

**BEFORE THE ENVIRONMENT COURT
I MUA I TE KOOTI TAIAO O AOTEAROA**

UNDER

the Resource Management Act 1991

IN THE MATTER

of appeals under Clause 14 of the First Schedule
of the Act

BETWEEN

TRANSPower NEW ZEALAND LIMITED (ENV-
2018-CHC-26)

FONterra CO-OPERATIVE GROUP
(ENV-2018-CHC-27)

HORTICULTURE NEW ZEALAND
(ENV-2018-CHC-28)

ARATIATIA LIVESTOCK LIMITED
(ENV-2018-CHC-29)

WILKINS FARMING CO
(ENV-2018-CHC-30)

**SUBMISSIONS OF COUNSEL FOR SOUTHLAND FISH AND GAME COUNCIL AND THE
ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC ON DIN
AND DRP MAPS**

1 June 2023

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GORE DISTRICT COUNCIL, SOUTHLAND DISTRICT
COUNCIL & INVERCARGILL DISTRICT COUNCIL
(ENV-2018-CHC-31)

DAIRY NZ LIMITED
(ENV-2018-CHC-32)

H W RICHARDSON GROUP
(ENV-2018-CHC-33)

BEEF + LAMB NEW ZEALAND
(ENV-2018-CHC-34 & 35)

DIRECTOR-GENERAL OF CONSERVATION
(ENV-2018-CHC-36)

SOUTHLAND FISH AND GAME COUNCIL (ENV-
2018-CHC-37)

MERIDIAN ENERGY LIMITED
(ENV-2018-CHC-38)

ALLIANCE GROUP LIMITED
(ENV-2018-CHC-39)

FEDERATED FARMERS OF NEW ZEALAND
(ENV-2018-CHC-40)

HERITAGE NEW ZEALAND POUHERE TAONGA
(ENV-2018-CHC-41)

STONE CREEK STATION LIMITED
(ENV-2018-CHC-42)

THE TERRACES LIMITED
(ENV-2018-CHC-43)

CAMPBELL'S BLOCK LIMITED
(ENV-2018-CHC-44)

ROBERT GRANT
(ENV-2018-CHC-45)

SOUTHWOOD EXPORT LIMITED, KODANSHA
TREEFARM NEW ZEALAND LIMITED, SOUTHLAND
PLANTATION FOREST COMPANY OF NEW
ZEALAND (ENV-2018-CHC-46)

TE RUNANGA O NGAI TAHU, HOKONUI RUNAKA,
WAIHOPAI RUNAKA, TE RUNANGA O AWARUA &
TE RUNANGA O ORAKA APARIMA
(ENV-2018-CHC-47)

PETER CHARTRES
(ENV-2018-CHC-48)

RAYONIER NEW ZEALAND LIMITED (ENV-2018-
CHC-49)

ROYAL FOREST AND BIRD PROTECTION SOCIETY
OF NEW ZEALAND
(ENV-2018-CHC-50)

Appellants

AND

SOUTHLAND REGIONAL COUNCIL

Respondent

MAY IT PLEASE THE COURT

Introduction

1. The Court made the following direction on 30 May 2023:

...Since setting down the appeals for hearing a third issue as arisen; namely the maps for inclusion in Schedule X prepared by Dr Snelder. In court yesterday (29 May 2023) I indicated that the court is not minded to include maps produced for catchments 'degraded' by DIN and DRP. Any party who wishes to be heard in relation to the inclusion of these two maps is to file written submissions by 10am Thursday 1 June 2023 and, if available, may appear in support of their submission on the same day.

2. These submissions respond to that direction.

DIN and DRP, TN and TP – a brief overview on terms

3. DIN is dissolved inorganic nitrogen. DIN includes three different forms of nitrogen: nitrate, nitrite and ammonia¹, but is predominantly nitrate (also called nitrate-nitrogen).²
4. Dissolved reactive phosphorus or DRP is the form of phosphorus immediately available to support algae and plant growth.
5. At higher concentrations, nitrate and ammonia are directly toxic to aquatic species. However, declines in ecological health of rivers occur long before toxic levels are achieved.³ Elevated nutrient (DIN and DRP) concentrations can drive nuisance plant growth, and that excessive algal and macrophyte growth can in turn drive high instream plant biomass which can result in changes to pH, and dissolved oxygen (eutrophication). Typical ecosystem responses can range from losses of plant, invertebrate and fish biodiversity, shifts in plant species composition and relative abundance, and increased algal productivity.⁴
6. Total Nitrogen and Total Phosphorus are used in Dr Snelder's evidence to refer to annual loads of nitrogen and phosphorus discharged from rivers into estuaries.⁵ They are used to assess estuarine degradation. This is assessed by comparing annual loads to maximum allowable loads (MAL) for TN and TP that are described by Plew (2020) as corresponding to thresholds for estuarine phytoplankton biomass. The chosen MALs corresponded to the phytoplankton

¹ www.lawa.org.nz/learn/factsheets/nitrogen

² Statement of evidence of Antonius Snelder dated 11 February 2022 at 22.

³ Statement of Evidence of Russell Death (Topic A) dated 15 February 2019 at 6.11

⁴ Statement of Evidence of Roger Hodson (Topic A) dated 14 December 2018 at 25 – 27 (DIN) and 32 (DRP)

⁵ Statement of evidence of Antonius Snelder dated 11 February 2022 at 35.

and macroalgae attribute thresholds for degraded state defined in the October 2019 JWS (Table 2).⁶

