to produce timber; the land is being used as an input in the agricultural production. In contrast, in both the exurban and rural cases, nature becomes a commodity that we no longer use as an input in production, but we are literally consuming it. So in the exurban case it becomes open space amenities, which can simply be a farm field or pasture that will attract growth. In rurbia the natural amenities are the engine of growth in terms of that beautiful mountain side, lake, or beautiful coast line that is attracting that growth.

## Slide 10

### Rural growth leads to increased rural-urban interdependence

Rural depends on urban for:	Urban depends on rural for:
Employment	Labor force
Private and public services	Market for private and public goods and services
Urban amenities	Market for urban amenities
Market for recreation activities	Recreation
Market for agriculture products	Food safety and security
Demand for environmental stewardship	Natural environment
Property taxes/land market	Land for residential and industrial expansion

Source: Mark Partridge, OMFRA Policy Workshop Guelph, Ontario (2008)

**Slide 10** is the crux of my talk today. Rural growth, whether in the exurban or rural case, leads to increased rural urban interdependence. Before rural growth occurred we had separateness between rural and urban areas, and urban areas had their own economy. This rural growth shows a fundamental interdependence between the economy of rural areas and the economy of the urban areas. We can no longer separate the two.

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For example, in this table, the left side shows the ways in which the rural area depends on the urban area which may be the typical way we are used to thinking about things. The right side is the flip of that, urban areas depend on rural areas. Looking again at this left hand column, what are the ways in which rural areas depend on urban areas? Some of these are very obvious in things that we are used to thinking about, for example, urban areas provide employment, private and public services. When I want to go to the art museum or any other cultural activity I go to an urban area. They also provide other urban amenities.

What we may not be used to thinking about is that urban areas provide a market to rural areas for things such as recreational activities. In other words the demand for recreational activities comes from urban areas, and many of these recreational activities are located in rural areas. Urban areas also provide a market or demand for other things such as agricultural products and certainly environmental stewardship.

Looking at the flip side on the right side of this column, what is it that urban areas depend on? How is it that urban areas are dependent on rural areas? Clearly they are drawing labour force from the rural areas and also providing a market for rural produce, goods and services. Rural areas also provide markets for urban areas for public goods and services and demand for urban amenities. They also supply recreation, agricultural goods including food safety and security, and the natural environment. They provide the land base for further expansion of the urban and the suburban areas. These are primary ways in which urban and rural areas are interwoven, and cannot be separated anymore. This has important implications for the planning process, something that will be followed up later.

### **Causes of rural population growth**

There has not always been this level of interdependence across urban and rural areas. Some of the factors that have changed have effected both exurban and rural areas, in other cases, one more than the other. Some of the major factors have to do with economic restructuring that has occurred for many years now, income growth, changing demographics and the draw of push and pull of public services and local goods. Other factors are more specific to exurban areas, such as declining transportation costs, central city decline, access to labour markets and proximity to urban amenities and are very important for the exurbs and exurban growth.

The two final factors that have tilted the tables more towards rurbia or rural growth are the declining communication costs and proximity to scenic amenities. We no longer rely on face to face communication, instead we substitute it with information technologies, which allow people to be much more foot loose than they have in the past.

In terms of economic restructuring, it is important to understand that we are no longer in the old economy, specifically in developed countries where manufacturing was the engine of growth. Industries would locate to places for advantageous resources, ports or good transportation networks. Households would follow the industry to wherever the industry located. The new economy is very different and service-based. Information and the creation of knowledge are the drivers of growth. It is important to note that it is not only that households follow firms, but firms follow households which explains a big part of the rural growth. Households look for quality of life, high quality amenities and public goods, and these can be found in rural areas. The tables have turned; households are locating in rural areas and firms are following households.

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There is a decline in manufacturing and primary production industries such as agriculture and natural resources and there is increasing wealth for many, though not all, households.

### Declining transportation and communications costs

It is the importance of the declining transportation and communication costs that has made this economic transformation possible and much more interdependent on a regional and global scale. In the 21<sup>st</sup> century communities are connected through flows of production, consumption, and information, in a way they have never been connected before. We no longer have isolated communities. This means, particularly for any kind of region, urban or rural, they must now compete nationally as well as internationally for scarce people, capital and entrepreneurs who bring growth to that region. This is particularly important for rural areas, because a small change in competitiveness can make a big difference in terms of these flows.

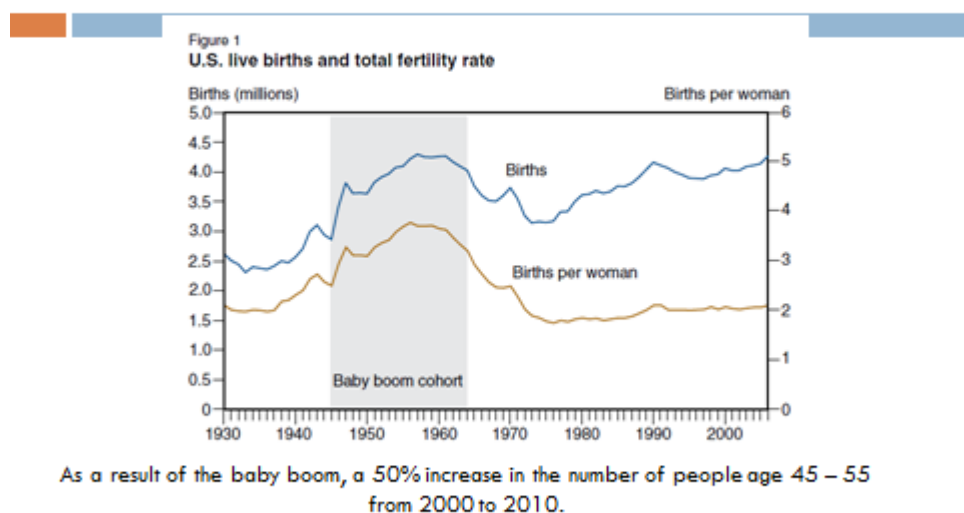
The other implication is that this interdependence is not just at a global scale, but also at a regional scale. We have regions that are comprised of urban, suburban, exurban and rural areas that extend far into the rural hinterland. Cities as small as 10,000 people will have growth, and impacts from that growth will spread out literally hundreds of kilometres from that city.

It also means greater commuting with larger market sheds for shopping, health care and other services, participation in service organisations, etc.

### Income Growth

#### Slide 17

### Demographic shifts: aging baby boomers



Source: Cromartie and Nelson (2009) USDA ERS report 79 <http://www.ers.usda.gov/Publications/err79/>

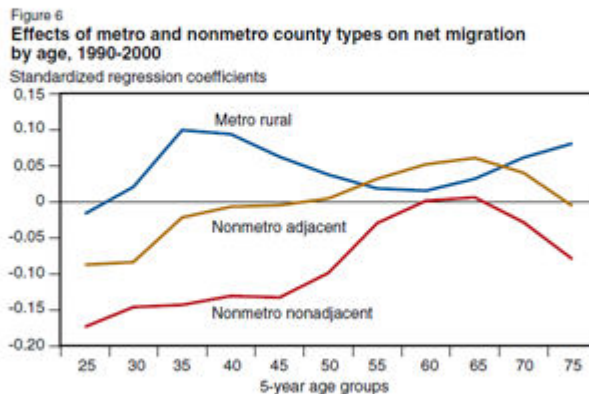
**Slide 17:** Between 1982–2002, the United States population increased by 24.2%, personal income by 77.2% and developed land by 46.3%. Housing and land are 'normal goods' – when income increases, so does the demand for these goods. The demographic shifts occurring that have driven this are aging baby boomers. There was an uptake in birth in the 1950's and these people have worked their way through our economy and are now retirees.

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**Slide 18** shows a primary reason why rurbia has been growing, because the number of retirees in the United States has grown tremendously in the last decade and will continue to grow for the next decade.

**Slide 18**

## Retirees are attracted to rurbia



Source: Cromartie and Nelson (2009) USDA ERS report 79 <http://www.ers.usda.gov/Publications/err79/>

### Public services and local goods

The role of public services and local goods influences pushes, or push and pull factors. In a city, suburb and exurb, there are factors that will push or pull people towards them that have to do with the quality of living in each one of those places. In economics we talk about household sorting, households that vote with their feet, in the sense that they will vote for the neighbourhood that has the best bundle of services, amenities and attributes relative to the tax rate and the house price. They will vote for that neighbourhood literally by moving there in a way that maximises their wellbeing. This is called the Tiebout hypothesis. There is a dynamic two way relationship as households move to a neighbourhood and they impact the quality of that neighbourhood. A richer household, moving into a wealthy neighbourhood, contributes to the tax rate, which increases the quality of the public goods provided, which attracts additional rich people to that neighbourhood. This creates a dynamic two-way relationship between household location choice and the quality of the local goods. These interactions create and react to pushes and pulls.

**Slide 20** demonstrates a very important push factor in the United States pushing people away from urban areas towards the rural areas, and that is the fact that many of our cities have been in decline for many years. Our research found that certain neighbourhood variables, particularly school quality, explain why people leave the city and go to suburban or exurban locations. An important factor in the United States, which I understand is similar in New Zealand, is that most cities and counties have local jurisdictions and do not cooperate. We have competition for growth that can be very detrimental and leads to, for example, a lot of inner city decline.

Slide 20

## Push factor: Household sorting and urban decline

- Relative effects of a change in neighborhood quality in the city versus suburban locations:

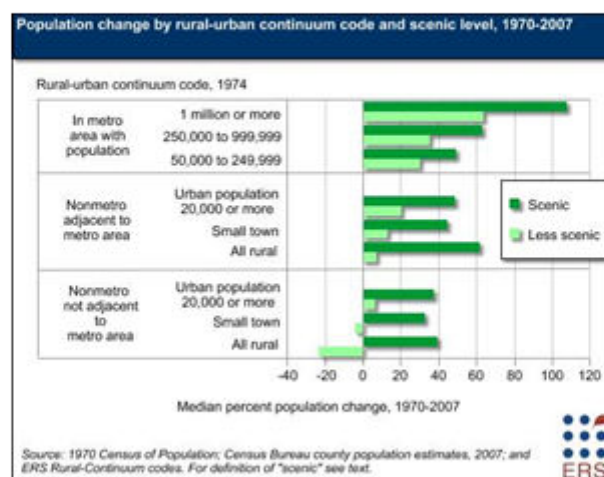
1 % change in neighborhood variable	Change in probability that household chooses to live in city
Decrease in school quality	- 3.7%
Increase in crime rate	- 0.2%
Decrease in median income of neighborhood	- 2.1%
Increase in age of housing stock	-0.8%

Source: Bayoh, Irwin, Haab (2006). "Determinants of residential location choice: How important are local public goods in attracting homeowners to central city locations?" *Journal of Regional Science* 46(February): 97-120.

**Slide 21** indicates that the most important pull factor is scenic amenities in both urban and rural areas. This bar graph shows population growth between counties with scenic amenities, and counties with less scenic amenities. Those counties with scenic amenities have outpaced consistently less scenic county population growth across the urban rural continuum.

Slide 21

## Pull factor: Scenic amenities

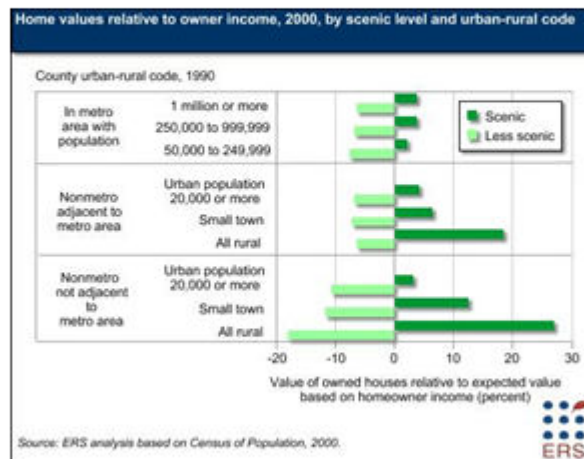


Source: David McGranahan, USDA <http://www.ers.usda.gov/Briefing/RuralAmenities/urbanization.htm>

**Slide 22** shows the exact occurrence for housing values. Across the urban rural continuum the scenic counties have outpaced the less scenic counties.

**Slide 22**

## Pull factor: Scenic amenities



Source: David McGranahan, USDA <http://www.ers.usda.gov/Briefing/RuralAmenities/urbanization.htm>

**Slide 24** indicates Lake Erie amenity driven growth. Lake Erie is one of the great lakes that abuts Ohio and has some coastline along it. While Ohio has not been a fast growing population state, research has shown that there is some amenity driven growth around the lake. Could housing values indicate the demand for lake water quality? The method used was called hedonic analysis.

**Slide 24**

## Lake Erie amenity-driven growth



**Slide 25** shows the results of this research. The method relates water quality variables with the housing price and identifies the separate contribution of that water quality variable to the overall housing price. By decomposing, we are able to estimate the demand for water quality. Water quality has been measured in two different ways; one looking at bacterial loadings, or Fecal Coliform counts, the other is of Secchi disk depth which measures water clarity. Using different scenarios the research measured the mean willingness to pay for each individual household living within some proximity of Lake Erie, in terms of either bacterial loading count or the secchi disk depth, which is the water clarity. For example, in the top table, the average fecal level in the whole study region was 256 counts per 100 millilitres.

If water quality improved to 250, the mean benefit per household would be over \$4,000. In other words, each individual household would be willing to pay that much in terms of an extra cost to the house in order to have that improvement in water quality. This is at the individual household level so added up over many houses in the region it is a big number in terms of willingness to pay. The research showed that the water quality of Lake Erie has significant effects on housing values and households are willing to pay for improved water quality.

## Slide 25

### Demand for Lake Erie water quality

	Target Fecal Level (/100ml)				
	350	300	250	200	150
Mean Benefits per Household (\$)	\$2,915	\$3,308	\$4,242	\$5,807	\$8,216
% Affected Houses in Sample (actual level > target)	23	32	39	45	50

	Target Secchi Disk Depth (cm)			
	100	150	200	230
Mean Benefits per Household (\$)	\$1,998	\$2,303	\$4,668	\$4,339
% Affected Houses in Sample (actual level < target)	1	16	41	61

Source: Ara, Irwin, Hoab (2010) "Measuring the effects of Lake Erie water quality using spatial hedonic price models." Manuscript

## Exurbia: Implications for Planning

In the exurban areas, the engine of growth in the exurbs is regional economic activity, which could be growth, or it could be decline. From the planning perspective, because the growth is regional, the planning also needs to be regional. There needs to be a regional governance approach looking at planning of the exurban growth. For example, there are some costs that accrue with exurban growth. There is an increase in public service demands and in terms of the impacts on the environment. These costs should be shared regionally. There is also a benefit to that growth because it brings in additional income and tax revenues. Those benefits should be shared regionally as well. From a planning perspective, it is also important to note that not all growth is good growth. There has been much growth in the United States that is what we call sprawl, increasing the congestion

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and eroding the rural amenities, exactly the amenities that have attracted the growth in the first place.

### **Rurbia: Implications for Planning**

Planning for rurbia is similar but also a little different, because the engine of growth is different. The rural atmosphere, or the undeveloped nature of the landscape, attracts the growth. From a planning perspective it is absolutely critical that the growth allowed to occur in these areas is both selective and protective. It is not any type of growth because it is essential to preserve the rural nature and natural amenities, the very assets that have attracted the growth in the first place. Things such as restoring and protecting eco systems become a key economic development strategy in this situation. The other thing that makes rurbia different is that rurbia can reach market saturation quickly. Because people are attracted to rurbia for its very rural nature as soon as that starts to change people are going to pick up and go elsewhere. Growth spill over effects can occur. As soon as congestion sets in, or housing prices rise, people will pick up and go to the next new rural town or rural area. Once again we come back to the importance of planning on a regional level so that we can incorporate and account for these kinds of growth spill overs.

### **How can cities influence rural growth?**

There are these push pull effects. Cities can either create exurban and rural growth by repelling it, meaning the cities decline and they repel the growth out to the rural areas, which is a push effect. Alternatively they can attract growth to rural areas, utilizing the regional strategy talked about earlier, pulling the growth, rather than pushing the growth into the rural areas.

How can they do it? Cities can work regionally to invest in their rural regions. People are attracted to rural regions for natural amenities, but natural amenities in themselves are not the whole answer. Amenities are produced within inputs of nature but also inputs of private and public capital. The fastest growing amenity-based rural areas are those with complementary manmade facilities, such as ski-resorts, trails, lodges and golf courses. But enjoying natural amenities is not easy if there is no adequate access. Road infrastructure and other development infrastructure are absolutely critical in order to enhance those rural amenities and attract the growth. We also have to have strong production land use and rural protection policies in place to protect those amenities once growth starts to occur.

### **Is rural growth good for cities?**

Rural growth can either be a complement or substitute for city growth. In the case where growth is pushed away from the city into the exurbs, rural growth becomes a substitute and clearly not a good thing, and exactly the situation in many of our cities in the United States. On the other hand rural growth can be a complement to urban development and growth if the rural advantages work to pull in growth and population from outside that region, rather than just redistributing the population within the region. If a new population, firms and investment come from outside the region, then rural growth can certainly benefit the whole region including the city. It critically depends on the local and regional governance structure. Where the regional governance structure includes the city and rural areas then they work together to try and enhance these complementarities between the rural and urban areas.

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My answer is good rural growth is good for cities and bad rural growth is not. What do I mean by good rural growth? These are things that complement the urban areas, protect the environment, promote the quality of life and attract knowledge high skilled workers. Bad rural growth does just the opposite, its unplanned, does not protect the amenities and by doing so, it erodes the very features that attracted people there in the first place.

A final caution is that fast growth is hard to manage. So I emphasise the importance of policies that both protect and enhance the rural amenities, policies that will slow down the growth, or at least manage the growth so that policy makers and planners can stay ahead of the growth rather than trying to play catch up.

Thank you.

*For more on exurban research in the United States, visit the Exurban Change website at Ohio State University: <http://exurban.osu.edu/>*

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## DISCUSSION PANEL - QUESTIONS

**Don Atkinson LakeWater Quality Society:** Rurbia – a new word for me today but I would like to focus on that. We see our region as one having all those resources that you identified, including a council that represents both city and district. But within the wider United States you must have observed some regions and councils that have got the same resources but some have achieved it and some have not. What have those key matters for achievement been, please?

**Dr Elena Irwin, Ohio State University:** That is a great question. Rurbia is selective in its growth and to some extent it is very difficult to predict where the next hot spot rurban development is going to be. But there are some common qualities across the areas that have seen this kind of growth. Some of those clearly are the natural resource base that you have.

Secondly there has to be something that is the next upscale activity or attributes that rurban seekers are looking for. Let me give you a specific example – in the United States fly fishing two decades ago was a rural activity. It has now become a multi-million dollar business where we have outdoor sporting goods that can outfit you for many, many dollars and just as many dollars on your fly fishing pole. Locating the best fly fishing part of the river has become an expensive business as well, with lots of people willing to tour you around these rivers and locate the spots. That would be an example of an activity that used to be rural and now has suddenly become very upscale and hip. Part of what feeds the location of the next rural hot spot is whatever that next upscale hip activity might be.

Other examples would include things such as rock climbing or wineries. Wineries have been around for a long time but they continue to hold their sway in terms of hipness and a fad or fashion that is the difficult part of growth to predict. But the important things to have in place are exactly what you said, the natural resource base and the planning so that when the growth comes you are able to manage it in a way that you are protecting and enhancing your natural resource base, rather than letting it erode.

**Don Atkinson:** You need to come and visit us.

**Dr Elena Irwin:** I would love to.

**Steve Goldenberg, Earlham College, Indiana:** What do you think the future and the viability of rurban and exurban growth might be if the peak oil crisis develops?

**Dr Elena Irwin:** My comments did not address the fact that since about 2007 we have had a major economic crisis. In many exurban and rural areas in the United States we have seen major foreclosures and drop off in the housing market. Residential construction has come to a standstill in many areas. We have done some work looking at what we call the housing glut, or in another words, the excess housing supply. One of the assertions was that the exurbs have been harder hit than urban or suburban areas in the United States. What we found is that that is not entirely true. In fact the exurbs have survived the best in the north, east and in the mid-west and in the west they have been the hardest hit. It seems to be that where growth was occurring very rapidly in places like Arizona and New Mexico and some south eastern places, those exurbs are suffering the most with vacancy rates of over 50% right now.

Now your question was specifically with respect to peak oil, and whether it is peak oil or the fact that we are going to get some kind of carbon trading tax and gas prices are rising, all energy is going to get more not less expensive. That is going to have some moderating

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effect on exurban locations and it remains to be seen whether it will be on what I call rurbia. They are not commuting into an urban or suburban employment centre like people in the exurbs. So it is more of an open question about what it might do to rurbia and I think rurbia could survive quite well.

**Nick Zaman, Bay of Plenty Regional Council:** You said rurbia are quite far distances from normal employment areas, but what about the planning for the service industries that develop around these rurbia locations. You mentioned the demographics are quite different, a lot of older people, retirees and quite well to do people as well. How do you allow for different planning types, in that you still have to service these areas? It is particularly relevant to peak oil and those people commuting in the service industry who are not able to afford to live in these places.

**Elena Irwin:** Can I clarify, when you say service industries, what specifically do you mean?

**Nick Zaman:** – Is it more a seasonal development where people come in for the season to support the trout fishing etc, or is it longer term involving healthcare needs, transportation, etc.

**Elena Irwin:** When rurbia first takes off it tends to be quite seasonal because it is very much a tourism and recreational, weather based activity and economy and you do see a lot of the seasonality. However, as it gets going more and more people locate there, not just for their second homes, but for their primary homes as well. That would include the retirees as well as other people who may be able to work remotely in these places and only have to check in with their job maybe once a week or so. As that transition occurs firms will relocate to these places. It becomes more of a year round economy, not just a seasonal economy, even though the tourism and recreation may still be a large chunk of the economic activity. The demand for public services really takes off at that point, once it becomes a year round economy no longer dependant on the natural resource recreation base. But it also starts to have its own economic drivers in terms of other service sectors, possibly even higher order businesses such as insurance, finance, etc.

**Denise La Grouw, Hannah's Bay Community Restoration Trust:** My question is for you John, and it is more holistic, I was very excited to see your presentation, and in particular in relation to becoming the Spirit, the Spirit of Love. The healing of our lakes water quality is an opportunity to heal our people and raise the standard of the way that we live in Rotorua. Are you keen to lead this Dream Team?

**John Sax:** Always very happy to contribute to a Dream Team.

**Matthias Schellhorn, Canterbury and Lincoln University:** I have been teaching both at Lincoln University and the University of Canterbury. I am fascinated about this concept of rurbia and rurban development. From what you outlined I see a great dilemma on the horizon in that the very nature of that kind of development means it will eventually lead to its own demise. I would call that the paradox of rural development.

I wonder how far there is a cultural context to this as well, in the sense that here in New Zealand part of the activity of the rural environment is derived from the fact that it is not entirely commercially developed. We value our environment partly for the fact that it offers a space away from commerce. How do you see the potential to address this paradox of rural development, whereby it leads to its own demise, and how do you see the potential for preserving some of what I would call 'intrinsic human need' to find spaces that are devoid of commercial development?

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**Chair - Roger Gordon, Chamber of Commerce:** I am going to ask you not to spend three hours answering that question Elena.

**Elena Irwin:** We could spend all morning debating the merits of that. Let me try to give a short answer. It comes down to what the community values are, and how the community itself wants to balance the economic goals with the nature preservation and social goals, and all the other goals that would come into a community planning process.

That is my shortest answer. My slightly longer answer would be that we do see different trajectories of these rural places. For example, we see that in some cases there is exactly what you described, the dilemma that occurs when the growth that leads to the rural amenities, which attracted the growth in the first place, becomes eroded and lead to their own demise. It is not of course a full demise, there are still people living there but it perhaps did not achieve the kind of preservation of the natural amenities, or the economic growth that it could have.

We do also see other rural places, such as Bend, Oregon and Bozeman, Montana, which are examples of places that make the full transition from a rural place into what you would call an urban metropolitan area. In fact some of these places are not categorised as metropolitan areas because of the population growth. They are fully functioning urban, suburban, rural areas, although they may look different than our traditional cities, but they function in exactly the same way. In essence they have made a transition from being a rural place into an urban place, with all the full functionality of an urban economy, but still, because they have access to the rural areas around them, retain some of those rural qualities. But they themselves as a town have not maintained the ruralness, they have transformed into urban.

**Chair:** –Thank you, it is with reluctance that we are going to have to finish this session. Elena, thank you very much for beaming into us today and we would like to extend an invite to you to come over and join with us so we can have more of this wonderful dialogue.

Thank you very much.

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## ***Session Six - Planning for Growth (1)***

**SESSION CHAIR: Rt. Hon Paul East**

### **CENTRAL GOVERNMENT**

**Hon Dr Nick Smith**

Minister for the Environment  
Parliament Buildings, Wellington  
nick.smith@national.org.nz

***Hon Dr Nick Smith*** was born and educated in North Canterbury in a bridge construction business family. He subsequently completed a first-class honours degree in civil engineering and a PhD in landslides at Canterbury University.

*Nick was politically active from a young age and influenced by a year as an AFS scholar to Delaware, USA. He became a district councillor while studying and has held many offices in Young Nationals and in the senior National Party prior to being selected as the National candidate for Tasman in 1989. He won the Tasman seat in 1990 and 1993, and following the introduction of MMP, Nelson in 1996, 1999, 2002, 2005, and 2008, despite both having a long previous history as Labour areas. Nick has held nine Ministerial portfolios in the Bolger, Shipley and Key Cabinets, covering Conservation, Education, Immigration, Corrections, Social Welfare, and Treaty Negotiations. He is currently Minister for the Environment, Climate Change, and ACC.*

*His greatest passion has been improving New Zealand's management of the environment and natural resources. In 1998, he founded the Bluegreens as a group within National that wish to advance policies that support economic prosperity and a clean, green New Zealand. National achievements in which Nick has played a significant role include the creation of the Kahurangi and Rakiura National Parks, 12 Marine Reserves, the introduction of the Emissions Trading Scheme to reduce greenhouse gas emissions, the establishment of the Energy Efficiency and Conservation Authority, and the Environment Protection Authority.*

### **TRANSCRIPT**

Kia ora hui hui tatou katoa

I am delighted to join you for this symposium today, and I want to congratulate the LakeWater Quality Society on its role and for this event. This morning I want to talk about the Government's agenda to improve freshwater quality in New Zealand. This includes: closer collaboration; increased funding; stronger central government direction; improved regulation; the need for better science; and a set of consistent and transparent reporting that will ensure we can monitor progress.

Before I touch on these, I want to acknowledge the many participants here, the people of Te Arawa and a special welcome to our overseas guests Bo Frank, Mayor of Vaxjo in Sweden, and Dr Elena Irwin of Ohio State University and thank them for their contribution. Can I also acknowledge Rotorua MP Todd McClay, who has been a constant and effective advocate in the Government for the Rotorua Lakes.

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I welcome the theme of your conference, *Fix a Lake and Grow a City*, in particular the topic you have asked me to speak on – planning for growth. Because it is planning for growth, in terms of how New Zealand can get the best out of freshwater, that has been forefront of my mind as Environment Minister.

## **Rotorua Lakes**

But first, I would like to acknowledge what has been happening here on a local level to clean up the Rotorua lakes. I have a personal interest in this from my time as a Master's Hydrology student at the University of Canterbury Engineering School studying stratification and mixing in Lake Rotoiti.

Rotorua is central to tourism in our country, and its iconic lakes are a key part of its attraction to more than half a million international visitors a year. With tourism one of New Zealand's biggest export earners, the Government has a key stake in the continuing success of Rotorua as a tourist destination.

The Government also has a key stake in the clean-up of these iconic lakes. This is demonstrated by our commitment of more than \$72 million to the Rotorua Lakes Protection and Restoration Programme. This funding amounts to 50% of the total cost. As you know, the programme focuses on addressing the different sources of nutrients entering the four lakes identified as priorities – Rotorua, Rotoiti, Okareka and Rotoehu. Key components of the programme include sewerage works, treatment or diversion of nutrient-rich streams, capping lake sediments to lock up nutrients, construction of wetlands and changes to land management.

I am really pleased to note the good progress being made under the clean-up programme. I particularly welcome the progress on the Rotorua District Council's sewage reticulation projects.

Last year I had the pleasure of visiting the Ohau Channel Diversion wall which is predicted to reduce harmful algal blooms by 40% within five years. And while it is early days, the clarity of Lake Rotoiti has improved markedly since the wall was completed.

I know that considerable effort is being put into finding cost effective ways of achieving the programme's large nutrient reduction target of 170 tonnes of nitrogen per year from land use change for Lake Rotorua.

As you will be aware, the Government is keen on promoting collaborative approaches to addressing environmental issues. I was greatly encouraged to hear of the engagement now taking place between the Council, sector groups and land owners to tackle these difficult issues. It is our best chance of making progress. I have been informed that following extensive discussions with representatives of the dairy farmers in the catchment, a significant industry commitment has been made through Dairy NZ to assist in finding and promoting appropriate land use solutions. In addition to this, the Council is developing a pilot grant scheme to trial a more effective way of engaging with landowners within the Rotorua catchment.

I look forward to further progress being outlined in the Intervention Packages for Lake Rotorua that is being developed. This will determine a cost-effective and efficient package of new and existing measures to ensure that no more than the sustainable level of nutrients enters the lake.

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The challenges you face in Rotorua are symptomatic of the far larger task we have in improving freshwater quality throughout New Zealand. Our goal has got to be ensuring other significant lakes do not deteriorate to the point where we face the sort of issues over eutrophication that has occurred here in Rotorua. This Government has made improving freshwater management an important priority.

### **The importance of freshwater**

The importance of freshwater – both to our economy and the environment that the economy is based upon – cannot be overstated. Freshwater is New Zealand's key strategic and productive asset. It is what gives our \$11 billion a year dairy industry its competitive advantage. It is pivotal to our clean, green brand and our \$8 billion a year tourism industry. Add in the contribution to our meat, horticulture, cropping, fresh water aquaculture and wine industries and we are looking at more than \$30 billion per annum.

Water is to New Zealand what minerals are to Australia. Managed wisely, our fresh water resource, unlike minerals, will be available for generations to come. But freshwater is so much more than just a commodity. It has cultural significance to Maori. It is also what makes our great Kiwi lifestyle – the fishing, swimming, kayaking and rafting.

### **The challenge**

On an international scale New Zealand's water quality is very good. The 2010 Yale and Columbia University Environmental Performance Index ranks us second in the world only to Iceland with a water quality index of 99.2 out of 100. However, this national index overlooks areas of increasing problems. Many of our lowland streams and our shallow lakes, especially in areas of intensive farming, have significantly deteriorated. The problem is that water has been so plentiful that in the past we have not had to be too sophisticated in how we have allocated or managed it.

Now there is accumulating evidence that our current system of water management is failing – to the detriment of both our economy and environment. It is not our view that the RMA framework is fundamentally broken. The Act has worked well in vastly improving many point source discharges. The real problems are in how we deal with the diffuse, incremental pollution and this is where we need to do considerably better.

I was pleased to see that this is being addressed in Rotorua with the Bay of Plenty Regional Council's proposed Regional Policy Statement providing a robust, integrated approach to the management of the region's natural and physical resources.

The Regional Policy Statement now requires a managed reduction of nutrient discharges in excess of the allowable limit for the Rotorua-Te Arawa Lakes. It has also replaced the high level water allocation principles with more specific matters to be attended to in allocating and reallocating water.

### **Report of the Land and Water Forum**

It is clear nationally that reform is needed on how we as a country manage our freshwater resources. That is why the Government is taking a fresh lead. The Government's programme is about finding durable solutions to issues of water quality, allocation and storage which are essential to a healthy environment and economic growth. This is in keeping with the Government's Bluegreen belief that economic growth and improving the environment can and must go hand in hand.

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In 2009, the Government embarked on its Fresh Start for Freshwater programme. A key part of this is the work led by the Land and Water Forum. Its mission was to build a consensus view on the best mix of economic, environmental, cultural and social benefits from New Zealand's water. I stated at the time, that if agreement could be reached, even on just a few pressing issues, then it will enable us to make real progress.

It is an extraordinary achievement when 58 very diverse stakeholder groups can come together and agree on a way forward on such a vexed issue as fresh water management in New Zealand.

Following the receipt of the Land and Water Forum's report in September last year, the Government asked the Forum to take its report to the New Zealand public and seek their views on its recommendations.

Today I am pleased to announce that earlier this week the Forum have reported back to me and the Minister for Agriculture with its final report on the completion of this public engagement. I can confirm that what the Forum heard around the country has led them to confirm the key conclusions of its report.

I have been informed that there was agreement on the need for change and to 'get on with it' – as well as a fairly widespread agreement that the Forum had set out a sensible high-level approach to change. Today, I am releasing the papers that the Land and Water Forum has provided to the Government. The Forum also has set out some thoughts about how those recommendations might be implemented. The Forum's engagement was a real success with about 1,200 people attending a series of eighteen public meetings held up and down the country. The meeting in Rotorua was notable for the depth and quality of the dialogue. I believe this is testament to the investment you have made as a community in thinking about how your water resources can be better managed.

The Forum has also provided the Government with some further thoughts on the collaborative process, which I think will be useful as we consider the lessons we have learnt from this approach to dealing with complex national environmental issues.

Before I move on to talk about what the government intends to do next, it might be useful to recap some of the main themes in the Forum's report:

- 1) The water management system is not fundamentally broken, but without improvement, water quality will deteriorate and the best economic advantage of water use will be compromised
- 2) The major gap in the current system is there is no requirement to set and manage limits in the amount of water that can be taken and the amount of contamination that can be released into water
- 3) The setting and management of limits will be crucial to future economic and environmental success
- 4) There needs to be more central Government support, and clearer expectations, to drive that process
- 5) Central Government needs to play a stronger role in partnership with local decision-makers, including iwi
- 6) There is still a place for local level involvement in the delivery of water decisions and management

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## **The Government's next steps**

Now that the Forum has reported back to the Government, I am turning my mind to the Government's response. Without pre-empting Cabinet's decisions on this, it is clear to me that the response will need to cover a number of bases. It will need to:

- support responsible economic growth
- offer improved environmental performance, and
- give clearer Government direction and an effective regulatory framework

Changes of any significance will take time to achieve and therefore I expect a staged programme of reform. The Forum's report has confirmed to me that one of the first steps must be a National Policy Statement for freshwater management. My officials are working on the NPS now. You can expect a public announcement on the Government's decisions this year. This is an important step and I am very mindful of the need to make progress.

As the Land and Water Forum notes in the report, the NPS will not and cannot do the job on its own. It needs to be backed up by a whole range of supporting measures that will help councils and water users adjust to a new way of managing water. We are also likely to need further policy reforms to deal with the matters that are outside the scope of an RMA-based instrument like the NPS. An NPS will therefore only be one part of a larger government package of reforms that will cover the four key elements of good freshwater management.

These are:

- 1) A robust governance system with the roles and responsibilities of all parties clearly defined
- 2) The capacity to identify the quality and quantity limit of fresh water bodies
- 3) The ability to set and enforce numeric limits on the quality and quantity
- 4) An efficient process for allocating the resource to users to ensure water is used in the best way.

Cabinet will need to make some critical decisions to decide the direction of water reform. The Government is commissioning further work from officials as part of preparing a more comprehensive government response to the Forum's recommendations. I expect major changes could then be decided in 2012, with opportunity for more public input into the direction before implementation over the next five years.

## **Conclusion**

I welcome the Forum's contribution to our thinking on water reform and how to get the best environmentally and economically out of this key asset. As the Forum has noted, this is not just a job for Government – all parties, including local government, industry and communities will have a part to play. That is why I am so encouraged to see the good work that has been done in Rotorua from a wide range of parties to improve water quality. Working together we will deliver on a fresh start for freshwater management in Rotorua and more broadly, in New Zealand.

