Science and Technical Advisory Group Meeting

Agenda - DRAFT

Dates and Location: Wednesday 27 November 2019 9.00am-5.00pm, Terrace Conference Centre, 114 The Terrace, Wellington.

STAG Members RSVPed: Joanne Clapcott, Ian Hawes, Clive Howard-Williams, Jenny Webster-Brown, Ken Taylor (chair), Bev Clarkson, Bryce Cooper, Jon Roygard, Adam Canning, Marc Schallenberg, Ra Smith, Mike Joy, Chris Daughney, Graham Sevicke-Jones

TBC: Tanira Kingi, Dan Hikuroa, Mahina-a-Rangi Baker

Apologies: Jamie Ataria, Russell Death

Items:

	8.45 am	*Coffee and tea*	(15 mins)
1.	9.00 am	Consultation debrief and feedback (Chair, STAG members)	(15 mins)
2.	9.15 am	Plan for next few months (Martin Workman)	(30 mins)
3.	9.45 am	Sediment	(45 mins)
	10.30 am	*Morning tea*	(10 mins)
	10.40 am	Sediment continued	(20 mins)
4.	11.00 am	Nutrients	(1.5 hr)
	12.30 pm	*Lunch*	(45 mins)
5.	1.15 pm	Nutrient impact analysis	(30 mins)
6.	1.45 pm	Brief items: maintain or improve, stock exclusion	(30 mins)
7.	2.15 pm	Ecosystem Health	(30 mins)
	2.45 pm	*Afternoon tea*	(15 mins)
	3.00 pm	Ecosystem Health continued	(2 hr)
	5.00 pm	*Meeting close*	

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Policy responses to STAG recommendations

See overleaf

STAG recommendation	MfE policy response (NPS section in brackets)
1. Amend current national direction on freshwater management to ensure that any future national direction: a. is designed to protect and enhance ecosystem health, defined as the extent to which a freshwater management unit supports an ecosystem appropriate to that freshwater body type (river, lake, wetland, or aquifer). b. recognises that five biophysical components contribute to freshwater ecosystem health: i. Water quality, ii. Water quantity, iii. Habitat, iv. Aquatic life, and v. Ecological processes	Presented in draft NPS for consultation: a. Definition of Ecosystem Health value incorporating five components (Appendix 1a) b. New attributes relating to a wider range of ecosystem health components (Appendix 2) c. Councils will be required to report against all five components of ecosystem health (water quality, water quantity, habitat, aquatic life, ecological processes) using at least the new national indicators/attributes. (Chapter 3, part 7) d. New compulsory Threatened Species value (Appendix 1A) e. Direct regional councils to set objectives for fish, informing consenting decisions and mitigation of structures. Specify minimum design standards. Direct Councils to assess existing structures, maintain records, and prioritise mitigation (Chapter 3, part 5C) f. Measures to prevent the further loss of wetlands (Chapter 3, part 5A) and streams (Chapter 3, part 5B)
2. Amend the national direction in freshwater management to better bring mātauranga Māori into the management framework by supporting the development of mātauranga-based indicators and facilitating better engagement between scientists and kaitiaki in freshwater monitoring and management.	Presented in draft NPS for consultation: a. Options for a compulsory Māori value presented in discussion document (Appendix 1a) b. Monitoring methods must include Mātauranga Māori where relevant – this was added in previous round of changes and is being retained in this version (Chapter 3, part 4H) c. Giving expression to Te Mana o te Wai includes acknowledging and applying broader systems of values and knowledge to the health and wellbeing of waterbodies (Chapter 1, part 5)

STAG recommendation	MfE policy response (NPS section in brackets)
3. Amend national direction on freshwater management to clarify the intent of the current policy expectation that the 'overall quality of fresh water within a freshwater management unit will be maintained or improved' by requiring: a. freshwater objectives to be set to maintain or improve the current state of all metrics (as opposed to maintaining metrics within a NOF band), b. regional councils to report on freshwater quality and the achievement of freshwater objectives alongside a wider range of information, including: pressures (e.g. changes in land use, human inputs, invasive species and climate); higher-level measures of state (e.g. ecosystem health); the effectiveness of management plan rules and methods; and progress towards implementing management plans, and c. guidance on how to determine what level of monitoring is enough to inform analysis and reporting, supported by worked examples of how this should be done.	a. Adopted (Chapter 3, part 4E) b. Adopted (Chapter 3, part 7B) c. Guidance will be provided
4. All bottom line numbers in proposed attribute tables should be read as being subject to the qualification: 'unless it can be shown reliably that the natural state does not meet the bottom line'.	Presented in draft NPS for consultation - provided for in Exceptions section (Chapter 5, part 8B)
5. Amend national direction on freshwater management to ensure the dissolved oxygen (in rivers) attribute applies in all river reaches and is not limited to "below point sources" of pollution.	Presented in draft NPS for consultation. There are two dissolved oxygen attributes proposed: Dissolved oxygen (rivers) – attribute requiring an action plan (Appendix 2B) Dissolved oxygen (rivers, below point sources) – attribute requiring limits (Appendix 2A)

STAG recommendation	MfE policy response (NPS section in brackets)
6. Amend national direction on freshwater management to: a. introduce numeric tables for bottom water dissolved oxygen in lakes specifying a national bottom line of 0.5 mg/L; and b. address mid-hypolimnetic dissolved oxygen in naturally seasonally-stratifying lakes with reference to specified numeric attribute bands.	Presented in draft NPS for consultation as attributes requiring management plans (Appendix 2B)
7. Amend national direction on freshwater management to introduce numeric biophysical tables for ecosystem metabolism, without specifying a national bottom line.	Presented in draft NPS for consultation as attribute requiring management plan (Appendix 2B)
8. Amend national direction on freshwater management by changing the table specifying numeric biophysical values for periphyton (trophic state) to: a. replace the exclusion allowing rivers in the 'productive class' to exceed bottom lines 17 per cent of the time, and b. require councils use the default nutrient criteria provided in the absence of robust, locally suitable, independently peer reviewed criteria.	Presented in Discussion Document for consultation.
9. Amend national direction on freshwater management to introduce a table specifying numeric biophysical values for fish biotic integrity, specifying a national bottom line of 18 when measured using the Fish Index of Biotic Integrity	Presented in draft NPS for consultation as attribute requiring management plan (Appendix 2B)

STAG recommendation	MfE policy response (NPS section in brackets)
10. Amend national direction on freshwater management to introduce tables specifying numeric values for a Macroinvertebrate Community Index, Quantitative Macroinvertebrate Community Index, and an Average Score Per Metric, specifying national bottom lines of 90, 4.5 and 0.3 respectively.	Presented in draft NPS for consultation as attributes requiring management plans (Appendix 2B)
11. Amend national direction on freshwater management to introduce numeric attribute tables for Lake ecosystem health by reference to the Lake Submerged Plant Index (LakeSPI), specifying a national bottom line for the native plant condition of at least 20% of the maximum potential score, and a national bottom line for invasive plants of less than 90% of the maximum potential score.	Presented in draft NPS for consultation as attribute requiring management plan (Appendix 2B)
12. Amend the national framework for freshwater management to introduce tables specifying numeric biophysical values for deposited and suspended sediment.	Presented in draft NPS for consultation: a. Suspended fine sediment included as attribute requiring limits (Appendix 2A) b. Deposited fine sediment included as attribute requiring management plan (Appendix 2B)
13. Amend the national framework for freshwater management to introduce numeric biophysical tables for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) and specifying national bottom lines of 1 mg/L DIN as an annual median (and 2.05 mg/L as a 95th percentile) and 0.018 mg/L DRP as an annual median (and 0.054 mg/L as a 95th percentile).	Presented in draft NPS for consultation. Further analysis underway to inform final decisions by Ministers.

STAG recommendation	MfE policy response (NPS section in brackets)
14. Amend the national framework for freshwater management to require regional councils to: a. identify the extent and evaluate the condition of existing wetlands b. prevent any further reductions in the extent of existing wetlands c. address the management of wetlands with reference to specified numeric bands, introducing a requirement to lift the wetland condition index to at least 10 and to maintain or improve the condition of existing wetlands where the condition score is greater than 10	Presented in draft NPS and NES for consultation: a. Incorporated (Chapter 3, part 5A, and in the NES rules) b. Incorporated (Chapter 3, part 5A, and in the NES rules) c. We have not incorporated a WCI attribute. Under the RMA powers of entry onto private land extends to compliance only, councils would not be able to monitor wetland condition where a consent condition was not invoked. Therefore including the WCI as an attribute at the moment would be asking councils to do something they cannot achieve. We will try to incorporate this into guidance. d. The minimum monitoring requirements cover most of the content of the WCI (rather than stipulating the use of the particular method in regulation). This is because the WCI methodology was published in 2004, and some councils use more recent iterations of it adapted especially for their regions, it is currently unclear which version would prevail at a national scale.
15. Undertake urgent work to fill the identified knowledge gaps which currently constrain our ability to effectively manage fresh water and the health of freshwater ecosystems.	MfE will progress with STAG.

Excerpts from submissions with a science focus

This document is intended to inform discussion at the STAG meeting and includes:

- excerpts from organisational submissions that raised science issues in relation to the proposals
- a collection of science issues that MfE would like to discuss with STAG.

This document does not include:

- a balanced summary of submissions, or a representative view of the level of support for proposals – that analysis is in progress
- a comprehensive summary of policy or impact analysis issues
- everything the submitters said on the subject - please refer to full submissions.
- sediment submissions – please see sediment paper

Contents

Ecosystem Health

Questions

1. We are going to provide an ecosystem health reporting template to encourage transparent reporting of ecosystem health, in accordance with the definition agreed by STAG. What should this look like? What is the appropriate scale for reporting?

2. Are any of the ecosystem health measures redundant? How could this be assessed, do we currently have the data available to do this?

Environment Canterbury

Ecosystem health and human contact attributes

11. We support the need to maintain or improve water quality and ecosystem health. However, for some catchments where water quality improvements are required, implementation and changing current practice will take time and in some cases may not be achieved within a generation.

12. We support **current** attributes requiring limits:
    - Lakes: phytoplankton; total nitrogen; total phosphorus; and cyanobacteria
    - Rivers: periphyton; ammonia toxicity; dissolved oxygen (point source); *E. coli* (all year round); and cyanobacteria.

13. We support the proposal that councils be required to implement action plans to drive improvements where attributes are declining or are below national bottom lines. We support this approach as it reflects that there may be a wide range of reasons for a deterioration, and the variety and specificity of actions that might be taken will depend on the catchment and situation. We suggest these action plans sit outside any planning framework to provide flexibility for updates to plans based on progress towards monitored outcomes. We suggest there needs to be greater clarity regarding the definition and composition of action plans and how councils will be held to account for them.

14. We support **new** attributes, national bottom lines and requirements for action plans including for:

- Macroinvertebrates with three measures (noting that the national bottom line for MCI has increased)
- Fish monitoring (noting that this imposes a new monitoring requirement on councils, requiring additional resources)
- Submerged plants
- Deposited fine sediment
- Dissolved oxygen - seven-day continuous monitoring at least once during summer
- Ecosystem metabolism
- *E. coli* at primary contact recreation sites (noting that the timing of the bathing season differs around the country and should be set by councils)

Cawthron Institute

Ecosystem health

We support using the framework for ecosystem health developed by Clapcott et al. (2018) with five components: aquatic life, water quantity, water quality, habitat and ecological processes. We support the addition of more national attributes into the NOF to provide more holistically for ecosystem health across these five components. Specifically, we support including attributes for aquatic life (macroinvertebrates, fish and macrophytes), habitat (sediment) and ecological processes (ecosystem metabolism). We acknowledge that some of these attributes are in their infancy in applied resource management, however they are critical to the management of healthy ecosystems.

Trout and salmon are highly valued and should be allowed for in definitions of ecosystem health. Section 7(h) of the RMA 1991 requires that decisions makers have particular regard to the protection of trout and salmon habitat. We therefore recommend, in waterbodies where trout and salmon do not threaten the extirpation of indigenous species, (1) that the definition of a healthy ecosystem include trout and salmon alongside indigenous species, (2) more stringent deposited sediment standards in spawning reaches apply (as suggested in the STAG's deposited sediment attribute note). We provide further comments in relation to the draft NPSFM later in our submission on the need to rectify the current omission of trout and salmon as valued introduced species in the NPSFM, and the need to safeguard their habitats and fisheries. The current situation is allowing perverse environmental outcomes for indigenous species and ecosystems and trout and salmon fisheries.

DairyNZ

DairyNZ supports the proposed approach of having some attributes managed via limits, and others via an action plan (i.e. attributes in Appendix 2A and 2B, respectively). DairyNZ agrees that in many cases an action plan, or adaptive management approach, will achieve better ecosystem outcomes than attempting to set contaminant limits that may explain <10-15% of the observed variation in ecosystem health measure being managed. We note, and fully support, the following statement in the discussion document:

> *'This approach reflects that there may be a wide range of reasons for a deterioration, a variety of actions that might be taken, and the specific actions might depend on the catchment and situation.'*

Importantly, having attributes where bottom-line exceedance triggers an action plan (as opposed to direct limit setting) allows for decision-making in the face of uncertainty.

Ecosystem health is complex. Therefore, having bottom-lines to trigger action plans for those attributes that relate to more integrated measures of ecosystem health is well suited for managing the multitude of stressors and associated uncertainty driving ecosystem health at each site. This also allows the number and extent to which different policy levers are pulled to be tailored to the specific challenges in each catchment, freshwater management unit or site. We suggest that this hierarchical approach across limits, action plans and monitoring is likely to achieve better water quality outcomes over the long term.

DairyNZ can see value in considering some of the five proposed components of ecosystem health:

- **Water quality** - strengthened by including sediment and dissolved oxygen.
- **Biology** - strengthened by inclusion of macroinvertebrates, fish, lake native macrophytes.
- **Habitat** - unsure of the added value. Value will depend on quality of action plans.
- **Water quantity** - strengthened by including flow requirements.
- **Ecosystem metabolism** - no value. Management approaches already include higher indicators of stream biological health such as macroinvertebrate indices that integrate lower level processes through inclusion of dissolved oxygen monitoring, which we support. The proposal presented is very unclear and does not contain any proposed values.

However, we do not believe that being a component of ecosystem health should be a default for attribute development. Of fundamental importance is the inclusion of a minimum set of attributes to cover-off contaminants that can be key drivers of degraded ecosystem health (e.g. fine sediment), and integrated measures of ecosystem health, which includes a sensitive, widely applicable, biological indicator of stream health (i.e. macroinvertebrate community health), and dissolved oxygen (essential for life-supporting capacity of freshwater ecosystems; integrating both biotic [ecosystem metabolism] and abiotic [reaeration] oxygen dynamics).

Local Government NZ

Our scientists advise that there is not the requisite rigour behind all the proposed attributes and monitoring proposals. It appears that application of some of the proposed 23 attributes will be inappropriate in certain circumstances. The DIN/DRP attributes in particular, have been developed on a basis that means the national bottom lines will be not necessarily applicable at the regional or catchment scale. Other attributes such, and Fish-IBI, LakeSPI and ecosystem metabolism appear premature because the science is still evolving and/or their applicability and appropriateness varies according to the nature of waterbodies. Applying these attributes as proposed could lead to perverse outcomes and impose unnecessary costs.

