Otago Regional Council

WATER QUALITY FORUM 2010 PROCEEDINGS

Good water, good farming.

A new approach to water pollution
from runoff, drains, and leaching

Editors: Peter Taylor
Mark Peart

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Steve LeGal (NIWA)

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Foreword

Water has often been described as "blue gold." Better investment, management, and use of NZ's water resources are necessary if the mainstays of our economy - agriculture, tourism, horticulture, and viticulture - are to continue to thrive and prosper.

A recent KPMG report underlined this, by spelling out what is required to capture the benefits this blue gold can bring.

It called for a policy framework that provides certainty over the access, quality and cost of water to agribusiness.

KPMG said: "(This) is important if the industry is to have the confidence to make long-term investments in improving productivity and increasing its contribution to the New Zealand economy."

The Otago Regional Council (ORC) agrees that skilful regional coordination of water management holds the key to New Zealand's economic future. It is crucial that the agribusiness and tourism sectors' contributions are handled in a manner that facilitates the development of business opportunities.

This is why we held a series of Water Quality fora in Cromwell, Oamaru, and Balclutha centred on the theme "Good Water, Good Farming."

At the Cromwell forum, where ORC's rural water quality strategy was launched, presenters from local and central government; the science community; iwi; and the agribusiness sector; gave their perspectives on this proposed new approach to managing water contaminant from runoff, drains, and leaching.

The approach underlines the emphasis the council has consistently put on water management, and on ensuring that an effects-based approach, based on permitted activities and environmental standards, is applied within the Otago region.

The *Good Water, Good Farming* fora were attended by more than 100 people with interests in rural water use and quality. I think is it is fair to say that the ORC strategy described in these pages was thoroughly endorsed by the participants.

I commend this collection of proceedings to you, and hope you find it useful as a reference that lays the foundation for the implementation of the ORC rural water strategy.

Stephen Woodhead
Chairman
Otago Regional Council

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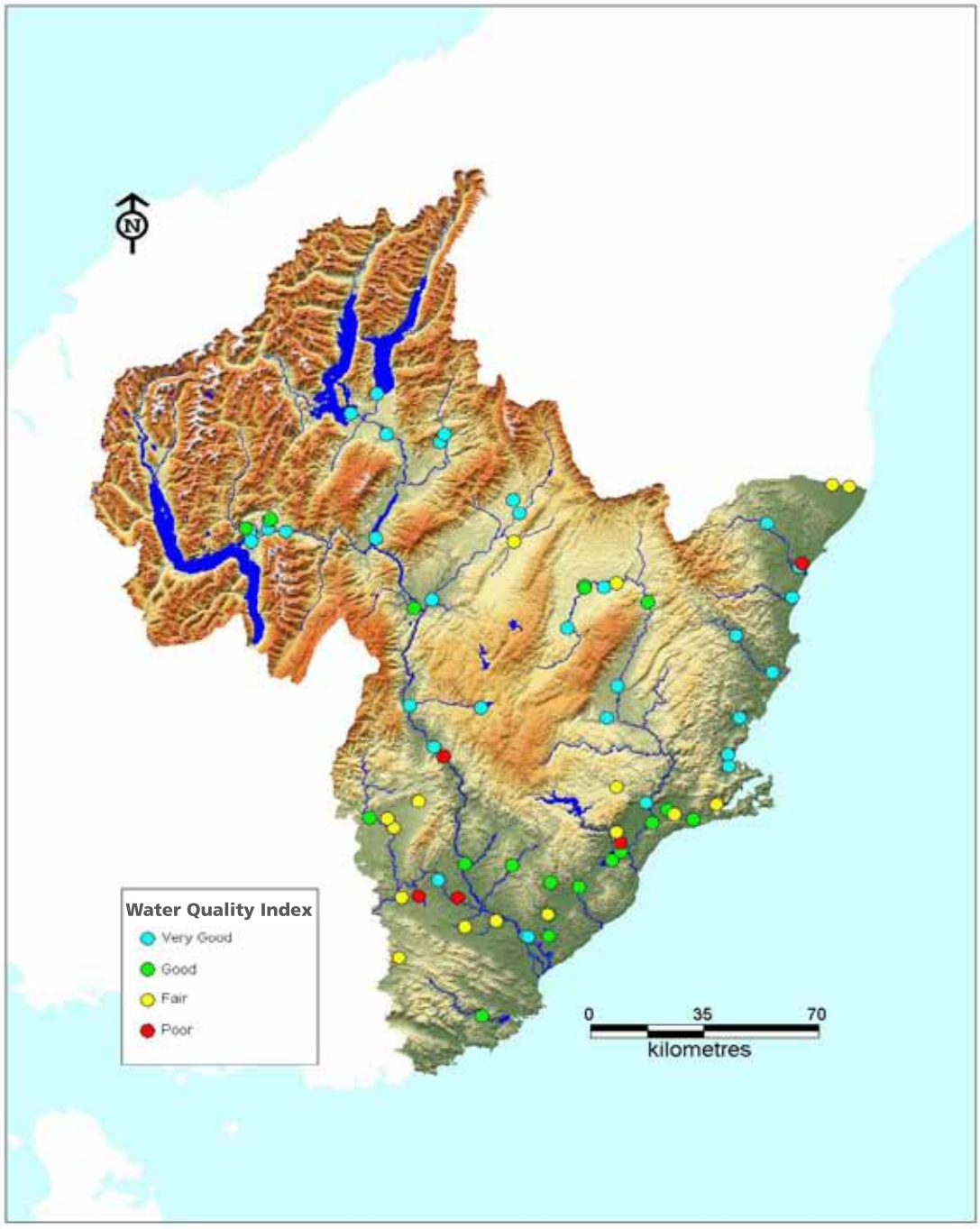


Figure 1 **Water Quality Index (WQI) results 2000-2006 from ORC State of the environment surface water quality report, May 2007**

John Threlfall
Director, Environmental Information and Science
Otago Regional Council

Water quality in Otago

This paper provides an overview of Otago's water quality, highlighting spatial variability and trends. It also focuses on the areas where there are water quality problems.

State of Environment (SOE) testing occurs every year at around 70 sites. Between six and 12 samples are taken and various tests done to determine the level of contaminant material such as nutrients, bacteria, and suspended sediment.

One method to present the monitoring results is to use a Water Quality Index (WQI). This records the averages of six important elements: turbidity, dissolved oxygen, dissolved reactive phosphorous (DRP), ammonia, nitrite-nitrate nitrogen (NNN), and *E. coli* bacteria.

Turbidity records how cloudy the water is or how much sediment it contains, as this can seriously affect fish and their food supply, and destroy habitat in waterways. Oxygen is an important indicator of ecosystem health. If you have no oxygen in a stream, things can't live there. Oxygen is also used up during the night if there is too much algae.

DRP and NNN are the nutrients that we monitor. Nutrients are the main source of food for algae, so measuring them provides an understanding of the potential for algal growth in streams and rivers. Too much algae can choke waterways. Un-ionised ammonia can be toxic to fish if levels are too high.

Lastly, we measure the levels of the bacteria *E.coli,* which is an indicator of faecal contamination from animals, and can have obvious effects on human health.

If measurements of all six elements pass the Australia New Zealand Environment and Conservation Council (ANZECC or MFE/MOH) guideline levels, water quality is considered to be very good; good, if five of the six pass; fair, if three or four pass from the six, and poor is two or fewer passes.

Thirty-six sites achieved a rating of very good water quality. Nineteen sites recorded a good level. In the areas where there are water quality issues, there were 17 sites which were fair, and five sites which were poor.

Is water quality improving?

The areas recording very good or good water quality include river headwaters for the major rivers. A few catchments look poor, such as Welcome Creek in North Otago, but this is a spring-fed waterway, so it is naturally high in nutrients.

Waiareka Creek stands out as having poor water quality, with the main problem being low dissolved oxygen. However, Waiareka Creek is now augmented with water from the North Otago Irrigation Company, and recent results show that water quality would now be classified as 'good'.

The urban areas around Dunedin show some yellows, and there's a red in the Main Drain on the Taieri Plains. Water quality from the Main Drain has also improved since 2006 because the main point discharge from Dunedin airport has been cleaned up.

Thirty-six sites achieved a rating of very good water quality...19 sites recorded a good level.

Looking at the water quality results for South and West Otago, we see more of a problem. Many of these sites have high nutrients and bacteria counts.

	Stonehenge	Halls Bridge	Waipiata	NIWA Tiroiti	Middlemarch	NIWA Outram	Allanton	Henley Ferry
WQI	very good	good	fair	good	very good	very good	good	good
NH_4	▲	▲▲▲	•	▲▲▲	•	▲▲▲	▲▲▲	▲▲▲
Cond	•	•	•	▼	▲▲▲	•	•	▲▲▲
E.Coli	•	▲▲	▲		▲	n/a	•	•
NNN	▲▲▲	▲▲▲	▲	n/a	▲▲▲	n/a	▲▲▲	•
SS	▲▲▲	▲▲▲	▲▲	•	•	•	▲▲▲	•
TN	•	•	▲	▼▼▼	•	▼▼	▲▲▲	▲▲▲
TP	•	•	▼	▼▼▼	•	▼	▲▲▲	▲▲▲
Turb	•	▲▲▲	•	•	•	▲▲	•	▲▲

Figure 2 **Water quality trends for the Taieri River catchment (Shaded cells represent a short-term record).**

Is water quality improving, staying the same or getting worse? We reviewed more than 10 years of results from 77 sites and looked for trends. The big lakes and the headwaters of the big rivers are fine and have always been that way.

However, at the other end of the scale, some areas have degraded water quality and are showing signs of further decline.

Figure 2 gives the results of water quality trend results for the Taieri River.

In the top row, which gives the WQI results, you can see that the Taieri in general is in very good, or good, condition at most sites. However, Waipiata has only a short data record at the moment and is graded as fair.

The blue triangles show an improving trend. That there are more blue markers suggests how statistically strong the trend is. Red triangles indicate that water quality is getting progressively and significantly worse.

Water quality at the Tiroiti and Outram sites is deteriorating as well. Signs of improvement can be seen at Allanton and Henley. A few years ago these sites would have been poor because they had point source discharges, but these have now been cleaned. However, upstream, where there are changes in land use, we are seeing signs that water quality is deteriorating.

Trends in water quality for the Pomahaka catchment are shown in Figure 3. The tributary sites all begin from a low position. They all have a WQI of fair and they're getting progressively worse, especially in relation to nutrients. Monitoring shows that nitrogen and phosphorus levels in the Crookston Burn, the Heriot Burn, and the Waipahi are increasing. The Waipahi is also showing degradation in sediment (turbidity).

	Pomahaka at Glenken	Pomahaka at Burkes Ford	Crookston Burn at Kelso	Heriot Burn at PK Rd	Heriot Burn at SH90	Waipahi at Waipahi	Waipahi at Cairns Pk
WQI	good	very good	fair	fair	fair	fair	fair
NH_4	▲▲	▲▲	▲	•	▼	▲	•
E.Coli	•	•	•	•	▲	•	•
NNN	•	•	▼▼▼	▼	▼▼	▼	▲
TN	•	•	▼▼▼	▼▼	▼▼▼	•	•
TP	•	•	•	•	▼▼▼	•	▼▼▼
Turb	▲▲▲	•	▲▲▲	▲▲	•	•	▼▼

Figure 3 Water quality trends for the Pomahaka River catchment.

Data monitoring will help set standards

The upstream and downstream sites of the main stem of the Pomahaka are either good or very good. In terms of downstream water quality, it looks as if things are holding their own. How long that can last is anybody's guess, when in fact the water quality in all the tributaries is progressively deteriorating. This will eventually reach a tipping point if the situation is allowed to continue.

The heavy pallic soils of the Pomahaka make this area marginal for many sorts of farming, unless the soils are drained. However, the tile and mole drains are a major conduit for contaminants. The moles can pick up contaminants far away from the waterways, and rapidly transport them to the tiles with no filtration.

Monitoring shows that nitrogen and phosphorus levels in the Crookston Burn, the Heriot Burn, and the Waipahi are all increasing.

The drainage water and contaminants then go straight into the waterways. We have known this for some time. What we didn't know, and what we wanted to know before we did the monitoring, was what caused the problems, where the contaminants were coming from, and what levels of contamination we were dealing with.

South and West Otago too, are still developing more intensified agriculture. We need to get onto these non-point source problems if we are to prevent further degradation of water quality.

To help with this, we carried out a 12-month intensive water quality sampling program in the Pomahaka catchment.

We need to get onto these non-point source problems if we are to prevent further degradation of water quality.

The Pomahaka catchment study sampled tiles which drain sheep and /beef countryside; and those from dairy-dominated land. Water samples were taken from the tributaries and the main stem of the river, to give us a good spatial picture of what was occurring.

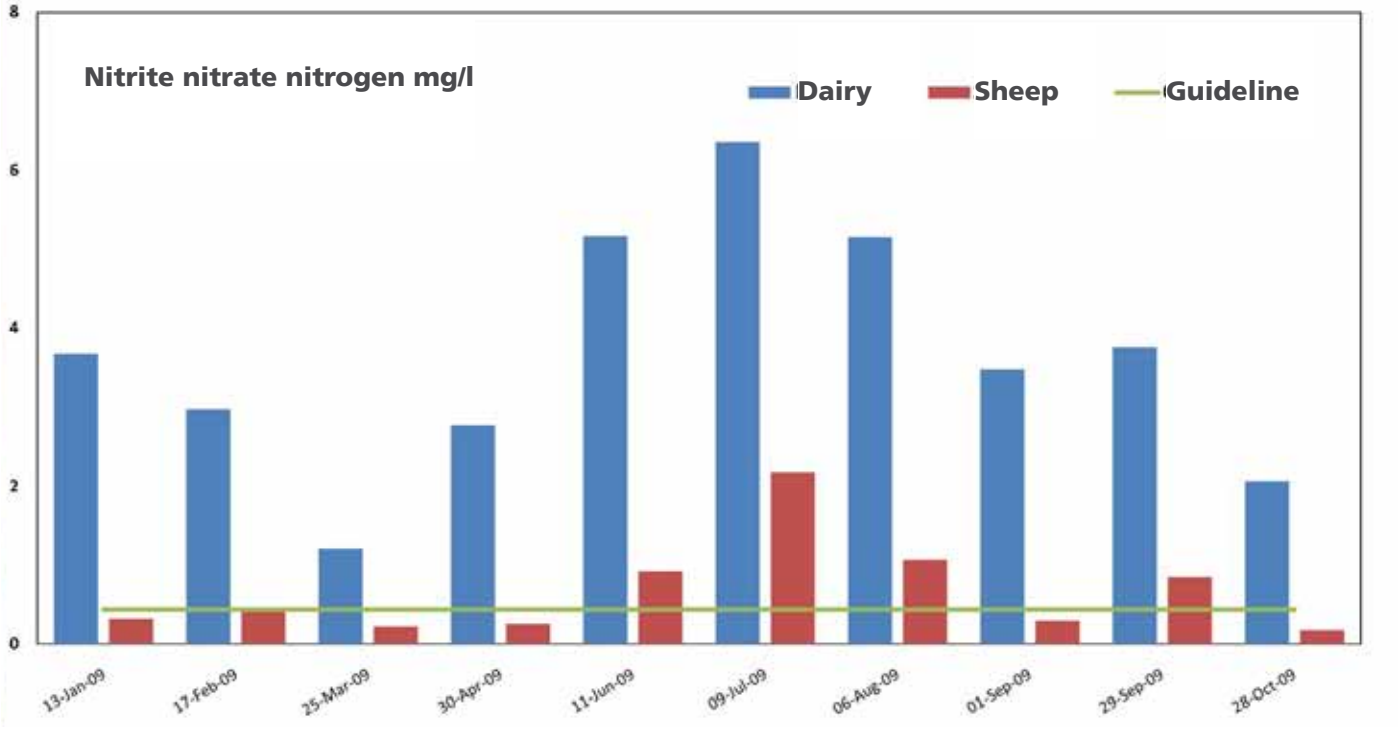


Figure 4 The quality of the drainage from tiles, compared to guidelines. Median values for NNN

To help assess the Pomahaka results, we used 'effects-based' guidelines which were specific for the catchment. The Pomahaka catchment is a significant trout fishery; thus results were looked at in the context of trout habitat and recreation. The guidelines were set accordingly. The following is a summary of the results in terms of tile drainage and then of surface waters.

Figure 4 shows median NNN results. The blue bars are for tiles draining dairy country, and the red bars are from sheep. Each pair of bars shows the sampling days. The results indicate that there are higher values of NNN from the dairy tiles than from sheep; but some samples still show that sheep tile drainage is above the guideline level. These results are the same throughout the year. DRP median values revealed much the same story: contamination from dairy exceeded that from sheep.

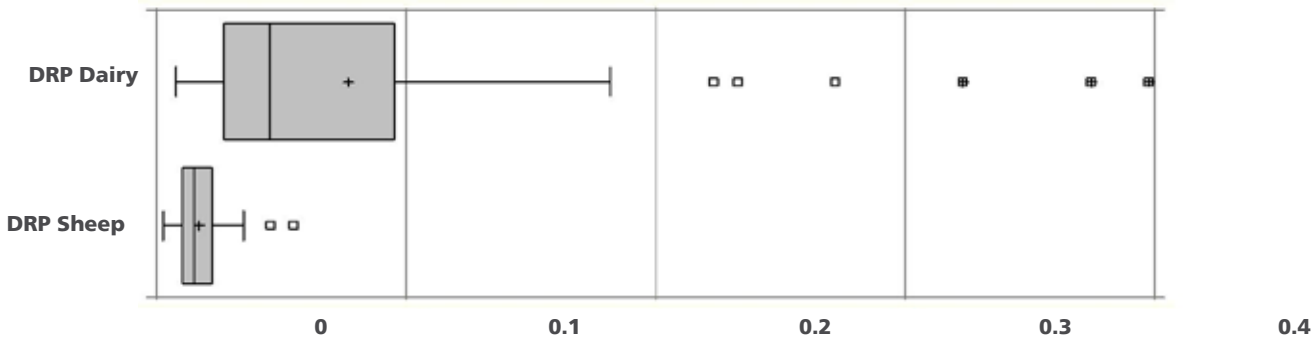


Figure 5 The range of DRP results from tile drainage

Figure 6 Possible source of sediment: bank collapse

Sediment a key issue

Figure 5 shows DRP values in more detail. The values in the box are where most of the values fall. Most of the sheep results are in a narrow band, but with dairy you get a much wider range, with many extremes.On some days the contaminant levels can be high. Dairy results are rarely as low as the sheep results.

The results also show that we are getting sediment from tile drains, and it appears that most of it is coming from dairy farming. Bacteria appears to come from both dairy and sheep farming.

There are some natural sources of these contaminants, but there are also some land management practices which cause contaminants to enter the tiles and the surface waterways. For example, any effluent ponding can drain through to the creek. Sediment loads can come from pugging. Bank collapse can be caused by stock access.

Results for surface waters were looked at for both high and low flows. It is expected that higher flows would generate more contaminant loads in waterways, while contact recreational activities would be more typical during low flows.

In the case of NNN, some of the tributaries had high readings, during both low and high flows. DRP was similar. The Waipahi and the Washpool produced a lot of the DRP input. Otherwise, most of the sites were similar.

Figure 7 Sediment smothering river bed affects fish spawning

Site	% Dairy	Chemical and bacteria	Physical habitat	MCI	Trout density/ condition
Leithen Burn	0	excellent	excellent	excellent	excellent
Black Gully	0	good	excellent	excellent	good
Spylaw Burn	1	fair	good	fair	excellent
Crookston Burn at Walker	44	poor	good	good	good
Waipahi at Cairns Peak (upper)	0	poor	poor	good	fair
Wairuna at Clydevale Rd	51	poor	poor	poor	poor

Figure 8 Landuse effects on instream values

Bacteria were found at most sites. Even in the upstream sites, we're finding sources of bacteria, especially after high flows.

The biggest inputs of bacteria occurred during wet weather, from the Waipahi and the Washpool. These tributaries also showed high bacterial levels in dry weather. If water quality is to be suitable for contact recreation, it is during the dry weather periods, when bacteria levels should be low.

Sediment is a problem for habitat. Some areas have high values, which may be due to bank collapse. But we also have some high values occurring in dry weather.

Figure 7 (see previous page) shows how the bed of one of the smaller tributaries looked after some bank disturbance upstream. Sediment is smothering the bed, causing macroinvertebrates (the fish food) to be badly affected. Fish spawning can't occur successfully in these sorts of conditions.

Instream values influence ecology

Ecological health is more than just water quality, it also looks at the type, the diversity, and the health of the macroinvertebrates. We also need to look at fish density and condition. Clearly, the best habitat for a trout fishery will allow lots of healthy fish, not lots of poor quality fish.

Ecological health is about more than just water quality...

Figure 8 records a range of instream values used to measure ecological health. The first column records the sampling site. The second column represents the percentage of dairy in that catchment. The third column refers to chemical and bacteria levels. The fourth and fifth columns show how healthy the conditions for fish spawning and macroinvertebrates. The right-hand column of the table shows fish quality.

The results do show that if you get good water quality and habitat, you're going to get good fish. You can't get away with degrading water quality and habitat without ecological consequences. When it comes to looking at Otago, we will need to consider a combination of factors, so that we end up with the values the community wants to achieve.

We need to take account of all instream values together to get a reliable measure of how good the ecology is of any stream. You can have poor water quality, but not necessarily have any noticeable impact on the fish.

During the Pomahaka study, we noticed that in one of the upstream sites, the water quality wasn't as good as it should have been. Further investigation revealed a wetland upstream, which had been modified around 2005. We found the median values for DRP and total nitrogen had doubled. The more extreme values were also seen only in recent years.

Pollutant measurement to become more specific

Conclusions drawn from the Pomahaka study show that high stock rates will always have some impact on the waterway, but with good land management these can be better controlled.

We have also seen that, as dairy farming increases, the water quality generally deteriorates. We found degraded water quality in all of the catchments that had more than 30% land use under dairy. Tiles draining dairy farms produce more phosphorous, suspended solids, nitrogen, and NNN compared to sheep farms.

We need to take account of all instream values ...to get a reliable measure of how good the ecology is of any stream.

The bacterial factor is present in all farming and can even be worse from sheep farming areas. Elevated bacterial counts can be found when you have perfectly natural waterways as well.

