Appendix 1

Overview of Taranaki Regional Council’s Riparian Management Programme

Transforming Taranaki, 2019
TRANSFORMING

TARANAKI

A strong community is one that comes together and collectively takes action for a common and worthy cause. This is the story of such a community. Our Taranaki community.

The common cause is healthier ecosystems. The Riparian Management Programme is transforming Taranaki.

Nearly 30 years ago, the community picked up a mammoth challenge. Fencing and planting thousands of kilometres of waterways. They made the project their own. Today, our waterways are at or near the healthiest state ever recorded, and the ring plain’s indigenous biodiversity is on a firmer footing.

It’s a world-scale ecological restoration project. This booklet celebrates its achievements and looks forward to more gains in the future.

David MacLeod,
Chairman, Taranaki Regional Council
October 2019
Taranaki at the forefront

As a field ecologist, there are many disadvantages in growing older. But one special advantage is being aware of the rate and magnitude of change on the landscape, especially when the change is for the better. I first became interested in indigenous nature in Taranaki 60 years ago and began formally documenting ecosystems, particularly in Egmont National Park, more than 40 years ago. It was possible in those earlier days to swim in and drink from waterways without any danger of a stomach complaint. And kōkako, kiwi and whio could still be encountered in many parts of the region. I distinctly remember the many ‘dead areas’ of the lower subalpine shrub belt infested by herds of goats, the regular cattle trespass within the park and the massive foliage loss of palatable native trees caused by rapid increases in possum numbers. Then there was the ‘tidying up’ of smaller remnants of lowland forest on the ring plain.

Who would have believed back then the potential for a turnaround in attitude and management practice evident today? This is beginning to gather pace. The Taranaki Regional Council has been instrumental in this shift through a collaborative partnership approach to management of our land and water ecosystems. A wide range of innovative projects, including the riparian planting programme, Towards Predator-Free Taranaki, Wild for Taranaki and Project Mōunga, are helping to reconnect and restore the health of our unique Taranaki landscapes and ecosystems.

“Who would have believed back then the potential for a turnaround in attitude and management practice evident today? This is beginning to gather pace.”

A good number of the sites I documented at the beginning of my career are now in better condition than previously and many of our native birds have been returned to areas they have been absent from for decades.

My own connection with this land, while inspired by a love of nature, is tempered by the more cautious analysis of an environmental scientist observing progress nationally and internationally. However, the evidence is gathering that Taranaki is on a trajectory, which puts it at the forefront of a more sympathetic and intergenerational approach to land and water management. This comes in the form of regenerative and sustainable agricultural practices and landscape-scale ecological restoration.

But we cannot be complacent. Significant challenges, including the climate change emergency and the arrival of new diseases such as myrtle rust, mean that conventional siloed approaches will be inadequate in scale and magnitude. Only with collaborative partnerships that empower and support community-level action can these challenges be met.

Professor Bruce Clarkson
Deputy Vice-Chancellor Research, University of Waikato
A region transformed

Since the 1990s, landowners and farmers on the Taranaki ring plain and coastal terraces have voluntarily protected rivers, streams and wetlands with 5.6 million plants and 13,000 km of fencing, with more of each to come. This work is:

- Transforming the landscape, breaking monotonous grassy monoculture with dense green ribbons, rich in biodiversity values, radiating from all sides of the mountain.

- Transforming rivers, streams and wetlands after decades of riparian vegetation being removed and waterways being used as disposal channels for pasture run-off and raw waste. Today they are at or near the best ecological state ever recorded, thanks to streamside fencing and planting along with major investments by communities and industries to clean up their acts.

- Securing the future of native plants and wildlife on the ring plain, where riparian protection now offers 6,000 hectares of protected native habitat alongside waterways. The community is currently rallying around an ambitious new campaign to build on this by ridding the region of introduced predators to help indigenous biodiversity recover and thrive.

Video: www.bit.ly/TransformTaranaki
How do we know it’s working?

Monitoring by the Taranaki Region Council in recent years shows our rivers and streams are at or near the best ecological health ever recorded.

The Council and independent NIWA scientists say riparian fencing and planting is a strong factor in the improved ecological health of Taranaki’s rivers and streams, along with a reduction in bacteria levels. Other factors include investment by communities and industry to eliminate or drastically reduce the impact of direct discharges.

www.trc.govt.nz/taranaki-waterways-updates

The bugs tell the story

The best way to gauge the overall health of a waterway is to study what sort of insects, molluscs, worms and other small creatures live in it. Are they fussy ones, who don’t tolerate poor-quality water? Or do they thrive in filth? Using a scoring system based on the sensitivity of different species to water quality, and monitoring the same sites over a long period, the ecological health of our rivers and streams can be assessed and tracked. Taranaki's waterways have shown consistent improvement in recent years.

Think carefully about nutrients

Ecological monitoring gives a more complete picture than nutrient levels and other physical and chemical measurements such as bacteria levels, water clarity, conductivity and acidity, nutrient levels and oxygen levels. At best, these intermittent measurements give an indication of the health pressures a waterway may be under. But they can also vary according to weather conditions and how high or low the river is running.

Crucially, the Council and NIWA scientists have found that ecological health is improving even where nitrogen levels are increasing. The relationship between nutrient levels and stream health is clearly not as simplistic and straightforward as often suggested.

The verdict of science

Taranaki Riparian Management Programme has had beneficial effects on stream health and water quality for human health and recreation in the region...

What’s different about this project?

- Scope and scale – it captures every waterway of any size, whether permanent or seasonal.
- It doesn’t stop at stock exclusion also but includes the far bigger task of planting. This brings greater ecological and freshwater-health benefits.
- Fencing and planting plans are individually tailored for each property – because clearly, one size cannot fit all.
- Landowners (mostly farmers) meet the cost of the physical work and materials. There are no subsidies. Only occasional minor grants have been made in some places.
- It has been voluntary, not required by regulation. Farmers knew it was the right thing to do and took ownership of it. Compliance and enforcement have not been costly issues.
- It is a happening reality, not a concept. It’s well-established and heading towards completion.

What the farmers say

“ This is our little slice of paradise, but it wasn’t always like this. I can remember trying to cross the river and the rocks would be all slimy and slippery and the water level was low and warm, like unnaturally warm – it’s because there wasn’t the shade. Now it’s a pleasure that my children get to enjoy this.”

– Megan Symons, Opunake www.bit.ly/TransformTaranaki

Megan and Matt Symons run the family farm where Megan’s father, Gordon Symes, was one of the first Taranaki dairy farmers to start streamside fencing and planting in the 1990s.

“ It’s a matter of complying with requirements and expectations, and it goes beyond that. We want cleaner waterways too, and we’re also enjoying the visual impact and the return of bird life. And from a stock-management point of view, it’s been useful … we see our fencing and planting as an investment for the future.”


Rob and Di Bridgeman have planted nearly 5,000 native plants and erected fences to protect 3km of streambank and a small wetland on their dairy farm.

“ I certainly feel that Taranaki’s further ahead than most regions because we’ve been doing it for longer and it’s been voluntary, with help. We don’t get paid to do it, we don’t get subsidised to do it, but we get helped to do it – farm plans, plants at cost.”

– Blue Read, Pukearuhe www.bit.ly/TransformTaranaki

Blue Read had one of the first riparian management plans, pre-dating the launch of the region-wide programme.
Substantially farmer-funded

This has been a voluntary scheme, funded largely by farmers. Great progress has been achieved because people understood what they needed to do, not because they were forced to by a rule in a Regional Plan.

Run-off from pasture – ‘diffuse-source discharges’ – was recognised in the 1990s as a key factor behind the poor state of many Taranaki waterways. After consulting specialists and engaging with the community, the Taranaki Regional Council determined that fencing and planting streambanks would be the most effective response. Fences prevent stock from entering and fouling waterways, and vegetation provides a buffer to run-off and shades the water, promoting stream health.

The Council then geared itself up to deliver this project, and started bringing key players on board by encouraging them to understand why it was important to be part of it.

This was the deal

Council staff have worked one-on-one with landowners to draw up individual, property-specific Riparian Management Plans setting out the areas to be fenced and planted, the best native plant varieties to use, and a timeframe for completion. The advent of digital technology has made this more efficient and speedier as the programme progressed. The Council has also organised the supply of suitable riparian plants at cost, and coordinated contractors for those unable to attend to fencing/planting/maintenance themselves. The Council’s one-on-one advice and support continues as plans are implemented.

Farmers are implementing their plans by making annual plant purchases, getting them planted and completing the required fencing.

Progress at 30 June 2019

- **2,889** Riparian Management Plans prepared
- **15,409 km** Covers of streambanks on
- **99.9%** of Taranaki dairy farms
- **13,756 km** (86.5% of total) protected by fences
- **8,928 km** (73.7% of total) protected by vegetation
- **5.6 million** new plants plus pre-existing planting
- **6,000 ha** of protected native habitat alongside streams
- **$128 million** spent to date
Are we there yet?

Freshwater management has been undergoing great change, with the Government issuing a raft of new requirements and proposing more. Whatever eventuates, the riparian fencing and planting effort by Taranaki landowners means they’re well placed to meet any reasonable responsibilities they may face in the future.

The Council, too, is thinking ahead. Taranaki’s new Regional Freshwater and Land Plan, due for public notification in mid-2020, will include compliance requirements aimed particularly at the small number of landowners who have stayed distant from the riparian programme. Council staff have begun auditing all riparian plans to ensure they include all waterways and regionally significant wetlands to meet future regulatory requirements.

Meanwhile, under direction from the Council, the dairy-farming community is also investing in improvements to effluent disposal, switching to land-based systems that leave waterways out of the equation. Together with continued riparian fencing and planting, this is expected to result in further improvements to waterway health.

Strong focus on biodiversity

As with the Riparian Management Programme, enthusiastic community support is the bedrock of more recent initiatives to protect and restore the region’s native biodiversity.

Towards Predator-Free Taranaki, launched in mid-2018, is already showing results in urban New Plymouth, where rat and possum numbers are decreasing, and the trapping network is expanding rapidly in rural areas as well, building on the success of the long-running Self-Help Possum Control Programme.

Led by the Taranaki Regional Council, the project will cost $47 million in the first five years, with $11.7 million from the Government. It is the biggest project of its kind in the country.

www.trc.govt.nz/pf-taranaki2050

The region’s voluntary Key Native Ecosystem (KNE) programme has also been growing rapidly. The Council has identified 293 KNEs covering almost 123,400 hectares, most partly or fully in private ownership. Council staff are working with the owners of 132 of them, covering 5,300ha, to prepare and implement individual Biodiversity Plans, mostly involving fencing, predator and pest-plant control, and restoration planting. Twenty to 25 new Biodiversity Plans are prepared every year.
Many lessons in long journey

Taranaki’s achievements offer useful pointers for all involved in resource and environmental management:

- Community buy-in is essential. Taranaki farmers are devoting millions of dollars and thousands of hours to riparian protection not because they have been forced to by a rule or regulation, but because they understand and accept the need for it.
- One size doesn’t necessarily fit all. New Zealand’s river catchments vary widely by soil, climate, hydrology and land use. To be effective, remedial work is best tailored by the local community to suit local conditions.
- The strategy must be clear. The success of Taranaki’s Riparian Management Scheme is built on three foundations: establishing a sound case for the project, ensuring that it can be delivered, and crucially, bringing key players on board by encouraging them to understand it and want to be part of it.