General support for proposals to "raise the bar on ecosystem health":

1. We support the drive to improve Ecosystem Health throughout New Zealand waterways and recognise this will be achieved through improvements at catchment (e.g. nutrient and sediment generation) and reach scale (e.g. local habitat quality, riparian condition).
2. There are multiple stressors that influence Ecosystem Health (e.g. flow, temperature, sediment, nutrients, habitat) through direct and indirect pathways (e.g. Figure 1), so achieving improved outcomes will usually require a variety of actions appropriate to the local context (see pg. 43 of Action for healthy waterways discussion document)
3. Direct toxic effects of nitrate and ammoniacal nitrogen on stream fauna are already addressed through existing NPS-FM attributes
4. Nutrients also affect Ecosystem Health through eutrophication (i.e. nutrient enrichment leading to excessive algae/periphyton) and associated stressors (e.g. degraded habitat, food web changes and dissolved oxygen variability)
5. Eutrophication in rivers is addressed through the Periphyton attribute in the current NPS-FM. Guidance for this attribute also requires consideration of downstream waterbodies.
6. Periphyton biomass is an important component of Ecosystem Health and influences multiple values including recreation, mahinga kai and sports fisheries. Nutrient management will often (but not always) be required to achieve desired periphyton outcomes – stream shade can also be effective at controlling periphyton biomass in small streams, although potential consequences for downstream waterbodies will need to be considered
7. We recognise there is a gap in national direction for nutrient management of primary production in those waterways that do not have conspicuous periphyton growth (e.g. soft-bottomed waterways that may be dominated by macrophytes – roughly 25% of NZ waterways)
8. Existing and proposed NPS-FM monitoring requirements (e.g. fish, macroinvertebrates and ecosystem metabolism) are likely to largely address the gap for waterways without conspicuous periphyton, and complement the existing Ecosystem Health attributes by requiring actions to address 'Poor' states of Ecosystem Health indicators
9. We support further development of attributes, relevant to the Ecosystem Health value, that recognise natural variability and local context, so that responses can be appropriately and effectively targeted

NZ Freshwater Sciences Society

Additional attributes for ecosystem health

14. The Society supports using the framework for ecosystem health developed by Clapcott et al. (2018) with five components: aquatic life, water quantity, water quality, habitat and ecological processes. We support the addition of additional national attributes into the NPS FM to provide more holistically for ecosystem health across these five components. In particular, we support including additional attributes for aquatic life (macroinvertebrates, fish and macrophytes), habitat (sediment) and ecological processes (dissolved oxygen and ecosystem metabolism) in the draft NPS FM. We acknowledge that some of these attributes are in their infancy in applied resource management, however they are critical to the management of healthy ecosystems.

15. We note that the NPS-FM does not specifically include any groundwater policies (in section 2.2 of the draft NPS FM) and the Society submits that these are freshwater ecosystems in their own right that harbour taxa and ecosystems dependent on freshwater and are therefore highly relevant to the NPS FM. By extension this lack of groundwater policy is reflected in the lack of proposed NBL for groundwaters. We acknowledge that the ability to set such NBL for groundwater is problematic but submit that even non-numeric targets or a limit on the range of change in relevant attributes can be provided.

16. Development of further habitat attributes and acknowledgement of groundwater ecosystems at a national level are needed for future iterations of the NPS FM to meaningfully support ecosystem health. The Society would like to engage directly with MfE on the forward work programme for future attribute development across the full range of values.

Attribute guidance

Question

1. What are STAG's recommendations on the statistics for assessing the state of the different attributes? (we can potentially go through this as a sub-group at a later date).

Cawthron Institute

Attribute guidance

There are inconsistencies in the degree of sampling and statistical specifications provided across the 23 attribute tables that need to be rectified (e.g. Tables 1, 3 and 4 do not specify a monitoring frequency or the timeframe over which to assess attribute state and Table 18 (deposited fine sediment) does not specify a statistic). Some medians are specified as *annual* medians while others are *rolling* medians, and some sampling requirements are presented as recommendations while others are more directive. Other than for Table 11, it is not clear when there is more than one numerical attribute state (e.g. Table 18), how to assign an overall attribute band. There is also a need to define the spatial scale at which statistics are applicable.

For example, a two-year annual median deposited sediment statistic applied at a single site is quite different from one applied at an FMU scale. Guidance on site representativeness is crucial for ensuring attributes are monitored where and when to provide a robust assessment.

NZ Freshwater Sciences Society

Attribute guidance

17. There are inconsistencies in the degree of sampling and statistical specifications provided across the 23 attribute tables that need to be rectified (e.g., Tables 1, 3 and 4 do not specify a monitoring frequency or the timeframe over which to assess attribute state and Table 18 (deposited fine sediment) does not specify a statistic). Some medians are specified as *annual* medians while others are *rolling* medians, and some sampling requirements are presented as recommendations while others are more directive. Other than for Table 11, it is not clear when there is more than one numerical attribute state (e.g., Table 18), how to assign an overall attribute band. One option to resolve this, which would also provide a place for further explanation of methods and streamline the updating of these over time (e.g., via the ongoing development of National Environmental Monitoring Standards), would be to remove details on sampling requirements and reproduce these in a stand-alone revised attribute guidance document that could be cross-referenced under each attribute table.

NIWA

68. There are inconsistencies in the data requirements and statistics used for the different attributes. In some of the attribute tables, no monitoring frequency or durations is specified. Some attributes are based on annual medians and others on rolling medians. For some attributes, there are two different variables and/or two different summary statistics in each band (e.g., MCI and QMCI in Table 13). With the exception of Table 11, no direction is given in these cases for assigning an overall attribute band. In the case of deposited fine sediment (Table 18), no summary statistic is specified at all. Each of these inconsistencies and gaps needs to be addressed. We recommend a stand-alone attribute guidance document with all sampling and statistical specifications.

DIN and DRP attributes, periphyton biomass

Questions

1. For the bottom lines of 1 mg/L for DIN and 0.018 mg/L for DRP, in how many places will we be overestimating or underestimating the impact on ecosystem health?

2. What is the ecological benefit of further reducing DIN and DRP if good 'ecological status' (e.g. ecosystem health components in a healthy state) can already be demonstrated?

3. The Freshwater NPS contains an exception for naturally occurring processes:

3.23 Exception for naturally occurring processes

(1) If all or part of a waterbody 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.

(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 prevent 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.

What methods and approaches does STAG recommend for separating the human-induced and natural components of water quality measures? Is the method in McDowell et al. (2018)[1] suitable?

[1] http://www.mfe.govt.nz/publications/fresh-water/establishment-of-reference-conditions-and-trigger-values-chemical-physical

Environment Canterbury

15. We have particular concerns about the new nutrient attributes requiring limits to be set to manage eutrophication (Dissolved Inorganic Nitrogen – DIN and Dissolved Reactive Phosphorus – DRP). We question the science underpinning the setting of national bottom lines for DIN and DRP based on separate correlation of these attributes with ecosystem health measures such as Macroinvertebrate Community Index (MCI). The scientific evidence we have seen points to eutrophication and MCI being driven by multiple factors, including flow regime, nutrient concentration and physical habitat. The ways that these factors interact are catchment specific and do not easily lend themselves to national attribute states.

16. We acknowledge that eutrophication is an ecosystem health driver that needs to be managed. In Canterbury's alpine and hill-fed river systems eutrophication can be seen in periphyton growth where the dissolved nutrients directly affect the amount of periphyton growth. For this reason, nearly all DIN limits set in our hill-fed and alpine rivers have been well under 1 mg/L.

17. In Canterbury's spring-fed streams (i.e. fed from groundwater) eutrophication is dominated by plants rooted in the streambed and banks. In this case plants can obtain nutrients (nitrogen and phosphorus) from the sediment. Drastically reducing dissolved nutrients in the water column may have very little impact on overall eutrophication. In these cases, we have concentrated on limiting sediment inputs and using shade and other aspects of physical habitat to improve ecosystem health.

18. This difference in eutrophication response between river types highlights the difficulty in setting national limits for single attributes in ecosystems that vary considerably across the country.

19. In recognising the need to manage eutrophication effects we suggest two alternative approaches to manage DIN:
    - Keep the current attribute structure but include an exception for spring-fed systems where nitrogen is managed via the nitrate toxicity attribute. Or:
    - Move the DIN attribute from a limit-setting attribute to an action plan attribute with clear direction that for spring-fed systems the action plan needs drive overall improvements in ecosystem health rather than drive reductions in DIN.

20. We see similar difficulties for setting DRP limits using national attribute states when we know there are natural variations around the country. In Canterbury we see DRP concentrations above the suggested national bottom line in catchments with volcanic geology (e.g. Banks Peninsula and Timaru volcanics).

21. We note that under the provisions for exceptions for naturally occurring processes (part 3.23) an improved attribute state is still required ("to the extent feasible given the natural processes"). It is extremely difficult to ascertain the "extent feasible" and therefore we suggest that under the "exception for naturally occurring processes" it is amended to "maintain or improve" rather than solely improve.

Cawthron Institute

DIN/DRP

Dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) are nutrients which can enrich freshwater ecosystems and at elevated levels result in poorer outcomes for ecosystem health in groundwater, rivers and receiving environments such as lakes, estuaries and the coast. We support the inclusion of DIN and DRP national attributes for ecosystem health and the inclusion of national bottom lines for these contaminants, noting that where natural processes exceed the attribute states this can be managed through the draft NPS FM provisions at 3.23. Limiting resource use to halt and reverse the uncontrolled discharge of nutrients into water is important to ensure that resource use is sustainable into the future and freshwater ecosystems and connected waterbodies are healthy. More work is urgently needed to identify nutrient limits for groundwater ecosystem health.

DairyNZ

Dissolved inorganic nitrogen (DIN)	**Do not support as attribute.** **Propose** that the combined measures will provide for ecosystem health outcomes, and in doing so address the perceived need for nutrient attributes that address trophic level effects of nutrients (especially in soft-bottom streams): 1. Correct implementation of the periphyton attribute as notified in the 2017 amended version of the NPS-FM (2014). 2. Raising the bar on nitrate and ammonia toxicity by increasing the level of protection to 90% (from 80%). 3. The introduction of new attributes that incorporate integrated measures of ecosystem health and processes (i.e. macroinvertebrates and dissolved oxygen) that apply in both hard and soft-bottom streams. 4. Recommend councils not report on nitrogen status of a waterway using the nitrate toxicity attribute as a measure of ecosystem health. Alone, nitrate toxicity is not reflective of ecosystem health. **Support** nutrient thresholds being made available as guidance table for councils (where required/applicable) in developing action plans for biological ecosystem measures/attributes - like macroinvertebrate health. This would be analogous to MfE's recommendation/proposal to make periphyton nutrient criteria available as guidance tables.
Dissolved reactive phosphorus (DRP)	**Do not support** (same reasons as DIN attribute).
Ammonia (toxicity)	**Support** with the recommendation to adopt 90% protection level of bottom-line, which increase the level of protection for aquatic organisms to 90%; reporting of ecosystem health, focused on biological measures of stream health, such as macroinvertebrate indices. **Recommend** changes to how councils report on nitrogen status of a waterway using the ammonia toxicity attribute. Ammonia toxicity should not be used to report/infer ecosystem health status (with respect to nutrient enrichment). Reporting should be aligned/structured with the higher prominence of integrated ecosystem health measures. For example, if macroinvertebrate objectives are not being met, reporting on whether ammonia concentrations are potential limiting ecosystem health (i.e. above/near national bottom-line) would be more informative and address concerns about toxicity reporting used to incorrectly infer nutrient pressures to ecosystem health.
Nitrate (toxicity)	**Support** with the recommendation to adopt 90% protection level of bottom-line. **Recommend** - same comment as for ammonia.

Hawkes Bay Regional Council

6.2 Nutrient management

The HBRC has particular concerns about the management of nitrogen and phosphorus in the NPS. It supports the LGNZ submission in this regard. The Council notes that the regional plan provisions for nitrogen management in the Tukituki catchment do not align well with the proposed new NPS requirements. Tukituki has DIN limits more severe than NPS proposed bottom lines with consents needing to be issued to allow production land uses to continue operating. A higher minimum standard as a national bottom line may lead to concerns at a local level about the level of performance necessary.

The HBRC also notes that the improvement of ecosystem health in lowland rivers such as those in the Karamū catchment is complex and fraught in some places by lack of good information about sources and pathways of nutrient loss from land. Furthermore, the Council has research information to support a focus on management of macrophytes as the priority action for improving ecosystem health in these lowland rivers. The main environmental stressors for those rivers have been found to be low dissolved oxygen caused by excessive macrophyte growth and high temperatures. The proposed TANK Plan Change for these rivers therefore has a particular focus on riparian land management. The NPS requirements for DIN and DRP would divert attention away from mitigation measures that would have the greatest benefit for ecosystem health outcomes.

Our solution
Remove DIN and DRP as Appendix 2A attributes and replace with more general policy direction to consider dissolved nutrient impacts on ecosystem health on a more site specific basis.

Local Government NZ

DIN and DRP: National 'standards' for matters that are inherently catchment-specific

The Regional Sector has given particular consideration to the merit of national attribute states for DIN and DRP and associated national bottom-lines for those nutrients.

Based on the advice of its science advisers (see box below), the Regional Sector is of the opinion that the DIN and DRP attributes states may not be effective in improving ecosystem health in many – mostly soft-bottom and spring fed - rivers. At the same time those national bottom-lines can be expected to impose significant

social and economic cost in some localities. In some instances, those costs include large-scale land use change. We note, for example, that the proposed national bottom-lines for both DIN and DRP are significantly more stringent than the limits recently included in the operative Canterbury Land and Water Regional Plan in respect of spring-fed plains and hill-fed lower streams in the Selwyn Waihora, Hinds and Waitaki sub-regions. In those, catchments nitrate-nitrogen (the major component of DIN) limits are set at levels up to 6.9 mg/L (in the case of spring-fed plains rivers) and up to 3.8mg/L (for hill-fed lower streams). These limits are obviously well above the 1mg/L national bottom-line proposed.

As per the science advice below, limiting nitrate-nitrogen in those spring-fed streams to 1mg/L will not address the macrophyte risk because macrophytes can obtain nutrient from river bed sediment not simply the water column. Other intervention measures will be needed.

While those Canterbury limits are some of the more extreme examples, other plans have set or in the process of setting DIN limits on some streams (or stream reaches) above 1mg/L. They have done so after careful consideration of risk, effectiveness and cost.

Advice of the Regional Sector's science advisers

Nutrients are undoubtedly a driver of eutrophication, which in turn is a driver of ecosystem health.

Regional Sector science practitioners question the validity of applying a correlative approach to setting attribute bands and bottom-lines at a national scale. We have yet to see the peer reviewed, published scientific papers that underpin the correlation approach to deriving those bands and bottom-lines.

Our experience from our own data sets is that there is a poor correlation between nutrient concentrations and macroinvertebrate scores which reflects the complex nature of ecosystem health with multiple drivers all working in differing ways in different locations.

In many New Zealand rivers the eutrophication outcome is periphyton growing on the hard bottomed stream bed. In this case managing dissolved nutrients is entirely appropriate in order to manage for periphyton growth.

The New Zealand Periphyton Guideline (Biggs, 2000) recognises the importance of dissolved nutrients, in addition to the frequency of flushing flows as drivers of the amount of periphyton growth.

Application of the New Zealand Periphyton Guideline across New Zealand has shown that it is a good predictor of periphyton growth in hill-fed streams but a poor predictor outside those streams.

In soft-bottomed streams and spring-fed streams (i.e. where they are groundwater fed and there is a low frequency of flushing flows) aquatic plants (macrophytes) are the dominant growth. Most macrophyte species can acquire nutrients from both the water-column and sediments (Matheson et al., 2012).

In these situations restricting the nutrient concentrations severely may have little impact on the plant growth; so, the eutrophication requires managing in different ways (e.g. shading, reducing fine sediment input, etc.).

