IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER **appeals under clause 14(1) of Schedule 1 of the Act in respect of Proposed Southland Water and Land Plan**

between:

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

FONTERRA CO-OPERATIVE GROUP LIMITED
(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)

(Continued on next page)

REBUTTAL EVIDENCE OF DR CRAIG VERDUN DEPREE FOR DAIRYNZ LTD AND FONTERRA COOPERATIVE GROUP LTD
22 FEBRUARY 2022

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

DAIRYNZ 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 Act 1991
(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)

STONEY 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, SOUTHLAND PLANTATION FOREST COMPANY OF NZ, SOUTHWOOD EXPORT LIMITED
(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

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1. EXECUTIVE SUMMARY

1.1 I do not consider that the thresholds applied in Dr Snelder's mapping are generally based on national bottom lines (NBLs). Rather, a level of judgement has been used in their derivation by the Science experts and, accordingly, in Dr Snedler's mapping.

1.2 In particular, I do not support the use of DIN and DRP thresholds in mapping for the reasons given in earlier evidence and because the thresholds are not NBLs. Furthermore, Dr Snelder's mapping applies an upland/lowland distinction that I do not generally support because, again, it is not consistent with the expression of NBLs in the NPSFM 2020.

1.3 I have noted Dr Snelder's opinion that regional models should be preferred over the national models I used but my own analysis suggest either model is fit for purpose.

1.4 Dr Snelder also noted that my mapping did not address all the estuaries. In my opinion, the status of many of the smaller estuaries has little impact on the combined map of catchments where ecosystem health is in need of improvement.

1.5 Perhaps that biggest difference between Dr Snelder's mapping and my own mapping relates to E.coli in the Waiau catchment. In my opinion, for reasons set out in this evidence, I am confident that my mapping of E.coli exceedance in the Waiau catchment is the most appropriate representation of waterbodies in need of improvement for human health.

1.6 For all those reasons, I continue to prefer my maps as included in my December 2021 evidence over the map(s) produced by Dr Snelder.

2. INTRODUCTION

2.1 My full name is Craig Verdun Depree. My qualifications are set out in my primary evidence dated 20 December 2021 and I do not repeat these here.

3. BACKGROUND

Code of conduct

3.1 I have read and am familiar with the Environment Court's Code of Conduct for expert witnesses and I agree to comply with it. Except where I state that I am relying on the specified evidence of another person, my evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions which I express

Scope of evidence

3.2 I have been asked to provide expert Rebuttal Evidence in relation to the Statement of Evidence of Dr Antonius Snelder, dated 11 February 2022. I comment in relation to the following matters:

a) The relationship between national bottom-line thresholds (**NBLs**) and 'catchments in need of improvement' as defined in the October 2019 Joint Witness Statement (**JWS**);

b) The unresolved issue from the JWS relating to the upland and lowland river distinction;

c) The appropriateness of 'catchments in need of improvement' mapping adopting DIN and DRP attributes; and

d) The approach to mapping, in particular the use of national modelling verses region-specific data and how the estuarine ecosystem health maps have been prepared.

4. WHETHER NBLS ARE USED TO DEFINE 'CATCHMENTS IN NEED OF IMPROVEMENT'

4.1 My understanding from reading the October 2019 science JWS (para. 19) is that the experts adopted the concept of using the NBLs as set out in the National Policy Statement for Freshwater Management 2020 (**NPSFM**) to define what is meant by degradation. The JWS states the following:

> "experts have adopted the concept of the "national bottom line" (NBL) or "minimum acceptable state" from the NPSFM as indicative of degraded state" (para. 19, JWS Oct 2019)

4.2 In his statement of evidence, Dr Snelder confirms this approach,[1] but acknowledges that the JWS October 2019 contained "some deviations to the adoption of the NBL."