National and international recognition

The Riparian Management Programme has been recognised with a number of awards

2019 Excellence Award for Environmental Well-Being (Local Government NZ)
2013 Green Ribbon Award (Ministry for the Environment)
2011 Geospatial World Forum Excellence Award for Land and Resource Management
2010 NZ Resource Management Law Association Project Award

Taranaki is on a trajectory which puts it at the forefront of a more sympathetic and intergenerational approach to land and water management.

It is likely one of the largest and longest-running restorative freshwater programmes in the world.

Professor Bruce Clarkson, University of Waikato
Dr. Elizabeth Graham, NIWA

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Appendix 2

Internal report reviewing DIN limit proposal in Essential Freshwater
Commentary on nutrient and other NOF attributes in EFM proposals package

Purpose

In this memorandum, I set out an assessment of the additional NOF attributes (measures of water quality, together with bands categorising the degree of quality associated with each level of the attribute) that are being proposed in the September EFM package. In particular I consider the new nutrient attributes Dissolved Inorganic Nitrogen (DIN, comprising nitrate, nitrite, and ammonium) and Dissolved Reactive Phosphorus (DRP). I also comment more briefly on others of the proposed attributes.

Executive Summary

I consider the nutrient attributes in the light of:-

a. how the proposed numerical values defining the attribute states compare with international guidelines or standards;

b. how the proposed numerical values defining the attribute states compare with the ANZECC guideline values that recognise varying degrees of modification of landscapes;

c. the implications of reliance upon control of nutrients as a means to enhancing in-stream ecological health;

d. the robustness of the correlation between nutrient concentrations and measures of stream health;

e. the meaningfulness of requiring year-round data as a measure of likelihood of summer low-flow based events;

f. the adequacy and relevance of land-use controls on DIN and DRP as a means to achieving water quality outcomes.

g. the E coli, sediment (turbidity), and deposited sediment attributes.

Recommendation(s)

It is recommended that you consider my comments as a basis for a Council submission to the Government.

Background

Set out below is a summary table and explanation of the NES/NPS requirements concerning the new DIN and DRP attributes, provided by LGNZ. The attribute tables themselves are attached as Appendix 1 to this memo.

1. Every council-
   a) Must identify the current state of every attribute listed in the NPS, together with any other attributes it identifies for any compulsory or other value of water
   b) must set a target attribute state for every attribute including DIN and DRP, for every monitoring site in each FMU.

2. Attributes are given in 2 categories- those that require imposition of limits, and those that require action plans. For those that require limits [chl-a measures for phytoplankton and for periphyton, TN (lakes), TP (lakes), DIN for ecosystem health (rivers), DRP for ecosystem health (rivers), ammonium (toxicity- rivers), NO3 (toxicity- rivers), DO (rivers- below point sources), turbidity (rivers and streams), E coli (swimmability), cyanobacteria (lakes)], councils-
c) must identify limits on resource uses that will achieve the target attribute state;

d) must include the limits on resource use as rules in its regional plan;

e) may prepare and publish action plans; and

f) may impose conditions on resource consents.

3. For attributes requiring action plans, councils

g) must prepare an action plan to achieve the target attribute state with the timeframe;

h) must publish the plan

i) may identify and impose limits on resource use as rules in a regional plan, and

j) may impose conditions within resource consents.

4. If the current state of an attribute is worse than the national bottom line for that attribute, the target attribute state must be set at, or better than, the national bottom line and must specify a timeframe for achieving it. Timeframes for achieving target attribute states may be of any length or period; but must include interim targets (set for intervals of not more than 10 years) to be used to assess progress towards achieving the target attribute state in the long-term.

5. An action plan must be prepared if there is any deterioration in any attribute.

6. 3.23 Exception for naturally occurring processes

7. (1) If all or part of a water body is affected by naturally occurring processes that mean that the current state is worse than the national bottom line, and a target attribute state at or better than the national bottom line cannot be achieved, the regional council may set a target attribute state that is worse than the national bottom line, but must still set it to achieve an improved attribute state to the extent feasible given the natural processes.

8. (2) In any dispute about whether this exception should apply, the onus is on the relevant regional council to demonstrate that it is naturally occurring processes that prevents the national bottom line being achieved.

(3) For the purposes of this section, naturally occurring processes means processes that could have occurred in New Zealand before the arrival of humans.

Note: Nitrate and ammonia tables are still in the draft NPSFM but would be redundant if DIN table is introduced, as the latter is much more stringent. The existing periphyton table is still in the NPSFM along with the current note directing councils to set DIN and DRP exceedance criteria for periphyton and other values, and N and P criteria for achieving outcomes for sensitive downstream receiving environments (e.g., lakes and estuaries). STAG proposed a default DIN and DRP table that was much more stringent than the more generic DIN and DRP attributes that are to be applied universally. No amendment to periphyton table (as recommended by STAG) is currently included. It can be assumed that any stream that is susceptible to periphyton blooms or which has a sensitive downstream receiving environment already requires stringent N and P criteria under the NPSFM 2017, so the new DIN and DRP attributes would apply in all other remaining streams that are currently below the national bottom line (assuming that councils cannot prove that non-compliance is due to natural causes (e.g., geology or geothermal).
Discussion

A. NOF states and international guidelines

Taranaki is not alone in having DIN and DRP concentrations in its waterways that are higher than the proposed national nutrient bottom lines. From McDowell et al\(^{27}\), average concentrations of Dissolved Inorganic Nitrogen (DIN) and Dissolved Reactive Phosphorus (DRP), the two key nutrients associated with farm runoff and its impact on water quality, are in fact lower in Taranaki than in most other intensive dairying regions (while above the proposed standards, especially in the case of phosphorus). The Council’s review of all sites on the LAWA website shows that 30% of all sites fail the proposed DRP bottom line, and 20% fail the proposed DIN bottom line. Attainment of the proposed NOF attribute bottom lines for DIN and DRP will challenge every dairying region in New Zealand.

It is highly informative to contrast the criteria being proposed within the draft NPS, with those in effect in the UK and across Europe for the same environmental objectives. The UK Technical Advisory Group (UKTAG) is responsible for providing the government (Department for Environment Food and Rural Affairs, or DEFRA) with instruction on the implementation of the Water Framework Directive (2000). The WFD requires the setting of biological and physico-chemical standards necessary to protect and enhance the ecological condition of the country’s waterways. A Phase 1 report was issued by the UKTAG in 2008\(^{28}\). In May 2014 the standards were updated and extended\(^{29}\).

The descriptions used within the TAG reports are as follows:


For example, for high status: there are no, or only very minor, anthropogenic alterations to the values of the physicochemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion.

And for good status: the values of the biological quality elements for the surface water body

\(^{27}\) Nitrogen and phosphorus in New Zealand streams and rivers: control and impact of eutrophication and the influence of land management, New Zealand Journal of Marine and Freshwater research 2009 Vol 43 pp 985-995, RW McDowell, S Larned, and DJ Houlbrooke

\(^{28}\) UK Environmental Standards and Conditions (Phase 1), April 2008, WFD UK TAG, at https://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%201_Final\_v2.010408.pdf

type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

…The standards and conditions associated with Good Status give, for example, the concentrations of a pollutant, or the change in water flows, that we believe can be accommodated without causing any significant harm to aquatic plants and animals.

All standards set out within the UKTAG reports are intended to support at least good ecological status in surface water bodies. The study focused on identifying the relationship between the biology and the pressures on the environment.

The UKTAG reports note that there is consistency in ecological status objectives in all member countries adhering to the WFD across the European Union.

Further, the UKTAG assessment considered and rejected any scientific validity behind imposing a DIN or nitrate criterion.

Although nitrogen may have a role in the eutrophication in some types of freshwaters, we consider the general understanding of this to be insufficient at present for it to be used as a basis for setting standards or conditions. The possibility is too strong that the statistical associations produced by these methods would represent correlation between nitrogen and phosphorus (and other factors), and not the standards for nitrogen that are truly needed to protect the biology. For these reasons no standards for nitrogen are proposed in this report.30

The WFD standards were updated in 2014. Within the 2014 assessment, conducted by the UKTAG, the implications of sustainable management of water quality were explored further. In particular it was noted:

Adopting these new and updated standards has implications for classification of water bodies and where we target our efforts to protect and improve the water environment. However, the standards do not dictate the achievement of the WFD objectives, since the latter strikes a balance between protecting the water environment and enabling its sustainable use. Where, for example, making the improvements needed to achieve the standards required for good status would be disproportionately expensive, we will extend the deadline for the achievement of the objectives or set less stringent objectives. When Ministers agree the final plans they will take into account the balance of costs and benefits and the appropriate phasing of improvements over this 2nd cycle period (to 2021) and beyond to 2027.

The nature of the 2014 review was described:-

In developing its standards, where possible UKTAG has used ecological data collected from hundreds or thousands of sites. UKTAG has compared these with information for the same sites on the environmental conditions to which the plants and animals are sensitive. This process can identify standards that correspond directly with the ecological definition of good status. In other cases, in estuaries and coastal waters for example, and generally for pollutants not historically subject

30 Pg 31, UKTAG 2008
to big programmes of monitoring, there are insufficient data to derive standards in this way. In such cases, UKTAG has used the current scientific understanding of the causes of ecological change, or the risk of harm in the case of chemicals. UKTAG has compared this understanding with the Directive’s biological descriptions of the classes. In doing this, UKTAG has sought advice from independent experts from a range of scientific disciplines. UKTAG has used this approach to identify limits for river flow and water levels, and for standards for particular chemicals.

Environmental standards form the foundation of a risk-based approach to river basin management planning. Updating environmental standards in light of improved scientific understanding enables us to ensure we appropriately protect the water environment without imposing unnecessary constraints on development. It also enables us to refine our understanding of where the water environment is under pressure and the scale of environmental improvements we would need to achieve good ecological quality.31....

The standards are based on the latest scientific understanding of aquatic ecosystems and take account of the evidence gained from using the existing standards and environmental monitoring programmes from across the UK and beyond.32

The standards for good and high status applicable to all but two of the methods have been harmonised with the corresponding standards used by other countries across the EU as part of the harmonisation exercise facilitated by the European Commission.33

In 2014, the UKTAG moved to river classification-based DRP criteria, that were more site-specific that in 2008. The full range of possible DRP values, across all classifications, together with the 2008 values, are set out below (reproduced from Table 5.1a, UKTAG 2014). These standards are specific to the particular conditions at a site. It is informative to note the explanation within the 2014 report:

This approach is designed to take account of the natural variation of nutrient concentrations along rivers and site-to-site differences in the ecological response to elevated concentrations....the proposed standards represent a major step forward in matching nutrient concentrations to ecological change. However, it is also clear that factors other than those taken into account in the method for setting the standards can affect the extent to which water plants at any individual sites respond to a given nutrient concentration...the proposal is not to seek costly action to reduce phosphorus concentrations at individual sites without appropriate ecological evidence of nutrient-related impacts.34

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31 Pg 8, UKTAG 2014
32 Pg 10, UKTAG 2014
33 Pg 12, UKTAG 2014
34 Pp18-19, UKTAG 2014
## Comparison of UKTAG standards with MfE proposals

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<td>19 (13-26)</td>
<td>50</td>
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</tr>
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<td>36 (27-50)</td>
<td>120</td>
<td>69 (52-91)</td>
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<td></td>
<td>Poor</td>
<td>50</td>
<td>24 (18-37)</td>
<td>120</td>
<td>48 (28-70)</td>
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Notes:
1. The revised standards illustrated are the medians from, respectively, 456 lowland, high alkalinity sites; 129 upland high alkalinity sites; 137, lowland, low alkalinity sites; and 97 upland, low alkalinity sites. The numbers in parentheses are the upper and lower 5th and 95th percentiles of the standards for the sites in each type.
2. "Lowland" means less than or equal to 80 metres above mean sea.
"Upland" means more than 80 metres above mean sea level.
"Low alkalinity" with a concentration CaCO3 of less than 50 mg per litre.
"High alkalinity" with a concentration CaCO3 of greater than or equal to 50 mg per litre.