The difference in the eutrophication mechanism in different streams highlights the difficulty in applying a simplified national bottom-line approach to a high complex system. We suggest the following options for Rivers dissolved nutrients:

- The DIN and DRP tables are removed; OR
- Nitrogen and phosphorus are identified in the NPS as drivers of eutrophication and there is a requirement for limits to be set to manage for eutrophication (as in 2017 NPS); OR
- Where the nutrient concentrations are greater than the proposed national bottom-lines, a process is developed that regional councils must follow to ensure improvements in overall ecosystem health; OR

- Spring-fed and soft-bottomed streams/rivers are given an exception to allow setting a DIN/DRP limit greater than the national bottom-line provided there are clear plans to improve the overall ecosystem health outcomes.

We also question the validity of including the 95th percentile as an ecosystem health measure. Aside from the difficulty in being precise at calculating 95th percentiles we have not seen scientific evidence that the measurement distribution for dissolved nutrients is a driver of ecosystem health (apart from through nitrate toxicity which is covered elsewhere in the attribute tables).

Where the dissolved nutrients attributes are for toxicity (ammonia and nitrate) we believe these should remain as there is clear evidence that elevated concentrations are detrimental to ecosystem health. We note that if the DIN attribute for eutrophication remains then the nitrate toxicity attribute becomes redundant.

We believe that the nitrate toxicity national bottom-line could be raised so that 90% of species are protected (i.e. annual median of 3.5 mg/L) rather than the current 80% protection. This would be challenging to achieve in many areas with intensive agriculture but would lead to a significant environmental improvement.

The broader point that is that there are multiple stressors that influence ecosystem health (e.g. flow, temperature, sediment, nutrients, habitat) through direct and indirect pathways. Achieving improved outcomes will usually require a variety of actions appropriate to the local context. The importance of limiting nutrients will vary significantly. It is not a question of 'one size fits all'.

Accordingly, we consider that the proposal for nationally prescribed DIN and DRP limits is inconsistent with the principles of *evidence-based policy* and do not enable *tailored solutions* applicable to local solutions.

In our opinion, such limits will likely lead to an over-emphasis on driving down nutrient concentrations when ecosystem health will (in some places at least) be more directly dependent on other factors.

A more detailed review of the DIN and DRP attributes (and the concerns with the way the proposed limits been derived) is set out in **Appendix 6**.

For those reasons, the Regional Sector does not support the retention of the DIN and DRP attributes in the draft NPS-FM. Recognising the role that nutrients can play in ecosystem health (and hence the need to control nutrients in some instances) we have developed an alternative approach as set out below. In advancing this alternative proposal we emphasise the robust testing that occurs through regional plan processes.

NZ Freshwater Sciences Society

Dissolved nutrients (DRP and DIN)

30. Dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) are nutrients which can enrich freshwater ecosystems and at elevated levels result in poorer outcomes for ecosystem health in groundwater, rivers and lakes and receiving environments such as estuaries and the coast. The Society supports the inclusion of DIN and DRP national attributes for ecosystem health in rivers and the inclusion of NBLs for these contaminants, noting that where natural processes exceed the attribute states this can be managed through the draft NPS FM provisions at 3.23. Limiting resource use to halt and reverse the uncontrolled discharge of nutrients into water is important to ensure that resource use is sustainable into the future and freshwater ecosystems and connected waterbodies are healthy. More work is urgently needed to identify nutrient limits for groundwater ecosystem health.

Periphyton biomass

35. Nuisance periphyton growth affects ecological, recreational and cultural values and is commonly reported to detract from freshwater values by the public, particularly at the 120 and 200 mg/m^2 band thresholds. We note that the bands below the A band threshold of 50mg/m^2 are not strongly correlated with ecological outcomes; rather they were more related to fishery and recreational values as per Biggs (2000). Although Matheson et al. (2016) using more recent data found there was some discrimination between chlorophyll *a* and macroinvertebrate indices, the greatest differences occurred between 1 and 50 mg/m^2.

36. We note that monitoring records show that for many months in a year there is very little periphyton biomass in many rivers as flow is the overriding control on periphyton growth during wetter periods in unregulated rivers. Exceedances of a band threshold or bottom line are more likely to occur over the summer period when flows are usually more stable (although high periphyton biomass is also commonly observed in late autumn and early winter). Allowing periphyton to exceed the national bottom line for six months of a three-year period (17% exceedance) by an unspecified amount (e.g., no maximum allowable biomass limit applies to the exceedance of the bottom line) does not protect ecosystem health or freshwater values.

37. Few rivers in Aotearoa New Zealand exceed the periphyton bottom line when the 17% exceedance criteria are applied, and 8% exceedance is also relatively uncommon. This means the current application of the bottom line does not effectively control nuisance periphyton growth or protect values and is so rare that it is meaningless. We question the effectiveness of any exceedance criteria for periphyton biomass as there is no scientific justification for exceedance criteria and their application does not manage periphyton to protect freshwater values. We support the STAG recommendation to remove the productive class (17%) exceedance criterion. We request that the 8% exceedance criterion is also removed as the draft NPS FM at 3.23 already provides an exception for naturally occurring processes and the exceedance criteria are therefore redundant in cases where regional councils can show clear evidence that periphyton biomass naturally exceeds the band thresholds.

38. If the 8% exceedance is not removed, we recommend revisiting this using the larger national dataset that has been collected over recent years.

NIWA

Dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP). The derivation of the proposed numeric attribute states for DIN and DRP needs to be set out in a comprehensive, publicly available report. The summary in Appendix 4 of the STAG report is not sufficiently detailed. The public report should include data sources and metadata, implications of averaging predictions from dissimilar statistical models (STAG Table A4-1), intercorrelations among the response variables, implications of averaging criteria across an order-of-magnitude range (STAG Table A4-3), and whether environmental or regional classes were tested. Further, a rationale is needed for the selection of eight response variables (periphyton chlorophyll *a*, MCI, QMCI, ASPM, fish IBI, ecosystem respiration, gross primary productivity, cotton decomposition) as the basis for the DIN and DRP attributes. That rationale needs to include evidence that the states of the eight variables are directly related to DIN or DRP concentrations. In the absence of this evidence, there is a risk of spurious correlations such that reducing DIN or DRP concentrations would not lead to a corresponding improvement in the response variables.

The DIN and DRP attributes are specifically intended to ensure that ecosystem health is achieved, based on putative relationships between DIN and DRP concentrations and ecosystem-health attributes. There are now 10 proposed NOF attributes that directly measure ecosystem health (Attribute Tables 13-22), plus additional ecosystem-health attributes carried over from the existing NPS-FM, such as periphyton. If the direct measures of ecosystem health indicate that their respective target attribute states are being met, achieving the target DIN and DRP attribute states seems superfluous. If this is the case, it needs to be accounted for through a regulatory process (e.g., target DIN and DRP attribute states must be achieved if the target ecosystem health attribute states are NOT achieved, and not if they ARE achieved).

We agree with the point made in the *Action for Healthy Waterways* discussion document concerning DIN and DRP: *"It is important to understand more about the ecological benefits from limiting nutrients, whether this varies by waterbodies, and what impacts the proposed new bottom lines would have on individuals and communities. Final decisions will not be taken until further analysis has been done".*

Page 34 Table 5 – Dissolved Inorganic Nitrogen (DIN).

78. The derivation of the proposed numeric attribute states for DIN needs to be set out in a comprehensive and transparent report that is publicly available. The bullet-point rationale in Section 3.9 and the overview in Appendix 4 of the STAG report are not sufficient. The comprehensive report should include at a minimum the data sources, spatial distributions of the data, implications of averaging predictions from dissimilar statistical models such as piece-wise, log-log and quantile regressions (STAG Table A4-1), lack of independence among the eight response variables, implications of averaging across criteria with an order-of-magnitude range (Table A4-3), whether alternative weighting methods were tested, and whether subdivisions of the attributes into environmental or regional classes were tested.
79. Currently, the only other publicly available information on how the DIN attribute was developed are an internal report to STAG on statistical MCI-nutrient relationships by Snelder and Canning[7],

and a paper in the Fertiliser and Lime Research Centre proceedings by Death et al[8]. that "inspired" the attribute development (STAG Report page 54), but has different numbers than those in the proposed attribute table. The Snelder and Canning analyses related 5-year median MCI values from regional councils and Cawthron Institute with the observed median of monthly monitoring of nutrients and the modeled "*average annual median (for 5 years ending 2017*)". The model fits to these relationships were very poor. There was no consideration of other environmental factors that are likely to influence MCI scores (e.g., suspended and deposited sediment, dissolved oxygen, flow conditions, predator abundance).

80. Table 5 provides no rationale for using eight response variables (periphyton chlorophyll *a*, MCI, QMCI, ASPM, fish IBI, ecosystem respiration, gross primary productivity, cotton decomposition) as the basis for the DIN and DRP attributes. There is no rationale provided in the supporting documents (STAG report, Snelder and Canning report, Death et al. 2018). In particular, no evidence is provided about causal relationships between DIN concentrations and the response variables. Some or all of these relationships may be highly indirect or spurious as well as statistically weak. Some or all of the response variables may be intercorrelated. A clear and defensible rationale that addresses these issues is needed. In cases where DIN concentrations are not causally related to response variables, it is unlikely that reductions in DIN concentrations will elicit improvements in the response variables.

81. Page 34 Table 5. The STAG report noted that it aimed to develop national criteria, "*and more stringent criteria derived locally if required*". There is no further information about local criteria or how the requirement for local criteria is to be assessed.

82. Page 34 Table 5. A footnote corresponding to the note in the periphyton attribute table is needed to explain that this attribute applies to rivers that do not support conspicuous periphyton or in cases where the median and 95th percentile DIN concentrations required to maintain periphyton at appropriate levels are higher than those in Table 5. We note the STAG report makes this clear (See STAG report page 41 and Appendix 5 Flow Chart). It may be useful to include the flow chart with Table 5.

83. Page 34 Table 5 -The second footnote in Table 5 should refer to "…the rolling median and the rolling 95th percentile", as both are included in the table. We note that reliable values for 95th percentile DIN concentrations will be difficult to estimate accurately at many sites.

ıge 35 Table 6 – Dissolved Reactive Phosphorus (DRP).

84. All of the preceding comments on the proposed DIN attribute in Table 5 apply to the proposed DRP attribute in Table 6.

85. For both DIN and DRP, we note that median concentrations in rivers in some native-forest areas (i.e., representative of reference conditions) exceed some attribute bands. For example, median DRP concentrations in some forested rivers draining North Island volcanic terrains are > 0.01 mg/L. Some consideration needs to be given to sites with naturally high DIN and DRP concentrations.

86. We agree with the point made in the *Action for Healthy Waterways* discussion document concerning DIN and DRP: "*It is important to understand more about the ecological benefits from limiting nutrients, whether this varies by waterbodies, and what impacts the proposed new bottom lines would have on individuals and communities. Final decisions will not be taken until further analysis has been done*".

Page 36 Table 7 – Ammonia (Toxicity) and Page 37 Table 8 Nitrate (Toxicity).

87. The toxicity attributes could be redundant if the DIN attribute (Table 5) is confirmed. However, we have provided comments on the adequacy of the DIN and DRP attribute derivations above, and comment here on the need to update the numeric attribute states for ammonia and nitrate toxicity. There is a strong argument to retain toxicity attributes for both nitrate and ammonia. The attribute states are based on a robust, peer-reviewed multi-species derivation procedure that provides benchmark sensitivities for individual species and for taxonomic groups (e.g., fish, invertebrates, amphibians).

88. The nitrate and ammonia toxicity tables have not been updated since their original derivation in 2014. At that time, the attribute thresholds were based on species sensitivity distributions for chronic (long-term) exposure to provide protection. The bottom-line values were 80th percentile protection values with the narrative descriptor being "*growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects*". Thus, while being "toxicity" thresholds, they were designed to be sub-lethal and compliance would not result in biodiversity reduction.

89. The interim period has seen new native species sensitivity data become available. New Australian and New Zealand Guidelines (ANZGs) have also been developed and are nearing completion of the technical review process. The original ammonia toxicity derivation was originally classed as "indicative", with the acknowledgement that new data for sensitive native species – such as the juvenile life-stage of kakahi (freshwater mussels) – needed to be incorporated[9].

90. We consider that the bottom-line attribute values would better achieve ecosystem health values if the new 90th percentile ANZG protection thresholds are used. This would be more suitably protective for anthropogenically modified river environments. To summarise, our recommendation is to retain the ammonia and nitrate toxicity attributes, and update the bands and bottom lines using the new ANZGs at the 90th percentile protection levels.

91. Groundwaters have potentially sensitive ecosystems that are not specifically protected by the NOF attributes or ANZGs for nitrate or ammonia. In the absence of specific data for groundwater species, consideration would need to be made as to whether the surface water attributes and guideline values apply to groundwater environments.

Page 38 Table 9 – Dissolved oxygen in rivers below point sources.

92. We presume this table will be redundant if the other dissolved oxygen (DO) attribute (Table 19) is confirmed for all rivers. The term '1-day mean minimum' may be an error and should probably be

[9] The ammonia derivation memo recommended adoption of the 90th percentile for the attribute bottom-line but this was not adopted by MfE in their final NOF standards: Hickey, C.W. (2014). Derivation of indicative ammoniacal nitrogen guidelines for the National Objectives Framework. No. CR 202. NIWA report to Ministry for the Environment, pp. 9. (https://www.mfe.govt.nz/publications/fresh-water/derivation-indicative-ammoniacal-nitrogen-guidelines-national-objectives).

Northland Regional Council

Table 2 Periphyton (Trophic state)

The Operative NPS defines what is meant by a default class and a productive class. A definition in the Draft NPS is conspicuously absent.

The Science and Technical Advisory Group recommended that a look-up table to calculate default TN and DRP criteria for the periphyton attribute be included in the Draft NPS, which would be used in the absence of robust, locally suitable, independently reviewed criteria. We are heartened that Government has not included the look-up table in the Draft NPS. The TN and DRP criteria are fundamentally at odds with our research.[11] We support the direction for regional councils to derive site, catchment or regional-specific nutrient concentration and exceedance criteria for managing periphyton biomass. The logic for this is set out in out in MfE's draft technical guide to the Periphyton Attribute Note,[12] and reinforced by recent research for NRC [13] and Horizons Regional Council[14].

NRC notes that Table 2 in the Draft NPS states that numeric attribute states must be derived from the rolling median of monthly monitoring over five years. The Operative NPS requires a minimum of monthly samples over three years. This will affect the ability of some regional councils to determine "current attribute states". It is also confusing that the table expressly requires a minimum of 60 samples but clause 3.8(3) states: "[I]f a regional council does not have complete and scientifically robust data on which to establish the current state of an attribute, it must use its best efforts to identify a current state using the information that is available, including partial data, local knowledge, and information obtained from other sources."

There is inherent tension between the data requirements specified in the table and clause 3.8(3). This also applies to other attributes.

Tables 5 and 6 – DIN and DRP

NRC strongly opposes the proposed new attributes for dissolved inorganic nitrogen and dissolved reactive phosphorus. We, along with others, including the Regional Sector consider that the DIN and DRP attributes are based on correlations rather than causation, and that the correlations are spurious (where other inter-correlated drivers of ecosystem health are ignored). NRC also questions the logic of proposing attributes for DIN and DRP that are based on a paper (in prep) that has not been published in a peer-reviewed journal,

particularly given the significant social, economic, and cultural implications of the proposed attributes.