Summary of position

7. The evidence relevant to this issue is set out in some detail in Appendix 1. The totality of the evidence, including Mr Hodson and Professor Death's evidence in Topic A, is particularly relevant to interpreting the JWSs on Water Quality, because the experts were expressing their opinions and the reasons for their opinions in the context of, and building on, the evidence that had already been presented.
8. In summary, Forest & Bird and Fish & Game submit that the appropriate course is for the maps of catchments degraded by DIN and DRP to be included in Schedule X (and for the combined map to include the layers relating to DIN and DRP), for the following reasons:
 - a. Objective 6 of the pSWLP requires consideration of what is meant by "degraded" in order to implement its objective that water quality is improved where degraded. Objective 6 implemented Objective 1A of the NPSFM 2014 (amended 2017) and more generally the relevant NPSFM 2020 directions including Objective 2.1, Policy 1, Policy 3 and Policy 5.
 - b. What constitutes "degraded" is the subject of a significant body of evidence before the Court.
 - c. With the exception of Dr Depree's opinion, the evidence is that "degraded" includes water quality that exceeds recommended thresholds for DIN and DRP.
 - d. The **reasons** that elevated DIN and DRP concentrations degrade water quality are addressed extensively in the evidence of Mr Hodson (Topic A), Professor Death (Topic A), Dr Snelder, Dr Canning and in the JWSs: Starting with Professor Death's evidence and developed in the JWSs and the evidence of Dr Snelder and Dr Canning, thresholds are recommended for DIN and DRP that are necessary to ensure "ecosystem health".⁷ Conversely, the thresholds establish degradation, where not met.⁸

⁶ At 42.

⁷ As set out in Appendix 1 of these submissions.

⁸ The October 2019 JWS defines "thresholds" as "the numeric value indicating degradation (defined by the experts)" – Appendix 1, paragraph 17.

e. In further detail, the **reasons for the specific thresholds** are explained as relating to specified MCI outcomes (in most detail in Professor Death's evidence) and with periphyton outcomes:

i. The influence of Professor Death's reasoning on the joint evidence is very clear, with each JWS referring back to Dr Death's (as he then was) evidence. For example, the September 2021 JWS says that Dr Death "had undertaken considerable work in relation to nitrogen, phosphorus and MCI values, which the other experts considered would provide a very helpful base for further consideration. This information will be taken into consideration in this and subsequent JWSs". And the October 2019 JWS says:⁹

At the time of the May 2019 Rivers JWS it was intended to undertake further work in relation to Dr Death's evidence on water quality numeric thresholds, as referred to in paragraph [48] of the May 2019 Rivers JWS. Since that time the experts have considered all relevant thresholds for ecosystem health... The experts agree that the thresholds to determine degradation to be used by the Court are those set out in this JWS and that further detailed evaluation of Dr Death's work was no longer required.

ii. Dr Snelder and Dr Canning then specifically relate the thresholds also to periphyton outcomes.

iii. For the specific DIN and DRP thresholds recommended in the October 2019 JWS, the experts included an "Explanation/Reference" that refers to papers titled *Instream plant and nutrient Guidelines. Review and development of an extended decision-making framework* and *Nutrient Concentration Targets to Achieve Periphyton Biomass Objectives Incorporating Uncertainties* along with the bottom of Band B of MFE 2019. Those references (even by consideration of their titles alone) indicate that the thresholds are related to periphyton objectives.

iv. The MCI-based approach and the periphyton-based approach are mutually reinforcing, rather than conflicting, bases for the recommended thresholds.

f. The thresholds applied in the October 2019 JWS represent "the best available assessments based on currently available data and research".¹⁰

g. On that basis, and for reasons discussed in more detail below, the Court's Fifth Interim decision:

⁹ October 2019 JWS at 15 – see Appendix 1 at paragraph 16.

¹⁰ October 2019 JWS at 47– see Appendix 1 at paragraph 17.

- i. Was incorrect that there is no accompanying text explaining and giving reasons in the JWS for the proposed threshold values¹¹ (and in any event the evidence was not limited to the JWSs but included individual evidence on this point).
 - ii. Was incorrect that these proceedings are not a forum to determine the threshold values of DIN and DRP.¹² The Court had directed conferencing on attributes and thresholds to be used as the basis of defining degradation on an interim basis¹³ and the JWSs and individual witnesses had recommended DIN and DRP thresholds for this purpose.
 - iii. Was incorrect in finding that the evidence before the Court is not of a standard that allows the court to make a finding.¹⁴ When the totality of the evidence is considered, there was extensive explanation of the reasons for DIN and DRP to be used as criteria for degradation, and for the thresholds recommended.
- h. The Court's Fifth Interim Decision makes that appear to be contradictory to the point reached on DIN and DRP:¹⁵
 - i. in approving Dr Snelder's maps; and
 - ii. in preferring the evidence of Drs Canning, Snelder and J Kitson and Ms K McArthur over Dr Depree's evidence that MCI was suitable as a single attribute for riverine ecosystem health.
- i. The maps prepared by Dr Snelder included estuaries degraded for TN and TP. These attributes are set based on their relationship to periphyton biomass in the estuaries, not in relation to the ecosystem health/degradation of upstream rivers and streams. TN and TP for estuaries are not a substitute for river DIN and DRP thresholds of degradation.

Discussion

pSWLP Objectives

- 9. PSWLP objective 6 provides for water quality in each freshwater body, coastal lagoon and estuary to be maintained where the water quality is not degraded;

¹¹ At [62]

¹² At [64]-[65]

¹³ First Interim Decision at [97]

¹⁴ At [64]-[65]

¹⁵ At [67], [78] and [84]

and improved where the water quality is degraded by human activities. That objective applies now (ahead of the FMU process).

10. Objective 6 therefore requires consideration of what is meant by degraded, and that issue is the subject of a significant body of evidence that it includes degradation in terms of DIN and DRP beyond recommended thresholds.¹⁶

Court's Fifth Interim Decision

11. The Court's Fifth Interim Decision made findings regarding DIN and DRP at [62] – [65]. At [62] the Court said:

DIN and DRP were modelled by both experts using thresholds set out in the Water Quality JWS dated 14-16 October 2019. Regrettably, although references are cited there is no accompanying text explaining and giving reasons in the JWS for the proposed threshold values.