Many sites in the UK in even the best ecological condition (‘high’) would fail to reach even the bottom line that the government is proposing for New Zealand, let alone almost every site in the UK that is only in the ‘good’ category. And as noted above, in the UK, sites that fail to meet the ‘good’ category may on the merits of their case have lower objectives established.

Conversely, every physico-chemical monitoring site in Taranaki would meet its corresponding 2014 UK ‘good’ standard for phosphorus, with the exception of the lower Punehu Stream (median of 44 µg/m³, against a UK ‘good’ standard of 40 µg /m³), yet every ringplain river with a source on Mt Taranaki has a DRP median concentration at or far over the proposed NOF bottom line.

And notably, the UK continue to have no place for any DIN or nitrate standard for protection of the ecological status of inland waters.
The clear interpretation is that by comparison with relevant standards elsewhere around the world, the proposed NPS limits are out of kilter, severe in the extreme, and on the face of it indefensible, given that the end ecological objectives have been framed in similar terms for both the UK and NZ but the numbers are so radically different.

B. **ANZECC (2003) unmodified and modified ecosystems approach, vs the NOF/NPS approach**

Relevant reference data for this discussion are presented in Appendices 1 and 2 of this report.

There is a fundamental divergence of philosophy, to the extent of contradictory interpretation and application of data, between the ANZECC 2003 and the EFM NPS approaches to nutrients.

ANZECC presents two sets of trigger values. The first set offers a suite of chemical and physical measures of water quality data that represent the state of water quality found at reference sites around New Zealand. The second set of data provide for variable levels of protection of in-stream ecology, based on the number of species that may be affected. More specifically, the first set answers the question ‘what’s the best water quality that can be found’, while the second set answers the question ‘for a pre-determined level of effect, what’s the water quality criteria that should be required?’.

On first inspection, the NPS has conflated the two functions.

The default low-risk trigger values were derived from reference sites around New Zealand. Such sites are defined as data from unmodified or slightly-modified ecosystems. That is, to all intents and purposes such data has come from pristine or relatively pristine sites, those with minimal disturbance. A further selection criterion was then applied to the data set itself: the ‘worst’ 20% of data was rejected, and the trigger level set at the 80th percentile value. That is, even 20% of the sites that would be expected to have the highest water quality attainable under real world, least disturbed scenarios, fail to make this trigger value. The interpretation of the trigger values, so derived, is that these trigger values are to be used to identify whether a risk of any effect (perturbation in biological condition) of any magnitude is more than low. The trigger values do not indicate whether any consequent perturbation will have an effect of any magnitude, nor whether such an effect if it occurs should be considered acceptable or unacceptable.

The 2003 ANZECC guidelines state that water quality at the reference sites has not been assessed against any specific biological state. That is, the criteria do not have any validity when trying to identify the water quality necessary to achieve any specific ecological outcome. ([T]he choice of these reference systems was not based on any objective biological criteria.⁶⁰) In other words, the trigger numbers are not equivalent to and cannot be used to justify establishing criteria to be applied for ecological condition. The ANZECC values do not establish that there will be unacceptable effects of any extent; if exceeded, they are to trigger further investigation to determine whether or not a real risk to the ecosystem exists.⁶⁷

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³⁵ Pg 3.3-8, ANZECC 2003
³⁶ Pg 3.3-9
³⁷ Pg 3.1-17
When the ANZECC 2003 trigger values are compared with the proposed NOF attribute bands (see tables in appendices 1 and 2), it is immediately obvious that the top two of the 3 ‘acceptable’ NOF bands lie below (that is, they are more stringent) than the ANZECC trigger values denoting the threshold of any more than a low risk of any degree of effect. Effectively there is only one NOF band, the ‘C’ band, that would provide for any degree of nutrient input above that to be found at reference sites but is still above the national bottom line.

What this means is that in essence, the NOF is instigating predominantly a ‘zero tolerance for risks, and zero room for effects’ philosophy in water management, through the selection of attributes and their associated band values. This contrasts with the second table in ANZECC, which sets out four bands of degrees of effect (with aligned limits on input concentrations) that thereby allow communities to determine their own objectives for water quality maintenance and enhancement, and provide corresponding criteria.

Further, what is noticeable is that NOF uses quite different descriptions of the significance of the bands, from those in ANZECC. ANZECC describes the reference sites as undisturbed ecosystems upstream of possible environmental impacts, and representing desirable conditions38, and the trigger values as those below which ecologically or biologically meaningful changes do not occur.39 By contrast, the NOF language suggests that even at better than ANZECC trigger levels (B band), there might be slight impact, and under some circumstances some effects upon sensitive ecosystems. The A band is reserved for sites where communities and processes are similar to those of natural reference conditions. No adverse effects attributable to DIN/DRP enrichment are expected. But according to ANZECC, this description would also apply to sites with nutrient concentrations in the B band. That is, the NOF downgrades site ratings to lower bands if there is or might be slight impact, whereas the ANZECC guidelines deem this same degree of effect as non-meaningful.

I note that the 2018 ANZECC40 updates modify the above assessment slightly, in that the NPS A band for DIN is reasonably consistent with the 2018 ANZECC trigger thresholds (the latter are REC-specific in the 2018 ANZECC, so there is some degree of variation around specific applicable trigger values), so the two frameworks are coherent to that extent; however the DRP trigger values for denoting reference conditions in 2018 ANZECC still align, not with the A band, but with the bottom of the B band in the NPS; thus the latter is clearly still much more stringent.

Further, there is internal inconsistency between NOF attributes. For the DIN and DRP attributes, the national bottom line is equivalent to concentrations at which there ‘may’ be some enrichment causing increased growth, or loss of sensitive taxa. On the other hand, for ammonia toxicity and for nitrate toxicity, the NOF bottom line is that the loss of even up to 20% of species is deemed acceptable. This degree of toxic impact represents a far greater impact that that which is tolerated for DIN and DRP enrichment. Within the ANZECC context, a 20% species loss is the worst degree of impact that is envisaged and that is provided for, with the suggestion that such criteria should be applied only in the case of highly degraded and disturbed systems, where there is no intention to rehabilitate.

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38 Pg 3.1-16
39 Pg 3.3-7
But no matter how well or how badly the ANZECC and NOF band trigger values align or do not align, there remains a more fundamental issue- that of identifying robust and meaningful numeric descriptors of appropriate water quality that correlate with a clearly identifiable and quantifiable change in ecological condition or drivers of water quality. This is expanded on further in Section D below and Appendix 4 attached, but for the present argument the statement within the STAG report on pg 12 must be noted: ‘Given the complex and dynamic relationship between attributes and ecosystem health, however, we have used these [attribute selection] criteria for guidance rather than as prerequisites, choosing to consider somewhat broader implications and imperatives….while we have worked hard to define ecologically meaningful bottom lines derived from empirical research, we are conscious that defining bottom lines will in some cases be as much a normative process as it is a scientific one. In providing our recommendations we have attempted to define our bottom lines considering both our understanding of New Zealanders’ views as to the bounds of acceptability, and, from a technical perspective, the points at which impacts on the health and functioning of aquatic ecosystems shift from moderate to severe’. There is thus no clear and unambiguous effects-based principle at work, yet the NPS attribute DIN and DRP tables are both onerous and prescriptive.

This shifting definition of what is a meaningful or non-meaningful change in ecological condition, together with variation in the scale of acceptable effects and re-casting of associated nutrient criteria, does not engender confidence in the integrity and credibility of the science. Tables 5 and 6 should therefore not be made compulsory to be attained and enforced, but rather used as the basis for action plans to more generally enhance water quality in a progressive manner, adopting a ‘no regrets’ philosophical approach.

Returning to the stated purpose of the EFM proposals, that the Government’s objectives include stopping further degradation of NZ’s freshwater resources and to reverse past damage, and given both the scientific uncertainties and acknowledged lack of appreciation re social acceptability of the proposed bottom lines, it is advocated that a much more meaningful and defensible banding of the attributes would be achieved by the simple expediency of ranking and banding nutrient concentrations at all monitored sites in New Zealand, with no national bottom line, in the style of Table 11 (E coli), and requiring instead that councils set targets for progressive improvement as shown by decreasing proportions of rivers in lower bands and increasing proportions in higher bands.

This approach offers integrity in the face of uncertain science and its inconsistent application, while at the same time delivering on council and government objectives.

C. Control of inputs vs control of outcomes

‘When a measure becomes a target, it ceases to be a good measure’ – Charles Goodhart, economist41

For river systems comprising broad, shallow rivers, with slow flows, lack of shading, warm air temperatures, infrequent floods or freshes (especially over summer), lack of upstream colonising sources, and meanders, within-flow lakes, and/or impoundments (natural or artificial), then it is logical that the only drivers left that can easily be manipulated to promote better in-stream ecological health are those of nutrients. Otherwise- otherwise. In particular, where there are fast-flowing short-run rivers, that are narrow, already well-

41 https://en.wikipedia.org/wiki/Goodhart%27s_law
shaded and with riparian protection, with demonstrably good ecological condition (e.g., good quality macroinvertebrate communities and low levels of periphyton), then a blinkered focus on controlling nutrients in the belief that doing so is both necessary and the only option to manage ecological condition becomes one-dimensional (and therefore lacks resilience) and sub-optimal (because other options may be more effective and more cost-efficient), as well as reliant on selective science (and therefore at risk of loss of credibility).

Accordingly, the NPS should not have Tables 5 and 6 (DIN and DRP) as compulsory values to be enforced at all sites under all circumstances, but as targets for a progressive approach, requiring the preparation of regional action plans that will provide a trajectory of travel.

The Council supports the inclusion of MCI as an attribute within the proposed NPS. However, notwithstanding that the region’s monitoring sites fall with only few exceptions into the A and B bands, the Council does not believe that the proposed universally applicable MCI attribute bands are suitable for adoption within an NPS, even as an ‘Appendix 2B’ attribute (action plan, not absolute limit). This is a matter of basic science. A single A-B-C (bottomline)-D system as proposed cannot be applied fairly and meaningfully to all wadeable streams and rivers across all geologies, hydrologies, and meteorologies countrywide. For a system like that to work for macroinvertebrates you would need multiple tables (in the style of Table 18, where there are 12 reference classes of river typology), with different MCI attribute scores for different river types - maybe based on REC. It could be quite complex and confusing to work out what attribute state should be applied in a given situation. On the other hand, trends testing answers the question “Is river health improving, staying the same, or getting worse?” The MCI can identify the comparatively worst sites within a region or sub-region (which can then be given a top priority for intervention) and the trends testing will reveal whether improvement results.

D. Trends in nutrients vs trends in stream health

Examination of the biological and physico-chemical monitoring data gathered over 25 years in Taranaki demonstrates plainly a lack of correlation between ecological health and nutrient concentrations, in either state or in trends. Data are set out in Appendix 4, attached. In summary, only two of the 11 sites in the Taranaki region for which both chl-a and nutrient data are available, meet both of the proposed DIN and DRP bottom lines. Yet every site lies in the ‘A’ band for the effect being controlled, that of chl-a in periphyton as a measure of trophic state.