4.3 The 'deviations' referred to by Dr Snelder relate to the experts decision(s) to apply:

a) higher standards to rivers designated as "upland".[2] (Given that upland rivers correspond to almost 50% of river length in the region[3]. In my opinion, Dr Snelder's admission of 'some' deviations to NBLs in the October 2019 JWS and subsequent mapping is a significant understatement); and

b) thresholds for DIN and DRP (as recommended in the October 2019 Science JWS) which are not NBLs as prescribed in the NPSFM (2020) (or any previous NPSFM).

4.4 To summarise the extent to which NBLs have been used in Dr Snelder's mapping, I have added the applicable NBLs (if any) to Table 1 in Dr Snelder's evidence[4] (refer to Table 1 below).

[1] Para. 19 – referring to the experts, Dr Snelder states "we generally adopted the "national bottom-line (NBL) or "minimum acceptable state" to define a 'degraded' condition.
[2] My understanding is that 'upland' is defined using river environment classification (REC) 'source of flow' class. Rivers, or more specifically, river reaches that have greater than 50% of precipitation occurring at an elevation of >400m (ASL) are defined as upland (i..e REC classification as 'hill', 'mountain' or 'glacial mountain'.
[3] Excluding Milford and Stewart Island. The proportion of river length characterized as 'upland' for Waiau, Aparima, Oreti and Mataura catchments is 71%, 26%, 27% and 35%, respectively.
[4] Table 1 in Dr Snelder's evidence appears to have the DRP thresholds for upland and lowland around the wrong way.

Table 1. Riverine attributes and thresholds used by Dr. Snelder to generate maps of waterbodies in need of improvement

'Attribute'	river	Threshold to indicate waterbody in need of improvement	Is threshold consistent with NPSFM NBL?
DIN	upland	>0.5 mg/L	**No** – DIN is not an attribute. There is no NBL.
	lowland	>1.0 mg/L	**No** – DIN is not an attribute There is no NBL.
DRP	Upland	>0.01	**No** – There is no NBL[a]. The the bottom of the B-band has been used.
	Lowland	>0.018	**No** – There is no NBL[a]. The bottom of the C-band has been used.
Suspended sediment (water clarity)	Class 1[b] Class 2[b] Class 3[b] Class 4[b]	<1.34m <0.61m <2.22m <0.98m	**Yes** as set out in Table 8 of Appendix 2A to the NPSFM 2020. Note these classes typical comprise both lowland and upland rivers.
E.coli (med) E.coli (Q95) E.coli (G260) E.coli (G540)	All rivers	>130 per 100ml >1200 per 100ml >34% >20%	**No**[c] as set out in Table 9 of Appendix 2A and Appendix 3 (National targets for primary contact) to the NPSFM 2020.
MCI (med)	upland	<100	**No** – midpoint of the C-band[d]
	lowland	<90	**Yes**

[a] The NPS-FM DRP attribute does not have a NBL threshold, and in giving effect to the NPSFM, councils only need to at least maintain, even if the current state is a D-band (MfE 2020).[5] This reflects that DRP, like sediment, show significant natural variation in different river types, a single NBL risks being "ineffective and inequitable".[5]

[b] River class based on REC class as described in Table 23 of the NPSFM (2020)

[c] Presumably the MCI value of 100 for upland represents the old lower limit of the B-band, which is now 110.

[d] Although the Appendix 2a E.coli attribute does not have an NBL (which reflects government targets for primary contact in Appendix 3 to NPSFM that allow for a proportion of D and E band rivers). National targets to improve the proportion swimmable large rivers define the bottom of the C-band as suitable for swimming – but this is not a NBL, as this would conflict with the national targets.

[5] MfE (2020). Information on attributes for managing the ecosystem health and human contact values in the National Policy Statement for Freshwater (2020). Publication number: INFO 942. 20 p. Action for healthy waterways: Information about attributes in the NPS for Freshwater Management (environment.govt.nz).

4.5 Table 1 shows that of the five riverine attributes, only water clarity and lowland rivers for MCI are assessed using thresholds consistent with NBLs under the NPSFM. Although the Appendix 2a *E.coli* attribute does not have an NBL, in Appendix 3 of NPSFM it is apparent that the bottom of the C-band is regarded as the threshold for a waterbody to be considered suitable for primary contact.