12. While it is correct that the October and November 2019 JWSs provide references, it is submitted that the statement “there is no accompanying text explaining and giving reasons” is not correct when the following is taken into account:
 - a. Professor Death had recommended threshold numbers for DIN and DRP, which the experts had started from. Professor Death's work is referenced as the basis for the thresholds in both the May 2019 and September 2019 JWSs. The October 2019 and November 2019 JWSs state that they are to be read in conjunction with the earlier JWSs.
 - b. The “references” given in the Explanation/References column in the October 2019 and November 2019 JWSs' Table 1 are to publications titled “Instream plant and nutrient Guidelines. Review and development of an extended decision-making framework” and “Nutrient Concentration Targets to Achieve Periphyton Biomass Objectives Incorporating Uncertainties” (the full names are given in Appendices to the JWSs).
 - c. There was no disagreement as to the appropriate numeric thresholds for DIN and DRP (rather the remaining point of disagreement was about whether a waterbody is degraded on the basis of it failing only on DIN and/or DRP when it is not degraded on the basis of indicators such as periphyton, MCI or fish IBI.¹⁷) In that context, it was reasonable for the experts to “shorthand” their reasons by reference to two publications that relate to setting nutrient concentration targets, particularly given the large number of attributes and thresholds that the witnesses were addressing in these JWSs.

¹⁶ As set out in Appendix 1.

¹⁷ November 2019 JWS at 80.

- d. The Court approved thresholds for other attributes, such as *E.Coli* which had equally “shorthand” explanations.
13. At [63]-[64] the Court refers to Dr Canning’s advice that thresholds are generally consistent with the levels required to manage periphyton (rivers) at the national bottom line but says that it is “unclear whether this is the purpose for which the threshold values are recommended in the 2019 JWS”. At [65] the Court says that these proceedings are not a forum to determine the threshold values of DIN and DRP and even if they were the evidence before the Court is not of a standard that allows the court to make a finding.
14. It is submitted that the JWSs and the evidence make clear that the DIN and DRP thresholds were recommended as being **consistent with ecosystem health** (and conversely, with “degradation” where not met).
15. This is clear in the JWSs:
- a. By the response, on the question “what is meant by degraded,” referencing the NPSFM 2017 description of the “ecosystem health” value.¹⁸
 - b. In statements such as:

... the experts agree that **other ecosystem health effects** are manifested at lower concentration than toxic effects. In general managing for ecosystem health will address toxic effects for Nitrate.
16. The relationship between DIN and DRP and ecosystem health (the explanation for the thresholds) is further described in the evidence and JWSs as relating to:
- a. their relationship to MCI – there is significant reliance in the JWSs on earlier work done by Professor Death; and
 - b. their consistency with the level required to manage periphyton in rivers.
17. Those two features are mutually reinforcing (not conflicting or differing): they are both aspects of ecosystem health responses to elevated DIN and DRP.¹⁹
18. Further, it was not essential for the rationale for the thresholds to come from the JWS; the Court was able to rely on individual witnesses’ evidence as to the appropriate thresholds, as it did in approving TN and TP for estuaries (which were not recommended in the JWSs but rather came from a publication cited in Dr Snelder’s evidence). The consistency of the recommended DIN and DRP

¹⁸ At 15.

¹⁹ See explanation from Mr Hodson in his evidence dated 14 December 2018 at 24, 25, 26 and 43 – Appendix 1 at paragraph 1.

thresholds were not only addressed by Dr Canning, but also by Dr Snelder²⁰ (and the earlier evidence from Professor Death also explains in detail the relationship between nitrogen and phosphorus and periphyton²¹).

19. There was no contrary evidence on the specific numerics recommended for DIN and DRP. There was a remaining point of disagreement between Mr Kitto and Dr Snelder on whether the recommended numeric was appropriate for non-periphyton producing waterbodies (but Mr Kitto did not give evidence in Topic B and Dr Snelder changed his position on this point²², so this was resolved). And Dr Depree's evidence was not in opposition to the specific numerics, but rather was that DIN and DRP thresholds should not be used at all.²³ In that context, there was no indication that additional reasoning for the recommended DIN and DRP thresholds needed to be provided.
20. There was a very extensive joint witness conferencing process to arrive at DIN and DRP thresholds and then map catchments that exceeded those thresholds, primary and rebuttal evidence of several witnesses on these points, and then extensive cross-examination and Court questions on these issues. In that context, if the Court intended to make an adverse finding on the standard of the evidence, it is, with respect, surprising that the Court did not (as far as counsel can ascertain from the transcript) ask the witnesses for the purpose for which the specific DIN thresholds were intended.
21. In relation to the Court's finding that these proceedings are not a forum to determine the threshold values of DIN and DRP, Forest & Bird and Fish & Game submit that:
 - a. The Court approved Objective 6, which refers to degraded waterbodies, and found in the First Interim Decision that Objective 6 "begs the question what is meant by 'degraded'"²⁴. The Court directed the experts to conference on that question. The experts did so, and recommended DIN and DRP thresholds as criteria for determining what is degraded. If these proceedings are a forum for determining what is degraded by reference to other attributes, such as MCI, TN and TP, it is not clear why they are not a forum for determining DIN and DRP thresholds. The thresholds were supported by all witnesses except Dr Depree.
 - b. Fish & Game's appeal sought amendments to Appendix E. Professor Death recommended nitrate and DRP thresholds in his evidence in

²⁰ Evidence of Dr Antonius Snelder dated 11 February 2022 at 22

²¹ Evidence of Dr Russell Death dated at 9.1 – 9.4

²² NOE at 708 line 17 – 709 line 9, see Appendix 1 at 38

²³ Evidence of Craig Depree dated 20 December 2021

²⁴ At [96]

support of that relief. The relief was not pursued through Appendix E as a result of the shape of the appeals process evolving to focus instead on defining degradation and mapping degraded catchments. For that reason also, the proceeding was properly a forum to determine the threshold values.

22. Other parts of the Court's Fifth Interim Decision appear contradictory to the finding on DIN and DRP. In particular, on Schedule X the Court found that:

[78] We are satisfied that for a range of attributes and minimum acceptable states, water quality in many of Southland's water bodies is, or is highly likely to be, degraded and it is our judgement that Policy 16 should respond to this finding. Furthermore, Dr Snelder's evidence satisfies us that there is an adequate evidential basis for inclusion of the identified catchments in Schedule X.

...