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## **PROVING THE ECONOMIC CASE - FUTURE FORESTS RESEARCH**

### **INTRODUCTION - RUSSELL DALE**

Chief Executive, Future Forest Research Ltd  
Rotorua  
russell.dale@elad.co.nz

*Russell Dale is the Chief Executive Officer of Future Forest Research. He has held senior executive positions in a number of New Zealand's largest forestry companies and has been involved in all aspects of indigenous and plantation forest management. Russell is based at the FFR Head Office in Rotorua.*

*FFR currently groups its activities under four Research Themes, Radiata Management, Diversified species, Harvesting and Supply Chain Management, and Environment and Social. The Chief Executive ensures that there is co-ordination and integration across the four research themes and is responsible for managing relationships with investors, including Foundation for Research, Science and Technology (FRST), and other research organizations such as WQI and RPBC.*

**Russell Dale will introduce the session on Forestry by briefly discussing the opportunities in future forest research.**

### **TRANSCRIPT**

Kia Ora Tatou. Good Morning and thank you for those introductory comments Paul.

I would like to say congratulations, as a local from Rotorua, to the Society for putting this excellent conference together today. I think the organisation and the quality of the speakers that you have drawn together are a real credit to the Society.

I would like, in the few short minutes I have, to introduce you to Future Forest Research Ltd; who are we and what we do? Future Forest Research was formed in 2007 as collaboration between the forestry sector, government and science. The company is governed by a Board of Directors comprising sector and research people. Our principle science partner is Scion, the CRI that is aligned or supporting the forestry sector.

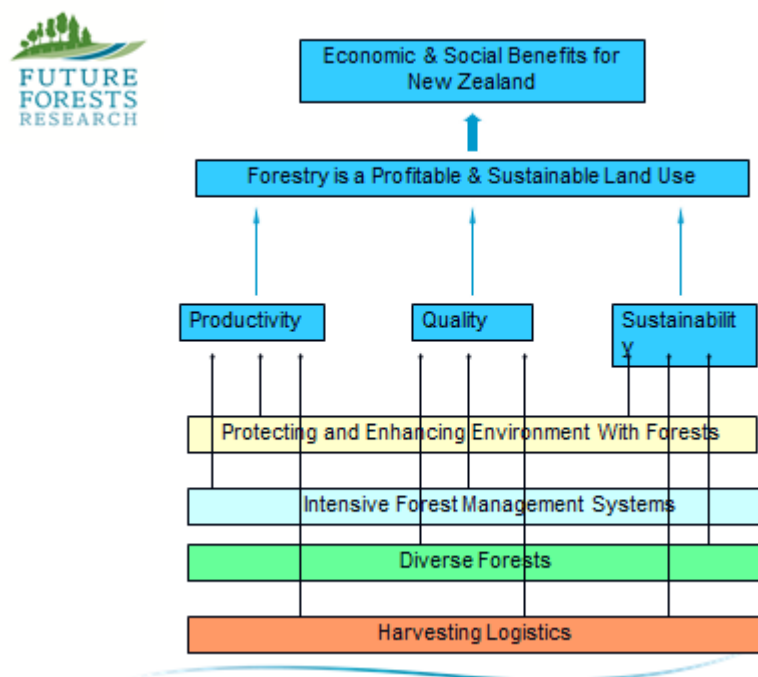
Our purpose is about providing a bridge between the sector and the research providers and a lot of our effort goes in at the front end to ensure that the research being carried out is well focussed, relevant and has good engagement with the end users, because unless you have that your chances of uptake later on, when the research is done, are probably slim. It is also at the back end of the work in assisting with the communication and transfer of that technology across to the end users. If we do the research but do not use it then we have not secured a return on the investment made by our members and our biggest investor, the government.

Who is involved in this programme? We have a broad range of stakeholders from all the large commercial exotic forest owners in New Zealand, ranging from our largest corporates right through to farm foresters which includes those people who have an interest in growing indigenous species. We have Maori forest owners and see them as an

increasingly important group in the future, given their land changes. Also involved are the many advisors and service providers to the industry, all of the education providers that provide education services to the sector, local and regional government participating in the programme and, as I said before, our central government is the largest investor. We have around eighty investors contributing over \$1 ½ million and another \$5 million coming from government.

**Slide 4** shows how our research is organised into four themes and running right through the programmes are three core strategies around productivity, quality and sustainability. When driving a sustainable industry all those elements are key components of sustainability. Our aim is to assist the forestry sector to deliver economic and social benefits to New Zealand. Within those four themes, two are around intensive forest management and harvesting logistics which are about producing the raw materials and providing opportunities for their use, which we will hear more from Hugh and Elspeth after I speak.

#### Slide 4



The other two themes that are probably of more interest to this LakesWater Quality Symposium are around the environment and diverse species areas. Firstly, the diverse species programme is providing opportunities that cannot be met through our main stream radiata pine forest, and to provide confidence to those growers who do want to grow other species on their land. Of particular focus are Douglas fir, our cypress or cedar species, our redwoods and two eucalypts species. They are 10% of the forest area but growing. There is a component of the programme also looking at indigenous species, particularly kauri and totara. There are possibilities with other species in very high quality hardwood flooring and exterior durable timbers.

The environmental theme focuses on three core things, sustainability, valuing environmental externality services, putting values on those externalities, and what our future forest might look like going forwards. The overarching philosophy is aimed very much at providing tools that can assist land use decision making, to recognise the true costs and benefits to New Zealand of land use decisions.

**Slide 7:** A key focus of this programme is to identify key indicators of sustainability for the forestry sector. After quite a lot of work we identified three to focus on around water quality, soil protection and biodiversity. The effort is not focussed on identifying how we collect data on those three key indicators, who collects it and then importantly how we actually report it in a form to our stakeholders? It is not only our forest industry members but the broader stakeholders which we see as the community.

Slide 7



## Sustainability Indicators

### ■ Key Strands

- Water
- Soils
- Biodiversity

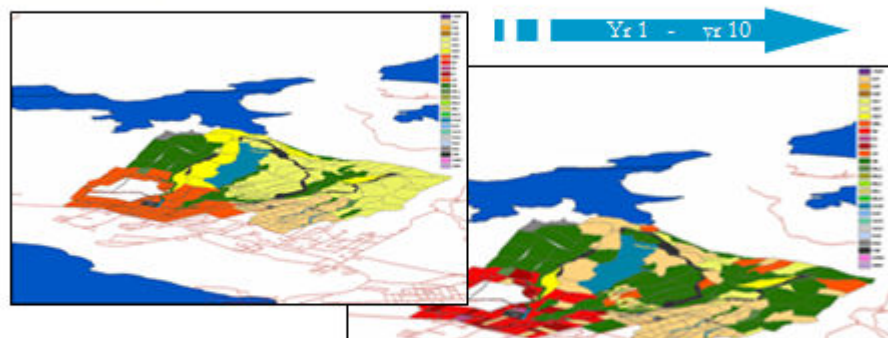


**Slide 8:** One of the things we tend to do in New Zealand is make land use decisions in a very single use way. Foresters look at how they can grow trees on their land, dairy farmers look at how they can produce milk, sheep farmers look at how many sheep they can run on their land. But we are not good at looking across land and asking how we can pull this together to make decisions that provide the best output or return to New Zealand

Slide 8



## Land use Optimisation



**How can societies progress – landscape scale change?.**

- Informs transparent debate & political process.
- Truer costs, benefits and transfers.
- Best net results for NZ inc - including environmental results

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for that land. One of our projects is bringing in a process that values all of the inputs and outputs to identify the land use options that provide the best overall return for New Zealand. It is our most valuable resource and we must make the best use of it.

We have a big project underway in the Rotorua Lakes area, working closely with Environment Bay of Plenty, providing a lot of data and building on an earlier project that was undertaken on the Ngati Whakaue Tribal Land, up behind the airport. How we can take land within the Rotorua lakes area and look at a whole range of land use options, value the inputs and outputs, including the environmental consequences of those land uses, and then look at how that might impact on land use over a longer period of time. The project is at quite an early stage and too early to present to you here today, but I think it will provide a very interesting topic for perhaps the next Symposium of the Society.

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## INNOVATIVE TIMBER STRUCTURES - OPPORTUNITIES FOR EXPANSION

**Hugh Morris**

Senior Lecturer, Auckland University  
hw.morris@auckland.ac.nz

*Hugh Morris has a Master's degree in Civil Engineering and worked in Gisborne before he began lecturing at The University of Auckland in 1989. His research interests include seismic resistant earth house construction and long term performance of large timber structures. He has recently installed a number of instruments into the NMIT building in Nelson that record both static and dynamic performance.*

*For the last eight years Hugh has been involved with teaching timber design and research into structural timber. He assisted in establishing the MAF supported Chair in Timber Design at the University of Auckland and setting up of the Structural Timber Innovation Company research consortium. He was President of the NZ Timber Design Society for two years and is Chair of the World Conference on Timber Engineering scheduled for Auckland in 2012.*

### ABSTRACT

Our industry is producing very good wood from an excellent sustainable resource that is widely used in New Zealand house construction but there are major opportunities for growth in commercial and multi-storey construction. The success of light timber framed housing in resisting earthquakes has been once again seen in Christchurch, the benefits of resilient light weight engineered timber are also significant for commercial buildings.

To expand the New Zealand market and to add value, our sustainable timber needs to be used in more commercial construction. Cross laminated technologies and new connection systems are being used internationally and have real potential for New Zealand and Australia in rapid erection offices and multi-residential structures. The innovations of the Structural Timber Innovation Company have developed new local technology for long span and multi-purpose high rise construction as demonstrated in the first post-tensioned LVL NMIT building in Nelson. The future is bright if these technologies are widely used in New Zealand.

### TRANSCRIPT

Thank you for the opportunity to be here.

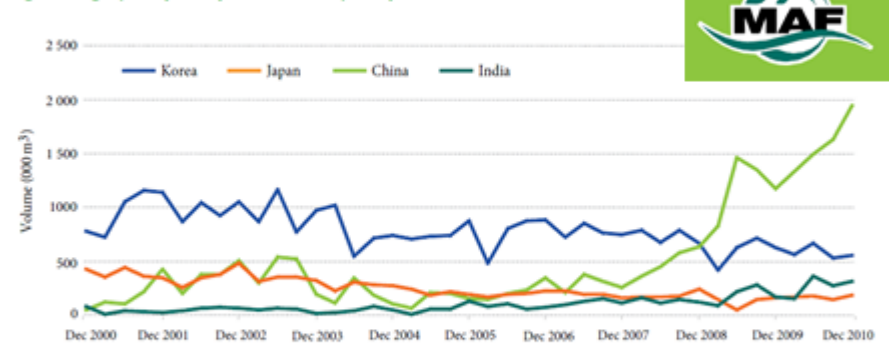
**Slides 2-3:** I am going to talk about timber structures and you probably know that we produce a lot of logs and exported \$1.3 billion worth last year. The total forest sector is now \$4.25 billion. The sawn timber sector is \$842 million of which 45% goes off through the Port of Tauranga. I think that shows just how significant it is in this area.

**Slide 4:** I want to also talk about innovative timber structures and the opportunities for expansion in this sector. I am a structural engineer and will start by looking at existing commercial construction and then move on to what has been happening in Christchurch as a result of the earthquake. I will finish with some of our new technologies and research, particularly multi-storey construction.

Slide 2

## Exports - Logs

Figure 2: Log exports by country of destination – quarterly volumes



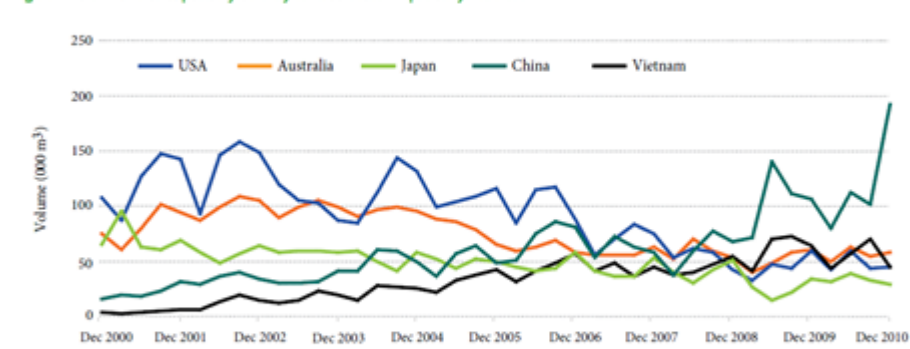
2010 up 42% in value to **\$1.35B**, Total forest sector up 21% **\$4.25B**

Statistical Release FORESTRY PRODUCTION AND TRADE, FOR THE DECEMBER 2010 QUARTER

Slide 3

## Sawn Timber

Figure 4: Sawn timber exports by country of destination – quarterly volumes



2010 up 16% in value to **\$842M**

**45% logs and timber through Tauranga port**

Slide 4 - Six storey building in Switzerland

**Slide 5:** What we are doing is exporting primarily at the low end of the value added spectrum. I would like to see us heading for that high value target right at the top of the slide. While we are exporting \$4 billion worth, there is opportunity for \$10 billion in added value, and Rotorua is in the prime position to get a good part of that.

I am sure that you are familiar with light timber frame houses that most of us live in (**Slide 6**). The light timber frame holds about 90 to 95% of the residential housing. We have also got mundane timber retaining walls and we can do



Slide 5



Slide 6 - Light timber frame



Slide 9 - Fale Pacifica, Auckland



Slide 10 - Wave Footbridge, Auckland



Slide 11 - Yellow tree house, Auckland

nice things with architecture, (**Slide 9**) using our timber materials. **Slide 10** is a footbridge in Auckland making good use of laminated timber, and, of course, **Slide 11**, the yellow tree house advertisement that ended up all over the world. It was even in the Aeroflot (Russian) in-flight magazine. This structure was designed entirely as a promotional

exercise with a life expectancy of six months, but it has been extended because of the interest.



**Slide 13**

**Slide 15** is laminated veneer lumber (LVL), produced in Nelson and Northland and also fabricated into I sections for roofs and floors. They are all engineered timber products.

**Slide 15**



**Slide 16** is the factory in Nelson for Nelson Pine and they produce huge volumes put together in 3mm veneer layers. The LVL process changes Radiata pine from a commodity to a top class engineering product with reliable properties and gives much more certainty about how we use the material.

Slide 16

LWQS ROTORUA LAKES SYMPOSIUM 2011

timber research group

THE UNIVERSITY OF AUCKLAND  
FACULTY OF ENGINEERING


### LVL - Laminated Veneer Lumber

LVL changes Radiata Pine from a commodity to a top class engineering material

Veneers 3mm thick

LVL Producers: Carter Holt Harvey, Nelson Pine

HUGH MORRIS



**Slides 17 and 18** show how large sized timber is used in an industrial building in Hastings and in the Museum of Transport and Technology in Auckland. (MOTAT) It is a very large span building and a visiting German Professor is taking a photograph in the foreground. It is where we are hoping to host the World Conference dinner in 2012.

**Slide 17**

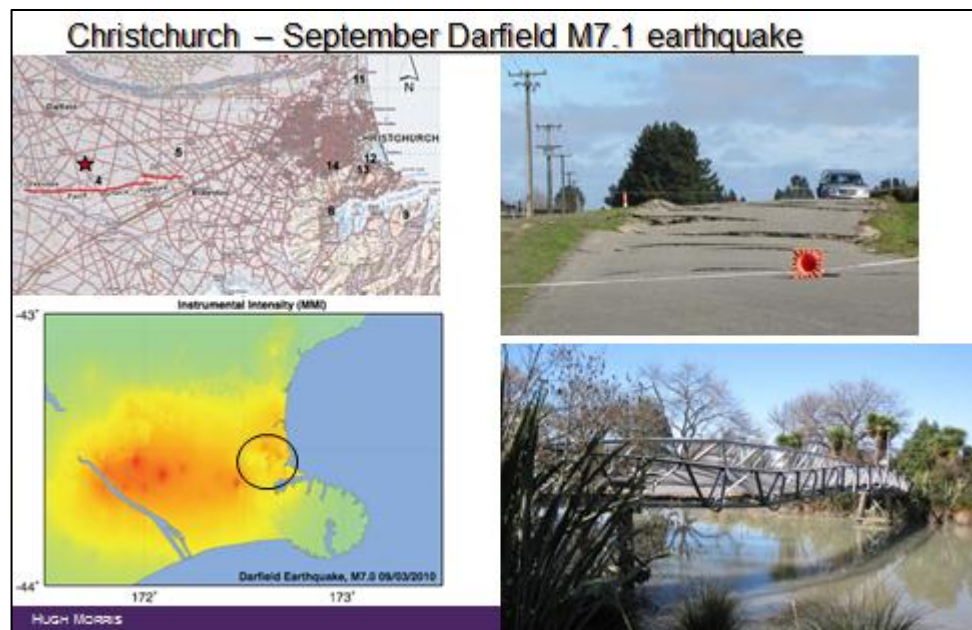
There are opportunities to go beyond our conventional light timber frame into commercial, industrial, government buildings and multi-storey residential. We can make use of our timber in a better way and adding value.

**Slide 18**



**Slide 23:** In September there was a sad seismic event in Christchurch, fortunately no one lost their lives. This slide shows where that happened in a fault trace. I saw these ground deformations, 1½ metres vertically, 4 to 5 metres horizontally, but in Christchurch city there were relatively low ground accelerations.

**Slide 23**



**Slide 24** shows the later earthquake in February was like a bull's eye with major accelerations right in the centre of the city. It impacted a smaller area, seriously damaging a lot of masonry construction. Engineers design buildings to save lives. We have a large number of buildings that stayed up through this level of earthquake which was well in excess of the design. But many of them will need to be demolished, they have done their job.

**Slide 24**



There is an interesting question – should we be designing buildings to survive these and have an economic life after such a major event? I think that timber is one of the materials that will help with that.



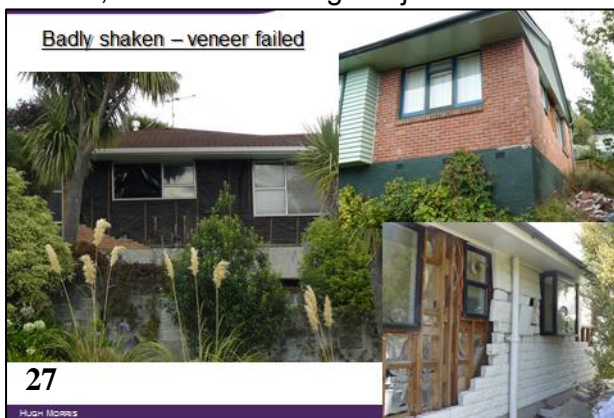
**Slide 25** is up on the hills in Christchurch and shows just how much shaking there was when all the roof tiles fall off the house. The timber house itself is sound and in good condition.

**Slide 26** is another house with the veneer cracked all around it. The people were safe inside, however it was a bit dangerous outside.

**Slides 27 and 28** show more timber framed houses standing up, protecting

the occupants, still keeping the roof up, even though the masonry has come off. People are getting more confident with using timber even with massive ground movement.

**Slide 29:** The garage filled with sand that liquefied and two sides of the house moved down but the middle stayed up. There was major veneer damage. I did put a red sticker on it as you would not want to go back. There was danger around the edge and the front end of the house, but timber did a great job.



Timber buildings mostly survived very well. Some old two storey buildings moved substantially and engineered timber buildings were excellent. The limited number of large timber buildings only had minor damage.

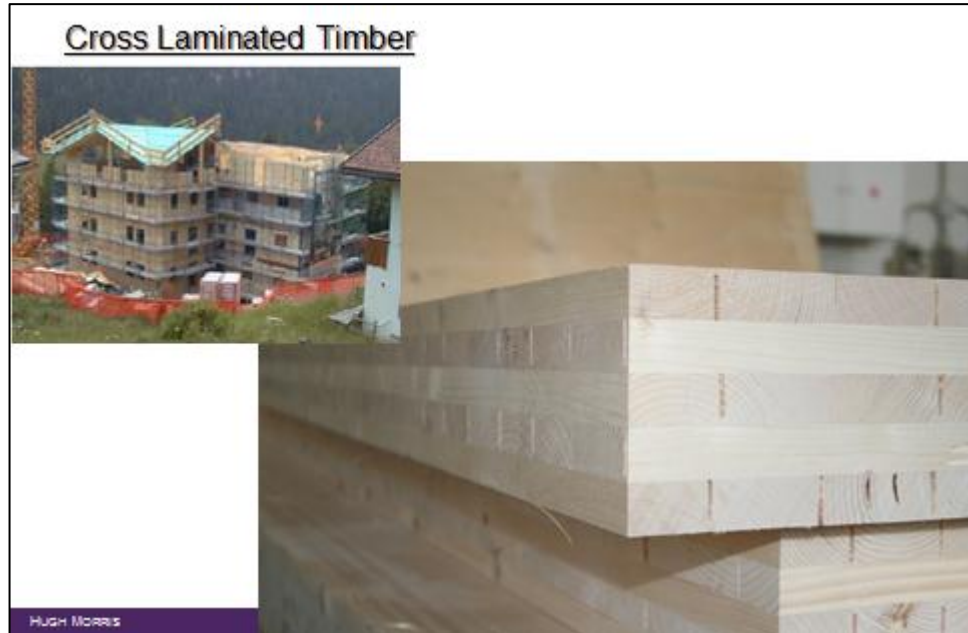
We need to take an example from L'Aquila, Italy, where there was a shallow 5.8 magnitude earthquake which killed 308 people, destroyed 11,000 buildings and left 65,000 homeless. Paolo Lavisci



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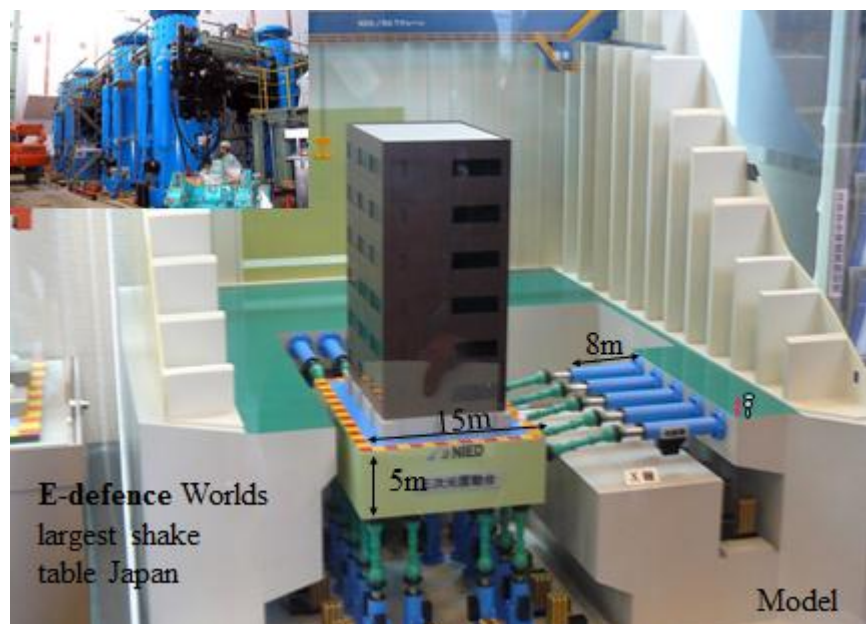
from the Society of Engineers said, “The people in L’Aquila were asking for no more concrete. Wooden buildings were erected meeting people’s full satisfaction.” His company built a number of three storeys, twenty seven apartment blocks, using cross laminated timber. Each one took seventy two days, the watertight outer shell only fourteen days. The completed apartment block weighed 430 tonnes compared to 2,000 tonnes in concrete. In an earthquake the amount of lateral load is related to the weight of the structure.

**Slide 32**



**Slide 32:** Cross laminated timber is where layers of plywood of 25mm are laid in different directions to form a wall panel and put through an automated system. They produce huge sheets, cut out doors and windows, and make a panel that is shifted out and stood up on site. There has been earthquake testing done by the Italians in collaboration with Japan as well as fire testing.

**Slide 34**



**Slide 34:** A couple of years ago, I was fortunate to see the largest shake table in the world in Japan which is about the size of a tennis court. On the right of the slide is the scale of a man, compare that to the hydraulic jacks at the bottom. At the top you can see the white hats of people watching. Actually the test was very unexciting to watch. You go to Japan,

it shakes and it all stands up; a collapse is far more interesting. This was a very well performing structure which they disassembled and took back to Italy and used for student accommodation. This sort of construction has many cross walls, so is very good for apartments but not so good for open office type space. (**Slide 36**)

**Slide 36**



**Slide 37:** In London there is a nine storey building in Murray Grove using cross laminated construction and the builders were surprised that they achieved faster construction times than expected. There are some excellent examples in Europe using cross laminated timber floors with extra sound proofing and nicely finished.

**Slide 37**





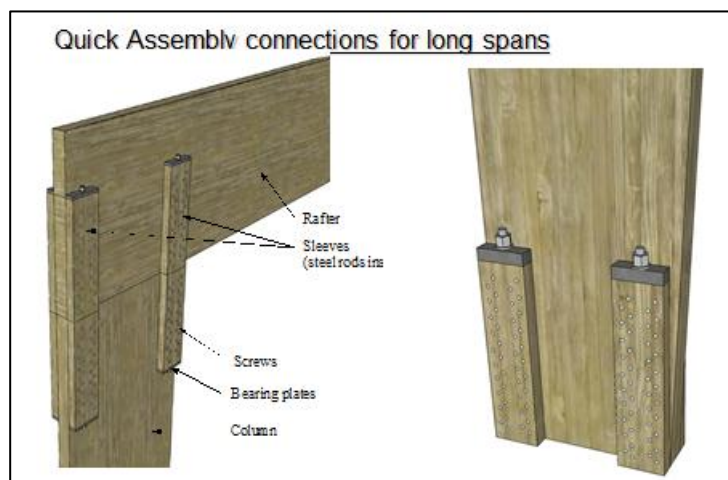
**Slide 44**

Other forms of construction are also used for multi-storey timber buildings. Another test in the same Japanese shake table last year was a six storey building using typical United States construction. It used light timber frame with structural panels on the outside. There is no reason why we cannot use this in New Zealand. Often in the US they have concrete basements which allow commercial users on the lower level and the concrete floor prevents fire spreading from commercial operations into the residential levels above. (Slide 44)

Structural Timber Innovation Company (STIC) is a research consortium funded by the LVL producers - Forest and Wood Products Association Australia, Building Research Association, Universities of Auckland, Canterbury and U.T.S. Sydney, with matching government funding. It is a five year programme. The primary aspect that I am going to talk about is the research at Canterbury, but work is going on in Auckland and Sydney. In Auckland we are investigating long span roofs used in factories. Improving the connection system will get more of these buildings going. This is led by Professor Pierre Quenneville and funded by MAF to start the programme. The Auckland team have produced the "timber portal frame guide" to make it easier for construction people to build these large timber buildings.

**Slide 48:** One of the Auckland developments was a rapid assembly connection so that we can put these buildings together faster. Take the parts onto site, bolt them together and get faster onsite construction times.

Canterbury is looking at wood composite concrete floors which have been tested for fire resistance. There were some lessons learnt but we have confidence now about the fire performance of those floors. Further research on the floors is continuing in Sydney.



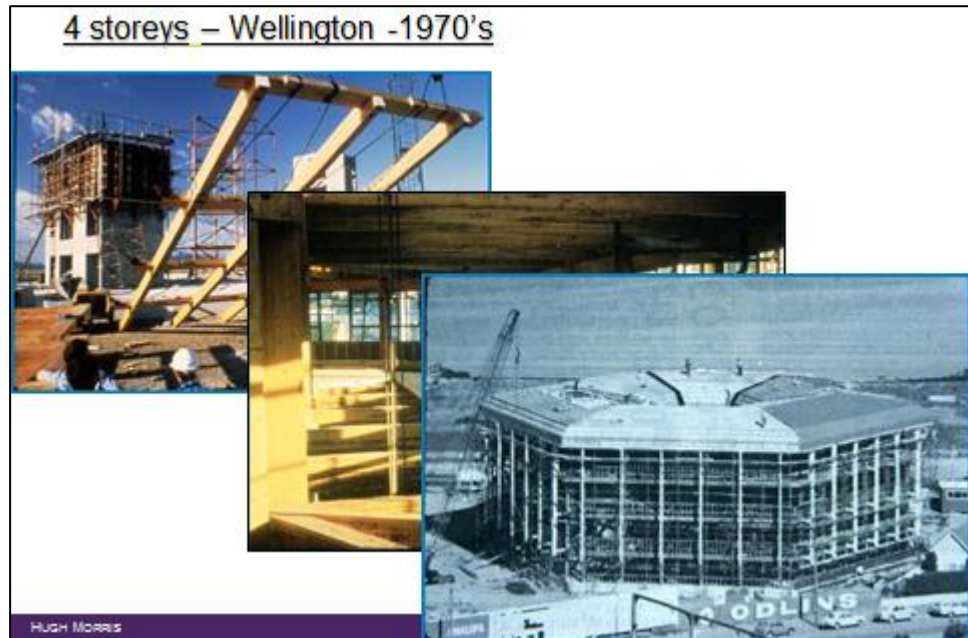
**Slide 48**



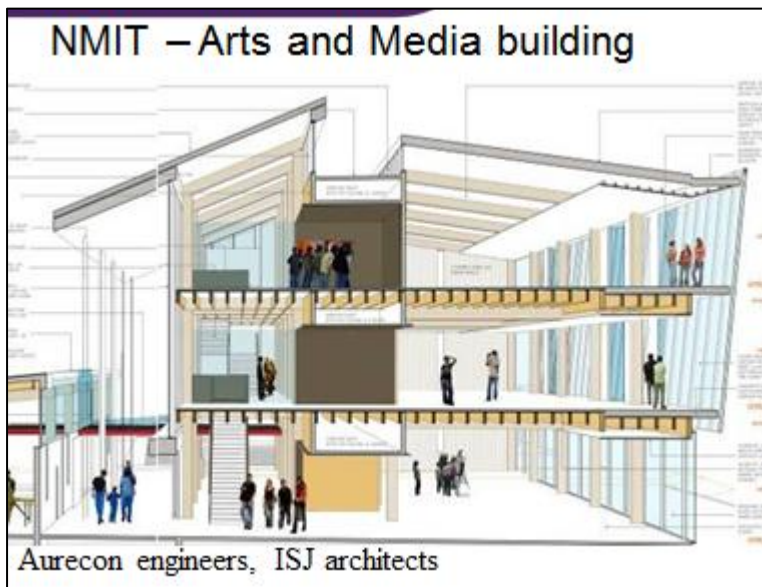
**Slide 51:** The Old Government Buildings, Wellington is a very good example of a multi-storey timber building in New Zealand that has been there over one hundred years.

**Slide 52:** In the 1970s the Odlins building in Wellington was built with timber and a concrete core. Since then there has only been a modest amount of multi-storey construction and a few apartment buildings. This is an area where we see room for real expansion in timber construction.

**Slide 52**



**Slide 53**



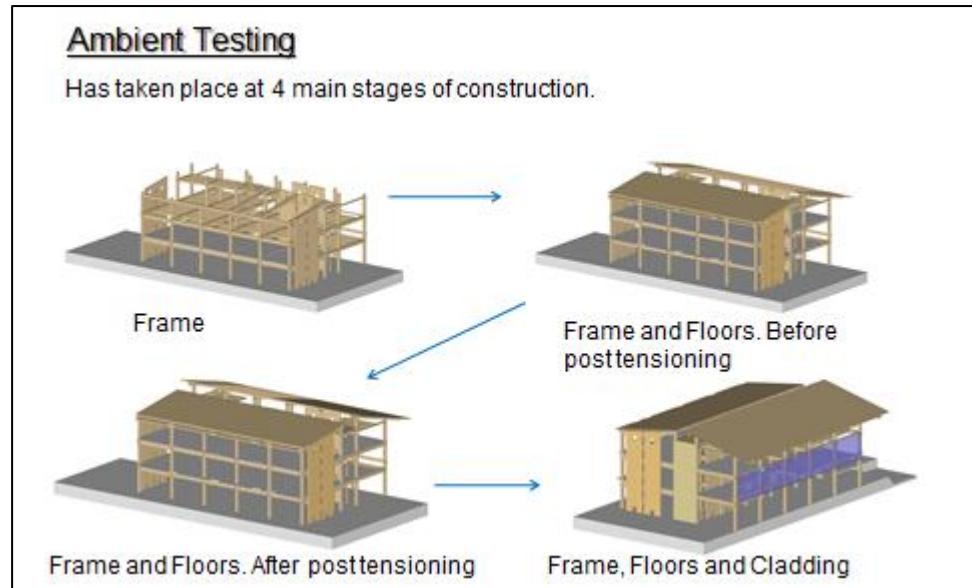
**Slide 53:** This is an initiative from the Ministry of Agriculture and Forestry to have a design in timber. The NMIT Arts and Media building was opened last week.

**Slide 54:** The building was designed by Aurecon Engineers and has three parts. Post tensioned timber shear walls, based on STIC technology, are installed at each end and along the centre of the three-storey Arts building, to carry the earthquake loads.

**Slide 54**



**Slide 56**



**Slide 56:** A student monitored the dynamic performance during its construction so we can derive its earthquake performance.

**Slide 58**



**Slide 58:** At the base of the shear walls post tensioning rods are tightened into couplers which hold the wall in place. In between the two wall panels are steel energy dissipaters. When there is an earthquake the shear walls will rock from side to side lifting up at the base by 50mm. The walls move relative to each other so the curved steel will yield, wasting energy, and when the earthquake is over the wall will return back to its initial position.

The architect chose to show the timber structure inside the building which gives a very nice effect. (**Slide 60**)



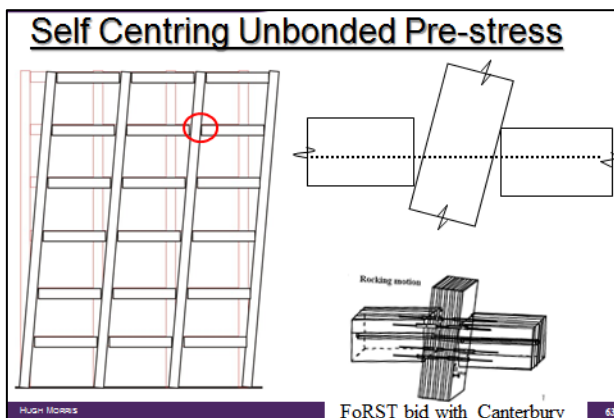
**Slide 60**



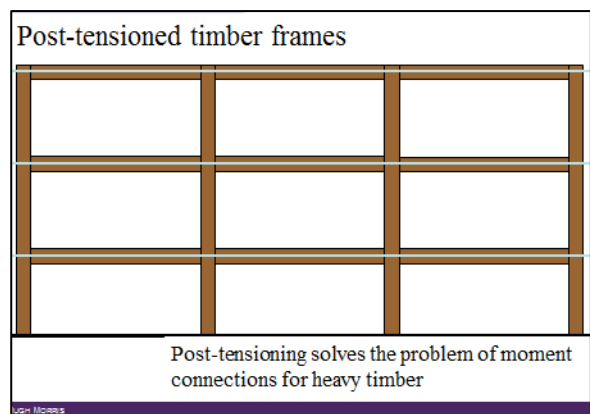
Slide 61

**Slide 61:** Outside it does not look different to other buildings.

**Slide 63** and **Slide 65** show another aspect of this technology that has huge potential for future construction and provides a real opportunity for buildings in the reconstruction of Christchurch. These technologies use post tensioning of structural frames so when the building moves high tensile steel will hold the building together and it can rock backwards and forwards with a small offset. When the earthquake is over it restores back to its pre-earthquake position. At Canterbury University they built a model of this in their laboratory. (**Slide 69**)



Slide 63



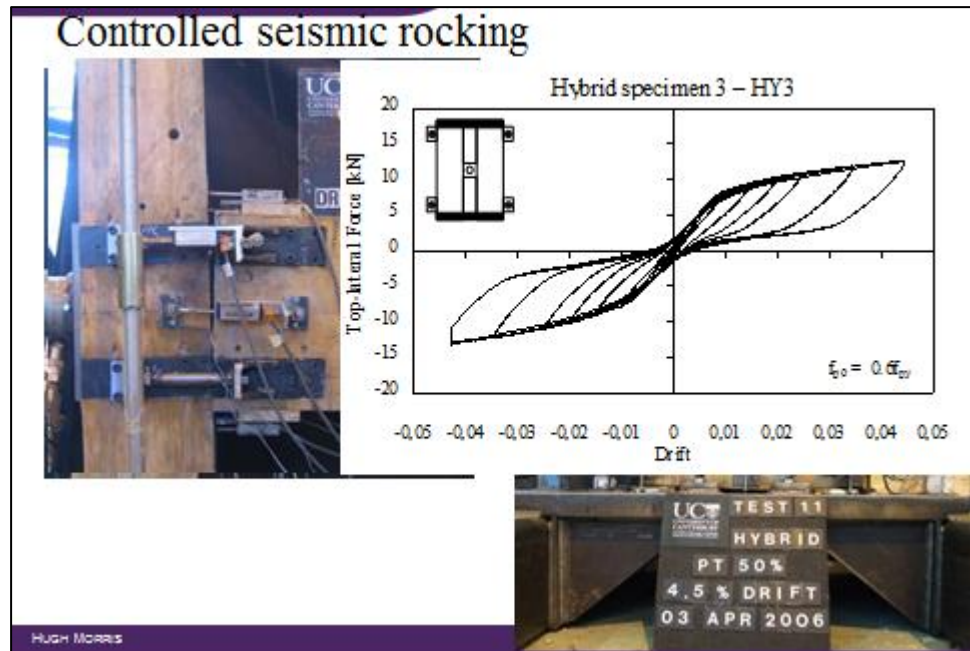
Slide 65

Slide 69



It is a relatively fast construction system because post-tensioning simplifies the timber connections which have traditionally been one of the more difficult parts of a building. The post tensioned frames mean that we can use large timber for bigger buildings with open spaces within the structure. It is taking us beyond the little regular boxes for residential accommodation, into commercial type construction.