As we develop instream, effects-based guidelines we will move towards measuring specific pollutants.

For the Pomahaka catchment, the contaminants which mostly affect the river and tributaries are sediment, bacteria, and dissolved phosphorus. If we can decrease the levels of those elements, the waterway will improve.

Sediments, *E.coli,* and DRP can be controlled, to a large extent, by good land management practices, sometimes involving relatively simple remedies. While this is not the whole solution, there are certainly a number of accessible ways to start improving water quality.

We now have a better understanding of the relationship between levels of contaminants and different land uses. The results of monitoring water quality will enable us to describe the parameters for the standards we should be aiming for. We can then meet the community and talk about what people want for the river, how it could be used, and how to achieve this.

We have also started a 12-month study of dryland country in the Manuherikia River catchment. This area has a different type of farming to that of South Otago, with irrigation rather than drainage issues.

We are monitoring different reaches of the main stem and the major tributaries to obtain flow information and water quality data. The aim again is to obtain data which will allow the setting of standards to feed into our water quality strategy.

John Threlfall *has been the ORC director of environmental information and science for six years. After training as a fluvial geomorphologist, his working career has been focused on water quality and environmental engineering in the UK and New Zealand.*

Richard McDowell
Senior Scientist
AgResearch

The migration of contaminants from land to waterways

There are many different water contaminants, with the most problematic tending to be nutrients (nitrogen and phosphorus), sediment, and faecal bacteria.

When do these contaminants move from land to water and where do they come from? Why should we be concerned about water quality? These are the questions I will discuss with you today.

Nutrients

Nitrate is a form of nitrogen. The World Health Organisation recognised nitrate as a contaminant many years ago, setting a discharge limit of 11.3mg per litre of nitrate-nitrogen. This followed studies showing that, if this water was given to infants, it could cause methemoglobinemia, a condition impairing the oxygen-carrying capacity of the blood, commonly called "blue baby syndrome."

Phosphorus is another important nutrient. In combination with nitrogen, it produces algal growth. Some algae are toxic and produce neurotoxins that can cause a rash on your skin and kill dogs if they eat it. In many waterways, very little phosphorus is required to induce algal growth.

To get a sense of proportion - superphosphate equivalent in size to a $2 coin is enough to seed an Olympic-size swimming pool. Such a small amount means phosphorus loss is more of an environmental issue than an agronomic issue.

Sediment contamination impairs fish spawning and stifles their breathing. Ammoniacal nitrogen- in its un-ionised form, ammonia is toxic at low concentrations.

Contaminant losses

So what's typical? The three box plots in Figure 1 show the kilograms per hectare, per year loss of three contaminants. The graphs show there is a wide range of loss. Some of the variation is due to climate, soil type, and typography, but most is due to management. That's encouraging because it means you can choose to manage your farm in a way that has a high loss of contaminant, or which results in a low loss.

A sheep and beef farmer can manage the farm and produce just as much phosphorus as a dairy farmer. There's a lot of leeway and there's a lot that you can do.

Contaminant movement to waterways

Contaminants can take a number of different routes to enter streams, rivers, and lakes. Surface runoff and subsurface flow are obvious ones. The subsurface pathway of leaching means the percolation of a mobile contaminant such as nitrate.

Nitrate flows through the soil, can be intercepted by your mole tile drain, and go quickly into the stream, or it can, via deeper drainage, end up in the ground water. If that is used as a potable water supply for drinking, then enriched concentrations could present a health hazard.

Surface runoff tends to take all the contaminants that are confined in the surface. This tends to be contaminants like sediment with phosphorus and faecal bacteria.

Saturated soils enhance contaminant migration. Like a soaked sponge, there's no more pore space in the soil for the water to fill when it rains, so it runs straight off.

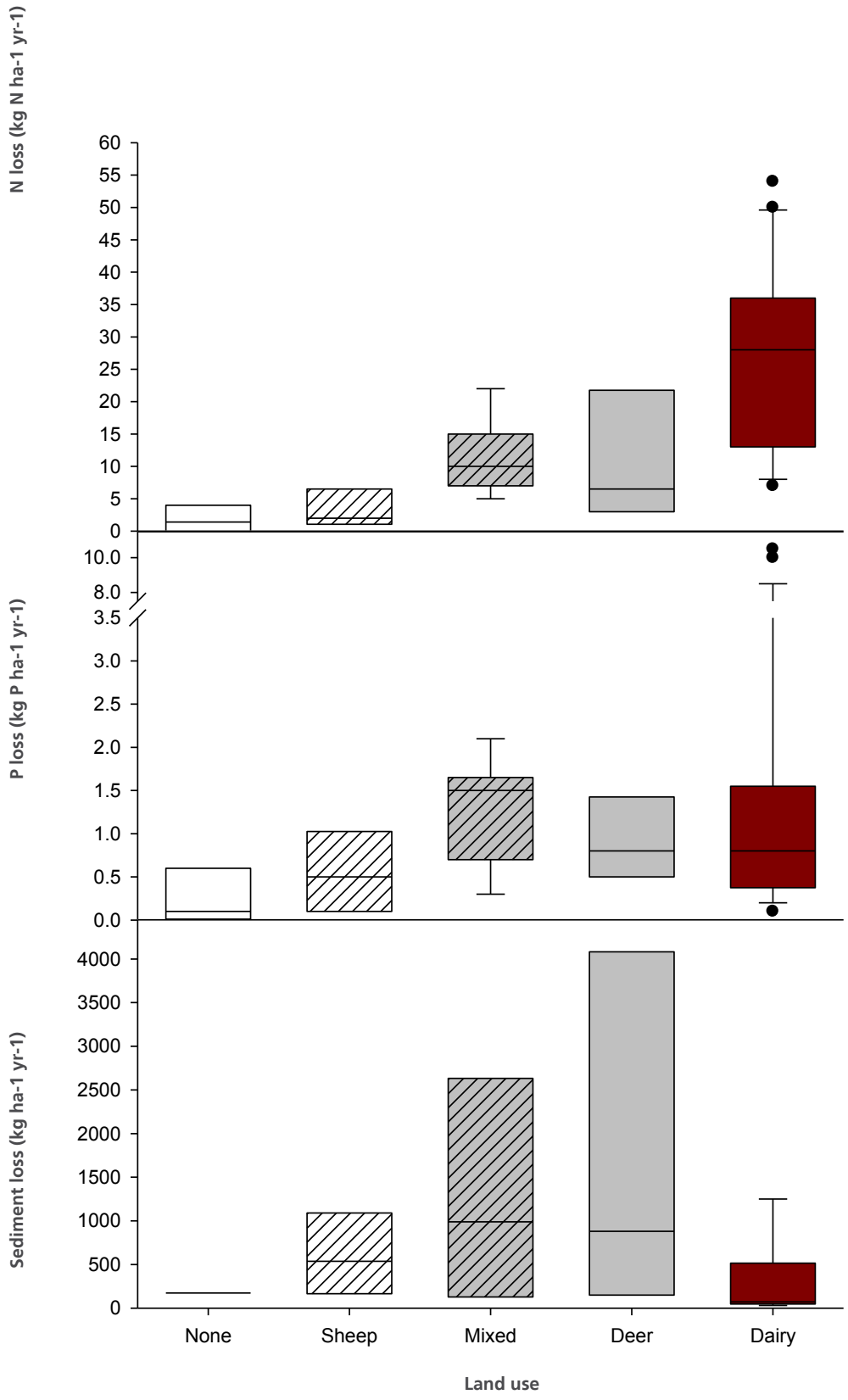


Figure 1 Kilograms per hectare, per year loss of sediment, phosphorus and nitrogen

Figure 2 Runoff from compacted soil

Restricted infiltration assists contaminant migration also via surface runoff. The photo above shows blue sky and no rain. Here there are seeps in the landscape and in the hill slope. The water is draining out onto the surface where it's hitting a compacted layer.

Surface runoff tends to take all the contaminants that are confined in the surface...like sediment with phosphorus and faecal bacteria.

The compacted layer is due to deer running around the fence-line over and over, causing compacted soil, and restricting the infiltration of the water into the soil. Surface runoff is a quick conduit taking contaminants to the stream in situations like this. It's the same for tile and mole pipe drains.

Heavy soils tend not to drain well, even when they are artificially drained. Drainage increases the potential for water contamination compared to well-drained soil, where contaminants can be filtered out by interacting with the soil.

Heavy soils tend not to drain well, even when they are artificially drained. Drainage increases the potential for water contamination...

If you have a wintering block, you can potentially compact the soil while also churning it up. If the this involves sloping land, the potential for surface runoff increases, bringing with it the sediment, the phosphorus, and the faecal bacteria.

Water contaminant sources

Urine equates to nitrogen losses. This is because a typical urine patch will contain between 500kg and 1000kg of nitrogen per hectare. That is far beyond what any pasture can utilise, so the surplus gets leached. Fertiliser itself is not a source of nitrogen losses. However, it can be an indirect source. As farmers apply more nitrogen, they grow more grass, and increase cow numbers to utilise the pasture, but produce more urine patches. This is one of the reasons agricultural scientists are studying the effects of urine patches.

The data in Figure 3 (overleaf) shows the role and influence of fertiliser method application compared to urine patches. When you're applying urea, the nitrogen is spread evenly so it can be utilised. The same occurs with effluent.

Although the application of either urea or effluent (without grazing cattle) can increase nitrate losses compared to a control, this is much less than nitrate leached from a urine patch.

If you're applying urea on top of urine patches, it exacerbates those losses. The important point here is that only about 25% of your paddock is covered by urine patches, so those losses are likely to be less than this extreme example shown here.

Effluent is a source of many contaminants

Effluent is a source of many contaminants – phosphorus, nitrogen, and plenty of faecal bacteria. The old type of travelling irrigator is a common culprit. Farmers without sufficient effluent storage capacity may have to apply effluent when the soil is quite wet.

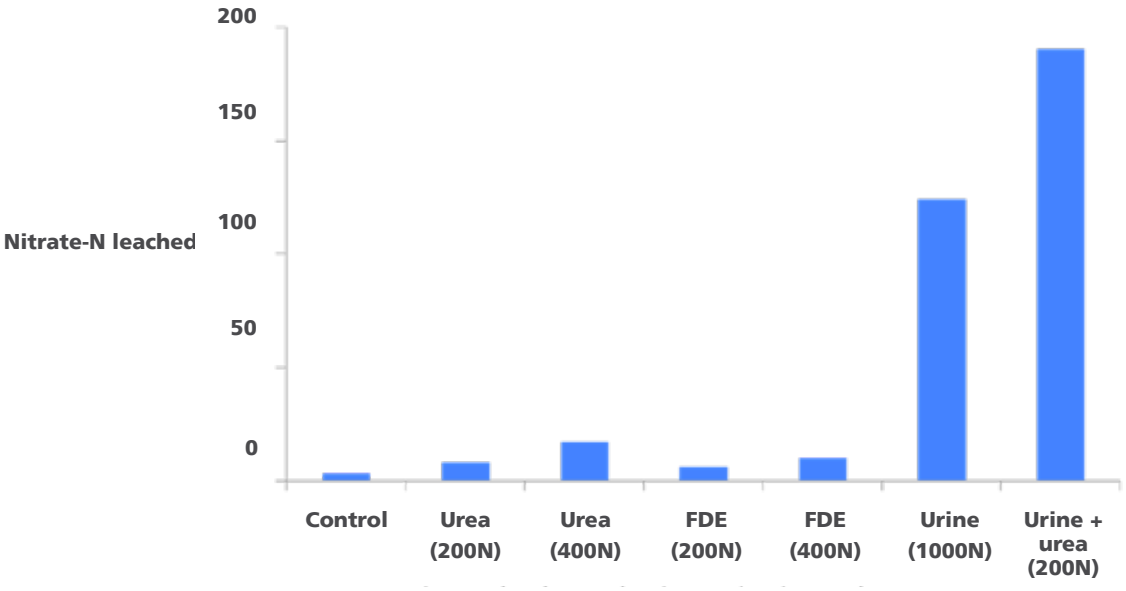


Figure 3 The influence of fertiliser application and urine patches on nitrogen leaching

Travelling irrigators tend not to apply it uniformly. They also spread excessive amounts of effluent at the extremities, away from the centre of the irrigator and at quite a high rate, typically around 127 mm per hour. When this exceeds the soil's infiltration rate, it leads to surface runoff.

If an irrigator fails, or you simply forget to move it, ponding of the effluent can result. If you are applying effluent onto mole and tile-drained land which is also wet, the contaminants can travel into the mole drain, straight into the tile and into a stream. I've seen examples of effluent applied 500 m away from a stream that still made it directly into the stream.

Fertiliser can be a source of phosphorus loss. There is exponential decrease in the potential for phosphorus loss, after application. When you apply fertiliser, most of your losses occur within the first week or two following application.

In one site, we studied the application of 35 kg of phosphorus. Seven days after application, the farm had a runoff event. Forty-five percent of the total phosphorus that came off that year occurred during that one event, when 20 mm of rain fell over seven days. It makes you think about how important it is to listen to the long-term forecast before applying fertiliser.

The same sort of relationship occurs within days of grazing. Dung is an enriched source of faecal bacteria. We've found that most of the losses come off within the first week or two, during or after grazing. Maybe we should think about the wisdom of grazing wet paddocks if there is potential for drainage or surface runoff.

Soil is a particularly good source of phosphorus loss. This is typified by Figure 4 showing the loss of P in overland flow (read surface runoff), versus Olsen P, a regular soil test. The Waikiwi and Woodland soils from Southland have different phosphorus retention. The Waikiwi soil has greater phosphorus retention than the other one.

The main point is that there is an exponential increase in the potential for phosphorus loss with Olsen P beyond a certain point. However, the yield response is inverse. In this case, you have 95% of your pasture production by the time you've reached 20, in the case of Olsen P, but beyond say about 20 or 35, you're starting to leak more.

So why would you exceed an Olson P of 20-35? It usually doesn't make economic sense-or economic sense either. It's not P in the bank; in fact, it's P lost.

Flood irrigation wash is a source of contaminants. About 10-50% of the water put on irrigation can be lost in outwash moving over the surface and out

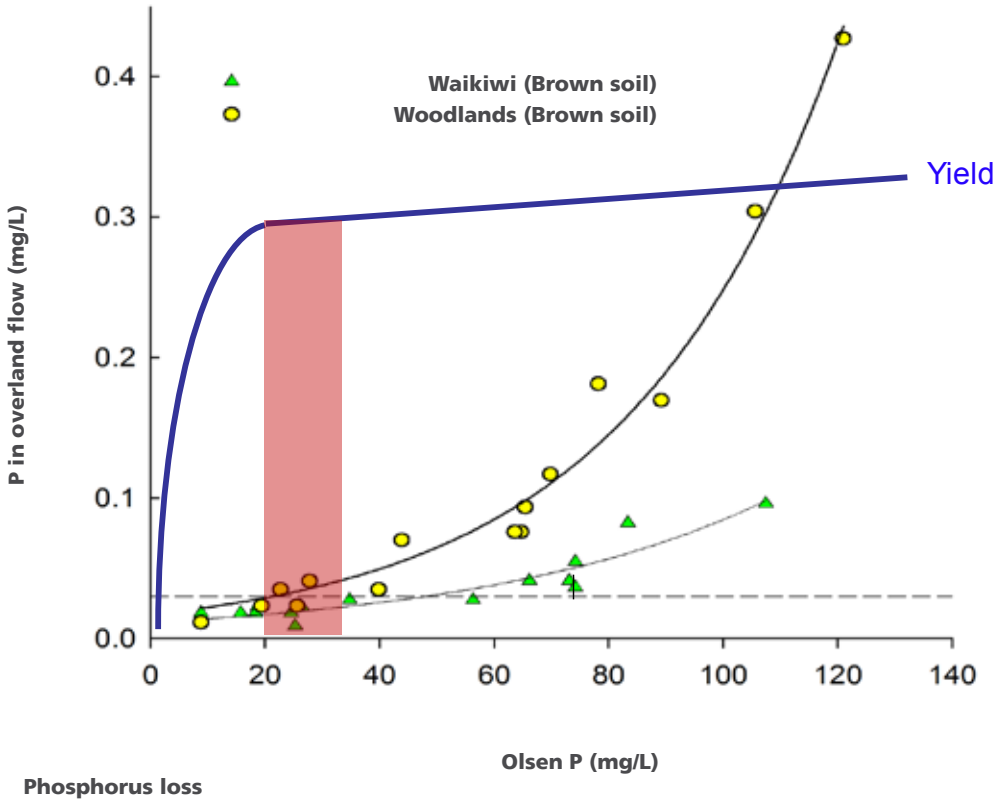


Figure 4 Phosphorus loss

the end of the bay. Outwash is also going to carry quite a lot of surface contaminants.

Tracks and lanes are used frequently and are a source of multiple contaminants, including concentrated faecal deposits. They are important, especially if your track or lane is adjacent to a drainage system, where they can act as a quick conduit for contaminant to go into the drain and into the stream.

Figure 5 (overleaf) shows ammoniacal nitrogen, *E. coli,* and phosphorus, in runoff from areas close to a dairy shed and from a bridge crossing half a kilometre away. The runoff from these sources is highly concentrated and nearly equivalent to raw effluent.

Concentrated sources are not all associated with dairy. Deer farming is another example where concentrated sources exist, which are particularly associated with wallowing and fence-line pacing. Fence-line pacing is associated with stress. It could be fawning, low feed, or seeing their mates next door.

Whatever the cause, it denudes the pasture, compacts the soil, and increases the potential for runoff. Wallowing when connected to a stream represents a concentrated source, as not only are deer churning up mud, they are also defecating.

The effects of the wintering block often represent design and inefficiency factors. It's great for stock, but not so good for nitrogen. For example, a 16 ton brassica crop would contain about 45 grams per kilo of nitrogen. That translates to about 400 kg of N per hectare being ingested.

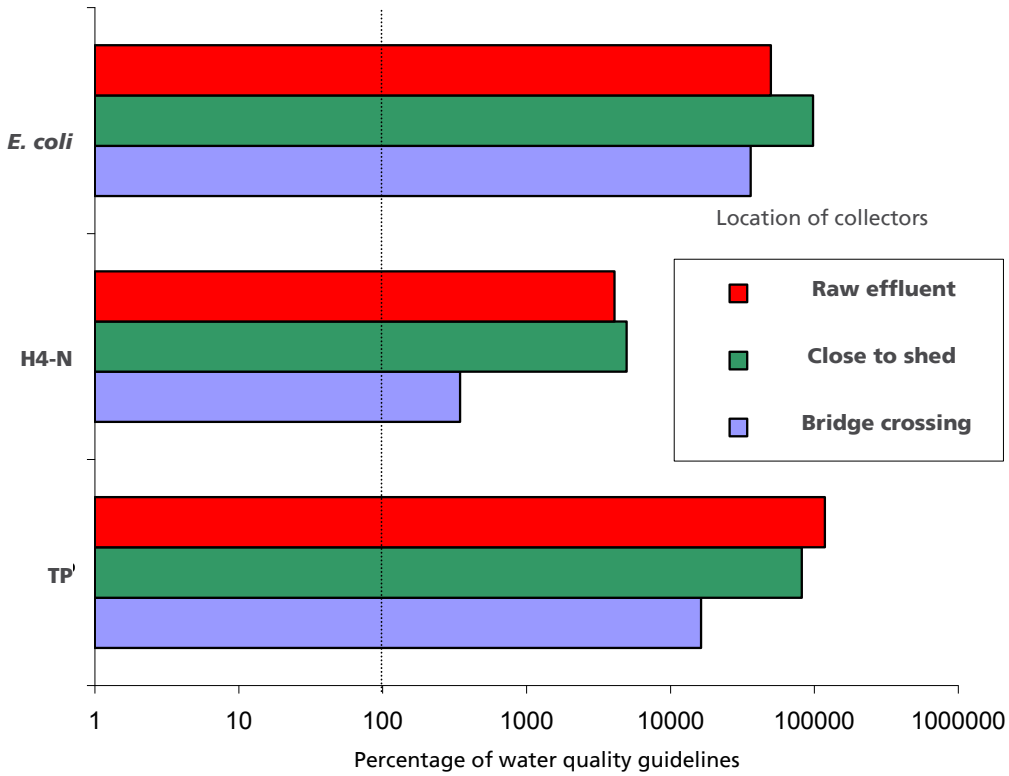


Figure 5 Distance of water contaminant travel

Unfortunately, only about 15% of that is utilised by the animal.

Eighty-five percent is excreted, resulting in 350 kilos of nitrogen being deposited on bare ground in winter. There are no plants to take it up, and because it's winter, it's going to leak. This causes the nitrogen losses from your winter forage crop to be about 3-4 times greater than your milking platform. To extrapolate that out and present it on a farm basis, you would have roughly 40-45% of your losses coming from an area that's only 10-15% of your farm.

Winter contamination of streams can also occur where you have deer on swedes. There's not as much nitrogen being lost, because they do not have as much nitrogen in their urine. They tend to spread it out more, but they can exacerbate phosphorus and sediment losses, due to behavioural issues compared to cattle.

Direct deposition is an obvious source. Stock excreta are a concentrated source of phosphorus, nitrogen, and faecal bacteria. If stock are in creeks and streams, not only are they going to defecate and urinate, they're going to stir up sediments from the stream bed and banks.

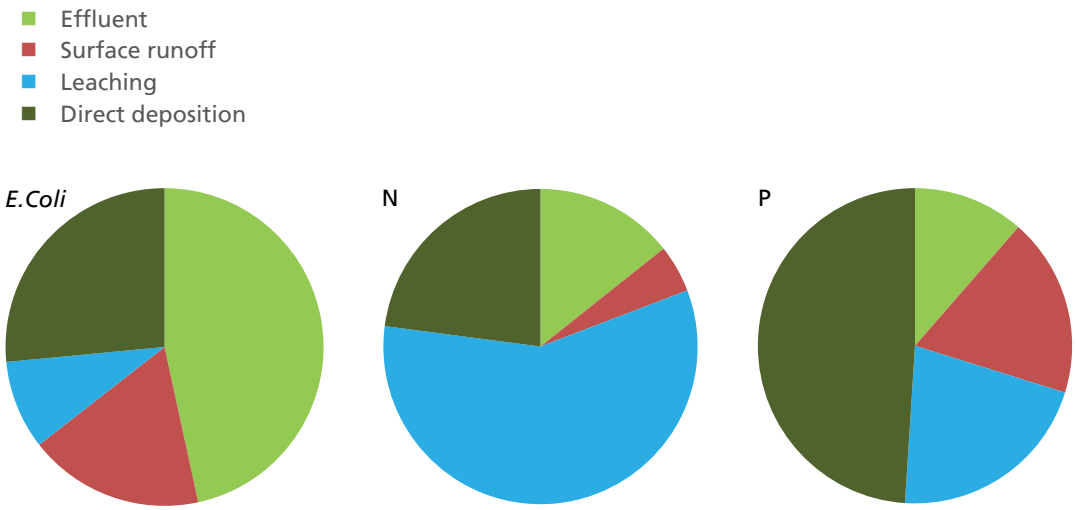


Figure 6 Direct deposition of water contaminants on a dairy farm

The pie charts in Figure 6 above show the influence of direct deposition. These results are from a Southland dairy farm, and identify the potential source of contaminants from direct deposition relative to effluent, surface runoff, leaching or drainage.