This suggests a significant mis-alignment between the nutrient concentrations that have been set within the NPS in order to control chl-a, against the concentrations of nutrients in the real world that are shown to not have an unacceptable effect upon periphyton.

The nutrient limits are overly conservative.

Moreover, this is borne out by the commentary in MfE’s own experts’ report42.

It is generally recognised that nutrient concentration criteria are highly site specific (Biggs, 2000; Snelder, 2018). A recent analysis suggests that total nitrogen concentrations that are

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42 Essential Freshwater: Impact of existing periphyton and proposed dissolved inorganic nitrogen bottom lines, September 2019
Ministry for the Environment
consistent with the periphyton bottom line vary spatially between approximately 0.2 to 3.5 mg L\(^{-1}\) (Snelder, 2018).

A key assumption in this analysis was that periphyton bottom lines would be achieved purely by managing instream nutrient concentrations. This is a conservative assumption (i.e., it maximises the impact of the current NPS-FM requirements) because measures other than nutrient concentration management can contribute to achieving periphyton objectives. Stream shading may be a more effective measure for achieving the periphyton bottom lines in many, particularly small, streams and rivers. Stream shading may reduce the need partially or wholly to reduce instream nitrogen. In some situations it may be possible to manage periphyton biomass by managing river flows, for example where additional flushing flows can be provided from hydro power facilities. However, it is expected that nitrogen load reductions are the most generally applicable method of managing periphyton biomass.

E. **Compulsory monitoring regimes - methodology and programming**

From a technical perspective, it is noted that the proposed DIN and DRP attributes are to be calculated on the basis of results from monthly sampling undertaken year-round under all flow conditions. However, this protocol is not relevant within all waterways if the consideration is for biological consequences of nutrient enrichment, which occur primarily within periods of low flows and elevated temperatures. Where a catchment consists of fast-flowing, frequently flushed, short-run rivers, with no in-stream reservoirs or likelihood of stagnant ponding along reaches of waterway, then nutrient concentrations during peak flows or in winter will have no meaningful association with potential ecological outcomes. The specified protocol actually has no bearing on the desired outcome, which should surely be the assessment of drivers of degraded stream health at times and conditions that are critical.

In Clause 3.13, the proposed NPS states that ‘monitoring methods must recognise the …relationship between results and their contribution to evaluating the environmental outcomes set under clause 3.7(2)’. Clause 3.7(2) refers to the environmental outcomes that a council wants to achieve for the value Ecosystem Health and each of its components. These statements are supported. But the results of a year-round programme monitoring nutrients do not have a direct and meaningful contribution to the outcomes required by the NPS, and given this inconsistency, then at the very least should not be compulsory.

I propose that for catchments within REC wet and/or cool classes, measures of potential contribution to eutrophication from dissolved nutrients should be based on the median concentrations measured in monthly sampling undertaken in summer only, under below-median flow conditions, rather than year-round data collected regardless of prevailing hydrology.

The relief the Council should seek is:-

1. In Tables 5 and 6, for catchments in the wet and/or cool REC classes, the numeric attribute states should be based on the median result of monthly sampling under below-median flow conditions during warm months (e.g., November-April inclusive), rather than year-round data

F. **OVERSEER: Land use controls or water quality outcomes**
The designation of Overseer as the obligatory tool, either explicitly (NES Schedule 1 catchments) or implicitly (elsewhere in the NES) by which farmers must calculate their diffuse losses of E coli, nutrient, and sediment to the wider environment, and by which councils must determine the magnitude of drivers of offsite effects and must regulate farmer practice, is opposed in full as it is a measure that will impose high additional individual costs but with uncertain benefit for receiving waters, creation of a sense of inequity and frustration, and bringing the credibility and integrity of the proposed NPS into disrepute. The Council’s concerns, and those of many other authorities and experts, are set out in Appendix 3. It defies logic that at the same time as the government has announced major funding to review the Overseer model, it is simultaneously making its use compulsory in short order.

The Environment Court has recently released a decision that finds that Overseer is not fit for and should not be used as a regulatory tool in the absence of fundamental re-development, and cannot be meaningfully applied at farm level to determine off-site effects without comprehensive (and thus very expensive) site-specific calibration and validation. This material is set out verbatim in Appendix 3C The status of Overseer in the Environment Court.

The finding of the Court that ‘It is important to note that Overseer is a long-term prediction model of nitrogen outputs and cannot be used to predict short-term management outcomes or changes that may be required to day-to-day farm operations’ must be given full weight.

There are alternatives to Overseer for farmers to demonstrate commitment to improved farm practices that have the outcome of reducing offsite discharges (eg recording changes in good farm practice).

A NIWA study specifically investigated sources and flows of nitrogen in a catchment on the southern ringplain\(^43\). In terms of the use of OVERSEER model, the study found that calculated rates of nitrogen leaching were very sensitive to rainfall, far more than to actual farm practice. The figure below is reproduced from the study.

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\(^{43}\) Source and specific yields of nitrogen and phosphorus in the Waiokura catchment, NIWA Client report HAM2015-124, October 2015.
The data showed that the primary driver of high N loss as measured by OVERSEER was not farm practice, but rainfall. The catchments of Taranaki encompass rainfall that varies from below 1200 mm per year at the coast, to close to 7,000 mm at the Park boundary. The farms in higher rainfall zones inevitably have higher leaching loss estimates.

While the proposal’s intent is to target farms with poor environmental practices, its design does not appear to distinguish farms in high rainfall zones versus those in lower rainfall zones. The farms impacted are just as likely to be those with best current management practices, as the lowest adoption.

Finally, there is a real issue of resource availability for the Council to implement the NES N-limitation requirements. Especially within the Waingongoro catchment, but equally across the ringplain, the Council’s current policy direction of stock exclusion on all waterways together with diversion of essentially all remaining dairy effluent discharges to land irrigation instead of to surface water, requires the full attention of current policy, land management, consenting, and compliance staff. The NES addition of OVERSEER-based farm plan considerations and an associated second layer of consenting imposes an imminent burden beyond current capacity.

G. Other matters

**Exemptions from bottom lines for naturally occurring processes**

Section 3.23 of Subpart 4 of the proposed NPS allows for exemptions from having to meet national bottom lines when a council is setting target attribute states for a water body or part thereof, and the effect of naturally occurring processes is to make even the national bottom line unattainable. The onus is placed on a council to prove that the bottom line is
unattainable. ‘Naturally occurring processes’ are defined within the NPS text as those that could have occurred before the arrival of humans in New Zealand.

The principle of the exemption is supported, but there is detail to work through, as set out below.

**E coli:** The Council notes that there is an ever-increasing body of evidence for naturalised *E coli* to be found in waterways across New Zealand. The option of identifying such colonisation where it is occurring, and applying the exemption provision, is a commonsense approach. The Council further notes that the worst bacteriological contamination of recreational waters in Taranaki is associated with large populations of waterfowl, both introduced and native- seagulls, ducks, and pukekos, for example. The interpretation of ‘could have occurred before the arrival of humans in New Zealand’ becomes problematic in the case of non-native ducks, for instance.

But in any case it should be argued that there is a case for provision of further exemptions in the case of introduced species such as ducks. There is Government support in legislation and in financial provisions for the proliferation of aquatic game birds across New Zealand. This is in direct and obvious conflict with the Government’s stated intention of requiring improvement of the recreational qualities of fresh water. Why should regional councils and communities have to bear the cost of the consequences of Government support for pollution of waterways by introduced aquatic species?

**Sediment (deposited or suspended):** The Council notes that the waterways of Taranaki are subject to significant and frequent erosion-driven sedimentation loads, originating either from the collapsing of the volcanic cone of Mt Taranaki, or through landslips and slumping of the mudstone sedimentary rock and riverbanks of the eastern hill country of the region. In the case of the latter, this encompasses land where previous governments have driven hillside clearances of protective vegetation and conversion into pasture or cropping, on land that is poor for production, is inherently prone to slope movement, and is subject to high and intensive rainfall episodes including cyclonic weather patterns. For the past 3 decades or more, the Council and its predecessors have been working to restore sustainable land management practices across this landscape. Clarification that natural processes that have been exacerbated by past Government policies and incentives are included in the NPS definition of ‘naturally occurring processes’ is urged.

The Council’s data shows very clearly that catchments fed from the eastern hill country fail the fine suspended solids attribute. The degree of failure is up to 3 times above the national bottom line for the particular land class as defined in Schedule 2B and 2C of the proposed NPS attribute tables. The land use in the eastern hill country is a mixture of sheep and beef pastoral farming, forestry, and planned reversion in private ownership (74%), together with regenerating DoC estate (26%). Of the private land, 87% is already in sustainable land management already.

Across the ring plain (intensive dairying together with urban land uses), most sites are in the ‘A’ band for turbidity.

**DRP:** The Council notes that the volcanic soils of Mt Taranaki and the surrounding ringplain have naturally high concentrations of phosphate, which by virtue of natural cycling of forms of phosphate will continually release DRP into interstitial (pore) water within the soil structure, and by subsequent transport into waterways. Even in very close proximity to the
boundary of the Egmont National Park, DRP concentrations are close to or above the national bottom line for DRP. Therefore it is eminently sensible to apply an exemption.

The issue that comes to mind for DRP is that as riparian shading and cooling of a waterway increases, then for a given pre-existing load of or rate of discharge of phosphate within the catchment, DRP concentrations could increase, because the rate of uptake by periphyton and phytoplankton will reduce through slower metabolic assimilation. This is certainly a naturally occurring process, although the technical difficulties around quantifying the effects in water quality accounting will be substantial.
Appendix 1: DIN and DRP attribute tables (Tables 5 and 6 in Appendix 2A of proposed NPS)

<table>
<thead>
<tr>
<th>Value (and component)</th>
<th>Ecosystem health (water quality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater Body Type</td>
<td>Rivers</td>
</tr>
<tr>
<td>Attribute Unit</td>
<td>DIN mg/L (milligrams per litre)</td>
</tr>
<tr>
<td>Attribute band and description</td>
<td>Numeric Attribute State</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>95th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≤ 0.24</td>
<td>≤ 0.56</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 0.24 and ≤ 0.50</td>
<td>&gt; 0.56 and ≤ 0.10</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 0.5 and ≤ 1.0</td>
<td>&gt; 1.10 and ≤ 2.05</td>
</tr>
<tr>
<td>D</td>
<td>&gt;1.0</td>
<td>&gt;2.05</td>
</tr>
</tbody>
</table>

**National Bottom Line**: 1.0 | 2.05

Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to DIN enrichment are expected.

Ecological communities are slightly impacted by minor DIN elevation above natural reference conditions. Other conditions also favour eutrophication. Sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.

Ecological communities are impacted by moderate DIN elevation above natural reference conditions, but sensitive species are not experiencing nitrate toxicity. Other conditions also favour eutrophication. DIN enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate & fish taxa, and high rates of respiration and decay.

Ecological communities impacted by substantial DIN elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DIN enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia and nitrate toxicity are lost.

Groundwater concentrations also need to be managed to ensure resurgence via springs and seepage does not degrade rivers through DIN enrichment.

Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.
## Table 6 – Dissolved reactive phosphorus

<table>
<thead>
<tr>
<th>Value (and component)</th>
<th>Ecosystem health (water quality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater Body Type</td>
<td>Rivers</td>
</tr>
<tr>
<td>Attribute Unit</td>
<td>DRP mg/L (milligrams per litre)</td>
</tr>
<tr>
<td>Attribute_band and description</td>
<td>Numeric Attribute State^2</td>
</tr>
<tr>
<td>A</td>
<td>Ecological communities and ecosystems processes are similar to those of natural reference conditions. No adverse effects attributable to DRP enrichment are expected.</td>
</tr>
<tr>
<td>B</td>
<td>Ecological communities are slightly impacted by minor DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.</td>
</tr>
<tr>
<td>C</td>
<td>Ecological communities are impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate &amp; fish taxa, and high rates of respiration and decay.</td>
</tr>
<tr>
<td>D</td>
<td>Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DRP enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost.</td>
</tr>
</tbody>
</table>

*Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.*
Appendix 2: ANZECC tables for DIN and DRP

ANZECC (2000) provided what are deemed ‘trigger values’ for New Zealand. ANZECC states that the purpose of the trigger values is to assess the risk of adverse effects due to nutrients (and other stressors) in various ecosystem types. ANZECC notes that regional guideline trigger values should be developed and used in preference to the generic (default) values given.

The ANZECC trigger values for nutrients\(^44\) are as follows:-

**DRP** (denoted FRP= filterable reactive phosphorus)
- upland rivers (above 150 m) 0.009 mg/L
- lowland rivers 0.010 mg/L

**DIN** (NO\(_X\) + NH\(_4\))
- upland rivers (above 150 m) 0.177 mg/L
- lowland rivers 0.465 mg/L

\(^44\) Median values from at least 2 years’ data. ANZECC 3.3-19
Appendix 3: Oversee

Appendix 3A: On-farm management vs off-farm effects estimation

Summary: The imposition of an OVERSEER-based N loss limit on selected farms within the catchment will impose high additional individual costs without certainty of any benefit for receiving waters, creating a sense of inequity and frustration, and bringing the credibility and integrity of the proposed NPS into disrepute.

- Section 32 imposes tests for criteria for policies and for consent conditions/rules in a regional plan, of relevance, certainty, clarity, necessity, effectiveness, and efficiency.

- Overseer does not enable a farmer to see any connection between day to day management choices, and long term environmental outcomes. It is seen as a hindrance and interference rather than as an advantage and assistance. Overseer is being seen as the tool/model to ascertain and set a nutrient loss limit/number, rather than a mechanism to assist consideration of whether nutrient management practices adopted are achieving or could achieve the overall objectives sought.

- A regulatory regime that is based on a whole of catchment approach must of necessity take a starting point of regarding all farms as having an equal contribution and having to meet the same allocation imposition if target water quality is to be attained, when this does not reflect reality.

- The use of Oversee by itself as a tool to set limits in receiving waters is outside the scope of the purpose and function and capability of the model.

- Any link between cumulative nutrient losses (as modelled by Oversee) and instream standards/guidelines/targets is missing and is simply unattainable. It might in theory be possible to look for indirect and tenuous relationships between cumulative long-term Oversee N and P losses in a catchment, and ecosystem health measures like MCI score and/or algal biomass/cover, but there is also a need to consider many other confounding and important factors, and such an approach would be very demanding and intensive. In a region like Taranaki’s, with over 230 catchments, the complexity of the task would be multiplied. For example, environmental monitoring has already demonstrated no discernible connection between trends in nutrients and trends in ecological health in the region’s waterways. The authors of the report believe there are not yet strong scientific links between long term average nutrient losses from farms (Oversee) or nutrient fluxes in streams (CLUES), and periphyton biomass or MCI index. Those links are the subject of ongoing research which is not yet mature. This also leads to a more immediate question: is there anywhere in Taranaki that such an effort could be justified?

- Rather, deteriorations in instream ecology occur only at very limited times for limited durations and only in particular circumstances. This in turn means that use of models that deal in annual average scenarios lack any relevance to effective management of water quality in the region.

- Oversee N loss estimates have been validated against farmlet system N losses but most of these studies occur where annual average rainfall is no greater than 1200mm. The model extrapolates its algorithms to higher rainfall based on first principles and the known interactions between rainfall and soil properties. Many of the catchments in the
Taranaki ring plain, which have their source in the Egmont National Park, have an annual rainfall of between 1100mm to 7178mm (at 900m above sea level). These rates of precipitation are much higher than those at which Overseer has been validated. Overseer remains unproven in the Taranaki context of highly variegated soils, meteorology, and climate.
Appendix 3B Overseer as a regulatory tool

Summary: alongside the Parliamentary Commissioner for the Environment and a number of mathematicians and scientists, the Council stands against the use of OVERSEER within any sort of regulatory framework. For reasons of uncertainty in results, unreliability in its modelling, lack of transparency, reliance upon unknown and unknowable inputs, lack of calibration in high rainfall zones such as the Taranaki ringplain, failure to recognise critical source areas vs ‘whole of farm’ leakage, and lack of connection between N loss modelled from a farm and N transportation to a waterway, OVERSEER remains indefensible.

From the outset it should be acknowledged that Overseer was never designed or intended to be used as a regulatory tool controlling off-farm effects. Rather, Overseer was designed and intended to support decision making around options for managing nutrient use and losses at a farm level. But inherently the regulatory setting requires certainty and accuracy to ensure environmental effects are identified and assessed and justified. Just as there is an onus on the resource user to demonstrate or prove what the effects of their activities will or will not be, the regulatory authority has to be able to demonstrate or prove where non-compliance with plan provisions or resource consent conditions has occurred, and what the consequences of this are, with certainty and accuracy (‘beyond reasonable doubt’).

On 12 December 2018, the Parliamentary Commissioner for the Environment (PCE) released his report ‘Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways’. The report was the PCE’s response to a growing debate nationally about the application of a model designed initially to help farmers with their nutrient budgets but which was increasingly used by regulators (regional councils) to set nutrient limits and to enforce compliance with those limits in an effort to address diffuse water quality impacts from farming practices (with tacit support at the time from the Ministry for the Environment for its use within a regulatory approach). MfE have now decided to rely on OVERSEER as a regulatory intervention at national scale.

MfE’s dependence on OVERSEER does nothing to diminish the strength of the PCE’s critique. The report’s main finding was that there were important gaps and shortcomings in Overseer that undermine confidence in its use as a regulatory tool and in its applicability in assessing environmental effects. It recommends that if the Government wants to see Overseer used as a regulatory tool, it needs to address these limitations as well as deal with issues concerning its transparency, ownership, governance and funding. The report acknowledges that this would be an expensive exercise that would take some time to complete and would not be sufficient on its own to validate OVERSEER’s use within regulatory management of water quality. Despite the PCE’s findings and that MfE have implicitly acknowledged the failings and shortcomings of Overseer by making a budget investment to improve Overseer in the future, the proposed NPS and NES nevertheless require the regulatory use of Overseer with virtually immediate effect.

The PCE’s main findings were:-
- attempting to calculate the scale of, much less the environmental consequences of, nutrient losses from an individual farm within a much wider catchment (and to a standard of assignment of cause and degree that would be acceptable for legal compliance and enforcement) is problematic in the extreme;
- Overseer is a model; it doesn’t actually measure nutrient levels or losses. It simplifies highly complex processes and standardises equally complex local variability by applying a series of algorithms designed to represent real-world but generalised conditions. All models operate with a level of uncertainty and the critical question for the PCE has been whether the level of
uncertainty and accuracy in the information used in Overseer is acceptable in the context of regulation where compliance needs to satisfy a pass/fail test and those being regulated need to feel confident in the results. The test in law for compliance is and remains proof beyond reasonable doubt;
- Overseer models nutrients lost from the farming system, but not what happens to the nutrients after that, nor what happens in the surrounding and receiving environments;
- even for types of farming systems within models that have been calibrated, calculated results for losses of nitrogen can be up to 25 to 30% inaccurate, and outside of these calibrated ranges can be more than 50% inaccurate. Some parts of New Zealand, including Taranaki, have not had Overseer calibrated to regional conditions.
- the report notes that the widely quoted ‘uncertainty’ in the model of plus or minus 30% ‘did not include errors associated with measurements, or uncertainty from data inputs, providing only part of the full picture of quantifying uncertainty.’ Instead, the PCE suggests ‘uncertainty is likely to exceed 50%, but could be much higher still’ The PCE notes that on well-studied soils in Canterbury, estimates of leaching rates derived from Overseer ‘could be anywhere from nearly 40% below to 60 per cent above the actual leaching rate’. In other words, a farm with an overall leaching rate of 30 kg N/hectare/year could be accused of leaching 50 kg N/hectare/year on the basis of Overseer modelling, even if the latter has been calculated using good field data for that specific farm and not just generic default values. In one case the PCE reports, experts came to the consensus that they were 90% confident the nitrogen loading rate on one particular catchment was somewhere between 400 and 910 tonnes/year - a range of well over 100% of the lower figure, and even then the experts could not exclude the possibility they were well off the mark.

The PCE’s report makes a number of specific recommendations, which call for:
- the commissioning of a comprehensive evaluation to ensure the Overseer model is independently reviewed, and is subject to sensitivity and uncertainty analysis;
- greater transparency about how the model works;
- aligning Overseer’s ownership, governance and funding arrangements with the transparency required for it to be used as a regulatory tool; and
- setting up a working group to provide guidance on how Overseer can be used by regional and unitary councils.

None of these recommendations have been delivered. The Government has announced funding to ‘improve’ OVERSEER over the next 3 years. Yet we see OVERSEER already being incorporated into proposed regulatory instruments.

Expert reaction to the PCE’s report was consistent in raising concerns with the use of Overseer for regulatory purposes. For example, Dr Julie Everett-Hincks, Legal and Scientific Researcher at the University of Otago in commenting on the PCE’s report stated that:
‘Overseer would not likely withstand legal challenge, but more importantly, is it right to burden farmers with regulatory compliance when the tool used cannot reasonably measure nutrient losses? In its current form and governance structure, Overseer is not fit to be a regulatory tool’.

Professor Troy Baisden, BOPRC Chair in Lake and Freshwater Science at the University of Waikato when commenting on the PCE’s report noted that:

45 Pg36
46 Pg37
47 ibid
48 Pg 38
‘On the upside, Overseer is well used and reflects some of our farming systems well. That would be perfect if Overseer was still mainly a calculator to improve farm nutrient management. But, when used to enforce regulation, Overseer lacks the openness and transparency needed for scientists to review model results or develop improvements’. 

Professor Richard McDowell, former Chief Scientist, Our Land and Water National Science Challenge commented that:

… an uncertainty and sensitivity analysis of many of the model’s components would be helpful’.

Former IPCC working group director Martin Manning, Massey University Professor Emeritus of Industrial Mathematics Graeme Wake, Massey agricultural senior scientist Tony Pleasants and a retired associate professor of mathematics, John Gamlen, jointly stated that proposals to spend millions fixing Overseer’s problems will not be enough unless the underlying mathematical model is ditched and replaced by more sophisticated modelling that can reflect interactions between different biological processes. They asked to be allowed to see inside the tool, and any moves to improve it.

In their critique, Wake and the others said MPI “lacked understanding” about what other countries were doing to model river pollution and other environmental effects, and called for a ‘proper’ peer review. One of their key concerns is that the model simply adds together the effects of various biological processes, without taking into account the complicated interactions between them. They said New Zealand had good research showing what happens to fertiliser on various soil types and in certain weather, for example, but that information needed to be fed into a better underlying model to get more accurate answers out the other end.