Slide 67



**Slide 67** is some of the early work done at Canterbury University where they applied loads to move these backwards and forwards with the animation showing the rocking motion. We engineers are very interested in load deformation performance shown by hysteresis loops and that sort of technical stuff. The small building from the laboratory experiment was disassembled, reassembled and turned into a real building that is now is the office for STIC.

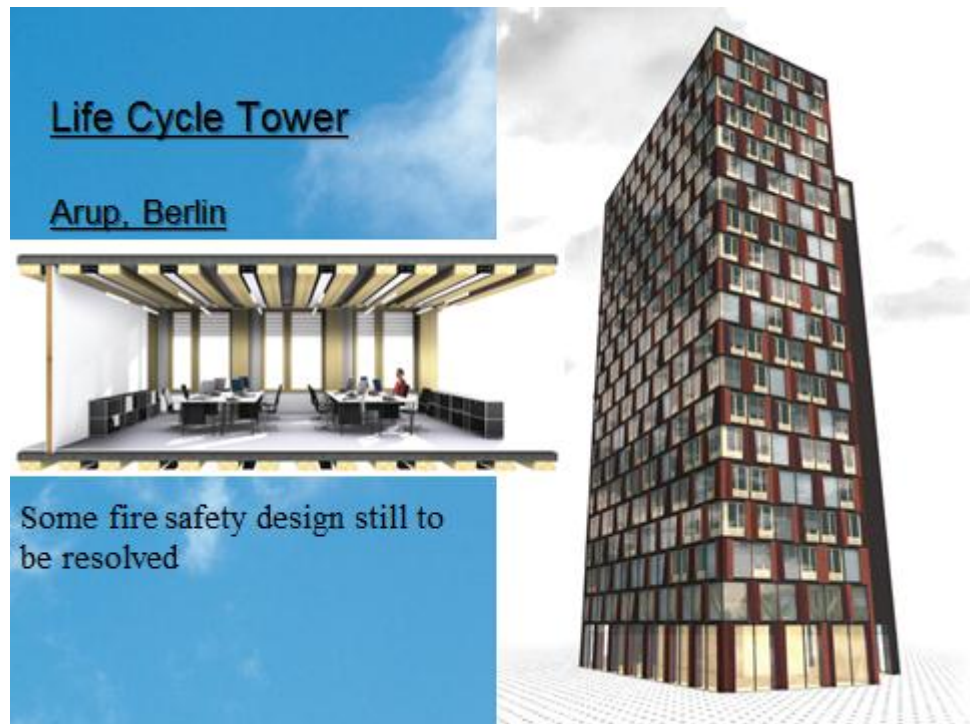
#### Four storey office building

Slide 72



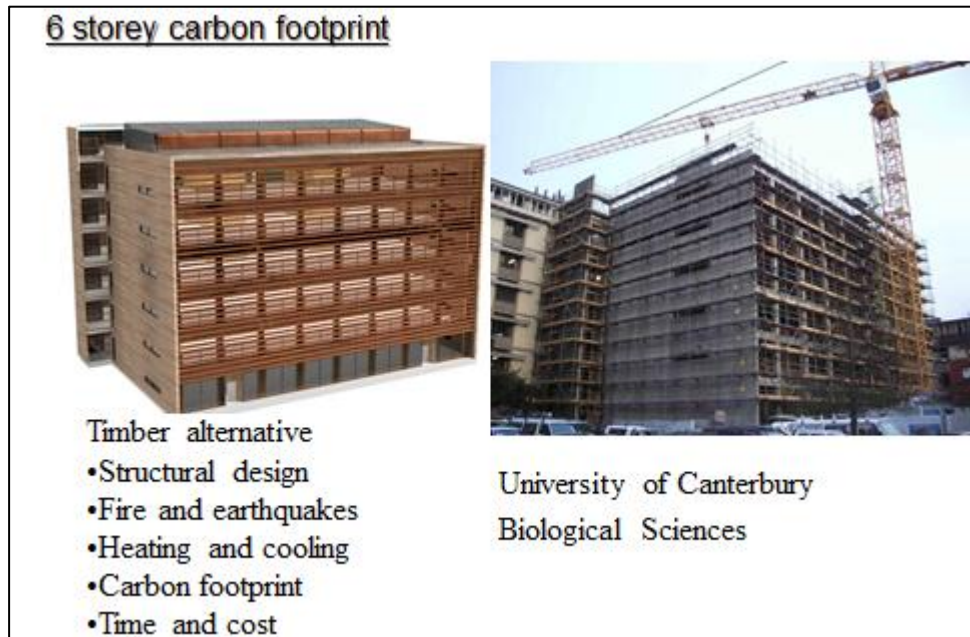
**Slide 72:** Andy Buchanan included a slide showing how these buildings might fit in between other buildings in the reconstruction of Christchurch. These structures do not have to be nice simple regular buildings; there is room to do things a little bit different. They have proposed a twenty-storey building in Berlin. (**Slide 73**) This is different technology for fire safety design and some of the issues are still to be resolved. However it is an example of things that are on the drawing board in terms of timber construction.

Slide 73



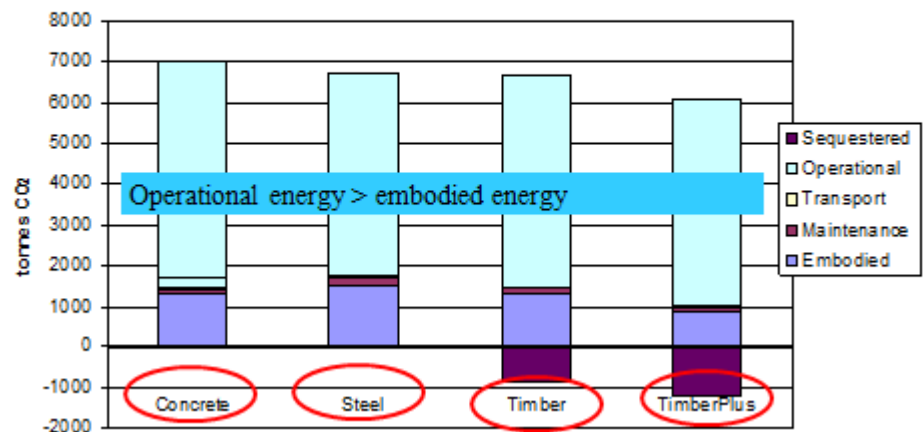
**Slide 74:** Further investigations are related to carbon footprint. Researchers took a new concrete building at the University of Canterbury, redesigned it with steel, timber and a more expensive design that incorporated timber wherever possible (timber plus). They undertook an analysis that compared it with the existing concrete building.

Slide 74

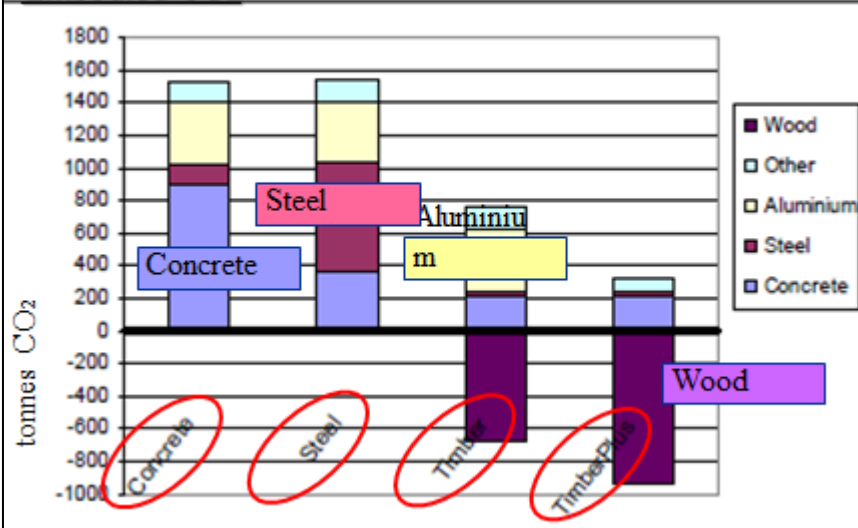


**Slide 75** looks at life time emissions in terms of carbon. When looking at the total CO<sub>2</sub> over a building lifetime the huge amount of energy that goes into heating buildings and their operation dominates. We get small gains in comparison with concrete and steel, but the real gain is carbon stored within the structure. (**Slides 76 and 77**)

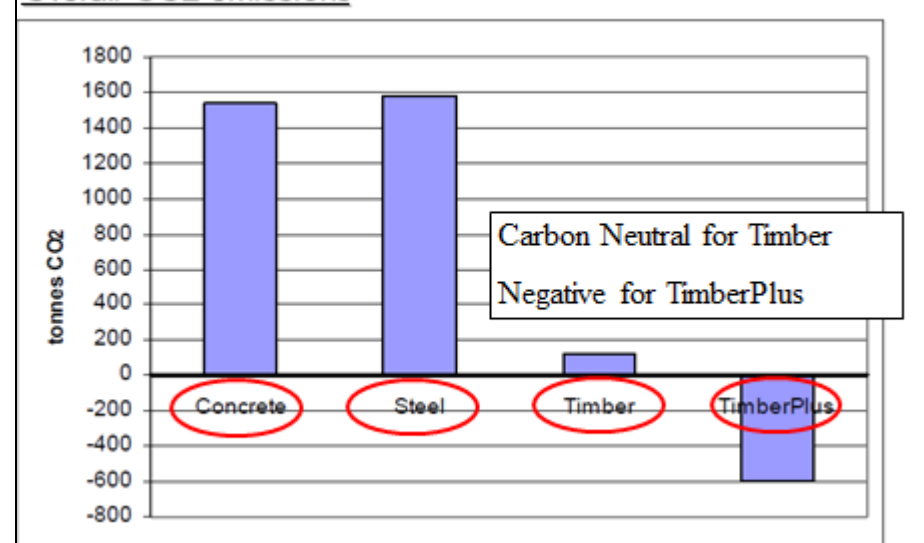
### Lifetime CO<sub>2</sub> emissions One building, four designs



### Embodied CO<sub>2</sub>



### Overall CO<sub>2</sub> emissions



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Multi storey timber is attractive, light weight, rapid to build, has a low carbon footprint and resistant to hazards. As this is new technology there has been a small price premium but as it becomes more common it will be very cost competitive. Now there is an environmental benefit but soon it will be more economical as well.

There is a need for better standardisation. Today when a client asks for a timber building the quantity surveyor thinks about it for the first time and adds a premium. A standardised approach would mean that when an architect or engineer specifies a detail the costing is quick and competitive.

I would like New Zealand to be exporting whole buildings. There is no reason why we cannot package these up and export with that value added. Have a representative in India who looks at design restraints, sends it back to New Zealand, finalise the design, add in that value, make the building, ship it off. Simple! The same could be done with flat pack housing,

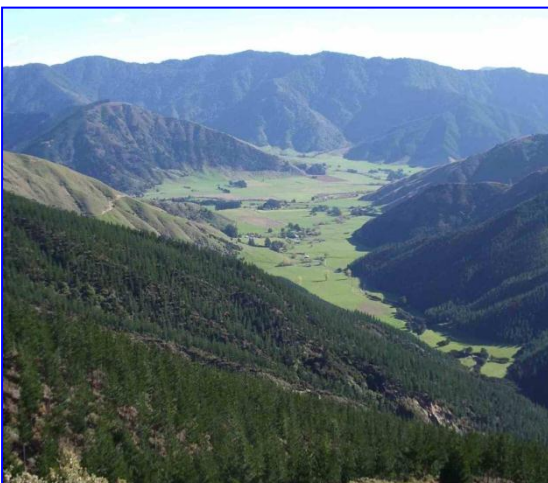
I would like to see, rather than just manufacturing wall framing, manufacturers make a whole fully fitted out wall, exterior cladding, interior cladding, wiring, inside the factory, shipped out, and then assembled on site. There are huge advantages but we need economies of scale and maybe Christchurch is going to give us that. The other possibility is Japan, while timber buildings are not great in terms of tsunami resistance there is going to be a huge opportunity for a large number of buildings to be delivered.



**Slide 79:** There are other things that we can do with timber. This is a beautiful bridge in Scandinavia.

In conclusion the more trees we grow, harvest and use, the better and it is good for the environment. Forestry is a resource; when you cut it down it regrows. Rotorua is ideally placed for a big part in this and it will be good for the health and wealth of New Zealand. Take those trees and turn them into buildings.

Finally I am really keen to show the progress we are making to the world in a year's time when they come to our World Conference on Timber Engineering in Auckland.



Thank you.



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## 2030: IS THIS ROTORUA?

**Dr Elspeth MacRae**

Scion, Rotorua

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*Elspeth MacRae, Scion, leads the Bioproduct Development business and science area which includes all Scion's wood and fibre processing as well as biorefinery, biodiscovery and bioplastic activities. She sits on the Board of the Biopolymer Network Ltd, a company developing and commercialising biopolymer products. She has also been responsible for negotiating some of Scion's recent collaborative relationships and international commercial contracts.*

*In her previous job at HortResearch (now Plant and Food Research) she was involved in development and commercialisation of several kiwifruit related technologies and was co-inventor on several patent applications as well as publishing widely. In her last role there she led the Industrial Biotechnology team. In addition, she carries out Futurewatch activities for MoRST - an initiative that identifies emerging science trends and innovations that will benefit New Zealand.*

*She was part of the FRST Innovative Foods Strategy team and has been instrumental in developing strategy in both the then HortResearch and Scion. She carried out an Industrial Biotechnology futures contract for the OECD Bioeconomy to 2030 programme which was released in May 2009. She is New Zealand's representative on the EU Plant Sciences organisation's overarching committee, and has just completed a three year term on a Marsden Fund panel.*

### ABSTRACT

Rotorua has been a tourist town since the mid-1800s, and tourism has been the mainstay of its revenue since then. The planting of trees for timber during the depression years in the 1900s donated a second source of income for the region. What could be the new source of income for the region in the 2000s?

In the coming years the world is facing many challenges that are converging and impacting on one another. We face global population growth with a growing middle class in developing countries who drive demand for products similar to those enjoyed historically by the West, such as more protein and more luxury goods. In addition, we have greater demands for energy while energy is less available and subject to price volatility. Climate change is likely to modify weather patterns and water availability and cities account for the majority of growth in global GDP. These changes are driving development of a bio-economy, with sustainability at its base and development of renewables as a core driver. The Rotorua region is well positioned to benefit from these changes, and some examples will be discussed.

### TRANSCRIPT

I am really pleased to be here especially after the stimulation of the previous speakers. I am going to ask you to let your imaginations roam free and take you to the future. Bring all of what you have heard here and think what kinds of futures you see for Rotorua. Combine those thoughts with other things I will raise.

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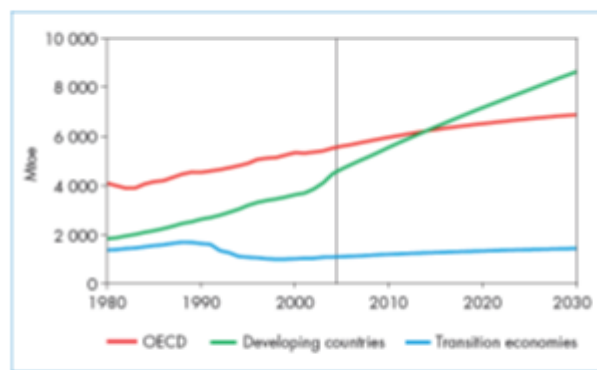
I will quickly remind you how Rotorua got its money from the past, and before addressing how forestry and all this might come together, I want to talk about the big global challenges, because when you have big challenges, you also have really big opportunities.

In the past Rotorua was one of the early tourism sites in New Zealand, based on the geothermal activity. Looking at it now we still have tourism and Maori culture, and the kind of fun activities that use the environment. If we look at forestry, there was the big injection of money in the last century. We are going to see if we can put all this into a future.

I am going to run through some of the global challenges and opportunities for New Zealand. Most of you will have heard these things before in some way or shape but I am trying to put some of them together.

## Slide 7

### World Primary Energy Demand



IEA Bioenergy 2006 (predictions of \$US55 per bbl 2030)

In a business-as-usual scenario, world primary energy demand will have increased by 62% between 2004 and 2030, with fossil fuels (coal, oil and gas) accounting for 83% of the increase.

Demand in developing countries will surpass that of OECD countries by 2013.

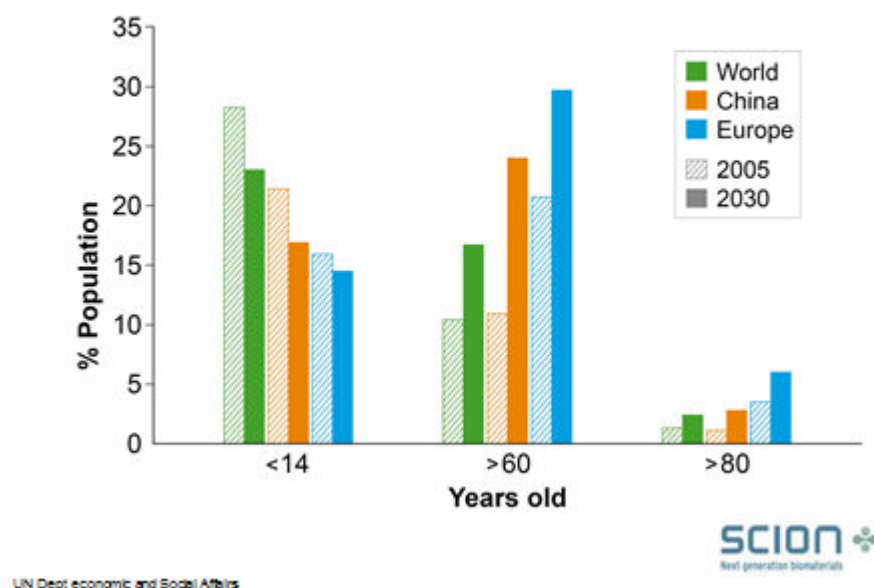


**Slide 7** shows world primary energy demand. It does not really matter about peak oil, the price, etc. because what you have is greater and greater demand. It is not the demand that is currently there but a demand of the future that is not going to go away. The IEA Bioenergy in 2006 drew this graph and at that time they were predicting in 2030 that oil would be \$55US a barrel. We are there now. In their business-as-usual scenario, there is an energy demand increase of 62%, based on doing everything with people and business as we do now. More particularly in 2013 with the OECD and developing countries, places like China, India and Brazil, their demand will have surpassed the whole of the OECD. It is really a significant driver.

**Slide 8:** What else is going on? The population is aging, we all know that, but here are some figures. The green figures are the world, China is in the middle and Europe blue. The striped lines are 2005 and the filled in columns are 2030. There are less and less children with little difference in Europe but a big decrease in the world and China. There is a big increase in people who are over sixty years old (and there will be a few in this room), and a big increase in the over eighties. How many of you will be hitting that eighty as well? This all changes the dynamics and the way the world is going to operate economically.

## Slide 8

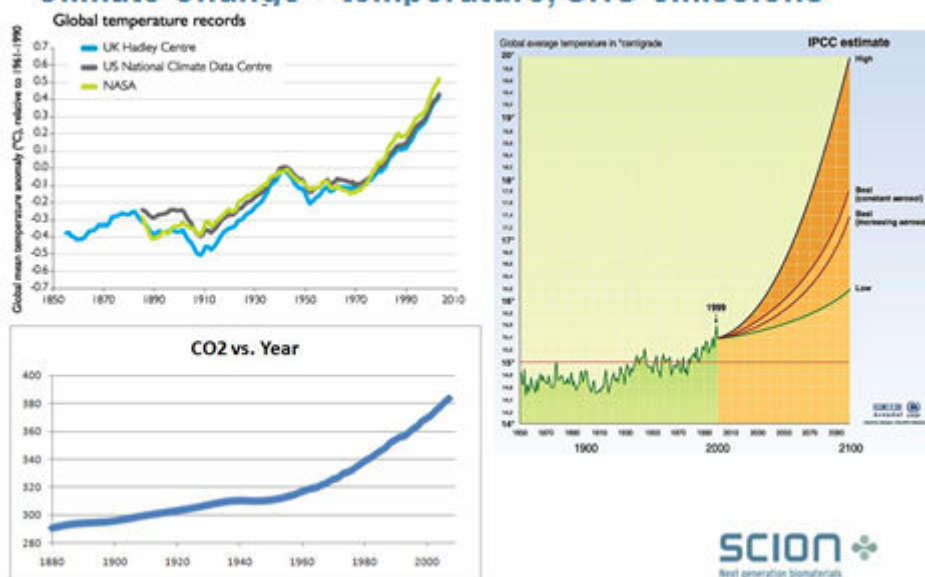
### Population aging



**Slide 9** shows climate change, temperature and greenhouse gas emissions. Here are examples of three separate sites giving the global change, the shift up in temperature, and parallel carbon dioxide increase. In the period of the 1900s which is the first increase period, it is the era where we capitalised on plants that used to grow in the past and became fossilised. We created all the petroleum-based industries and chemicals. Many of the things in this room have components that rely on those fossil fuels and chemicals. The big challenge is to not keep increasing them. The IPCC prediction for the future shows best estimates. Look at where the world tries to cap its greenhouse gas emissions, (low) and compare with where everything just carries on as usual (best). Already most of the predictions say this low level is never going to happen because we are way past that, with higher temperatures and greenhouse gases.

## Slide 9

### Climate Change – temperature, GHG emissions

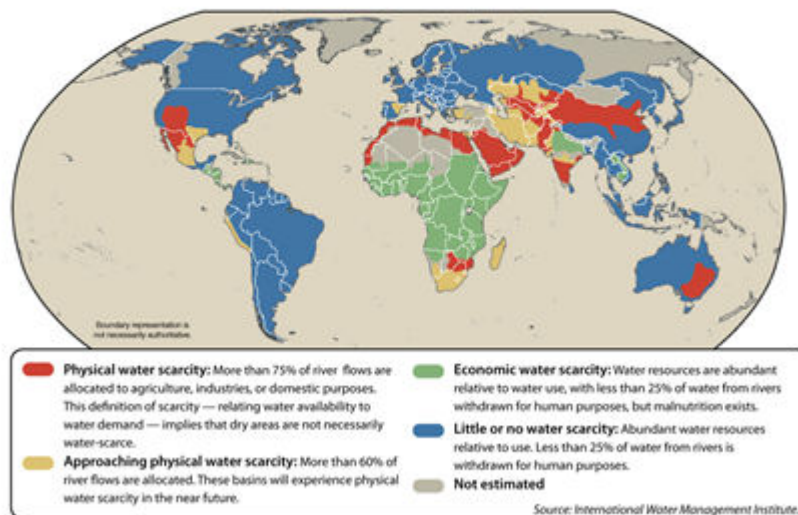


**Slide 10** shows there are big changes in water availability and weather events. You can see a picture of water scarcity in 2025 which is only about fifteen years away. The big red patches are where there will be an increase in water scarcity, so these will be drought regions. Notice New Zealand is looking fine.

**Slide 10**

## Climate Change – water, events

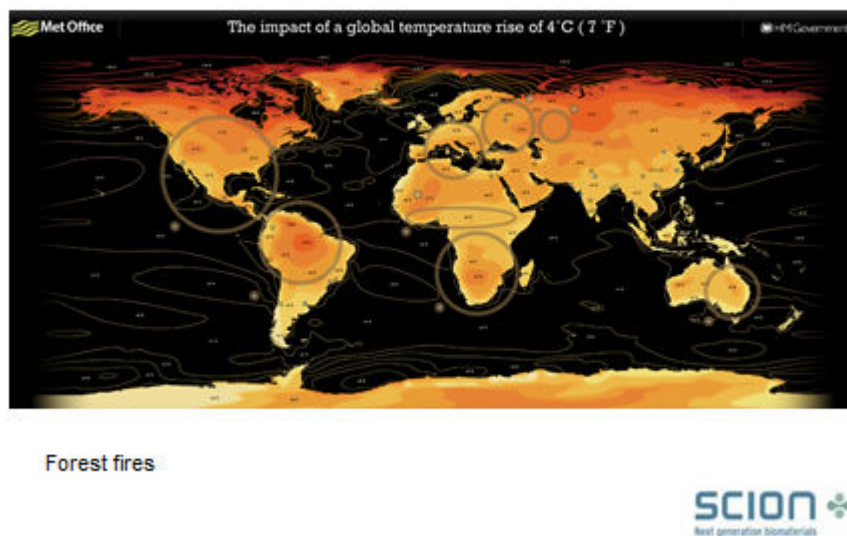
Projected Global Water Scarcity, 2025



**Slide 11** is one of a series of maps from the British Government, of the kinds of events that will happen. You can access these online. This one is a prediction in 2025 of a 4 degree increase in temperature. Some regions will have significant increases in forest fires, e.g. Australia, but New Zealand is okay.

**Slide 11**

## Climate change - events



## Slide 12

## Cities and economic growth – new markets



GDP per capita hotspots for growth

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McKinsey predictions 2011

**Slide 12** is a recent McKinsey release predicting the cities where the economic growth of the world is going to be into the future. The new markets will all be growing urban areas. We heard this morning that Wellington has been thinking about exports and these might be the kind of markets that we would target to grow Rotorua.

**Slide 13:** The global economic growth is all in cities that are greater than 150,000 people. Emerging cities are 150,000 to 10 million in population; megacities are greater than 10 million in population; 62% of growth in GDP is in these cities. Hot spots for growth as GDP per capita would include Sydney and cities in Asia and parts of South America, places where major growth is expected economically. The population in the top 600 cities is going to grow 60% faster than the world population, so that means there is going to be movement of people into urban environments which will create a big growth engine. The middle weight cities, 150 to 10 million in population, are the ones where the biggest growth is expected to happen.

## Slide 13

## The 600: The global city 600 population will grow 60% faster than the world population

### A new growth engine

Middleweight cities in emerging markets are poised to deliver more growth than the entire developed world and emerging-market megacities combined.

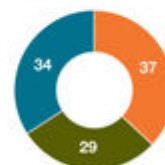
Contribution to GDP and GDP growth<sup>1</sup> by type of city, %

- Developed economies and megacities in emerging markets
- Middleweight cities in emerging markets
- Small cities and rural areas in emerging markets

GDP in 2007  
100% = \$55.5 trillion



GDP growth, 2007-25  
100% = \$54.9 trillion

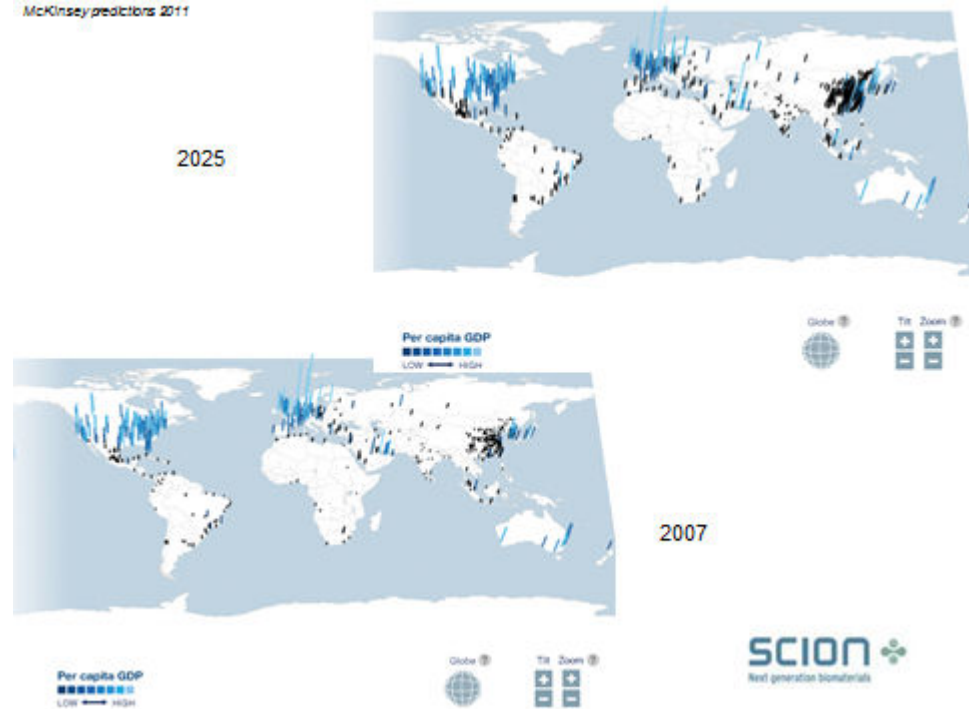


<sup>1</sup> GDP is measured in dollars, using market exchange rates in 2007 and predicted real exchange rates in 2025.

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McKinsey predictions 2011

## Slide 14



**Slide 14** is another way of looking at the picture, in 2007 with all the cities including Auckland, then in 2025. The big growth is in the Asian regions, around the edge of the Mediterranean and India. This is rapid growth, and you cannot think of the same old ways of doing things.

**Slide 15:** There has been a lot of scientific research on global trends in the new industrial sectors. The World Wildlife Fund has examined industrial biotechnology as a growing sector. This sector converges with clean tech; both technologies refer to the same kind of thinking. The challenge in these particular sectors is reducing the carbon usage and greenhouse gas emissions. It is in the food industry where some of these technologies are first being used to improve efficiency of manufacturing, and then they lead to fossil fuel substitutions as in biofuels and biochemical. Then we start going into bio-substitutions for

## Slide 15

## New industrial sectors

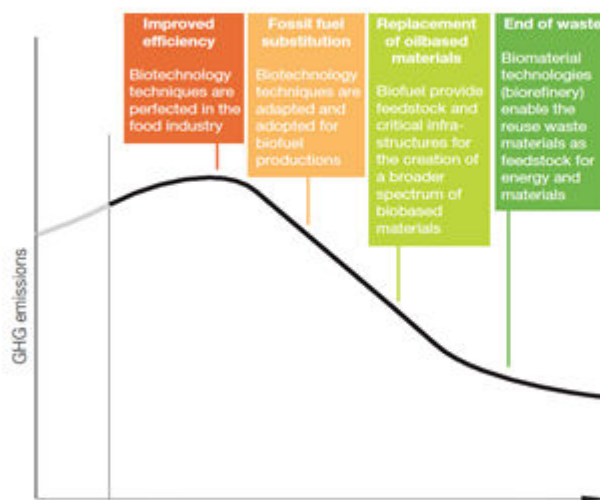


Figure 4: Industrial biotechnology's path to a low carbon economy

WWF report Industrial Biotechnology 2009

**Slide 16** shows the big picture of biorefinery developments, and I will talk a little bit later about what we mean by a biorefinery and give you some examples. To develop more biobased materials there are processes designed which rely on feed stocks from the agriculture sector. This then is the potential for forestry to replace the oil-based materials. The technologies and infrastructures for this will need to be developed. This is an area that is growing rapidly in many parts of the world. Again, when you look at waste systems, you look at a service-based economy, using waste as a feed stock, reducing pressure on land use.

# Biorefinery developments

WWF report *Industrial Biotechnology 2009*

**Impact: developing biobased materials**

The left graph illustrates the impact of developing biobased materials. It shows GHG emissions on the y-axis and Time on the x-axis. A black curve represents the emissions over time. The curve starts at a low level, rises to a peak, and then declines. The decline is attributed to three factors: 'Improved efficiency' (orange box), 'Feedstock substitution' (orange box), and 'Replacement of oil-based materials' (green box). The curve ends at a low level, labeled 'End of waste' (green box). A green arrow points from 'End of waste' to a green box labeled 'Enabler for a service-based economy'. A red arrow points from the peak of the curve to a red box labeled 'Feedstock supply' and 'Reduced pressure on land use'.

The right graph illustrates the impact of closing the waste loop. It shows GHG emissions on the y-axis and Time on the x-axis. A black curve represents the emissions over time. The curve starts at a low level, rises to a peak, and then declines. The decline is attributed to three factors: 'Improved efficiency' (orange box), 'Feedstock substitution' (orange box), and 'Replacement of oil-based materials' (green box). The curve ends at a low level, labeled 'End of waste' (green box). A green arrow points from 'End of waste' to a green box labeled 'Biorefinery technologies and infrastructures'. A red arrow points from the peak of the curve to a red box labeled 'Processes designed to rely on feed-stocks from the agriculture sector only'.

**Impact: closing the waste loop**

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So what could New Zealand be like? It is way down here at the end of the world, but it is a small biologically resource-rich, isolated country. It is only the size of a small global company and as a small company we are just one unit. But we could become energy independent with no more petroleum imports of \$6 billion. If we move fast, we could do it by 2030, blending wind, water, solar, biomass, coal and geothermal types of renewables. There is a range of solutions with many different technologies so the challenge will be which technology works in which place and for what reason.

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We could be trading in biobased substitutes for petrochemicals used throughout society. In some classes we might not import, for example, at present we import all our plastic materials and for any plastic manufactured in New Zealand, the precursor materials have been imported, which is a \$3 billion industry. We could be a key exporter in bioplastic niches; speciality chemicals based on our biomass feed stocks alongside all our other current products in production. We could have key technological niches adopted globally and respected knowhow.

We could still be a quality food exporter despite the food miles because of the way we measure and do our life-cycle analysis. The health system could be functioning on preventative diagnostics; down here is a lab on a chip, and with this you can use high throughput techniques to process things.

Tourism could still be fun and still be green New Zealand, but it could also include innovative technologies that New Zealand does alongside the greenness. We could make those into tourist packages too.

We could be carbon credit rich with pollution below 1980 levels, (but unlikely), but we could, through biorefineries and waste management, have excellence in these areas, and global partnerships with developing and technology-rich countries. Maybe we should have partnerships and business opportunities with some of these growing cities. This is becoming a conundrum for diplomats globally because they are starting to realise they should not interact at a country level, but rather be based in these rapidly growing cities instead of the political capitals. It is different way to think.