Where the cattle had stream access, direct deposition makes up about half of the phosphorus losses coming out of that farm. Faecal bacteria (*E. coli*) make up just under a third and just under a quarter of the losses are nitrogen.

If cattle are excluded from streams, the size of the pie chart decreases (Figure 7). It decreases for *E.coli*, and a bit for nitrogen.

That leaves the other sources, particularly surface runoff for phosphorus, with some tile drainage that I've called leaching, and effluent. For *E.coli* it can be seen that effluent accounts for the majority of losses, while leaching, or tile drainage accounts for the majority of the nitrogen losses.

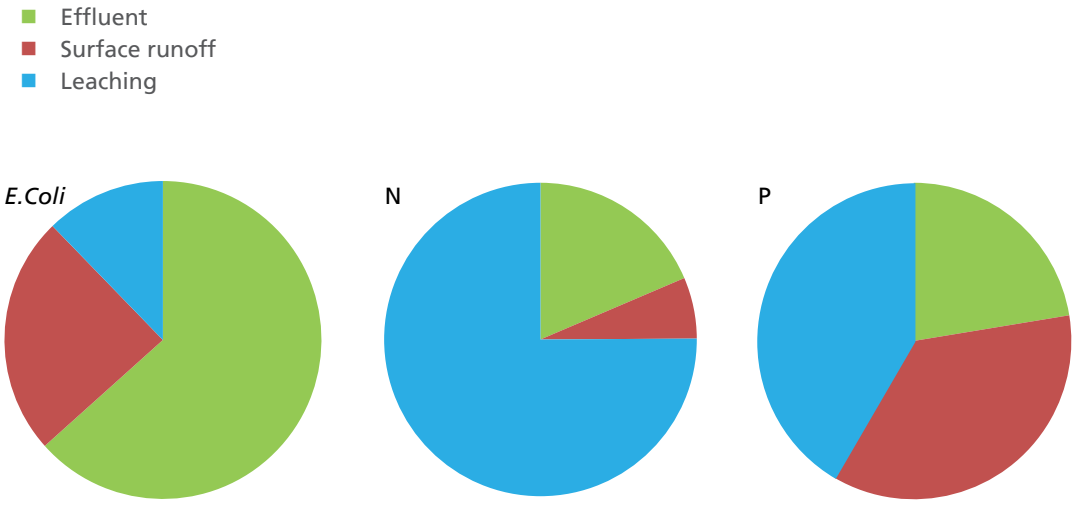


Figure 7 Direct deposition of water contaminants on a farm where cattle are excluded from streams

These are not only dairy farm issues. Deer enjoy wallowing. But commonly deer wallows tend to be connected to a stream. We don't fully understand the reason for it - they do it whether it's wet or cold. While they are wallowing, they are not only eroding the wallowing area, they're also excreting.

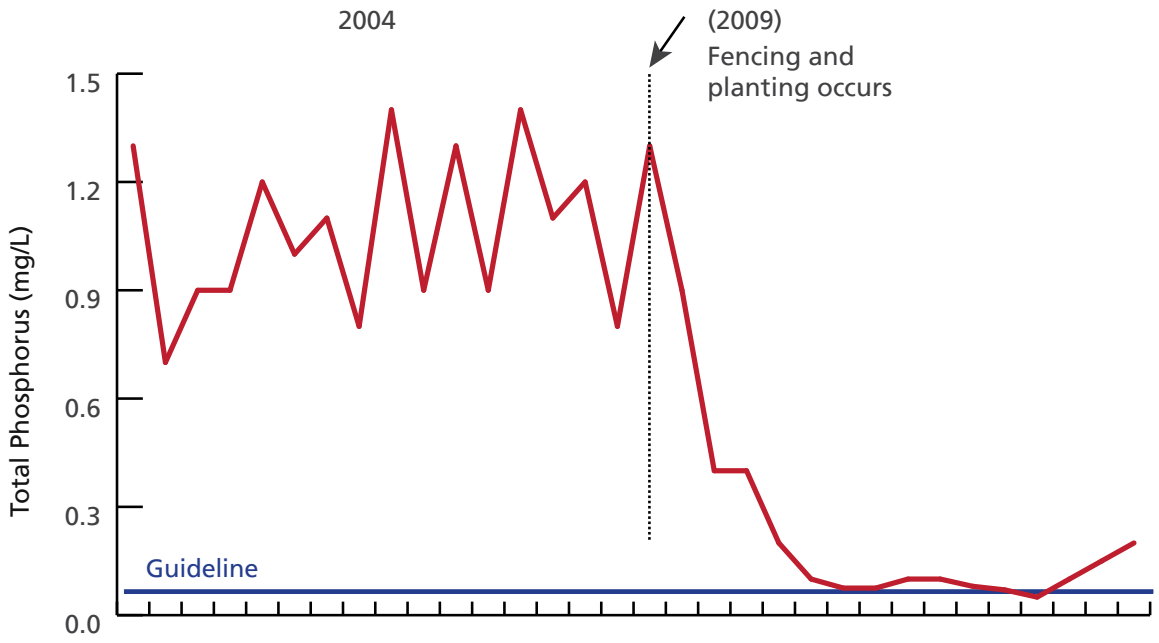


Figure 8 The effect of fencing and riparian planting on phosphorus levels

This can create a concentrated source of contaminants. The obvious thing to do would be to fence them out and do some riparian planting. Figure 8 shows that fencing and planting caused the total phosphorus to decrease to a point where it met the guideline most of the time.

Source	Nitrogen	Phosphorus	Sediment	Faecal bacteria
Urine	*****	-	-	-
Effluent	**	****	***	****
Fertiliser	*	***	-	-
Drainage	**	**	*	***
Soil status	*	***	*	?
Flood irrigation wash	*	****	**	****
Stock wintering	*****	****	****	****
Track/lanes/ fencing	*	***	***	***
Direct stock access	***	*****	*****	*****

Figure 9 Sources of water contaminants (Number of asterisks correspond to importance)

Figure 9 gives an estimate of the relative importance of potential contaminants (nitrogen, phosphorus, sediment and faecal bacteria) sources. The number of asterisks on Table 1 above corresponds to their importance, with five being of highest importance.

There are some commonalities in the table: effluent and stock wintering are important sources of all contaminants as are tracks and lanes for all contaminants, except nitrogen.

The one source of contaminant not commonly thought about, but which is pretty simple to fix, is flood irrigation wash. If you had 10-15% coming off as irrigation wash, associated losses, if irrigation practices were improved, could fall to < 5%.

In summary, we should be concerned about water contaminants because of the potential effects on human and aquatic health. There is the potential for algal growth.

How do the contaminants get to waterways?

Saturated soil conditions and areas with poor infiltration can cause excess surface runoff and take with it most contaminants. Leaching can also be an important route for contaminants such as nitrogen, especially if accompanied by artificial drainage. Behavioural aspects, such as wallowing and fence-line pacing, tend to exacerbate the transport by runoff and hence cause contaminant losses.

Direct access is easily fixed with fencing and culverts. Effluent could also be another easy fix by using low-rate application to land, coupled with plenty of storage, to avoid application when soil is wet. Flood irrigation is another easy fix by preventing outwash. There is much that can be done to decrease water contaminant losses. My colleagues will elaborate on this later in the conference.

Richard McDowell *is a senior scientist within AgResearch's Climate, Land, and Environment section, and adjunct Professor of Soil Science at Lincoln University. In recent years much of his work has involved quantifying pathways of contaminant loss from pastoral land to surface water, and developing mitigation strategies.*

Edward Ellison
Chairman
Otakou Runanga

Tangata whenua perspectives on water quality

The proceedings so far underline the complexity of this particular issue. I would like to highlight the importance of the recognition that the Otago Regional Council has accorded the tangata whenua interest in rural water quality.

Let me give you some understanding of that interest in Otago water.

Undoubtedly water is a treasure to our people. It is an underlying feature of our culture. We relate strongly to our water and its many categories in Otago. It is, in its most precious form, at the tops of the mountains. We know it deteriorates as it gets closer to the coast because of mankind's influence.

Tangata whenua categorise water using traditional descriptors: wai-ora (pure water), wai-maori (freshwater), wai-kino (polluted water), wai mate (water that's lost its mauri), waimanawa-whenua (water from under the land), and waikarakia (water for ritual purposes). These are some among many.

Kai Tahu have a whakapapa and traditional relationship with water. Our history describes water from the beginning of time, and we relate the creation of our environment to water. The expression *Na te Po, Ko te Ao* refers to the beginning of time when there was darkness and there was nothing. It follows through the various stages until water appears as moisture - Na Te Korematua, Ko Te Maku. In our traditions, moisture was put forth. Moisture coupled with Mahoranuiatea (ka puta ki waho ko Rangi), and Rangi was born.

Undoubtedly water is a treasure to our people. We know it deteriorates as it gets closer to the coast because of mankind's influence.

Many of you may be familiar with the tradition of Rangi (Sky Father), who coupled with Papatuanuku (Earth Mother). This resulted over time in many children being born, including Tane Mahuta, Tangaroa, and Tawhirimatea, to mention a few.

As far as legal considerations go, it is a fact that New Zealand legislation, plus many international conventions, state and underline the interest of indigenous peoples in the management of water. The framework we work within is Kaitiaki (trustee, custodian, guardian).

Our role with water has changed significantly from traditional times. We are now more involved in looking at restoration and enchancement, and we are assessing the cultural assessment of resource consents, policies, and plans.

Tangata whenua partnerships

Tangata whenua are putting submissions into the various public processes and are committed to forming constructive relationships, and ensuring that we are a part of the picture. Currently we are ramping up our work with the regional council to enhance our relationship, and we are enthusiastic about contributing to the gradual review of the water plan.

The regional council came to the marae in March, as a part of that particular initiative. We are looking to gain confidence from the process, and the level of endeavour that is going in, to ensure that we enhance our waters as a result of this Water Plan review.

The cultural values that we apply to water are holistic – we do not separate land from water. We see it catchment by catchment, mountains to the sea. Therefore, water quality, water quantity, and land uses are inter-related, and affect mahinga kai (food source and cultivation) customs. That is the basis of our approach to managing water quality in Otago.

The cultural values we apply to water are holistic – we do not separate land from water

Maori cultural values essentially point to the spiritual element of water, a relationship which underpins our identity and links us to the natural resources of the region. Water is the life-force, or Mauri, so to speak, and is invoked traditionally by the people who have had the skills to do that.

Kaitiakitanga encompasses our custodial role. We are often busy doing this through the requirements of the Resource Management Act.

Mahika kai underpins Maori culture

Mahika kai is a cornerstone of our culture, and represents the customary practices that our people use to live off the land. Kai Tahu were very mobile and nomadic in many respects, travelling and traversing the whole interior annually or bi-annually, generally in search of food or other resources. In some cases, we went as far inland as the head of the Dart River for pounamu, which was a prize resource for trading.

So Mahika kai is a cornerstone of our history, and our traditions. The people who had the rights to these areas are known to us. It is not something that you can buy, it's a whakapapa thing – you inherit your rights and you take responsibility for them along with it.

Tikanga is lore, our form of law. It determines how we manage access and rights and the utilisation of those mahika kai. Hikoi is a term we use for travelling around the area and being able to carry out customary practices, including maintaining contact with, and passing knowledge onto, succeeding generations.

The tributaries that feed into the main stem, the Clutha/Matau Au, are where many of our mahika kai resources, such as the native fishery habitats, are located. We're interested in protecting those tributary areas, which are subject to low flows and modification.

It is difficult to have detrimental effects on the quality of the large freshwater bodies of Lake Wakatipu, Wanaka, and Hawea, given the large volumes of pure water feeding into those lakes. Coming down the main stem, where there is extensive dry land country, there is not a lot of opportunity (perhaps) for intensification. The downlands and some of the valleys where there is high intensification potential are the areas we are particularly interested in. We do not want changing land use to impact on water quantity or quality any further.

So, in this process, we come to the SWOT test, or the strength, weaknesses, opportunities, and threats. The key thing for us is the retention of our mahika kai and the enhancement of those opportunities.

That's the number one driver for us because it relates directly to our identity.

If we lose that, we lose a large part of our identity and our relationship with our land and water.

The key thing for us is the retention of our mahika kai and the enhancement of those opportunities.

The settlement between the Crown and Ngai Tahu sought to provide some protection for those relationships and to this end included provisions. The settlement between the Crown and Te Runanga o Ngãi Tahu was intended to restore the ability of Kai Tahu to give practical effect to its kaitiaki responsibilities and provide instruments to recognise the mana and mahika kai practises of Kai Tahu.

These included statutory acknowledgements on some of the rivers and waterways to ensure we receive copies of notified resource consents. Basically, that is all it means, but it has helped to put Kai Tahu in the picture because, before settlement we weren't even seeing those.

Nohoaka were identified. These are temporary camp sites to allow our people access or to camp temporarily by various waterways our people had

traditionally accessed. There are other provisions to ensure that we are engaged in policy and planning processes.

The outcomes we are seeking in relation to freshwater involve employing best practice and new technology. It is changing land use that will put the pressure on our waterways. Couple that with new technology and knowledge, and there is potential for that impact to be mitigated. These two have to go hand in hand, in our view. There is a lot of information and knowledge out there to help us all deal with water quality issues. These available resources need to be utilised effectively.

The outcomes sought by Kai Tahu in relation to freshwater, we believe, are consistent with the outcomes sought by all Otago communities, i.e. clean and sufficient freshwater that supports a range of ecosystems, activities and values, and which are able to be passed down to the next generation in a better state than it is now. This is similar to a farmer wishing to see their land handed on to the next generation, also in a better condition than it is now.

There has got to be a partnership between landholders and scientists and others with expertise. Certainly the regional council has a key role, in our view, to ensure that there is a joining up of the different parties concerned to work together to achieve good water quality outcomes in Otago catchments.

Holistic water management

As part of this partnership, Kai Tahu encourages a shift from being 'consulted', to having a meaningful role in governance and the decision-making required for water quantity and quality.

It is well understood that land-based activities and land use influence water quantity and quality. Given the holistic view with which Kai Tahu approaches resource management, we encourage the Otago Regional Council, in partnership with the territorial authorities, to prepare a Land Plan for Otago.

The wider context of this needs to be better understood: what land is already irrigated; what potential for further irrigation exists; what tools are available or under development to monitor any impacts of irrigation on water quality.

Having a Regional Water Plan that provides a coherent framework for the management and use of water, while protecting and enhancing instream values, is essential. Protection and enhancement of water quality and quantity in tributaries is also important.

The ORC rural water quality strategy must ensure appropriate and efficient methods of irrigation are employed. Kai Tahu supports appropriate riparian protection of lakes, rivers, streams, wetlands, and riparian management, to minimise nutrient discharges to waterways. Access of stock to waterways needs greater attention.

Tangata whenua seek confidence in strategy process

As tangata whenua, we want to have confidence in this water quality strategy process. We look for transparent standards and systems to ensure that we get a better result, which ensures healthy streams, rivers, and lakes can be passed on to future generations. We would like to pass our land and water onto the next generation in better condition than it is now.

Kai Tahu believes in the 25-year principle, where each generation cannot make watertight commitments for the next which do not allow them the opportunity to revisit previous decisions.

The ORC rolling review of the Water Plan is segmented, which limits Kai Tahu's ability to articulate a holistic view of water resource management. We are attempting to address this. As I said earlier, we are beefing up our relationship with the regional council in respect of that.

Successive policies and legislation have diminished or modified the relationship over many generations, and, influenced the way we exercise our Kaitiakitanga. It is much more bureaucratic now, than actually getting out there into the environment and doing it.

Kai Tahu believes in the 25-year principle, where each generation cannot make watertight commitments for the next...

There are opportunities. For example, Dr Gail Tipa and Laurel Teirney developed the Cultural Health Index (CHI). This is a tool to facilitate the input and participation of iwi into land and water management processes and decision-making. The Cultural Health Index for streams provides a means of linking western scientific methods and tangata whenua cultural knowledge about stream health.

The CHI index also provides an opportunity for the Otago Regional Council and iwi through the present Water Quality Plan Change to meaningfully engage with one another. We hope there will be a place for that engagement in this particular process, so that the indicators we apply to the health of the waterway will have that cultural component applied.

Other possible tools are being worked on, or modelled, particularly on the Waikato River with the Tainui settlement. An enormous amount of effort and energy is going into those processes, so we are watching with interest to see what comes out of that.

Consultation is important

We have generally been consulted, but we are looking for a much more active role in the process. Consultation is only the first step. We would like to be much more engaged, have a much better handle both on the expertise that goes into the whole process, and ensure that there is an integration and coherent understanding of the cultural elements as they apply to this process.

We also want to ensure that we have that sense of connectedness. It is integration that we're looking for, whereby the way this rural water quality strategy links into the plan change incorporates our cultural values in a consistent way.

In summary, we want the decisions around this process to enhance rather than diminish the relationship between Kai Tahu and our freshwater.

The Cultural Health Index presents an opportunity to integrate some of those tools into the Otago Water Plan through the review process.

The water plan review process in our view is legitimate if it results in enhanced water quality, while providing for the cultural, economic, and social needs of the community. We certainly understand and recognise the benefits gained from utilising water in a commercial way to produce the goods that come off the land in the region, but there are responsibilities that go with that.

The Cultural Health Index for streams provides a means of linking western scientific methods and tangata whenua cultural knowledge about stream health

My end notes on this are around land-use change, and intensive activity. Many activities have been occurring on the land for a long time, and from some of the water quality evidence we have seen so far at this conference, it is not having too much of a detrimental impact.

We are concerned with land-use change, a failure to replace old practices, and adopt new technologies and efficiencies. Flood irrigation is a good example. There is a responsibility to adopt new practices to minimise impacts around our waterways; for example, riparian planting and control of access of stock to waterways.

So, enhancing the quality of freshwater resources, and safeguarding the associated values are key concerns for Kai Tahu. Having a Regional Water Plan that provides a coherent framework for the management and use of water, while protecting and enhancing instream values is essential. Protection and enhancement of water quality and quantity in tributaries is also important.

We support the implementation of this water strategy. We understand the importance of a Regional Water Plan that is up-to-date and takes on new knowledge. We are aware of the inadequacies of not having a plan, having seen examples of this in Canterbury.

We see the absolute value in having a Water Plan. Otago has had one for sometime and therefore, we support this review and we want confidence in the process. In our customs we do not commit successive generations to a fixed, lock-down position, but seek to allow each generation to make their own affirmation or otherwise.

This ensures genuine commitment on a generation-by-generation basis to our values and objectives. We prefer to allow each generation to make their decisions by following the examples of previous generations.

In this case, the RMA is normally reviewed every 10 years. We think this is absolutely appropriate because of the intensity of activity on land, and the rate of change.

Who knows what is next around the corner in terms of economic activity on the land that may impact on the waterways?

We are aware of the water quality issues in south-west Otago and that is quite a concern.
I have referred to efficient methods of irrigation and riparian protection of our waterways. Riparian management to minimise nutrient discharges to waterways and access for stock to waterways needs much better management than we have at present.

A final note on water harvesting options in dry land areas to reduce demand on our waterways, or the depletion of ground water as well. We think this is something that is worthwhile looking at.

Edward Ellison *is an Otakou farmer of Ngai Tahu, Te Atiawa, and Ngati Mutunga. He is chairman of Otakou runanga; a director of KTKO Ltd, an iwi consultancy specialising in resource management, a member of the Ministerial biosecurity advisory committee, and a member of the Government's agriculture emissions trading scheme advisory committee.*

Fraser McRae
Director
Policy and resource planning
Otago Regional Council

Current regulatory framework

The Resource Management Act provides for the development of national policy statements and national environmental standards.

At the moment, these are absent. However, the Government has tasked the Land and Water Forum with offering advice on bringing some of those tools into play for freshwater management.

The consequence of the absence of national policy statements and environmental standards is that Otago Regional Council (ORC) has operated at the highest level, if you like, in policy development in relation to non-point source pollution. In Otago, we have a Regional Policy Statement with the Regional Plan: Water for Otago, and the various district plans.

We don't have a regional land plan. However, the district plans, through the Triennial Agreement, control land use. Rather than using a Regional Land Plan, this arrangement enables a degree of separation, meaning that there is no duplication of controls over land use and its effect on water quality.

ORC has retained control over the water side of non-point source pollution. Section 5 of the Resource Management Act refers to the importance of enabling activities, while avoiding, remedying, or mitigating adverse effects. The act also makes a distinction between a regional control and a district control.

Under Section 15 of the RMA, which concerns discharges to the environment, you cannot discharge contaminants to water, water to water, or contaminants to land where it may get into water, unless it's allowed by a national environmental standard, regional plan rule, or a resource consent. You cannot discharge anything unless the plan provides for it.

This is why we are pushing to create the permitted activity path as the preferred means of enabling you to manage your farm management without requiring consenting, provided you comply with discharge standards.

ORC has retained control over the water side of non-point source pollution

On the land-use control side, you can do whatever you like, unless it is restricted by a rule in a district plan. So it's the complete reverse of water. Hence, we are required to write rules that allow minor effects of activities that cumulatively are not going to cause harmful environmental effects. Without that rule, no minor discharges can happen.

The permitted activity rule for discharge of water in the Regional Plan, relates to the Resource Management Act, which defines "discharge" as to include "omit, deposit, or allow to escape." This definition is quite broad in the context of rural runoff, drainage, and leaching.