[84] We approve:

- (a) the maps prepared by Dr Snelder⁹⁴ for inclusion in a new schedule, Schedule X;
- (b) the title of Schedule X shall read 'Catchments of degraded waterbodies where improvement in water quality is required'. (Annexure 4).

⁹⁴ Individual maps for nitrogen, phosphorus, suspended sediments, MCI (<90) and *E.Coli* together with a single map for all attributes. Segments of degraded water quality are to be distinguished from upstream catchments contributing contaminants as he has shown.

23. The maps prepared by Dr Snelder included maps of catchments degraded in terms of DIN and DRP.
24. The maps prepared by Dr Snelder also included estuaries degraded for TN and TP but these attributes are not relevant to river degradation.
25. The Court said that it preferred the evidence of Drs Canning, Snelder and J Kitson and Ms K McArthur over Dr Depree's evidence that MCI was suitable as a single attribute for riverine ecosystem health.²⁵ The evidence of Drs Canning, Snelder, Kitson and Ms McArthur on this point was that nutrient attributes (DIN and DRP) were required, in addition to a MCI attribute, to determine ecosystem health.²⁶ If DIN and DRP are not used as attributes for riverine ecosystem health, then Dr

²⁵ At [67].

²⁶ Rebuttal evidence of Adam Canning dated 22 February 2022 at [12] [15] – [16], [27], [28], [29], [30], [33], [36]; Oral evidence of Adam Canning (NOE page 1082 line 10 – line 32) ; Rebuttal evidence of Kate McArthur dated 22 February 2022 at [11] – [15], [16]-[17], Oral evidence of Kate McArthur (NOE page 928 line 20 – page 929 line 32); Oral evidence of Antonius Snelder (NOE page 703 line 27 – page 704 line 31; page 723, lines 13 – 22); Section 274 party evidence of Jane Kitson dated 4 February 2022 at [9]; Oral evidence of Jane Kitson (NOE page 970 line 5 - page 971 line 10; page 972 line 2 – page 973 line 18).

Depree's evidence has been preferred, despite the Court's finding to the contrary.

Conclusion

26. For those reasons, Forest & Bird and Fish & Game submit that the appropriate outcome is for the individual maps of catchments degraded in terms of DIN and DRP to be included, and for the combined map to include the DIN and DRP layers.

A handwritten signature in black ink, appearing to read "Sally Gepp". The signature is written in a cursive style with a large initial 'S'.

Sally Gepp

Counsel for Forest & Bird and Fish & Game

Appendix 1 – Evidence relating to DIN and DRP

1. Nitrogen and phosphorus as contaminants affecting river health were first addressed in the pSWLP evidence in the Topic A evidence of Roger Hodson for Southland Regional Council.²⁷ Mr Hodson’s evidence was that the main contaminants impacting Southland’s freshwater quality are nutrients (nitrogen and phosphorus), fine sediment, and disease-causing micro-organisms²⁸, that elevated nutrient concentrations can drive nuisance plant growth and be toxic to aquatic organisms and have negative health effects for humans,²⁹ and that nuisance aquatic algal growth, and excessive macrophyte (aquatic plant) growth in turn, can drive high instream plant biomass and can result in changes to pH, and dissolved oxygen (eutrophication). Typical responses can range from losses of plant, invertebrate and fish biodiversity, shifts in plant species composition and relative abundance, and increased algal productivity.³⁰ Dr Hodson’s evidence then assessed the ecosystem health of Southland’s rivers using Council State of the Environment monitoring and reporting data for macroinvertebrates, benthic periphyton, NNN, ammoniacal nitrogen and DRP.³¹
2. Dr Hodson’s evidence was followed by the evidence of Professor Russell Death.³² Professor Death’s evidence was framed around the concept of “ecosystem health”, because:
 - a. Objective A1 of the NPSFM 2014 (amended 2017) which applied at the time that he prepared his evidence, was:

Objective A1
To safeguard:

 - a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and
 - b) the health of people and communities, at least as affected by secondary contact with fresh water;

in sustainably managing the use and development of land, and of discharges of contaminants.
 - b. “Ecosystem health” was one of the two compulsory national values in the NPSFM 2014 (amended 2017).

²⁷ Statement of Evidence of Roger Hodson dated 14 December 2018.

²⁸ At 24.

²⁹ At 25

³⁰ At 26.

³¹ At 43.

³² Evidence of Professor Russell Death dated 15 February 2019

- c. As explained in his evidence, he considered the terms “ecosystem health”, “ecological health” and “life supporting capacity” interchangeably, because they mean the same in an ecological context.³³
3. In that context, Professor Death’s evidence focussed on key water quality parameters and associated “numerics” that he recommended as necessary to ensure ecosystem health. His evidence:
 - a. Stated that nitrogen and phosphorus are critical parameters to manage for ecological or ecosystem health (alongside instream habitat quality, water quantity, flow pattern, deposited fine sediment and riparian margins).³⁴
 - b. Recommended key water quality parameters and the associated “numerics” that are appropriate to ensure ecosystem health as per NPSFM Objective A1 (as it was in the NPSFM 2014 (amended 2017)). These included nitrogen and phosphorus “numerics”.
 - c. Explained that elevated nutrients cause nuisance algal (periphyton) growth, and that the two main nutrients that can result in excessive periphyton growth, are nitrogen and phosphorus. This excessive periphyton growth can result in dramatic changes to the biological communities in rivers and streams.³⁵
 - d. Explained that waterways need to be managed for both N and P to prevent any significant adverse effects on the ecosystem health of those waterways, and that management of both these nutrients is required if MCI states are to be met.³⁶
 - e. Explained that “N and P are essential parameters for management because managing activities to a measure such as periphyton biomass is extremely difficult - periphyton is highly variable in space and time (you can’t ask a farmer to limit the excess periphyton in his or her stream). Because of ease of collection, measurement and the strong correlation with periphyton, dissolved nutrients are what is managed and reported by almost all regional councils.”
 - f. Assessed the current state of Southland’s waterbodies in comparison to his recommended “numerics” for nitrogen and phosphorus. His assessment addressed waterways by waterbody type (used in Appendix E), and found that the majority of “Mountain” reaches are below proposed

³³ At 6.1 – 6.3.