What could it mean for Rotorua? More merging between tourism and forestry. We could have bioeconomy advantages pulling together alongside tourism and forestry. We could have lots more trees as feed stocks and fibre and waste streams into biorefineries, leading to new industries which have added value and greenhouse gas emission reductions. Imagine coming to New Zealand and seeing John Sax's buildings and the feed stock and a clean biobased refinery that is processing biomaterials. You might actually have tourists moving through experiencing these, as they do with the Zorb and other tourist activities.

There are many options and opportunities for economic growth beyond timber, and there are economic or financial incentives.

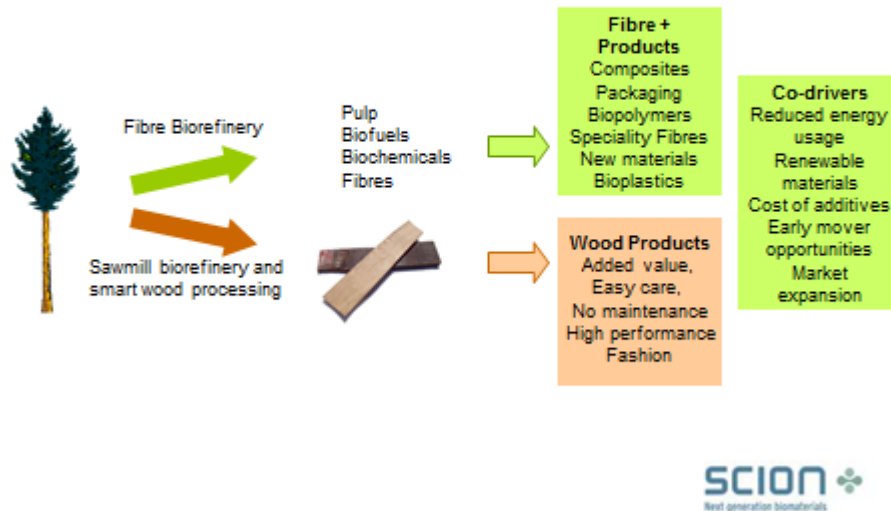
- Carbon storage, both internationally and in New Zealand
- Conservation of biodiversity
- Water quality and quantity
- Soil stability
- Recreation
- New products, e.g. energy
- Biorefineries, etc.

What will people value and pay for? **Slide 25** gives some of the challenges we have in terms of market drivers and how we can get more value out of the types of trees that New Zealand has historically grown. Hugh Morris referred to *Pinus radiata* which tends to be down the bottom in terms of performance quality. How can we improve that and get more out of everything we do, so that we do not waste material but rather use everything for added value? The sort of drivers in wood products from the consumer perspectives are added value, easy care, no maintenance, high performance, fashion. People tend not to think about fashion, but fashion is an important driver. Renewable material, reduced

energy usage, cost of additives. For example, all glues and laminations at the moment come from petrochemicals. We could turn them all into biobased glues, and take advantage of early mover opportunities and market expansion.

## Challenge: market drivers and trees

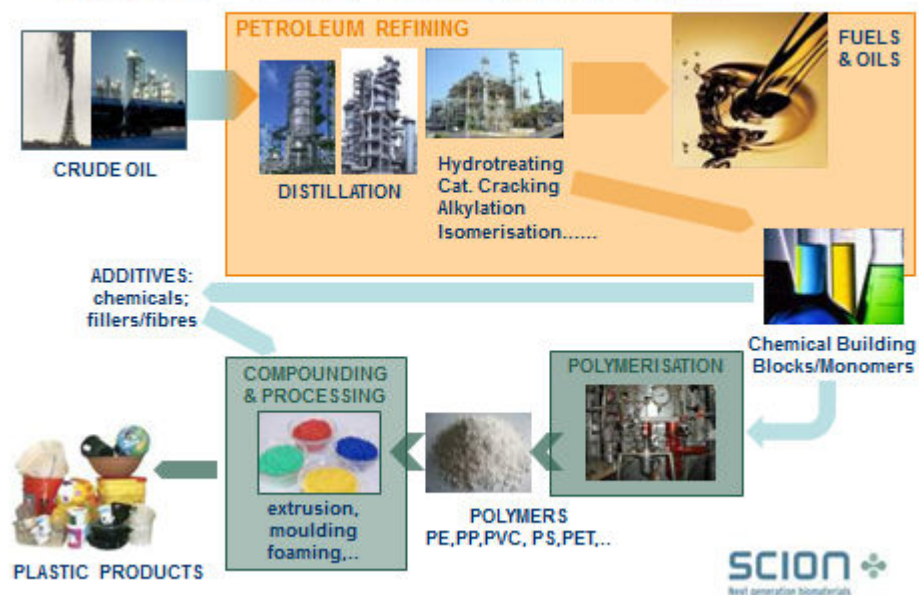
### Slide 25



How can we make this tree do all the things that we currently do so well, and want to still do as well as a whole lot of new things? These are some of the growing markets, e.g. glass fibre in aeroplanes and cars substituted with fibreglass made with biobased materials such as wood fibres and bioplastics and/or various other carbon fibres which are becoming strong drivers in those industries.

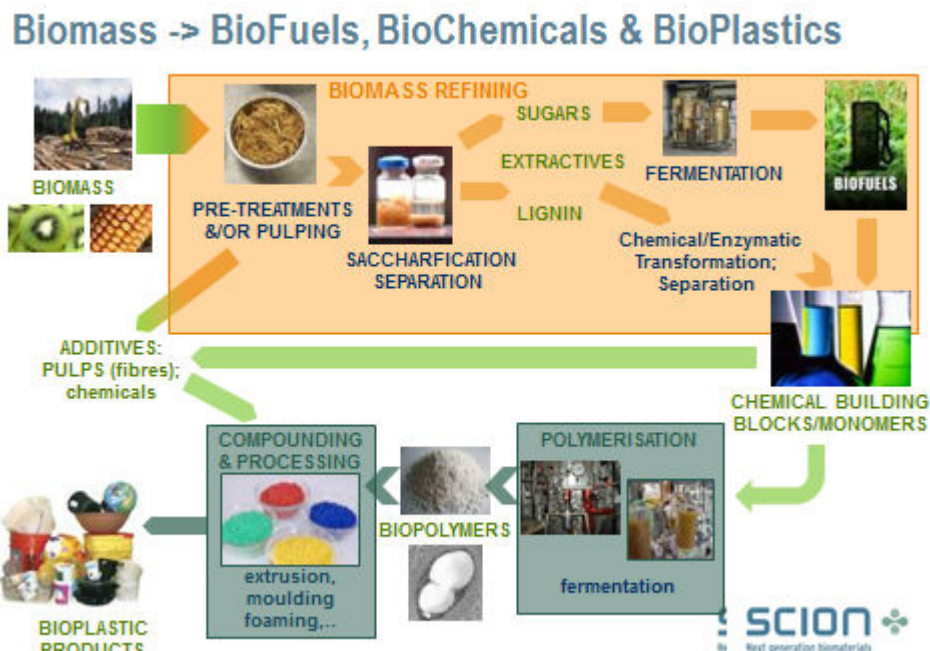
### Slide 28

## Crude Oil -> Fuels, Chemicals & Plastics



**Slide 28** is an oil biorefinery using old trees (i.e. oil), etc., from the past. It moves through a whole series of processes, 90% coming out as fuels and oils, and 10% going into making a whole lot of chemicals. Those chemicals come all the way through various processes and become, for example, plastic products. It has taken over a hundred years to create that value chain.

#### Slide 29

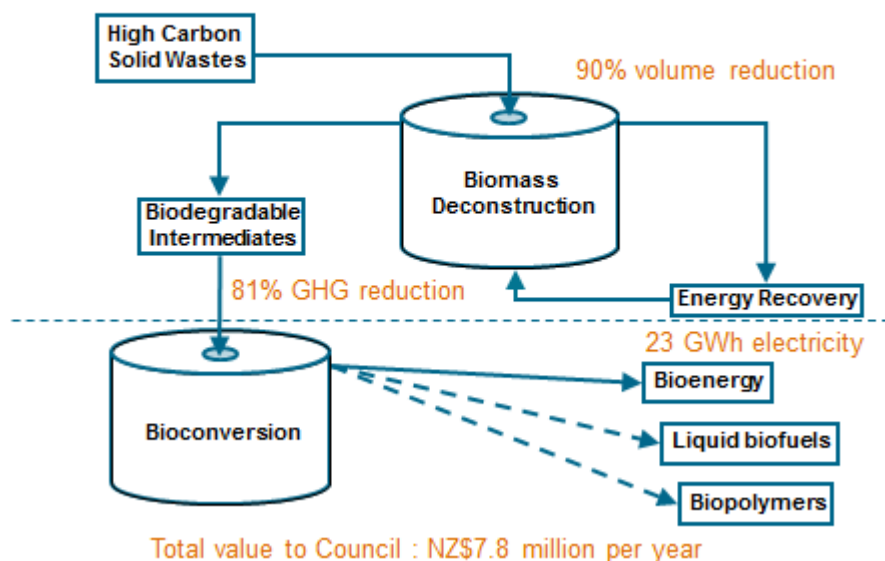


**Slide 29** looks at biomass and we substitute it for oil. It could be trees, but it can also be waste streams as well, feeding into a whole lot of new technologies that are being developed rapidly. If it is trees, only about 70% can go out to biofuels; 30% goes into chemical building blocks, so there is a big shift in potential of what we can do. There are now types of processing, for example, a microbe that makes plastics and that leads to bioplastic products.

#### Waste 2 Gold technology platform – Case Study

#### Slide 30

##### Rotorua District Council Landfill



**Slide 30** is an example where Rotorua District Council, in partnership with Scion, is developing the same kind of thinking and processing to remove waste in the landfill. It is taking in the high carbon solid waste which goes through a deconstruction process and there is energy recovery and potentially several other products. This is happening right now.

**Slide 31:** In Denmark is an example of a wheat straw biorefinery of which there are many around the world. But this is waste wheat straw and the wheat is sent off as food and all the bits left over turn into other types of materials.

Slide 31

## Danish wheat straw biorefinery

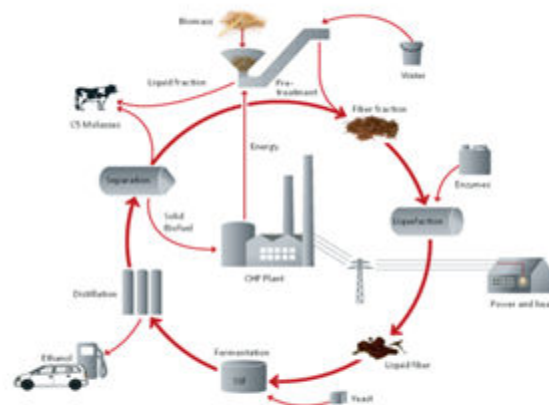


Figure 5. The overall process flow in the BWU process. From 1 ton of wheat straw (86% DM), the BWU process produces 143 kg of bioethanol, 353 kg of solid biofuel, and 420 kg of liquid biofuel (45% DM).

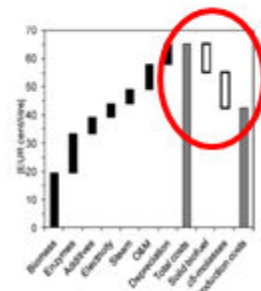


Figure 3. Cost and income for a 1000 ton per day ethanol plant located in the US. The main price assumptions are: corn stover at gate, 40 EUR/t DM, and enzyme cost, 0.14 EUR/L of ethanol.

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**Slide 32:** The German chemical companies are researching growing beech and poplar trees to make chemicals and some of these were not able to be made with oil-based chemistry and some of them were. They contain 30% lignin which is a great source for new chemistries. Lignin occurs in pine trees.

Slide 32

## Beech-poplar biorefinery an initiative by German chemical companies



betulin  
lupeol  
betulinic acid  
9,10-epoxy-18-hydroxyoctadecanoic acid  
9,10,18-trihydroxyoctadecanoic acid  
tannins  
fatty acids

Lignin

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Slide 33

shows some examples of what Scion has been doing with different companies in New Zealand, developing background research. These demonstrate that the new technologies are not that far away, you can actually touch them. There is a geo-peg with a washer which holds the erosion matting in place when land is being cleared, protecting it from slips. Normally they are either plastic or steel which last in the ground for years. The companies then have to send someone back to pull all those pegs up, in theory at least. We were asked to design a peg that would biodegrade. The washer degrades in two years, and the peg degrades in the order of ten years. Then no one has to go back and pick these pegs up and the degraded material turns into CO<sub>2</sub> and nutrients in the soil.

### Slide 33



We worked with Zespri, who have done their carbon footprint for their whole process and products, and this polystyrene spife, which some of you may have seen, is sold often with fruit packs so that people can picnic with a knife/spoon to eat the fruit. It is made of polystyrene and is 3% of their carbon footprint. We have been looking at taking waste streams from kiwifruit industries, and using a biobased plastic, putting the two together to make a substitute that will reduce the carbon footprint, be environmentally friendly and have a good market consumer brand solution.

Normally when cosmetic pots are made they have to cope with a high temperature and currently available biobased plastics not good operating at a high temperature. We have looked at reformulating these plastic pots plus using waste streams for a natural cosmetic company so they can package and claim benefit.

A fan typical of those in a meat processing plant is shown. Normally they have big steel fans but this is with engineered biofibres and plastics together to make a substitute fan to lower the footprint.

Another project on the slide is packaging material made from bio-based substitutes. Globally in packaging there is a very large movement for non-trade tariff barriers so people will not be able to sell products from New Zealand unless they pass a whole series of criteria in terms of sustainability. This packaging material is a substitute for polystyrene boxes like the ones that you take your beer in for a picnic, but uses a biobased plastic. In

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## DISCUSSION PANEL - QUESTIONS

**Dave Donaldson, Rotorua District Council:** My question is for the Minister, and is an issue that came up three years ago. We heard yesterday from Professor Hamilton how Lake Rotokakahi is in decline. His slide illustrated what a lot of us think happened. We heard this morning from Dr Irwin how scenic amenities are a pull factor in growth. I would like the Minister's view on how hard should central, regional, local government, Iwi and the community try to protect the 100 year old Douglas fir forest surrounding Lake Tikitapu? It is one of our scenic and key amenity gems in this community and tomorrow 2,000 people will participate in the Xterra Festival at that lake. There is a 25 year harvesting programme, so that 100 year old forest will be replaced by a 25 year old forest in another 20 years for the Crown Forest Licence owners to realise their economic return from the cutting rights. How hard should we be trying to make that harvesting programme more like a 125 year programme?

**Hon Dr Nick Smith, Minister for the Environment:** I think that goes to the core of the challenges, not just for Rotorua, but for New Zealand as to where that balance is. The forestry industry is hugely important to the Bay of Plenty and any changes you make in the property rights that those foresters have about their degree of flexibility of land use and capacity to generate the sort of wood products that you have heard from the panel, is tested against the tension for the opportunities for the visitor industry.

My plea around these tensions that exist in every community, in one way or another, is to find how to get the best of both worlds. How is it that trees can be harvested in a way that minimises the impacts on the aesthetic and environmental benefits that that forest provides? My encouragement with this is around collaboration, rather than the protest mode. The best example I have is in my home community, where the growing industry has been in agriculture, and a real tension has been whose run off makes it near impossible to harvest the shellfish. It has been through those two industries engaging together that they have been able to get the right balance. That is exactly the sort of challenge to apply your mind to as a Council, in terms of the tension between the forest industry and the aesthetics and recreation opportunities that go with those forests and how they interact with the lakes.

**Rt. Hon Paul East, Chair:** I think we see it in wind power and windmills for frost on vineyards as well, so there are a lot of clashes.

**Rikihana Hancock, Ngati Rangiwewehi:** In the first instance I would like to thank the organisers for giving us a chance to have this symposium. "Great mahi, nga mihi.." (Good work, best wishes). Secondly, I would like to thank the many speakers who have attended over the last two days. I have found great value in the discussions held.

The question I have is for the Hon Dr Nick Smith. As a representative of Ngati Rangiwewehi we have inherent interests in the whole water debate. In terms of consultation with Maori what has taken place has solely taken place with the Iwi Leaders forum but they are not representing our view. I would like to suggest further consultation is required and should include other groups such as the Maori Council to widen the base. There is no disrespect meant or intended for the Iwi Leaders, they represent the many Rangatira lines of our many tribal nations. However it is our contention that they do not represent the view point of Ngati Rangiwewehi. Kia Ora Tatou.

**Hon Dr Nick Smith:** – Kia Ora. The issue you raised goes to the core of the tensions that the Government is grappling with in Christchurch and equally so with tensions around how

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we make progress on the Fresh Start For Fresh Water Programme. Governments always walk a fine line between 'you can consult forever and do nothing', or 'you can power ahead and not take people with you'. Somewhere you have to find that balance.

On the Fresh Start For Fresh Water Programme the Government has been very upfront about the need to engage with Iwi throughout the country. We have had repeated forums at Waitangi Day and with Iwi Leaders Group around fresh water. There has been very good participation by Maori and Iwi in the Land and Water Forum and there are key recommendations in their report that relate to the involvement of Iwi and fresh water issues. I take on board your message that we need to ensure that we are getting down to the grass roots of Maoridom. There will be further consultation on the NPS decisions due in the next few months. This will be in respect of the Board of Enquiry process and in terms of any legislative change that may be progressed. My engagement with the Iwi Leadership Group has been very constructive. The difficulty that governments always get into, which is true for the Rotorua Council and any public body, is that unless you have a conversation with absolutely every individual, are you guilty of not consulting? I do not accept that and take the challenge that fresh water reform is required and that means we need to make progress and we are going to get that balance between consultation and action right.

**Rt. Hon Paul East, Chair:** I would like to ask our three panellists, put in one sentence, in thirty years what they think the major industry and production in Rotorua will be, what the impediments are to achieving that and what assistance and help we might need to give those industries to get there. They are all going to be timber related in some product I think from these three, but Russell start with you.

**Russell Dale, Future Forest Research:** One sentence!!

**Chair:** You are allowed three sentences probably.

**Tom Walters, Federation of Maori Authorities:** A question to Dr MacRae, given the Maori initiatives and increasing our forest at the moment, what has happened with the initiative to pressure carbonise biomass from the forest waste? Scion did have a machine there recently and we have done a lot of work with a scientist in Hawaii, but it seems to get to a stage of the invention and then it stops. Perhaps you can tell us a little more about where we are going? Can we safely call it the pressure carbonisation of biomass where we produce carbon and methane out of the waste of the forest?

**Elsbeth MacRae, Scion:** I can give you a bit of an update. It has not died. Sometimes when things go quiet you get the impression that something has. Often it is going, "Is this the right way to do things", or "What are the next steps to do?"

There is a Maori owned Iwi based company looking at transforming forest biomass waste into charcoal and I am unable to talk about that. It is moving very fast right now and if the product is the right shape someone wishes to purchase that material.

There is a technology that Scion has also been working on here and in other parts of the world called Torrefaction, a process doing what has been done to fossil fuels and coal in millions and millions of years only in a very short space of time. We are at the moment scaling up to a pilot programme for that. One of the reasons for torrefying wood is that it is a better way of transporting biomass from somewhere far away to a place where it can be onward processed. It is more compact and has lost all its water. So does that help?

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**Matthias Schellhorn, Canterbury University and Lincoln University:** I want to comment on the earlier point made by the representative of the Bay of Plenty Regional Council regarding the forest at Tikitapu. I draw your attention back to the presentation by Mayor Bo Frank from Sweden from the greenest city in Europe, and to the fact that that city was surrounded by production forest and yet it is one of the key tourism resources of the region. My question is to the representatives of the timber industry on the panel – do we need to change the way we approach harvesting of our forests, particularly if they are in areas of high recreational and tourism amenity values? I am not a forester, but is there a possibility that instead of clear felling forests, using methods of harvest that would allow recreation and tourism to continue and yet achieve the same economic timber harvesting gains?

**Russell Dale, Future Forest Research:** It depends very much on the species and the terrain. Some species lend themselves to an uneven age class management, where you can take out a few stems per hectare and they will regenerate. The tree that is commonly grown in New Zealand, radiata pine, is a very light demanding tree and difficult to manage on that basis. So it depends on the species. Forest companies in areas that do have high visibility look at how they can schedule their clear felling but it is very difficult, if growing radiata pine, to do other than a clear fell. There is a minimum size to go down to if replanting that species.

**Rt. Hon Paul East, Chair:** Thank you Russell. We have run out of time but I will come back to comment briefly on what you see in thirty years?

**Russell Dale, Future Forest Research:** In thirty years I would like to see an industry using the forest resources grown within this region producing a range of low carbon building products and a range of materials, bio-materials and energy fuels that can contribute towards this region, Rotorua and New Zealand as a more sustainable society.

**Chair:** Any impediments you see in reaching that goal?

**Russell Dale:** No.

**Hugh Morris, Auckland University:** I want to see a world scale production facility for buildings and building products. We have 45% of the production coming out of this area, we need something that is on a scale to deal with that and be economically comparable with what is happening overseas. At the moment our industry is very small.

We have huge forests but only doing the edges of what is possible in terms of high value product export. I want to see major plants established here. There are some problems in reaching the economy of scale to get the price to export. We need a major conglomerate that can fund and develop that level so we can have a world class industry coming out of Rotorua.

**Elsbeth MacRae, Scion:** I would echo all that. I think it is people. We talked early on about Wellington and people getting together and finding a consensus and then driving forward. It needs people who do not normally talk together. Energy companies talking with forestry companies, perhaps talking with construction companies and a chemical company, creating the new framework. There is nothing to stop Rotorua and New Zealand doing it except willpower and people talking together.

**Steve Chadwick, M.P.:** We are all very passionate about our lakes and Rotorua. Minister, thanks for coming to the Symposium today and thanks to LakesWater Quality. My concern is that we are aware that eleven of our twelve lakes are moving forward, which is

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reassuring. I am worried, when you look at a collaborative model and take into account governance, that what we have now with the LakesWater Quality Society, which seems to pull everyone together, is that we do not want to lose the confidence and collaborative approach. We might have to alter parts of it. We want to have your assurance that the Ministry for the Environment remains at the table, because we will be coming back to government for more funding to keep the sustainable funding pathway especially for Lake Rotorua. I hope that we can have the assurance that they remain at the table.

**Hon Dr Nick Smith:** The Government is very committed to the engagement and collaboration that has occurred around lakes water quality. I am having further meetings on the next steps and trying to ensure there is flexibility for funding going in the best places. I do not think there is a person in this room that would not appreciate the sort of fiscal pressures at local, regional and central government but the Ministry for the Environment will remain very actively involved in ensuring that the Rotorua Lakes Project continues with the progress it is making. The most important next step is the engagement with the farming community and I have been hugely encouraged by the way in which there has been a new dynamic of, rather than quite polarised positions, the agricultural community around Rotorua recognising they need to be part of the solution. That is a great step forward.

**Rt. Hon Paul East, Chair:** The Minister has already said he would like to take the measure of cooperation and collaboration that he sees in this room and between these organisations to be a model to the rest of the country. I think that is marvellous.

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## ***Session Seven - Planning for Growth (2)***

**SESSION CHAIR: Ian McLean, LakesWater Quality Society**

### **TOMORROW'S TOURIST**

**Tony Marks**

Chair, Rotorua Tourism Committee  
tonymarksnz@gmail.com

*Tony Marks, of Auckland, was Pacific Blue's inaugural chief executive in New Zealand and he has held the role with Origin Pacific Airways and Zespri International and was Air New Zealand International's general commercial manager for nine years.*

*He is on the board of a number of tourism-related companies and holds an honours degree from Harvard University. He has experience as chairman of the Marketing Council of New Zealand and as a member of the Auckland Regional Transport Authority. He now chairs Rotorua's new tourism committee.*

### **ABSTRACT**

Tourism is extremely dynamic as increasing wealth creates generations of travellers keen and anxious to explore new continents and new countries. Competition is fierce, driven initially by air services and prices, then by increasing knowledge of places and attractions and finally by experiences and cultural appreciation.

Tony will look at the trends in international tourism, their impact on visitor arrivals (as well as domestic travel) in New Zealand, and the impact that social media and knowledge will have, especially environmental appreciation. New Zealand is hugely dependent on its international image but many are questioning the commitment to keeping the environment impressive. Equally, locking up vast swathes of countryside, and effectively preventing access, will dramatically affect the potential prosperity of our country where tourism is the #1 earner of export \$s.

Tony will outline the aspirations and prospects for Rotorua in the next few years with an emphasis on environmental factors.

### **TRANSCRIPT**

Good afternoon. Let me start with a true story. A few years ago the worldwide head of Saatchi and Saatchi, Kevin Roberts, was entering the Northern Club in Auckland and he was stopped in the foyer by the Assistant Manager saying,

“Excuse me, sir, I can’t allow you to come into the Club, you are not wearing a tie.”

Roberts was wearing his normal New York advertising agency gear, black trousers, black tee shirt, black jacket.

“I don’t wear a tie”, said Kevin.

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“Well, in that case, sir, I cannot let you enter.”

At this point the Manager appeared and asked what the problem was.

“Sir, this gentleman is not wearing a tie and I’ve therefore had to stop him from entering the Club.”

“Quite right, Smithers”, and turning to Kevin Roberts he said:

“May I ask what brings you to the Club, sir?”

“Well, I’m here to deliver a speech later to the Auckland University MBA students and I want to check on the layout.”

“Oh well in that case, sir, of course you may proceed. We don’t care what the entertainment wears.”

I was wondering a little if that is what I am – the entertainment - especially when I noted the calibre and quality of the speakers that you have had over the last day and a half. You have had a magic series of experts of erudite people, and now you have a knackered, retired, old airline executive who, when hired by Virgin Blue to start Pacific Blue, thought his ten years’ experience at Air New Zealand counted. However, I was told Virgin Blue is a very young company, average age 28, so, “the reason we hired you is not that you used to run Air New Zealand International in the nineties, it is to avoid an age discrimination suit”!

Anyway, I am here to talk briefly about tourism, particularly tourism in the next ten years, a topic of very significant interest in the heart of New Zealand tourism, namely Rotorua. I recently found an excellent article by Justin Frances and I would like to quote some of his comments to you as I think they sum up future tourism quite brilliantly:

*“The rise of the package holiday and the bucket and spade culture, during the past half century, has led us to believe that travel is about jetting off for two weeks to experience the four S’s – sun, sand, souvenirs and if you are lucky sex”.*

More recently the advent of low cost airlines has seen tourism become, for many people, a race to tick off trophy experience and destinations. We collect the passport stamps, we take the digital photographs and then we move on to the next unmissable sight. If I walk into any High Street travel agent today, the first question would be, “Where do you want to go?” I have always thought that was completely the wrong question. These days it is not ‘where’ that is important, it is ‘why’ and ‘how’.

I want to go on holiday to recharge my batteries, or to reconnect with myself or family. Sometimes I want to meet new people or discover and learn about a new place and different culture. When deciding where my next holiday will be, I try to place the focus on what I need from a holiday, not where it is. As the cost of flying increases, and whether that is the cost of aviation fuel, tax rises, or the imposition of emission trading costs and carbon guilt tends to set in, we no longer feel quite so comfortable about boasting of our foreign holiday.

The ‘why’ and the ‘how’ will surely become more paramount, travel will have even more purpose otherwise known as deep travel. It will be about getting under the skin of a place. We have already tried to seek out authenticity, real experiences rather than those fake culture packages for tourists, but travel in 2020 will go further. It will be about the

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appreciation of local distinctiveness, the idiosyncrasies and the detail, the things that make a place unique and special. Sound like Rotorua? I think it does. Rotorua has all the ingredients to meet these future tourism needs. All we need is to assemble the ingredients and make a very distinctive cake.

Justin Frances goes on to qualify his statement saying: *“Destinations will need to plan ahead to ensure they attract a specific type of visitor in a way that maximises sustainability. For too long tourism ministers have single mindedly pursued increasing tourism numbers without fully understanding either the local economic benefits of different tourists, or the true cost of tourism to local cultures and the environment.”*

I would imagine that reigns very true for this particular conference. He goes on to say that: *“smart destinations will no longer pursue more tourists per se; we’re going to see a change in the way destinations are presented and marketed. There will be an increase in consumer led, online, peer to peer travel advice, and this will spark what’s called a democratisation of travel. Travellers and locals alike will generally speak on behalf of a diversity of new and interesting places. Everyone will have a say in the destinations of the future and that will probably threaten the mega icons and the must see sights, whether they’re the Inca Trail, Kilimanjaro or Taj Mahal.”*

I think he means that the future traveller is likely to be highly focussed with a passionate reason to visit, rather than a collector of places and a once every five years trip to exotica. Of course for some people, indeed most people in the world, New Zealand is a complete mystery.

Let me tell you of an experience in Japan in 1993 when I was the Marketing Director of Air New Zealand. Jim Scott, the former Chief Executive of Air New Zealand, was then working as the Vice President of North West Airlines in Tokyo. North West was, and it still, the second biggest airline after Japan Airlines. Based on his New Zealand heritage, Jim was keen to get North West to expand into the South Pacific and asked me to attend this meeting. During the meeting, with enthusiasm running high, we needed a map to show options and opportunities.

Jim asked an underling, “Quick go out and grab the North West inflight magazine because I know they have a world map on the inside cover.”

One was quickly produced, Jim opened it, “Damn”. The world map had an advertisement for their frequent flyer club that covered the whole of Australia and New Zealand. As far as the Japanese or anyone else flying on North West, neither New Zealand nor Australia existed. It brought home to me and everybody else in the room, there is no room for complacency in tourism marketing. You have to start, unless you are in Paris, London or New York, on the premise that most of the world has little or no idea of what you offer, except that your country seems to be far, far away.

Let me go back to that key ingredient mentioned by Frances, the consumer led democratisation of travel. When I was growing up everything was fixed; the radio was fixed, the television, if you had one, was fixed, and the telephone, again if you had one, was fixed. Information about almost anything was very hard to find, hence the demand and universal usage in the travel industry for travel agents. They knew stuff you did not. Even if you did, they had all the best prices and deals.

Today there is a 100% reversal; access to anything you need to know whenever you need it. Trip Advisor and Fossil and other similar sites tell you what other people thought of places, accommodation, sights and people, and the value you might get out of visiting.

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This is in real time, and when you are in New York, pointing an iPhone at the building these days, it gives its history. Up will also come restaurants and attractions within two kilometres, the review of each and prices, opening times, and star ratings. So brochures and guides – goodbye. Why carry anything when its loaded on your phone. Forget a lot of the planning and booking, just go and decide.

You and I will be dealing with an informed population of visitors, some of whom will know what environmental standards our lakes have, and what steps are being taken to restore them. Your efforts will not just end up in erudite journals or obscure magazines, but front and centre because people want to know what is happening. I believe increasing numbers will.

We believe in New Zealand we are pretty good, and compared to most of the planet we are. We have run the 100% pure campaign for some years overseas. But I had a holiday recently in Slovenia, a place I knew very little about. To my surprise they have pristine lakes and streams. Their success is partly driven by policies different to anywhere else that I know. On their main lakes, like Lake Bled, no petrol or diesel driven boats are allowed. If you want to go out on the lakes you either rent a row boat or go on electrically driven boats. Have we the courage to do it here in our lakes? Even one lake? If not, why not?

We talk about tourists. I do not like that word and believe we should call them visitors which has a very different connotation. When I was at Virgin, travellers were always called guests, rather than passengers, and it does make a difference in attitude. I recognise that visitors to Rotorua will continue to be a mix of groups, especially from Asia, and free independent travellers from most of the world. Our main visitors for the next few years, unless there is significant intervention, will be Australians, Chinese and Aucklanders. Asia and Auckland will dominate, far fewer Americans and Europeans as the recession bites. I accept that the cultural norms of our principle visitors will be different from ours, but I am excited about those opportunities, because we have to understand that within five years China will be the second biggest supplier of visitors to New Zealand, and within ten will easily be the biggest.

Tourism in the future will not be watch and see, it will be participate, engage, understand, and Rotorua is uniquely placed to exploit this changing requirement. Soft and hard adventure, an emphasis on health and wellbeing and appreciation of the awesome power of nature, all overlaid with a physically impressive setting and infused with Maori culture. We have the assets. We do not need to invent reasons for coming, we just need to play to our strengths.

When I was 16 I wanted to be a professional soccer player. I played for a few rep sides in England and was good enough to get a trial with Bristol Rovers, the local professional side. After the game the coach took me aside and, in a strong North Country accent, informed me,

“That’s not going to make it, Son. I’ve been watching you and thou’s got a cultured right foot but the left ones strictly for standing on, aint it!”

I protested but we both knew he was right.

However he said, “Listen, Son, you can still have a good time playing football, it’s too late to fix your left foot so just play to your strengths. Play on the right side of the park and you’ll be fine.”

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It was very good advice and I have used it the rest of my life. I went on to play for Harvard and become an All American, but it was also great advice in business. "Maximise what you have, don't fret about what you haven't got".

Here in Rotorua some would say we are blessed with incredibly important assets, especially the lakes. But we cannot rest on our laurels, and this Symposium is all about doing more, doing better, and doing it quickly; about intent and inclusion. Your combined efforts will make life for us in tourism that much easier.

Promotion is the key, and promotion of the right information. I am currently a Director of Zespri. Some years ago the *Guardian* in England credited kiwifruit flown to the United Kingdom with the highest carbon footprint worldwide. I am sure that is completely correct, except that kiwifruit has never been flown to England, never ever. Yet if you Google 'carbon footprint' and 'kiwifruit', up will come the *Guardian* article of four years ago. Zespri has had to spend a lot of money correcting this false information. We too will need to be vigilant and get the truth out there.

I am very conscious that a man should not speak for longer than he can make love, so I can quit now, or carry on. I am also very conscious of the phrase, *the mind can absorb what the arse can endure*, and you have been sitting on those seats for a couple of days now. Let me leave you with a vision and a challenge. I grew up, as you can probably hear from the accent, in England, in a place called Bath, perhaps the most famous hot water spa in Europe. Our first visitors came heavily armed from Italy in AD60 but they rapidly saw the potential in what they called 'Aquae Sulis'. They built saunas, spa baths and plunge pools that you still see today.

Bath, a rural back water, became the most sought after posting for Roman Centurions. Fast forward 1,700 years, Bath was the pre-eminent social city in Europe based on taking the waters, where you floated for hours and felt a lot better after it. Bath was also famous for gambling which drew in visitors. They had an enlightened city council and a great marketing manager called Richard Beau Nash. You may be interested to know that in 18<sup>th</sup> century England it was said there were three ways to lose money – gambling, women and farming. Gambling was the quickest, women the most pleasurable, farming the most certain. Not sure if things have changed!

Fast forward another 250 years; Bath is still very famous in 2010 and attracts about 400,000 visitors a year. It is a place where you see architecture, Georgian buildings built in the 18<sup>th</sup> century to celebrate the Roman baths, and the Roman baths themselves. You can see the water, drink it for 50 P a cup and it tastes awful. Until very recently you could not get into it. Tourist authorities lamented to me when I was there in January that less than 0.1% of all tourists coming to Bath can sit in the water that made the place famous.

Is that possibly a little familiar for Rotorua? Rotorua is, or arguably could be, the most famous spa hot water city in Australasia; we just need to create more opportunities and value to that total experience. Massage, health advice, battery-recharging, detox treatment and exercise. I believe we could get several thousand people a week here on special house-oriented detox weeks, relaxing, eating carefully, cycling, bathing, having nutrition courses, learning Maori lore, and many others.

I know places in Rotorua are already offering that, but what I would like to do is turn Rotorua into the local equivalent of a little village near Bath, England, called Ross-on-Wye which was a two horse town, in fact probably a one horse town, and that horse was thinking of leaving about thirty years ago. They opened a couple of book stores and over the years the place has become the biggest book selling city or town in the world. They

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have book festivals and about sixty shops doing nothing but selling books. Ross-on-Wye has completely reinvented itself and yet had nothing going for them before.