If you have something leaking, it is considered a discharge, the same as if you turn the tap on and direct the hose. If you have, or should have, or could have had, control over runoff, drainage or leaching, and it still happened, that is considered to be your discharge.

Ignorance not a defence against contaminant discharges

It really doesn't cut the mustard to say:'I didn't know' or 'It just happened' or 'It's an accident.' Therefore, you need to be aware that everything you're doing that allows contaminants to get into the environment is a discharge, whether or not it is under your control.

There is a series of permitted activity rules

about discharge to water in the Water Plan. These rules address stormwater, drainage, pesticides, agricultural waste, and fertiliser, and they have various conditions attached to them. Collectively, they all connect together through conditions around producing conspicuous films, conspicuous change in the colour and clarity of water, objectionable odour, rendering freshwater unsuitable, and having significant adverse effect on aquatic life. That same control is in the water plan for non-point source discharge.

Otago policies for water

In Otago, we have the policy frameworks for water through the Regional Policy Statement which became operative in 1998, and the Regional Plan: Water, which became operative in 2004.

The Regional Policy Statement references to discharge to water look at land management activities and contaminant movements that can have an effect on habitats. It recognises the inter-relationship between land-use activities and discharges. The policies aim to see discharges fitting back into applicable standards for the environment they are going into.

Everything you're doing that allows contaminants to get into the environment is a discharge, whether or not it is under your control.

The Regional Plan approach to non-point source pollution identifies the issue – which is that non- point source discharges can adversely affect water quality – and links this issue to an objective: water quality will support the natural values and use of water.

The plan describes the policy approach: education and promotion are the preferred means of encouraging changes in land management practices to reduce poor water quality effects of land use. Finally, it backs the policy and objective up with a rule: *that discharge of drainage [and other] water will have no more than minor adverse effects on natural land use values.* This sums up the rules around discharge of drainage water and other discharges coming off farmland.

If we look at the detail of these rules we see the following**:**

The discharge of drainage water is a permitted activity, providing it does not give rise to:

(i) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or

(ii) any conspicuous change in the colour or visual clarity; or

(iii) any emission of objectionable odour; or

(iv) the rendering of freshwater unsuitable for consumption by farm animals; or

(v) any significant adverse effects on aquatic life.

The terms *conspicuous, conspicuous change*, *objectionable*, *unsuitable*, and *significant adverse effects* are important. They are taken from the Resource Management Act and put into the Otago Water Plan. However, there is a problem in that there are many different views on what "conspicuous" and the other terms mean. This ambiguity creates problems with making them enforceable, even though that that rule attaches to a range of activities as a means of controlling dischargisi nto the environment.

The uncertainty in those rules [italicised above], as far as compliance with permitted activity rules goes, means that it is difficult for ORC to control non-point source discharges at the property level.

We have been quite successful in controlling dairy effluent discharges in many parts of Otago through our best farm practice field programmes, and bringing prosecutions where this has not been heeded. In contrast to that, we have driven improvements to point source discharges by encouraging positive environmental change in industry, in particular. So the point source discharges are improving, with the current regulatory frameworks working quite well.

The same cannot be said for the non-point discharges, which are problematic due to the level of uncertainty inherent in the rules we administer. This also creates a high level of uncertainty for those of you in the

farming community who need to understand what you actually can do, and how you can comply with the rules.

We have difficulty telling you precisely what the policy and compliance issue is, in relation to farming, and therefore you also have a real problem trying to understand the issue.

This difficulty has driven the need to go back and address what is in the Water Plan concerning non-point source discharges, their effects on the general water quality in the catchment, and how to best address their management.

Fraser McRae *has been policy director of the Otago Regional Council since 2005. His career has been built on water and soil resource use and management. Throughout his career Fraser has been an active participant in policy development relating to water management.*

Graeme Martin
Chief Executive
Otago Regional Council

A new effects-based approach

Water quality can't be discussed without placing it in some broader context. There are many issues concerning this context that we need to be acutely aware of.

In Otago, we have reasonably good water quality. By global standards it is very good. But, since we began preparing our Otago water plan, back in the mid-1990s, we have identified some areas of Otago where the water quality needs improvement.

This is mostly in the Pomahaka catchment area, in south-west Otago. Elsewhere, there are areas where land-use intensification is occurring. It's appropriate that we should avoid degradation of water quality. There are also particular issues around some of the inland lakes, such as Lake Hayes, for example.

Because we've got areas that need improvement and areas where we need to avoid water quality degradation, Otago is undergoing intense national and international scrutiny.

ORC chairman Stephen Cairns and I recently met Auditor-General Lyn Provost, who had just returned from an international meeting of auditors-general, where water quality was a talking point.

This is also the case within the OECD. There is a lot going on around water quality in an international context that we've got to be aware of, because it may affect us in Otago.

Since our Water Plan was put in place, there have been some good industrial and municipal improvements to water quality. Dunedin International Airport, for example, has shown superb leadership in this area.

The quality of water discharge there has improved immensely.

PPCS Finegand, as it then was, did some major improvements after some ORC pressure, and the quality of their discharge now is extremely good. It should come as no surprise that within a month or two of this cleanup, they changed their name to Silver Fern Farms, and started marketing the Finegand plant as an environmental success story.

Similarly, a number of you may recall we had public arguments with the nation's biggest company, Fonterra, over the quality of the discharge from their cheese plant at Stirling. Even the Clutha/Mata-Au, the largest river in New Zealand, could not successfully dilute the effluent coming from Finegand and Stirling.

Since our Water Plan was put in place, there have been some good industrial and municipal improvements to water quality.

Fonterra's Stirling plant now has absolutely exemplary water quality treatment for their discharge. They also discharge much less effluent than they used to. Dunedin City Council has also made some big gains, despite still only being partway through their process. In Wanaka, the effluent from the local Wanaka community no longer goes into the Clutha River.

So there has been huge investment, which is not to say there isn't a need for more. This also needs to include land-use improvements in both the urban and rural areas.

Public keen to see action on water quality

There is an important New Zealand context to consider. Water quality, I would suggest, is among the top five public concerns. It doesn't matter

where you go in New Zealand, you can find water quality being mentioned. People have clear views about whether we're making progress or whether we're allowing things to deteriorate. In that context, they demand improvement and assurance about water quality.

Water quality issues are nationally important. The previous and current governments have responded to these concerns, and tried to drive progress, and appropriately so.

The public demand instant, effective action, which cannot be reasonably and rationally done, but the demand is there, nevertheless. Often effective action is seen as sharp regulation. These things are driven by lobbyists of all persuasions. This is the context as I see it, which all parties in Parliament are grappling with.

This public and political context is also driving the science developing around water quality management issues.

'War of words' underpins debate

There is an intense national war of words about water quality. It concerns me that in the process of recognising the need for change and the design of change, there is not enough 'think' time given, or enough sensible policy focus. There is not enough debate on practicality.

In some places, there is not enough supporting research effort. There is not enough analysis of the economic and community effects, and there is not enough airtime, other than for those who are lobbying to create divisive attitudes. This milieu prevents informed discussion and is likely to yield knee-jerk reactions.

The central lobbying process, which has been intense for several years, drives centralised solutions, whether through a National Policy Statement, or through the Environmental Protection Agency's expanded role and powers. That's not necessarily all bad.

Some things should be cloned for efficiency and effectiveness from the centre. But many things should not be. The skill is to determine which should be handled in which way. We're not seeing that debate.

Most resource management regulations need a lot of tailoring for local circumstances. But the intense public interest in water quality issues nationally is leading to the popular view that tough central rules are needed.

Having read public submissions from across the country, it is clear that many think that consents for farming must be made mandatory. Failing that, there has to be a better solution.

Land and Water Forum convened

A draft National Policy Statement on water has been prepared and presented to the Minister for the Environment. He has not actioned it, but referred it to the Land and Water Forum. There are various government decisions pending, on water quality and quantity, which reflects the amount of thinking that is going into these issues.

The Minister has set up the Land and Water Forum with a variety of interested parties around the table looking for solutions. Further changes have also been foreshadowed to the Resource Management Act, and there is no question that amendments are needed. However, what that should entail, and what other methods should be applied when handling regulatory control, are open questions..

The media often portray farming as damaging to the environment. They purvey a popular view that regional councils fail to exert control, and that the RMA processes are flawed, because, apart from everything else, they take far too long and are too costly.

All these are important parts of the context in which the country is trying to farm, and in which we're trying to run our regional economy around water quality matters.

For a regional council, the legal options are narrow. You either prescriptively regulate, as specified in the National Policy Statement on water, by setting general or individual specifications that might be needed for each consent.

As well as, or instead of this, you can regulate by permitted activity. This second scenario can work well where there are specific outcomes, set in rules, in a plan that can be enforced, but does not require individual consents to be obtained.

Those are the options for a regional council. Central government has an additional option to regulate from the centre, either through a change of law, by using a National Policy Statement, and-or National Environmental Standards. If regulation comes from the centre, it will tend to be highly cloned one way or another.

The Otago Regional Council has a particular style of avoiding over-prescription

All government moves have been centralist, prescriptive, and directive in terms of the detailed thinking. I'm not saying that the government has moved on any new framework for water quality yet, but the preparation is there. The decision will be an interesting one to see when it comes.

Prescriptive central government approaches produce added costs that lie where they fall. Analysis of this area tends to be largely ignored. However, the Otago Regional Council has a particular style of avoiding over-prescription which we are quite proud of. We are mindful of the financial equations that are inevitably linked to regulatory process.

As a part of establishing functional, enabling, and environmentally sound policies, we have set clear principles and expectations for good environmental stewardship, attached to permitted activities. We have applied that style when going through the water quantity parts of the plan change that we've been undertaking over the last few years.

We actively promote awareness and co-operation. Without that, we're in deep trouble, and that's why we're here today. Promoting awareness and co-operation is a two, three, four, five, or six-way process. You have to get people together in a room to do it.

Encouraging self-management

We want to encourage self-management and local management. If people do not self-manage, the regulations are not going to work anyway. We need to minimise costs and increase effectiveness. We want to minimise individual consent requirements. Why? Because it involves more cost and time, and the expense comes back to the regional council in terms of compliance issues with consents.

We want to maximise the use of permitted activity rules, so farmers and others can be sure the world is their oyster. How you farm and meet environmental requirements is your business. There are no special rules for your particular property, but general rules for everybody.

To make change, time must be allowed for practical transitions. Working through what are practical transitions is a crucial issue and is something that is difficult to do from the nation's centre, using national instruments.

Above all, we have to provide certain and sure enforcement. On that note, I often get asked how many prosecutions the Otago Regional Council has taken against dairy farmers for consent breaches. The answer is none.

It is true that we have prosecuted on about 50 occasions for breaches of permitted activity rules, or for breaches of the Act itself. We don't have the worst national record of pollution from dairy farmers. In fact, Otago's national standing is very good. We also don't have consents for dairy farming, which sits at odds with where some of the national pressures are focussed.

We want to maximise the use of permitted activity rules, so farmers and others can be sure the world is their oyster

So what is the Otago Regional Council proposing? First of all we need to understand catchment effects. There has got to be continuous, joint efforts going on for a number of years where council, community, farming, industry, research, and supply groups combine to further develop our knowledge. We have to understand the natural processes that occur in our catchments.

We must then think about those natural catchment processes and forces; how we interact with them; and what we do on the land and within the streams and groundwater. That is an ongoing process, and we've been doing a lot of work collectively together over a number of years.

Contaminant measurement issue is water quality 'blind spot'

Then we have got to stop 'blind-driving'. If you look at the processes that cause water quality problems, it is because contaminants are leaching through the ground and going out to waterways, or down to groundwater, or it's running off, or it's coming out of drains. You must be able to know and see that there is something happening in that water that is undesirable.

If you cannot see water discharge and measure it yourself in your own back yard, then of course you cannot deal with how your management of what's happening on your property impacts on those discharges.

This lack of ability to measure water contaminants is one of the great blind spots of our process in trying to improve water quality, particularly from farming.

New research on water quality tools

The instruments aren't readily available at present for farmers to actually be able to see the water quality consequences coming from the management of their property.

This is a research imperative, and we have started on that process through a recent partnership with Landcare Research.

The tools must be practical and cost-effective. It does not matter how you approach non-point source water quality issues – having those quantifying tools is an essential priority. Beyond that, there will have to be assistance with practical land management change. The regional council could do some of that.

Catchment values

Our land resource group is constantly working to help farmers to keep developing their knowledge of good environmental land management practices. This is not just a regional council issue; it is a primary industry issue as well. It is a research organisation issue and it is a government department issue.

Once we have the tools to help us see, look, and measure using day-to-day practical methods, then we've got to think about what we do with this knowledge, and how we make the changes that are needed to sustain appropriate water quality standards.

I suspect that if we get the instruments that are needed, then we will find there will also be a major change in the research program of our Crown Research Institutes (CRI's), because the farming community will be acknowledging water quality issues that don't look too good in some places. This will change the research focus. At the moment that research is regrettably disparate and thin.

Once we've got better information through that process, we've then got to look at catchment values or outcomes. Edward Ellison talked briefly this morning about the Cultural Health Index and mahinga kai values that Kai Tahu has been developing. John Threlfall referred to the extensive scientific data we've got, and that's just part of the network of information.

If we get the instruments that are needed, then... there will also be a major change in the research program of our Crown Research Institutes (CRI's).

That has got to be linked in with the catchment models, the farm models, the OVERSEER-type models, and other nutrient input models, to seek catchment values and outcomes for the values we want.

It is not good enough to record, as most national research does and, dare I say that Otago Regional Council reporting does as well; that water quality results are worse than the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for fresh and marine water quality.

The ANZECC guideline wasn't designed to determine the value and good in the stream or river or lake at your place. It was derived for some other purpose. It might be good for considering public

health issues at some level, but it does not drive the values we need to have in our streams and rivers.

We must set catchment values appropriate for the Otago context. This will involve extensive discussion. I believe that there is already much common ground about what the values should be for most of our catchments.

Our ORC teams have worked with Otago communities over the years on land and water management issues and policies. There have been precious few disputes. Most people have a pretty clear idea about the state in which they'd like to see their stream or river.

Once we work through the catchment values, we then must set farm outputs to fit the catchment. Trying to police all farms on the basis that something has happened in the catchment will not work.

That is part of the difficulty of water quality management, and it's a global problem. If you've got something undesirable happening in a stream, do you need to penalise or limit the entire catchment?

Or should you look to the farm, or farms, that need to pay particular attention to some aspect of their land and water management, and work on those points directly? If they are recidivists, then it becomes a compliance issue requiring a stronger intervention.

Practical transitions key to water management package

When the whole water management package is shaped, we must then map it out with practical transitions. If we get the tools, set the catchment values, identify realistic farm outputs, and set some appropriate water quality limits, then councils will not need to know what you are doing on your farm.

All this will need practical, staged time frames to be implemented. Getting a significant change will, I suspect, require 5-7 years and not more than 7-10. This is because it will take us an initial three years to get a plan change in place. While that's going on, a lot of work can be put into developing new tools and collaborating with communities to look at what the values are and how we apply them. Only after that is all done, can change really begin.

There also has to be a practical, affordable, transition process to allow farmers time to improve some of their farming operations. These improvements largely relate to straightforward management issues, which can be dealt with quite quickly. Practical transition times will usher in the changes that are absolutely critical to achieving effective outcomes on the farm.

To summarise. To implement this rural water quality strategy in the real world, we must make use of the many important linkages operating within catchments. This will give effect to those things that will improve water quality management. We must involve many people in local communities, who can offer a body of knowledge, which at the outset, links to the outcomes through shaping practical transitions. This starting point will determine what our end point is, and how quickly we can get through to it.

To stop driving blind with water quality, we need tools and instrument development and use. This is the most critical issue. We have been having discussions with the chief executive of Landcare Research, Warren Parker.

I am delighted that he has picked up on the challenge we put to him and his staff to undertake developmental work on tools that ORC and farmers need. Some good progress has been made.

Any tool used on farms to record discharge levels will bring with it a need for learning together, and setting up new research. New research will assist the practical land management changes that may be needed in some areas, as we work through the transitions and staged targets.

Setting the catchment values and outcomes will link back to catchment modelling, farm modelling, input modelling, data collection, and the Overseer-typ[e models. The systemic linkages need to be clearly established for this strategy to work.

To stop driving blind with water quality, we need tools and instrument development and use.

Determining what matters and what is myth, is something that we have to work through and be clear about, as part of setting values. There is some mythology out there, particularly when people want to blindly extend a standard from some distant point in the catchment to your local patch.

A good example of that is in a recent report referring to the Kawarau River produced for the Ministry for the Environment (MfE) by NIWA. It contains good science, but it reports that the standard of water quality in the Kawarau River is not good because it is dirty.

It is dirty with sediment because that is how it naturally is, not because farmers made it that way. We must make sure we get the right context, so facts do not become distorted into myth.

Modelling links farm outputs and catchment values

The ANZECC water quality standards have value in their context. However, should some new water quality standards, more appropriate to Otago's values, circumstances and catchments, and which may be appropriate to other New Zealand catchments, be developed.

Setting farm outputs to meet catchment values will come back to a modelling process, which must answer a number of questions including: What can a catchment take? How much discharge can go through a farm? How much discharge can go through part of the catchment? How much will damage the catchment?

What is important is that we do not get caught in the Taupo-type situation where water quality issues accumulating over several decades, and seeping into the groundwater, now mean there are major limitations for the use of that land and on the lake.

Farm models will see inputs and practices driving outputs, which must be measured to ensure they fit with catchment outcomes.

There are interconnections that have to flow from catchment understanding, and necessitate having the tools to see clearly what is happening over time.

I want to highlight the importance of involving all the community in advancing this issue. Once we have the tools, we must still learn together about what these instruments are telling us.

Setting farm outputs to meet catchment values will come back to a modelling process, which must answer a number of questions...

There are two distinct situations where tools are vital. One is measuring what is coming out of drains – tile and mole drains, and open drains. The other is securing leachate samples.

That needs to focus on sediment, nitrogen, phosphorus, and bacteria. There must be easier ways of measuring it. It's been done the hard way so far in New Zealand, because research and court work, should things get to that point, require specific details, standard and detailed tests, and a high level of accuracy.

But, to drive farm management for water quality you don't need that level of accuracy or cost.

The level we need the new instruments to operate at is more akin to one of the most used in the world, the speedometer of your car. This can have a small margin of error which doesn't matter, because it guides our driving. Another analogy is the vehicle warning light for oil or temperature.

The moment that comes on, you stop and seek help. You can't avoid this, you know you have to stop and pay attention. The fact that these gauges are not precise and not up to research standard does not alter their usefulness and effectiveness.

They give a loud and clear message that something needs to be attended to. That's the sort of tool, the level of measurement, we need for water discharge.

As part of this process of learning together, we must be prepared to review the rules and introduce any changes in stages, as the new catchment knowledge and instruments emerge, and as farmers are able to reasonably adapt to them.

Otherwise, we will fail to ensure appropriate water quality standards in Otago rivers and streams. We've got to assure progress.

That comes back to compliance and monitoring issues. The regional council unquestionably has to be involved in that.

How much can be self-managed and self-reported is an important point. It is not our intention to burden the community with having to self-report where it is unnecessary or is not justified.

There is a recommended National Policy Statement (NPS) on water that has been through a public submission process, and considered by a panel appointed by the Environment Minister.

The panel, led by Judge David Sheppard of the Environment Court, has reported back. On water quality, it includes a policy proposed for inclusion in regional council plans. It states:

"This policy applies to any change in the character. and to any increase in the intensity or scale, of any land use or activity, that is not of the same or similar character intensity or scale of that which immediately proceeded, and that involves any discharge by any person, or by any animal of any contaminant of water, into fresh water, or onto land.."

NPS would eliminate permitted activity rules

That is the costly depth of detail and analysis that has emerged through the national tools process over the past five years. If those things hold true, you will have to have resource consents for many activities in Otago which are currently permitted activities under the Otago Water Plan.

It is interesting to note that it does not pick on farmers. It also includes any subdivision in a town, or anything that needs an extra pipe for stormwater discharge. I refer to this, not because the Minister has adopted it, he has not; he has referred it to the Land and Water Forum to consider.

But it typifies the processes and the circumstances that we're looking at. This NPS reminds me of a square wheel – it doesn't roll, it cannot do the job of a round wheel. The logic of the NPS is absolutely immaculate. It is professionally, technically and legally excellent. But it won't roll. There are better ways, albeit ways that take more time.

The Otago Regional Council has a vision. If we look further to our community choice for Otago we must decide: Do we lead, or do we procrastinate? Do we do, or do we get done to? There is no one we can follow, because no-one has walked the path described in our rural water quality strategy. Other agencies have dealt with the issues by detailed consent in every case for farming. Is this what we want for our future in Otago?

Graeme Martin *has been CEO of the Otago Regional Council since 1993. His career has been built on water and soil resource use and management. Throughout his career Graeme has been an active participant in policy development relating to water management at both a central and local level.*

Hon David Carter
Minister of Agriculture

Enhancing agriculture and its environments

I have been asked to speak on enhancing New Zealand agriculture and its environments. Let's first look at the wider landscape.

We have a lot going for us as a country. We are rich in natural resources. We are one of the best food producers in the world. We have a stable system of government. We have secure tenure of land. We are home to some of the smartest, hardest-working people on earth. But, we have not been fully capitalising on these strengths.

Last month KPMG released a report into the primary sectors, which referred to our water resource as "liquid gold". I totally agree. Fresh water is New Zealand's greatest competitive advantage. A huge amount of rain falls on our landmass. Compared with Australia, on average we receive three times the annual rainfall on a per hectare basis.

Despite this, right now a considerable part of the country is dealing with the effects of a severe autumn drought. The fact rain doesn't fall in the right place at the right time means we must store it. But water management is about more than just storage. It's about efficient distribution, better allocation, better utilisation and, what you are focusing on today, water quality.

In my role as Minister of Agriculture, I have a responsibility to promote ways in which agriculture can play a greater role in delivering the Government's growth agenda. The most obvious way to do this is by accelerating reliable irrigation. The Ministry of Agriculture and Forestry has been doing considerable work identifying ways in which we can deliver better water storage and irrigation.

But, there will not be progress unless we take people with us. In other words, it won't be irrigation at any cost. We need to collaboratively engage with our communities. There are legitimate concerns from other water users and environmental groups. We have to be prepared to respect the interests of all stakeholders and develop solutions that deliver for everyone.