We note that the Interim Regulatory Impact Analysis states:[15]

> *There are concerns that the existing periphyton attribute could be inappropriately applied by setting incorrect in-stream nutrient concentrations. There are technically difficult and complex modelling calculations required to set these nutrient concentrations to provide for periphyton objectives. Because of this, council approaches may lack transparency and rigour, allowing room for actual or perceived misuse of modelling. These concerns could affect public confidence in councils' ability to maintain or improve water quality.*

We dispute this. Council plan changes are open and transparent. They are subject to Schedule 1 requirements of the RMA. We are not aware of any examples of regional councils setting inappropriate nutrient concentration criteria.

The Interim Regulatory Impact Analysis goes on to state:[16]

> *Essentially, the NPS-FM gives councils a lot of flexibility in terms of the levels at which they choose to set water quality objectives, to the extent that it is possible that they could be set in a way that doesn't support a healthy ecosystem. At this point we do not know the levels at which all councils will choose to set these objectives.*
>
> *... The tables are based on an approach introduced by* ***Death et al. (in prep)***[17] *and subsequently modified based on review and discussion by STAG.*
>
> ***... While there may not always be a direct link and well-defined mechanistic models between nutrients and components of a healthy ecosystem, ecosystems are dominated by indirect and complex relationships that are difficult to accurately quantify.*** [emphasis added]

The Regional Sector considers that the proposed DIN and DRP attributes are based on spurious correlations, and should be deleted. We strongly agree. The attributes are also underpinned by a very inadequate benefit-cost analysis.

Because of the relatively short consultation period, NRC has not been able do a robust assessment of the consequences of the DRP and DIN attributes. That said, approximately 37% of our river water quality monitoring network sites fail the proposed national bottom line for DRP (See Appendix 2 of this document). If the network is representative of Northland's rivers then the proposals will have major social and economic costs implications for people and communities.

Fertiliser Association of NZ

New attribute for nitrogen

88 When looking at reversing damage over a generation, it is more appropriate to give the relevant decision-making body the ability to select the DIN and DRP numbers which are appropriate for each catchment or sub-catchment rather than to set them based on a simple metric in the NPS. Using a national nutrient concentration number to manage all rivers, will mean that regulations will tend to be overly permissive for certain areas such as an alpine stream, and overly restrictive for low lying waterways. The scientific basis of these numbers is evolving and there are significant interactions between these and other catchment specific attributes.

89 The Land and Water Forum considered proposals to establish nutrient criteria in New Zealand rivers and introduce an in-stream limit for nitrogen. In August 2016 the Forum recommended:

a. *that the NPS-FM should have a requirement to set in-stream concentrations for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP), as objectives in regional plans, to support the existing periphyton attribute in Appendix 2 of the NPS-FM.*

b. *the development of a mandatory decision support tool councils would have to use to derive and set the DIN and DRP concentrations.*

c. *that there would be benefit in a multi-variate lookup table for DIN and DRP concentrations, which should be provided in guidance to give councils and communities a broad idea of what nutrient concentration ranges were appropriate in a variety of conditions.*

90 The Government accepted this recommendation in the 2017 revision due to the limited science to establish national level thresholds. The STAG group has included some information on nutrient criteria to manage periphyton in their report. However, this information appears to have been ignored in proposing a single DIN number. The main intent of introducing a DIN number appears to be focussed on introducing nitrogen restrictions for soft bottom streams that do not grow periphyton. However, the growth of macrophytes in these catchments is substantially driven by the sediment load in these catchments.

91 Establishing a single national DIN target will result in councils having no flexibility to consider what approaches will be effective to manage ecosystem health in specific catchments and will mean that they will no longer be able to meet their obligations under the RMA to consider approaches that will be most socially and economically viable for individual catchments.

92 The proposed nitrogen limit may introduce an unnecessary restriction on rivers that do not grow periphyton. In the Taranaki ring plain, periphyton growth is limited by the high rate of river flushing. Growth of periphyton is limited in Southland because of cooler temperatures and regular flushing river flows associated with high rainfall. This means that in these areas higher levels of nitrogen may be compatible with maintaining ecosystem health.

We propose that:

93 The nutrient criteria to manage for ecosystem health developed by the STAG be made available as information rather than as regulatory direction to councils to consider in setting objectives for ecosystem health as an interim measure.

94 Ensure that work is in place to develop nutrient criteria to support the development of bottom lines specific to different river types over the next four years.

New attribute for phosphorus

95 The proposed dissolved reactive phosphate (DRP) limit of 0.018 mg P/l effectively seeks to return all rivers to close to an undisturbed natural condition. The value of 0.18 is close to the reference state for many catchments. If this change goes through, New Zealand would be the only country in the world to use regulatory controls to set an objective of natural state for all rivers.

96 The relationship between the DRP and ecosystem health in many streams is poorly understood. The STAG report suggests that DRP limits of 0.012-0.289 mg P/l would be required as a bottom line to control periphyton growth. The number of 0.018 mg P/l is also more restrictive than currently included in the NPS for total P as a bottom line for lake

catchments (0.05 mg P/ml).[2] Lakes are extremely sensitive to phosphate and the bottom line was set at a level intended to be very restrictive because of the sensitivity of these waterbodies. The proposed limit is very much on the restrictive end of what is required. While tight controls may be required in some catchments to achieve ecosystem health, the ecosystem health benefits of setting restrictive controls in all catchments are unclear.

97 We are concerned that the proposed DRP sets a target that will have significant impacts on economic outcomes without a demonstrated benefit for the environment. Approximately 30% of monitored river sites are in excess of this threshold. Further, the data suggests DRP concentrations are showing an improving trend in most rivers suggesting that existing actions are having a positive impact.

98 The draft RIS suggests that most of the North Island rivers would be covered under the exemptions policy included in the draft NPS because they have high natural phosphate levels. The wording in the NPS says exceptions can be made based on natural state but does not include a process by which natural state can be identified. This creates significant uncertainty.

99 We believe that a better approach would be to include a classification system in the NPS that varies the limit for phosphate by accounting for high background levels rather than apply an exemption regime. We acknowledge that significant science would be required to develop a classification system to support such an approach.

100 If the Government wishes to improve water quality in the short run, we suggest it considers the ecosystem health benefits that will result from the proposed sediment limits, as managing sediment is likely to have a co-benefit in terms of stream phosphorus reductions.

We propose that the Government:

101 Invests in further research so that the benefits and costs of setting a DRP at a specific level can be assessed.

102 Develop a classification system to reflect variation in stream types rather than requiring an exemption in cases of naturally high phosphate.

103 Consider the DRP alongside the sediment attribute, as controlling DRP is unlikely to influence ecosystem health unless sediment is also managed.

Dissolved oxygen

Questions

1. For dissolved oxygen in rivers, is there sufficient natural variation to warrant the creation of different attribute states for different river types? Is the evidence base sufficient to do so? (see Hawkes Bay Regional Council submission below)

2. Would percent saturation be a more suitable measure of dissolved oxygen than concentration? Why/why not? (see Hawkes Bay Regional Council submission below)

3. Lake dissolved oxygen – we think that the topics raised in submissions have been discussed by STAG, and have no specific questions. Is there anything else STAG wants to add?

Cawthron Institute

DO

Dissolved oxygen is critical for aquatic life. We support the extension of dissolved oxygen as a national attribute for all rivers and lakes, not just those reaches downstream of point-source discharges. We once again note the need to provide guidance on the suitability of the monitoring network to provide a representative assessment of this attribute at the FMU scale. It is possible to select sites and deploy continuous dissolved oxygen loggers in a manner that prejudices outcomes.

DairyNZ

Dissolved oxygen	**Support.**
Lake bottom dissolved oxygen	**Support in principle.** But given the uncertainty expressed in STAG documents, we are concerned that science is not yet robust enough for this to be a national attribute. We suggest it would be better implemented as a monitoring requirement. If adopted, we support the need for section 3.23 exclusions, where there is uncertainty about natural state. **Propose** making this a monitoring requirement, rather than a national attribute.
Mid-hypolimnetic dissolved oxygen	**Support in principle,** but we are concerned that this ecosystem health attribute has been driven by salmonids. That is, their requirement to seek out cooler lake water, and hence the requirement to ensure this cooler water has sufficient oxygen. **Propose** the MfE reconsiders whether salmonids should solely drive the requirement for a national attribute, given that these fishes are generally detrimental to native fish (particularly in lakes) and are explicitly excluded from the proposed fish IBI attribute metric.

Hawkes Bay Regional Council

6.1 Dissolved Oxygen

The Hawke's Bay Regional Council considers that the proposed NPSFM needs to better account for different oxygen states in depositional rivers. The depositional rivers should not be subject to the same DO states as other river types and more granularity should be provided in the new attribute standards for dissolved oxygen.

The proposed deposited sediment and macroinvertebrate standards recognise the different potential of depositional streams. This recognises the natural physical drivers of stream environments. The same approach should also apply to oxygen. This is discussed in more detail in the box below.

Our solutions
Develop oxygen state attributes that better reflect the different oxygen potential of depositional streams.

Base the NPSFM on oxygen saturation, rather than concentration.

Dissolved oxygen in rivers
The Leaders Report (2019) supported dissolved oxygen bottom lines for New Zealand rivers (page 15). Oxygen is vital for life, and resource management must maintain adequate oxygen if rivers are to support healthy ecosystems. The problem comes in the specific dissolved oxygen concentrations chosen for Table 19 of the proposed NPS, in particular, the attempt to apply a single set of oxygen standards as a blanket rule across all rivers, regardless of their natural potential. This fails to recognise the fundamental physical drivers of river environments, in particular the greater oxygen demand and lower reaeration in depositional environments.

Oxygen is naturally lower in environments where organic matter settles to bottom, and accumulates over time. That is how fossil fuels and peat soils occur. Neither would have accumulated over millennia if oxygen remained above the Table 19 standards prior to the Anthropocene. Depositional environments, like estuaries, wetlands AND low-energy rivers support precious, and unique, ecosystems because of their depositional nature, despite their inability to achieve the proposed NPSFM oxygen standards. Actually, some of their values fundamentally depend on low oxygen conditions (e.g. carbon sequestration, denitrification). There is no simple delineation between river, wetland and estuary – low energy rivers blur any point of distinction through gradual transitions. The streams left behind when wetlands are drained will be depositional – because the same physical processes that created the wetland continue to deposit organic matter. These low energy environments are also where pressure on natural resources is highest, with the most intensive land uses concentrated on flat, alluvial soils. The depositional processes which create the land form and soils that support more intensive land uses are the same processes that support different ecosystems and lower oxygen potential. As written, the proposed national standards for oxygen ignore these fundamental physical drivers.

In contrast, the proposed NPSFM standards for macroinvertebrate do recognise the importance of physical processes by using different MCI taxa scores for REC classes that correspond to depositional environments (Table 18 and footnote in Tables 13, 14 in the proposed NPSFM). Given oxygen tolerance is a major driver of invertebrate taxa score, the potential for oxygen to vary by stream type is recognised in the proposed macroinvertebrates scores. Deposited sediment varies by stream type, this is also recognised in the proposed Deposited Fine Sediment standards (Table 18). The two-class system for invertebrates is an over-simplification of a broad continuum, however it is an improvement over the single blanket rule proposed for oxygen.

The REC is a fantastic tool for large-scale resource management issues. But it is also in desperate need of an upgrade. Stream gradient is an important driver of the erosional energy of a stream (in addition to flow regime). The developers of the original REC had to make do with elevation data that was inadequate for flatter areas. A river can travel tens of kilometres before crossing the first 20 metre contour, as defined in the source topomap data. LiDAR mapping of all flat areas vastly improves our ability to distinguish depositional stream reaches – those with lower potential for oxygen. Many regional council have already completed LiDAR mapping of flat areas. MfE is therefore well placed to revise the REC framework for New Zealand rivers, and revise the classification as a more defensible basis for macroinvertebrate, sediment and oxygen standards. As it stands, the REC classes used for deposited sediment encompass a wide range of stream types, so still has the potential to under-protect some streams, and over- protect others. Hawke's Bay Regional Council have developed oxygen saturation standards that are relevant and achievable for depositional streams. The LiDAR and oxygen information is available and ready for MfE to use in revising the NPSFM oxygen standards, standards that better reflect the last 30 years of scientific research.

We also need different oxygen measures to facilitate more holistic management. The proposed NPSFM oxygen standards are copied from 1980's standards developed for cold water rivers by the United States Environmental Protection Agency (actually, just one from the set of

tables). In the 1980's, point discharges were the primary management target, both in the USA and here. The USEPA made a conscious decision to use oxygen concentration, instead of obvious alternatives (oxygen saturation or partial pressure), which simplified the effect of temperature in dealing with point discharges. Regional Councils have come a long way since then in tackling raw sewage, meat works effluent, and other oxygen-demanding discharges. Councils don't just manage point discharges anymore, there have been significant advances in terms of scientific understanding of what drives oxygen in rivers.

Using concentration to measure oxygen only serves to confuse and complicate resource management. Temperature is a vital resource and potential stressor of stream ecosystems in its own right, and is driven by separate management variables (compared to oxygen), including riparian management, shading and climate change. A more holistic management framework would recognise these as important management variables, rather than concealing them within oxygen concentration. Further, the discipline of fish physiology does not recognise oxygen concentration as a valid measure of oxygen availability. Decades of debate between physiologists and ecologists was put to rest in 2011 by Verberk, who demonstrated the true measure of oxygen availability more closely resembles oxygen saturation, rather than concentration (i.e. temperature and salinity play a minor role in oxygen supply). The NPSFM should therefore be based on oxygen saturation, rather than concentration. Temperature is an important determinant of life-supporting capacity in its own right, for many reasons, including its role in determining how much oxygen a fish needs to stay alive (oxygen demand, rather than oxygen supply). This provides clarity in terms of both what must be managed to maintain ecosystem health, and what should be measured and monitored in providing a clear path to achieving more holistic objectives.

6.3 Lake management

The HBRC has continuing concerns about how the NOF applies the same standards to deep alpine lakes as it does to shallow lakes. Shallow lakes have quite different water quality and might be a high C band naturally (this is supported by a Waikato study which suggests some shallow lakes may be high C and D bands naturally). Shallow lakes are often more valued for wetland type values than for their water quality based values. A shallow lake with wetland type values cannot be compared to a deep alpine lake. For example, an alpine lake in the C band would represent both a huge deviation from its natural state, and would be a large deviation from what those deep lakes are typically valued for (e.g. clear water). A shallow lake in a C band might represent natural water quality state for that type of ecosystem.

While state objectives based on deviation from natural state is considered more appropriate than applying the same banding to all lakes (deep, shallow, lowland, upland, coastal etc.), we appreciate this may not be achievable at this time. However, the HBRC does suggest an additional proviso to the lake attribute states that recognises that shallow lakes may be subject to objectives that are relative to their natural state and local values for their management.

Our solution
Include proviso or exception for all lake attributes that recognises relative natural state condition for shallow lakes and that water quality objectives are set appropriate to the primary values held for the lake.

Local Government NZ

We support inclusion of dissolved oxygen in rivers as an attribute but note that this will add significant costs to regional councils for monitoring. We seek clarification that the monitoring can be achieved using a flexible regime rather than continuous monitoring at one place (and therefore multiple instruments required at the same time).

We suggest that the NES aligns with the NEMS in terms of site placement for the appropriate monitoring of DO.

We support the introduction of dissolved oxygen monitoring in lakes, but we note that many lakes will have naturally low oxygen levels.

We note and support the approach outlined in the Action for Healthy Waterways discussion document allowing for an action plan approach that involves learning before taking drastic management interventions.

Preventing anoxia in deep, eutrophic lakes will often require unnatural interventions such as artificial destratification. Artificial destratification may not always result in an overall improvement for holistic lake health.