It is all about marketing, the focus, and most importantly, the experience. We will need to dominate; we can be a world leader with the best people, the best environment and best reputation, spiritually as well as economically. We need to forget what we have been and focus on what we could become.

Thank you.

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## GEOTHERMAL OPPORTUNITIES FOR THE ROTORUA DISTRICT

### INTRODUCTION - Dr Toby Curtis

Chairman, Te Arawa Lakes Trust

Rotorua

curtisp@xtra.co.nz

As the Chairman of Te Arawa Lakes Trust, Toby was to introduce the topic of geothermal opportunities in the Rotorua district. Unfortunately he was called away but his introduction has been included here.

### BRIEF HISTORICAL BACKGROUND

The geothermal sites that stretch from Whakaari (White Island) through Whakatane, Rotoma, Rotoiti, Rotorua, Waiotapu, Waikite and Waimangu valleys, past Wairakei, Taupo through to Tokaanu at the base of Tongariro Mountain are known as the Waiariki Geothermal Region.

The name Waiariki when translated means *The Water of High Chiefs*. Heated water was accorded a level of importance in the daily lifestyle of the community. All hot water in the region shared this rank of distinction.

#### Slide 1

#### White Island



#### Origin of Title

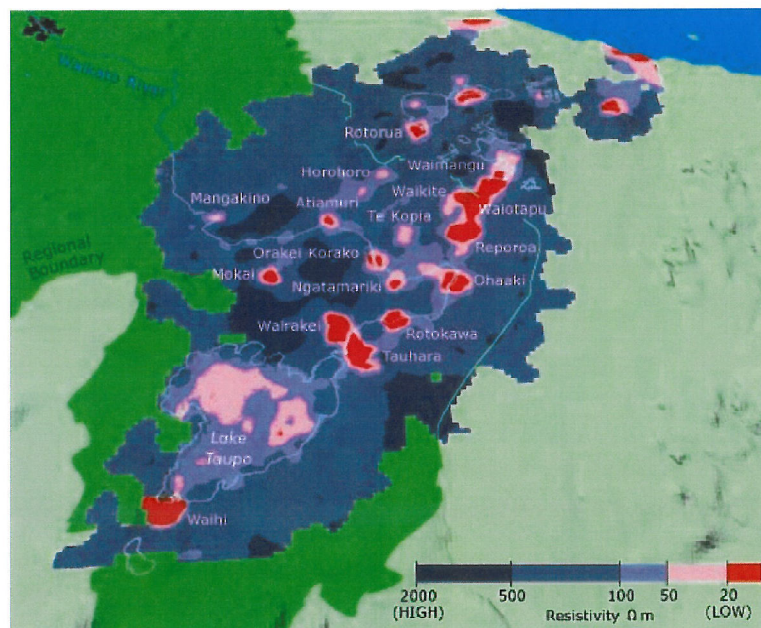
**Slide 1:** Ngatoroirangi was the high priest and chief navigator on board Te Arawa waka, when it set forth on its journey from Hawaiki to Aotearoa/New Zealand. On arrival, he soon distinguished himself as a hinterland explorer. He journeyed south toward Taupo and eventually found himself high up the slopes of Mt Tongariro. While still some distance

from the peak, his body began to literally freeze into a block of ice. He immediately recited *karakia*, special prayers which summoned his sisters back in Hawaiki to rescue him from this petrified frozen state. They quickly rushed to his aid by swimming underwater. Their speed was such that they arose out of the water like objects of molten lava. When the lead sister emerged from the sea, her back leg created a thermal site that has been active ever since.

Today, Whakaari or White Island is the first geothermal footprint created by one of the sisters.

## Slide 2

### Geothermal – Whakatane to Tokaanu



**Slide 2:** The identified geothermal sites that currently exist today are acknowledged as the hot footsteps of the sisters as they quickly traversed the countryside to reach their brother Ngatoroirangi, to save him from the deathly freezing temperatures.

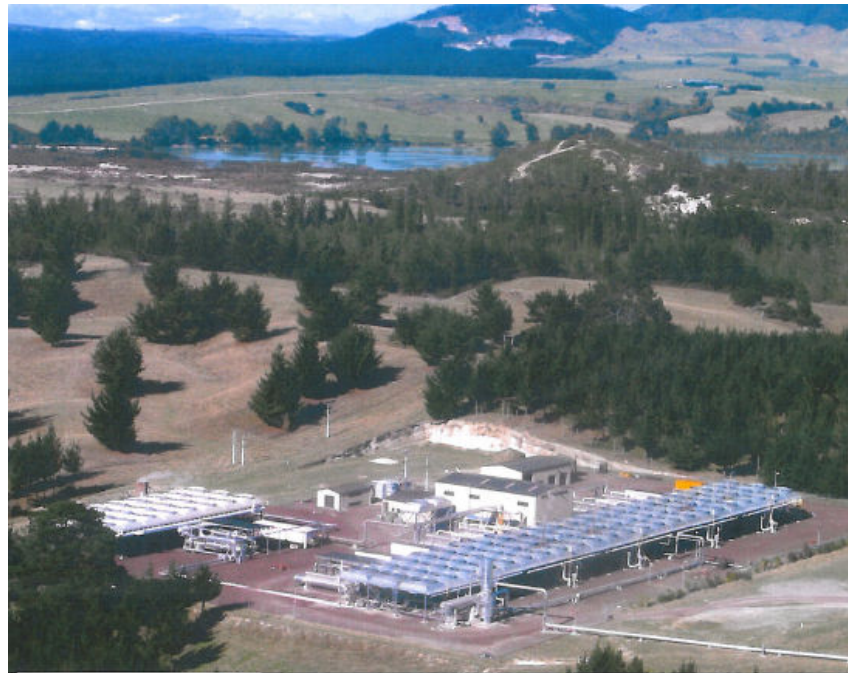
### Past and Current Use of Geothermal Sites

- a) Domestic: bathing, washing clothes, cooking
- b) Health Remedy: arthritis, rheumatism, body fatigue
- c) Fabric Enhancement: accelerating drying process, dyeing and recolouring materials
- d) Generating Electricity

**Slide 3** is the present site of a geothermal plant that one iwi has constructed in partnership with Mighty River Power.

Mighty River Power has a number of the potential sites that are being planned for development. It is an indication of the wealth that can be created with the add-on value of agri-, horti- and aquaculture:

### Slide 3



TAUHARA NORTH  
No. 2 TRUST

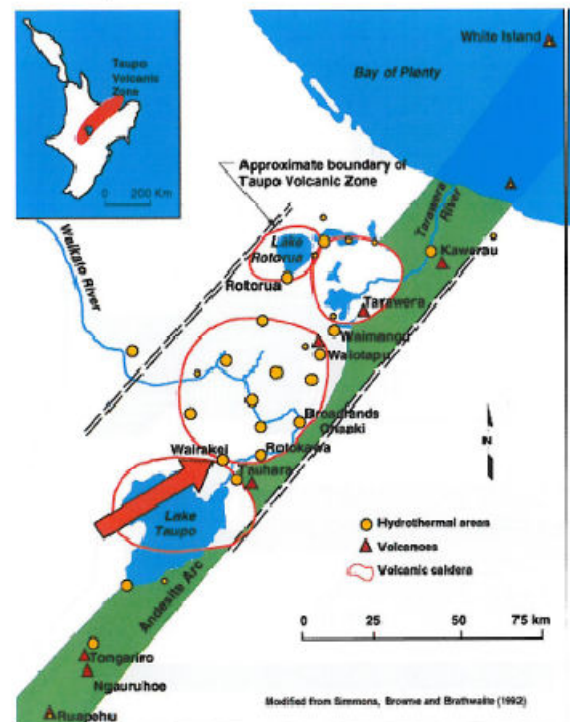
ROTOROKAWA – 33MW

### Slide 5

- **Kawerau: 100 MW** 100% owned but through partnership with Putauaki Trust and Ngati Tuwharetoa Settlement Trust
- **Rotokawa: 34 MW**  
100% owned but ownership rights for 50% with Tauhara North No. 2 Trust
- **Mokai: 112 Mw**  
Owned by Tuaropaki Power Company (75% Tuaropaki Trust and 25% Mighty River Power since 2003)
- **Nga Awa Purua: 123 MW**
  - Located on the Rotokawa Field
  - Joint venture with Tauhara North No. 2 Trust (25% from plant handover)
  - 2010 New Zealand Energy Project of the year

In order for this potential to advance growth, everyone living within the area must receive some form of material benefit. When people become beneficiaries of any growth strategy, they begin to seek pathways that will lead to better and greater opportunities.

### Taupo Volcanic Zone



The next two presenters from GNS will provide us with some possible insights.

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## GEOTHERMAL OPPORTUNITIES FOR THE ROTORUA DISTRICT

**Brian Carey**

GNS Science, Wairakei Research Centre  
Taupo  
b.carey@gns.cri.nz

*Brian Carey is the Geothermal Manager at GNS Science Wairakei Research Centre with over 25 years of geothermal resource management experience in geothermal power generation. He holds a Master of Mechanical Engineering from University of Canterbury.*

*He is the Vice President of the New Zealand Geothermal Association and a member of the Environment Waikato's Rotokawa Geothermal System Peer Review Panel. As the Low Temperature Geothermal Project Leader he is supportive of wider use of geothermal energy as it is a low carbon emission energy source.*

### ABSTRACT

#### **Resource With More Potential - Low Temperature Geothermal Energy**

Key words: New Zealand, Rotorua District, geothermal, low temperature geothermal, social understanding, ground sourced heat pumps, hybrid geothermal technologies.

New Zealand is endowed with significant geothermal resources which are sought to be further developed under a New Zealand Energy Strategy (NZES) to 2050 seeking to increase the nation's use of renewable low carbon energy sources. The Rotorua area is particularly well endowed. As part of the NZES, there is potential to increase the use of lower temperature geothermal resources. By 2025 a target of 12 PJ per annum of direct use has been suggested. This represents an increase of 2 PJ per annum from the estimated 10 PJ per annum usage in 2005. The understanding across the New Zealand public on low temperature geothermal resources is however generally poor.

This presentation will introduce a brief overview of the social understanding of low temperature geothermal resources elicited from targeted surveys, identify the geothermal resources in the Rotorua District, discuss a range of technologies including ground sourced heat pumps and hybrid technologies that are gaining popularity in other parts of the world, suggest areas of geothermal utilization that might be useful to encourage in the broader Rotorua area and discuss ways to better foster the understanding of low temperature geothermal in New Zealand.

### TRANSCRIPT

Thank you, it is good to be here. Today we will be talking about earth energy and geothermal energy in Rotorua. For me it is a bit like preaching or teaching to the converted. You have sister cities, including Klamath Falls in Oregon and have international connections to the Geo Heat centre, which specialises in low temperature geothermal systems which Lisa Lind will discuss.

I shall begin by setting a broader scene, an introduction with a discussion of the world scene and then what is going on in New Zealand. After that I will discuss some of the very interesting things going on in technologies and people's thinking about how to harness earth energy: what to do with it, and how to make the best of it. Next I will talk about the Rotorua district and some of the marvellous assets which you have here. I then

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change tack and talk about the research work that we are doing at GNS: our low temperature work and our hotter and deeper work. I am going to talk about extremophiles, which are the bugs that live in strange hot geothermal places. Then I will talk about forestry and geothermal, because this is another synergy with which the Rotorua district is endowed.

Lisa and I are going to do a joint presentation today. We are part of a substantial team at GNS Wairakei: seventy five staff. Ten years ago there were about twenty five staff. Of the seventy five today about thirty five are in my geothermal team. We have a broad team and it is growing.

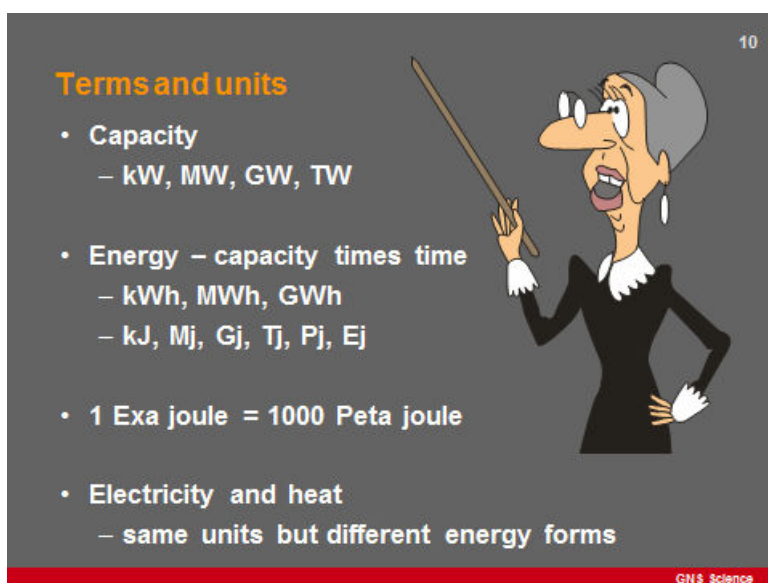
I am Brian Carey, Geothermal Manager and this slide shows what life is like in the geothermal world at the moment.

I will also introduce Lisa Lind who will talk about low temperature geothermal. She has an interest in skiing and she comes from the right nation, doesn't she, Mayor Bo Frank?

Now to the world scene in geothermal - it is an explosion. But before I take you through that explosion I am going to talk about some terms and units. I was really interested in your Symposium Handbook on page 36, where there are units like *milli* and *micro*. These are very small units. I am going to take you to the other far end of the scale, to massive units. **Slide 10** shows units like *kilo*, *mega*, *giga*, *tera*, *exa*, etc.



#### Slide 10



**Terms and units**

- Capacity
  - kW, MW, GW, TW
- Energy – capacity times time
  - kWh, MWh, GWh
  - kJ, MJ, GJ, TJ, PJ, EJ
- 1 Exa joule = 1000 Peta joule
- Electricity and heat
  - same units but different energy forms

In energy we talk about *capacity*, which is basically the size of something. At home you may have a two kilowatt heater. The units are kilowatts. With power generation megawatts and gigawatts are involved, and on the world scene the units are terawatts. These are all a factor of a thousand bigger than the next lower on the scale.

Energy is the capacity multiplied by time. If you run a one kilowatt heater for one hour you use one kilowatt hour: that is the energy consumed. Running a unit with one megawatt capacity for one hour uses one megawatt hour. So that is energy. Another way of

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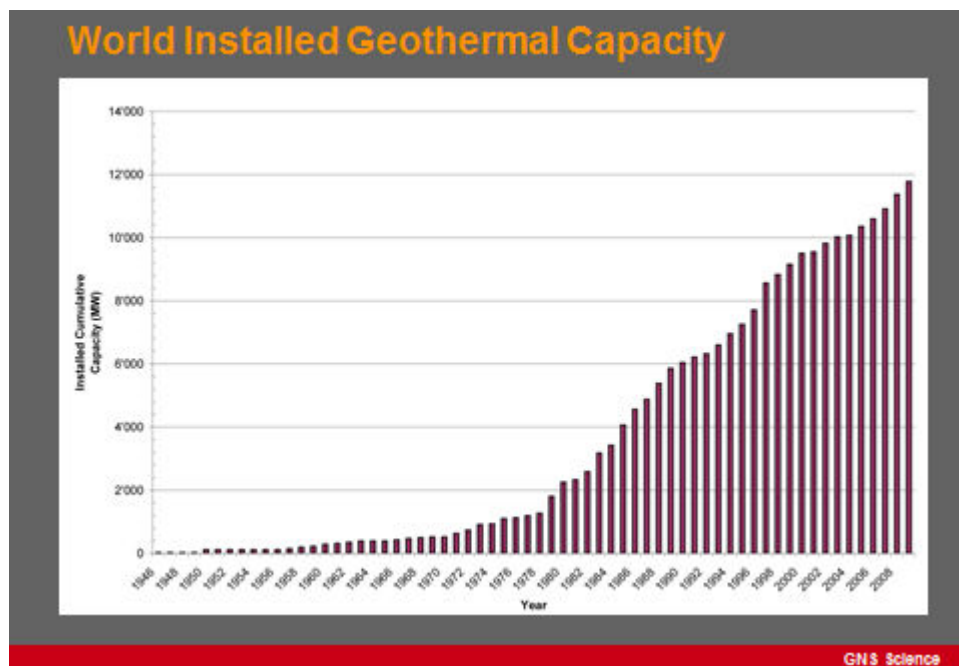
expressing that is to use joules, and hence kilojoules, megajoules, gigajoules, terajoules, petajoules and exajoules, massive units. One exajoule equals 1000 petajoules. Some of you will be familiar with petajoules if you are in the energy sector.

I also need to stress that although electricity and heat are measured with the same units, they are very different types of energy - very, very different. That needs to be kept clearly in mind because the units are the same in terms of quantity, but in terms of their quality and what you can do with them, they are very, very different.

What can be done with geothermal energy? Some can be converted to electricity given the right circumstances, but it can also be used directly as heat energy. This is growing in popularity, both in New Zealand and around the world. There is another aspect which people have not really caught onto so much in New Zealand but its growing in the world rapidly. Sweden has taken a massive lead in the field of ground-source heat pumps, and ground energy. The term *GSHP* applies to ground source heat pumps: or *GHP*, meaning ground heat pumps. I will talk about the technology in a little while and how it works. This may be new for some because it is a different way of thinking, in terms of where energy is, how we can access it and how we can use it.

New Zealand generates in total about 43,000 gigawatt hours of electricity per annum. That is the maximum total generation produced in any one year. It is produced from an installed generating capacity of about 9,000 megawatts in the power stations up and down the nation, whether they be in Clyde or in the Waikato or Huntly.

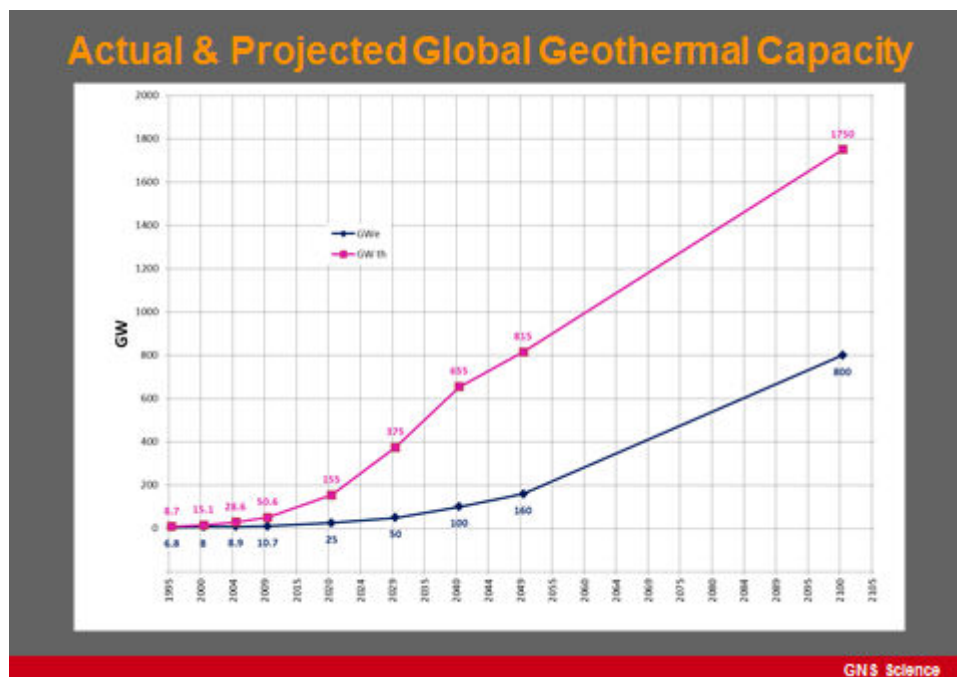
### Slide 13



**Slide 13** shows the installed geothermal capacity in the world. Before World War II there was little geothermal, and mostly in Italy, dating from the early 1900's. In 1946 there was very little geothermal capacity in New Zealand. Through the late 40's and early 50's Wairakei was built in New Zealand and commissioned in 1958. By 2010 there was about 12,000 megawatts capacity installed. The gradient on the graph is quite interesting: it is in two stages with an increase from 1946 through to 1980, and then a more rapid rate of increase.

I want to talk about the International Panel for Climate Change (IPCC) and the Special Report on Renewable Energy Sources and Climate Change Mitigation. From the IPCC there has been a push to manage CO<sub>2</sub> emissions and on the fuel use in the future for managing climate change. Geothermal is a low carbon emission energy source, and has received a rather large boost as part of this IPCC work. A geothermal team has been working on this, to which I will refer later. The data discussed below is from the draft report presented at the World Geothermal Congress in 2010. This is provisional information because the final report is being reviewed before its release. One of my colleagues, Chris Bromley, is providing a lead role in this team in compiling geothermal information for this report. He is a geophysicist working at the GNS Research Centre at Wairakei.

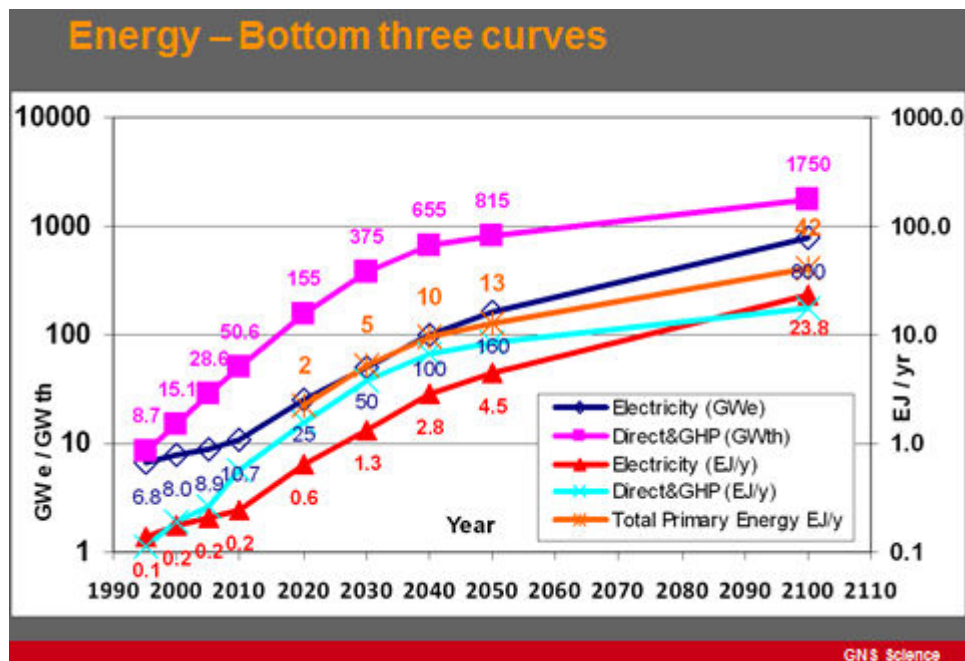
## Slide 15



**Slide 15** shows actual and projected global geothermal capacity data. On the previous plot the vertical axis was in megawatts, whereas this one is in gigawatts, i.e. 1,000 megawatts, a thousand-fold different. On the graph are two energies: the blue lower line is the electrical gigawatts, and the pink top line is the thermal gigawatts. The IPCC panel looked at both electrical and thermal energy. In 2009 there were about 11 gigawatts (or 11,000 megawatts). With the growth rate to 2100 they project about 800 gigawatts of global geothermal capacity installed ninety years from now. The pink line shows geothermal **thermal** energy (i.e. the direct use, the heat energy) over the same time period. In 1990 there are 50 gigawatts of thermal capacity, and by 2100 the figure shows 1,750 gigawatts thermal. These are massive increases.

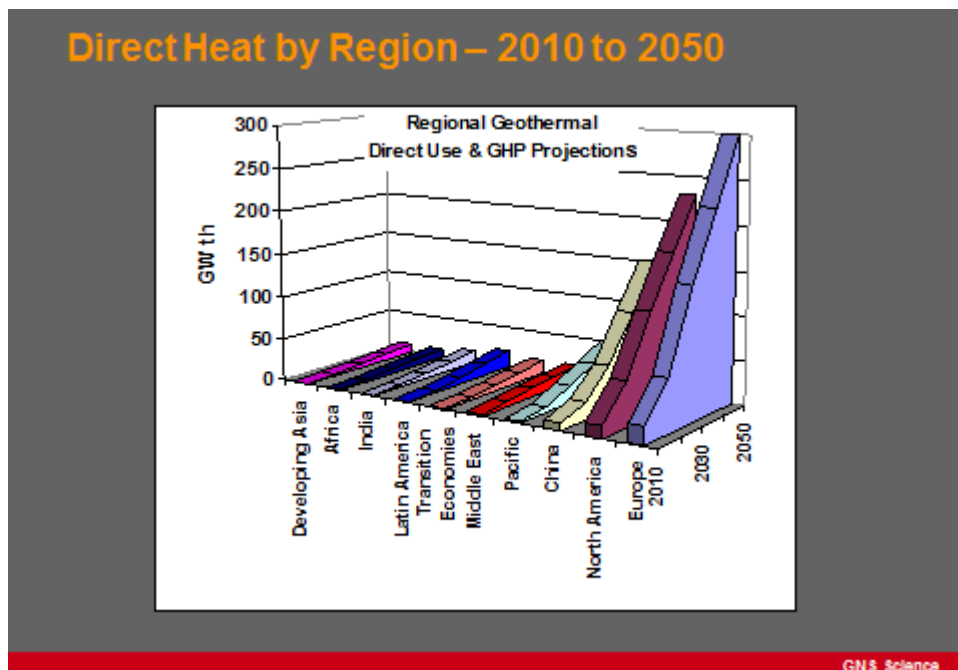
**Slide 16** retains the pink and blue lines from the previous graph, but on the right side scale is delivered energy. This relates to the other lines: the red line on the bottom is delivered energy expected to come from that installed capacity, and the blue line is the direct geothermal energy use including ground heat pumps. Note carefully that this plot is a log plot, and although it looks as though growth flattens out over the decades, in fact it does not: it grows massively. The clear message is that massive growth is expected for geothermal; whether it is electrical or direct use.

Slide 16



**Slide 17** gives the data by nation, and indicates the countries where direct use and ground heat pump projects are expected to grow. Europe with massive capacity growth will be the leader in direct geothermal use and ground heat pump projects. North America follows and China is next. China will grow rapidly over the next five years. Other nations shown on the left side of the plot will be much lower in terms of their direct heat use.

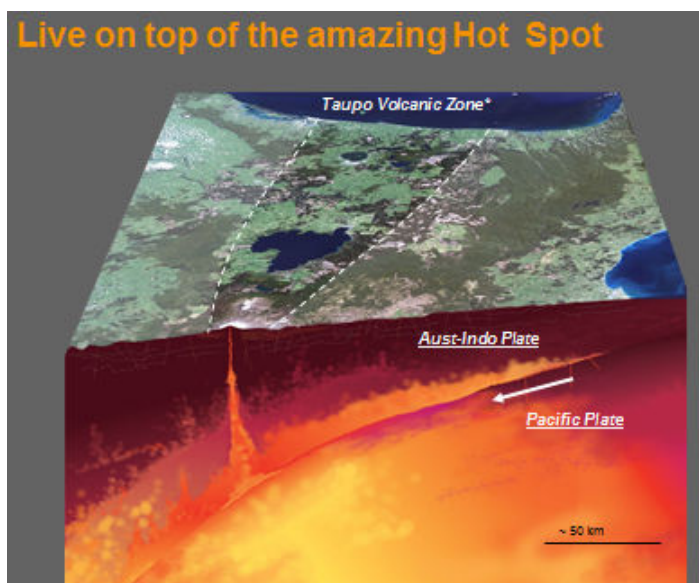
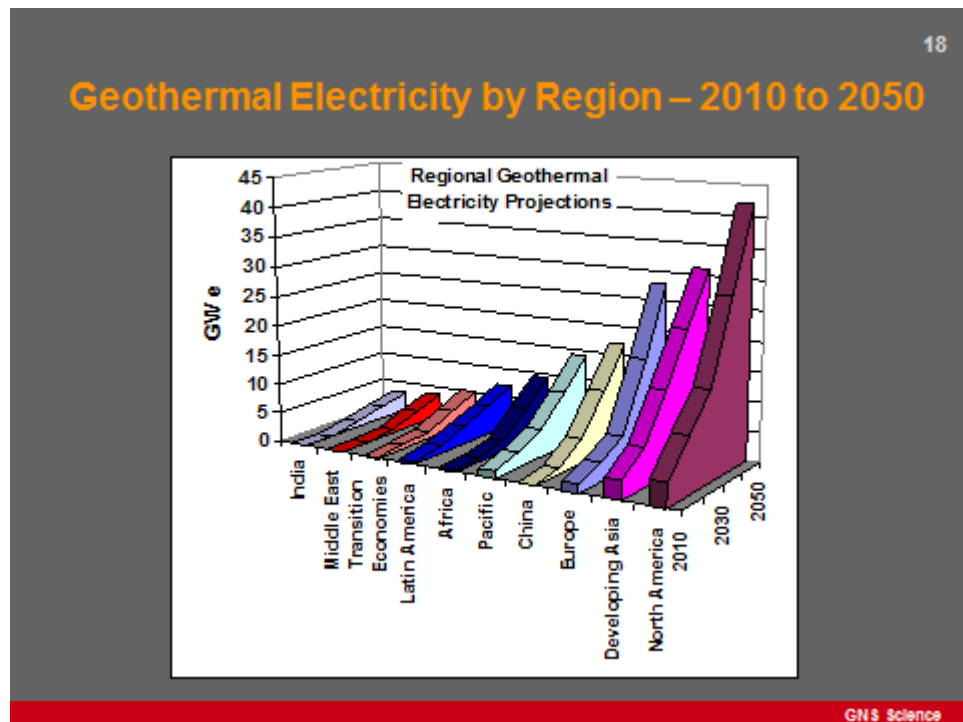
Slide 17



Slide 18 shows electrical capacity which is a different picture. North America is at the top, but developing Asia makes a massive contribution: countries like Indonesia and the Philippines. Europe follows, with China next at about fourth on the list.

Depending on the type of energy being used, whether it is generating electricity or whether it is using heat directly, various nations will see different growth rates. An *explosion* is quite the appropriate term for the world scene over the decades ahead. But what about New Zealand? We are really a baby coming out of the cot: we are growing quite quickly but we are still a baby.

Slide 18



Slide 21

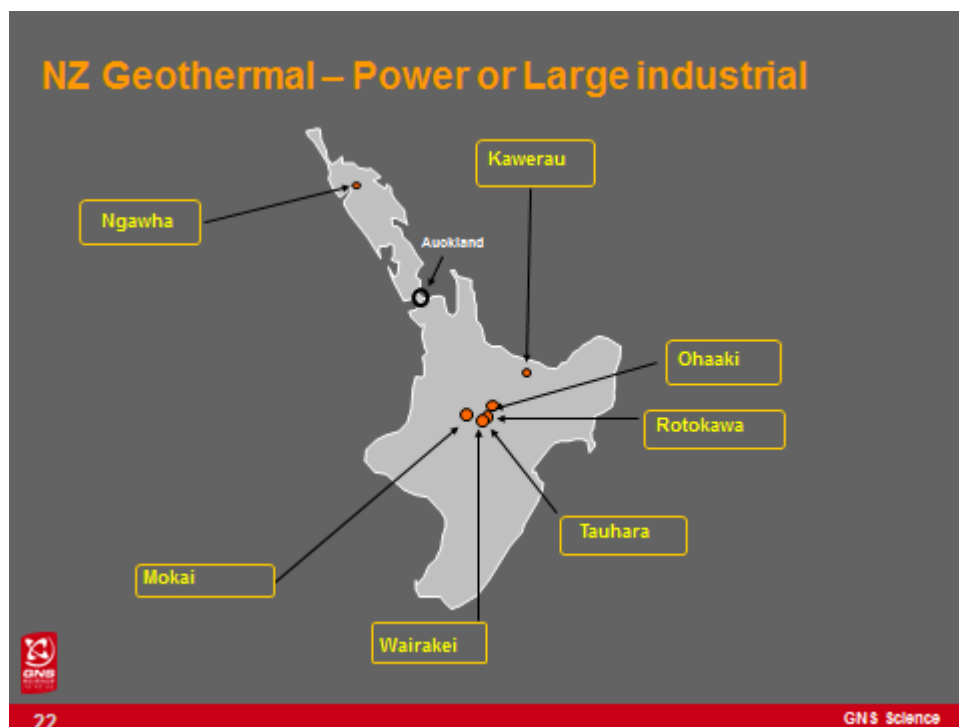
**Slide 21** indicates that we live on top of an amazing hot spot in world terms, with massive heat energy coming through the ground, courtesy of our tectonic setting, with the Pacific plate and the Indo-Australian plate pushing up against each other. It gives us the Taupo volcanic zone, from Tongariro in the South to Whakaari (White Island) in the North. The Taupo volcanic zone is an amazing hot spot that is naturally sourced and with natural energy flowing through the surface.

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**Slide 22** shows the location of the major power and industrial facilities using geothermal in New Zealand. They are clearly focussed on the hot spot in the Taupo volcanic zone. The facilities are:

- Kawerau for industrial use
- Ohaaki, partly in the Rotorua district, for electricity
- Rotokawa, Tauhara, Wairakei and Mokai, in the Taupo district, for electricity
- Ngawha in Northland, just out of Kaikohe, with a power plant of about a 25 megawatts

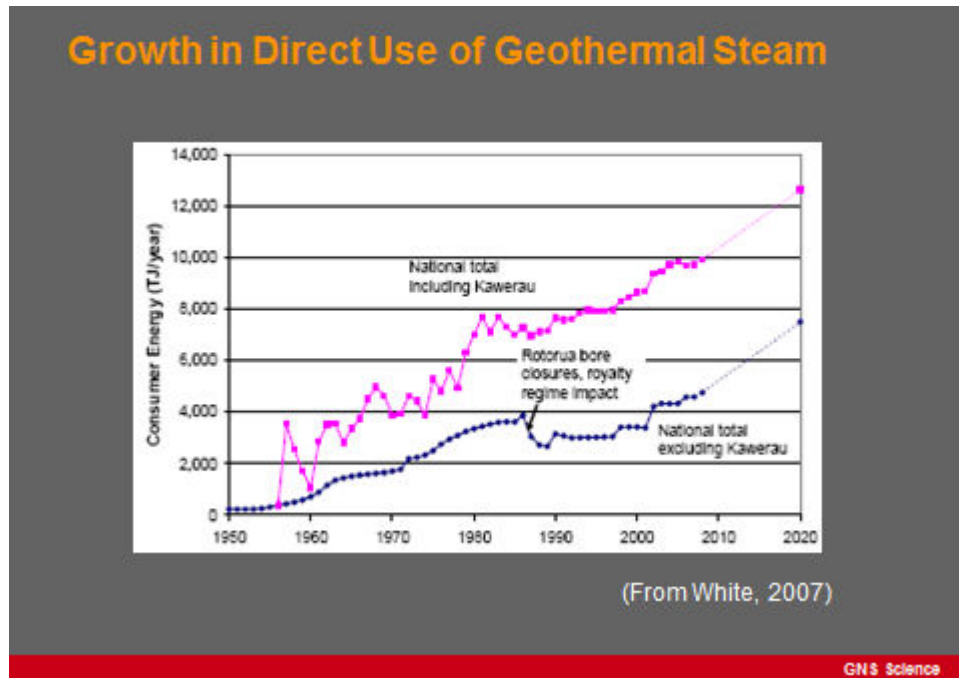
**Slide 22**



These are the key industrial and power generation sites in New Zealand now. We are number four in the world currently for installed electrical capacity and have the world's largest geothermal heat use at one location (Kawerau). We are slow in other areas however: in other direct heat uses and in the uptake of ground source heat pumps or ground heat pumps.