4.6 Given that upland rivers comprise almost 50% of the region's total rivers, and that significantly higher thresholds are applied to upland rivers (e.g. DIN, DRP, periphyton, deposited sediment), I do not agree with Dr Snelder's (para. 19) assessment that the experts[6] "generally adopted the 'NBL or 'minimum acceptable state' to define a 'degraded' condition". It is clear to me that the technical experts exercised some discretion about what should be regarded as 'degraded'. My evidence of 4 February 2022[7] outlines my concerns with adopting the 'degraded' terminology, where the JWS thresholds identified do not reflect NBLs.

5. THE UPLAND AND LOWLAND RIVER DISTINCTION

5.1 In para. 15-16 of his evidence[8], Dr Snelder discusses the unresolved issue regarding whether the lower reaches of some of the region's mainstem rivers should be classified as lowland or upland rivers. I have two comments about this.

5.2 First, I do not agree with the justification provided by Dr Snelder at para 20 of his evidence, that under natural conditions concentrations increase in streams and rivers as the proportion of lowland areas contributing to those waterbodies increases. Any such increases are, in my opinion, likely to be well below NBL thresholds and therefore are not a valid reason for differentiating rivers in assessment based on NBLs. Critically, in my opinion, this approach is inconsistent with the NPSFM which does not apply an upland / lowland differentiation to any of the 15 compulsory

[6] October 2019 Science JWS (Table 1).
[7] Statement of evidence of Craig Verdun Depree for DairyNZ and Fonterra Cooperative Group Ltd at [7.1 – 7.4]
[8] Statement of Evidence of Dr Antonius Snelder on behalf of Southland Regional Council, 11 February 2022

attributes that relate to rivers[9]. In my opinion, the use of higher standards applied to upland rivers is unnecessary, and inconsistent with the original intent of identifying water bodies in need of improvement using NBLs or minimum acceptable standards.[10] I note that the footnotes to Table 1 of the October 2019 Science JWS, highlight that there were differing views between experts regarding the application of more stringent thresholds to upland rivers.[11] I am not aware that the differing views of the experts were resolved.

5.3 Secondly, if an upland/lowland classification is used to identify waterbodies in need of improvement (which I do not agree with[12]), I do not agree with Dr Snelder's assertion at para. 16 of his evidence that there is not a scientific answer to whether the low reach of a mainstem river should be classified as lowland or upland.

5.4 My understanding is that the River Environment Classification (REC) has an operational definition for defining where a mainstem river transitions from upland (i.e. hill/mountain) to lowland. This is defined as the reach where 50% of estimated rainfall in the upstream catchment occurs at an elevation <400m (asl). For example, based on the REC source of flow classification, Figure 1 indicates that the mainstem channels of the Aparima, Oreti and Mataura transition from upland to lowland approximately 71.9 km, 46 km and 46.3 km, respectively from the coast. The Waiau is upland to the coast, but the REC calculations do not take

[9] The REC-based suspended sediment attribute could potential differentiate between upland and lowland, but I notice that across the classes of different water clarity thresholds, they comprise a mixture of lowland and upland (i.e. hill / mountain) river types.

[10] Especially given that 'degraded' water quality is propagated up through the river network, and therefore upland contributing reaches are 'captured' under the definition of waterbodies in need of improvement.

[11] Footnotes in Table 1 of Oct-2019 Science JWS state: "*There is a difference of view between the experts and relates to whether there should be a more stringent standard for upland areas.*"

[12] The maps presented in my 20 December evidence adopted the upland/ lowland thresholds outlined in the JWS table to populate the MCI map (excluding DIN and DRP). Despite supporting this conservative approach, it is my opinion, that the setting of meaningful instream nutrient criteria, that are linked to achieving freshwater objectives (target attribute states) set by the Southland community is something that needs to occur as part of Plan Change Tuatahi.

into account that most of the precipitation upstream of Lake Manapouri is diverted out of catchment.