NZ Freshwater Sciences Society

Dissolved oxygen

31. The Society supports the extension of dissolved oxygen as national attributes for rivers and lakes. The decision to limit dissolved oxygen as an attribute only for rivers downstream of point source discharges in the NPS FM (2014) was not supported by the Society and was contrary to the recommended thresholds developed to support a dissolved oxygen attribute for the NOF for all rivers (Davies-Colley et al. 2013).

32. Dissolved oxygen is critical for aquatic life. Aquatic species can suffer hypoxic stress, will actively avoid low oxygen waterbodies and can be lethally affected and become locally extinct when dissolved oxygen concentrations are below critical levels, particularly during warm summer periods when thermal stress also contributes to lowering of the saturation of dissolved oxygen. Furthermore, unnatural anoxic conditions at the bottom of lakes can cause irreversible changes in the biogeochemistry that must be avoided.

33. We strongly recommend removing the focus on point source discharges and replacing Table 9 in Appendix 2A of the draft NPS FM with Table 19 from Appendix 2B so that dissolved oxygen applies as a limit for all rivers. The Society also supports the dissolved oxygen attributes and the STAG recommendations for dissolved oxygen at the bottom of lakes and for seasonally stratified lakes a mid-hypolimnetic dissolved oxygen attribute to protect for aquatic life directly and prevent the episodic release of nutrients from lake beds that occurs in anoxic conditions.

NIWA

Lake bottom and mid-hypolimnetic dissolved oxygen. The STAG report has extensive comments and caveats about the effects of data shortages on the development of the two attributes for lake dissolved oxygen. We recommend that these attributes are deferred pending further data collection and analysis.

Page 38 Table 9 – Dissolved oxygen in rivers below point sources.

92. We presume this table will be redundant if the other dissolved oxygen (DO) attribute (Table 19) is confirmed for all rivers. The term '1-day mean minimum' may be an error and should probably be replaced with the '1-day instantaneous minimum'. The rationale for applying the attribute in summer only is not clear, as point source discharges can reduce DO concentrations to levels causing adverse effects at any time of the year. The table should stipulate the use of continuous DO measurements, to ensure that diel fluctuations are measured and to enable 1-day minima to be determined. Guidance will be required for carrying out DO measurements and for the data analyses required to determine whether sites meet the band thresholds. See the corresponding comment below regarding Table 19, dissolved oxygen in rivers.

Page 48 Table 19 – Dissolved oxygen in rivers.

114. We agree with the statement in the STAG report that the DO concentrations in the attribute table are widely applicable to rivers, not just downstream of point sources. It is ecologically appropriate that the objectives apply year-round. We presume that the term '1-day mean minimum' is an

error, and should be the '1-day instantaneous minimum'. It should be stated clearly in the attribute table that the attribute state is to be assessed using continuous DO measurements. We note that the requirement for a seven-day continuous monitoring at least once in summer to define the numeric attribute state is achievable, but there are several associated problems. First, it is not clear how a 7-day measurement period is to be used to assess compliance with objectives that apply year-round. Second, it is not clear how measurements over a 7-day period will account for natural variability in DO concentrations and variations in flow rate. Substantial guidance concerning these issues will be required. Further guidance will be required for carrying out DO measurements and for the data analyses required to determine whether sites meet the band thresholds.

Pages 50, 51 Tables 20 and 21 – Dissolved oxygen in lakes.

115. We draw attention to the multiple caveats in the STAG report about data shortages for developing attributes for lake-bottom and mid-hypolimnetic dissolved oxygen, e.g., *"More work is required to adequately interpret and understand the national characteristics of lake thermal profiles to assist with appropriate sampling of water masses"* (STAG report page 22). We recommend that these variables do not progress as attributes until further data collection and analysis has been carried out. If these attributes are to progress, the sampling frequencies and periods required to estimate the 'annual minimum' will need to be determined; they are currently missing from the tables.

Ecosystem metabolism

Question

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Cawthron Institute

Ecosystem metabolism

Ecosystem processes, like ecosystem metabolism, are a key component of ecosystem health. The importance of including ecosystem processes in river health monitoring and management is increasingly being recognised internationally (Young et al. 2008, Elosegi et al. 2017). We note that both ecosystem metabolism and organic matter decomposition are ecosystem processes that have now been included in several regional council monitoring programmes. Unlike other indicators of ecosystem health, their application is not limited to wadeable rivers.

Advances in dissolved oxygen logger technology and data processing means it is now possible to gather continuous dissolved oxygen and calculate ecosystem metabolism in a resource efficient way. We support the inclusion of an ecosystem metabolism attribute and acknowledge that application of this attribute requires further development to define appropriate attribute bands. This could involve collation and analysis of existing datasets to further develop draft bands already proposed (Clapcott 2015); followed by national testing across a gradient of environmental variables known to influence spatial and temporal patterns in ecosystem metabolism. Restricting assessment to summer low flows when streams are most stressed by resource allocation is a logical first step (Clapcott et al 2016).

DairyNZ

Do not support. We have significant concerns about what this means. STAG was unable to define a bottom line, or other attribute states (numeric or narrative). This metric is achieved through a combination of biological (MCI) and physio-chemical (dissolved oxygen) attributes. These attributes have high certainty and well defined, accepted bottom-lines.
While an ecosystem metabolism attribute *could* have some value, it will not work as a national attribute.

Local Government NZ

We recognise that ecosystem metabolism is an important part of ecosystem health and agree that it should be measured. However, we question what management measures can be put in place beyond nutrient management and flow regimes (already covered elsewhere in the NPS) when the drivers are complicated and largely unknown.

We question how management for this attribute can take into account naturally productive reaches? For example, do we need to get a predicted reference Ecosystem Metabolism for a site on which to base the monitored values against?

Overall, we believe the science underpinning monitoring and managing for ecosystem metabolism is still in development, so we feel it is premature to include it as an NPS attribute.

NZ Fish & Game Council

c. Table 22 for ecosystem health. The current table has no numerics and is unhelpful for communities when setting attribute states. The table should be as recommended by the STAG report and include a bottom-line at the C/D boundary. Whilst STAG have not suggested a bottom-line, we consider that the precautionary use of a bottom-line is warranted to drive improvements in the worst rivers. Furthermore, any river that cannot naturally meet the bottom-line will be exempt under 3.23.

NIWA

Ecosystem metabolism. There may be merit in an ecosystem metabolism attribute, but it has not been set out clearly in the draft NPS-FM or the STAG report. We concur with the statement in the STAG report that further work is required to develop a national bottom line for ecosystem metabolism. Therefore, we recommend that the ecosystem metabolism attribute is deferred until that work is completed.

Page 52 Table 22 – Ecosystem metabolism.

116. There may be merit in an ecosystem metabolism attribute, but it has not been set out clearly. We concur with the statements in the STAG report (page 24) that the driving variables are not well-understood (which impedes the development of action plans) and that further work is required to develop a national bottom line for ecosystem metabolism. It is unclear why this attribute is expected to proceed with no bottom-line (STAG report page 23). There are very few data from New Zealand rivers to work with. Therefore, we recommend that ecosystem metabolism does not progress as an attribute until further data collection and analysis has been carried out.

Fish

Question

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Cawthron Institute

Fish

We support the inclusion of a fish attribute as a national attribute. Fish are critical components of healthy freshwater ecosystems and provide a direct measure of aquatic life. The requirement to use fish survey protocols from Joy et. al. (2013) is likely to result in substantial commitment of resources as the methods are labour and time intensive to undertake. While this is appropriate and supported in lowland water ways with diverse fish communities, this effort is likely to be considered excessive in high country areas with few if any fish species. However, a balance between effort and number of survey sites could be considered with less effort required for areas where fish communities are restricted to one or two species. We recommend providing a mechanism for incorporating new technology into fish assessment methods, such as environmental DNA. A current Envirolink Tools project will deliver this tool to regional councils in 2020 and may provide a more resource-efficient method for assessing fish diversity.

DairyNZ

Support as a monitoring requirement not as an attribute. Monitoring fish is important but we have concerns about the appropriateness of using this as a national attribute for freshwater management, given that fish community metrics are generally not good indicators of habitat or water quality pressure. If the intent of the draft NPS-FM is to have the best (i.e. most sensitive, most widely applicable and understood) integrated measure of biological stream health, then this is achieved via a macroinvertebrate attribute.
Need clarification from Government on how reference states would be set, especially for a national bottom line.
Support STAG view that exceptions will be needed where a site naturally departs from the IBI bottom line (i.e. geothermal/natural barriers to migration). These could be identified by regional councils.

Environmental Defence Society

3.10 Whilst EDS supports the increased measures and bottom-lines to provide for indigenous species, we also recognise that trout and salmon are highly valued. That is not only for their recreational and food source value, but also the conservation benefits arising from their management advocacy as they are often described as the 'canaries in the goldmine'. In addition, section 7(h) of the RMA 1991 and para 1.3 of the Cabinet Paper: Restoring New Zealand's Freshwater and Waterways, seek the protection of trout and salmon habitat - which has not been addressed in the draft NPS-FM.

3.11 We seek, for rivers identified in the relevant Sports Fish and Game Management Plans, (1) that the definition of a healthy ecosystem includes trout and salmon alongside indigenous species, (2) the Fish Index of Biotic Integrity includes trout and salmon as a positive species (to provide for their habitat); and (3) more stringent deposited sediment standards in spawning reaches (as suggested in the STAG's deposited sediment attribute note).

Local Government NZ

We fully support the inclusion of fish as an essential component of ecosystem health.

We have major reservations about the robustness of the existing IBI for low diversity fish communities in New Zealand. We stress that priority effort should go into the development of more robust and meaningful fish indices.

We note that a programme of fish metric development could commence immediately and use existing datasets available from some councils, e.g. Wellington, Waikato or Otago.

We fully support the use of the Joy et. al. (2013) methods for wadeable streams and note that work is needed to develop methods for non-wadeable systems including lakes and estuaries.

The purpose of the fish monitoring needs to be refined in terms of what we are looking to assess. Are we interested in presence/absence, diadromous fish extent, population dynamics, recruitment potential etc. The questions being asked has big implication on the required monitoring and its associated techniques.

NZ Fish & Game Council

Trout and salmon as valued species

24. Trout and salmon are valued species for many, New Zealanders and vistors alike. They provide a valued recreation resource and support a thriving tourism industry. The protection of habitat of trout and salmon is a matter that all decision makers must have particular regard to under s7(h) of the RMA. The draft NPSFM needs to include more specific recognition of trout and salmon to ensure this valuable resource is properly provided for. In particular, in waterbodies identified in Ministerially approved Fish and Game Management Plan for a region, trout and salmon and their habitat should be:

    a. Identified as a valued introduced species next to indigenous species in the description of healthy freshwater ecosystem in Appendix 1A(1);

b. Specifically included as a positive indicator in the calculation of the Index of Biotic Integrity in Table 15 (rather than specifically excluded as they currently are), in areas recognised as salmonid fisheries in the Sports Fish and Game Management Plan;

c. Specifically excluded from being an 'undesirable species' in provisions relating to fish passage (3.17(c)). Merely taking into account the Sports Fish and Game Management Plan is not enough to ensure that trout and salmon will not be excluded from sections of river because of barriers to fish passage. Specifically, we seek that 'undesirable species' be defined as a 'pest' as per the Biosecurity Act 1993 and any other species prescribed by the Director-General of Conservation; and

d. Identified in an amended Table 18 (deposited sediment table) to include a footnote requiring more stringent attribute states at salmonid spawning reaches.

NZ Freshwater Sciences Society

Fish

19. The Society supports the inclusion of fish as a national attribute. Fish are critical components of healthy freshwater ecosystems and often provide a proxy indicator of habitat quality and barriers to fish passage. The health of indigenous fish communities is an important addition to macroinvertebrate attributes for ecosystem health. Fish and macroinvertebrates provide different, but complementary information about the health of freshwater ecosystems. The indigenous fish communities of Aotearoa New Zealand are unique as a result of our remote island biogeography. However, the proportion of indigenous fish species that are threatened or at risk of extinction has risen over the last decade and is higher than the global average (Joy et al. 2018). Whilst some of the increase in the number of species with an assigned threat status has been as a result of changes in taxonomic resolution or better data over the years, many species of indigenous fish populations have continued to decline and their habitats are directly at threat from activities which can be controlled under the RMA. We consider the inclusion of fish and threatened taxa as a specific focus of the Action for Healthy Waterways is scientifically justified and long overdue.

20. The exclusion proposed for large hydro-electric schemes will mean even when migratory fish passage is blocked, and the fish community is impaired these cases will be excluded. For regions such as Southland (the Waiau catchment), Otago (the Clutha catchment), Canterbury (the Waitaki catchment) and the Waikato (the Waikato catchment) this will limit the value of the Fish IBI in these catchments and exclusions should be considered on a case by case basis as discussed further below.

21. The requirement to use fish survey protocols from Joy et al. (2013) may result in substantial commitment of resources as undertaking the methods is labour and time intensive. While this is appropriate and supported in lowland waterways with diverse fish communities, this effort may be considered excessive in high country areas with few if any fish species. However, guidance on balancing effort and number of survey sites could be provide with protocols to cover less area where fish communities are restricted to one or two species.

22. Reach and catchment (including downstream) scale habitat information also needs to be collected alongside fish surveys to enable effective interpretation of reach-scale fish IBI scores. And, the Society recommends further development of fish community indicators for non-wadable rivers, lakes and wetlands.

NIWA

Fish Index of Biotic Integrity. We agree with the statement in the STAG report that there is a need to monitor fish populations, identify causes of population declines, and develop management plans. However, the fish index of biotic integrity (fish IBI) may be unsuitable as an NOF attribute due to naturally low site-specific fish diversity and the prevalence of migratory fish species in New Zealand rivers. The method set out in the draft attribute table is subjective and would need modification or replacement. Further, no explanation is given of how the proposed numeric attribute states for the fish IBI were derived.

Page 44 Table 15 – Fish (Rivers).

108. We agree with the statement in the STAG report that there is a need to monitor fish populations, identify the causes of declines in populations and develop management plans. Fish are an indicator of ecosystem health that the public relates to easily and that has high relevance for and alignment with community and tangata whenua values. Whether a fish index of biotic integrity (fish IBI) is an appropriate metric for characterising New Zealand riverine fish communities is questionable, for two important reasons. First, the prevalence of diadromous fishes in New Zealand fish communities weakens the coupling between local habitat quality and fish populations (McDowall & Taylor 2000[19]). Second, the low average species richness at a given monitoring site (i.e., an average of three species per site in the New Zealand Freshwater Fish Database) severely limits the candidate metrics that can be used in the IBI.

109. The preceding arguments against using the fish IBI in New Zealand remain valid, but the fish IBI may be adequate in the interim until an alternative metric is developed, if the following two methodological problems are addressed. First, the procedure for calculating the fish IBI described in Joy & Death (2004) is not reproducible as it involves fitting lines by eye, which is subjective. A quantitative, objective method must be defined. Second, there is no justification for the thresholds described in Joy & Death (2004) used to define metric scores – they are arbitrary and have no apparent ecological basis. A more robust evaluation of the constituent metrics and performance of the fish IBI is recommended.

110. No explanation is given for how the proposed numeric attribute states for the fish IBI were derived. Consequently, it is not possible to comment on the appropriateness of the proposed thresholds, or the method used. All steps used to develop the proposed fish IBI attribute need to be set out in a comprehensive and transparent report that is publicly available. The report should explain the method used to derive attribute states and their thresholds, address the validity (or otherwise) of a single national scoring system, explain the calculation of the numeric attribute state (e.g., the number of samples required to calculate average state), explain how fish IBI scores are affected by natural variations in fish populations, and how that is accounted for in sampling specifications, and provide evidence that the scores reliably reflect "habitat and migratory access" as stated in the narrative attribute band descriptors. The spreadsheet referenced in the STAG report for calculating fish IBI scores needs to be made available.