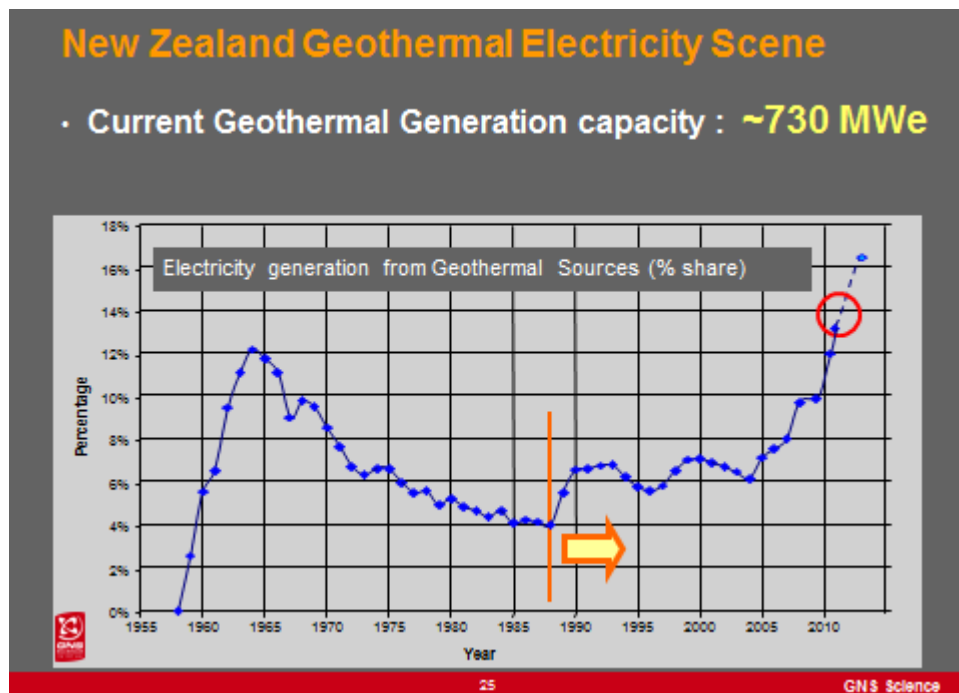
**Slide 24** is data from the 1950's through to 2010 from Brian White, Executive Secretary of the New Zealand Geothermal Association. It is direct use of geothermal heat, and is separated into two parts: the pink line at the top is the national total which includes Kawerau; and the blue line beneath is energy use excluding Kawerau. It is interesting to note the growing use of energy at Kawerau. SCA Hygiene Australasia in Kawerau has started using a clean steam generator using geothermal to generate clean steam for their Yankee dryers for tissue making. Other developments are occurring in the Taupo volcanic zone. The milk industry is using geothermal energy in milk drying, and by June there will be a geothermal powered milk-drying factory at Mokai, on stream for the start of the 2011 milk season. The direct use of geothermal for industrial processes is growing, and will continue to grow in New Zealand.

## Slide 24



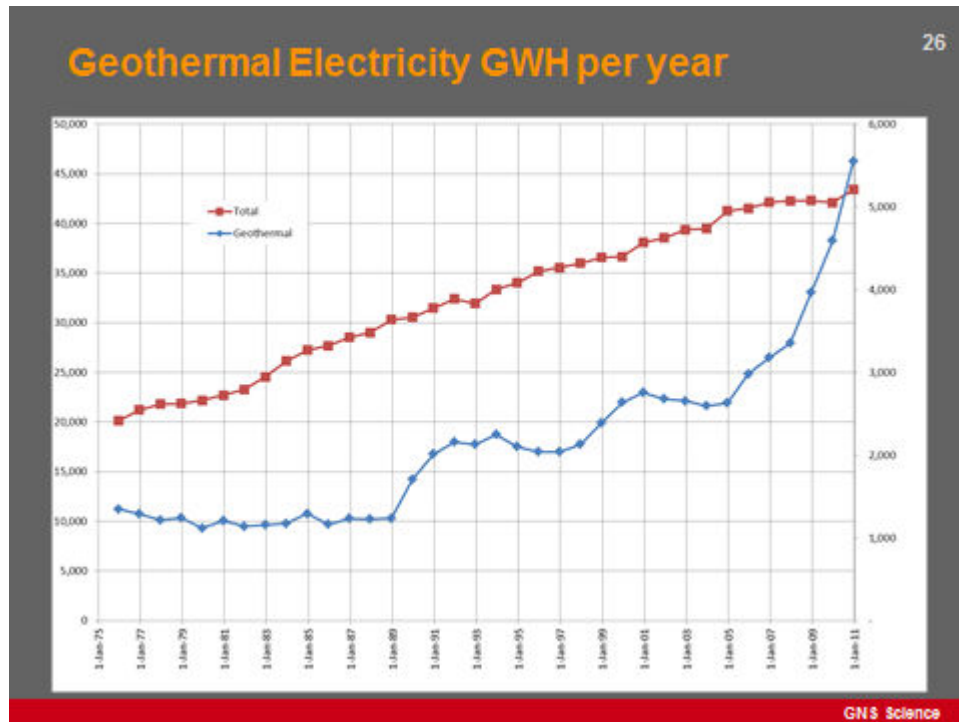
**Slide 25** shows geothermal electricity generation. 730 megawatts are currently installed producing about 13% of the nation's electricity from geothermal energy. The plot shows the percentage of New Zealand's electricity that was produced by geothermal from 1955 through to 2011. It peaked at about 12% when Wairakei was a significant contributor to the overall energy required by the New Zealand grid, and then as the grid grew New Zealand did not grow its geothermal, and the percentage dropped away. Since 1987 New Zealand has grown its geothermal again, but we were static for a number of years from 1990 through to 2005 at about 7%. Now we are on a massive growth path which is projected to continue.

## Slide 25



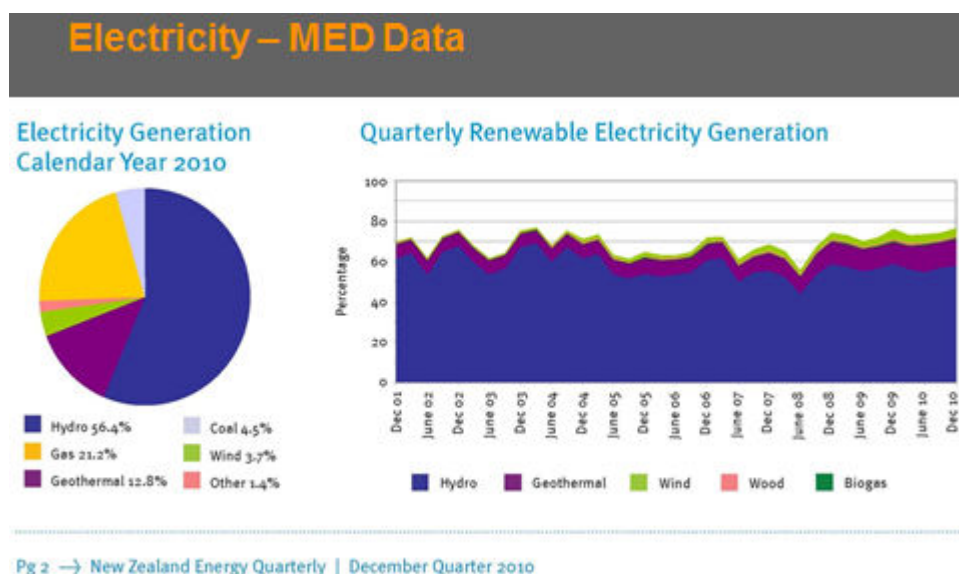
**Slide 26** identifies that in 1976 New Zealand's total generation was about 20,000 gigawatt hours, growing to about 43,000 gigawatt hours in 2010. The geothermal level is also shown on a different scale on the right hand side. Geothermal was running at about 1,200 gigawatt hours until about 1987, and then grew to the current production contribution of about 5,700 gigawatt hours.

## Slide 26



**Slide 27** is data from MED from 2001 to 2010. At the bottom of the graph is hydro, (blue) purple is geothermal and the green on top is wind. In 2010 hydro produced 56% of the nation's electricity, geothermal 13%, and wind 4%; gas 21% and coal 5%. This means that 75% of the nation's electricity is from renewable sources today.

## Slide 27



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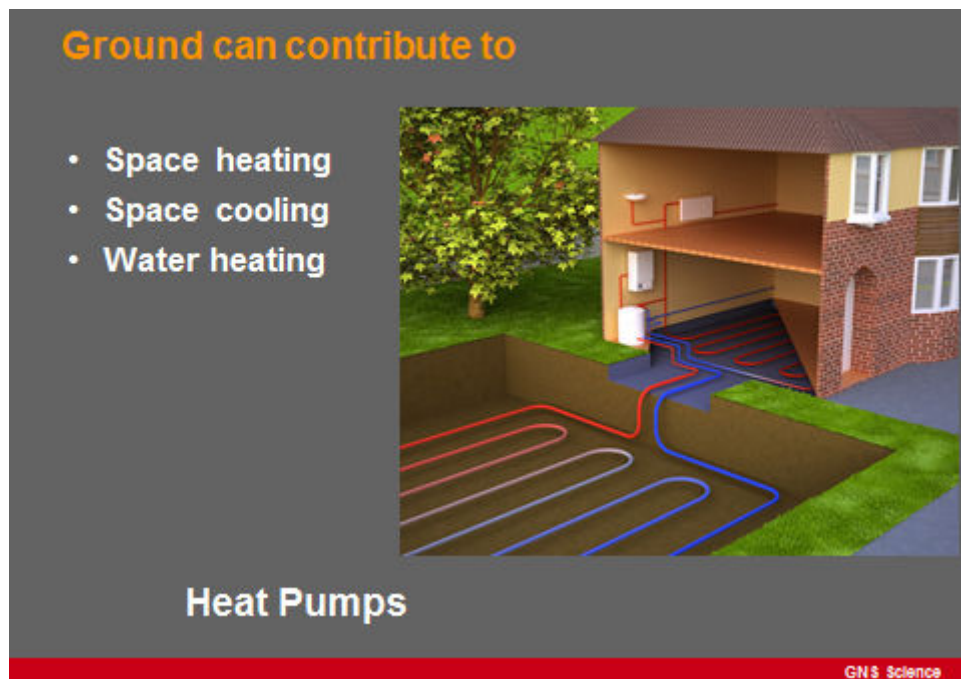
More geothermal capacity is being built: the Te Mihi Project, now under construction, will give a 90 megawatt increment. Consents are in place for an additional 350 megawatts at Tauhara and Ngatamariki.

**Slide 30** shows process heating, particularly in the timber industry, with the Kawerau plant and Putauaki (behind), timber kilns at Tenon in Taupo, (bottom right) and the paper mill Kawerau shown top right.

**Slide 30**



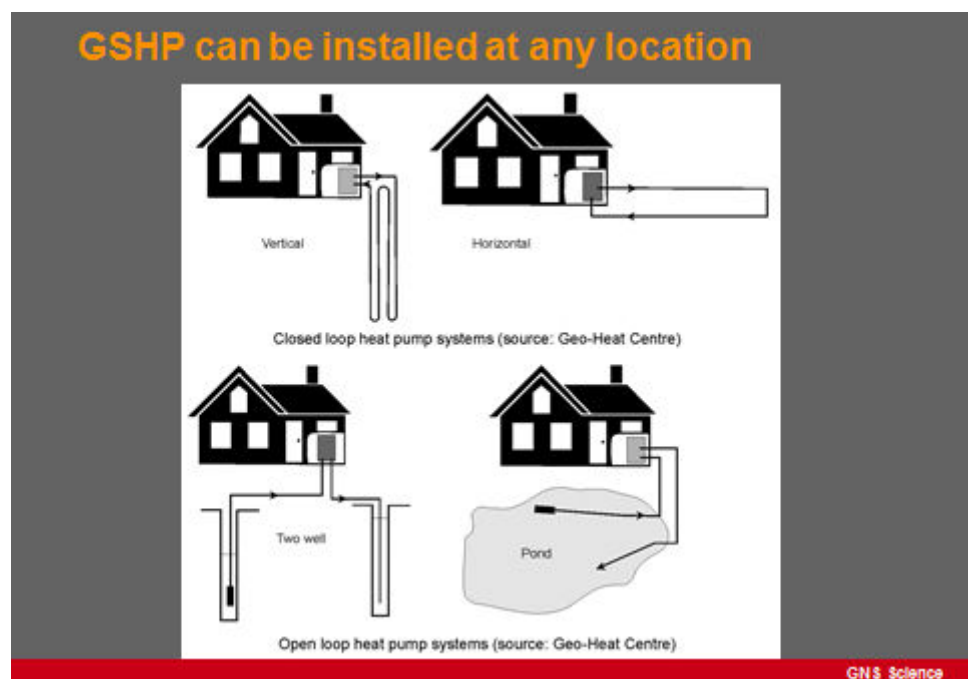
**Slide 31**



**Slide 31** indicates how the ground can contribute too. Heat pumps can pump heat from the ground into a building. There is a loop arrangement in the ground, a heat distribution system in the building and fluid is circulated through the ground and back to a unit called a heat pump. Essentially it is a refrigeration device, with a refrigerant in it, driven through a compressor powered by electricity. It pumps heat from the ground, from a cooler source temperature, to an area where it is required at a hotter temperature. These systems work with the ground as an energy source. They can be used for space heating, space cooling and water heating. They can be installed in **any** location.

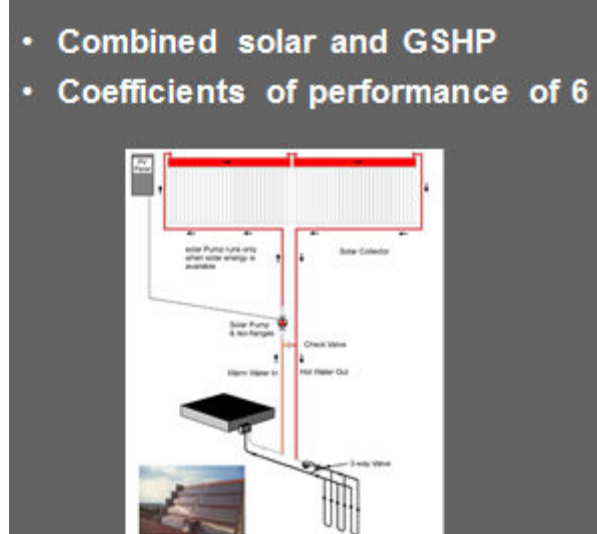
**Slide 33** identifies several different types. Loops do not need to be horizontal: they can be vertical, drilled into wells, as is done in Sweden. A system which uses aquifers can be used, taking water from one and putting it into another, and using the heat in the water as the source of heat for ground source heat pumps. A pond can be used, as can the sea; they are just a source of energy.

### Slide 33



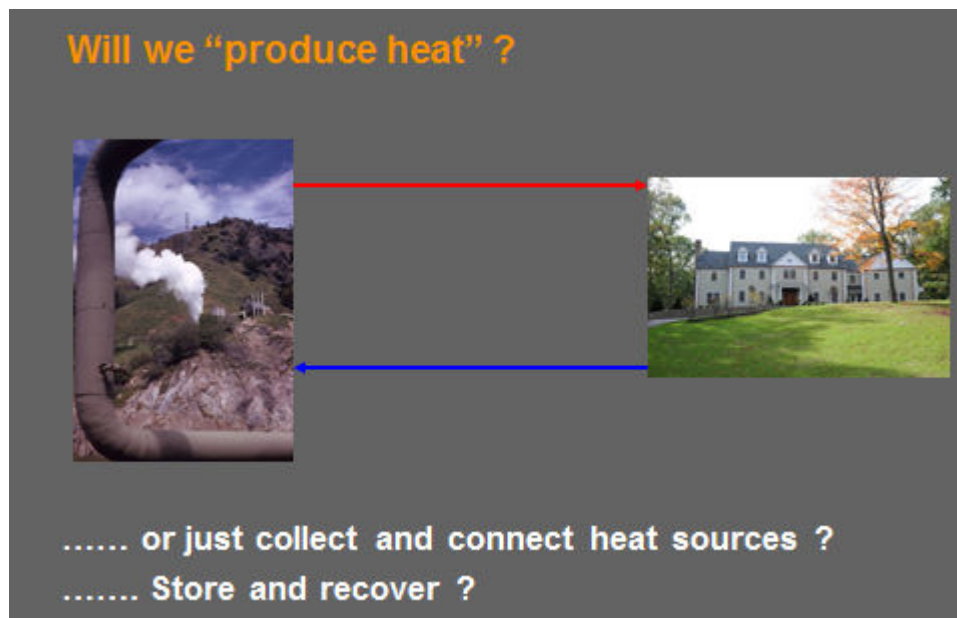
**Slide 34** gives an example of a hybrid technology. This is a combined solar and ground source heat pump. The co-efficient or performance of this device (i.e. the input of electrical energy compared to the output of heat energy) is from one kilowatt hour of electrical energy and six kilowatt hours of heat energy are produced. This is an arrangement which uses a combination of solar panels and a ground source heat pump. These systems are being developed, and in the UK there are examples running with the co-efficient performance noted above.

### Slide 34



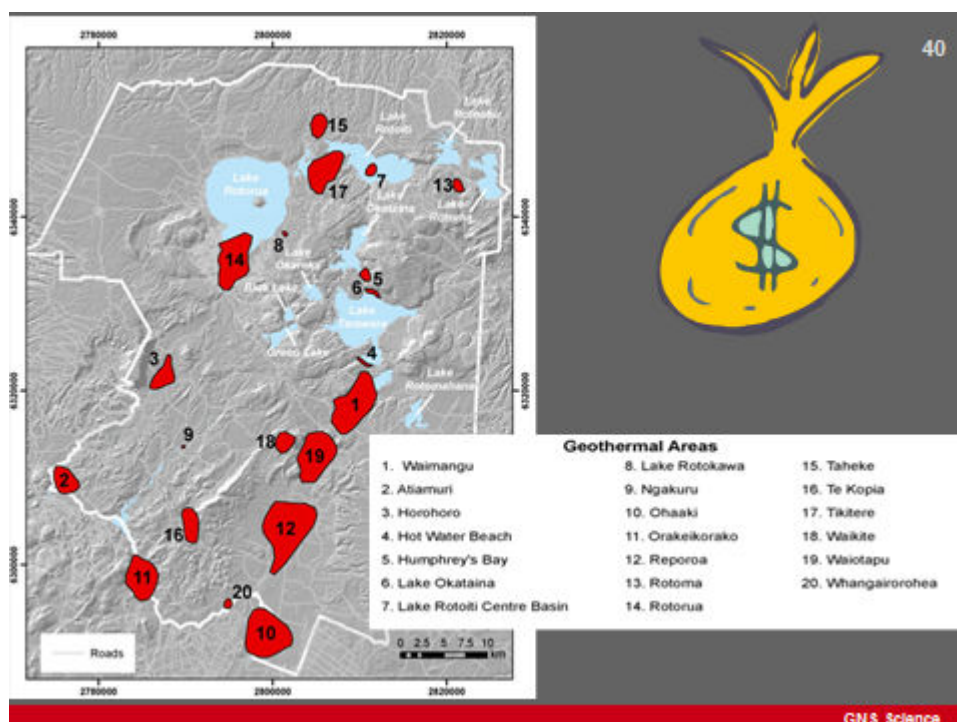
**Slide 38** illustrates that a **paradigm change in thinking about heat needs to be embraced**. Most important is that the regular old ground upon which we walk every day can be used as a source of heat. The ground can be considered like a rechargeable heat source, like a rechargeable battery. Heat can be stored and recovered.

## Slide 38



Where will we be in the future? Will heat be produced as we do today and then just thrown away to flow into the atmosphere? Or will the heat sources be connected, and heat pumped back to a place where it can be used again? Will this store and recovery mode be achieved? New Zealand is now wasteful in its approach to energy: we use and lose it.

## Slide 40



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**Slide 40** indicates that **the Rotorua district is well-endowed with geothermal energy** - it is extraordinarily lucky. Few places in the world have as much. There are twenty fields of known geothermal resources in the area. In addition there is the 'regular old land' as well and a lot of water.

In a shift of focus, I now turn to three research themes that are underway at GNS:

- low temperature geothermal
- 'hotter and deeper' - one of the future for New Zealand
- bioethanol from Thermophilic bacteria

Lisa Lind will open the discussion.

**Lisa Lind**  
GNS Science, Wairakei Research Centre  
Taupo  
l.lind@gns.cri.nz

*Lisa Lind is currently managing the Low Temperature Geothermal research programme at GNS Science. She holds a Master of Science in Chemical Engineering from Chalmers University of Technology in Sweden.*

*She has investigated technologies for utilising low temperature geothermal energy that will assist New Zealand moving forward in the development of this indigenous, renewable and widely distributed resource.*

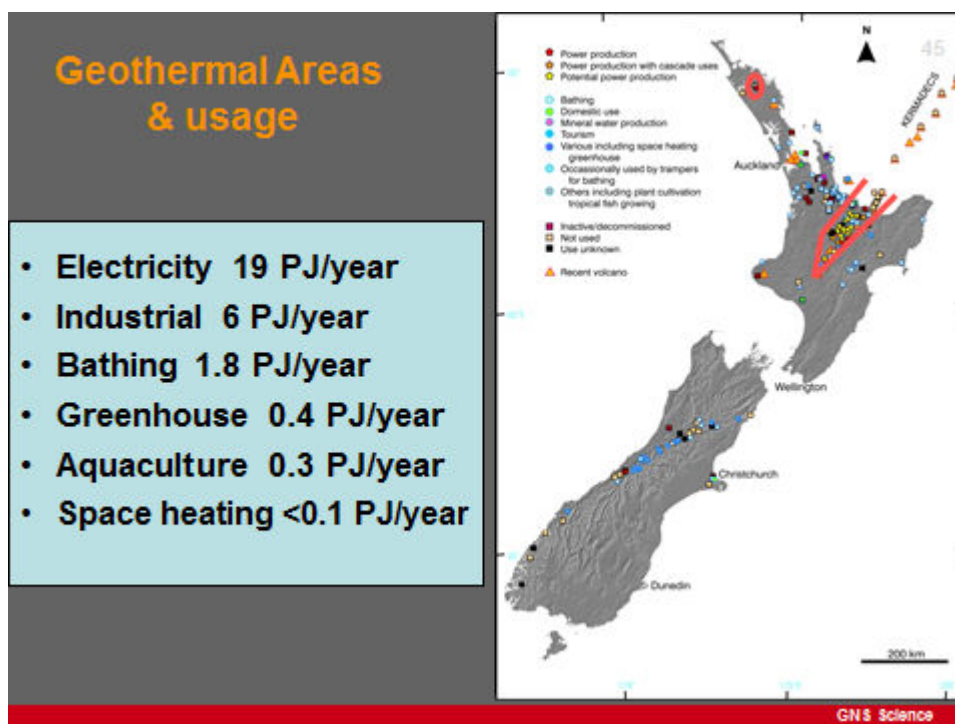
## TRANSCRIPT

This is a bit off the topic but I am going to pay some attention to the bag that everyone was given with the logo on it: *Keep Rotorua Beautiful*. Many people here contribute to this through the work you do with the lakes, but if you put that to the side and imagine you are a person living in the Rotorua community, I have a question for you. What do you do to keep Rotorua beautiful? For example what car do you drive? Is there an alternative? Could you drive a more environmentally friendly car? Or maybe not use your car so much. You could walk or bike or carpool. What do you eat? Do you have beef every day? Is that sustainable? Maybe you can have a vegetarian day just once a week. What do you do with your rubbish? Do you recycle it? Do you minimise your rubbish?

You have to make those choices when you go shopping in the first place. If you do not make those right choices, or the good choices to keep Rotorua beautiful, why? Is it because you do not know? Or is it because you simply do not care? If you here in this room cannot make good choices, how could you expect other people in the community to? **So I challenge you.** I would like you to think *Keep Rotorua Beautiful* when you make choices in your everyday life. I want you to be role models here in Rotorua.

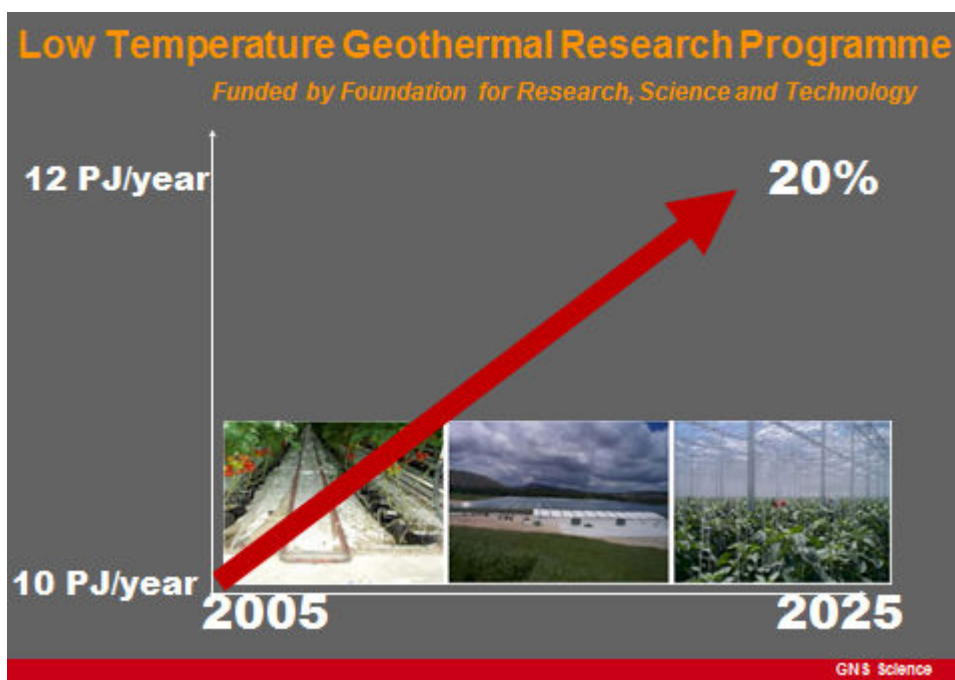
Back to geothermal: New Zealand is famous for its geothermal energy. It is a big tourist attraction, with lots of tourists coming to experience geothermal resources. New Zealand was one of the first countries in the world to utilise electricity from geothermal, it is part of the New Zealand culture. But what most New Zealanders do not know is that geothermal resources are available throughout their country. Even the people in the South Island can utilise geothermal energy, using the ground source heat pumps that Brian Carey was talking about.

## Slide 45



**Slide 45** indicates the geothermal areas in New Zealand and most of the high temperature geothermal resources are located in the Taupo volcanic zone and in Ngawha as Brian pointed out. 13% of all electricity is generated from geothermal in these areas. But the heat can be used straight away; it does not need to be turned into electricity. That is called *direct heating*. New Zealand is very good at using geothermal industrial direct heat. Direct heating is also used for bathing, greenhouses, agriculture and space heating; mostly in the Taupo Volcanic Zone.

## Slide 46



**Slide 46** is about the Low Temperature Geothermal Research Programme being undertaken by GNS Science, funded by the Foundation for Research Science and Technology, to foster more widespread use of low temperature geothermal resources. The focus of the research is to use geothermal resources other than for electricity, especially direct heating and ground source heat pumps. The aim of the programme is to increase the direct use of low temperature geothermal resources by 20%, by 2025, to about 12 petajoules per year.

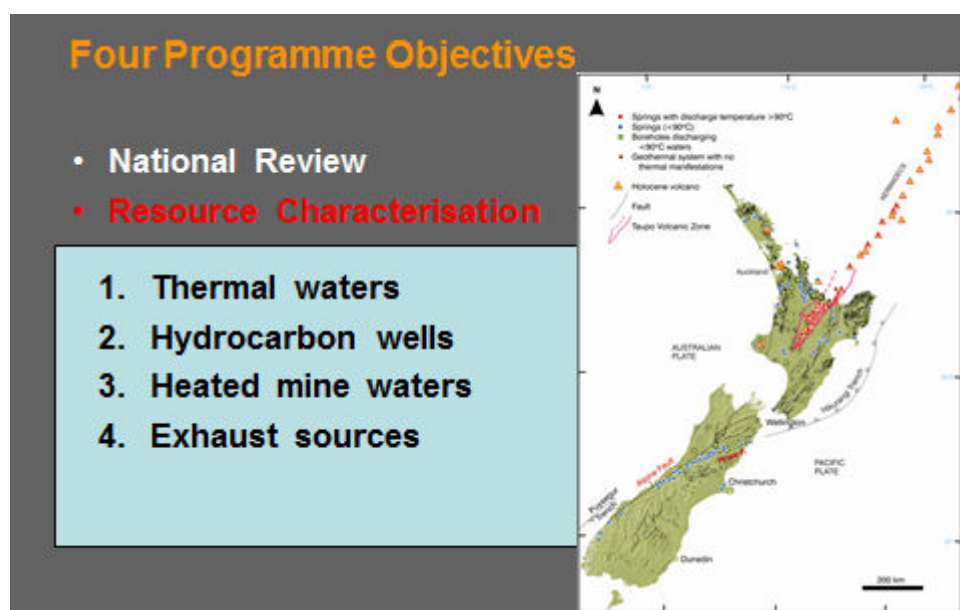
The programme has got four objectives:

- National Review, which is basically a stock take. What is the energy demand for heating and cooling in New Zealand today and what will it be in the future? What resources do we have and what technologies are available to utilise these resources? What do New Zealanders know about geothermal resources? What are the costs to utilise the technology? What policies are in place?
- Resource Characterisation, which is adding information to the current geothermal resource map. (**Slide 49**) It also looks into energy sources such as exhaust sources from industry which may be able to be utilised in a similar way to geothermal resources.
- Technology and Tool Development in which a variety of geophysical methods are being tested. It creates an image of the ground below, from the surface, using geophysical methods. Thermal properties of New Zealand rocks are also being tested, which should assist in sizing ground source heat pumps. Case studies and modelling are also part of the programme.
- Integrated Assessment is an integrated report which presents new data together with historical data, and some scientific tools. This will be the base on which increased utilisation of low temperature geothermal resources can be built.

The situation today is that we have been gathering data and have finished a few desk top studies. These can all be downloaded from our website.

[www.gns.cri.nz/earthenergy](http://www.gns.cri.nz/earthenergy) or [www.gns.cri.nz/lowtempgeothermal](http://www.gns.cri.nz/lowtempgeothermal)

#### Slide 49



**Slide 53:** The technology review showed that there are technologies to utilise low temperature geothermal resources being used overseas. For New Zealand the task is to adapt these technologies and modify them to suit our conditions. **The task is not to invent new technologies, but rather to raise public awareness.**

### Slide 53

**Technology review**

- Technology adoption from other nations
- Technology modification
- Public technology awareness
- Case studies



GNS Science

Ground source heat pumps could potentially play a larger part in the New Zealand energy market, but there are some barriers too. They include:

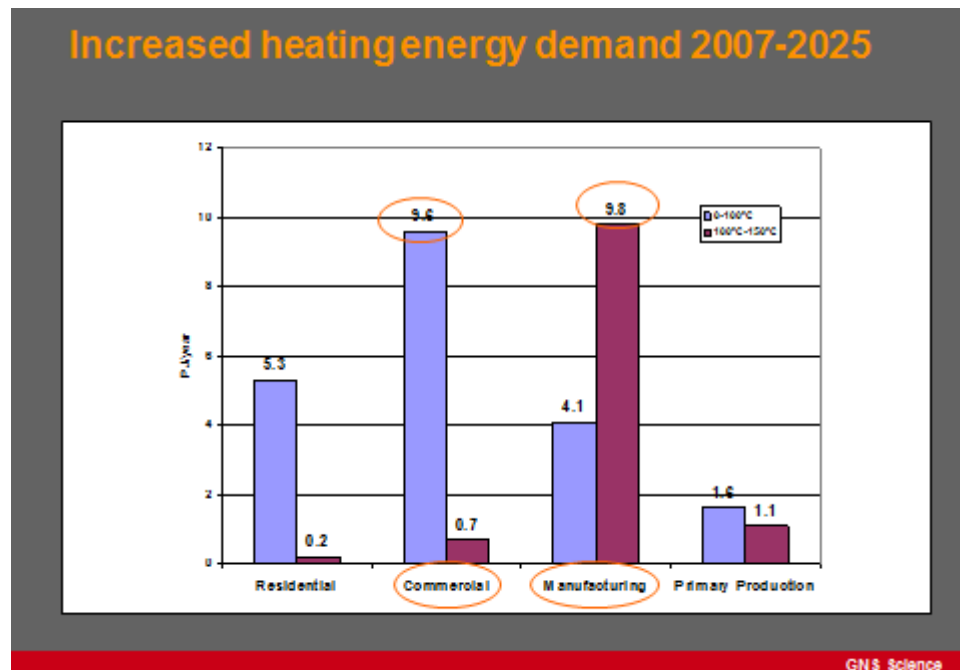
- low heat demand in the residential sector
- the high capital costs of a ground source heat pump system
- the absence of existing central heating systems
- the lack of installation experience and absence of quality standards
- a low level of awareness amongst the general public and decision makers

How many have heard of ground source heat pumps before today? There are a few, very good.

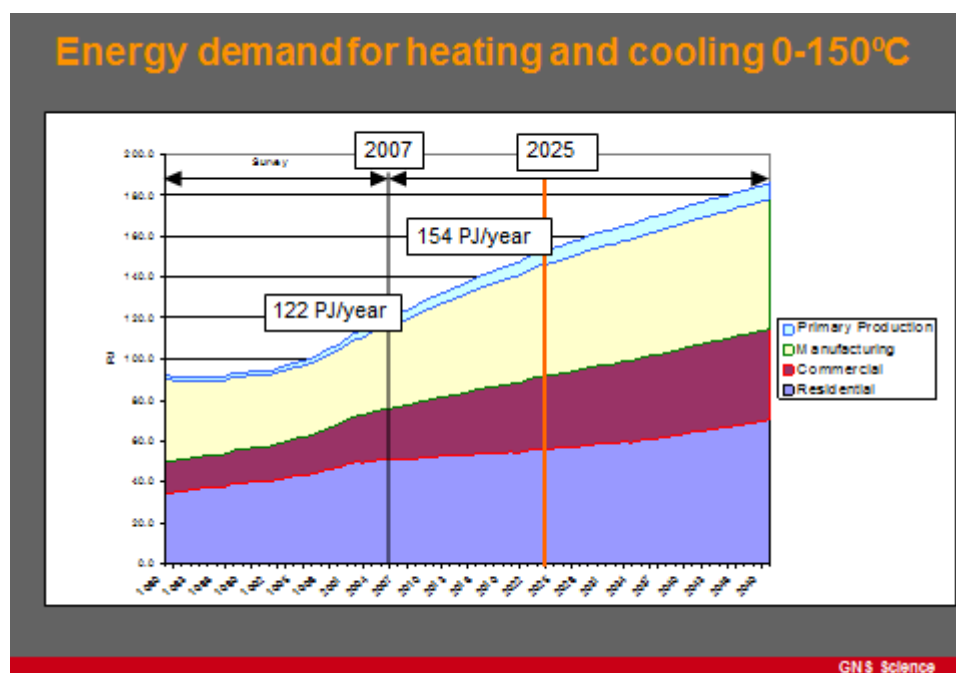
**Slide 55** shows the energy demand for heating and cooling in New Zealand. The energy demand was 122 petajoules per year in 2007 compared to a total energy demand in New Zealand of about 500 petajoules per year. It is predicted to increase 27% up to 154 petajoules per year in 2025.

**Slide 56** is the increase in heating energy demand in the temperature range 0 to 100 degrees. The greatest growth is likely to be in the commercial sector. This is mainly for space heating and space cooling and in the bigger cities. Here ground source heat pumps could assist. For example, Dunedin airport is heated and cooled by a ground source heat pump using an aquifer. Christchurch airport will be heated and cooled by a ground source heat pump in the same way. In the temperature range of 100 to 150 degrees the biggest growth is likely in the manufacturing sector. Manufacturers should be encouraged to move to the Taupo volcanic zone or close to a place where heat is available at above 100 degrees Celsius.