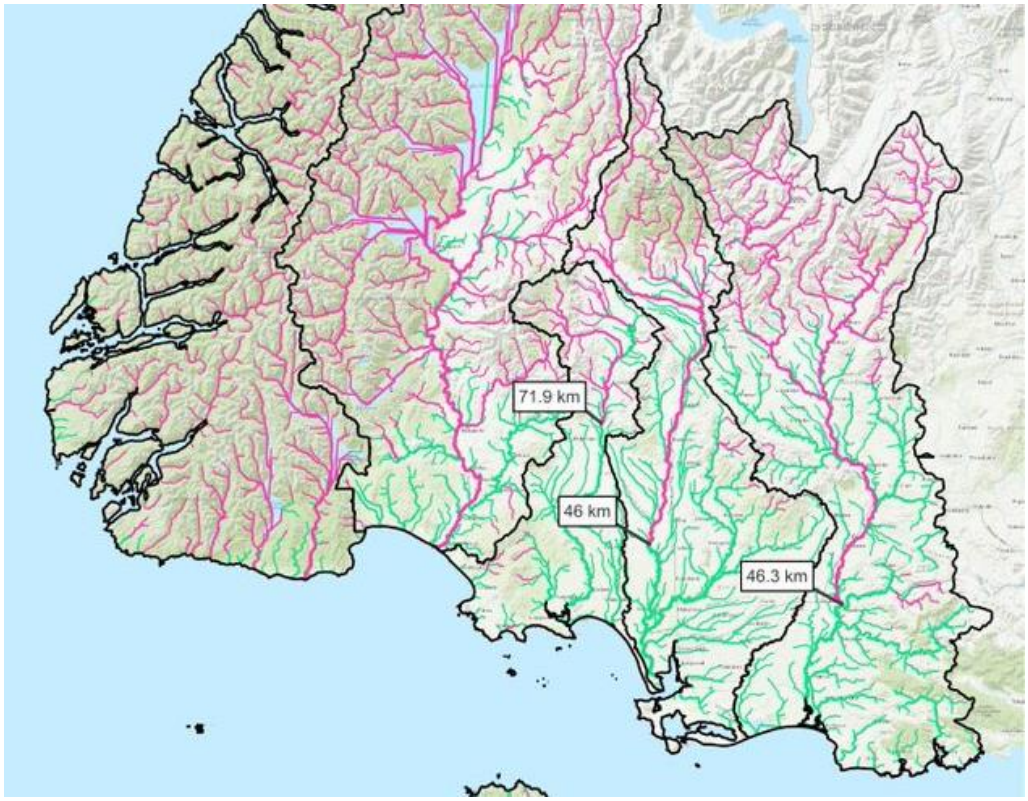


Figure 1. Transition point of mainstem rivers from upland (pink) to lowland (green) classification according to the REC classification.

6. SUITABILITY OF RIVERINE DIN AND DRP ATTRIBUTES

Dissolved Inorganic Nitrogen

6.1 DIN is not a NPSFM attribute. I can understand why it was considered by experts at the time of conferencing[13], however, in the final NPSFM the DIN attribute was not included due to concerns that proposed nutrient thresholds (Table 1) could not be used reliably and effectively in a management framework.[14]

6.2 In para. 34, Dr Snelder states that reliable[15] models were developed for DIN and DRP. In my opinion, modelled nutrient concentrations are only

[13] June 2019 Science and Technical Advisory Group (STAG) reported to the Minister for the Environment included recommendations for DIN and DRP riverine attributes. freshwater-science-and-technical-advisory-group-report.pdf (environment.govt.nz)
[14] These were the concerns of a sub-group of senior STAG members that are summarized in para. 4.11 in my primary evidence (December 2021).
[15] Reliable is the term used by Dr Snelder to described models with good predictive power (i.e. good performance between modelled and measured concentrations).

useful for identifying water bodies in need of improvement if they are assessed against meaningful[16] nutrient thresholds that relate to ecosystem health responses to anthropogenic nutrient enrichment.[17] In my opinion, the nutrient thresholds in Table 1 are based on weak relationships derived from national and modelled data.