[19] McDowall RM, Taylor MJ. 2000. Environmental Indicators of habitat quality in a migratory freshwater fish fauna. Environmental Management 25: 357–374.

111. Metrics that incorporate fish abundance will be more sensitive to environmental changes than metrics based on presence/absence. New work is required to develop appropriate metrics that are suitable for detecting temporal trends in fish populations. This must also include consideration of sampling methodologies to achieve the appropriate sensitivity for detecting changes. We recommend that derivation of a fish IBI with abundance metrics is not pursued without first evaluating its suitability for application in the context of the objectives of the NPS-FM. Whilst we are pointing out a number of issues with the proposed IBI approach that need to be addressed, or perhaps even alternative options explored, we reiterate that this is an analysis issue for a national dataset that we do not currently have, but urgently need.

Northland Regional Council

Table 15 – Fish (rivers)

NRC understands that there is much debate about the effectiveness and appropriateness of the Fish IBI in assessing state of fish communities. For example, a decrease in the Fish IBI of -20% below the bottom line does not mean a loss of species. It just means that averaged over the 3-7 fish that comprise the index, there is a 20% lower probability of catching the same fish. NRC considers that more research is required for a fish IBI and therefore table 15 should be deleted for the time being.

That said, NRC recognises the importance of monitoring freshwater fish and consider that a multiagency approach (regional councils and DoC), using an established protocol, would be beneficial.

LakeSPI

Question

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

DairyNZ

Submerged plants (natives)	**Support** as a monitoring requirement in representative lakes, not as an attribute, and an important measure of lake habitat that is not currently assessed by existing freshwater attributes. However, submerged native plants are impacted by invasive plants (and fish) as well as water quality meaning that their management may require biosecurity approaches (as opposed to land use and catchment management approaches). Water quality limitations of native submerged plants are adequately addressed via the existing three lake trophic attributes (phytoplankton, total nitrogen and phosphorus). **Propose** this indicator is incorporated into the NPS-FM framework as a monitoring requirement, with the caveat that action plans may not be related to resource use limits in an FMU/sub-catchment.
Submerged plants (invasive species)	**Do not support as an attribute.** Action plans to improve this measure would be limited to weed spraying/harvesting and not related to setting resource use limits in an FMU. Accordingly, it should be a supporting measurement only in assisting to understand invasive plant pressures on native macrophyte biodiversity.

Local Government NZ

Vegetation cover is a critical aspect of lake ecosystem health, but the LakeSPI method is not designed to robustly assess vegetation cover. It is designed to assess vegetation composition (native versus exotic) and growing depth (an integrated picture of water clarity). It is not well suited to many of the shallow lakes that are in the worst conditions, because growing depth is irrelevant when the maximum depth is 1-3m. We think stipulating that LakeSPI is used will force monitoring funds into a method that is not fit for purpose for many of the most at-risk lakes in New Zealand.

A review on LakeSPI is available here www.waikatoregion.govt.nz/assets/WRC/Services/publications/technical-reports/2018/TR201814.pdf

Removing Tables 16 and 17 will not limit the effort being spent on lake restoration. Protecting and restoring lake ecosystems is already a high priority across New Zealand. LakeSPI is already widely used in situations where it is very helpful. But including Tables 16 and 17 in Appendix 2B may hinder, rather than help, lake monitoring and restoration efforts by forcing its use in situations where it is not helpful.

We have concerns around the required management response when the submerged plants (invasive species) NBL is breached. Invasive macrophyte removal may lead to a long period of phytoplankton dominance before any natives recover (providing that the seed bank is still viable). This lag period could also create conditions that will stem any native recovery due to a reduction in water clarity. Currently we have no proven restoration techniques for macrophytes and no way of assessing what species has historically existed in non-vegetated lakes aside from seed banks that may not be viable.

The requirement for invasive species monitoring to be annual (rather than every three years for native cover) seems to be based on a biosecurity risk rather than ecological health. We suggest that if SPI is included then both angles should be monitored every three years.

NIWA

Page 45 Table 16 and Table 17 – Lake Submerged Plant Indicators: Native Condition Index and Lake Submerged Plant (Invasive Impact Index).

112. Regional councils will require guidance to implement LakeSPI assessments. We recommend that lakes at risk of pest plant invasion or habitat degradation be assessed every three years using LakeSPI methods[20]. Lakes at risk are identified by deteriorating water quality or new records of invasive pests. However, if an interim assessment method were developed for use by councils, then a 5-10 yearly timeframe could be suitable for LakeSPI assessments of these lakes, depending on the results from interim assessments. The 5-10 yearly assessment timeframe applies for low-risk lakes. We also note that the one-year timeframe stated on Table 17 for invasive species, is not a surrogate for surveillance. This appears to link back to the second bullet point under the "Additional STAG member comments" on page 35 of the STAG report. We recommend that the timeframe for the invasive species (Table 17) is the same as for native species (Table 16).

Northland Regional Council

Tables 16 – Submerged plants (natives) and 17 – Submerged plants (invasive species)

Invasive species can negatively impact on native species and lake ecosystem processes. Lake SPI is a function of an accumulation of several stressors. Targeted interventions are required to remove invasive species. In some situations, it may be preferable for councils to leave populations of invasive macrophytes in place, if they are providing a useful ecosystem function and the lake no longer supports native macrophytes. The community may prefer invasive macrophytes over nuisance algal blooms. The consequences of macrophyte removal or management will need to be considered by councils when creating their management plans.

NRC considers that target attribute states should not have to be set for Lake Submerged Plants. Instead councils should only be required to monitor submerged plants using Lake SPI in representative lakes. This recommendation is consistent with recommendation of the wider regional sector.

Macroinvertebrates

Question

1. Is a bottom line of 90 achievable in urban streams? How much more rehabilitation would be required to get to 90 as opposed to 80?

Cawthron Institute

Macroinvertebrates

We support the inclusion of macroinvertebrates as national attributes and bottom lines for macroinvertebrate community health. Macroinvertebrates are the most commonly used biological indicator for freshwater in Aotearoa New Zealand and their use in biomonitoring of aquatic ecosystems is regularly used to inform water resource management globally.

DairyNZ

Macroinvertebrates (MCI & QMCI)	**Support** proposed attribute as integrated measure of biological stream health. **Do not support** multiple measures on the basis this will create confusion as different measures will produce different band grades for the same ecosystem health measure. It is also unlikely that regional councils have the capacity to undertake quantitative monitoring (for QMCI), and we do not consider that this additional resourcing is justified given that the non-quantitative measure of MCI is fit-for-purpose, and represents the recommended approach (in MfE documents) for undertaken State of the Environment Monitoring. **Propose** only using MCI as this is the recommended metric for SoE monitoring (Stark and Maxted, 2007)[25] Comprehensive MfE-commissioned reports concluded that MCI is one of the most sensitive indicators of stressor effects on macroinvertebrates and can be used to distinguish the ecosystem health of streams at a national scale.
Macroinvertebrates (ASPM)	**Do not support** this metric. Includes MCI and EPT, the latter of which is strongly correlated to the former, and therefore a superfluous attribute. Justification for needing an addition attribute measure due to it being more sensitive is inconsistent with comprehensive reports commissioned by MfE (refer to comments above for MCI/QMCI). **Propose** using MCI as this is recommended metric for SoE monitoring (as above).

Local Government NZ

We note that the MCI national bottom-line (NBL) has been raised from 80 to 90 with little documentation on the reasoning for this.

We have particular concerns around how the NBL can be achieved in urban catchments due to the large amount of impervious surfaces without significant removal of existing paved areas and infrastructure.

NZ Freshwater Sciences Society

Macroinvertebrates

18. The Society has consistently advocated for and strongly supports the inclusion of macroinvertebrates as national attributes and NBLs for macroinvertebrate community health. Macroinvertebrates are the most commonly used biological indicator for freshwater in Aotearoa New Zealand and their use in biomonitoring of aquatic ecosystems is regularly used to inform water resource management globally.

NIWA

Page 42 Table 13 – MCI and QMCI.

101. The footnote to Table 13 indicates that the numeric attribute states correspond to MCI and QMCI scores for hard-bottom streams, except when a monitoring site is in deposited sediment class 1, 5 or 11, in which case, soft-bottom MCI and QMCI scores are to be used. The three deposited sediment classes correspond to REC warm-dry and warm-wet lowland classes. It is not clear why sites in these specific environments are to be evaluated differently than sites in other environments. Soft sediment streams also occur in cool climate classes and in different topographic classes. Presumably, soft-bottom MCI and QMCI scores are more lenient than hard-bottom scores for a given site. Therefore, the guidance needs to distinguish between naturally occurring soft-bottom streams and soft-bottom streams that would be hard-bottom (and subject to more stringent MCI and QMCI requirements) under natural conditions. More generally, the STAG report does not provide a rationale for the mixture of hard-bottom and soft-bottom scores. Further, it is unclear how the distinction between hard- and soft-bottom streams in the attribute table relates to the definitions given in the MCI Users Guide[14] and the New Zealand Macroinvertebrate Sampling Protocols[15].

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[13] Ballantine DJ, Hughes AO, Davies-Colley RJ. 2015. Mutual relationships of suspended sediment, turbidity and visual clarity in New Zealand rivers. Proceedings of the International Association of Hydrological Sciences 367: 265-271.
[14] Stark JD, Maxted JR. 2007. A users guide for the MCI. Cawthron Report 1166.
[15] Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR. 2001. Protocols for sampling macroinvertebrates in wadeable streams. Ministry for the Environment, Sustainable Management Fund Contract 5103.

102. We note that the numeric attribute states for each band differ from those in the cited references. For example, Stark and Maxted 2007 regarded MCI > 119 as "Excellent" or "Clean water" (see table below, reproduced from Stark and Maxted 2007), but in the proposed macroinvertebrate attribute table, an MCI score of 119 is in the B band, indicating mild organic pollution.

Quality class (Stark and Maxted 2004, 2007)	Description (Stark 1998)	MCI MCI-sb	QMCI QMCI -sb
Excellent	Clean water	> 119	> 5.99
Good	Doubtful quality or possible mild pollution	100-119	5.00 – 5.90
Fair	Probable moderate pollution	80-99	4.00 – 4.99
Poor	Probable severe pollution	< 80	< 4.00

103. It is not clear whether the attribute state for a site is to be determined by satisfying both the MCI and QMCI values, or either one. I.e., if the QMCI value is ≥ 6.5, but the MCI value is < 130, is the site assigned to attribute band B? A clarification is needed in the attribute table.

104. The attribute band descriptions in Table 13 refer only to organic pollution and nutrient enrichment, but MCI and QMCI scores are known to respond to many other stressors and natural drivers, including fine sediment, flow fluctuations, changes in temperature and dissolved oxygen, and stormwater inputs[16]. While MCI and QMCI are useful as a general indicators of degradation, they are not diagnostic (i.e., they cannot be used to distinguish among causes of degradation). This point is made in the report cited in the attribute table (Clapcott et al. 2017): "*However, the MCI is not diagnostic and cannot inform specific management decisions on resource use*"[17]. The lack of a diagnostic function for the MCI and QMCI poses problems for the requirement to develop "action plans" if target attribute states are not achieved, due to uncertainty about the stressors to be ameliorated through management actions.

Page 43 Table 14 – ASPM.

105. Several points in Table 14 require clarification. First, it is unclear whether the numeric attribute state thresholds are based on the paper by Collier 2008[18], in which the distribution of ASPM scores calculated on data from Waikato streams, or from Clapcott et al. 2017, in which ASPM was calculated using a national dataset from regional council and NWRQN sites. It would be inappropriate to use the values from Collier 2008, which may only apply to the Waikato. Contributing to this confusion, Collier 2008 is cited for the proposed normalization values, which are actually from Clapcott et al. 2017.

[16] Collier et al. 2014 A macroinvertebrate attribute to assess ecosystem health of New Zealand waterways for the National Objectives Framework, ERI Report 36.
Wagenhoff et al. 2016 A review of benthic macroinvertebrate metrics for assessing stream ecosystem health, Cawthron Report No. 2852.

[17] Clapcott J, Wagenhoff A, Neale M, Storey R, Smith B, Death R, Harding J, Matthaei C, Quinn J, Collier K, Atalah J, Goodwin E, Rabel H, Mackman J, Young R (2017). Macroinvertebrate metrics for the National Policy Statement for Freshwater Management. Prepared for the Ministry for the Environment. Cawthron Report No. 3073.

[18] Collier KJ. 2008. Average score per metric: an alternative metric aggregation method for assessing wadeable stream health. New Zealand Journal of Marine and Freshwater Research 42: 367-378.

106. Second, the issues concerning soft- versus hard-bottomed MCI scores set out above apply here as well, because MCI is one of the component metrics of the ASPM. Furthermore, the normalization values for EPT richness are based on the maximum observed value from a national dataset (Clapcott et al. 2017); maximum values are most likely from hard-bottomed reference streams. It should be confirmed whether this value is also appropriate for soft-bottomed streams or if a different normalization value is required for soft-bottomed streams, where EPT may be naturally less abundant (Collier et al. 2014).

107. Third, no rationale is given for using a single normalization value rather than relevant reference values for MCI and % EPT abundance. The normalization values given for these metrics are the maximum possible values (200 for MCI and 100% for % EPT). In lieu of these single values, regionally relevant reference values would better account for natural geographic variability in invertebrate communities, as recommended by Collier (2008).

Other (missing) attributes

Question

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Cawthron Institute

What about physical habitat?

Physical habitat condition is a key component of ecosystem health and often controls the values that can be supported by a waterway. We would like to see further work on indicators of physical habitat that could be included as attributes in the NPSFM in the future. In particular, consideration of attributes such as reach-scale hydraulic heterogeneity (e.g. percentage mesohabitat types) and depth variation (e.g. as measured by residual pool depth) are affected by activities as wide ranging as forestry harvest to mechanical channel alteration for drainage maintenance or bank erosion control. Some physical habitat attributes are already routinely collected by Regional Council staff as part of State of Environment monitoring. We support the inclusion of a provision for how these data could be used to assess ecosystem health.

NZ Fish & Game Council

c. Fish & Game New Zealand would like to see measurable bottomlines for instream habitat in the draft NPSFM. Specifically we seek that:sinuosity, active channel area, bankfull channel area, permitted flood plain area, braiding index, thalweg length, and area of pools is at a minimum maintained since a 1991 benchmark. All these metrics can be measured from aerial imaging1, which is available nationwide for 1991.

d. All in-stream works extending more than 20m or extracting more than 50 m3 of gravel require no more than a 20% change (relative to pre-works condition and to the extent of the works) in the following metrics, unless desired for restoration purposes: percent deposited fine sediment; particle compaction; Simpsons diversity of inorganic substrate and D50 (mm) from a 100 particle Wolman Assessment 2; area of riparian and overhanging vegetation; length of undercut banks; area of instream wood; area of macrophytes; and the area of shallow pools (<1.5 deep), deep pools (>1.5m deep), backwaters, side braids, riffles and runs.

45. Riparian vegetation is another important component of and indicator of instream ecological health. A minimum of 40% of the length of a river should have 5 metres or more of riparian vegetation that is not grazed, trimmed or mown. This should form a national target or bottomline for all rivers in New Zealand. Fish & Game New Zealand understand the practicalities of this, and it should be phased in overtime.