³⁴ At 7.2.

³⁵ At 9.11

³⁶ At 9.11.

nitrogen and DRP concentrations, however, a high proportion still do not meet an acceptable bottom line for ecological health (indicating that other variables are the cause of low ecological health), some "Lake Fed" reaches are below acceptable bottom lines for ecological health, most, if not all, "Spring Fed" reaches are below acceptable bottom lines for ecological health, some "Hill" reaches are below acceptable bottom lines for ecological health and "Lowland hard bed", "Lowland soft bed" and "Mataura 3" reaches have the greatest number of reaches that are below acceptable bottom lines for ecological health.

4. Key passages from Professor Death's evidence are set out in Appendix 2 to these submissions.

5. In April 2019, the Court directed expert witness conferencing in respect of water quality and ecology (rivers and wetlands).³⁷ The JWS dated 9 May 2019 contains a suite of definitions that the experts agreed, including:

(d) Degraded and at risk sites – the experts have developed criteria to define sites as set out below

6. It goes on to refer to the definition of over-allocation in the NPSFM, which the experts agreed could not be applied until the full FMU process had been completed, and until that is done:³⁸

...the experts consider and agree that some interim criteria are required and have used criteria for degradation instead of over-allocation under Objective 6 [pSWLP] for ecosystem health and human health.

7. The JWS included a table of information in evidence for assessing ecosystem and human health. The entries include "Nitrate and Ammonia toxicity" and "Nitrate/Nitrogen for ecosystem health effect", "Total Nitrogen", "Dissolved Reactive Phosphorus for ecosystem health effect", and "Total Phosphorus".

8. The experts agreed that "holding the line" as set out in Objective 6 requires an understanding of what is meant by degradation and when improvement should be considered. When considering how to determine whether degradation has occurred, they recommended that in addition to the values in Appendix C and E, the Court should consider adding methods, including nitrogen and phosphorus.³⁹ They record that it is clear that there are areas of the region that are degraded with respect to ecosystem health, as evidenced by "nitrate and ammonia concentrations above the NPSFM band A for toxicity". It is noted that "Mr Kitto and Ms Bennett have concerns at using band A as a toxic threshold".⁴⁰

³⁷ Minute dated 15 April 2019.

³⁸ JWS dated 9 May 2019 at 21

³⁹ At 41-43

⁴⁰ At 44.

9. The JWS records that “additional water bodies may be degraded or at risk of being degraded when considered against [additional] criteria ... this would result from the establishment of appropriate criteria for nitrogen, phosphorus, and other attributes relevant to periphyton ... [but] the experts were unable to agree on thresholds that they could provide for the Court at that time”.⁴¹ They go on to say that Dr Death has undertaken considerable work in relation to nitrogen, phosphorus and MCI values that the other experts consider provides a very helpful base for further consideration, and that the experts consider that it should be possible to provide the Court with interim thresholds that could be used prior to the Topic B hearings.⁴²
10. From this statement it is clear that in considering nitrogen and phosphorus as criteria for degradation, the experts were considering this in the context of the explanation given by Professor Death as to the level of these nutrients that equates to ecosystem health and, conversely, degradation.
11. In its First Interim Decision, the Court directed expert conferencing as a matter of urgency on attributes and thresholds to be used as the basis of defining degradation on an interim basis and an assessment of waterbodies against those attributes and thresholds.⁴³
12. Conferencing occurred on 3 and 4 September 2019. The resulting JWS records that considerable time was spent discussing what methods should be used to assess degradation, and in that context notes that Dr Death “had undertaken considerable work in relation to nitrogen, phosphorus and MCI values, which the other experts considered would provide a very helpful base for further consideration. This information will be taken into consideration in this and subsequent JWSs”.⁴⁴ Again, the experts are referring back to Professor Death’s evidence recommending particular nitrogen and phosphorus concentrations, and the extensive explanation given in his evidence for the concentration “numerics” recommended.
13. On the question “what is meant by degraded” the experts reference the NPSFM 2017 and the description of the “ecosystem health” value.⁴⁵ They experts agreed that the attributes they listed in Tables 1-3 were appropriate for the definition of degradation.⁴⁶

⁴¹ At 48.

⁴² At 49.

⁴³ At [97]

⁴⁴ At 7.

⁴⁵ At 15.

⁴⁶ At 23.

14. Table 1 is Preliminary attributes and associated spatial scale to identify degraded rivers. The first listed attribute in Table 1 is “Dissolved Inorganic Nitrogen (DIN) (nutrient)”. A footnote to this attribute states:⁴⁷

In the first JWS, ammonia and nitrate were assessed separately for nutrient effect. On further consideration, the experts consider that these should be combined as DIN for this JWS

15. Table 2 is Preliminary attributes and associated spatial scale to identify degraded Lakes and ICOLLs (Intermittently Closed and Open Lakes and Lagoons). The Attributes include Total Nitrogen and Total Phosphorus. Table 3 is Preliminary attributes and associated spatial scale to identify degraded estuaries. Attributes include Total Nitrogen and Total Phosphorus. At this stage of conferencing, the “numeric threshold” column was left blank, to be completed later.

16. Further conferencing occurred on 14 to 16 October 2019. The October 2019 JWS again refers back to Professor Death’s evidence, and explains how his evidence has been built on through the experts’ work in conferencing:⁴⁸

At the time of the May 2019 Rivers JWS it was intended to undertake further work in relation to Dr Death’s evidence on water quality numeric thresholds, as referred to in paragraph [48] of the May 2019 Rivers JWS. Since that time the experts have considered all relevant thresholds for ecosystem health... The experts agree that the thresholds to determine degradation to be used by the Court are those set out in this JWS and that further detailed evaluation of Dr Death’s work was no longer required.