The quality of Otago's freshwater resources is generally very good. It supports a wide range of uses, such as tourism, recreation, industry, energy production, domestic and public water supply, and irrigation. But as with many other regions where land-use has intensified over the past decade, water quality in some parts of Otago has deteriorated. Here in Otago, even though land-use is gradually changing, sheep and beef farming is still the mainstay.

I have a responsibility to promote ways in which agriculture can play a greater role in delivering the Government's growth agenda. The most obvious way to do this is by accelerating irrigation.

There is significant viticulture and horticulture in Central Otago and we are now seeing a number of dairy conversions primarily in south-west Otago in the Pomahaka River catchment. An increase in irrigation will mean more intensive farming, so there will be an environmental impact. This is why whenever I talk about removing regulatory roadblocks to water storage and irrigation, I stress we must also maintain high environmental standards. In general, water management has not kept up with the extra pressure on our water system.

In June last year the Environment Minister, Nick Smith, and I announced reform of New Zealand's

freshwater management. To address the issue of deteriorating water quality and poor incentives for water allocation and storage, we set up the Land and Water Forum.

This group involves major water users in agriculture, industry, and power generation; as well as major environmental and recreational groups. It will ensure changes we make are workable, and carefully balance our important environmental reputation with further economic growth from the primary sector. Like me, you'll be interested to see what it proposes as a way forward for freshwater management. I can assure you once that report is back, we won't be sitting on it.

To reiterate, the Government is really focused on freshwater management and progressing irrigation to ensure economic growth. Up until now the regulatory environment has been so bad, it has stopped progress.

This Government's first efforts have been to unblock that regulatory environment. Stage one of the Resource Management Act reform, passed within our first 100 days of government, and recent legislation involving Environment Canterbury, are examples of this. We must first get the regulatory environment right, so we can get some decisions and attract capital. Once that is addressed, if we are still not seeing progress, we will look at other options.

The government is focused on freshwater management and progressing irrigation.

I am always asked about central government funding at meetings such as this. Already we have widened the scope for applicants of the Community Irrigation Fund to include local government agencies developing water strategies. Most of you here will also know there is also opportunity for grants via the Sustainable Farming Fund.

With regard to directly funding regional irrigation schemes, this is an idea which both Prime Minister John Key and Finance Minister Bill English are on record as being open to.

In saying that, any proposition for government funding would have to demonstrate that all other commercial solutions had been exhausted. It would also have to demonstrate that the wider community stands behind the proposal, and that it has a

commitment to good management of water and nutrients.

If all these boxes are ticked, I can assure you we will consider the role of central government funding to get the progress this country needs on water storage and management.

Hon David Carter *was appointed Minister of Agriculture, Minister for Biosecurity, and Minister of Forestry following the 2008 general election. He was first elected to Parliament as MP for Selwyn in 1994, became MP for Banks Pensinsula in 1996, and has been a list member since 1999.*

Trevor Webb
Senior Scientist
Landcare Research

Water quality monitoring instruments

This paper will focus on on-farm instruments for monitoring water and contaminant flows in water draining from agricultural soils.

Farmers need tools that they can use to improve water quality. They need to be able to 'see' the effects of management decisions, so they can learn how to manage their land sustainably. There are no 'silver bullet' monitoring tools available off-the-shelf, but there are some good prospects under development.

A key to obtaining better water quality outcomes is to minimise drainage losses, and so retain water and nutrients on-farm. Irrigation itself therefore, needs to be viewed as a key instrument that can be tuned to minimise the loss of contaminants.

This presentation will evaluate current technology to help the efficient use of irrigation water. I will then look at options for capturing drainage water and directly testing water quality. Several methods of monitoring of soil water content and contaminant losses under grazed pasture are relatively expensive, and can be of questionable accuracy.

We need to use methods that provide suitable information to address the water quantity and quality issues. Landcare Research is working to design instruments based on the real-time soil water storage and drainage in the paddock.

We want to be able to measure the water left in the soil, knowing how much you need, and then base irrigation on that, rather than on what we estimate is being lost from evapotranspiration.

This could also potentially decrease the amount of contaminant loss from drainage. We are also developing a robust method to measure soil drainage.

We need to...address water quantity and quality issues.

Irrigation scheduling is a key controller of the amount of nutrients your pasture and crops absorb. Irrigation is therefore one of the most powerful tools a farmer can use to attain maximum production and minimise contaminant losses.

There are two main aims in using water efficiently to provide sufficient water in the soil root zone to maximise production; and to prevent water being leached out the bottom of the soil profile.

It is our view that we need to improve the way we schedule irrigation. Efficient water use requires an assessment of the amount of water that is stored in the soil, and the amount of irrigation needed to restore the soil to field capacity. This can be done through interpretation of climatic data, or through instruments that measure water in the soil.

Extensive areas of irrigated land use a water balance equation (subtracting rainfall from estimated evapotranspiration) to schedule irrigation. A major problem with this method is the large uncertainty associated with the estimation of evapotranspiration (ET), because this calculation depends on a large number of parameters, most of which are only approximations; they are not measured.

Efficient water use requires an assessment of the amount of water that is stored in the soil...

Therefore, the ET calculations always have an element of error. Let's suppose there is a half a millimetre error per day in the estimation of ET, and that we were to irrigate according to this calculation over the current irrigated land of New Zealand.

This would result in about 50 million cubic metres of wasted water. There is a real possibility that we're wasting that level of water in New Zealand.

Instruments to measure soil water for irrigation efficiency

There are a few tools available to measure water in soil profiles to aid irrigation scheduling. Each tool has a different way to measure water and with it, its strengths and weaknesses:

Neutron Probes
Neutron-probes measure water surrounding aluminium pipes installed into the soil to a depth of 1 to 1.5 metres. This records how much water the soil contains at the time of measurement. Subtracting the water content from the amount of water when the soil is full provides a direct measure of the amount of water needed to restore the soil to field capacity. The measurement provides a complete measurement of water content for the entire profile.

However, this method has limitations. You only measure occasionally – maybe every two or three weeks — to determine your irrigation requirement, so this information does not always help you to accurately decide how much irrigation water should be applied.

You still need to extrapolate the amount of water needed at the time of measurement to the amount needed on the day of irrigation. Water content is also only measured at a limited number of points, and therefore does not represent the variation related to soil differences and irrigation patterns.

Aquaflex
Aquaflex is a strip about three metres long, inlaid into the soil, usually at depths extending on an angle from 15 - 40 cm. It has a 50 mm radius of influence. This integrates the soil water measurements over a wider area than for a neutron probe. Measurements are made automatically at whatever time interval you select. The data is recorded on a logger and can be sent directly to a computer.

Ceramic water sensor
This cost-effective water potential sensor is being developed by Landcare Research. These are made of ceramics, and are relatively cheap at about $50 a unit. A small ceramic sensor is placed in the soil to provide a direct measurement of soil water content. Sensors can be placed at two or three depths to measure penetration of water. This provides a similar measurement to the Aquaflex, but is much cheaper. Location of sensors can be designed to cover soil variability and for different paddocks.

The data can all be downloaded to a computer through an automated radio system. You can link into the Internet and see how your irrigation's going and what is happening on your fields. Irrigators can then apply the right amount of water to each part of the farm or field. This allows farmers to observe and manage irrigation water use efficiently and in real-time. You can even watch the wetting up of soil as irrigation is being applied.

Current research is investigating soil water monitoring under centre pivots overlying variable soil types. Paddock-based sensors can determine exactly how much water is already available on the day the irrigator comes across. Farmers in New Zealand are currently applying this method. The technology is available now and it pays dividends. Where the water is short, 10-20% of irrigation in one area can be saved to irrigate 10-20% more of the farm.

Measuring drainage and leaching

Many farmers use annual nutrient budgeting models such as OVERSEER for annual fertiliser planning and crop production. These play an important part in controlling nutrient losses but are based on annual-average conditions. Alongside these, we need tools that can help the farmer make sound management decisions in the face of the current season's climatic conditions, including rainfall and ET.

There are several tools available to measure drainage and leaching, which could assist with water quality control. However, the available tools are mainly used as research tools. They're too expensive and difficult for farm management purposes.

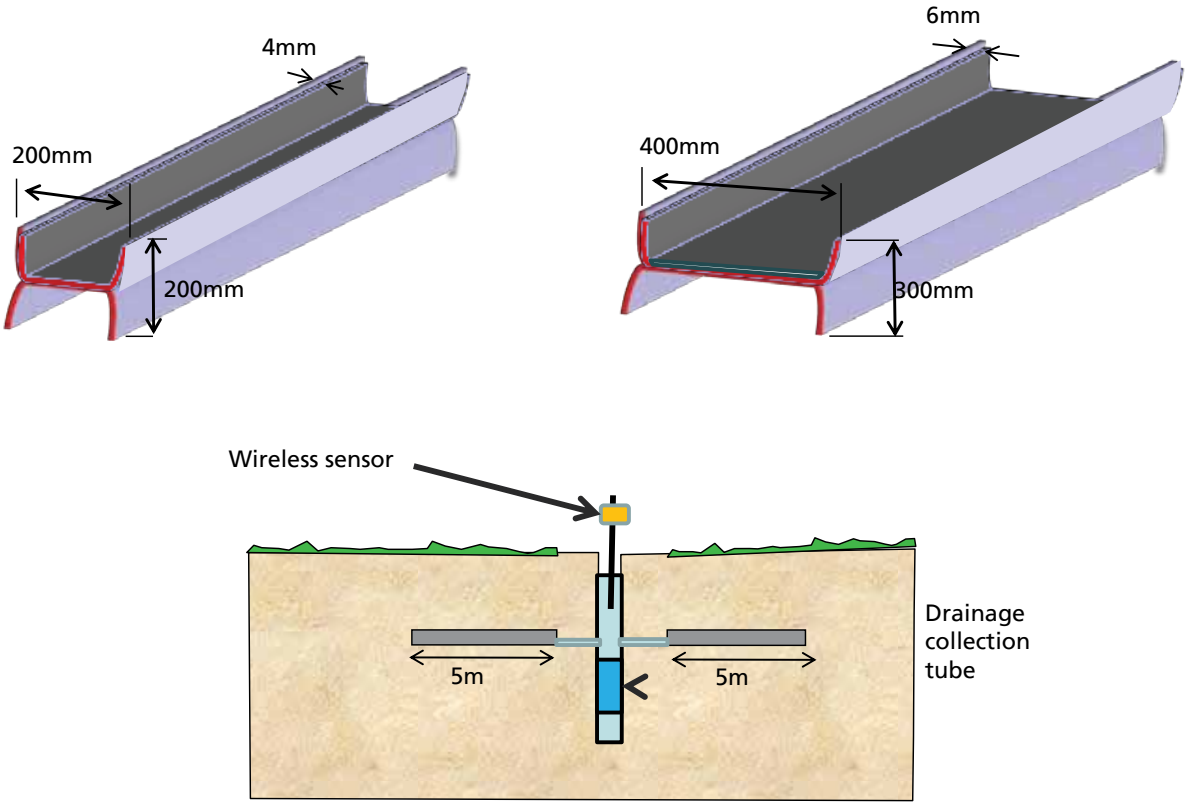


Figure 1 Lysimeter design

Suction cups

Are small ceramic cups placed in the bottom of a tube installed in the soil. The suction cups are below the root zone where they can record the nitrogen that is passing through in the drainage water. Samples of drainage water are extracted from the suction cup and analysed to determine the concentration of nitrate. To determine the amount of nitrate lost requires the concentration to be multiplying by an estimation of the amount of drainage. This is usually done by a water balance calculation. (But sometimes drainage is measured separately)

The estimates from this method will have a number of errors due to the very small sampling volume, the high variability of nitrate in the soil both over time and space, and the problem of calculating drainage.

We need tools that can help the farmer make sound management decisions....

Barrel Lysimeters

This is a metal or plastic drum inserted into the soil so that the soil profile is kept intact. The bottom of the barrel is sealed off and drainage is collected from a pipe at the base. This is a simple but expensive method, which is good for measuring drainage and leaching.

Discharge from the tile and mole drains

In lands with artificial drains, water can be collected from the end of the drain and tested for amount of drainage and contaminants.

Channel lysimeter

Landcare Research is designing a Channel Lysimeter to intercept drainage water beneath the soil profile. This is a simple instrument that can be pushed into the soil below the root zone to capture the drainage water over a large surface area. The lysimeter is simply a metal channel pushed horizontally into the soil, which collects drainage from below the soil. Installation is a matter of excavating a hole, pushing the lysimeter into the gravels, and collecting the samples. Only one lysimeter is needed to get up to 1 to 2 m^2 of sampling area.

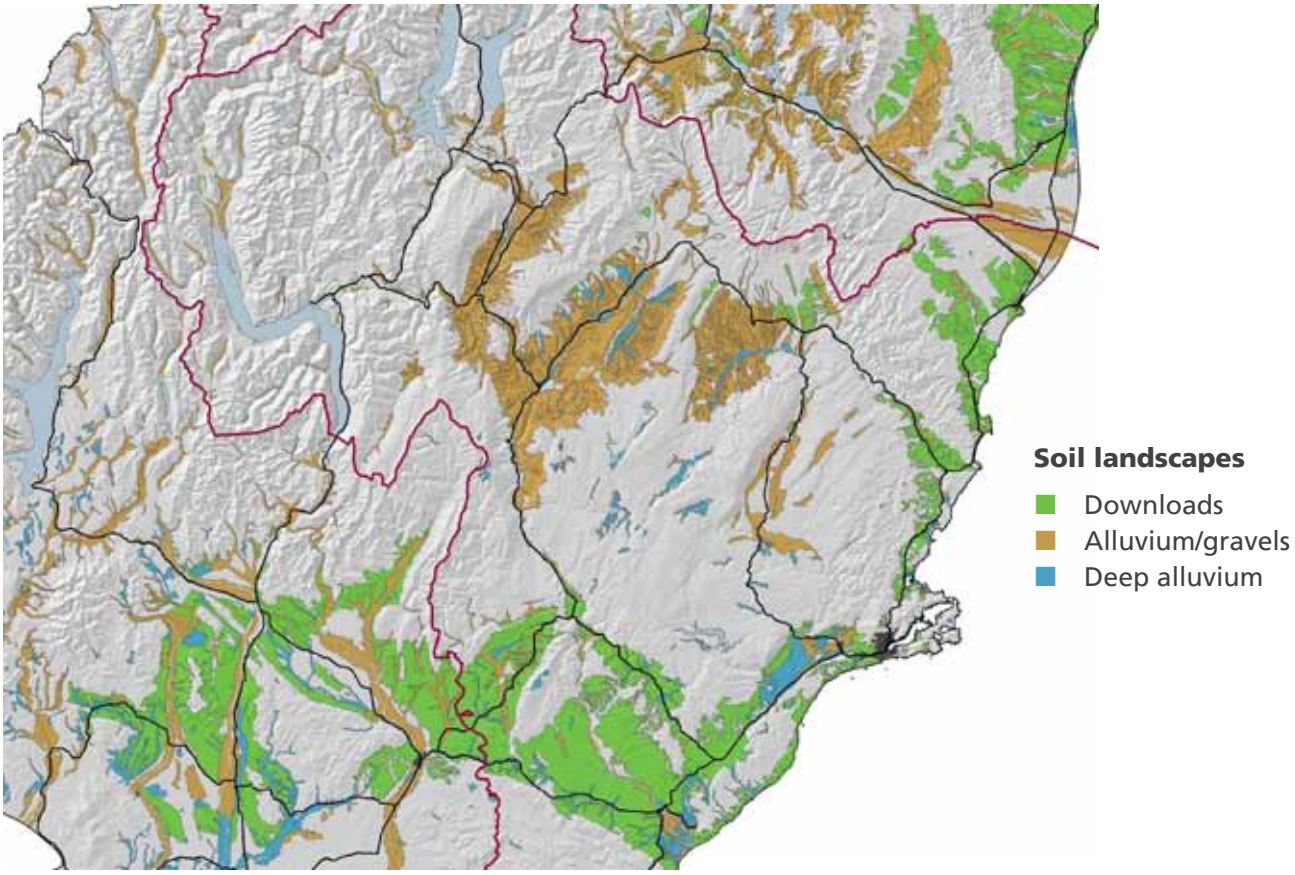


Figure 2 Otago soil landscapes

This system will be applicable to the sandy gravels, which are widespread in Otago, Canterbury, and Southland, and represent about 80% of irrigated land. A sketch of the design is shown in Fig.1. This way of capturing drainage may have major applications for irrigation. At present no one knows how much drainage is occurring under irrigators working in New Zealand. Farmers don't know how much water is being wasted. In one site with barrel lysimeters on a stony soil, we estimate about a 20% loss of irrigation water. If farmers could have a simple tool to show them when drainage is occurring, they could change their management to use water efficiently.

Monitoring on different soil-landscapes

Otago's intensively-used lands can be subdivided into three different main soil-landscapes: the rolling downlands, the poorly-drained deep alluvial basins, and the alluvial plains that overlie gravels. Each landscape requires a different approach to water quality monitoring.

Downlands

Large areas in North Otago and South Otago around Balclutha contain deep, loess-mantled silty soils with dense subsoil pans. In the downlands, there is almost no natural drainage. Drainage is often accomplished via mole and tile drains. The water entering streams either comes overland or through sub-surface flows from these soils. In these landscapes you can either measure at the end of a drain, or you can build a weir. Whilst a weir is an expensive option, it catches not only the water that comes through the drain, but also the water that comes from surface runoff.

Otago Regional Council has done some work looking at what is coming from the drains. Work by AgResearch has found that about the same amount of phosphorus and microbial material comes from runoff as comes through the drains.

To accurately measure discharge loads in these areas you have to build a weir in a sub-catchment, or in a strategic point served by a large catchment area. Because of high cost, this could only be done at a few benchmark sites.

These benchmark sites would show what the flows are, when they occur, under what circumstances, what time of year, and when contaminant flows are high or low.

Strategic sampling like this may determine a much simpler sampling scheme that could be used as an index of losses where you would only need to measure occasionally rather than all year round.

Deep, alluvial soils
Areas on the Taieri Plains contain deep, alluvial soils where high water-tables occur within the fine soil material. Leaching cannot be accurately measured here because of the upward movement of water from the groundwater. Measurement of leaching losses on these landscapes is limited to methods of measuring water samples from drains or aquifers.

Alluvium over gravels
There are alluvial surfaces in extensive plains in Central Otago and North Otago. These areas have underlying gravel areas, which are being considered for increased irrigation in Central Otago. On the gravel plains the current methods – suction cups, water balance, or barrel lysimeters can be used. However, as I noted earlier, these are costly and the accuracy is questionable when used for grazing management.

The channel lysimeter under development holds promise for a cheaper and more robust method of capturing drainage losses in these difficult landscapes. There is little information on leaching losses under the extensive areas of shallow and stony soils being irrigated in large areas of Canterbury and Otago. More data points are needed to help calibrate leaching models.

Urine patches

We now come to the challenging problem of urine patches. It is well known that over 80 percent of leaching of nitrate under gazing comes from urine patches. Most of the leaching from urine patches comes from urine deposited during late autumn and winter. This means that an accurate in-field measurement of nitrate leaching requires a sampling method that will accurately represent the leaching from about four grazing events (about 12% of the area in a dairy pasture).

To obtain a reasonably accurate measure of leaching, the samplers must sample the right proportion of urine and non-urine patches. That's a huge challenge. We estimate that even with 100 x 50 cm-diameter lysimeters scattered across a paddock, the results will still significantly under-sample the urine patches.

The cost, therefore, of using barrel lysimeters to measure leaching under direct on-farm conditions is prohibitively expensive. (Barrel lysimeters may however be used to measure nitrate leaching with carefully-controlled urine application combined with modelling of the estimated proportion of urine patches to estimate leaching on the paddock scale).

To measure in-field leaching under grazing requires a tool that can sample a large area of the drainage water beneath a paddock. The channel lysimeter samples a surface area of 1-2 m^2 per lysimeter, compared to 0.2 m^2 for a 50 cm-diameter barrel lysimeter. This tool greatly increases our ability to statistically sample the distribution of urine patches. Work has yet to be done to determine the best sampling strategy and the number of channel lysimeters required to accurately measure leaching under grazed pasture.

The development of the channel lysimeter has received funding from the Otago Regional Council, together with investment funding from Landcare Research to do a proof of concept for this method. It requires the right design to work. We will be doing design experimentation over the coming months to make the method suitable for a wide array of applications.

Trevor Webb *is a Landcare Research soil scientist based at Lincoln, with 38 years experience in land resource assessment for agriculture, horticulture, and forestry. His recent research work has focused on valuing and managing soils to support sustainable agriculture.*

MAF activities supporting water quality management on NZ farms

Chris Arbuckle
Senior Policy Analyst
Natural Resources
MAF

Today I will cover five categories of work MAF is engaged in which supports water quality management in New Zealand.

I will link these to the purpose of this forum, and what the Otago Regional Council is doing in areas like the Pomahaka catchment.

Sustainable Farming Fund

Through the Sustainable Farming Fund MAF funds many regionally-based projects focused on sustainable land management. For example, this includes the High Country Erosion programme, which is primarily aimed at erosion-prone hill country in the North Island.

MAF also manages the reporting associated with the Dairy Clean Streams Accord. The Primary Sector Water Partnership is an industry partnership which MAF facilitates. It works within pastoral industries to have a co-ordinated approach to water management.

MAF supports water quality through a number of partnerships within the Sustainable Farming Fund process, including rural communities and regional councils. About $8.2 million has been spent at a community level across New Zealand on water quality objectives since 2002. MAF has recently funded another seven projects throughout the country, accounting for another $1.1 million in investment, targeting community-based water quality projects.

Several of these projects have occurred throughout NZ, in Otago and Southland. Importantly, these projects are glued together by the farming community. They use community engagement to promote environmental awareness and co-operation. These projects are about creating more awareness of water quality issues and getting co-operation across a range of stakeholders.

One project that's gained momentum is in Golden Bay, where the community is looking at a value-based approach to fisheries output. Mussel farming was restricted on several harvesting days, as was mussel collection, where there was poor water quality in the catchment from contamination of local streams by dairy farm discharges.

The Sustainable Farming Fund has enabled communities to better respond to the issues and practices associated with dairy farming by incorporating best practice methods. This includes adopting new technologies. I understand that good progress has been made in improving the water quality as a result, and that this is helping restore the quality of the mussels and the health of the fishery.