6.3 I describe the difficulties of defining meaningful nutrient thresholds that relate to ecosystem health outcomes in para. 4.3 to 4.10 of my 20 December 2021 evidence, and at para 4.11 I outline the concerns of the government's Science and Technical Advisory Group (STAG) subgroup with the nutrient criteria (Table 1 of this evidence).

6.4 Accordingly, in my opinion, the second step in the riverine mapping described by Dr Snelder (para. 38) should not include DIN and DRP, as the nutrient thresholds are known to be problematic.[18] My understanding is that Dr Snelder, in his capacity as a technical expert for the Ministry for the Environment (MfE) assisting the STAG, presented technical information that challenged the robustness of the nutrient thresholds in Table 1. For example in a MfE prepared briefing paper for STAG, analyses by Dr Snelder showed that nutrients, when controlling for catchment variables, only explained 1% of the observed variation in MCI scores.[19] Furthermore, analysis provided by Dr Snelder determined that the DIN concentration corresponding to the NBL for macroinvertebrate health (i.e. MCI score of 90) was >5 mg/L, a value that is 5- to 10-times greater than the DIN thresholds in Table 1.

6.5 Based on the above, I am not comfortable with the DIN thresholds proposed and I do not support the use of the DIN map layer in preparing the overall composite map. My mapping at Appendix 1 of my 20 December evidence should be preferred because it relies on a widely

[16] The term *meaningful* refers to nutrient thresholds that provide confidence that at the regional / catchment-scale they are applied, they are likely to result in an improved ecosystem health outcome (e.g. periphyton and/or macroinvertebrates).
[17] For example, periphyton, macroinvertebrates, fish, ecosystem metabolism and dissolved oxygen.
[18] Dr Depree primary evidence (Para. 4.7 to 4.12); Statement of evidence (4-Feb 2022) – Appendix 1.
[19] Ministry for the Environment (2019). Freshwater Science and Technical Advisory Group: 16 April – priority paper compilation. 10-STAG-meeting-docs-16-April-2019_0.pdf (environment.govt.nz)

measured and accepted holistic biological response that incorporates nutrients, other contaminants and aquatic habitat stressors.

Dissolved Reactive Phosphorus

6.6 Although DRP is an attribute in the NPSFM, it suffers the same limitations and uncertainties that resulted in the DIN attribute being excluded from the NPSFM. In addition, the DRP attribute thresholds were derived without considering natural levels of DRP in streams. This resulted in thresholds (including the NBL) being set at concentrations so low that significant proportions of rivers in undeveloped catchments can fail the NBL for DRP. Because of this, the DRP attribute was included in the NPSFM without a NBL threshold to avoid ineffective and inequitable outcomes.[5]

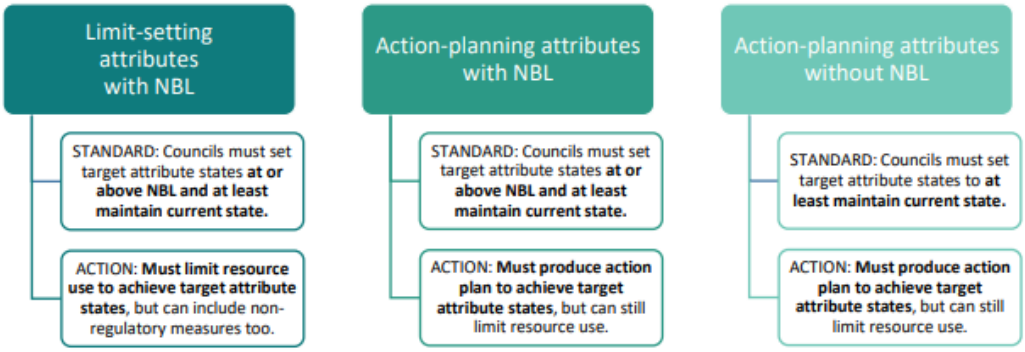


Figure 2. NPSFM 'standards' and council actions for different categories of attributes – DRP is an "action-planning attribute without NBL". (MfE 2020)[5].