They noted: ‘New Zealand is at serious risk of losing its credibility in agricultural and environmental management with the public and from our international colleagues….the science does not stand up to peer scrutiny’.
Appendix 3C The status of Overseer in the Environment Court

Environment Court Decision [2019] NZEnvC 136 Interim Decision
Federated Farmers and others vs Bay of Plenty Regional Council (with Section 274 parties)

35. We received expert evidence that Overseer is the most appropriate model to use for this purpose. While this approach has become common practice in many areas of New Zealand, it has notable limitations and presents both procedural and substantive risks when used in regulatory processes. We return to this later in our decision.

Method for assessing nitrogen loads in the catchment using Overseer

107 Both nitrogen allocation methods incorporate the use of Overseer software to calculate long-term average losses of nitrogen from below the root zone of rural land uses on an individual property and, in the case of the sector range method, on a sector basis.

108 The Overseer software is jointly owned in equal shares by the Ministry for Primary Industries, AgResearch Limited and the Fertiliser Association of New Zealand. Use of it requires payment for user licences. The software models nutrient flows on a farm using farm information and scientific knowledge to produce, among other things, predictions of nutrient losses based on farm management practices. By modelling different scenarios, farmers can make decisions about their management approaches. The model's algorithms are not available for inspection and testing by either users or the Court. The Overseer software has gone through many versions since first being published as Overseer 2 in 2000. The current version is Overseer 6.3.0. The version used in PC10 is Overseer 6.2.0. Apparently, no library of earlier versions is publicly available.

109 It is important to note that Overseer is a long-term prediction model of nitrogen outputs and cannot be used to predict short-term management outcomes or changes that may be required to day-to-day farm operations.

110 The Regional Council's position is that"... the Integrated Framework when shown in PC10 should remain as shown in Overseer 5.4 as that is the base position from which all other computations in succeeding versions of Overseer occur." Counsel explained that the data "is a post-attenuation statement" provided in PC 10 for information only. Whatever the reason for its inclusion, the different ways that Overseer information was presented did not assist our understanding and introduces an unnecessary level of confusion.

111 Overseer has notable limitations in a regulatory context. One of the main limitations is that different versions of Overseer may give materially different predicted nitrogen losses. By way of example, Version 5.4 (as used initially in PC10) and Version 6.2.0 (as now proposed) differ in their nitrogen loss predictions by approximately 88%, the later version giving the higher figure. 30 The evidence before us included reference to five different versions of Overseer. PC10 includes predictions based on both versions 5.4 and 6.2.0, even though the sustainable lake load to be achieved remains unchanged and is determined independent of Overseer.31 We consider the uncertainty caused by
referencing the Oversee versions 5.4, 6.2.0 and future versions in the same plan makes understanding of plan requirements more complex than necessary and potentially confusing for some users of the plan. We sought clarification on this matter from the Council and return to it later.

112 A further notable limitation of the Oversee model is that the overall level of uncertainty associated with modelled outputs is difficult to ascertain. The only attempt to quantify this in evidence before the Court is in the First JWS on Water Quality, which referred to a degree of uncertainty of 30 - 50%.32 In response to a question from the Court, Dr J C Rutherford, a specialist in water and nutrient management through catchments and engaged by the Regional Council confirmed "... for the period 2003 and 2011, I think that uncertainty of 30% in my opinion is consistent with what the owners of Oversee believe. Prior to that, some of the historic land use ... is a little bit less well defined and .... ascribed a higher uncertainty."

113 In December 2018 the Parliamentary Commissioner for the Environment published a report on Oversee33 which identified the need for greater transparency and for a comprehensive and well-resourced review of the model, including an independent peer review. We were particularly interested in the section of the PCE's report on model uncertainty, which indicates uncertainty associated with Oversee Version 6 could be in the range 25 to 30% for farms within "the calibration range." It is unclear to us whether this includes errors associated with measurements and uncertainties arising from data inputs. The report goes on to note that for farms outside the calibration range, higher levels of uncertainty of 50% or greater are possible. For the avoidance of doubt, while lysimeter testing is being undertaken in the Lake Rotorua catchment which will increase certainty in the predicted nitrogen losses, overseer has not yet been calibrated for conditions prevailing in the Lake Rotorua catchment, which means uncertainty could exceed ±30%.

114 This assessment of uncertainty is consistent with the Court's own experience and understanding gained from evidence presented in a number of other cases over several years, including this one, and we are satisfied that it represents the current state of knowledge. It is important to note that if a nitrogen loss below the root zone was predicted (hypothetically) by Oversee to be 4,000 kg a year for a particular property, the actual loss at an uncertainty of ±30% could be anywhere between 2,800 and 5,200 kg a year, which is substantial and makes sound resource management planning problematic.

115 Notwithstanding those concerns, we have no evidence that there is any realistic alternative method presently available to the Regional Council or to farmers to obtain the necessary information about nitrogen loads in order to manage them. We note that Policy LR P14 recognises the possibility that there may be alternatives to Oversee for nitrogen budgeting purposes, but requires any alternative to be authorised by the Regional Council.

116 We are also particularly concerned to ensure that, as far as reasonably practicable, resources should be used for environmental improvements on-farm, not for unnecessarily high regulatory and monitoring costs.

117 In summary, it is the Court's view that a range of specific requirements need to be met when using Oversee in a regulatory context, including:
(a) A consistent approach to model input data and maximising the accuracy of that data;
(b) The use of best management practices appropriate for the local environment conditions such as soil types and weather patterns;
(c) Using the model to predict trends and relative changes in farm management systems, rather than absolute values;
(d) Calibrating the model outputs with field measurements for environments where conditions differ significantly from those where an acceptable level of calibration has been achieved;
(e) Using only appropriately qualified and experienced experts to run the model for compliance purposes;
(f) Establishing a clear, efficient and reliable process to review and update model outputs and management practices at appropriate intervals;
(g) Appropriate on-site verification that modelled inputs and outputs are being complied with, in addition to independent peer review of performance; and
(h) A compliance mechanism that is certain, reasonable, practical and legally enforceable.

The extent of attenuation that can be relied on in the catchment is fundamentally critical to understanding future nitrogen loads reaching the lake, and the limits that will need to be placed on nitrogen discharges from land within the catchment in the future. This is a highly complex subject where reliable information is not available to quantify overall attenuation and variability across the catchment. On the other hand, we have difficulty in placing significant reliance on model predictions of attenuation that move up or down to facilitate calibration of the model.

On the other hand, the Regional Council has clearly recognised the inherent difficulties when using Overseer in a regulatory setting and has put considerable effort into understanding and managing those difficulties, for which the Council is to be commended. We consider the use of benchmarking, reference files, and five-yearly Nutrient Management Plan reviews designed as an integral part of PC10 as deserving of particular mention for their likely contribution to simplifying the use of Overseer, making it a more efficient management tool and providing greater certainty for farm managers and the regulator. Overall, we consider the proposed use of Overseer as included in PC10 is acceptable given our current state of knowledge. However, this will need to be confirmed through working experience and, in our view, should be considered as a "work in progress", which is likely to require modification over time.
Appendix 4: Monitoring data for ecosystem health and for nutrients in Taranaki

Notes: these sites are not identical to those used by the Council for its longstanding monthly physico-chemical monitoring undertaken for state of the environment purposes, but have been instigated by the Council following the 2014 NPS, for the purpose of monitoring streambed periphyton at representative sites in wadeable rivers as specified in the NPS. A suite of nutrient analyses is undertaken simultaneously.

Data below has been analysed according to the NOF tables 2, 5, and 6 in the Draft National Policy Statement for Freshwater Management, 22 August 2019.

Colour key

<table>
<thead>
<tr>
<th>NPS attribute band</th>
<th>blue = Attribute band A chl-a &lt; 50; DIN&lt;0.24 DRP&lt; 0.006</th>
<th>green = Attribute band B chl-a &lt; 50; DIN 0.24-0.50 DRP 0.006-0.010</th>
<th>yellow = Attribute band C chl-a &lt; 50; DIN 0.50-1.0 DRP 0.010-0.018</th>
<th>pink = Attribute band D (below the national bottom line) chl-a &gt; 50; DIN&gt;1.0; DRP&gt;0.018</th>
</tr>
</thead>
</table>

Site no. | NIWA REC | DIN | DRP | Chl-a (mg/m²) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>KPA000950</td>
<td>WW/L/VA/P/LO/MG</td>
<td>0.352</td>
<td>0.022</td>
<td>6.12</td>
</tr>
<tr>
<td>MGN000195</td>
<td>CX/H/VA/P/MO/LG</td>
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<td>NA</td>
<td>1.01</td>
</tr>
<tr>
<td>MKR000495</td>
<td>WW/L/SS/P/MO/LG</td>
<td>0.365</td>
<td>0.0048</td>
<td>44.23</td>
</tr>
<tr>
<td>MKW000300</td>
<td>CX/H/VA/P/MO/LG</td>
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<td>0.032</td>
<td>20.155</td>
</tr>
<tr>
<td>MTA000068</td>
<td>CW/L/SS/P/MO/LG</td>
<td>0.186</td>
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<td>25.04</td>
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<td>PNH000200</td>
<td>CX/H/VA/IF/MO/MG</td>
<td>0.0845</td>
<td>0.01995</td>
<td>1.305</td>
</tr>
<tr>
<td>PNH000900</td>
<td>CW/L/VA/P/MO/LG</td>
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<td>0.035</td>
<td>3.85</td>
</tr>
<tr>
<td>STY000300</td>
<td>CX/H/VA/S/MO/MG</td>
<td>0.04025</td>
<td>0.0192</td>
<td>0</td>
</tr>
<tr>
<td>TWH000435</td>
<td>WD/L/VA/P/LO/MG</td>
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<td>0.022</td>
<td>31.59</td>
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<tr>
<td>WGG000500</td>
<td>CW/L/VA/P/MO/LG</td>
<td>1.14</td>
<td>0.03</td>
<td>10.8</td>
</tr>
<tr>
<td>WKH000500</td>
<td>CX/H/VA/P/MO/MG</td>
<td>0.092</td>
<td>0.031</td>
<td>23.6</td>
</tr>
<tr>
<td>WMR000100</td>
<td>WW/L/SS/P/LO/LG</td>
<td>0.576</td>
<td>0.0095</td>
<td>6.645</td>
</tr>
</tbody>
</table>

Only two of the 11 sites for which both chl-a and nutrient data are available, meet both of the proposed DIN and DRP bottom lines. Yet every site lies in the ‘A’ band for the effect being controlled, that of periphyton as a measure of trophic state. This suggests a significant misalignment between the nutrient concentrations that have been set within the NPS in order to control chl-a, against the concentrations of nutrients in the real world that are shown to not have an unacceptable effect upon periphyton. The nutrient limits are overly conservative.
Appendix 3

Assessment of the dairying economic impacts of DIN limit proposal in Essential Freshwater package in Taranaki
Assessment of the agricultural economic impacts of DIN limit proposal in Essential Freshwater package in Taranaki

Report prepared for Taranaki Regional Council

October 2019
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1. Background

In 2015 LWP (Harris, 2015) undertook an analysis of the impacts of 3 policy options for nutrient management in the Taranaki region. These included assessments of changes to dairy effluent discharges including discharge to land, completion of the riparian fencing programme, and a cap on discharges of N to the environment.

MFE recently (September, 2019) released a consultation document on changes to the management of freshwater in New Zealand. This included an update of the National Policy Statement for Freshwater Management (NPS-FM) and the National Objectives Framework (NOF). As part of the proposed changes, there are intended to be a number of priority catchments which are designated as having high nitrate nitrogen where immediate action is required, and a limit of 1mg/L for Dissolved Inorganic Nitrogen (DIN). The Waingongoro catchments has been identified as being a high nitrate N catchment, and the proposals are for a cap on N losses at the 75th percentile of the catchment (or somewhere between 70th and 90th percentiles, and this would have to be implemented within 12 months.