These projects are about creating more awareness of water quality issues and getting co-operation across a range of stakeholders.

In the Rotorua Lakes area, we have another project, which is again looking at the effect of pastoral farming on the water quality in a small lake. These projects are becoming quite common, and can involve MAF supporting a community where it sees issues with, for example, a waterbody. We work with communities to look at farming activities which could be changed or updated with new technology, to enable people to farm without compromising the values of local rivers, streams, and lakes.

A recent project in Otago which is supporting a bottom-up relationship approach involves farmers

at Lake Waihola. There's a lot of interest in that area because it's a nationally significant wetland, and it represents a unique environment. This project has local communities working with the Otago Regional Council, and looking at farming practices which influence the water quality of that lake. This is a good example of community involvement contributing to an overall environmental gain.

In the Waituna catchment in Southland, MAF is funding farmer-based approaches to the management of their effects on the freshwater environments. The focus is on dairying issues and tile and mole-drained land in that catchment. This project is addressing what farmers can practically do to mitigate the effect of any leaching or contaminant discharge, and the challenge that represents to farm management that we are here to discuss today.

The Hill Country Erosion programme is a regionally-based programme funded by MAF, focusing on sediment control and the management of the hill country. This programme has been adopted by numerous councils. A significant amount of funding is going into mitigating previous land management effects.

Primary Sector Water Partnerships

At a much higher level, MAF is working with the Primary Sector Water Partnership, which includes most primary industries, who are represented by their chief executives. You would have heard, no doubt, that the Partnership has identified a number of targets to improve water quality, associated with a variety of land management practices.

This involves practical on-the-ground work with farmers, and demonstrates to them that a certain management technique may improve the water quality, be it in a stream, or groundwater system. This hands-on approach to support initiatives is something that MAF is well known for.

You would have recently heard about the annual report of the Clean Streams Accord, updating its current status. This industry initiative was supported by MAF and regional government to set some over-arching objectives.

We heard a lot about doing some simple things on farms which can result in water quality improvement, including fencing waterways, riparian planting, and keeping stock out.

MAF has focused on assisting compliance with effluent management rules, and also relating to nutrient management. A great deal of work has gone into establishing nutrient budgets for farmers and encouraging their use. Many farmers have a budget, but we don't see enough farmers using them to advance their on-farm nutrient management.

New Start for Freshwater

As Minister Carter mentioned, New Start for Freshwater was a significant move last year to look at reforming water policy and water management for New Zealand. This is a joint project between MAF and MFE, and both Minister Carter and Minister Smith have a dual role in delivering it. The project includes working directly with iwi leaders in relation to the water policies where the Crown has a relationship with iwi.

New Start for Freshwater focused on critical areas where government needs to rethink, or at least improve, what had been learned previously. This includes environmental flows and water measuring. Many people at this conference will be aware of the new measuring regulations, which require irrigators to install a meter. This is a significant step for NZ. The Otago Regional Council required metering some years ago, but there are many other regions that are just getting off the ground with requirements in water measuring. This regulation will help them move forward with their own policies.

MAF has focused on assisting compliance with effluent management rules, and also relating to nutrient management.

A MAF work programme on allocating water and maximising its use was focussed on looking at how water is allocated at a regional or even national level, and whether it is being used in the best, or most efficient way possible. As far as over-allocation goes, there is a significant lack of knowledge in some areas about how much water is used and where. Government sees that as an important facet of its reporting nationally on water use and new

infrastructure, where we need to put water in the right place.

There's a project called Supporting Measures, which relates a lot to the voluntary approaches which farmers and regional councils invest in to make people adopt new practices to improve water quality.

We also have a large project on rural water infrastructure, which many people here are probably aware of, because they're working with government on initiatives for irrigation. We're also looking at dependable monitoring and reporting, and aligning agricultural investment and science. This is a critical area of investment. I'm not convinced it's not in the right place at the moment, but I think we need to smarten some of our investment and the tools that are currently used for water management.

Water governance

Finally, and probably the most important is water governance. This is a key area where we will learn from the Land and Water Forum. Essentially we take the view that ultimately, governance resides in the hands of the people in the catchment. At a central government level, we can roll out some initiatives and help make informed decision-making a little bit easier for communities.

A lot of work is being done looking at the values which rural communities place on water. This includes how they can respond to a need to improve their land management activity, and improve or maintain the water quality in their streams and rivers.

MAF work and policy development operates from a national level, then drops to a regional level, and finally a catchment level. We are trying to articulate our view right across the landscape at different levels.

The government is looking at how it can assist the decision-makers, be they regional government, a water user group, or a farmer, into making the right decisions about their use of water and how it affects the environment.

We are also looking at how to track the performance of regional plans. Where there is an aspirational goal to improve water quality in a catchment, the regional council or a decision maker rarely tracks the performance of that policy. There's no point in getting a whole suite of farmers measuring their water quality if they can't see the desired results at the end of all that hard work. It's a leap of faith to think that they alone would be able to change water quality, just by doing something on the ground. There must be a process to assess whether the whole planning regime, including governance processes, has performed.

ANZECC water quality guidelines

We are working with the Australian Government on a review of the Australian and New Zealand Environment and Conservation Council (ANZECC) water quality guidelines.

ANZECC was tasked to "*provide an authoritative guide for setting water quality objectives required to sustain current, or likely, future environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand*"

Rightly or wrongly, they're utilised in a lot or reporting as the benchmark for the measurement of poor water quality, or they're used inappropriately because they're used to compare results between regions. Unfortunately, they can be used as a tool to say: 'this water is bad relative to water from somewhere else,' without accounting for the different regional contexts which influence the water quality.

The government is aware that when guidelines are drawn up in regional plans, those ANZECC guidelines can be used incorrectly. It is important to note that they are trigger values, so if you're measuring water quality, and it's showing a value similar to what we have in those guidelines, you're somewhat past being concerned about it, because it really is a trigger value to say you've got an issue associated with an environmental effect.

Unfortunately, they can be used as a tool to say: 'this water is bad relative to water from somewhere else,' without accounting for the different regional contexts which influence the water quality.

Those values also tend to be about harming things. They are related to human health and to whether you kill fish or other species. If measured values are triggering that sort of effect in a waterway, we should be looking seriously at how the land is being managed.

There is a lot of concern about water quality guidelines for stock water - what quality level stock water should have from a health perspective. This is critical to our pastoral economy. The review is also looking at the relationship between water quality and catchment soil types, and whether the values we have at a national level should even apply to specific catchments. Hopefully, we can provide guidance for national values that relate to human health effects, and then regional councils can build on this with their own community-based values, based on what it expects its water quality should be like.

Water quality...is critical to our pastoral economy.

Voluntary approaches

An area where we've done a lot of work is looking at voluntary measures. Most farmers measuring the effect of what they do on their property want to do it voluntarily, and be encouraged, without being made to do it. A lot of the work in councils and through government, is aimed at getting people to adopt new best management practice, because they see their neighbour employing better technology, such as for effluent management.

Most farmers, if they see a tool that will work well and not cost them time and effort, will take it on board. If you can demonstrate an environmental benefit from that approach, then even better. Most farmers respond to not being heavily regulated.

There are some things that they may need to be made to do. Some people can't adopt a technology because they don't understand it, or they cannot see how the benefits outweigh the costs. There are times when regulation is needed to help shift people along.

We've got a massive focus on integrated catchment management. Most regional councils treat catchments in an integrated manner as part of their planning process. A lot of work is being done on how communities, regional councils, and government can work together to move the catchment and community faster to a sustainable end point with water quality issues. Many Sustainable Farming Fund initiatives are supporting the idea that communities can become more engaged in controlling some of their own activity on their landscape.

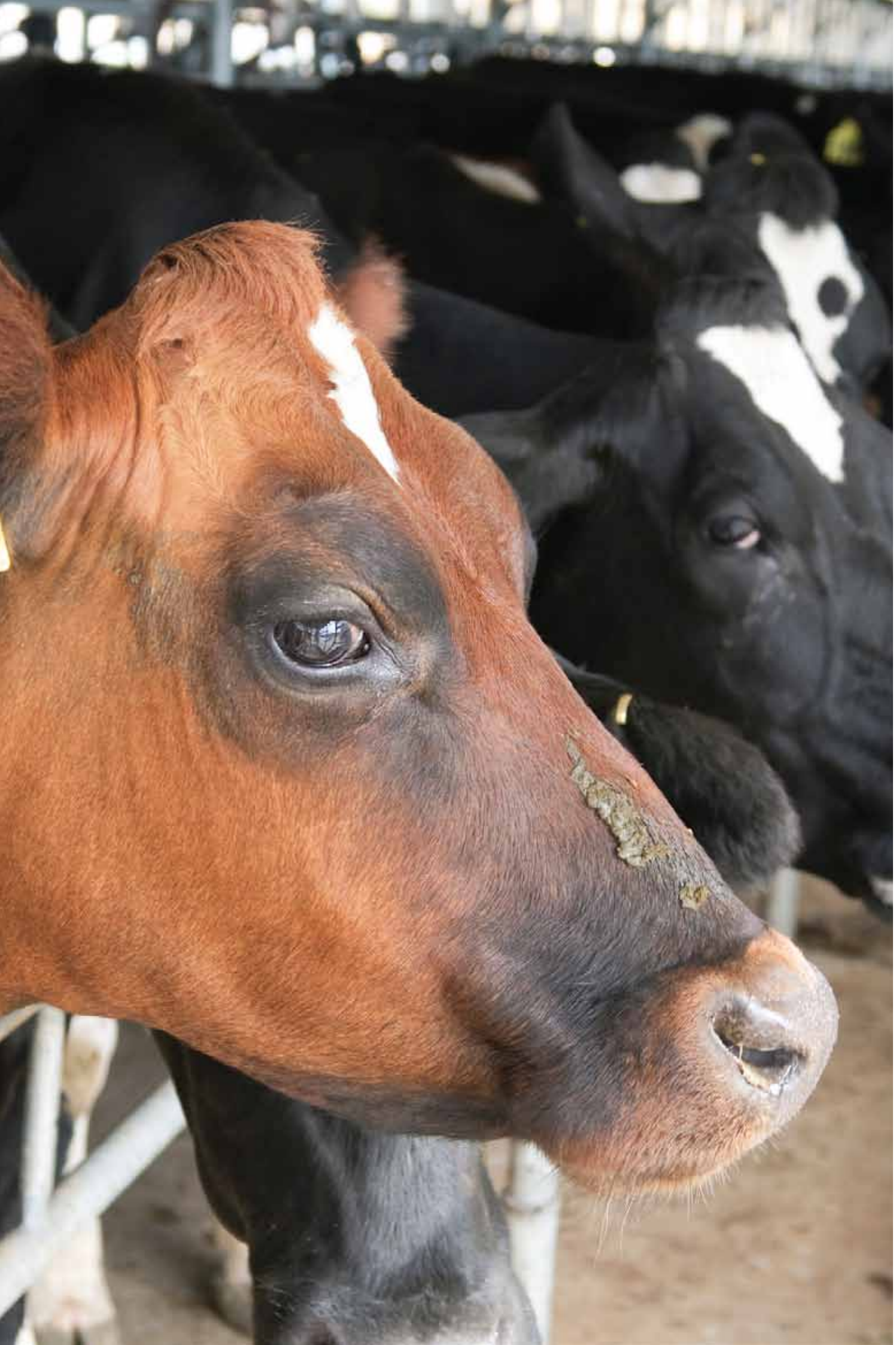
We have a lot of work that builds around Overseer, which is comprehensive nutrient modelling software. Overseer is becoming widely used by farmers and fertiliser reps. The programme is able to model the surplus nutrients left in the ground and the risk of leaching to the environment.

We've got a massive focus on integrated catchment management.

Getting the nutrient application levels right can have positive results, not only for farm budgets, but for reducing nutrient water contamination. We're reviewing the utilisation of Overseer to see if it can be improved to make it more than a modelling tool.

So, this covers much of what MAF is doing on the water quality front. There are other initiatives coming through operational research aimed at improving tools for catchment management. A lot of it is still dependent on farmers adopting it and using it. However, one of MAF's strengths is that it has a good grounding in the pastoral economy. It tends to listen to farmers when making policy decisions.

Chris Arbuckle *was standing in for MAF director-general Murray Sherwin at the 2010 Water Quality Forum.*



Mike Hide
Sustainable dairying specialist
Fonterra

Dairy industry perspectives

I'm going to talk about Fonterra's interest in sustainability and in matters environmental.

We can't talk about water quality and the dairy industry without addressing the issues of effluent management in Otago and around New Zealand. I'll also talk about our preferred approach to managing nutrient loss from agricultural land use. Finally, I'm going to look at keys to success that we think are required for effective policy formulation in that area.

The dairy industry is getting signals from two main areas concerning environmental matters. The first one is from our community and our regulators. All the surveys and communications we do generally show that the community accepts dairying as an acceptable land use; they love what it brings in terms of benefits to the economy; and the jobs it creates. However, this always comes with the proviso that it should not be at the expense of the environment. As the community develops environmental concerns, and these are predominantly around water quality, the regulators pick up and reflect that to us as well.

The other messages come through the supply chain, from our customers and consumers around the world. They're increasingly looking for more information about the environmental footprint of the products that we produce.

Sustainable dairy farms, sustainable environments

Water quality is obviously still a major issue, but there are big questions around climate change, food miles, and how much water is being used to produce the products that we're manufacturing. We obviously have to address all these concerns because otherwise they pose a serious risk to the business.

We need to be mindful in our work that the media always play on where the industry is getting it wrong. This is not what we want to see. It has the potential to turn off the farmers that are proactive and doing good things on their farm. There are a lot of dairy farmers out there incorporating best environmental farm practices into their daily management.

The key part of our strategy is to be at the forefront of profitable and sustainable dairy farming. The important word in that statement is the 'and.' There is no point in being profitable if it's at the expense of our environment and the future opportunities for both New Zealand Incorporated and the business.

Clean Streams Accord

There's also no point in us being sustainable if we're going broke, because in that case we're not going to be operating for long. The Clean Streams Accord was Fonterra's first initiative aimed at building a framework around environmental management and how we deal with these issues.

It was a voluntary agreement between Fonterra, the Ministry for the Environment, MAF, and regional councils. We've made some significant progress. We are much better at excluding stock from waterways. From 2005, all of our new suppliers had to comply with the accord, resulting in compliance rising over the last few years.

The key part of our strategy is to be at the forefront of profitable and sustainable dairy farming.

We have worked with the fertiliser industry to improve the level of nutrient budgets on farms.

Nearly every farm in New Zealand now has a nutrient budget. Over the next few years, we'll be working with the fertiliser industry to increase that to full nutrient management plans.

There is one trend that isn't going the right way. Dairy effluent management continues to be the area where we need to focus more of our efforts. Fonterra has a group of sustainability work streams which we are working on. These include effluent management; nutrient management; water efficiency; solid waste; animal welfare; climate change; biodiversity; biosecurity, and soil quality. The company wants to give our farmers the tools they need to face the challenges that we see coming up in the next few years.

Effluent management

Effluent management is at the top of our list, because it is such a critical issue in the media and it has big implications for water quality. We do have a wide variance in compliance figures for effluent management across the country. We're working with several different regional councils to try and get more consistency around effluent management rules, so that they're focusing on addressing the actual impact, instead of on superfluous regulations that are not really achieving what we want.

Dairy NZ, in conjunction with several other organisations, has been working on a code of practice and design standards for effluent management systems that will be released this year. It's aimed at getting effluent equipment supplies certified so that when a dairy farmer purchases or invests capital in an effluent system, they've got some certainty that the system they put in is capable of complying with the consent or permitted activity requirements of their region. I say "capable of complying" because there's also got to be the operational management to back it up.

> Dairy effluent management continues to be...where we need to focus much of our efforts.

We will be doing an appraisal of effluent on every farm from the start of next year. It's been trialled in the Waikato for the last few months of this season. This involves adding a check to our existing milk quality system. Every dairy farm has an annual check of the milking plant to make sure it complies with food safety requirements. The appraisers will now be looking at the effluent system at the same time. Any issues that need addressing will be referred to my team. We're going to be out on farms working

with our farmers on a plan to address the issues with their effluent systems to ensure they become fully compliant. This will be a collaborative process involving the farmer and to work out the "best fit" for them.

If there is a critical failure which needs to be fixed, farm managers will have 24 hours to rectify the problem. If we don't have co-operation rectifying those serious issues, then it will probably be a case of stopping milk collection. It's a rare situation where a farmer says they don't want to deal with an issue like that. These guys are there to identify risks and obvious system failures so they can fix it.

The recently-announced effluent improvement system is at the other end of the spectrum. This process imposes a financial deduction on our suppliers when they get effluent management wrong. This applies where they are prosecuted by a regional council or they receive an infringement notice. The deductions are $1,500 for an infringement notice and $3,000 for a prosecution. They can also use that money on their effluent system or staff training to avoid the issue happening again. They have to go through the process of developing an effluent improvement plan to rectify the issue that led to them being non-compliant in the first place.

The 2009-2010 season has been purely advisory so there haven't been financial penalties imposed. We've told our farmers they are under the gun this year, and if they infringe again next year, money will be withdrawn from their milk cheque. My team and our area managers have been offering farmers support to make sure that they are prepared for this change.

Environmental Management System

In terms of Otago projects, we have worked with the Otago Regional Council on the Environmental Management System. One of the highest risk areas for effluent management in Otago is the risk of effluent getting into tile and mole drainage systems. This system was developed to work with suppliers to minimise those risks.

The four categories of activity are:

1. Mapping the areas of risk on your farm
2. Categorising areas on your farm as being high, medium, or low risk for effluent disposal
3. Maintaining a staff training schedule
4. Maintaining equipment maintenance schedule (this is audited annually by the shed inspector)..

We are working with individual farmers to improve their effluent system. We provide advice and guidance and, if needed, to help things to happen if there is a serious on-farm issue. We also implement the effluent improvement system and deal with those other issues that I've mentioned.

Collaborative systemic approaches to managing water quality

Our preferred approach to managing non-point source discharges from dairy farms has been developed from our experience with the Horizons Regional Council and their One Plan.The first stage sets out community expectation, making it clear what level of water quality you want, and doing that in the context of understanding the costs of achieving those changes. The second stage is about understanding the existing state of water quality in the region. This includes understanding the cause and effects, the things that are impacting on water quality, and acknowledging the pre-existing residual effects.

Changes can be made to land management practice to improve water quality outcomes but the improvements will not arrive instantly. We must accept that as farmers make the changes, they might not have the results that they're looking for for quite some time.

When developing a water quality standard, understanding the existing state of management within the industry is really important. This includes understanding what mitigation technologies are already in use, what are the areas that we can change quickly, and what kind of impact those things will have on contaminants such as nitrogen, phosphorus, *E.coli* and sediment.

Then it's about assessing the options for increasing the management of those contaminants within the farming sector, coupled with a rigorous cost-benefit analysis of the different systems, to arrive at the most efficient ways of getting the changes that you need on-farm and in the catchment.

Setting the drivers correctly is an important part of the process. This is crucial to encouraging your supply-base of farmers to invest in those changes, or make the changes that are required to achieve the improvement in water quality. In Otago, we've got a reasonable idea about what the drivers are. We just need to make sure the support's there to ensure that as an industry and a council working together, we can support farmers through making those changes long before things get to the point where they have to go to court.

When developing a water quality standard, understanding the existing state of management within the industry is really important

Setting targets and timeframes is also important. This includes working out the timeframes we need to achieve the desired level and scale of environmental improvement, whether that's to a farm or a catchment. This gives farmers some security as they move through the process. Another question is: How fast can these changes realistically be made?

We must address behaviour change and capacity-building by developing the technological tools and the practices on the farm, with farmers, and putting them in place. That's going to involve a collaborative

effort between the council and the industry to help farmers to adopt these changes.

The final stage is around progress measurements. This includes monitoring, auditing, and making sure that the things that we expect to happen relative to the changes we're making, are actually being reflected in the field in the real world.

You must have really strong governance, good scientific information, and project management. That mostly comes down to the regional council and their collaboration with other members of the community.

Keys to successful management of water

So what are the keys to success? Getting the right people involved is obviously critical. If you don't have the right people involved early on, there's a risk that superfluous arguments ensue later that derail the process. Community decisions on appropriate targets need to be well supported by science and cost-benefit analyses.

Most people in a community will answer yes to the question, 'Do you want good water quality?' But we need to have a clear understanding of what the implications are of moving towards better water quality across the whole community.

Change timeframes need to be realistic and achievable. We can't expect our farmers to change their entire farming system overnight when they've invested significant capital and time on management practices.

We need to minimise bureaucracy and focus on dialogue. Farmers respond well to having people come and talk to them, giving them information, showing them what they need to do, and giving them the tools and ability they need to make the on-farm changes that will get the water quality results that we're after.

Mike Hide *is Fonterra's sustainable dairying specialist. He works closely with dairy farmers thorughout the South Island providing advice and assistance on effluent disposal, and delivering programmes which reduce the environmental effects of dairying.*

Keith Cooper
Chief Executive
Silver Fern Farms

The importance of the environment to agricultural markets

How we portray New Zealand is incredibly important to our marketing. This includes the backdrop of how we produce the product, and how we present it to our global customers.

Silver Fern Farms and other producers and exporters of New Zealand products and services regularly utilise images and messages related to New Zealand's clean natural water in our marketing. One way or another, water underpins many different aspects of our business and is crucial for future success in our export markets.

We put a lot of effort into water management. But we all need to be thinking about how we protect and utilise this resource in a manner that creates some great productivity or productive capacity gains for the New Zealand economy. In other words, are we doing the right things and capturing value from our water at the same time as protecting the environment?

Silver Fern Farms' strategy is to introduce technology to achieve best practices and optimal returns from the farming sector. We are working to implement enabling systems that help our farmers produce a product in line with our customers' requirements. This approach is transferable and can be applied to many areas of farming and water quality management. We use a lot of benchmarking, data-basing, and measuring, so we can manage and drive the consumer's requirement into the production base.

One way or another, water underpins many different aspects of our business and is crucial for success in our export markets.

The present government's attitude to the primary sector is different from the previous government's in that they acknowledge that the sector is the basis of our economy. They are attempting to resource it and help it a lot more than perhaps previous governments have.

Sixty-six percent of our exports are food-related and 25% of that comes from the meat sector. So, it's still incredibly important, albeit we have some enormous challenges ahead of us.