7. COMMENTS ON MAPS IN LIGHT OF DR. SNELDER'S EVIDENCE

7.1 As Dr Snelder indicates in paragraph 51 of his evidence, there is a high degree of correspondence between his maps and the maps I produced in my primary evidence (22-Dec 2021), particularly macroinvertebrates (MCI). However, there are some differences in the ecosystem health estuarine maps (mainly relating to Toetoes Estuary) and human health *E.coli* map (mainly relating to the Waiau catchment). Dr Snelder points out that he used a regional model as opposed to the national models I used.

With the exception of *E.coli* in the Waiau, I believe the final maps can be adequately produced via either of the models.

Regional vs national modelling

7.2 At paragraph 37 of his evidence, Dr Snelder suggests that national models tend to be less reliable than 'region-specific' models. In principle, I agree with Dr Snelder, however, a common 'trade-off' for developing region-specific models is the much smaller data set. For example, Dr Snelder's regional models are based on approximately 60 sites, whereas the national models (Whitehead 2018)[20] are based on 800-900 sites.

7.3 Dr Snelder does not appear to have provided a reference for the MCI and water clarity regional models, so I cannot comment on whether these performed better than the national MCI. Using 68 Southland sites, I compared the national and regional model predictions with observed MCI scores, and this showed no significant differences between the two models. Accordingly, I consider the maps in my 20 December evidence that identify waterbodies in need of improvement using predicted data from national models to be at least equally fit-for-purpose[21] to the regional models relied upon by Dr Snelder.

7.4 The national models (Whitehead 2018)[20] I used to produce the maps in my 22-Dec 2021 primary evidence, are the same models that the Ministry for the Environment and Statistics NZ use to report on the state of water quality throughout New Zealand. The median *E.coli* national model of Whitehead (2018) had better performance than that reported by Snelder and Fraser (2021) for the regional model. As discussed in 7.12 below, I note that the regional model of Dr. Snelder's did appear to not perform well in the mainstem of the Waiau, whereas the national model did.

7.5 Although the national model uses sites that are outside the region, it is important to note that regional boundaries are arbitrary and do not define similarities in river characteristics. For example, Southland has 11,000 km of river classed as cool-dry-low (CDL) rivers; whereas nationally, the

[20] Whitehead A (2018). Spatial Modelling of River Water-Quality State. Incorporating Monitoring Data from 201 3- 2017. NIWA Client Report, NIWA, Christchurch, New Zealand.
[21] Possible more robust for some attribute like E.coli where performance in the Waiau catchment was not problematic as it was for the regional model.

length of CDL rivers is 49,000 km. Accordingly, the data incorporated in the national models transfers and is relevant to the Southland context.

Estuarine ecosystem health maps

7.6 At paragraph 53 of his evidence, Dr Snelder asserts that I used a different approach for constructing maps and that I based my assessment on the Science JWS (Nov 2019), and that he had used a different approach based on the estuarine trophic index (ETI) assessment (Plew 2020)[24]. My assessment was limited to the estuaries discussed in the JWS, however, my assessment method to determine if an estuary was a waterbody in need of improvement also considered the ETI assessment process that Dr Snelder used, and used the same trophic state thresholds (refer to Table 1 in Dr Snelder's evidence).

7.7 Importantly, where measured trophic state[22] data are available for Southland estuaries[23], I used this to sense-check the desktop assessment of the ETI tool. This is something I believe is a weakness in the approach taken by Dr Snelder to identify estuaries in need of improvement. It is important to note that even the authors of the ETI tool describe it as "*best suited as first-order screening assessment that might trigger more detailed investigations if changes in susceptibility are significant*."[24] In my opinion, the strength of the ETI tool 1 screening assessment is that it allows a screening level 'ecosystem health' assessment to be undertaken on an estuary that has no ecological (or water quality) monitoring data. The assessment provides an indication of the susceptibility of the estuary, which would ideally be followed up/confirmed by monitoring. By contrast, if you have monitoring data for an estuary, then this data is more robust and hence more reliable for assigning whether an estuary is in need of improvement.