17. The October 2019 JWS confirmed the experts’ recommended classification systems for rivers, lakes and estuaries and confirmed the attributes and thresholds to be used as the basis of defining degradation on an interim basis. The JWS includes a note on definitions. “Threshold” means the numeric value indicating degradation (defined by the experts).⁴⁹ On level of certainty, they say that the thresholds applied in the October 2019 JWS represent the best available assessments based on currently available data and research.⁵⁰

18. Tables 1-3 then follow, now with numeric thresholds added. Table 1 applies to rivers, and lists “Dissolved inorganic nitrogen (DIN) (nutrient)” as the first attribute with a numeric threshold of >0.5mg/l (upland)⁵¹ and >1.0mg/l (region). Table 1 also includes an “Explanation/Reference” column, which for DIN give the following explanation/reference:

⁴⁷ FN 13

⁴⁸ At 15.

⁴⁹ At 45

⁵⁰ At 47

⁵¹ A footnote says that there is a difference of view between the experts and relates to whether there should be a more stringent standard for upland areas. The same footnote is given on the DRP upland attribute.

- a. Upland: Matheson et al 2016 (the full reference in Appendix 1 gives the title of this paper as “Instream plant and nutrient Guidelines. Review and development of an extended decision-making framework.”), Snelder et al 2019 (title: “Nutrient Concentration Targets to Achieve Periphyton Biomass Objectives Incorporating Uncertainties”); bottom of Band B of MFE 2019.
- b. Lowland: Matheson et al 2016; Snelder et al 2019; Bottom of Band C and national bottom line of MFE 2019

19. A footnote to the “region” line says that Mr Kitto and Dr Snelder were of the view that where rivers do not have plant growth issues, restricting DIN to less than 1 mg/L is not justified and the operative NPS nitrate toxicity attribute is more appropriate.

20. Table 1 lists “Dissolved Reactive Phosphorus (DRP) (nutrient)” as the next attribute, with upland and region numeric thresholds of >0.01mg/L and >0.018mg/l respectively, with the same explanation/references given as for DIN.

21. Table 1 also includes a Nitrate-N toxicity attribute, but no numeric threshold. The explanation is that “the experts agree that other ecosystem health effects are manifested at lower concentration than toxic effects. In general managing for ecosystem health will address toxic effects for Nitrate”.

22. Table 2 applies to Lakes and ICOLLS and Table 3 to estuaries. No numeric threshold was given for the Total Nitrogen and Total Phosphorus attributes, which the table stating that the experts would give this further consideration in the final JWS.

23. The fourth conferencing round occurred on 20 to 22 November 2019. The purposes of the conference included finalising attributes and thresholds to be used as the basis of defining degradation on an interim basis, and identifying which waterbodies are degraded and by which attributes. The November 2019 JWS records that it is to be read in conjunction with the May 2019, September 2019 and October 2019 JWSs and that “the October JWS provides context”.⁵²

24. The degraded thresholds “are generally as defined in the JWS 14-16 October 2019” with final agreed thresholds in the tables in Appendix 4.

25. In relation to Conference Outcomes, the November 2019 JWS says that:

The experts record that there is a high level of agreement between them, with only three matters of significance where some disagreement remains.

⁵² At 5.

26. Those remaining areas of disagreement were:
- The separate upland and lowland thresholds (with disagreement limited to how the lower reaches of main stems should be classified for the purpose of periphyton and MCI attributes).⁵³
 - The threshold for ammonia toxicity.⁵⁴
 - Whether a waterbody is degraded on the basis of it failing only on DIN and/or DRP when it is not degraded on the basis of indicators such as periphyton, MCI or fish IBI.⁵⁵
27. The thresholds for degraded state for DIN and DRP are given in Table 1 on p 12 (also in Table 1 of Appendix 4):

Table 1. Thresholds for degraded state for DIN, DRP, and NH₄N (in mg/L).
Thresholds differ by river class for DIN and DRP

| Variable | River class | |
|---------------------------|-----------------------------------|---------|
| | Upland | Lowland |
| DIN Median | 0.5 | 1.0 |
| DRP Median | 0.01 | 0.018 |
| NH ₄ N Median | 1.0 (C/D band) or 0.03 (A/B band) | |
| NH ₄ N Maximum | 2.2 (C/D band) or 0.05 (A/B band) | |

28. There is no disagreement recorded on the DIN and DRP threshold numbers.
29. In Table 1 Appendix 4, the same “Explanation/reference” is given as was given in the October JWS (paragraph 18 above).
30. Table 3 of Appendix 4 is the preliminary attributes to identify degraded estuaries. Total Nitrogen and Total Phosphorus are not included.
31. In November 2021, conferencing of planners occurred, and resulted in a list of questions for the water quality experts to answer, many of which related to information needed to inform the spatial identification of degraded catchments.⁵⁶
32. The water quality experts conferenced on 24-26 November 2021 and their responses fed back into the reconvened planners conferencing on 9-10 December 2021. With respect to Schedule X, the planners agreed that mapping

⁵³ At 31.

⁵⁴ At 34.

⁵⁵ At 80.

⁵⁶ Joint Witness Statement – Planning (identified Water Quality questions) # 2 dated 19 November 2021.

of all areas where water quality is degraded should occur. The planners agreed that a single map that identified where water quality is degraded by any one or more of nitrogen, phosphorus, sediment or microbial contaminants would be helpful.

33. There followed the evidence exchange for the Tranche 1 disputed provisions. Relevant evidence on the DIN/DRP issue was produced by Dr Snelder, Ms McArthur, Dr Canning and Dr Depree.

34. Dr Snelder's evidence relevantly says:⁵⁷

22 ... The experts agreed to dissolved inorganic nitrogen (DIN) thresholds that are considerably lower than the NBL for nitrate-nitrogen (note the DIN is predominantly nitrate-nitrogen). I am comfortable with the DIN thresholds defined in the Water Quality JWS of October 2019 because these are generally consistent with levels that are required to manage periphyton at the NBL threshold.

35. Dr Snelder produced maps for a subset of the attributes recommended in the Water quality JWSs. The subset were those for which reliable models were able to be developed. For rivers, these included the median value of the nutrient DIN and the median value of the nutrient DRP.⁵⁸ The degradation thresholds that Dr Snelder used were those set out in Table 1 of the November 2019 JWS reproduced above.