Slide 55



Slide 56

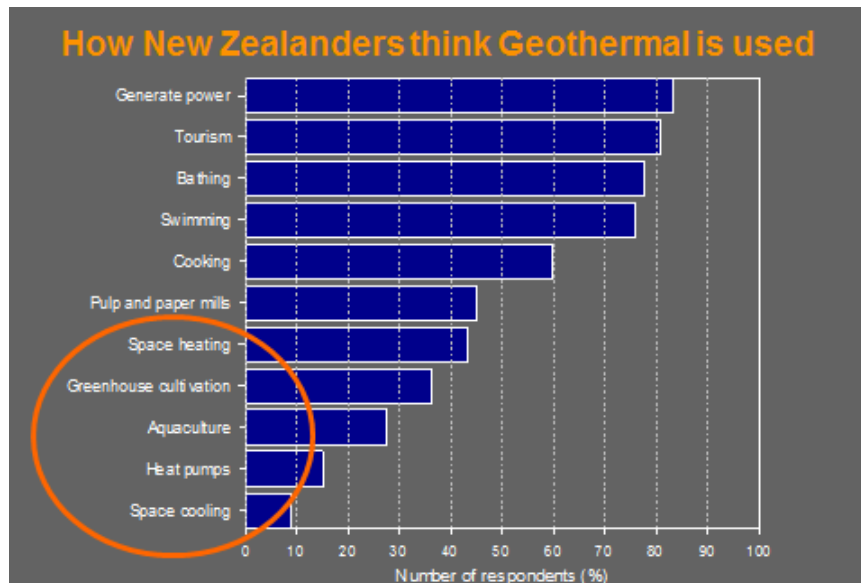


We also have a social science team at GNS who did research on people's knowledge and understanding of geothermal resources, and also consumer energy use behaviour. How do they heat and cool their houses, and how do they make decisions on heating and cooling their houses?

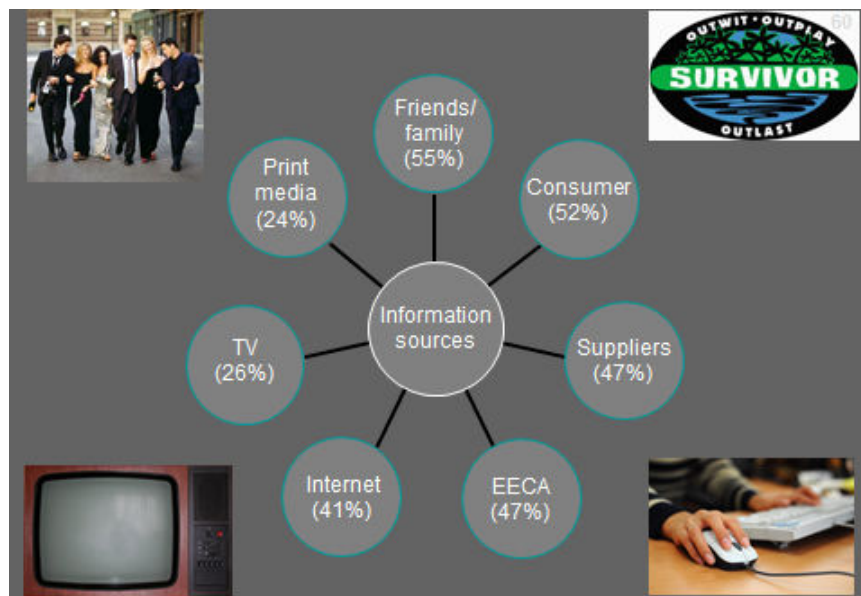
**Slide 58:** The team undertook twenty interviews together with a questionnaire sent out to 3,500 people, and found that people in New Zealand are fairly knowledgeable about high temperature geothermal resources. They think that geothermal can be used to generate

power, and for tourism, bathing, swimming and cooking. Regarding the uses made at lower temperature, the knowledge was not as good. Less than 10% thought that geothermal could be used for space cooling, and you can. Wherever a demand exists for heating or cooling you can use geothermal heat, either directly, or together with a ground source heat pump.

## Slide 58



## Slide 60



**Slide 60** is the result of research examining how people make decisions on how to heat and cool their houses. It found that people seek information from the public domain and ask experts, but most of all they rely on experience from family and friends. This indicates that people want to see the technology in action before they commit to the alternative themselves. This highlights the value of demonstration sites and case studies to showcase technology and credibility.

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We are researching in the low temperature geothermal area to see how a 20% increase can be made. It requires the right technology to fit New Zealand conditions: the right place, encouraging manufacturing industries to move into the Taupo volcanic zone for instance, and focussing on ground source heat pumps in the bigger cities where the demand for cooling and heating in the commercial sector is great. Low temperature geothermal is available here and we can make use of it. The increase involves raising public awareness, and this is what we are working on today.

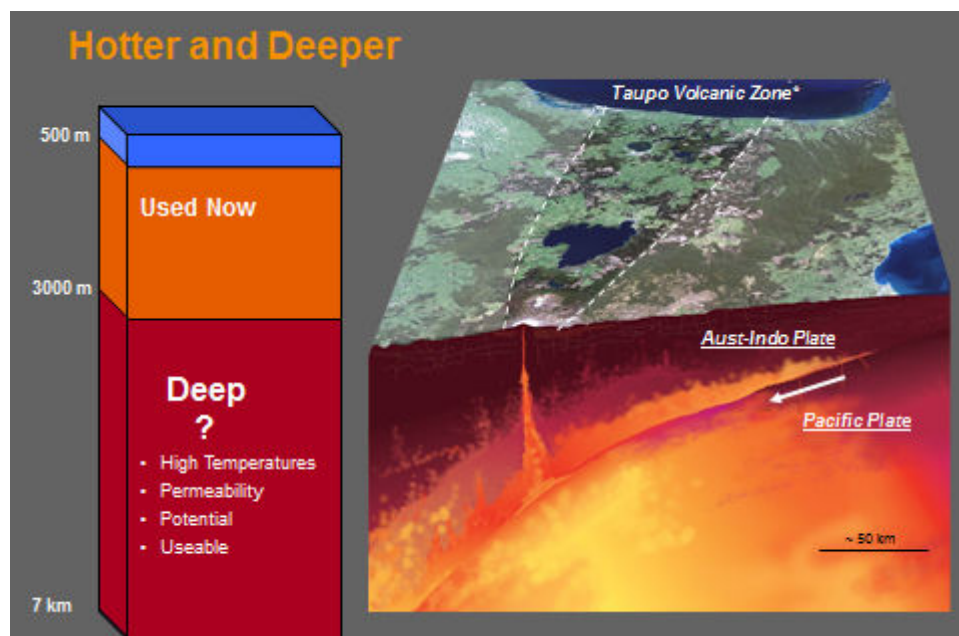
We are doing some case studies such as at Tenon, which is running a wood-drying plant with geothermal energy. As these become available they will go up on our website, so watch that space.

Growth requires communication and the term *low temperatures geothermal resources* is quite long and wordy. We have decided to use **earth energy**. It is accessible, reliable and renewable, and it will help New Zealand meet future energy demand. So please visit our website to find out some more and keep updated.

### Brian Carey

Thank you Lisa that is very good. The topic is quite different now: not low temperature but the hotter and deeper resource. This is in preparation for harnessing New Zealand's very deep geothermal resources. I have a team led by Dr Greg Bignall who is looking much deeper than where New Zealand currently drills: i.e. deeper than 3,000 metres. A well 3,000 metres deep is about 1½ times the length of Fenton Street. This is the depth of the deeper wells now being used to tap high temperature geothermal resources.

### Slide 67



**Slide 67** illustrates our research into what is beneath the levels that we currently tap in the three to seven kilometre range. The reason for not going much below seven kilometres, (or the reason that we think it will be difficult below seven kilometres), is that at those depths the rocks change from being brittle to being somewhat ductile. We see this as an absence of seismic activity beneath seven kilometres in this part of the Taupo volcanic zone and it has been interpreted that permeability is restricted at these levels.

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For this work we are focusing on the three to seven kilometre depth range, seeking a better understanding of the deep structure of the Taupo-Reporoa basin, the physical and chemical nature of the deep fluids and the flow paths. It is in preparation for drilling a deep well in the Taupo-Reporoa basin. We are probably going to look at a well about 6,000 metres deep, three times the length of Fenton Street, costing about \$30million.

Before doing so, we are testing using hydrothermal experimental geochemistry equipment, to better understand what these fluids are like. We have purchased equipment that can test to 500 bar and 400 Celsius. We expect to learn about the chemistry of the fluids and what some of the issues might be. Dr Bruce Mountain is the geochemist in charge. We are seeking to understand the permeability and fluid-rock interactions; looking at thermal properties, scale formation and the effective inhibitors, corrosion of fluids, stability of traces, and possibly testing some drilling fluids.

**Slide 71** shows results from some of the first tests. Basically, the mineralogy that is attached to rocks can be transformed by what you put through the system as high temperature and high pressure transformations occur. A key part is to understand permeability and how we maintain it.

**Slide 71**



Why do we want to do this? **Because there is a vast potential.** I talked about how big the Taupo Volcanic Zone is in terms of its natural heat source. But if we look even at one tenth of the size of that zone, using conservative numbers, there is potentially available to New Zealand 10,000 megawatts for 100 years, in one tenth of the zone in the three to seven kilometre depth range.

The real question is whether it can be realised. Have you got an interest in a deep well? If you are very passionate about it and have an interest and some money come and talk to me soon, because I need some contributions to that \$30 million.

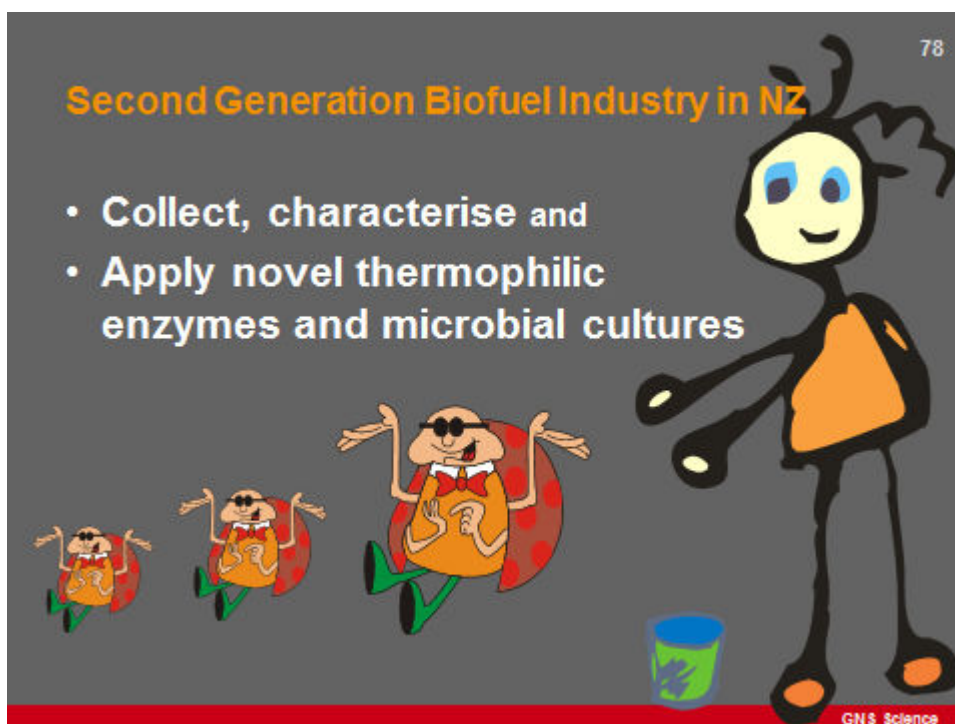
Changing topics again, to bioethanol from thermophilic bacteria (BTB), I have a group of extremophile microbiologists who are prospecting in the Taupo volcanic zone in these

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strange volcanic and geothermal environments for organisms which can operate at high temperatures and high pressures with unusual characteristics. It is a three year work stream led by Matt Stott. We want to harness those strange characteristics and characterize thermophilic enzymes and bacteria consortia. We are bio prospecting for cellulolytic thermophiles and then sequencing them to identify their genomes.

The purpose of this work relates to *increase*, because if organisms operate at higher temperatures then reaction rates are faster, then the production efficiency of conversion of bio mass to bio ethanol increases. The whole premise of this programme is about increase: increasing the temperature, increasing the reaction rate, increasing the production efficiency.

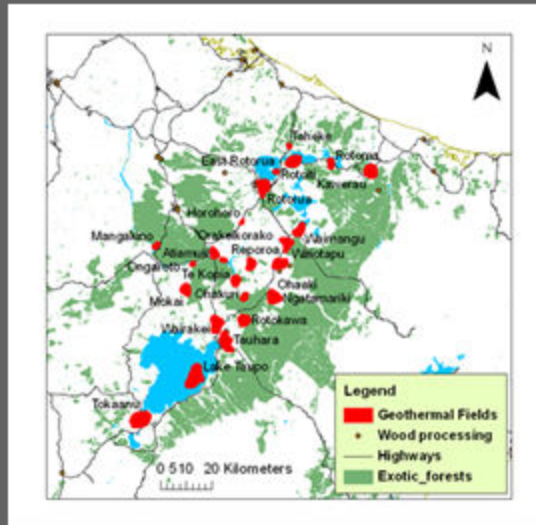
#### Slide 78



**Slide 78** shows where I hope we are going, to increase the generation of bio fuels: little greebies waving their hands with glee with a few novel enzymes to drop in the bucket. So maybe, just maybe, geothermal energy will assist in the manufacture of fuels for transportation by the provision of enzymes which we have found in the Taupo volcanic zone.

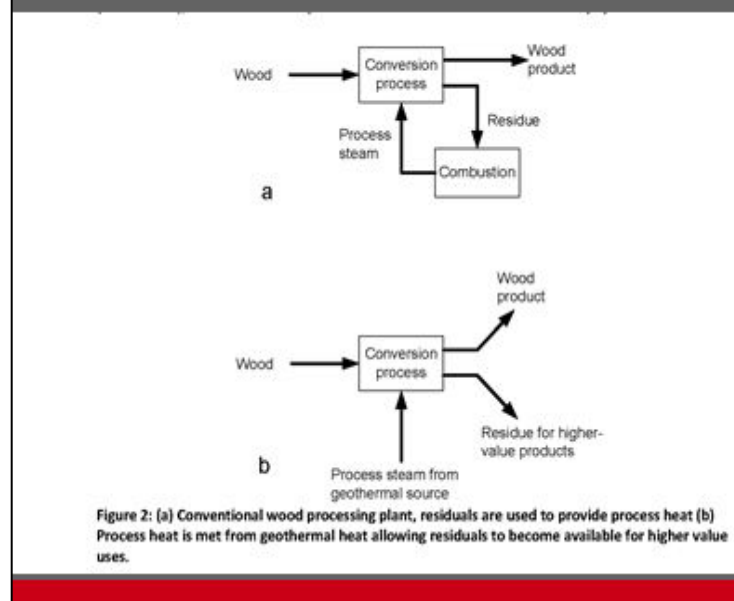
The next topic is forestry and geothermal. There are synergies because of the co-location of geothermal resources and New Zealand's largest plantation forest area (**Slide 81**). Within a 75 kilometre radius of Reporoa in the centre of the Taupo volcanic zone is potential sustainable harvest of 5 to 10 million cubic metres per year, about 24 to 30% of New Zealand's total harvest. The green on the map is forestry, and the red geothermal - it is obvious that there has to be some way that they can be put together. Direct heat has been used at Kawerau since the 1950's, work is going on in Tenon, and there are some kilns at Ohaaki.

## Forestry and Geothermal



**Slide 82:** What else can we do with it? There is a question of geothermal energy releasing more value. The top diagram shows the conventional processing arrangement where the wood comes in and, after a conversion process, a wood product goes out. The residue is used in combustion to produce the fuel to power the conversion process. A lot of this combustion is producing process heat. The objective is to substitute a geothermal source in place of the combustion process. Wood or biomass comes in to the process, geothermal energy comes in and wood products come out as before. But now there are residues for high value products and that is where the real gain is. The residue which is currently burnt is now released for high value production by using geothermal energy to power the process.

## Geothermal heat releasing more value



It is all about releasing potential value. For instance, geothermal heat use and a bio refinery would release lignin for conversion to higher value chemical products. A bio refinery produces bio fuels for transportation. We are working with Michael Jack of Scion,

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Rotorua, on this. He has published papers, but it is a large area that needs to be explored more.

Rotorua district is right in the middle of it. What part are you going to play?

So if you are passionate about this, if you have some interest, and you also have some money, talk to me soon.

Find some hot water, some bio mass, even a bit of the regular old ground, enjoy the synergies, and change the district.

By the way our website is **[www.gns.cri.nz/lowtempgeothermal](http://www.gns.cri.nz/lowtempgeothermal)** or **[www.gns.cri.nz/earthenergy](http://www.gns.cri.nz/earthenergy)**

Thank you very much.

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## DISCUSSION PANEL - QUESTIONS

**Maggie Bentley, Rotorua District Council and Lakes Community Board:** My question is for our scientists. We acknowledge that the Taupo volcanic zone is huge and Rotorua is right smack in the middle of it, yet that whole body is run by two regional councils. Is that a hindrance? Would it be better run by one Body?

**Brian Carey, GNS Science:** That is rather a loaded question Maggie. The current situation is probably a matter of working together, rather than saying one is better than the other. There are a range of synergies to work on and a range of organisations which have to work together, whether it be district or regional councils, or individual parties where those bodies have jurisdiction. It is working together which will bring the results.

**Matthias Schellhorn, Canterbury University:** A practical question to our scientists. In the recent earthquake in Christchurch, a problem people have now is that the earthquake destroyed their heating source, in particular heat pumps that were operating above the ground. Of course, chimneys also came down, and many people are facing a cold winter ahead. What is the danger of installing low temperature heat pumps that penetrate into the earth in the high risk seismic areas where the potential of damage to the infrastructure could be a factor?

**Brian Carey:** It is no different to any infrastructure exposed to seismic activity. Potentially they can have failures as a consequence. Ground source heat pumps are no different to a building itself.

**Lisa Lind, GNS Science:** I had the pleasure of talking to an installer down there and he reported to me that they had no damage on any of their ground source heat pumps that they had installed.

**Matthias Schellhorn:** That is good news and it seems surprising considering that the sewerage and storm water piping system has been destroyed, so I was wondering how these pipes would cope with seismic activity.

**Brian Carey:** I could definitely see some liquefaction issues, but I do not think it is any different to other infrastructure. Whatever happens, the sewerage infrastructure will need to be rebuilt, and to new standards. Whatever you put in the ground will need the same sort of principles applied.

**Don Atkinson, LakesWater Quality Society:** I would like to challenge both geothermal experts in a similar way that we did to Dr Irwin. You have shown us, in both your fields, the huge opportunity for the Rotorua district. We are wealthy, we hear that, but clearly there are obstructions in the process to achieving that wealth, because we are not seeing it right now. Can you identify three key points where the obstructions are, and how we are going to get through them?

**Brian Carey:** I will throw a couple out there. I was pleased to be at Bo Frank's discussion on Wednesday night. He said you have to develop a forward view. Maybe your major obstruction is that, there is no forward view. There are probably a whole set of pictures but who is going to pull them together and develop a forward view?

The second thing is that that forward view has to be a long forward view. Reflecting on what Bo said the other night, it was an oil crisis which prompted his town into action and change the way they went about things. It might not have been the cheapest way to go in

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those early days, but looking back they are rubbing their hands with glee and saying, "This is just marvellous, we're in the right place."

You have to think with a longer term in mind. There are going to be a whole range of other things happen, in terms of oil, coal and gas. Our whole energy thinking will be thrown upside down. The question is – can we think beyond that and get into the right state 25 or 30 years out from now? If you start positioning yourself in that place it will be better.

The third thing is mobilisation, and pulling together to work on that, which is a step by step process. Again I reflect on the Swedish example, it did not happen overnight, it was a progressive process that worked away slowly, but someone had the vision and drive to push it through. There are probably about four or five things right now.

**Lisa Lind:** Another comment, it will cost some money, but what will it cost if you do not do it? It is another way of thinking. I appreciated the talk that Ian did last night about heroes. You need a hero to make it happen.

**Tony Marks, Rotorua Tourism Committee:** I would like to add to what John Sax said this morning. He threw out a vast number of great ideas, not all expensive to implement. His challenge is that the infrastructure is largely already there, the strategies are there, it is whether we have the courage to execute. There were half a dozen things that could be achieved in the next couple of years if people had a will to do them. Is there the will there? I would like to think there is, and certainly the group that I head up will be pursuing some of the areas that John Sax has already identified.

**Mary-Anne MacLeod, Bay of Plenty Regional Council:** Thank you very much for the presentation, it is great to get the overview of both the national and the local picture. I am standing in answer to the question from the councillor from Rotorua, to let people know that there is a MOU in place between ourselves and Environment Waikato, looking at aligning all policies and plans across both regions in recognition of that Taupo volcanic zone. That is a key thing for those here at the Symposium who might be interested.

**Brian Carey:** If I might just pass a comment. There are some drivers inside the regional councils which may not be aligned with some of the strategies and that is going to be an impediment. You need to be very involved with these processes to make things happen. If you have your own set of rules to drive things, it may be contrary to where others need to get to. Even alignment between yourselves and the Waikato Regional Council is probably not enough. You will need to get much more aligned with the local thinking and where you need to move.

**Ian McLean, Chair:** What about the use of geothermal for district heating. Bo Frank has told us that in Växjö district heating predominates, does it not?

**Brian Carey:** Lisa and I can both pass some comment on this. I see a forward trend in New Zealand. I think heat is going to become a utility. In time a new subdivision will develop with heat reticulated and sold by various utility companies. That is district heating. Is it going to come? Rotorua has a gold mine. Now Rotorua has small scale district heating with motels and other buildings. Have you got the courage to take it further? These issues will be dealt with if the District Council gets behind it and pushes the heat out further. I am sure it will be quite a useful thing to think about. It is going to cost, but it is the forward view.

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**Lisa Lind:** One comment there, I heard from Mary-Anne MacLeod that there are problems with air in winter here, and a district heating system would definitely help the air being healthier. I would line up to do a case study on that district heating system.

**Ian MacLean:** Bo, would you be using geothermal for district heating?

**Bo Frank:** The answer is no. It must be profitable for the company, for the plant, and also for the individual. If you have a very dense population then it is profitable for the individual, and for the bio fuel plant, but ground heating is a very good alternative as well. Many people here are wondering – how does the technique work in a cold country like Sweden where we have winters with heavy snow? You have to explain that.

**Lisa Lind:** Firstly, in Sweden geothermal energy or resources is not of a high temperature, it is the temperature in the ground which is about 10 degrees. But it can still be used because it is constant year round. It works like an air source heat pump that most of you are familiar with. Instead of using air as the heat source, you use the ground which is more stable and economic. The 10 degrees all year round is utilised as heat. 1 kilowatt of electricity goes in and provides 4 or 5 thermal kilowatt hours. It is very economic.

**Mark Collette, Lakes Water Quality Society:** I want to add one more thing to the district heating discussion. I understand in Sweden there is legislation which sets a minimum temperature for a house or flat? What is that minimum temperature if that is so?

**Lisa Lind:** Is it 20? I think the World Health Organisation says 18 in some areas and 20 in other areas of your house. In Sweden normally heating is included in the rent of a house, not on top of the rent.

**Mark Collette:** I have read that in Lund there was a case where people said that their flat was below the temperature set by the law. Is there a law about this?

**Brian Carey:** – Is there a law in Sweden that says you must?

**Lisa Lind:** I do not think there is a law. You can decide what temperature you want in your house but no-one controls it. For comfort you would probably have 20 degrees.

**Bo Frank:** I can add that in all new apartments and houses you pay extra for electricity and have an individual meter. In some houses you know what each hour has cost. That is very effective when it comes to energy saving.

**Nick Zaman, Bay of Plenty Regional Council:** Thanks very much for your talk. A question for Lisa - can ground source heat pumps be retrospectively fitted to houses or do they have to be put in at the design and build stage?

**Lisa Lind:** No, you can do it in a retrofit. You can put it in an old building, but if you do not have a central heating system in your house it is going to be quite costly. You can have it with an air source heat pump with warm air getting into your house and heat it that way, but it is more efficient together with, for example, a hydro under floor heating. Definitely if you are building a new house then get that hydro piping in your concrete slab, and then choose to have a ground source heat pump but make sure the piping is there because it is much cheaper to put in at the beginning.

**Brian Carey:** In New Zealand we will see schools retrofit where there are already in-situ reticulation systems. I believe that schools with good land areas will put ground loops in and then there will be a heat pump which pumps from the ground loop up into the existing

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boiler system. Schools and residential homes and mid-sized commercial are probably the first places where we will start to see traction.

**Bo Frank:** There is a market for electricity in all Scandinavian countries and as a consumer there are between two hundred companies producing electricity to choose from. You could even change supplier every month if you want to, or ask, for example, for electricity which is produced by renewables, for electricity from windmills or hydro power, etc. There is a lot of competition in the market and also several net owners. Our system is quite unique.

**Ann Green, LakesWater Quality Society:** I am a late-comer to Rotorua but I understand in the 50s and 60s people came here because they had heating from the bores, they had their spas in the garden and it was a very popular place to retire. Then almost overnight the Government of the day decided that the Pohutu Geyser was not performing, and within a certain distance from that geyser a lot of these bores were closed down, filled in, and that was the end of the heating for these people. I understand a good many of them went off to live in Tauranga. It was obviously a different form of heating, but why did that happen, and could it happen again? It put Rotorua back in heating and growth for a long time.

**Brian Carey:** I think there are others that know more about that history but if I reflect there was uncontrolled bore drilling going on, and probably the Crown felt that the Rotorua District Council was not managing it appropriately. They stepped in and introduced a regime which was the 'bore closure regime'.

Since that time there has been a lot of new technology, changes in thinking and a whole range of other things. To make these resources work they have to be well managed. Inevitably there will be conflicts which the local people need to work through and be happy with. At the moment Whaka is in a certain state, and some people would say it has not fully recovered. The heat use issue is still going on, so what is your future and how do you want to manage this resource? That is a district question that can be influenced locally. To take it forward it needs to be worked out as a district as to how the resources under your feet are to be managed. It needs work with the regional and district councils, but, hey, get stuck in and work out what you want.

**Tom Walters, FOMA:** Just an observation after gallivanting around the world for years sailing and playing rugby, I returned in 1995 when Maori were having a difficult job down in Taupo trying to address this geothermal system. I am very happy to be able to say that one of the gentlemen that got us in the door at Waiarakei was Brian Carey, and we thank you for that Brian.

My question is when we do find a resource, and I am speaking predominantly about Maori, its usual that we go gallivanting around the world trying to find the expertise we need to get the steam out. Has it ever been thought that perhaps GNS should take up the reins and provide a one stop shop? We could have all of this information come into Mr Brian Carey at GNS, and then we can all go down there and save ourselves millions.

**Brian Carey:** It depends, it is all a dollar question and about economics. It depends how the pots fill, Tom. Currently the pots filled with government research contracts and private contracts, and we work in the mix. But no one is funding to put together a comprehensive New Zealand wide deep geothermal data base. We have funding for some research work in those areas, but not a mandate to manage that information in total. Various other clients who pay will own parts of information which we put together. That is the reality of where we are at this stage.

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In terms of our low temperature programme, the government has pushed us. We see this as an opportunity and have quite a role there. We can assist New Zealand, in a promotional way, to understand this energy source and take it forward. That is what we are doing at GNS in terms of taking the science out and delivering it, and our website is an example of that.

**Tom Walters:** You know right here we have all this steam and people ducking and weaving and not really knowing where to go to utilise the resource. Perhaps we should take the bull by the horns and do a bit of work ourselves and see if we can bring it to that one stop shop. I think it will help the whole country.

**Brian Carey:** I have the expertise Tom, but you might have to pay.

**Tom Walters:** Okay, it sounds good.

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## THE WAY AHEAD

### Guy Salmon

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*Guy Salmon has worked as an environmental policy specialist in consulting, policy advice and research roles. He leads the Ecologic Foundation, a think tank which focuses on the challenge of integrating economic and environmental perspectives in decision-making. His research on environmental decision-making in the Nordic countries has contributed to the recent focus in New Zealand on collaborative policy-making. Guy is a member of the Land and Water Forum, and of the Government's Advisory Group on Green Growth.*

## ABSTRACT

This presentation will draw on all the presentations made during the two days of the Symposium. Its purpose is threefold: (1) to identify some key themes; (2) to clarify how far the Rotorua community has come in answering the key questions that need to be answered before a widely agreed solution to the lake issues can be found and implemented; and (3) to suggest a way forward.

## TRANSCRIPT

Good afternoon everyone, Kia ora tatou. What I am going to embark on is not a summary of what you have heard over the last two days, because the organisers asked me not to do that, but rather to draw on what we have heard and try and distil from it some sense of a vision or strategy for going forward.

In attempting to do that, as well as drawing on the Symposium, I drew on some interviews with many of the people in this room and others in the district, for a Ministry for the Environment Project looking at the history of efforts to improve the quality of Lake Taupo and Lake Rotorua. There are some lessons we can learn. That report is due at the end of the month, and will eventually be on our website at Ecologic and probably the Ministry for the Environment's website.

In light of the emphasis on the Swedish experience, which has been a highlight of this seminar, I have also drawn a little on five years spent working with collaborators in the Nordic countries on a project comparing New Zealand and Nordic approaches to solving environmental problems. Having said all that, I should add that this actual presentation was put together rather hastily during the lunch hour, and if I have missed some key elements, which I probably will have done, I apologise now.

Last night Ian McLean took us through the history of the LakesWater Quality Society. There was a big step taken when it changed from being the Lakes Weed Society to the LakeWater Quality Society. In the last two days we have also seen another big step taken, as the Society has leapt passed the limnology into the whole context in which the hope for the future of the lakes rests, in the context of Rotorua's economic and sustainable development generally. I think when you look back from some future point as to one of the turning points, this will have been one of them.

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We have heard a lot about holistic vision, setting the lakes in a wider context of development. It has been a visionary Symposium. We have seen a very coherent selection of intellectual leaders and speakers who have been able to construct, in a compelling way, a new narrative about the lakes and the community's future and how they are connected. I would characterise it this way - as a green growth story, a new vision about the future of Rotorua; not just a story about saving the lakes.

Some of the speakers have drawn our attention to the big emerging trends that are part of the world today. One of them obviously is that it is getting greener in its values as it develops. This is partly a function of rising incomes, rising education and certainly something which has been happening in Rotorua. The community has become greener over the two or three decades that I have been a regular visitor here. It is an inexorable trend that is going a lot further forward in the future. Professor Elena Irwin spoke about some other important trends to think about; firms are now following households, rather than vice versa. Households are moving to places that have great natural assets, and great lifestyles. Though there is the germ of a big idea here for Rotorua, to what extent can Rotorua become one of those places that people want to move to, and which businesses will follow them?

It used to be said, not so long ago, that the dairy industry was so important to the region, and indeed the national economy, that we could not afford to stop its growth for the sake of the lake. Emerging now is a different view that we cannot afford **not** to cap the inflow of nutrients into the lake if we are to create a promising future for Rotorua, and its economy. Interestingly, that view is held not just in the LakesWater Quality Society circles, but in the business community too. One of the interesting encounters I have had at this Symposium was with Roger Gordon, Chief Executive of the Chamber of Commerce, Rotorua, who told me that in the last two Chamber of Commerce surveys about the top issues that his Chamber should be tackling over the years ahead, improving lake water quality came out at number three out of ten issues in 2007, and number two in the ten top priority issues in 2010. I sense an important change is taking place here in which those who are concerned about the community's economic livelihood have fully taken on board the importance of the lake and its water quality.

It seemed natural against that backdrop that one of the community's own visionaries, John Sax, could come forward and talk about dream developments, and there were many of them, but to pick on two, the eco-trail through the lakes and the lake front developments. These are things which showcase the lakes, and would make their clean up almost inevitable. There was a very tangible linking of economic and environmental assets going on in his talk.

Let me go next to our Swedish example, Växjö. I took several key lessons from Bo Frank's presentations. One was that green and growth go together; in fact it was interesting that Växjö has even formed a joint venture company between the City Council, University and business community to exploit the commercial advantages of being Europe's greenest city.

A second point I took was that green growth as a commitment has to be a long term one. It was perhaps fortunate for Växjö, and certainly for its Mayor, that he was able to sustain that commitment through a twenty year period of continuous political dominance from 1991. It reminds us also that even though in New Zealand we are more in the habit of tossing out our Mayors every three years, we should try and ensure that we can get a wide buy-in across the political spectrum to ensure that long term commitment to green growth. Talking with the Mayor, I also asked him:

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“Did you rely mainly on regulation or on voluntary methods to achieve these great gains made over the twenty years?”

He said in reply, “We use regulation but we also go beyond it with voluntary measures.”

There is a lesson there for us too.

Another thing which I found of great interest about his presentation is that he comes from the political right, and in Sweden the political right has taken a leadership position on the environment, and we see that also in the United Kingdom and in many other countries nowadays. Here in New Zealand it has not been quite such a consistent story. One does not have to think back far to the mining and National Parks episode, or indeed my current worry – what is going to happen to the National Policy Statement on Fresh Water Management? It is important that we establish in this country that it should be a pre-condition for a serious political party that it be green. I hope that those here from the political right listen to what Bo Frank had to say and pick up that message.

The last point I took from his presentation which is worth reflecting on when he was asked - “How did you get started on this whole green thing?” He said “Well, when I was first elected in 1991 we went away for a week with the City Council to have a retreat. There were eight different political parties on the City Council, but notwithstanding that political fragmentation, there was a capacity to reach a multi-party agreement on three big priorities for Växjö, multi-party commitments that were not going to be the subject of political disputation. One of them was the environmental strategy, a second was growing the Linnaeus University and a third had to do with sporting facilities.”

Now that ability to build across party consensus is a really important strength of the Nordic way of doing things, and something we could learn from. I would go one step beyond the Mayor’s answer and ask the question – how was it that eight political parties could reach agreement on putting a priority on the environment in the way that they did? The answer to that in Sweden has always been that lying behind a multi-party consensus there is first created a multi-stakeholder consensus, in which farmers, industry people, environmental interests and other community groups, trade unions and so on, get into these collaborative processors and try and build a consensus around emerging new ideas.

Once the stakeholders have that consensus it becomes so much easier for politicians and political parties to form the same consensus. That capacity for forming a consensus in civil society has given the Nordic countries a great openness to new ideas. If you look at their history, they have a capacity to pick up new and emerging ideas earlier than most other countries. Those ideas are always out there. Some countries can reach an agreement quickly, picking up the emerging ideas; other countries spend a long time arguing about it. I worry that here in Rotorua we have spent a long time arguing about this lake and the time now is to crystalize and confirm the emerging consensus. I have a few suggestions about how that might be done.

When Peter Skelton spoke to us, and it was of course appropriate from his background as Judge of the Environment Waikato decision, he expressed a modicum of scepticism about the idea that you could do something as difficult as set a nutrient cap on a lake by a consensus based approach. He saw that a voluntary method was not going to bring us there at the end, and we would have to rely on a regulatory approach. I do not disagree with Peter Skelton on that point, but I think there is a little more that should be said as well in getting to a decision in Lake Taupo about rules on the lake. There were some difficult things that people could not in the end agree on, but like an iceberg, there is a lot below the surface. There was a long process of collaboration which resolved a great many of

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the critical issues before we got to the judicial phase of the decision making. It was all about trying to establish some rules to all agree on. Establishing some broad consensus across the community about what kind of rules we want to agree on for Lake Rotorua is going to be important, notwithstanding the fact that at the end of the day there is an Environment Court Judge who might be able to make the final say.