Taranaki Regional Council (TRC) is concerned at the impacts that the DIN and high nitrate nitrogen catchment proposals would have on the agricultural sector and the economy. They have requested that LWP use the information from the 2015 report to provide an estimation of the costs of the Essential Freshwater package as it relates to nitrogen limits, specifically the DIN limit of 1mg/L and the requirement to reduce N losses to the catchment 75th percentile in the Waingongoro catchment.

2. Method

Because detailed data is not available on the exact reductions required and the locations where it is would be required, a broad approach has been adopted. TRC has indicated that the proposal will affect farms primarily in the southern ring plain. They estimate that there are approximately 1000 farms in the southern ring plain, and that ¾ of the catchments will exceed the DIN limits. TRC have estimated that the reduction required will be from approximately 1.8mg/L to 1mg/L (the proposed national bottom line for DIN set out in the draft NPS-FM), a reduction of 44%. They have requested the analysis consider two approaches to meeting the limit:

- A cap on N losses where all farms above the cap must reduce their losses to the cap, and all those below cannot increase their losses.
- A proportional reduction approach where all farms reduce by the same amount in order to achieve the required catchment reduction.
- A third method was added where areas of the land use was substituted by forestry to achieve the require reduction in N loss.

In addition the analysis tests the impact of a requirement for an immediate reduction of N losses to the 75th percentile of N losses for the Waingongoro catchment.

TRC supplied:
- Data on land use in three sample catchments, the Kaupokonui, Waingongoro, and Punehu catchment, which are considered typical of the southern ring plain area likely to be affected.

- Overseer estimates of N losses for 397 farms in the Taranaki region for which farm plans have been completed.

- Reports from Dairy NZ (DairyNZ, 2015) and Ogle Consulting (Ogle & Stantiall, 2015) on the costs of reducing N losses on dairy and sheep and beef/dairy support farms respectively. These reports are the same as those used as the basis for the Harris (2015) report, and no later data is available on which to base the costs of reducing N losses in Taranaki.

**Land use data**

The land use data for the three sample catchments are shown in Table 1 below. They show that dairy at 67% - 78% of the catchment area is the main land use in all three sample catchments, with Other (which include conservation land, roads, reserves, urban areas, transport corridors etc) as the other main category. Sheep and beef and dairy support are minor land uses in all three sample catchments at generally less than 5% of the land area.

**Table 1: Land use for sample catchments by rainfall band (ha)**

<table>
<thead>
<tr>
<th>Rainfall</th>
<th>Kaupokonui catchment</th>
<th>Waingongoro catchment</th>
<th>Punehu catchment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;1500mm</td>
<td>1500-2500mm</td>
<td>&gt;2500mm</td>
</tr>
<tr>
<td>Dairy (ha)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy support (ha)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep and beef (ha)</td>
<td>20</td>
<td>220</td>
<td>210</td>
</tr>
<tr>
<td>Other (ha)</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Total (ha)</td>
<td>660</td>
<td>2,900</td>
<td>7,180</td>
</tr>
<tr>
<td>Dairy (ha)</td>
<td>1,231</td>
<td>689</td>
<td>725</td>
</tr>
<tr>
<td>Dairy support (ha)</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Sheep and beef (ha)</td>
<td>38</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Other (ha)</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Total (ha)</td>
<td>1,269</td>
<td>689</td>
<td>873</td>
</tr>
</tbody>
</table>

**Estimated loads and N loss reductions required of the primary sector**

The reductions in N losses can only be achieved through changes in the primary sector, although there may be some reductions that can be achieved by urban areas and residential properties, these are generally minor in the context of the overall N losses from productive land uses. The estimated loads for the catchment were calculated through a number of means,
including using the losses estimated by the DairyNZ and Ogle reports from 2015, and using the more recent overseer loss reductions supplied by TRC both for the region and for the specific catchments. A loss rate of 1.5kg/ha was assigned to Other land to cover background losses. The loads calculated using the different per ha loss rates from different sources were generally in close agreement (<10% difference), and the larger dataset from the whole of Taranaki was used thereafter to estimate mean loss rates and their distribution. The location of farms used for the regional dataset is shown in Figure 3 below, and given the relative uniformity of soil types across the ring plain, and that rainfall has a significant influence on N loss rates, it does not appear that the regional dataset is substantially skewed relative to those farms occurring in a southern ring plain dataset.

The mean loss rate for the larger dataset was 49.6kgN/ha with a standard deviation of 19.3kgN/ha. The range in mean loss rates for the three sample catchments was 48.6 for the Punehu to 55kgN/ha for the Kaupokonui and 53.8 for the Waingongoro. The 75th percentile loss rate is 58kgN/ha across the whole dataset.
Figure 3: Location of farms supplying N loss rates for regional dataset (Source: TRC)
Required reduction

Because not all land uses are able to reduce their N loss rates any required reduction must be achieved from the remaining ‘manageable’ load. For example neither production forestry nor conservation forestry is able to reduce its load, yet they contribute at low levels to the total catchment loads. In the case of the sample catchments, most of the load is manageable, and only 3% of the load is unmanageable. In order to achieve the required 44% reduction, the manageable land uses must reduce by 46%.

N cap

The cap approach requires that all land uses above the cap must reduce their N losses down to the cap. Because the N losses from dairy farms were 97% of the total N losses for the sample catchments, the cap that would achieve a 46% reduction in manageable N losses was calculated from distribution of N losses in the TRC supplied regional dataset of N losses for dairy farms. This figure was 27.2kgN/ha, which is a 40% reduction for the median property in the dataset.

For the immediate reduction requirement in the Waingongoro catchment the 75th percentile of N losses is 58kgN/ha (again calculated from the full N loss dataset, not the catchment specific subset).

Mitigation costs

The costs of mitigation were estimated from information supplied by DairyNZ and Ogle Consulting. For dairy a regression analysis was used to estimate a curve of mitigation costs based on the sample of 18 mitigation examples from DairyNZ. This gave a curve as shown in Figure 4 below.

The costs of mitigation in dairy support was based on the cost per kgN removed in the Ogle report, which was $10.07/kgN for moderate rainfall (<1500mm/annum) and $5.66/kgN for high rainfall (>1500mm/annum). For sheep and beef no costs were estimated in the Ogle report, and it was assumed that the reduction in N loss was linearly related to reduction in stocking rate (or equivalently the proportional retirement of land from production). A model of production was based on the Beef and Lamb NZ Class 5 per stock unit returns, linear reductions in revenue and operating profit with reduced stocking rate, and no change in fixed expenses. The resulting curve of mitigation cost is shown in Figure 5 below.

Forestry replacement

The third method of achieving a reduction in N loss involved replacing the highest leaching land with forestry such that the desired reduction target was achieved, allowing for a leaching loss of 1.5kgN/ha from forestry land. This calculation relies on the distribution of N losses in the affected areas matching that for the region overall, and results in 40% of the dairy land use being replaced with forestry in order to achieve the desired 46% reduction in catchment N loss. This calculation may not be exactly correct, because the replacement with forestry may also affect the water yield, which in turn would affect the concentrations resulting from a given load loss. However the approach adopted is likely to be sufficiently accurate for the purposes of this analysis.
The costs associated with the replacement by forestry were estimated as the change in operating profit for each land use. A figure of $130/ha for forestry plus $266 for carbon\(^{49}\), $2017/ha for dairy based on DairyNZ Economic Survey regional data for Taranaki, and $520 for sheep and beef and dairy support based on Beef and Lamb NZ farm survey data NI Intensive Finishing model (Class 5). The operating profit for dairy and sheep and beef/dairy support was based on revenue minus working expenses (including insurance, ACC levies and rates) and minus depreciation.

\[ y = 1348x^2 + 992.3x \]

\[ R^2 = 0.7122 \]

\[ \text{Cost } \$/\text{ha/annum reduction in operating profit} \]

\[ \% \text{ reduction in N loss} \]

![Figure 4: Cost of N mitigation for dairy land use](image)

\(^{49}\) Calculated based on MPI lookup tables for carbon absorption in the southern NI, converted into a NPV at 6% and then converted into an annuity in perpetuity at 6%. An averaging approach to the ETS was assumed, with a rotation length of 24 years – ie carbon was claimed up to year 12.
3. Results

Caveats

The analysis relies on information from TRC on the reductions required to achieve the DIN limits, and on approximate values they have supplied for the extent of catchments likely to require reductions.

The data supplied on the distribution of N losses is regional for Taranaki, and may not apply directly to the southern ring plain area where the higher DIN concentrations largely occur. However, as it is based on Overseer model runs and contains a large number of sample farms, it is high quality data.

The work here has been undertaken in a relatively short time frame, and relies on mitigation costs that are several years old (2015), and which may over or underestimate the true cost of achieve reductions in N loss. We note that it is broadly similar to other exercises of this nature, although it may overestimate losses at lower levels of mitigation (0 – 20%). The costs of higher levels of reductions in N losses have generally been shown to have substantial impacts on operating profit.

The analysis has been undertaken in a relatively short time frame, and has not been as detailed or comprehensive as might be desirable when assessing changes of such a substantial nature as proposed in the Essential Freshwater package. In that sense it should not be considered as a comprehensive analysis.

Figure 5: Cost of N mitigation in sheep and beef land use
Farm level results

The results of the analysis are shown on a per ha basis in Table 2 and per farm basis in Table 3. The results show that dairy and dairy support farms will need to reduce losses by close to 50%, and sheep and beef farms will on average only reduce their losses marginally.

Table 2: Per ha N losses and cost for DIN limit of 1mg/L

<table>
<thead>
<tr>
<th>Land use</th>
<th>Per ha average loss (kgN/ha)</th>
<th>Cost of mitigation</th>
<th>Cost of forestry conversion ($/ha/annum operating profit)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>Mitigated by N cap</td>
<td>Proportional – all farms reduce by 46% ($/ha/annum operating profit)</td>
</tr>
<tr>
<td>Dairy</td>
<td>50</td>
<td>27</td>
<td>$740</td>
</tr>
<tr>
<td>Dairy Grazing</td>
<td>55</td>
<td>27</td>
<td>$120</td>
</tr>
<tr>
<td>Sheep and beef</td>
<td>23</td>
<td>22</td>
<td>$400</td>
</tr>
</tbody>
</table>

Table 3: N losses and per farm cost for DIN limit of 1mg/L

<table>
<thead>
<tr>
<th>Land use</th>
<th>Per farm cost</th>
<th>Cap of 27.2 kgN/ha ($/farm/annum operating profit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proportional – all farms reduce by 46% ($/farm/annum operating profit)</td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>$80,000</td>
<td>$70,000</td>
</tr>
<tr>
<td>Dairy Grazing</td>
<td>$23,000</td>
<td>$31,000</td>
</tr>
<tr>
<td>Sheep and beef</td>
<td>$79,000</td>
<td>$5,000</td>
</tr>
</tbody>
</table>

The distribution of costs at a farm level based on average farm size for Taranaki and the regional distribution of N losses is shown in Figure 6. These show that the costs for 33% of farms would exceed $100,000 per annum, and for 70% of farms would exceed $50,000 per annum.