7.8 Dr Snelder assessed several smaller Southland estuaries, whereas when I prepared my ecosystem health map for estuaries in my primary evidence

[22] Trophic state here refers to the excessive or nuisance growth of algae, which may be phytoplankton and/or macroalgae.
[23] Note that in my primary evidence (22 Dec-2021), I focused on the estuaries of the 4 main FMUs (Waiau, Aparima, Oreti and Mataura). The only small estuary I considered (due to its Ramsar significance) was Waituna lagoon.
[24] Plew et al. (2020). Assessing the Eutrophic Susceptibility of New Zealand Estuaries. Estuaries and Coasts (2020) 43:2015–2033.

(20-Dec 2021) I included the four main developed FMUs (Waiau, Aparima, Oreti and Mataura) and the Waituna Lagoon catchment. In my opinion, the status of many of the smaller estuaries has little impact on the combined map of catchments where ecosystem health is in need of improvement. The revised estuarine map (Figure 3), made no significant difference to the catchment area identified as 'in need of improvement' when combined with the riverine MCI map (57% vs 56% in Map 1 in Appendix 1, primary evidence (20 Dec 2021). Accordingly, I do not consider it is necessary to amend the ecosystem health Map 1 in my earlier evidence.

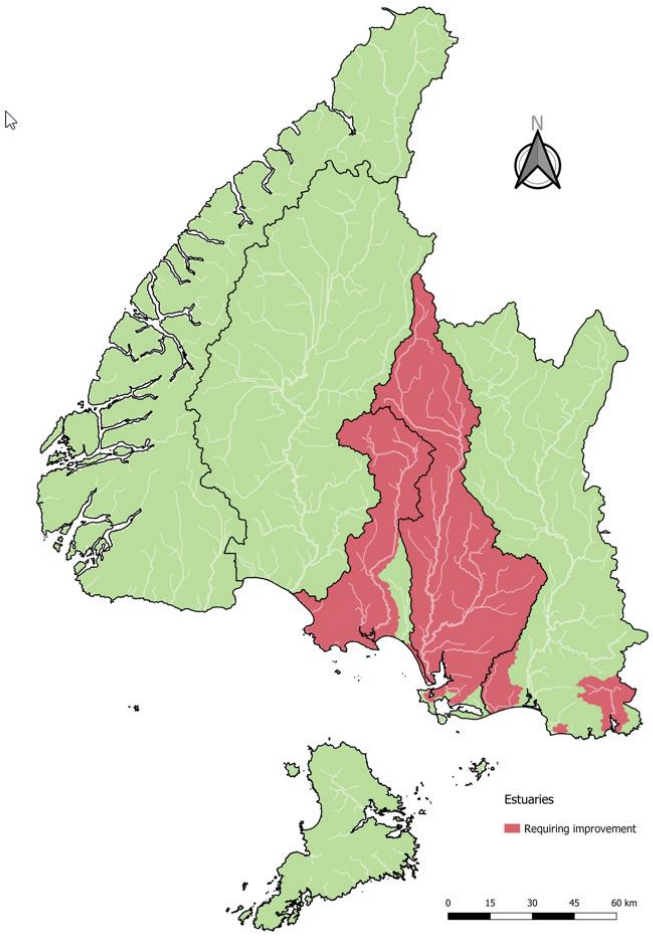


Figure 3. Map of Southland estuaries in need of improvement based on trophic state ecosystem health attributes. Estuaries include Jacobs River Estuary (Aparima catchment), New River Estuary (Oreti catchment), Waituna Lagoon, Lake Brunton and Waikawa.