Fifty-two percent of the land area of New Zealand is utilised by the primary sector, which underlines that the economic sustainability of the sector is important to New Zealanders, and the lifestyle that makes New Zealand an attractive place to live and for tourists to visit.

We have this forecast of a massive global food shortage. The opportunity for us is not so much from a population explosion, but more of an explosion of wealthier people who want to buy better food.

That's putting pressure on various economies to produce more, as well as to develop technology so that more can be produced, whether that's through genetically-modified products, or different animal modelling. There's a lot of research and development going on to feed these people and meet their demand.

We can't afford to sit still in New Zealand and think we can carry on doing what we're doing and take for granted that we're going to capture some value for it. We need to be adaptive, adopt new technologies, utilise our resources efficiently, and manage our effects on the environment. There are plenty of countries around the world that have got land that hasn't been utilised it yet, and they're going to become big food producers.

Primary sector custodians of precious resource

The primary sector is a major water user, but in some areas our water usage is poor. We depend on water as our natural resource. We are known for it. It's a major part of our proposition supporting tourism and our export products. We're 12th out of 193 countries for the size of our renewable freshwater resource, but we only use five percent of it.

That said, we've also got to make sure that we're good custodians of that water. The challenge in this whole water management debate is to decide how we can best utilise it without damaging the environment on the way through.

The branding we use offshore forms part of our whole image of how we market the product. About half of the images Silver Fern Farms use in our campaigns involve water. It keeps cropping up as an important element helping take our products offshore.

The fact that we are environmentally friendly helps us achieve better premiums in the global market. This branding is incredibly important. It's not just about New Zealand anymore, it's about brand values and how you perform as a business in the eyes of the customer. The challenge for us here is to find ways to utilise the water and ensure we have best practices to manage the side effects of utilising water. This is an important part of our quest to take primary products to the world.

The challenge in this whole water management debate is to decide how we can best utilise it without damaging the environment on the way through.

We are clearly branding our product with environmental images reflecting consumer expectations. The value proposition for our branding is about the promise of the purity, the taste, the quality, and the natural environment. The *100 Percent Pure* tourism campaign also features water heavily. Any good marketing campaign needs a story - not a cock-and-bull story, but a real story in which the consumers can engage with the product and understand what the brand stands for, and its value. Consistency and product continuity to the supplier are key, as is integrity.

It's incredibly important that we don't do things on a whim, or expediently, in the short-term, and think that we can retrieve the brand or the integrity of the brand down the track if we make a mistake.

In my view, you only need to make one mistake, which can be difficult to come back from. Then you become like any other industrialised nation and lose the premium you had in the market.

So, what do consumers want from us? Apart from knowing that we're doing the right things and producing a good product at a competitive price, the list continues to grow. Rather than governments

or food service authorities, the biggest regulator of all is going to be the consumer. If they don't like what your product stands for, how it's grown, where it's grown from, all those things, they're they're not going to buy it. That's a big challenge.

So we've got to ensure we've got a great story, and that we are true to it. Whether it's environmental quality, food safety, security, animal welfare, traceability - all those things, they are all incredibly important. Our future depends on the market understanding, accepting, and trusting that we are good custodians and have a good channel to market.

The bottom line is we can't afford to get it wrong. We have got an outstanding position; my point is that we can't afford to lose it. We do need to regulate it, but at the same time we need to make sure we make good use of the resource. Striking that balance is part of the process you're embarking on here. That includes using the water in a responsible and productive manner and managing the resource to protect the values that support us in the global marketplace.

If we do it wrong, it's gone for good and we end up relying on being a low-cost producer. I don't think you can retrieve a brand, particularly when it's so tied to the environment, and when you're coming from such a prestigious position that New Zealand currently holds in the global marketplace.

The "take-away" from here is that what we do environmentally is incredibly important to the world in terms of our product, so we can't get it wrong. It's challenging enough for us, as little old New Zealand, 12,000 miles away from our main markets, to be competitive, let alone if we shoot an own goal.

Keith Cooper *has been chief executive of Dunedin-based Silver Fern Farms since February 2007. He entered the meat industry in 1980 with Producer Meats Ltd, and has held numerous management positions since.*

National perspectives on water quality management

Guy Beatson
Deputy Secretary Policy
Ministry for the Environment

I was recently at a meeting of the Land and Water Forum, where one of the presenters distributed an article entitled *'A time to stock-take on water'.*

In the midst of it was a paragraph that ran like this: '*..our indifference over water use, waste and pollution has brought us to the point where many parts of New Zealand are already plagued by either too much, or too little water, while pollution of some streams with industrial or urban waste restricts the use of these sources of supply.*'

This was the editorial from *The New Zealand Farmer* from 23 July 1959. It is illustrative of the complex nature of the issues you now face. Those issues have worsened in some parts of the country where land-use intensification has occurred.

Water quality is a critical issue for consumers, the people who actually pay the bill. Large quantities of water are required to produce everyday food items, so costs translate directly to how much consumers pay for their food. It's critical from the farming community's perspective and other producers as well. Water quality impacts on the quality of life for all of us.

At the Land and Water Forum, I heard a farmer talk of having to treat his water, not just for himself and his household and the 250 households in that catchment, but also for the stock. They had found E.coli in their water supply that meant that it wasn't suitable for humans or for stock to drink. So it's quite important to think about the indispensible role water has in our production systems.

Water quality is a critical issue for consumers

It takes 1,000 litres of water to get one litre of milk. It requires 200 litres of water to get a glass of milk, and 2,400 litres to get a hamburger. It takes 1,000 litres of water to get one litre of milk. It takes 16,000 litres of water to get 1kg of beef.

This illustrates how important water is to our food producers, and emphasises that the water we use must not be laden with contaminants.

One thing that is emerging, in terms of international markets, is that ultimately consumers, whether they are supermarkets or their customers, are starting to ask about the quality of water and how much water goes into products they consume.

The Ministry for the Environment has recently released two new reports..The following data comes from those reports. The maps below indicate nitrogen, phosphorus, and sediment levels in various water bodies around New Zealand. These point to a problem with nitrogen and phosphorus and deteriorating water quality.

In terms of water quality things are improving. I have to stress that we are starting from the perspective of a place that's not too bad internationally. The key message to take from this is that a good part of our competitive strength and advantage comes from our abundant good quality water. It is important for the long-term profitability of New Zealand farms.

There is another risk emerging to this competitive advantage, with the enormous increase in the use of nitrogenous fertilisers in New Zealand. There is potential here for much of that nitrogen to end up contaminating our waterways. From an economic point of view the data available indicates that there is some inefficiency in the system, which means there's more nitrogen being put on the land than is necessary.

Another interesting benchmark is data showing the total nitrogen in rivers in pastoral areas is five times worse than in native forests. Importantly, it's also ten times worse in urban areas. There's a challenge in there for both urban and rural dwellers that may require the same kind of instruments to fix it.

In the rural areas, the surplus nitrogen may refer back to how people are managing their business, and that further work is needed to help farmers think about how they apportion their budget to obtain the best value from their farm. In terms of nitrogen, any reduction in use should benefit the environment.

I don't want anyone to take it that MfE is advocating an overnight change to the quality of waterways showing signs of deterioration. There are many transitional issues and water policy and management issues that make that impossible. But this does provide a good benchmark.

Government freshwater initiatives

There are three things going on right now at central government level under the umbrella of a programme called *The New Start for Fresh Water*.

The Land and Water Forum is a group that currently has about 56 different organisations and individuals meeting. It's been in operation for about twelve months. It's been tasked by Ministers with focusing on three things: water allocation, particularly where there's water scarcity; water quality; and the way in which water management decisions are made.

We use this kind of long word 'governance' which centres on where the decisions are made, what kind they are, and who makes them. The governance structure has wide representation from the primary sector, environmental NGOs, and recreational water users. This is important because in the end these issues are about values.

An initial starting point for the Land and Water Forum to consider around water quality issues is that science can help us solve these problems. But the scientists advised that unless the community is clear about what values it wants for its water, and the weight it wants to give water quality, or water allocation or economic development, or tourism and contact recreation, they can't advise how best to achieve those results.

The reason I was alluding to consumers earlier, is that they are important too in determining values. It's not only the community values in New Zealand that matter; it's also the 'pseudo-regulators' if we call them that. These are the point-of-sale retailers and supermarkets, whether they're in Asia, the US, or Europe. These groups will also have an increasing effect on those values.

Court-driven processes under scrutiny

The values for water is one of the big things the Land and Water Forum is working on. They are also focusing on that when it comes to some of the processes for distributing and managing the use of water. This includes the court-driven processes, where we try and reconcile what are essentially

policy issues in the Environment Court, and head-to-head negotiations between various interests through consent hearings and plan hearings. The forum is looking at these processes and asking whether these are good means to reconcile issues between stakeholders. No conclusions have been reached yet, but there's good progress being made.

When the Land and Water Forum reports, ministers will have to decide what happens next. There is work being done in the Ministry for the Environment towards the next stage. There are no constraints from the government directing our focus, whereas often in these exercises there are. For example, you may not be able to think about say, a market mechanism for water allocation. Or, there's no way to investigate how a community may accept some limits on the use of nitrogen. So a lot of things are on the table for discussion.

This approach is important because we understand that there is no single right answer to issues arising from water use and quality.

None of these things are happening in a vacuum. Several speakers at this conference have discussed research that is going on to develop tools and processes to support better management of water quality. So there is quite a broad base from which this work is building.

This includes the Primary Sector Water Partnership, which is starting to set some pretty ambitious goals. If you look at some of the MAF reporting on the Clean Streams Accord, it's clear there's a way to go, but it's important to acknowledge there is work being done on that. There's also many other support measures that are being taken by a whole range of bodies. It's interesting to sit on the Land and Water Forum and listen to people from Horticulture New Zealand, and the sorts of things they're doing.

There is no single right answer to issues arising from water use and quality.

The reason for acknowledging that is that if you listen to some of the rhetoric from people in towns in particular, they refer to things like the dirty dairying campaign run by environmental NGOs. Yes, there's a grain of truth in that, but with these issues some of the good work that is being done, and the attempts that are being made to improve water quality, go unacknowledged. We have to realise that there's a range of people in the rural communities who are actually trying really hard. They can see the problems, and they're doing their best to deal with it.

So, where are we with rural water quality? It's clear the stakes are high. There's an opportunity, but there's also a threat. The opportunity here is to continue to build on New Zealand's reputation, build on that brand, but in the absence of deliberate action and doing more, we run the risk of actually losing that brand which is a part of our competitive edge.

That's why I think it's good to see the Otago Regional Council starting to work directly with a whole range of stakeholders, including farmers, to explore the options for managing things like non-point source discharges. That notion of looking at what's happening with runoff and leaching from various farming operations is very important.

As I was preparing this talk, I thought about what Nirvana might look like in terms of water management? The first thing that struck me, in terms of farmers, was the notion of having high levels of certainty about access to water. This means getting high levels of clarity about what water's going to be available, when it's going to be available and where it's going to be available.

That struck me as being similar to any other property right. Then I thought about the flip side of Nirvana. You'd tie the use of the water to the outputs. So if you've got water of a particular quality going into a particular farming operation, you could measure what quality was coming out the other end.

If I was applying this in an urban area, you could have a water meter, given a household is a point source, measuring the quality of the water coming out. Nirvana might well be achieving that sort of situation with a farming operation. That would allow farmers or horticulturists or whoever to manage their own operations within those parameters.

This also gets the regulators off the farmers' backs at some level. Unfortunately, this depends upon having some pretty advanced technology. It's clear from the work that the Otago Regional Council's doing, that there might be some prospect of being able to do that. The technology is moving on well enough. As long as you're prepared to accept a bit of variability in that, and it's not going to be absolutely accurate, it holds real potential.

If some progress can be made on that, it would have significant benefits for farming operations, because you could measure the amount of fertiliser being put on, and then measure the amount of loss using some of the available models. This has a positive environmental effect, and beneficial effects for the farming operation's productivity and profitability.

Improvements around New Zealand

There are several other initiatives around the country through which water quality issues are being addressed. These are horses for courses, because catchments differ, the hydrology differs, and the geology differs from place to place. One initiative around Taupo involves nutrient trading arrangements. One of the things that often happens is that somebody tries something new like the Taupo nutrient trading. Then, someone thinks:

"If it works there, why not try it in the rest of the country," and trials begin in different locations.

Some good things are happening around the Rotorua lakes. A local initiative involving six long-time farming families was looked upon as a great model which featured collaboration and discussion about values. All the things you'd want materialised, including people responding positively. The people around the lake asked who was responsible for the deterioration of water quality and found much of this lay with six households. They negotiated a range of solutions with them. That's a unique situation.

In terms of looking at solutions that worked well in that circumstance, some attention to what made it happen can help us see how it could be replicated in other parts of the country.

The cautionary note is that where you've got several hundred or more land owners, you'll have quite a lot of movement. You've got changes in land use and other things that make it much more complicated, so many local problems will need customised local solutions.

Where to from here then? The Land and Water Forum will report later in the year. What's likely to happen partly depends on what it recommends. There's potential there for wider public consultation. The kind of ideas that are being debated, and the sort of input from many of the constituent organisations, will then be fed back into the community. When you look at some of those deteriorations in water quality, none of this gets fixed overnight.

It's one of those things where two things matter quite a lot. One is being really clear about, as a community, where we want those water quality measures to be over time. The second is the timeframe over which we think that should happen. We need to be mindful that some of the solutions may impose significant costs. Where and how these fall will need consultation with communities throughout the country

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Guy Beatson *has been deputy secretary (policy) of the Ministry for the Environment since July 2009. His role includes oversight of.policy advice on resource management issues, links between environmental ane economic policy, climate change policy, and hazardous substances.*

Ross Monaghan
Senior Scientist
AgResearch

Contemporary mitigation measures for agricultural runoff

I'd like to discuss the mitigation science completed over the last 10-15 years, and look at some of the options available to us.

I also want to focus on the next generation of mitigation measures that can make additional improvements to farm and environmental performance. If we're going to tackle the nitrogen problem, we've got to tackle urine patches.

Urine patches and nitrification inhibitors

One option is the use of a nitrification inhibitor that inhibits this process of converting ammonium through the process of nitrification to nitrate. Nitrate is in soil and is lost in drainage.

It can disappear as a greenhouse gas as well. The fertiliser industry has developed inhibitors which block that process and keep the nitrogen in the soil in the immobile ammonium form.

Some nitrification inhibitors are applied as a spray, or in granular formulations which are dispersed by a fertiliser spreader. Several field studies are underway to figure out how effective these products are.

A trial in Southland over the last seven years applied the inhibitor and found a 50% reduction in nitrate leaching had been achieved. It's an option available for nitrate-sensitive catchments.

It works well in Southland, because it's not too warm and it's not too wet, so the product stays around long enough to be effective.

As it gets warmer and wetter, the substance breaks down faster and becomes less effective. However, these inhibitors can be an effective option, because conserving nitrogen in the soil produces some extra pasture production. We think you might get annual yield increases of somewhere between 1-10% and that helps cover the cost of applying the inhibitor.

Herd shelters

A second strategy for managing the nitrogen problem is to use herd shelters. These shelters can collect the animal excreta, particularly urine patches deposited at times of the year when the risk of runoff is highest

Used strategically in Otago during the late autumn and winter, the shelters capture the excreta. It can be conserved and re-applied to the land in the spring when the conditions are safer.

We followed this strategy at a Tussock Creek field site from 2001-2003, where we got about a 40% reduction in nitrate-leaching losses.

The strategic use of a herd shelter is another option to help reduce nitrate leaching. The other area where these herd shelters might be helpful is in improving the efficiency of wintering systems.

These are leaky parts of the nitrogen cycle, with losses from grazed forage crops being about 4-5 times greater per hectare than those measured from the pastures on the milking platform. Winter grazing sites are also relatively leaky for phosphorus, sediment, and faecal bacteria.

Various types of herd shelters are available, including stand-off and feed pads. If they're well designed, all the drainage and runoff can be collected from the pad.

They fulfil the same function of conserving excreta during the risky time of year. Shelters that have a roof over them are preferable because they greatly reduce the volume of effluent that's generated, and make it easier to get it back out to pasture in the spring.

There are a couple of good structures on the market, including the European-style wintering barns starting to be seen around here. They are pretty good at minimising the volume of effluent that we have to deal with in the spring.

The owners of these herd shelters say they are good for soil and feed efficiency, and animal welfare, and are worth the money.

These things fit in as part of a hybrid dairy production system, utilising the advantages of our low-cost pasture-based system, while the shelter looks after the animals and the environment as well.

We have also researched whether the nitrification inhibitor technology could help reduce the nitrogen leakage from grazed winter forage crops.

During a three-year trial in Southland, we reduced it by about 20%. It's not clear if it's a good idea to apply the inhibitor onto these crops, especially on muddy pasture, but more research might reveal whether we can make that type of management strategy work better.

Effluent management

Improving management of our effluent systems is another area of mitigation which is particularly important for improving on-farm environmental performance.

E.coli is an indicator organism we often use. Leakage from poor management of the travelling irrigator can contribute about half a farm's faecal bacteria loss.

The most common method for improving performance is the deferred irrigation approach, which effectively means storage ponds.

Effluent is stored during the wet times of the year when it's unsafe to apply it to land. Storage ponds are a tried and trusted technique.

Another option is an advanced pond system, which is a four-pond treatment and discharge system. It's good for cleaning up the faecal bacteria content of effluent, but not so effective for nutrients. But if your catchment concern is faecal bacteria, then this is one tool that would do the job.

Figure 1 Advanced effluent pond system

A low-rate effluent applicator (e.g. K-line) offers the option of applying effluent using a pulsed application method – which means small quantities more often. The soil can then soak up some of the contaminants in the effluent and greatly reduce the concentration coming out in the drainage water.

Improving management of our effluent systems is another area of mitigation...for improving on-farm environmental performance.

Another recent development is a new type of dairy yard that does not generate such large volumes of effluent. It is effectively a herd home with a slatted floor and bunker placed in front of the milking parlour. The yard doesn't need hosing down, and it doesn't generate large volumes of liquid that are difficult to handle on wet soil. So it produces a much smaller volume to handle and needs a smaller pond, which results in less effluent to pump.

Best Management Practice Toolbox

There are tools being developed to help find the most efficient and cost-effective way to mitigate the effects from non-point source water contaminants. The 'Best Management Practice Toolbox,' or BMP Toolbox, is designed to help select the right tool for the job. The programme bundles up all the currently available and proven mitigation techniques, plus some metrics around the use of natural wetlands and constructed wetlands. It estimates the cost-effectiveness of each of these mitigation practices.

We ran some dairy farms through the toolbox to give us an idea of what would be available to us. This revealed seven options which could reduce nitrogen losses from those farms, all of which varied in cost per cow, ranging from not much to quite a lot.

The least cost-effective thing to do on those farms is to actually go back to dry stock farming, which incurs a large opportunity cost. Going out of dairy farming wouldn't be a smart way to manage the nitrogen losses. A more sensible way would be to think about the management systems and where your cost per kg of energy conserved is lowest. In future, I think we will be much smarter in what we do. We'll be using a cost-effectiveness metric to guide the way we spend our mitigation dollar.

OVERSEER nutrient budgeting programme

This is another tool that helps improve farm management. It's designed to identify situations of surplus fertility or where there is a deficit. Too much fertility is an unnecessary environmental risk; too little and you're limiting production. The Overseer model calculates all the inputs based upon farm management inputs. It then estimates leaching outputs. The agricultural industry takes it quite seriously and most people now have good budgets in place.

	N	P	K
INPUT			
Fertiliser	68	68	83
Atmospheric (clover)	61	0	0
Supplements brought in	24	3	14
Effluent	129	15	132
OUTPUT			
Product (milk etc)	83	15	18
Transfer	28	3	28
Atmospheric loss	66	0	0
Leaching	25	1	24
Immobilisation/ absorption	78	24	0
CHANGE OR BALANCE	0	+47	+187

Figure 2 Example of effluent block nutrient budget

The budget above highlighted an inefficiency that was easy to correct. The effluent area was too small and it was forgotten that nutrients were in effluent as well. Therefore, not only are you applying mineral fertiliser, you're also getting the effluent nutrient on top of that, so a large surplus is building up, which is a waste of money.

Putting the effluent 'P' onto the fertiliser that's been applied gives a similar result. It builds up the phosphorus in the soil, which is an unnecessary environmental risk, and a waste of money. Fortunately, with these tools in use, you don't find these surplus conditions occurring much anymore.

We have defined economically optimal input levels. Using the Overseer nutrient budgeting tool, we went through inputs with farmers and pointed out that fertilisation rates to begin with were much higher than they needed to be. Using Overseer, we managed to get them back to what was optimal.

Successful mitigation programmes in the dairy industry

A national dairy catchments study was set up in 2001, with the aim of discussing some key environmental issues, especially in relation to productivity.

The agencies involved are AgResearch, NIWA, regional councils, and industry groups. There are five study catchments around the country, located in the key dairying regions. We have tried to develop and improve practices where we thought it was necessary, and then encouraged their adoption.

I've been working in the Bog Burn catchment in Central Southland. This successful project followed a multi-disciplinary study process, with much attention being paid to benchmarking, and figuring out how good, bad, or ugly things are.

The science in this has given us a good understanding of where key land-water transfers are occurring. We also figured out why these catchments were so important to us, and after we had all that information, we began working out the farm plans. Working out what it is about these catchments that is of most concern gave the project a clear framework and made it such a success. All the stakeholders met and clearly articulated what the various groups thought were the catchments' key values. The councils presented community expectations, thus providing a broader perspective. Those who lived and worked in the catchments provided theirs as well.

In the case of the Bog Burn, we came up with three key values, or goals, to work towards: looking after the trout spawning and fishery values of the Bog Burn stream itself; looking after contact recreation values in the Oreti River, into which the Bog Burn drained (initiatives were therefore aimed at reducing faecal runoff from Bog Burn farms); and farm profitability, which was seen as an important value within that catchment.

All the stakeholders met and clearly articulated what the various groups thought were the catchments' key values.

We set about trying to devise farm plans that addressed all three of those values. Riparian works, fencing, planting, and erosion control were aimed at supporting the fishery. For the contact recreation value, we promoted improved management of effluent as this was the key contributor of faecal bacteria to the stream.