NZ Freshwater Sciences Society

15. We note that the NPS-FM does not specifically include any groundwater policies (in section 2.2 of the draft NPS FM) and the Society submits that these are freshwater ecosystems in their own right that harbour taxa and ecosystems dependent on freshwater and are therefore highly relevant to the NPS FM. By extension this lack of groundwater policy is reflected in the lack of proposed NBL for groundwaters. We acknowledge that the ability to set such NBL for groundwater is problematic but submit that even non-numeric targets or a limit on the range of change in relevant attributes can be provided.

16. Development of further habitat attributes and acknowledgement of groundwater ecosystems at a national level are needed for future iterations of the NPS FM to meaningfully support ecosystem health. The Society would like to engage directly with MfE on the forward work programme for future attribute development across the full range of values.

Periphyton cover

39. We recommend the inclusion of periphyton weighted composite cover (and concurrent measures of benthic cyanobacteria cover) are included as complementary periphyton attributes for rivers as there are significant advantages to measuring and monitoring periphyton cover over biomass (chlorophyll *a*), enabling more sites to be monitored in a cost-effectively. The work of Matheson et al. (2012) provides attribute states with respect to ecological condition and a threshold for recreational values (Table 1) that can easily be adopted as national attributes complementary to the periphyton biomass attribute (in a similar way to the complementary attributes for macroinvertebrates) and will provide better protection across a broader range of freshwater values (e.g., ecological, cultural and recreational values).

40. The work of Matheson et al. (2012 and 2016) was undertaken at the national level through MBIE Envirolink Tools funding in three phases work to support councils in setting periphyton outcomes in regional plans for various values as an update to Biggs (2000). The advantages and

NIWA

70. None of the 23 attributes (and none of the compulsory values) refer to groundwater ecosystems and their values. The only consideration of groundwater in the draft NPS-FM is that taking, damming and diverting water must account for effects on groundwater levels; there is currently no reference to ecological conditions in groundwater ecosystems. We recognize that the science of groundwater ecology in New Zealand is less advanced than surface-water ecology, and that this science shortfall limits the ability of regional councils to manage groundwater ecosystems effectively. However, the absence of any consideration of ecological conditions in groundwater ecosystems is probably remiss. We suggest that some of the stressor attributes (e.g., nitrate and ammonia toxicity) could apply to groundwater as well as surface water, as a default regulation.

disadvantages of each attribute are discussed further below. Although measures of periphyton biomass and cover do not always correlate, the attributes complement each other and provide for more thorough measures of the state of periphyton across multiple freshwater values and both should be included for the reasons set out below.

Table 1. Matheson et al. (2012) provisional guidelines for periphyton weighted composite cover percentage (periWCC) for classes of ecological condition.

PeriWCC	Ecological condition
<20%	Excellent
20 – 39%	Good
30%	Recreation threshold
40 – 55%	Fair
>55%	Poor

41. Chlorophyll *a* biomass has been used in many studies (both in New Zealand and internationally) to determine the effects of periphyton on ecological communities. The disadvantages of measuring periphyton biomass include: the potential for bias in the collection of stones for substrate scrapings (although there are standard protocols to address this); it can be time consuming to collect in the field; samples need to be shipped to a laboratory on ice or frozen; laboratory testing adds costs to monitoring; and the return time for results can be weeks or months (although laboratory processing can be completed within two days if it is urgently required).

42. Periphyton percent cover is measured by in-stream visual observation in the field across measured transects, using standard protocols (Biggs and Kilroy 2000; Kilroy et al. 2008). There is some potential for between-observer bias, particularly if observers are not well trained. However, this bias has been shown to be much lower than expected (Kilroy et al. 2013) and periphyton cover is a scientifically supported, and recommended alternative or complimentary method to periphyton biomass sampling, that is readily available to councils. The advantages of periphyton cover include: it is easily collected in the field; observations of periphyton cover can be efficiently measured at the same time as fine deposited sediment and benthic cyanobacteria cover; there are no transport logistics for samples; there are no laboratory costs; if appropriate training is provided it can be used by tangata whenua and the community to monitor their own rivers; and the results are almost instantaneous. Additionally, because the costs are significantly less than biomass monitoring, councils can include more sites in periphyton assessment programmes.

43. We recommend including periphyton cover (with concurrent measurement of potentially toxic benthic cyanobacteria) as a complementary national attribute, using the methods and thresholds developed nationally by Matheson et al. (2012) and (2016) to better reflect the influences of varying amounts of periphyton on ecological condition. There is also a draft National Environmental Monitoring Standard (NEMS) in progress that includes periphyton cover.

Benthic cyanobacteria

44. We have has consistently advocated for the inclusion of a benthic cyanobacteria national attribute for rivers (since the 2014 NPS FM submission). There are significant human health, mauri, aesthetic and recreation effects from potentially toxic benthic cyanobacteria (e.g.,

Phormidium autumnale, now known as *Microcoleus autumnalis*) and our knowledge of these organisms has improved greatly over recent years commensurate with the rise in prevalence of rivers affected by benthic cyanobacteria. The STAG report highlights the need for an urgent update of the MoH/MfE (2009) guidelines to support a national attribute. We support the need for this to occur and note the NPS FM should include as a minimum a requirement for councils to monitor and report benthic cyanobacteria and frequency of activation of the alert status from the 2009 guidelines with a view to gathering the necessary data and inclusion of benthic cyanobacteria in future NPS FM iterations. We note that benthic cyanobacteria information can be collected by councils within the monitoring protocols for periphyton cover with no additional monitoring effort required. Moreover, some councils already actively monitor cyanobacteria cover, particularly at primary contact sites.

Metals, metalloids and toxicants

45. We consider further national attributes associated with key toxicants and metals (notably copper and zinc, two metals commonly found in stormwater) are needed and development of bands for these attributes should be initiated as soon as possible.

Sediment paper to STAG – 27 November 2019

The purpose of this document is to propose a structure for STAG's ongoing consideration of the sediment proposals as well as to provide context for this meeting's discussion. In relation to STAG's ongoing consideration of the sediment proposals, this document provides:

1. an initial summary of technical/scientific issues submitters raised
2. a proposal for collaborative engagement on specific technical issues.

In relation to the specific content for today's meeting, this document provides:

1. A summary of key issues for each theme
2. Excerpts from key submissions on the discussion themes (see Appendices)

This paper poses key questions for STAG in each relevant section.

STAG's ongoing consideration of the sediment proposals

A. Initial summary of technical feedback on the attribute

Our analysis of submissions on sediment proposals to date identified several issues of a scientific/technical nature that we would like to discuss with STAG. Further submissions analysis may identify other substantive scientific issues.

Suspended fine sediment attribute

1. The robustness of the method used to set the proposed bottom lines and bands, and a related preference for use of the extirpation method-derived bottom lines and bands.
2. Attribute indicator, proposed as turbidity measured by Formazin Nepthelometric Units (FNU), and related preference for use of visual clarity or turbidity as measured by NTU.
3. Attribute assessment timeframe and specific assessment statistic (two-year versus five-year medians).
4. Technical support required for successful implementation of the attribute by councils.

We propose to focus discussions with STAG primarily on the first two themes as we consider them the most substantive issues to address prior to policy recommendations.

Deposited fine sediment attribute

1. The robustness of the method used to set the proposed bottom lines and bands, and a related preference for the use of alternative, simpler classification systems.
2. The appropriateness of the proposed bottom lines and bands in specific classes within the proposed environmental classification system (too lenient in some classes).
3. The precision of bottom lines and bands given the monitoring method.
4. The appropriateness of the measurement method in all stream classes.

The Ministry is currently scoping further work (with NIWA/Cawthron) to address issue two, and we propose to focus deposited sediment discussions with STAG primarily on issues 1-3.

Environmental classification system for both suspended and deposited fine sediment classes

1. Some rare groups in the River Environment Classification (REC) are not covered in the proposed attribute classification system.

2. The complexity of the environmental classification system and potential redundancies in classes.

The Ministry is currently scoping further work with research providers (NIWA) to address issue one. The second issue is relevant for both suspended and deposited sediment. Some submissions question the robustness and value of increasingly complex spatial classification systems. In general, they consider that using the more spatially complex classification clusters (12 classes versus 8 or 4 classes) introduces potentially redundant classes and also may be "stretching" the meaningfulness of model outputs to predict reference state given underpinning observed data availability and its paucity in some classes.

Question 1 for STAG: Do STAG wish to consider technical issues about the attributes other than those described in this section?

B. ***Proposal for collaborative engagement***

The Ministry would like to discuss with regional council and research stakeholders aspects of the proposals for which submitters requested technical changes. We would like to host a workshop in December or January (more likely) to discuss the rationale and implications for:

1. using visual clarity as the attribute indicator as opposed to turbidity OR using NTU versus FNU as a turbidity indicator;
2. changing the suspended sediment attribute timeframe of assessment;
3. incorporating changes to the environmental classification system (unmapped REC groups);
4. using less spatially complex classification systems;
5. other science matters arising from subsequent submissions analysis or that attendees desire to discuss with MFE.

We request that at least one STAG member participates and reports back to STAG prior to the STAG meeting(s) at which we request recommendations on the matters under discussion. Invitees would include members of the regional council technical working group that has informed the sediment attribute research programme and informed proposals development. They would also include researchers from CRIs who have subject matter expertise regarding suspended sediment monitoring.

Question 2 for STAG: Is STAG willing to participate in a workshop with council and research stakeholders as described above? If so, what process would STAG suggest for member involvement and reporting back?

Context for 27 November meeting

In this meeting, we would like STAG to consider two specific and inter-related issues:

1. The robustness of the method used to derive the proposed suspended and deposited sediment attribute bottom lines and bands;
2. The rationale for using suspended sediment bottom lines and bands derived from the extirpation method rather than the current proposal.

The Ministry has received submissions that generally criticise the proposed bottom lines and bands for being too close to predicted pre-human states. The substance of, and preferred alternative

options stemming from, these comments is best characterised by DairyNZ's submission that critiques the robustness of the method on which the proposed bottom lines were based.

Question 3 for STAG: Does the community deviation method require further review, validation, or explanation before results using the method are adequately robust for use in setting public policy?

- See Appendix J of Franklin et al. (2019) for a detailed description of the community deviation method.
- See the Appendix of this document for excerpts from Dairy NZ's submission that posits further review and/or validation of the community deviation method is required.

MFE does not anticipate that STAG will reach a definitive answer to this question at this meeting, but we consider it helpful for STAG to deliberate on this question now and also discuss a proposed alternative to basing the bottom lines on the community deviation method. The answer to this question will also inform future discussions of the proposed deposited sediment attribute in light of issues raised in submissions.

DairyNZ submitted that as an alternative to the current proposed suspended sediment bottom lines, it would be more defensible either to:

1. use the bottom lines and bands derived from the extirpation analyses reported in Franklin et al (2019); or
2. to set bottom lines at a 5NTU offset from predicted reference state.

Question 4 for STAG: Are results from the extirpation analysis appropriate for setting bottom lines? If so, are the ecological impact thresholds used in the extirpation analyses from Franklin et al (2019) appropriate for setting bottom lines and bands?

- The extirpation method and findings (including potential bottom lines and bands) are described in depth in Appendix H of Franklin et al. (2019);
- See the Appendix for specific excerpts from Dairy NZ's submission on this issue.

The Ministry's sediment attribute development research programme aimed to define explicit ecological impact thresholds for in-stream sediment and therefore considers a uniform offset from predicted reference state to be inappropriate for setting bottom lines and bands. What is STAG's view?

Appendix – Excerpts from submissions

DairyNZ

1. Use of community deviation method

(Submission pages 58-59)

DairyNZ does not support the use of the untested and bespoke fish community index method as the basis for deriving thresholds for a limiting setting attribute in the NPS-FM. DairyNZ is not satisfied with the technical foundations and lack of peer review of the proposed fish community index method. We note that the Stage 2 report did not support using this newly developed, non-validated model as the basis for setting national bottom-lines for suspended sediment (Depree et al. 2018).

DairyNZ recommends an approach that focusses on setting bottom lines for fine sediment that are consistent with effects-based thresholds as published in international and national studies.

DairyNZ emphasises the importance of having confidence in the thresholds, particularly bottom-line values which will drive limit setting. It is concerning that current bottom-line thresholds are not met in sub-catchments dominated by natural landcover (including DOC conservation estate land). This indicates that either the classification system and/or bottom-line thresholds are not robust. It also highlights the challenges of using an untested, newly developed method.

(Submission Appendix 3 pages 132 – 133)

2) The method used to derive the thresholds are problematic
Both suspended and deposited sediment thresholds used a newly developed methodology (not peer-reviewed) based on the deviation from reference using a bespoke 'community index'; fish and macroinvertebrate community indices were used for suspended and deposited fine sediment, respectively National bottom-line (C/D band) thresholds are based on a 20% change (decrease) in the community index, relative to reference.

The defined 'level of effect' is inconsistent with NPS-FM delineation of C/D band thresholds which attempts to define a point along an effect gradient where impacts move from 'moderate' (i.e. minimum acceptable state, or C-band) to 'major or severe' (i.e. unacceptable state, or D-band). Importantly, the 20% deviation from reference state does not represent extirpation of species, and hence not necessarily a change in 'community composition'.

For the fish community index, the term is misleading, as the index likely consists of 3-5 native fish (this data has not been provided, despite being request by the Ministry), and the bottom line merely define the turbidity (modelled) that corresponds to an average 20% reduction in the probability of catching the same subset of fish (at sites with that turbidity), relative to a model reference state value.

In this way, D-band states are arguably more consistent with an A/B band threshold, given that they effectively define a state that is 80% of reference condition. This could explain why for several of the sediment classes the difference between modelled reference state and the national bottom-line is only 0.5 and 2 NTU respectively. This is well below effects-based thresholds in literature that indicate effects begin to occur between 5 to 10 NTU.

The result of the proposed bottom-line thresholds cause a large numbers of sites/catchment to be classified as D-band despite having median turbidity values less than current ANZECC trigger values, for example, the cumulative total of D-band sites with median turbidity values less than 3, 4 and 5

NTU is 36, 75 and 103 sites, respectively.
DairyNZ do not support the use of the untested and bespoke fish community index method as the basis for deriving thresholds for a limiting setting attribute in the NPS-FM. We note that the Stage 2 report (Section 7.3.2) did not support using this newly develop, and non-validated model as the basis for setting national bottom-lines for suspended sediment.87

If the Ministry continue to support thresholds based on fish community index for suspended sediment, we strongly recommend that the following steps be undertaken to at least respond to some of the method's many limitations, namely:

1. Clear articulation about what the bottom-line means – as currently proposed, the bottom-lines are defined by a modelled value that represents, on average, a 20% lower probability of capturing the same group of fish (between 3 and 7 fish species) at a site relative to a modelled reference site.

2. Peer review of method by technically qualified experts, including estimates of uncertainty that propagate through the many steps of the 'model-heavy' method.

3. Validation of the model output (e.g. suitability of -20% for bottom-line); and transparency about how final numbers are derived – for example, the number of fishes included in the index for each class, modelled probability of capture curves showing fit to measured presence/absence data and tabulated values of normalised probabilities for reference and impact conditions (Note: that this data is still an outstanding OIA request with the Ministry)

4. Sensitivity analysis / recalculation of thresholds with brown trout are removed (1 of 7 fish species used in the index). removal of brown trout (or at least understanding impact of its inclusion) is consistent with draft NPS-FM Fish IBI attribute that excludes salmonids.

DairyNZ emphasise the importance of having confidence in the thresholds, particularly bottom-line values which will drive limit setting. It is concerning that current bottom-line thresholds are not met in sub-catchments dominated by natural landcover (including DOC conservation estate land). This indicates that either the classification system and/or bottom-line thresholds are not robust, and highlights the uncertainty of using an untested, newly developed method.