50 Uses an average farm size of 105 ha for dairy (DairyNZ/LIC Dairy Farm Statistics 2017/18) and 198 for other land uses based on the average farm size in Beef and Lamb NZ Class 5 for 2017/18.
The likely impact of these measures is obviously difficult to predict, and it will depend substantially on the time scale over which the changes are implemented. However regardless of the approach adopted it is likely to involve large scale changes to the catchment, and substantial disruption to the existing structure of farming and the community. To achieve reductions in losses in the order of 50%, dairy farms are likely to have to make major changes to the farm system, such as moving to housing of stock and capture of all effluent. Even fewer options have been found for drystock systems which are typically lower input and with more marginal returns.

The changes outlined here will impact on the sustainability of farming businesses. The average dairy farm in Taranaki is small producing 103,000 kgMS average per farm compared with 167,000 kgMS/farm nationally. The average debt to equity ratio for Taranaki dairy farms in 2017/18 was 53%, with each farm carrying ~$34,000/ha in debt or $3.4 million per farm. In the 2017/18 season the average farm made a loss (i.e. the current operating profit is not sufficient to pay debt costs) and a return on equity of -8.4%. The small size and low profitability of dairy farms in Taranaki means that reducing intensity and profitability will also reduce the ability of the farm to support a family. In the practice this is likely to mean fewer labour units employed and the rationalisation and reorganisation of farms into fewer, larger units with an associated loss of population from the rural areas.

The Reserve Bank (Reserve Bank NZ, 2015) undertook national level stress testing of the potential impact of the (then) low farmgate milk price through to 2018/19. Under a base scenario with the milk price recovering51 to $5.50/kgMS in 2016/17 and subsequently to $6.50 in 2018/19, non-performing loans (where cashflow is negative and equity is less than 10%) increase to 7.8% of debt. In a scenario where the milk price is $4/kgMS in 2015/16 and increases at 50c/kgMS annually through to 2018/19, 25% of farms and 44% of debt is in non-

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51 The payout for the 2014/15 year was $4.40/kg MS (excl dividend), and the Reserve Bank used prices of $4 to $4.15 in their scenarios of 2015/16 payout.
performing loans. This indicates that a small proportion of farms (<10%) are vulnerable to any decrease in operating profit, and a larger proportion (~25%) are vulnerable to a sustained decrease in operating profit.

Generally, the value of a productive asset reflects its ability to generate a profit, although this is not always true because some of the returns (e.g. capital value gains) may not be reflected in the annual operating profit. However, in a stable situation where demand for land and product are in equilibrium, and product prices are not increasing, there is a reasonable expectation of a relationship between operating profit and asset value. The changes required to achieve a DIN limit of 1mg/L will reduce operating profit substantially for most dairy farms, and depending on the way in which this achieved, the implications could be very significant for land values. For example a 33% reduction in operating profit, such as might occur with a proportional application of the 46% reduction (i.e. all farms reduce by 46%), would mean that land values would be expected to reduce by a similar amount, and given that no capital gains would be expected to occur in the immediate future, it may be that land values would decline further. Such a decrease in land values would result in a significant proportion of farms becoming insolvent because of the high debt to asset ratio in the Taranaki region.

**Aggregate impacts**

The results of the analysis for the three sample catchments are shown Table 4, and aggregated up to the full 750 dairy farms likely to be affected in Table 5. The overall cost of the DIN limit is estimated at $46 - $60 million per annum, and could involve large parts of the southern ring plain (up to 30,000 ha or 32% of the area) being converted to forestry.

The costs will depend on the method adopted to achieve the mitigation. The conversion of large parts of the area to forestry would be lowest cost when the returns from greenhouse gas emission absorption is included, but this would require co-ordinated action to purchase and convert the highest leaching properties. Furthermore this option depends on continued robust markets for forest products and NZUs\(^{52}\), which is not guaranteed if large scale conversion to single species (radiata) forestry occurs.

The costs for proportional mitigation will be more evenly spread, and would result in higher costs for all farm types, but no extremely high costs for individual farms. The N cap approach would be a similar cost per ha on average for dairy and dairy support, but significantly lower cost for sheep and beef farms. The distributional impacts of these should be noted. In the cap approach, there are likely to be properties in high rainfall areas which will need to reduce losses by over 80% which could only be achieved by conversion to forestry or retirement of the land. Even the median property would need to reduce N losses by ~45%, which means that over 50% of dairy farms would have to reduce losses by more than this figure.

\(^{52}\) NZ Units – 1 NZU = one tonne of CO\(_2\) equivalent greenhouse gas emission.
Table 4: Results of analysis for three sample catchments for DIN limit of 1mg/L

<table>
<thead>
<tr>
<th>Land use</th>
<th>Proportional reduction ($/annum operating profit)</th>
<th>Cap of 27.2 kgN/ha ($/annum operating profit)</th>
<th>Area converted to forestry (ha)</th>
<th>Cost of forestry conversion ($/annum operating profit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>$21,570,000</td>
<td>$19,020,000</td>
<td>10390</td>
<td>$17,050,000</td>
</tr>
<tr>
<td>Dairy Grazing</td>
<td>$35,000</td>
<td>$47,000</td>
<td>300</td>
<td>$43,000</td>
</tr>
<tr>
<td>Sheep and beef</td>
<td>$660,000</td>
<td>$45,000</td>
<td>1660</td>
<td>$238,000</td>
</tr>
<tr>
<td>Other</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>Total</td>
<td>$22,260,000</td>
<td>$19,120,000</td>
<td>12350</td>
<td>$17,330,000</td>
</tr>
</tbody>
</table>

Table 5: Total cost of DIN limit of 1mg/L for 750 farms in South Taranaki

<table>
<thead>
<tr>
<th>Land use</th>
<th>Proportional reduction ($/annum operating profit)</th>
<th>Cap of 27.2 kgN/ha ($/annum operating profit)</th>
<th>Area converted to forestry to achieve 46% reduction in N loss (ha)</th>
<th>Cost of forestry conversion to achieve 46% reduction in N loss ($/annum operating profit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>$58,000,000</td>
<td>$51,200,000</td>
<td>27960</td>
<td>$45,900,000</td>
</tr>
<tr>
<td>Dairy Grazing</td>
<td>$95,000</td>
<td>$127,000</td>
<td>800</td>
<td>$115,000</td>
</tr>
<tr>
<td>Sheep and beef</td>
<td>$1,775,000</td>
<td>$120,000</td>
<td>4470</td>
<td>$639,000</td>
</tr>
<tr>
<td>Other</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>Total</td>
<td>$59,900,000</td>
<td>$51,400,000</td>
<td>33230</td>
<td>$46,600,000</td>
</tr>
</tbody>
</table>

Impact of high nitrate-nitrogen catchments requirements in Waingongoro

The requirement for all farmers to reduce N losses to the 75th percentile of all losses in the Waingongoro catchment will mean that all farms will have to be at or below 58 kgN/ha. The Waingongoro catchment is largely in dairy farms, with most of the land in higher rainfall areas (>1500mm), and there is a reasonably substantial area (15%) in other land uses.
Table 6: Land use in Waingongoro catchment

<table>
<thead>
<tr>
<th>Area</th>
<th>Rainfall (mm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;1500mm</td>
<td>1500-2500</td>
</tr>
<tr>
<td>Dairy (ha)</td>
<td>1,000</td>
<td>8,900</td>
</tr>
<tr>
<td>Dairy support (ha)</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Sheep and beef (ha)</td>
<td>-</td>
<td>800</td>
</tr>
<tr>
<td>Other (ha)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total (ha)</td>
<td>1,100</td>
<td>9,900</td>
</tr>
</tbody>
</table>

Under the Option 1 proposal in the high nitrate N catchment proposal of the Essential Freshwater document, a maximum cap on N losses would be set at the 75th percentile of ranked losses for the catchment, presumably on a per ha basis and possibly with an area weighting. This analysis assumes that 25% of properties will be affected and based on the regional distribution of N losses it would result in an approximately 10% reduction in N losses for the catchment.

The cost of such a measure is shown in Table 7 below. The impact will occur only for dairy farms, although there is limited data for dairy support and it may be that some dairy support in higher rainfall areas would also exceed the cap\(^53\). The total cost is estimated at $1.16 million per annum, and an average of $30,000 per property in the affected 25%. The distribution of the effects are shown in Figure 7 and suggest that while ~10% of properties will experience costs in the order of less than $20,000 per annum, some properties will experience costs exceeding $100,000 per annum.

Table 7: Impact of 75th percentile cap in Waingongoro catchment

<table>
<thead>
<tr>
<th>Land use</th>
<th>Per ha average loss (kgN/ha)</th>
<th>Cost of mitigation</th>
<th>Per affected farm cost of 75th percentile cap ($/annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>With 75th percentile cap</td>
<td>Total cost of 75th percentile cap ($/annum)</td>
</tr>
<tr>
<td>Dairy</td>
<td>50</td>
<td>46</td>
<td>$1,160,000</td>
</tr>
<tr>
<td>Dairy Grazing</td>
<td>55</td>
<td>55</td>
<td>$0</td>
</tr>
<tr>
<td>Sheep and beef</td>
<td>23</td>
<td>23</td>
<td>$0</td>
</tr>
</tbody>
</table>

\(^53\) There is only a small area of dairy support in the catchment, so this is not likely to make a serious difference to the results.
The scale of these changes, while impacting on a smaller proportion of the catchment than the DIN of 1mg/L, would result in significant impact for those properties. Quite apart from the practical difficulties of implementing these changes if they are required over a short time period, the reduction in profitability and associated reduction in land values would appear to have the possibility of rendering some farms insolvent.

Regional impacts

The analysis does not quantitatively consider the implications for the wider Taranaki economy, as the necessary information and time was not available to carry out this analysis. Given the scale of the changes, the impact would be expected to be reasonably substantial, particularly in the rural areas affected and for local businesses and communities that provide support services to dairy farms. We would typically expect restructuring of farming businesses into fewer larger farms and less employment, falling populations in affected areas, loss of scale for service providers, and flow on impacts into the regional towns of Stratford, Hawera and New Plymouth. Because household incomes of business owners and their employees will be affected, the impacts will extend into businesses that are not directly related to the agricultural sector. The option of conversion to forestry would appear to be the lowest cost approach, but this would result in reduced local population and associated impacts on local businesses, schools, clubs and community organisations, and a resulting reduction in health and other community services.

However the exact nature of the changes required, their timing and how they are implemented will have a significant influence on the way in which the community is affected. Where changes occur over a longer time period, there is a greater capacity for the community to adapt and for new land uses to arise. Additional time can also help avoid large scale bankruptcies, which create additional social stresses for individuals and their community that can be hard to accommodate. In the last rural downturn that resulted from the 1980s reforms and sustained low commodity prices in the 1980s and 1990s, the government provided assistance packages to the rural sector and 20% of rural debt was written off (Ministry of Primary Industry, 2017). It is unclear whether the scale of changes indicated in the Essential Freshwater package would
be as widespread as they were during that period, but for specific areas and farmers they will be in the same order of magnitude.

4. Summary

The analysis undertaken here is limited in extent, relies on older data and should be read with the caveats in Section 0 in mind. The analysis suggests that the implications of DIN limit are potentially substantial, and will require major changes to land use in the southern ring plain area of Taranaki, and will result in high annual costs. The manner and time frame in which they are implemented will have a major bearing on the overall impacts, but they will have a more immediate impact on land values that needs to be considered alongside the profitability implications. For significant proportion of properties the changes will be too substantial to accommodate, and the business will not be able to continue operating.

If the changes were to occur, regardless of the manner in which it is accomplished, there will be associated impacts on the local and regional community, and particularly on those businesses that support and service dairy farms and the local community.
5. Bibliography