In the case of the Waikakahi catchment in South Canterbury, with ECan's support, many culverts were installed to eliminate stock crossings. Resources also went into fencing and planting the riparian margins. All this activity has led to a substantial improvement in sediment loads, which have fallen from around 470 tonne/pa to about 120 tonne/pa.

We have also been pushing messages about better management of flood irrigation systems. This includes improved management of irrigation timings, moving to wider laser-levelled borders, and using spray irrigation where most appropriate. These measures have helped to reduce border dyke wash volumes considerably. We think that has helped contribute to the decrease in the concentration of *E.coli.*

In the Waiokura catchment in Taranaki, there is a different set of issues. Those with an interest in the

catchment decided that the thing they valued most about that catchment was the riparian zone itself. They wanted to ensure that the stream was looked after, that it was protected from stock access, that it was planted and that it looked good.

Riparian improvements have contributed to good reductions in dissolved phosphorus and sediment losses. Sediment levels moved up and down a bit, but we think the improvements are due to the good riparian management practices that have been implemented up there.

The shift away from two-pond treatment systems to land application has also helped. We're not sure which measure has been the more important of the two, but both of them together have helped to move things in the right direction. All these activities come at a cost. For example, a planted 5m buffer fence could represent as much as 5-6% of your annual profit. It's part of the trade-off we all need to make to build sustainable farm environments.

Planned problem solving

One of the key lessons we've learnt from the dairy catchments study is to be quite clear about the issue or the problem we're trying to address. It was only after we had designed some effective farm plans that we tackled the problem and spent our money wisely.

At a broader level, logistics and economics are the major drivers for farm decision-making rather than the environment. My experience with small groups of stakeholders within those small catchments is that being clear about what it is we value has helped us with what we wanted to achieve.

If we're going to make progress elsewhere, we're going to have to repeat that, which will require a lot more time, and a lot more people on the ground than we've got currently.

Those mitigation improvements that I've demonstrated suggest that farm intensification doesn't have to lead to poorer water quality. If we specifically target the management practices well, we can uncouple that link between intensification and poorer water quality.

One of the key lessons we've learnt... is to be quite clear about the issue or problem we're trying to address.

In the table below I have summarised some of the mitigation options we can use for each of those sources. Initially I thought the number of options were promising. But you could look at it the other way and realise that there is still a lot to be done to address multiple contaminants.

SOURCE	Option
Urine	Nitrification inhibitors; Herd shelters
Effluent	Pond storage; low rate/ depth applications
Fertiliser	Low solubility P forms; economically optimal rates
Drainage	?
Flood irrigation wash	Bunding; re-bordering; correct timings; water re-use
Stock wintering	Herd shelters
Track/lanes/ fence-lines	Bunding; correct siting
Direct stock access	Stream fencing

There are quite a lot of things we have to get right for mitigation to work. That's a sobering message, but it's one that needs to be heard at all levels when developing plans for improving water quality in New Zealand's streams, rivers, and lakes.

Dr Ross Monaghan *is a soil scientist specialising in nitrogen cycling in grazed dairy systems. He is also heavily involved in a range of dairy industry-funded research projects developing on-farm mitigation.*

Leigh Hamilton
Director,
North Otago Irrigation Co.

Managing water environments on modern dairy units

I was grinning about my topic as I left home yesterday, because I'm supposed to consciously manage the water environments on my dairy farm.

However, as I drove down the driveway, the road was all washed out. I was driving through water, and it was a mess. It reminds us that when we're dealing with environmental issues, we need to be fairly humble.

I was thinking about the issue of nitrates in Taranaki that were portrayed as not really a big issue, because they just went to the Tasman Sea. I was reminded of an old Fred Dagg sketch about the oil tanker - it broke up and all the oil spilt. Fred was being interviewed about it and the interviewer said:

'Well what about all this oil?'
Fred said: 'Well, it doesn't matter.'
'Well, it's polluting the environment,' said the interviewer.
'Well no, it's outside the environment,' replied Fred.
'What do you mean it's outside of the environment?' asked the interviewer.
'There's nothing out there but a heap of water, a few fish, and a couple of birds.'

Part of our humility is realising that we're globally linked when it comes to environmental issues.

Having said that, I have to admit that when it comes to environmental issues, I'm not always the best manager. I realise how fallible I can be, but that's the starting point for improving things.

I want to talk a little bit about management and structure because, the better the structure is, the better I can manage things, and the simpler it is, the better it is for me to manage.

Part of our humility is realising that we're globally linked when it comes to environmental issues.

Imagine if you were asked to drive to Christchurch as economically as possible, and I delivered a '57 Chevy to you. You'd probably pump up the tyres as tightly as you could; you'd check the spark plugs; you'd take the car for a test drive to find its optimum speed. You'd then set off on your journey and you'd probably do a reasonably economical trip. If I then told you to repeat it in a Toyota Corolla, and I said: 'just drive however you like,' you'd probably still do a better job in the Corolla. The structure of the car plays such a big part in the result.

Managing water on a dairy farm

Dairying is no different to any other pastoral farming activity. But the thing about dairy farming is it's more intense. We grow more grass by using more nutrients and more water. The issues from pastoral farming with stock are highlighted and exaggerated on a dairy farm. Those issues are fairly simple and they mostly relate to water use. It's water that runs off; it's water that runs through the soil profile; and it's anywhere where our land meets a water body of any sort.

As a pastoral farmer, irrigation is my most important structure. I can control the water that goes on my paddocks. Most of the water that goes on, goes on as irrigation water, and it goes on as fairly clean water.

The better I can manage that, the better my pasture results will be, and the less impact I'll have on the water quality in streams and groundwater. This comes down to the instantaneous rate at which

the water goes on, the scheduling versatility that's available with the system, and the amount that goes on at any one time.

My preference is for using pivots, or lateral technology. We have the ability to add technology for better control to those systems as well. On the places where I can't put pivots, I've ended up with K-lines. They have good and bad points. There's some technology that can be added there, so we only have them on for a shorter period, not the full 24 hours. I'm moving at the moment towards using 'in-place' systems. This means they can be operated by solenoids, giving us control over the amount of water that goes on.

The second place where water goes on is with effluent. The soil has to be in a suitable state to take the effluent, and often in the spring the soil is too wet to do that. So, there needs to be timing flexibility, so we can put it over as wide an area as possible and at the lowest rate possible.

Having a suitable structure for effluent storage is important so I can hold the effluent until I most need it. The storage can also be utilised to treat the effluent so it is able to be put through my irrigation infrastructure, which enables me to spread it wider, and at a lower rate.

One of my farms has very efficient irrigation. There is one place where there is potential for runoff, but because the irrigation system is efficient, there is very little. The runoff is very potent because it's full of nutrients. It's something I want to utilise.

If you've ever heard of 'compost tea,' effluent is 'paddock tea'. I'm building a dam this spring to stop that getting to a waterway. I'll be able to recycle that safely back onto my pasture. When it's raining, there are areas where water can get to waterways, and that's where we must use riparian planting.

Improving water management

When we talk about managing water, we're referring to the need to change management, because we're not doing a good enough job at the moment. With intensification, we are going to have more and more problems. So we are going to have to change our management, whether we like it or not.

The problem with substantial change is it usually takes a crisis to make it happen. Farmer groups have an important role to play to make these positive changes for water quality without a crisis developing.

I'm a Fonterra supplier and a Silver Fern Farm supplier. I suspect both these companies will say they get a lot of feedback from farmers saying: 'This is not your business,' 'Stay out of that, and 'We don't like that'. As a member of those two organisations, I think we do have to take responsibility for better farm management of water contaminants. We'll need to take even more responsibility in the future.

An irrigation company is another place where that responsibility should be taken. I'm part of North Otago Irrigation Company, and we realise that we have to take the responsibility for water quality. It comes back to the carrot and stick idea. If you want to control someone's behaviour, you can beat them when they don't behave, or you can put a carrot out to try and entice them to try to behave. It's hard to get that balance right, and it's harder still to get people to change in real terms.

If you're part of a close business group with a family-type arrangement, and that's where Fonterra, Silver Fern Farms, and irrigation companies fit in, you don't have to wield a carrot and stick as much. You can take steps to discourage poor behaviour and support better behaviour through that sort of management structure.

We are all realising that now. I was watching the ads on TV about drinking. It was asking what you would do as a mate with someone who has a drinking problem. You'd get alongside them, you'd support them, and you'd point out their problem. We need to do that as as a farming community with responsibilities for the environment.

> We... have to take responsibility for better farm management of water contaminants...

There are two things we're trying to do. We're not just trying to stop the bad practices, or the bad practitioners. That's easy enough to do with a big

stick such as prosecution. They probably deserve a big stick. We've also got to shift the middle people who are good people and believe they're doing things properly but need to make some more improvements. That's a much more delicate task.

For the North Otago Irrigation Company to exercise its consent, we have to run environmental farm plans. Each plan has policies concerning water, irrigation management, effluent management, and riparian management. These are areas that we're struggling to get farmers to actively engage with. They like to just tick the boxes and be done with it. As an irrigation company, we're getting them together in small groups, and we're saying: 'Show us the worst stuff on your farm. We're not going to beat you with a stick, we just want to see the worst stuff.'

It's amazing what we find when we go and look at the worst stuff. Some people in the group think it's ok, and some people think it's not. We're having to move people and say: 'the standards should be over here, not over there. What's the best way that we have of mitigating this problem?

We can only do that from a position of closeness. That's where we're moving at the moment. One-third of our farm plans are audited each year by somebody who is independent and outside the group.

There are a few things to say to sum up. Firstly, water management is about how we go about changing our current practices. If we are going to change water management, it has to come from positions of unity and good working relationships between farmers, councils, irrigation companies, and our businesses.

I was reading the Kai Tahu presentation and their 25-year philosophy, where you should be able to revisit something and give the next generation a chance to look at it and change it. I was reading about how many cultures around the world have understood that principle.

I was reminded of the New Zealand Rugby Football Union, which apologised the other day for treatment of Maori players during the apartheid era in South Africa. This highlights that there are some difficult things there. The reality that we all face is if you and I were living their life back then, whether we were Maori or Pakeha, we would have made similar decisions. Yet were they here today looking back, they would also apologise for what was done back then. That's the humility we must live with when we're working with the environment. That's what I have to face when I dairy farm with water. I will look back in 25 years, and I will have to review what I did 25 years ago.

Also keep in mind that 'farm pollutants' are emotive words. These things running off my farm in the water are called pollutants, but they are also too much of a good thing in the wrong place.

The issues from pastoral farming with stock are highlighted and exaggerated on a dairy farm.

There was a time when I lived in a little African village when I had quite a bit to do with compost. The people there knew that I valued my compost. One day, some children were playing with fire and it got away on them. It burnt my compost, and there was a lot of wailing, and yelling.

A lady dragged a small boy to my door because he was the culprit who lit the fire. She said: 'I'm very sorry about your compost because I know how much it matters to you, but don't worry I've beaten the boy' He had snot all over his face, and he was very distressed. It didn't really make me feel any better. As a dairy farmer I feel the same way about my dairy effluent as I did then about compost.

Leigh Hamilton *and his wife Raewyn began farming in 1983, and currently farm a dairy unit on the Waitaki Plains and another on the North Otago downlands, which is irrigated by the North Otago Irrigation Company (NOIC).*

A farmer's view of effects-based approaches to non-point source discharge

Geoff Crutchley
Chairman
Maniototo Irrigation Company

I am supportive of the Otago Regional Council on this Rural Water Quality Strategy and the other water management initiatives they have taken in recent times.

I'm impressed by the lengths that they've gone to in consulting with communities, and the extent to which they've been prepared to break new ground in the face of national moves which threaten to limit local input in favour of national guidelines. I support any approach or strategy the council employs which reduces the number of their staff on our pasture, and keeps them out of the hair of farmers who are doing no harm.

For me, the choice of an effects-based approach to managing water quality is a no-brainer. If I have to pay bills, I'd prefer that they were my bills. And if I have to pay a penalty for breaking the law, or committing a crime, then I would expect that it was my crime and not someone else's. So it makes me wonder what they're up to when I see farmers complaining about the prospect of an effects-based approach; or what they're planning to get up to. I think I'd keep an eye on that guy.

I find it interesting to note the contrast between the rather pleasing data regarding water quality in the Taieri catchment and the local perception of the same. A few years ago, some high *E. coli* readings were taken in the upper regions of the Taieri, and they made the headlines in the ODT.

Bad news travels fast and bad reputations linger. Local opinion of the Taieri is still poor. I spent some time the night before last, wading waist deep in some rising flood waters in the Upper Taieri. I had the opportunity to have a good look at some of those waters at their worst because it's been a long time since we had a flood. As some bird carcasses and other unmentionables floated by, I was taking the advice of my great-aunt' long dead, who used to say: 'You boys keep your mouth shut and spit frequently'.

In the Upper Taieri, farmers' opinions regarding water quality are little different from those of non-farmers. There's a total abhorrence of the degradation that we've seen over the last few decades in water quality, and a near-universal condemnation of the farming practices that have brought it about. You don't need to be as old as me to remember a clean gravel bed, and sparkling water in the Taieri, even when it was running much lower summer flows than it does now.

Around the turn of the century, the smell alone was enough to drive people away from the popular picnic sites, where you could find many of them on the hot summer weekends. This has improved a lot since, which proves that it is a manageable problem.

Effects-based approach fair and targeted

The regulatory response, which is to restrict land use across all affected properties, is, in my opinion, a cop-out. It penalises everyone for the actions of the few. Its costs should be measured, not only in terms of the bureaucracy involved, but also in terms of lost production and the opportunity for innovation. An effects-based approach is not an easy option because it may well lead to confrontation and litigation; but it is fair, and it targets the perpetrator rather than a whole category of land users.

There's a total abhorrence of the degradation that we've seen over the last few decades in water quality, and a near-universal condemnation of the farming practices that have brought it about.

My feeling is that the risk of litigation is probably quite small, especially if the process has the support of the community. Those who see an effects-based approach as the ambulance at the bottom of the cliff are probably under-estimating it. I suspect there will be something a lot less sympathetic than an ambulance waiting for those who transgress. With that realisation, I think it will function as a deterrent.

I farm in a dry catchment where there is obviously a close association between irrigation and water contamination. If you're putting dirty water into the river, then there's a fair chance you took it out in the first place. One of the major changes that we're seeing is in land use. These are presenting challenges that we're still coming to grips with and having to learn about. It's created quite a wide culture gap within our community. I listened with some envy to the comments Leigh Hamilton made about the ability of his group to share common experiences.

In the Maniototo, we have some intensive farming operations with high stocking rates and some extensive farms covering large areas of land. And neither one knows a lot about the other. We certainly don't have the kind of liaison between the different users of water that Leigh described. That's something that we probably need to try to achieve.

The Maniototo Irrigation Company is the biggest single consumer of water in the Taieri catchment. It follows, therefore, that we're culpable for much of the pollution that is occurring, and has occurred, in that part of the catchment. This is a concern for us, but we have been limited in what we can do because we have no direct control over what happens to the water after it is supplied, other than through the provisions of the supply agreement.

Those in-house rules allow us to withhold water where it is used in such a way as to damage the reputation of the company and thereby impair our ability to maintain the consents that we need to keep supply. To date, this rule has only been applied, or made effective, in respect of flooding of public roads. But it could be used where an effect on water quality was identified. It hasn't been used in the past because it's much easier to define the problem of water flooding a road, than to define an effect on water quality, as the council is well aware.

The process relies on a complaint being received by the board and on validation of the complaint. It's unlikely that we would achieve much in regard to managing water quality without the backing of ORC. I believe this presents an opportunity for that sort of collaborative approach in the future.

We're not happy with the situation in which we have little ability to address a problem for which others hold us responsible, and I welcome the opportunity for the company to work with the ORC through this approach. I believe that the provisions of our supply agreement will complement it.

I hear some talk that the science is not there for such an effects-based approach. My immediate response to that is how much science do you need when you can see it and you can smell it as you drive by? That has been the case at times in the past. We're not talking about minor breaches here. The community is justifiably outraged at those fairly obvious ill-effects, and it should be possible to deal with them.

We're not happy...(when) we have little ability to address a problem for which others hold us responsible...

I don't know how this will pan out. We could be in for some surprises. We might find we have to change things. I'm prepared for that, and I'm accepting of it because I believe that the approach is fair.

The value of water is better recognised now than ever before. While ownership is clearly vested in the community, the right to use it is highly contested. In recent decades, the value of water has become caught up in the boom in rural land values. The right to take a sufficient and reliable supply of water in Central Otago currently has a higher value

than the land it serves. My sentiment on this is that the right to take water from a public waterway is a privilege; it does not amount to ownership; it is always a privilege. To return any part of that water in a degraded state is an abuse of that privilege. The reputation of irrigation is a vital component of our industry.

It requires us to take a hard look at how we use water, and a hard line about how we affect water quality in our rivers.

There are questions to be answered as to how, when, and where effects will be monitored and by whom. It should not necessarily become the sole prerogative of the ORC. But it is in the interests of efficiency and transparency that there should be some community involvement. As I mentioned earlier, I commend the council on the initiatives they've taken, one of which has been the promotion of community groups to manage water.

I think this is an ideal management vehicle to integrate into this effects-based approach for water quality. Community water management groups can make a contribution whereby the information that is gathered through monitoring is made available to them. This would help with transparency and would assist considerably in restoring the image of irrigation as a legitimate use of our water resource.

That evolution of those community water management groups is currently well under way. The Upper Taieri project is probably at the stage now where it is becoming self-sustaining. The project has a little while to run, and when that is over; I'm confident there will be no going back. Those groups will become a major feature of water management in the Upper Taieri catchment.

Geoff Crutchley *has been involved with the Maniototo Irrigation Company since 1984 and is currently the chairman. He has been a beef and sheep farmer in the Maniototo for nearly 40 years.*

Fraser McRae
Director
Policy and resource planning
Otago Regional Council

RMA Planning process

The first and most important part of any proposed plan change is the preparation stage. In this we go through a consultation process, which today's forum is part of. There will be many more similar meetings involving a range of groups, as we work with communities to:

- define what the water quality issues are
- identify community values for separate rivers
- set local discharge standards.

Following the consultative process, we embark on the formal part of the process; remembering that we're looking to write a permitted activity rule for discharges, rather than trying to write rules that will require consenting for farm activities.

Discharge output rules

We are looking at writing rules to permit discharges from what you're doing on the farm, rather than trying to control how you farm. This creates opportunities to use things like the Overseer model, which helps farmers make the right management decisions for their farm, rather than manage what they do on the farm through the RMA consenting process.

This approach means farmers are free to make on-farm decisions as long as their discharges comply with the water quality standards for nitrogen, phosphate, bacteria, and sediment.

Once a draft plan change is prepared, elected council members approve it for public notification. This includes information about where you can find a copy of the plan change, details about when submissions close, and how you prepare a submission.

Now, obviously that process is going to happen in a public way, and because of the subject that we're dealing with, notification will be widespread throughout Otago. This is because anybody can make a submission in the first round on the plan change. We then note and summarise all those submissions and publicly notify the summary's availability.

At this point, a recent change in the Resource Management Act comes into effect, whereby only certain people can make further submissions. The provisos are that you either have to represent relative public interest, or have an interest greater than the general public (whatever that might mean).

Submission process outlined

When you make a further submission, you must link it to the content of an earlier submission, and serve copies on ORC and on the original submitter, so they know whether you're supporting or opposing them.

Once the submission process has been completed, the council embarks on a hearing process where anyone who's made a submission or further submission, and wants to speak to it, will be heard by a panel of councillors or appointed commissioners.

Again, as a result of changes to the RMA, there's been a slight change in how councils make decisions. We now make decisions on the matters raised by submissions, and have to give reasons for those decisions, rather than making individual decisions on each and every submission.

Once the submission process has been completed, the council embarks on a hearing process...

Then, if you're not happy with the decision the council makes, you can appeal to the Environment Court. That's the process we go through with a plan change, as set out in the RMA.

We can, on a good day, get a minor plan change through the RMA process in six months. But this one's going to be rather slower than that. This current process will take us at least two years to get through, because there's a lot of work to be done to set values in catchments. There will also have to be a long transition period, which previous speakers have talked about. It's a complex issue that we are addressing, because you can't turn those sorts of things around quickly. We recognise that change is going to take place slowly, and this forum marks the beginning.

Community consultation

If you really want to be in the game, you have to get in early and have your say, rather than hold back and then seek to counter somebody three-quarters of the way through the process. We're intending to have community groups around Otago looking at catchment values; a process which is similar to our process for setting minimum flows.

For example; when setting a minimum flow, we need to identify river management values before we set the minimum flow. If a catchment is valued for, say, fish spawning and recruitment back into a larger area, a certain flow regime is needed. If you value that same river for trophy fish, you need a completely different flow regime, and if the river is valued for native fish, you would need another different flow regime.

When setting a minimum flow, we need to identify river management values...

However, if the river is valued purely for economic return, you would manage it quite differently than you would if it was valued for amenity values and recreation. So, working out what the river's values are at the outset is an important step in the process.

The values that are derived for rivers drive expectations for water quality. That, in turn drives standards for water discharged from land through runoff, drainage, and leaching.

Water quality standards

We will be administering water discharge standards for your farm drainage through a permitted activity rule. You can't blame somebody for the general water quality in a river,so we've got to go back to the quality of each discharge.

This is similar to how we treat a point source discharge, which means we acknowledge a close relationship between the discharge effects and the land-use activity. This reflects our concern about what you put into the environment and our approach to water quality, given that what you do on your land is up to you, provided your discharges meet the set standards.

There could be different standards throughout Otago, but they won't be based on land use; they'll be based on the local communities' values and the natural values of each river. A downlands stream may naturally be higher in some contaminants because it is slower flowing and has a muddier bottom stream than, say, an alpine stream, which is faster flowing with a gravelly bottom. People's values for different rivers will be different, so the standards will be different.

Regardless of your type of farming, you would need to meet the standards to maintain community values for your river.

If, as we're trying to clean up the environment, we find consented point-source discharges are not performing as well as modern technology suggests they could, then their conditions could well be reviewed. That's not part of where we're heading with the rural water quality strategy, but it could well be a consequence if water quality deteriorates in the future.

Fraser McRae *has been policy director of the Otago Regional Council since 2005. His background is in rural land use. Fraser has policy experience relating to land and water management from Marlborough, Waikato and Otago.*

Notes

Private Bag 1954
70 Stafford St, Dunedin
www.orc.govt.nz