7.9 The most noticeable difference between Figure 3 and Dr Snelder's estuary map (Figure 3, para. 45) is that my map does not show Toetoes Estuary (Mataura) as being in need of improvement. Briefly my reasons for this are:

a) the use of nitrogen thresholds are inappropriate to assess whether an estuary like Toetoes require improvement[25]; and

b) actual measured trophic values (i.e. amount of macroalgae growing in the estuary) for monitoring carried out between 2016 and 2020 are all above the macroalgal threshold used to determine whether the estuary is in need of improvement.

7.10 For the reasons discussed in paragraphs 7.6 to 7.9, I consider my estuarine maps to be more suitable than Dr Snelder's. This biggest difference applies to the Mataura catchment (Toetoes Estuary), but this difference has little overall effect when combined with the MCI riverine ecosystem map.

Human health – *E.coli*

7.11 Outside of the Waiau catchment, Dr Snelder's *E.coli* map in his Feb 2022 evidence (Figure 8) appears to be very similar to my *E.coli* map in Figure 7 in my primary evidence (20-Dec 2021). However, in the Waiau catchment there are major differences between the two maps. Dr Snelder's map indicates that close to 100% of the catchments waterbodies are in need of improvement for human health. By contrast, my map (using MfE's national model) indicates that a little over a third (36%) of the catchments waterbodies are in need of improvement.

7.12 The reason for the difference is explained in Snelder and Fraser (2021). Basically the regional model did not perform well in the mainstem Waiau river (presumably due to the Manapouri diversion). The solution was to discard the model *E.coli* values for the Waiau mainstem and replace with measured data from Sunnyside (upper sections) and Tuatapere (lower sections). I suspect this has resulted in a local exceedance (worse than

[25] Refer to para. 9.17 (Appendix 1) Statement of evidence of Craig Verdun Depree 4-February 2022

C-band) in the main stem, which Dr Snelder has then propagated upstream through the entire catchment.

7.13 By contrast, the national model I used did not predict any *E.coli* states worse than C-band on the mainstem river. Accordingly, there is no mainstem propagation of the 'need to improve' applied to the entire Waiau catchment.

7.14 I checked the predicted values from the national model against the 5 year *E.coli* statistics for the period 2013-2017 for the Waiau River site at Tuatapere (Table 2). Both modelled and measured data are consistent with a C-band state, which does not exceed the threshold for a waterbody in need of improvement.

7.15 Based on these data, I am confident that my *E.coli* sites is a more reliable representation of the waterbodies in the Waiau catchment that are in need of improvement for human health values.

Table 2. Modelled and measured E.coli values (2013-2017) for Waiau River at Tuatapere.

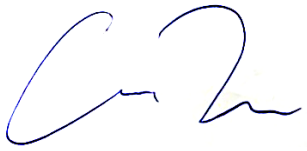
	% of samples >540	% of samples >260	median	95th %ile	NPSFM grade
measured (2013-2017)	9%	14%	60	1130	C
modelled (2013-2017)	10%	15%	54	1068	C

8. RECOMMENDATIONS REGARDING MAPPING

8.1 In my opinion the process of identifying water bodies in need of improvement for the purposes of pSWLP is best delivered using a map for ecosystem health, and a separate map for human health *(E.coli*). The Ecosystem health map should comprise both riverine and estuarine layers. In my opinion, just as estuaries are assessed by one 'attribute' (i.e. trophic response of either macroalgal or phytoplankton as a proxy for ecosystem health), in my opinion, a single biological 'response attribute' like MCI is equally appropriate for assessing and identifying riverine water bodies in need of improvement.

8.2 Having considered the maps presented by Dr Snelder, which apart from some estuary and *E.coli* issues (refer para 7.6 to 7.15), generally showed high degrees of correspondence, I consider that Dr. Snelder's final aggregated map (Figure 4 in his Feb 2022 evidence) provides no advantages over the maps in my primary evidence (Map 1 and Map 2, Appendix 1).

8.3 For the avoidance of doubt, I recommend Map 1 in Appendix 1 of my primary evidence for identifying water bodies in need of improvement for ecosystem health; and Map 2 in Appendix 1 of my primary evidence for identifying water bodies in need of improvement for human health.



DR CRAIG VERDUN DEPREE

22 February 2022