2. Recommendations for suspended sediment (Submission Appendix 3 pages 124 – 125)

Recommendation for Suspended sediment

We recommend that attributes only define bottom-lines that represent turbidity values most likely to result in significant adverse effects. There are two potential approaches (or a hybrid of the two): (1) increase in of 5 NTU relative to reference state (i.e. 0.5 to 2.5 NTU)[89]. This would equate to absolute turbidity bottom-lines of between around 5.5 and 7.5 NTU, consistent with the 'global average' extirpation thresholds derived in Appendix H of the Stage 3 sediment report.[90]

An example of how this could be executed is provided in Figure A3.1. Blue datapoints (95% confidence intervals shown) represent modelled reference state (McDowell et al. 2013, used by MfE in deriving default guideline values, DGVs)[89], and the orange datapoints represent proposed bottom-line of a 5 NTU increase above reference. The dashed line shows the global average turbidity value of 7.2 NTU corresponding to this 5% macroinvertebrate extirpation threshold (Table A3.1; Appendix H in the Stage 3 sediment report).[91]

[87] Depree, C., Clapcott, J., Booker, D., Franklin, P., Hickey, C., Wagenhoff, A., Matheson, F., Shelley, J., Unwin, M., Wadhwa, S., Goodwin, E., Mackman, J., Rabel, H. (2018). Development of ecosystem health bottom-line thresholds for suspended and deposited sediment in New Zealand rivers and streams: NIWA Client Report prepared for the Ministry for the Environment 190 p (plus appendices).
[88] Clapcott et al. Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.
[89] McDowell RW, Snelder TH, Cox N (2013). Establishment of reference conditions and trigger values for of chemical, physical and micro-biological indicators in New Zealand streams and rivers. AgResearch report prepared for Ministry for the Environment. 70 p.
[90] Franklin et al. (2019). Deriving potential fine sediment attribute thresholds for the National Objectives Framework. NIWA Client Report 2019039HN. Prepared for the Ministry for the Environment (February 2019)
[91] Franklin et al. (2019). Deriving potential fine sediment attribute thresholds for the National Objectives Framework. NIWA Client Report 2019039HN. Prepared for the Ministry for the Environment (February 2019)

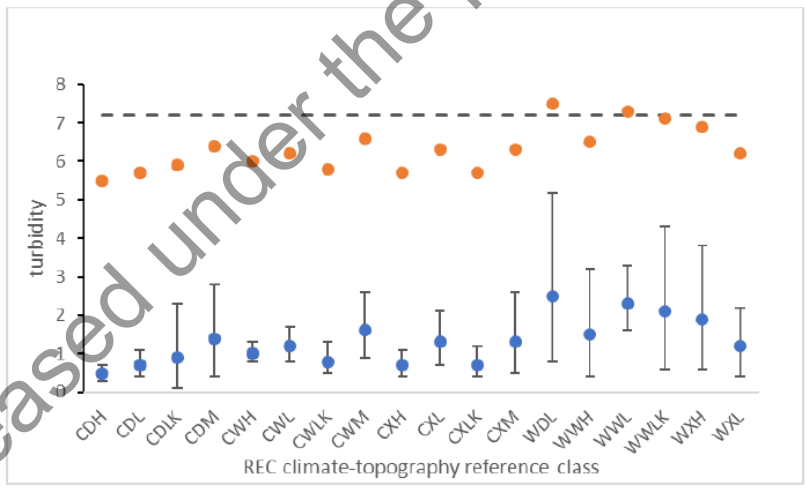

Figure A3.1 – Climate – Topography REC classes (McDowell et al 2013)[89] showing modelled reference state (blue) and suggest bottom-line (C/D) thresholds from 5 NTU increase (orange). The black global average turbidity value of 7.2 NTU corresponding to this 5% macroinvertebrate extirpation threshold (Appendix H in the Stage 3 sediment report).[92]

Table A3.1: Selected literature thresholds limited to the lower (most conservative) range of suspended sediment effects (Table 7-6 from Stage 2 sediment report)

study	comment
Newcombe (2003)	reactive distance - EL50[a] = c. 7 NTU (brook, lake and rainbow trout)
Vogel Beauchamp (1999)	reactive distance LOEL[b] = 3 NTU (*Salvelinus namaycush*)
Quinn et al. (1992)	50% effects level (EL50) macroinvertebrates = 3.7 NTU
Lloyd (1987)	increase of 5 NTU (in cold, clear water stream) could reduce primary productivity by 3-13% high level of protection would be 5NTU above natural conditions for clear, cold water streams
Boubee et al. (1997)	avoidance response , estimated EL25[c] values of 6.7 and 6.5 NTU for banded kokopu and koaro, respectively
De Robertis et al. (2003)	5-10 NTU decreased rate at which sable fish pursue prey and the probability of capture
Cavanagh (2014)	21 day experiment tank trials, inānga, kōaro, eels and brown trout. Inānga showed a significant decrease in growth rates from 5 to 15 NTU.
Hay et al. (2006)	Predicted 50% reduction in the reactive distance of 520 mm brown trout at 10 NTU
Newcombe (2003)	Impact assessment model for fish – with duration exposures from 1 h to 11 months Severity score ranging 1-14; 1-3 = *slight impairment*; 4-8 *significant impairment* (feeding and other behaviour begin to change); 9-14 = *severely impacted*. 4 month duration: '3 to 4' or '4 to 5' transition is predicted to occur at 0.77 and 0.55 m (corresponding to c. 5 and 7 NTU), respectively. 11 month duration: '3 to 4' or '4 to 5'or '5 to 6' transition is predicted to occur at 1.1, 0.77 and 0.55 m (corresponding to c. 3-3.5, 5 and 7 NTU), respectively.

[a] EL50 = 50% effects limit. [b] LOEL lowest observed effects limit. [c] EL25 = 25% effects level

[92] Franklin et al. (2019). Deriving potential fine sediment attribute thresholds for the National Objectives Framework. NIWA Client Report 2019039HN. Prepared for the Ministry for the Environment (February 2019)

Cawthron Institute

Fine Sediment

Elevated fine sediment loading is one of the most pervasive stressors on freshwater ecosystems in Aotearoa New Zealand. Deposited and suspended fine sediment can have adverse aesthetic, cultural and recreational effects; it is also of considerable ecological concern because fine sediment smothers benthic macroinvertebrates; clogs the gills of fish and macroinvertebrates; and reduces the ability of fish to feed, find refuge or spawn within the gravels of river beds.

We support the inclusion of this key component of ecosystem health with respect to aquatic habitat and support the need for both suspended and deposited fine sediment national attributes for ecosystem health. Their inclusion represents a significant investment by the Crown towards ensuring this significant and pervasive stressor on freshwater systems is managed. The proposed fine sediment attribute bands consider natural spatial variation in sediment state across 12 sediment classes; a different classification for suspended and deposited fine sediment respectively. The fine sediment attribute bands were developed using a data driven approach (Franklin et al. 2019). However, the data used to derive the attribute bands was limited in its representation of some environment types in New Zealand. We note that not all REC classes are represented by the fine sediment classification. Further, the method used to collect the deposited fine sediment data used to derive the attribute bands (i.e. reach-scale visual assessments of deposited sediment from the stream bank) differs significantly from the proposed method to assess the attribute (i.e. run-scale visual assessment in stream).

New data show that, for some sediment classes, the proposed attribute bands for deposited fine sediment are overly permissive and allow too much deviation from a healthy waterway status. Data recently collated for national reporting show how the predicted reference state, which is used to derive deposited fine sediment attribute bands, is much higher than the observed reference state in some sediment classes (Clapcott et al 2019). Based on this new information, we recommend the methods used to derive the deposited sediment attribute bands be revisited and attribute bands updated accordingly. The data driven approach should be grounded in theory whereby the relationship between deposited sediment and ecosystem health is negative for all sediment classes.

Fish & Game NZ

b. Table 18 for deposited sediment. More stringent attribute states should apply in salmonid spawning stream reaches, as listed in the relevant Sports Fish and Game Management Plan. Table 18 should include a footnote requiring a more stringent attribute state (suggest <=10% cover) where salmonid spawning is identified as a value for a particular stream reach. Indication of this is also in the initial footnote of the table in the STAG report but not in the draft NPS Table 18.

LGNZ

Table 10 - Suspended fine sediment (turbidity)	Turbidity is a proxy for suspended sediment; it is not a direct measurement. Although suspended sediment is the primary influence for turbidity change it is not the only one (e.g. colour of water can influence turbidity measurements). Therefore, we are wary of using turbidity as a direct measure of suspended fine sediment. We suggest that more effort is put into the development of clarity as an attribute as it is the outcome ultimately being sought. Our experience of measuring turbidity is that there is considerable variation in measurements between different instruments (Hughes et al., 2019). We suggest that more guidance is developed on measuring suspended sediment and that this could be done through MfE providing more financial support to National Environmental Monitoring Standards (NEMS). Clarification is required about why this table is now in FNU when all data used for method development is in NTU. These two measurements are not directly comparable.
Table 18 - Deposited fine sediment	We seek clarification about the proposed method for deposited fine sediment and its relevance to regions with naturally soft bottom streams. We question whether the measurement method can actually detect the small changes identified between bands, when the method has a 5% error.

NIWA

Page 39 Table 10 – Suspended fine sediment.

93. In our view, the use of turbidity as the measurement variable for suspended fine sediment is not workable. This view is based in part on a new NIWA report concerning variation in output between turbidity sensors[10]. Results in the report indicated that different turbidity sensors, run side-by-side, varied up to 5-fold in output, despite compliance with the international standard ISO 7027, which was adopted in the NEMS for turbidity. This variation was observed in comparisons of individual sensors of the same make and model as well as between different makes and models. We are currently working with the regional sector to repeat the experiments on a wider suite of turbidity sensors in use in New Zealand, but a clear ramification of the NIWA report is that poor comparability would pose practical problems with consistent monitoring and reporting of the proposed turbidity thresholds.

94. We recommend recasting the suspended fine sediment attribute in terms of visual water clarity. There are three main options for defining new attribute states in the form of visual clarity using existing data. First, the current turbidity thresholds could be converted to visual clarity using national scale regression models. Second, the proposed visual clarity attribute table derived from national visual clarity and ecological response datasets in the NIWA technical report used to develop this attribute (Franklin et al. 2019)[11] could be used. Third, a hybrid of these two methods could be used. Due to scarcity visual clarity data being available for some sediment state classes, the first or third of these options is recommended.

95. Further on the sediment state classes, we note that not all REC groups are allocated to a sediment state class in Appendix 2C, Table 1. This reflects insufficient data in some REC groups to map them directly to a sediment state class. However, all reaches on the digital river network have been allocated to a sediment state class. This information needs to be incorporated into Appendix 2c.

96. In our view, visual clarity is a better measurement variable for suspended fine sediment than turbidity for four general reasons. First, recent research indicates that the reproducibility of visual clarity measurements is better than the reproducibility of turbidity measurements[12]. Second, visual clarity is more precise than turbidity around the proposed thresholds for suspended fine sediment. Third, visual clarity is recognised by policy-makers, iwi, and the New Zealand public as an ecological, cultural and social value. Fourth, visual clarity has direct effects on aquatic organisms and on human use of water bodies; turbidity per se does not directly affect aquatic organisms or human use.

97. Visual clarity can be measured discretely (as it is now by most regional councils), either in-situ using a black disc or in the laboratory using a beam transmissometer. If turbidity is to be used as a proxy variable for visual clarity as is has been for suspended sediment[13], site and turbidity-sensor specific statistical relationships will need to be developed and maintained.

98. We note the proposed suspended sediment attribute does not account for event-based impacts on ecosystem health. Further research on event-based impacts is required.

99. In the event that turbidity is retained as the measure of suspended fine sediment, some clarification of the measurement requirements are needed. The required summary statistic for this attribute is not stated in Table 10. In the Franklin et al. (2019) report, that statistic is the median of 24 monthly values.

[10] Hughes A, Davies-Colley R, Heubeck S. 2019. Comparability of ISO 7027 compliant turbidity sensors. NIWA report 2019125HN.
[11] Franklin P, Stoffells R, Clapcott J, Booker D, Wagenhoff A, Hickey C. 2019. Deriving potential fine sediment attribute thresholds for the National Objectives Framework. NIWA Client Report 2019039HN, Ministry for the Environment.
[12] Davies-Colley R, Milne J, Heath MW. 2019. Reproducibility of river water quality measurements: inter-agency comparisons for quality assurance. New Zealand Journal of Marine and Freshwater Research, DOI: 1 0.1080/00288330.2019.1585886.

NZFSS

Sediment

23. Elevated sediment is one of the most pervasive impacts on freshwater in Aotearoa New Zealand. Deposited and suspended fine sediment can have adverse aesthetic, cultural and recreational effects; it is also of considerable ecological interest.

24. When suspended sediment loads become too high to stay in suspension or flow velocity reduces, sediment settles on the substrate and in interstitial spaces (small spaces between stones and gravels) of the streambed. Sediment that falls out of suspension fills interstitial spaces and reduces the amount of habitat available for fish and invertebrates. Grazing invertebrates need low (healthy) levels of periphyton to be able to feed. Deposited fine sediment, however, can smother periphyton, preventing invertebrates from grazing. Even low levels of deposited and suspended sediment in the water column can reduce the feeding efficiency of aquatic invertebrates (Broekhuizen et al. 2001). Invertebrate production (particularly in the lower gradient sections of the stream) is likely to be negatively affected by large volumes of fine sediment smothering the underlying substrate. Direct effects on fish and invertebrates can occur when sediment clogs or abrades the gills of these taxa.

25. Indigenous fish, salmonids and macroinvertebrates need access to hyporheic habitat, which is the zone beneath the bed of rivers where shallow groundwater flows. The hyporheic zone provides refuge to indigenous fish during droughts and floods and spawning habitat for many fish species (both indigenous taxa and salmonids). Fish have been found to burrow deep into the gravels of riverbeds (McEwan and Joy 2011; McEwan and Joy 2013a, b and c), receiving essential dissolved oxygen flowing through gravels at the surface. Deposited fine sediment reduces fish access to the hyporheic zone and blocks flow from the surface.

26. Numerous studies in New Zealand streams have clearly shown the impacts of excess sediment on stream habitat and ultimately fish and invertebrate species, their relative abundances and community structure (e.g. Ryan, 1991; Rowe et al. 1999, Richardson & Jowett 2002, Rowe et al. 2002).

27. The Society strongly supports the inclusion of sediment as a key component of ecosystem health with respect to aquatic habitat and supports the need for both suspended and deposited sediment national attributes. Both suspended and deposited sediment should operate as limits. We note, however, that not all REC geology classes are included in the tables in Appendix 2C, for example, in Nelson there is a monitoring site with CD_low_VA REC classes which does not fit into the suspended sediment classification. Additional guidance on REC classes or a default protocol where the classifications do not cover monitoring sites is needed in Tables 1 and 2 of Appendix 2C or a reference to the tool developed to inform regional councils and communities.

28. The Society also notes that the deposited sediment attribute bands and bottom lines are not as stringent as previous national guidance (Clapcott et al. 2011), particularly in naturally hard-bottomed rivers. We are concerned that the attribute may not provide a high level of protection for ecosystem health in these systems and more stringent thresholds already contained in regional plans (e.g., Canterbury and others) may be undermined by the bottom lines in the draft NPS FM.

29. Additionally, we note that many councils include limits for water clarity for safe contact recreation. An attribute state for recreational water clarity should be included in the primary contact provisions along with a threshold for periphyton cover for recreation (discussed below).