This process of getting the community to the point of accepting there are some rules that we can all agree on has a lot to do with people feeling confident that they are being treated fairly. Even in the Taupo situation, looking at the history of it as I have been doing over the last couple of months, I found that almost all the stake holders, in particular those that were inside the catchment, were able to reach an agreement on the solution before the final Environment Court stage. The final Environment Court stage was only needed because there were some people from outside the catchment who had a worry about the precedent being set nationwide by the Taupo decision, and that drew them into the appeals process and that is why the final decision had to be made by a Court.

Sure some things will be too difficult, but nonetheless let us do the best we can to reach agreement on everything else, and find how little the things that divide us are. There are two reasons for doing that. One is around durability, saving a lake is a multi-decade project and we cannot afford to have commitment flip flopping back as political parties change or as the composition of city councils or regional councils change. Secondly, delivering on this is a project for the whole community and for a whole lot of businesses, and getting ourselves all aligned is a really important thing to do. So the time and effort which goes into collaboration, even if it cannot finally resolve everything, is time well spent.

**Slide 5**



ecologic  
RETHINKING TO SUSTAINABILITY

## Collaborating on the way forward



- ❖ Voluntary or regulatory?
- ❖ Rules we agree on
- ❖ When people feel confident they are being treated fairly
- ❖ Durability; alignment for implementation

I want to go through **Slide 5** twice. Once saying something about Taupo, and secondly saying how many of these features also apply to Rotorua. The first feature is that Taupo has regulation imposed on land users in the catchment. That is widely thought to have changed people's property rights. But, as Peter Skelton will probably rise to correct me if I do not do so myself, it is not entirely a correct perception. What has happened is that there has been a change in people's perceived property rights. Farmers never did actually

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have the right to pollute the lake, although they farmed as though that right was part of their land ownership. Similarly foresters may never actually have the right to deforest their land and convert it to some other, higher polluting, activity, but the right to deforest their land has in fact been taken away from them by this decision. So these, at least in the eyes of the protagonists, if not in the eyes of the law, have been major changes in people's property rights. They are very difficult things to negotiate, perhaps negotiate is the wrong word; they are very difficult things for a community to negotiate, and to change.

A second point I would take from the Taupo experience is that they have instituted trading of nitrogen, between people who have more than they need and would like to sell, and others who would like to move into the catchment and want to be able to buy. There are two important features here. Firstly it has greatly lowered the overall cost of saving that lake. A market is always a more efficient way of doing things. They have designed one at Lake Taupo and it is saving people money, in the same way that markets do in so many other spheres of life. A second feature dramatically highlighted for us by William Oliver's presentation, where he showed that the opportunity to trade unlocked economic opportunities in land use change, invited innovative entrepreneurs into the district and galvanised all sorts of new ways of earning a living that had not been recognised before. There is a question that we need to ask – Do we want this kind of thing?

A third point – farms in the Taupo catchment are overwhelmingly the main source of nutrients flowing into the lake and that outflow from farms was capped. But the position of the farmers was safe-guarded by the use of \$81.5 million of public money, and also by capping the use of undeveloped land and forestry land at its existing level.

The last point to make about the Taupo situation is that within Tuwharetoa, who are such large land owners and have a huge spiritual investment in the catchment of Taupo and its waters, there was no single tribal view of the outcome. They were pleased the lake was being saved, but they did not, as a tribe, align themselves either with the farming viewpoint or the undeveloped land owners view point. So the decision that was arrived at in Taupo could not be seen as anti-Maori.

Let me go through that **Slide 5** again from a Rotorua perspective. We have with Rule 11 got a cap in place, although it is not being enforced. It is not quite the same situation as in the Taupo catchment. There has been a long dialogue in this district led by Motu around the idea of tradable nutrient discharge rights into Lake Rotorua. In interviews I have encountered a sense from many people that trading is too difficult to understand. This may be partly a criticism of the Motu model, but it also a criticism of trading generally. Given the huge advantages that trading offers in terms of lowering the cost of cleaning up a lake, and of bringing new entrepreneurs into a district to exploit new opportunities and innovate, I am not quite sure that saying it is too difficult to understand is a good enough reason for rejecting it. It is something the community here needs to look at more closely.

The question of public money, which once again has been allocated for land use change in Rotorua, is \$10 million over ten years under the present arrangements. That is unlikely to be sufficient. There is a case for looking at some of the other projects for lake restoration and asking the question – Is there a different or better way of using the funds that we have available? It was interesting this morning to hear the Minister for the Environment signal that if the community wanted to change its priorities and spend more of that pot of money on land use, he would be open to that possibility.

The way in which the community has proceeded with Rule 11 has in fact discriminated, just as in the Taupo case, against the owners of undeveloped land. But there is an important difference between Rotorua and Taupo. In Rotorua, Maori land ownership is

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mostly in the undeveloped land category. It was clear to me from my interviews that many Maori leaders are very concerned that the clean up process of the lake is going to disadvantage them. There was even a suggestion that we are on the brink of creating a new source of Treaty grievance that would be a very unfortunate development in the progress of this debate.

There is another sector which also feels threatened and for good reasons. The New Zealand livestock farming business model has always depended on increasing stocking density. The heart of the business mode is making a livelihood in farming by gradually building up stock numbers. Once you impose a nutrient leakage cap those business models have to change and there are only two ways forward. One of them is to move into winter housing of the animals, so at the time when the nitrogen is most likely to leak from the urine patches into the ground water and thence into the lake, the animals are indoors and the urine is collected and not discharged into the lake. But that is a kind of factory farming concept quite alien to New Zealanders and something we have yet to have a national debate about. Many farmers in the catchment will also tell you, herd homes or barns are a pretty expensive investment to make in the context of a New Zealand farming model with current prices. It is a strategy that is there but we are not sure yet whether we can pursue it.

The other strategy which is open to farmers, once their livestock numbers have in effect been capped, is to find a higher value product to sell. In the Rotorua catchment organic production may be a possibility, because there have been scenarios which show the dramatic reduction in nitrogen leakages achieved from an organic farm. There is also a premium available now for organic dairying and other organic opportunities. There may be other ways. The French have a concept of *appellation* where by simply building up the brand of a particular locality and making it highly renowned and sought after, you get a premium. There are opportunities for New Zealand communities to take on an *appellation* and earn a premium for having the food or wine or whatever, produced in an environmentally friendly way which protects a lake and models desirable sustainable behaviour to the rest of the world. People who have green values will buy food from that *appellation*.

But beyond that there has to be a willingness by the community to help farmers, either to navigate through these difficult strategic transitions or to exit from the catchment perhaps. These are possibilities, but what we cannot fairly ask them to do is leave the catchment, having lost all the investment they have built up in their farms over long periods of time. These are big issues and have to be faced fairly and squarely. Think about the wider ramifications. The Minister this morning released the Land and Water Forum's final Report which calls on every New Zealand community to set limits for every water body in this country. When we do that we are going to challenge the existing New Zealand livestock farming model, not just in Rotorua and Taupo, but in every part of New Zealand.

We are embarking here on what is going to be a long and difficult, but very important for our future, transition from livestock farming based on ever increasing animal numbers to one of those two new strategies that I spoke about a moment ago. We need new business models for agriculture in the whole country. You can see this as a threat, or you can see it as an exciting time, as long as there is a commitment by the community to manage that transition well. I believe that is what we must seek.

Let me draw together some key elements for the future of Rotorua going forward and I emphasis the word 'some'. Obviously I have not thought as widely as many of you will have done about some of the other great opportunities that sit around geothermal, for example, and forestry, tourism and so on. But to draw some of the strands together at

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least from the presentations, there is a long way to go and it is going to be quite a difficult road. The question is – Can we make it difficult by getting polarised, or can we make it an easier road by trying to collaborate?

My first point is a great need to consolidate the emerging shared vision of green growth that has been coming through this Symposium and the Chamber of Commerce seminars, and in the new collective that has been formed of the livestock producers in the catchment. That green growth idea unifies all those communities of interest. We need to consolidate and reaffirm the commitment and make sure the councils are aligned with it. I heard Peter Guerin say that he has reorganised the second tier management so that the regulatory and economic development people are reporting to the same individual. That is what is needed if we are going to get green growth.

Secondly, start up on some of John Sax's dream developments that focus on the natural assets of this region and showcase them. That is clearly an important ingredient in the on-going strategy.

Thirdly, and I hear Frank Boffa's remarks to us, it is not by liberalising the district scheme and allowing people to subdivide all over the place, but rather in a planned way and also with some public-private collaborations like we saw in the presentations on Västana and we have many examples of in New Zealand as well.

A fourth point recognises the costs of this transition for the land users who are going to be affected by it. Both the developed land users, like the livestock and dairy farmers, but also the less developed land owners, who own land that they had hoped for generations could become dairy farms, but who are no longer going to be able to. We must have some regard in our strategy for those people. We have to take the step of apportioning sustainable discharge rights into the lake in a way that is fair and transparent. Fairness is not an easy concept, it means different things to different people, but my point here is that we have to try and have a community dialogue which distils out some agreed principles of fairness, and gives some weighting to them.

I come back to the Swedes who have gone before us in much of this, there is a wonderful little Swedish word which sums up their commitment as a culture to this, and it is *lagom*. It is a hard word to translate. People try to translate it for me by saying it means *not too much, and not too little*. They say in days gone by when the Vikings sat around the camp fire and passed a mug of mead from one to the other, each person knew that they had to take a certain amount, a sip that was not too much, not too little, so there was enough for everybody.

The word *lagom* has come into the Swedish language and culture and embodies values around careful moderation and attention to fairness. That is what we need to import into this thinking about land use and the lakes.

We have money already committed by central government and by regional and district councils and if, as we have heard indicated, that money can be used flexibly, I believe it could provide the basis for a fair transition for the land owners in the catchment.

My last point is that Rotorua, like Västana, and like Wellington, needs to approach these quite considerable hurdles that still lie ahead in a collaborative spirit. It is in that spirit that so much more will be achieved than would be possible if you polarise, disregard minority interests and try and bulldoze ahead with them.

Thank you very much.

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## **ABSTRACTS OF POSTER PRESENTATIONS**

(in alphabetical order of presenters)

### **Title: Nutrient transport to Lake Rotorua following rain events**

#### **Authors**

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#### **Abstract**

Rainfall in a catchment can mobilise and transport high loads of pollutants over short time periods. Although these transfers may be large, such episodic events are often inadequately included in routine monitoring programmes. This study aims to better quantify and understand the fate of sediment and nutrients entering Lake Rotorua following heavy rain.

Water samples have been collected from two major inflows to the lake at one- to two-hourly intervals immediately before, during and after rainfall. Samples have been analysed for total suspended sediment (TSS) and dissolved and particulate forms of nitrogen and phosphorus.

Concentrations of TSS and total phosphorus (TP) can be greater in stormflow than baseflow by a factor of ten and three respectively. These determinants correlate well with discharge suggesting that this variable is useful as a proxy for TSS and TP in catchment models. Concentrations of dissolved nutrients are less variable although greatly elevated concentrations of ammonium and phosphate have been measured and may reflect incidental transfers such as point-source discharges.

Future work will involve further sampling to refine empirical models to predict stormflow nutrient flux. Biological assays will also be conducted to better understand how nutrients transported in stormflow are assimilated by phytoplankton and thereby contribute to eutrophication in the lake.

### **Title: Remote sensing of the Rotorua lakes**

#### **Authors**

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#### **Abstract**

Remote sensing provides a unique opportunity to obtain synoptic quantification of lake water quality and water surface temperature. This research used Landsat satellite data to investigate temporal and spatial variation of Chlorophyll *a* and surface water temperature in the Rotorua lakes, using an automated methodology to process images from captured from 1989 until 2009.

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Additionally, lake water surface temperature images were then used to validate a three-dimensional (3D) hydrodynamic model of Lake Rotoehu. This validation proved that the 3D model reproduced the dominant spatial variations in temperature in the lake including the path of a geothermal inflow and basin-scale thermal patterns.

**Title: Can common smelt sustain rainbow trout populations in Lake Rotoiti following diversion wall construction?**

**Authors**

Jennifer M. Blair<sup>1,\*</sup>, Brendan J. Hicks<sup>1</sup>, Nicholas Ling<sup>1</sup>, Rob Pitkethley<sup>2</sup>

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**Abstract**

Common smelt are the main prey of rainbow trout in Lake Rotoiti. Limited trout spawning occurs in the lake's tributaries, and about 25,000 hatchery trout are released each year. The capacity of the smelt population to support trout stocking is unknown. In 2008, the Ohau Channel Diversion Wall was installed to divert nutrient rich water from Lake Rotorua directly down the Kaituna River, rather than into Lake Rotoiti. It is possible that the diversion wall has affected spawning migrations of common smelt between Lake Rotorua and Rotoiti. However, the effect of the diversion wall on Lake Rotoiti smelt populations is unknown.

To assess the health of smelt populations post-Wall installation, we surveyed seasonal dynamics of littoral smelt populations, spatial variability of smelt within Lake Rotoiti, and smelt spawning dynamics. Our study found that spawning dynamics and spatial variability suggest that smelt reproduce well and are highly abundant in the lake's littoral zone. Because of this, the impact of the diversion wall on smelt populations should be limited. Self-sustaining smelt populations should continue to support Lake Rotoiti trout populations into the future.

**Title: Pore water chemistry of Pockmarks in Lake Rotorua**

**Authors**

Sara Corry & Chris Hendy

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*\*Corresponding author: Tel.: +64 7 838 4381, Fax: +64 7 838 4312. E-mail address: chendy@waikato.ac.nz (Chris Hendy)*

**Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. By comparing the composition of the pore waters contained in the sediments within five of the holes with those outside of the holes we can show no differences in the chemistry between inside and outside. This implies that the holes are not made by continuous flow ground water, but is consistent with the pockmarks being created by methane loss.

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**Title: The composition of gas rich sediments in Lake Rotorua and formation of pockmarks**

**Authors**

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**Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. Apart from reworked tephra at the base of the pockmarks and older tephra beneath, the composition of the sediments inside and outside of the pockmarks are very similar. The pockmarks appear to have formed by bubbles of methane escaping from the sediment and carrying away the diatomaceous ooze in suspension to resettle elsewhere on the lake floor.

**Title: Attenuating sediment and nutrient losses from dairy farms – restoring shallow peat lakes**

**Authors**

Rebecca S. Eivers<sup>1\*</sup>, David P. Hamilton<sup>1</sup>

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**Abstract**

Lakes and rivers are under increasing pressure from elevated sediment and nutrient loads associated with intensification of agriculture in New Zealand. In the Waikato, shallow peat lakes within dairy farming catchments are particularly vulnerable to eutrophication, with regular, often toxic algal blooms. End-of-drain treatment systems (constructed wetlands, silt traps and infiltration filters) have been implemented to reduce sediment and nutrient inputs, particularly nitrogen (N) and phosphorus (P), to downstream lakes however their efficacy remains unclear.

Twenty six treatment systems including infiltration filters (2), silt trap/infiltration filters (10), constructed wetlands (6), and silt traps (8) on five shallow peat lakes within the Waikato region were surveyed to investigate attenuation efficiencies. Volumes ranged from 2–2030 m<sup>3</sup>.

Preliminary results indicate sediment and nutrient loads exceed treatment capacity based on treatment system volume to subcatchment size ratios. However, total suspended solids were reduced in some systems suggesting some benefits despite suboptimal sizes. Further analyses will determine more conclusively the effectiveness of different treatment systems under a range of flow conditions, and which design characteristics most successfully reduce sediment and nutrient inputs to downstream lakes.

**Title: Organic matter content inside and outside of Pockmarks in Lake Rotorua**

**Authors**

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#### **Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. Organic content in the sediments is much higher outside of the pockmarks than inside and decreases with depth. This suggests that the sediments inside the pockmarks is much older than that outside and has already lost much of the organic carbon to methane formation before the pockmarks were formed.

#### **Title: Sediment and stratigraphy of Lake Rotorua**

#### **Authors**

Philip Jennings & Chris Hendy

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#### **Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. Outside of the pockmarks the sediment is dominated by diatomaceous ooze with a narrow size range peaking at 20µm, interspersed with thin bands of very much coarser tephra. Inside the pockmarks, a mixed bed of tephra forms the floor of the pockmark, with diatomaceous ooze beneath. It appears as if slow bubbling of methane from the sediments has removed the fine diatomaceous ooze but left behind the coarser tephra.

#### **Title: Monitoring water quality and meteorology in real-time on the Rotorua Te Arawa lakes**

#### **Authors**

Chris G. McBride<sup>1\*</sup>, David P. Hamilton<sup>1</sup>

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#### **Abstract**

The University of Waikato first deployed a solar-powered lake monitoring buoy on Lake Rotorua in mid-2007. Buoys are now active on four Te Arawa lakes (Rotorua, Rotoiti, Tarawera and Rotoehu), collecting quarter-hourly data for meteorology (air temperature, wind speed and direction, humidity, barometric pressure, solar radiation and rainfall) and water quality (chlorophyll and phycocyanin (cyanobacterial) fluorescence, turbidity, dissolved oxygen, and water temperature through the water column). Data are telemetered and available in real-time on the Bay of Plenty Regional Council website.

These stations enable the collection of monitoring data at a frequency not previously obtainable—important for detecting episodic events such as short term stratification and

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oxygen depletion of bottom waters in polymictic lakes such as Rotorua and Rotoehu. With longer time-series now available, buoy data are increasingly useful to research on the Rotorua lakes.

Uses include the improvement of ecosystem model calibration and validation for investigating catchment landuse change at Lake Rotorua, and monitoring the effects of the upcoming aeration project at Lake Rotoehu. The buoy network is also a contributor to the worldwide monitoring network 'GLEON' (Global Lakes Ecological Observatory Network). A water-column profiling version of the buoys is under development, in order to increase the vertical resolution of all sensors.

**Title: Lake restoration modelling as a decision support tool for Lake Rotorua**

**Authors**

Deniz Özkundakci<sup>1,\*</sup>, Chris G. McBride<sup>1</sup>, David P. Hamilton<sup>1</sup>

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**Abstract**

The coupled hydrodynamic-ecological model DYRESM-CAEDYM was used to simulate the lake ecosystem over six 8-year periods within 1920–2100 in Lake Rotorua. Meteorological input included historic measurements and forecast simulations based on IPCC climate change predictions and downscaling with the model DARLAM. Catchment nitrogen inputs were obtained using the NIWA model Rotorua Taupo Nitrogen (ROTAN) for three land-use scenarios, including “business as usual” and two levels of dairy conversion within the catchment.

Bottom sediments are a significant source of nutrients to Lake Rotorua, therefore, a further scenario of internal phosphorus load reduction by application of a capping agent in 2031 was also simulated. Sediment nutrient concentrations in CAEDYM are currently static, and therefore incapable of representing interactions between changes in external nutrient load and bottom sediments.

We observed a significant relationship in historic monitoring data between nitrogen load and hypolimnetic oxygen demand, as well as sediment nitrogen concentrations. This relationship was used to adjust model parameters for sediment nutrient release and oxygen demand. The coupled models satisfactorily reproduced historic and contemporary lake trophic state, and showed that substantial catchment and in-lake restoration would be necessary to achieve the desired improvement in water quality.

**Title: Location of pockmarks in the gas rich sediments in Lake Rotorua**

**Authors**

David Roberts & Chris Hendy

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**Abstract**

The sediments of Lake Rotorua contain many holes (pockmarks) typically 50m in diameter and 5m deep. The location of the 50 of the most prominent pockmarks is given along with their diameters and depression depths. The majority of the pockmarks are located to the west of Mokoia Island.

**Title: The distribution of gas rich sediments in Lake Rotorua****Authors**

Jessie Sixsmith & Chris Hendy

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**Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. Methane gas is abundant in sediments in Lake Rotorua at depths greater than about 10m, but is not present in the pockmarks, from which it appears to have escaped. The gas filled sediments cover 39km<sup>2</sup> of the lake and may be a significant energy resource.

**Title: Nutrients in the gas rich sediments in Lake Rotorua****Authors**

Erin Telfer & Chris Hendy

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**Abstract**

The sediments of Lake Rotorua contain about 50 holes (pockmarks) typically 50m in diameter and 5m deep. There are no real differences in the nutrients between pore waters inside and outside of the pockmarks. The pockmarks appear to have been caused by local supersaturation and resulting bubbling of methane produced by anaerobic fermentation. The light diatomaceous ooze is remobilised to settle elsewhere in the lake but the coarse tephra remain behind.

**Title: Are phytoplankton phyla an indicator of trophic status?****Authors**

Wendy Paul<sup>1,\*</sup>, Austin Zhang<sup>2</sup>, David P. Hamilton<sup>1</sup>

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## Abstract

The Rotorua lakes are a diverse group of volcanically formed lakes ranging in size from 0.33 to 80 km<sup>2</sup> with catchment landuse that varies from almost entirely pastoral landuse to mixed landuse (urban, forest, pastoral) to almost entirely forest. These differing landuses contribute to the nutrient status of the lakes. Algal growth is fuelled by nutrients and chlorophyll *a* is the algal component of the trophic level index. The most representative phyla or group of phyla may also be an indicator of each lakes trophic state. Bay of Plenty Regional Council collected phytoplankton samples between 2003 and 2007 and a subset of those samples were analysed at University of Waikato.

When the results were grouped by phyla, each lake appeared to have its own representative signature, a result of its species composition. This study seeks to investigate any relationship between relative abundance of certain phyla against the Trophic Level Index for each of the Rotorua lakes.

## Title: Nitrogen-15 isotope enrichment in benthic boundary layer gases of Taupo Volcanic Zone lakes

### Authors

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## Abstract

The applicability of the natural abundance of nitrogen gas isotope ratios was used to indicate the spatial distribution of nitrogen transformations in the water column and sediment porewaters of five TVZ lakes. Samples were collected from the epilimnion, hypolimnion, benthic boundary layer and at 5 cm intervals within the sediments at monthly intervals for one year.

There was no seasonal trend in the epilimnion of the lakes, with  $\delta^{15}\text{N}$  [N<sub>2</sub>] around 0 ‰. The hypolimnion showed slight seasonal trends, but the most significant zone for denitrification on the basis of highly enriched  $\delta^{15}\text{N}$  [N<sub>2</sub>] was in the benthic boundary layer. The most eutrophic lakes have the greatest enrichment in  $\delta^{15}\text{N}$  [N<sub>2</sub>]. Peak enrichment values are around 0.4‰ for Taupo, 1.3‰ for Tarawera, 5.3‰ for Okataina, 6.4‰ in Rotoiti and 12.2‰ in Ngapouri. These  $\delta^{15}\text{N}$  [N<sub>2</sub>] values correlate strongly with hypolimnetic oxygen demand ( $r^2 = 0.92$ ,  $p < 0.001$ ) and Trophic Level Index ( $r^2 = 0.88$ ,  $p < 0.001$ ). Analysis of the settling POM shows that the organic matter cannot cause the enrichment in <sup>15</sup>N without fractionation. We hypothesise that substantial formation of <sup>15</sup>N enriched dinitrogen takes place in the benthic boundary layer during periods of anoxia accompanied by ammonium production.

## Title: Mitigation of nitrogen leaching ‘spike’ during gorse conversion to forest

### Authors

Caleb Male<sup>A</sup>, G.N. Magesan<sup>B</sup> and John Paterson<sup>A</sup>

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Rotorua lakes are a resource with significant importance to iwi, local communities and New Zealand. Eutrophication has been the main cause of concern for the Rotorua lakes' water quality. A recent study (Magesan and Wang, 2008) showed that gorse (*Ulex europaeus*), a leguminous shrub, is a contributor to nitrate leaching. Another study (Male et al. 2010) mapped the distribution of gorse and estimated that 43 tons of nitrogen is leached from gorse in the Lake Rotorua catchment each year. To reduce this source of nitrogen leaching from the lakes' catchments it is suggested that gorse be removed or controlled through land use change – and in particular gorse converted to pine forest. Pine forest is known to leach only 3kg N ha<sup>-1</sup> year<sup>-1</sup> compared to 50kg N ha<sup>-1</sup> year<sup>-1</sup> from mature gorse areas. However, there remains a risk of a nitrogen leaching 'spike' during the land conversion process.

The aims of this study are to (a) identify the best way to manage gorse conversion in terms of nitrogen losses to ground water; (b) measure the effectiveness of a nitrogen inhibitor in reducing the nitrogen leaching 'spike' that may occur during conversion; and (c) develop best management practice to reduce nitrate leaching.

There are seven treatments at the experimental site at Whakapoungakau Land Blocks (near Rotorua airport). The experimental plots are 0.4 ha each. DCn (a nitrogen inhibitor), which has been used in two plots, is to test its effectiveness in reducing any nitrate losses from gorse. All the cleared and roller-crushed plots have been planted out in pine trees. The seven treatments are as follows: (i) sprayed and roller-crushed gorse; (ii) sprayed then cleared gorse; (iii) sprayed and roller-crushed gorse with two DCn applications; (iv) sprayed then cleared of gorse with two DCn applications; (v) gorse left growing as a control; (vi) gorse sprayed and left to decay; and (vii) pine tree control.

The experiment is expected to run over two years in order to incorporate seasonal differences. At each of the experimental plots, four drainage flux-meters have been installed. The study commenced in November 2010 and water samples are being collected monthly. The samples are being analysed for nitrate, ammonium, dissolved organic nitrogen and dissolved organic carbon.

It is expected that this research will determine and develop a best management practice for managing gorse conversion on Central North Island volcanic soils. This will focus on mitigating the expected increase (or spike) of nitrate losses during gorse conversion to forestry.

### **Acknowledgements**

We would like to thank Bay of Plenty Regional Council for funding this project and Ballance Agri-Nutrients Ltd for supplying DCn for the experiment.

### **References**

- Magesan, G.N and Wang, H. 2008. Nitrogen leaching from gorse – final report to Environment Bay of Plenty
- Male, C., Paterson, J. H., Magesan, G. N. 2010. Quantification of nitrogen leaching from gorse in the Lake Rotorua Catchment. Bay of Plenty Regional Council, Environmental Publication 2010/03

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## **Title: Quantifying distribution of gorse and estimating nitrogen leaching from gorse in the Lake Rotorua Catchment**

### **Authors**

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Rotorua lakes are a resource with significant importance to iwi, local communities and New Zealand. Water quality in the Rotorua lakes catchment has been declining due to increasing nutrient loads in waterways, particularly nitrogen and phosphorus from livestock farming, urbanisation and other land use activities. However, nitrogen leaching from gorse (*Ulex europaeus*), a leguminous shrub, has not received much attention despite the fact that gorse has infested large productive areas. A Bay of Plenty Regional Council (BOPRC) commissioned study (Magesan & Wang 2008) suggested that gorse could be one of the contributors to nitrate leaching. This paper summarises further BOPRC funded work (Male et al. 2010), which mapped the distribution of gorse and estimated nitrogen leaching in the Rotorua lakes catchments.

The aim of this project was to quantify and categorise the actual amount of gorse in each of the Rotorua Lakes catchments, and to estimate the amount of nitrate leaching to groundwater from gorse stands in the Lake Rotorua catchment.

The following methods were used:

1. *Quantifying the distribution of gorse*: Gorse patches were categorised by age (old, medium, or young), and spatial variation (dense, medium, or scattered).
2. *Categorisation and scoring percentage*: Maturity of gorse plants was used to distinguish the contributing (the old and medium gorse plants) from the non-contributing (e.g. the young plants) on N-leaching, as it was judged in the field.
3. *Estimation of N leaching (from previous study)*: The investigation of Male et al. (2010) assumed that an average rate of 50 kg N ha<sup>-1</sup> year<sup>-1</sup> for gorse stands, found by Magesan and Wang (2008), can be extrapolated to all mature stands of gorse in the Lake Rotorua catchment area and can be used to estimate the total amount of nitrogen that gorse is contributing to groundwater.

The investigation and survey data enabled the quantification of total mature gorse cover in the lake catchment area and estimated the potential nitrate leaching to ground water. About 43 tonnes per annum of the 547 tonnes of nitrogen (7.9%) entering Lake Rotorua each year is attributable to gorse. This amount has not been previously accounted for as a land use-derived nitrogen source.

The Bay of Plenty Regional Council is currently reviewing its Regional Pest Management Strategy, and is considering options for managing gorse in the Lakes Rotorua and Okareka catchments. The Council also has a land use change programme underway which actively encourages the conversion of mature gorse areas to forestry in these areas.

### **References**

- Magesan, G.N and Wang, H. 2008. Nitrogen leaching from gorse – final report to Environment Bay of Plenty
- Male, C., Paterson, J. H., Magesan, G. N. 2010. Quantification of nitrogen leaching from gorse in the Lake Rotorua Catchment. Bay of Plenty Regional Council, Environmental Publication 2010/03

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## **Title: What do high Olsen P values mean on pumice-gravel soils in the Rotorua District?**

### **Authors**

Gordon Rajendram<sup>1</sup>, Martin Hawke<sup>2</sup>, Alastair MacCormick<sup>3</sup>, Lee Matheson<sup>4</sup> Louise Butler<sup>5</sup>, Kyle Devey<sup>1</sup> and Aaron Stafford<sup>6</sup>

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To achieve maximum pasture production on pumice soils, Olsen P levels of 35-45 mg/L is required. However, soils derived from the Tarawera eruption and associated soils require Olsen P level of approximately 90 mg/L to maintain maximum pasture production.

Forty-one sites from the Bay of Plenty region were sampled to a depth of 7.5 cm. The soils included Tarawera Gravel (11), Matahina Gravel (10), Rotomahana Mud (7), Oropi Sand (4), Taupo Ash (7) and Te Pepe (2).

The amount of gravel, which did not pass through a 2 mm sieve for the Tarawera and Matahina gravel soils, ranged from 24-67% and 9-29% respectively. For the other soils there were minimal amounts, which did not pass through the 2 mm sieve. Olsen P, P retention, total P, 0.01 M CaCl<sub>2</sub> extractable P (potential P-leaching) and Cd were measured on the <2 mm fraction, gravel only and a mixture of the two fractions which was naturally found in the field.

This study showed that the exclusion of the gravel fraction prior to analysis (common laboratory practice) would have lead to the higher Olsen P values required to maintain maximum pasture production when pasture growth trials were conducted. The exclusion of gravel will also have implications on other chemical tests such as Cd levels in the soil.

Most of the sites within this study had low to medium phosphate retention (11-52 %) and elevated Olsen P values (average value 57 mg/kg). The 0.01 M CaCl<sub>2</sub> extractable P gives an indication of the amount of dissolved reactive P (DRP) which has the potential to be lost via subsurface flow (leaching). Phosphorus (P) loss from soil to water is implicated in the accelerated eutrophication of surface waters. Extractable P (0.01 M CaCl<sub>2</sub>) levels >0.15 mg/L are deemed to trigger eutrophication in waterways. Sixty-seven percent of the sites within this study had levels of 0.01 M CaCl<sub>2</sub> extractable P > 0.15 mg/L.

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## GLOSSARY

This short glossary is intended as a guide to technical terms for those attendees who are not involved in science. Not all the technical words that you will hear can be expected to be listed below, but we have done our best! This is a shortened version of glossaries provided for our previous Lakes Symposia, reflecting the decreased emphasis on science this time.

### UNITS

Abbreviation	Expressed as	Full name
mg	$1 \times 10^{-3}$ g	milligram (1/1000 gram)
µg	$1 \times 10^{-6}$ g	microgram (1/1000,000 gram)
ng	$1 \times 10^{-9}$ g	nanogram (1/1000,000,000 gram)

### Abbreviation

ppm (parts per million)

### Equivalent to

1 mg per litre (1 mg/l or 1 mg.l<sup>-1</sup>)  
or 1 g per cubic metre (1 g/m<sup>3</sup> or 1 g.m<sup>-3</sup>)

### Algae

Primitive plants, often almost invisible to the naked eye. The term algae often also refers to microscopic plants that are suspended in the water of lakes or the sea (also known as phytoplankton). Excessive quantities of these can result in algal blooms.

### Algal biomass

The amounts of algae present in the water. The concentration of chlorophyll-a is the most widely used method to measure and describe algal biomass.

### Ammonia

Ammonia (NH<sub>3</sub> as ammonia or NH<sub>4</sub><sup>+</sup> as the ammonium ion) is the form of nitrogen that is easiest for plants to take up. It may be released from the sediment of lakes during periods when the dissolved oxygen concentrations in the bottom waters are low.

### Anthropogenic

Derived from human activity.

### Clarity

Often determined in lakes using a secchi disc (a disk painted in contrasting black and white 'pie wedges'). This gives a measure of the vertical distance that objects can be seen from the surface of the lake.

### Chlorophyll-a

Often abbreviated to Chl-a. Chlorophyll-a is the major plant pigment responsible for photosynthesis. It is used to give an indirect measure of the amount of algal biomass in the water.

### Cyanobacteria (cyanophyta)

'Blue-green algae'. Generally not regarded as algae (see above) these days, but are very primitive, usually microscopic, organisms that may sometimes produce powerful toxins. Common genera of cyanobacteria in the Rotorua lakes include *Anabaena*, *Aphanizomenon* and *Microcystis*.

### Diatoms

Unicellular microalgae with silica shells, often very elaborate.

### Dissolved reactive phosphorus

Phosphorus is an important plant nutrient. Dissolved reactive phosphorus is often measured in water as it stimulates the growth of algae.

### Epilimnion

The upper, warmer, and circulating layer of a stratified lake. Generally high in dissolved oxygen. To clarify this in your mind, remember that a **hypodermic** needle goes **below** your **epidermis**.

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**Eutrophic**

Eutrophic lakes have a high concentration of nutrients. This results in high algal biomass that in turn gives poor water clarity.

**Eutrophication**

Lakes develop from an oligotrophic state (high water quality) to a more eutrophic state (lower water quality) over geological time. Eutrophication is thought to be a natural part of lake development but the rate is increased by human activities which increase the input of nutrients, specifically phosphorus and nitrogen.

**Hypolimnion**

The cool and relatively undisturbed lower layer of a stratified lake. Often deficient in dissolved oxygen.

**Limnology**

Limnology is the study of surface freshwaters, their chemistry, interaction with land and air, and of the freshwater communities which they support.

**Macrophyte**

Macroscopic (i.e. larger than microscopic) plants. Aquatic macrophytes are water plants.

**Mesotrophic**

The water quality of mesotrophic lakes is intermediate between oligotrophic and eutrophic lakes.

**Nitrate**

Nitrate ( $\text{NO}_3^-$ ) is a form of nitrogen readily available for plant growth.

**Nitrogen**

A major plant nutrient, occurring in various chemical compounds. Often abbreviated as "N".

**Oligotrophic**

Oligotrophic lakes have a low concentration of nutrients. This results in low algal biomass and high water clarity.

**Phosphorus**

A major plant nutrient, occurring in various chemical compounds. Often abbreviated as "P".

**Phytoplankton**

Very small plants or plant-like organisms living freely suspended in water.

**Plankton**

Microscopic (usually) organisms living freely suspended in water.

**Stratification**

In lakes usually applies to thermal stratification, in which warming of the surface waters leads to the formation of three layers of water, warm, sharply cooling, and cold (as seen from the surface down).

**Tephra**

Fragmental material produced by a volcanic eruption regardless of composition, fragment size or emplacement mechanism

**Thermocline**

The layer (usually narrow) of water between the epilimnion and the hypolimnion is known as the metalimnion, where the temperature changes rapidly over a short distance in a stratified lake. This sharp temperature gradient is called the Thermocline. Also known as the discontinuity layer.

**Total phosphorus**

Total phosphorus includes dissolved forms, phosphorus adsorbed to particles and phosphorus in algal cells. Total phosphorus can be used to define the trophic state of lakes.

**Toxins**

Poisonous compounds or elements.

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**Trophic state**

Trophic state describes the productivity of lakes. It may be determined using single measures of water quality (e.g. algal biomass, clarity and nutrients) or a combination of measures.

**Water column**

The full depth of a body of water from surface to bottom.