36. For estuaries, reliable models were also able to be developed to describe the annual loads of total nitrogen (TN) and total phosphorus (TP).⁵⁹ These were compared to attribute states derived from maximum allowable loads (MAL) recommended in Plew (2020) corresponding to thresholds for estuarine phytoplankton biomass defined by the 90th percentile of chlorophyll – a concentrations. The chosen MALs corresponded to the phytoplankton and macroalgae attribute thresholds for degraded state defined in the October 2019 JWS (Table 2).⁶⁰ In other words, the TN and TP thresholds were not themselves specified in the JWS (which initially recommended TN and TP as estuary attributes, but did not appear to come up with thresholds for these) but from an external reference source which Dr Snelder used to equate TN and TP to the phytoplankton and macroalgae attribute thresholds in the JWS.

37. The TN and TP thresholds were not derived by reference to effects of the nitrogen and phosphorus on river ecosystem health prior to reaching the estuary.

⁵⁷ Evidence of Dr Antonius Snelder dated 11 February 2022 at 22

⁵⁸ At 34.

⁵⁹ At 35.

⁶⁰ Dr Snelder's evidence at 42.

38. In oral evidence he gave additional explanation of in relation to the residual disagreement referenced in paragraph 19 above (relating to the appropriate DIN threshold for rivers that do not have plant growth issues):⁶¹

A. ... the reason that Mr Kitto and myself disagreed with one milligram per litre uniformly is that the bottom line for nitrate toxicity in the NPS-FM is 2.4 milligrams per litre and we were being guided by the national bottom lines, as I said earlier, whereas some of the other experts felt that toxicity we should be extra cautious about and therefore they were proposing a number of one milligram per litre to which our – Mr Kitto and myself said “well, that’s breaking our guideline of using the national bottom line”. **The issue of plant growth, periphyton, another reason to manage nitrogen is to manage periphyton biomass in rivers. Some rivers have physical characteristics that mean that you don’t get a large amount of periphyton growing and they are generally rivers with soft bottoms where the algae is unable to adhere to the bed. In those locations, you don’t manage nitrogen to achieve Periphyton outcomes. You manage nitrogen for other reasons, the main of which is managing toxicity and in those locations, Mr Kitto and myself said that the national bottom line for nitrate toxicity should apply which is 2.4. However, subsequently it’s become clear that it’s very difficult to identify places in Southland where Periphyton doesn’t grow and there appears to be very few locations where bed sediments are such that we don’t get under the right conditions high Periphyton biomass and so therefore, that concern that Mr Kitto and myself is rather less of a concern because we would be needing to manage the Periphyton** and what we’ve assumed is we need to manage the Periphyton in all locations in Southland rivers. There are no locations that we can identify easily in this large exercise of looking everywhere in Southland where the only concern is nitrate toxicity.

39. Dr Snelder’s evidence also explained that his recommendation to use total nitrogen load is because of its relevance to estuary degradation:⁶²

Q. So it’s entirely consistent with the national policy statement for the Southland Water and Land Plan to identify a DIN threshold for rivers and receiving water bodies isn’t it?

A. Yes, in broad terms. What I would say is that when we are thinking about estuaries though, we tend to think about the total nitrogen load, so we don’t think about DIN, we think about the type of nitrogen generally discharged into the estuary.

Q. And you have proposed, or you have used total nitrogen to identify degraded estuaries and then the catchments that contribute to those as well haven’t you?

A. That’s correct

40. This issue was not addressed in any detail in primary evidence for Forest & Bird and Fish & Game, because there was no indication in Mr Kitto’s Will Say Statement that any witness opposed the use of DIN as a threshold for degradation (Dr Depree did not produce a will say statement), and the witnesses reasons on the three matters that were in dispute had been set out in the JWSs.

41. However, her rebuttal evidence addressed this, in response to Dr Depree’s evidence. Her evidence responded to Dr Depree’s evidence that proposed using

⁶¹ NOE at 708 line 17 – 709 line 9.

⁶² NOE at 721, lines 5 – 15.

MCI as the sole attribute for riverine ecosystem health (as opposed to using DIN and DRP).⁶³ She also confirmed her agreement with Dr Snelder's maps (including the DIN and DRP maps).⁶⁴

42. Ms McArthur's oral answers also included evidence relevant to the reasons for recommending the DIN threshold numbers:⁶⁵

Q ... My question is, is around how you got to 0.5 for DIN when there is no national guidance that that's the appropriate place to land for upland rivers?

A. There is plenty of scientific papers that we use as guidance. That's how we establish our opinion is through peer-reviewed literature.

Q. Okay.

A. Dr Canning lists many of those publications in his evidence.

43. Dr Canning's rebuttal evidence was solely focussed on the reasons for recommending nutrient (DIN and DRP) attribute thresholds of degradation in addition to MCI for river ecosystem health.⁶⁶ In particular, he said:

36. ... I am also comfortable with the nutrient criteria used in the analysis as I, in agreement with Dr Snelder, consider the DIN and DRP concentrations generally consistent with the levels required to manage periphyton at the national bottom-line threshold.

⁶³ Rebuttal evidence of Kathryn McArthur dated 22 February 2022 at 10 – 15.

⁶⁴ At 16 – 17.

⁶⁵ NOE at 918, lines 14 - 20

⁶⁶ Rebuttal evidence of Adam Canning dated 22 February 2022 at 12, 15 – 16, 27 – 36.

Appendix 2 – Excerpts from Professor Death’s Statement of Evidence for Topic A dated 15 February 2019

7.2 In my opinion the critical parameters to manage for ecological or ecosystem health are instream habitat quality (i.e. natural character), water quantity, flow pattern (i.e. floods and droughts), nutrients (nitrogen and phosphorus), deposited fine sediment and riparian margins. If these are managed appropriately then this should lead to healthy periphyton and invertebrate communities that in turn will maintain sustainable and healthy fish populations and a healthy resilient ecosystem.

7.3 It is important to manage for all these parameters. ...

8.1 Table 1 includes the key water quality parameters and the associated numeric that I consider are appropriate to ensure ecosystem health (as per NPSFM Objective A1), for each of the waterbody types used in the pSWLP.

8.2 Table 1 includes numerics for fine deposited sediment, **nitrate, DRP**, MCI, or QMCI. As the NPSFM already has Chlorophyll a as a compulsory attribute, I do not include periphyton.

8.3 As Mr Hodson explains, nitrogen can be in an aquatic environment in a number of forms and nitrate, nitrite, ammonium and particulate organic nitrogen are directly available for plant uptake. Although Mr Hodson uses Nitrate-Nitrite-Nitrogen (NNN) as the measure that Environment Southland has historically tested, below I derive Nitrate-Nitrogen (N-N) values for use in Southland. I consider these comparable, as nitrite is almost always very low.

[Table 1 follows, and proposes Nitrate concentrations of between 0.1 and 0.89 mg/l depending on waterbody classification, and DRP concentrations of between 0.006 and 0.038 mg/l depending on waterbody classification]

[Notes to the table state that the parameters in Fish & Game’s appeal on Appendix E are consistent with the Table, subject to three points, including that:

- Nitrate and Dissolved Reactive Phosphorus columns have been added to achieve the relevant MCI/QMCI states]

9. EXPLAINING CRITICAL PARAMETERS: STREAM BIOLOGICAL COMMUNITIES

9.1 Mr Hodson’s evidence discusses the effects of elevated nutrient concentrations. I agree with his description of the effects of elevated nutrient concentrations and nuisance algal growth and expand on it briefly.

9.2 The two main nutrients that can result in excessive periphyton growth, are nitrogen (N) and phosphorous (P).¹⁹

9.3 Excessive periphyton growths are not only aesthetically unappealing, they can also result in dramatic changes to the biological communities in rivers and streams.

FN ¹⁹ (Biggs, 1996; Dodds, Jones & Welch, 1998; Biggs, 2000; Death, Death & Ausseil, 2007). As also stated by Mr Hodson at [43]: “The Council’s SOE reporting for rivers includes a number of indicators of ecosystem health: macroinvertebrates, benthic periphyton, NNN, ammoniacal nitrogen, and DRP. **These nutrients are the most readily available to drive instream algal and macrophyte growth, which can adversely affect ecosystem health**”. (Professor Death’s emphasis).

9.4 Periphyton is the algae (often only visible microscopically or as a coating of slime) that forms the basis of most stream and river food webs. Aquatic invertebrates consume this periphyton either directly (along with other organic sources) or by predated the smaller grazing invertebrates. Some periphyton is required as food for many aquatic invertebrates;

...

9.11 ... waterways need to be managed for both N and P to prevent any significant adverse effects on the ecosystem health of those waterways. Management of both these nutrients will be required if MCI states are to be met.

10. RECOMMENDED MCI, QMCI, N AND P STATES

10.1 In this section of my evidence I recommend annual median N-N and DRP levels to assist in meeting the MCI and QMCI desired states set out in Table 1.

...

Nitrogen and Phosphorus

10.13 N and P are essential parameters for management because managing activities to a measure such as periphyton biomass is extremely difficult - periphyton is highly variable in space and time (you can't ask a farmer to limit the excess periphyton in his or her stream). Because of ease of collection, measurement and the strong correlation with periphyton, dissolved nutrients are what is managed and reported by almost all regional councils.

10.14 The EPA Board of Inquiry hearing for the Ruataniwha scheme in Hawkes Bay opted for managing MCI using my derived DIN levels (Death, 2013). This was preferred over management using periphyton biomass from the TRIM model proposed by HBRIC (Chisholm et al., 2014; Death, 2015), in effect because periphyton biomass can only be managed by a control on nitrogen and phosphorus. Although parameters such as MCI and periphyton are good measures of an environmental outcome, numerical parameters for N and P are more suited to making comparisons with resource use.

10.15 To determine the nutrient concentrations to achieve the a healthy ecosystem appropriate for each waterway type, I used the methodology set out in Appendix 1. I consider this approach improves on existing nutrient guidelines for New Zealand's rivers, because it is based on empirical and/or modelled data.

10.16 In Appendix 1, a statistical approach is used to derive nutrient concentrations to achieve ecosystem health QMCI or MCI levels, based on the weight of evidence analysis. This research established that the critical nutrient concentrations differentiating rivers in each of the A, B, C and D states from the NPSFM are 0.10, 0.46 and 1.32 mg/l for nitrate-nitrogen and 0.006, 0.019 and 0.057 mg/l for DRP respectively:

| MCI | QMCI | Nitrate-Nitrogen (mg/l) | DRP (mg/l) |
|-----|------|----------------------------|---------------|
| 120 | 6.0 | 0.10 | 0.006 |
| 100 | 5.0 | 0.46 | 0.019 |
| 80 | 4.0 | 1.32 | 0.057 |

Table 4: Nitrate-Nitrogen and DRP concentrations to achieve MCI and QMCI states

...

12 THE CURRENT STATE COMPARED TO THE RECOMMENDED NUMERIC OUTCOMES

12.1 Using modelled data of nitrate, DRP and MCI from (Unwin & Larned, 2013), 28 I was able to calculate the percentage of stream reaches in each of the waterbody types that had values that exceeded (nitrate and DRP) or were below (MCI) thresholds identified in Table 1. For the purpose of this analysis a stream reach was defined as the NZ reach; a section of stream between tributaries.

...

12.2 The relevant water body classifications [sic] are mapped in pSWLP Map Series 1. Table 5 illustrates that:

- a. The majority of "Mountain" reaches are below proposed Nitrate-Nitrogen and DRP concentrations, however, a high proportion still do not meet an acceptable bottom line for ecological health. This indicates that variables, other than Nitrate-Nitrogen and DRP concentrations, are the cause of low ecological health.
- b. Some "Lake Fed" reaches are below acceptable bottom lines for ecological health.
- c. Most, if not all, "Spring Fed" reaches are below acceptable bottom lines for ecological health.
- d. Some "Hill" reaches are below acceptable bottom lines for ecological health
- e. "Lowland hard bed", "Lowland soft bed" and "Mataura 3" reaches have the greatest number of reaches that are below acceptable bottom lines for ecological health.