Technical note

Project:	TANK Plan Change 9
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Date:	15/03/2021
Subject:	**WATER QUALITY ATTRIBUTES - SCHEDULE 26**
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UPDATE OF TANK PLAN SCHEDULE 26 AND 27 TO NPS-FM 2020 NOF ATTRIBUTES (SURFACE WATER, RIVERS)

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1. BACKGROUND

HBRC worked with a collaborative stakeholder group to determine how water bodies in the TANK catchments should be managed. Plan Change 9 used a values-based approach to identify objectives for water management in the TANK catchments as outlined in the NPS-FM 2014: the community identifies the values for which the water is to be managed, adopt objectives in relation to those values and establish methods, including limits to ensure those objectives will be met.

Key attributes that allow the state of the values to be assessed and monitored were identified and objectives established for them. Some attributes were compulsory through the NPS-FM 2014 (MfE, 2017): ecosystem health (trophic state and toxicants) and human health for recreation (pathogens). Available attributes (guidelines) that relate to the state of the value were presented and discussed, then the most suitable attributes were chosen as outlined in the report by Haidekker (2019).

The changes and new attributes in the NPS-FM 2020 National Objectives Framework (NOF) affect 6 attributes already contained in the TANK PC9: Water clarity (NOF: suspended fine sediment), deposited fine sediment, DRP, nitrate and ammonia concentration, and macroinvertebrate indices.

This memo considers the differences between the NPSFM and the proposed target attribute states in PC9 and describes options for amendments that enable PC9 to give effect as much as possible to the NPSFM 2020.

In order to keep consistent with the objectives/targets of the TANK stakeholder group, NOF attributes that have different thresholds than the ones discussed in the TANK process, new attributes or changed application of the attributes have been adapted whilst maintaining the value and protection level the stakeholders intended.

The TANK group set water quality objectives based on the 2008-2013 State of the Environment (SOE) reporting period (Haidekker et al., 2016). In agreement with the group, this was not updated throughout the stakeholder group process to avoid confusion. This is used as 'baseline state' in accordance with the NPS-FM 2020 1.4 (1) b, as it was discussed in the process of setting freshwater objectives for the attributes under the National Policy Statement for Freshwater Management 2014 as amended in 2017 (NPS-FM 2014/17).

Sites that were added to the network after 2008 to inform the plan change process ('gap sites') did not have the 5 years monthly monitoring data at the time of the stakeholder group process. These sites were updated with a full 5-year data record at the time of the completion of the 2013-18 SOE reporting period (Haidekker and Madarasz-Smith, 2020), which is the baseline state for gap sites (Irongate, Raupare, Ohara streams).

General differences between TANK schedule 26 attributes and NOF attributes

Each Freshwater Management Unit (FMU) of the TANK catchments is divided into water quality management areas (TANK areas) of similar ecological characteristics (Haidekker (2019) Chapter 1.2.4) using the predominant Freshwater Ecosystems New Zealand (FENZ) class as a high-level classification system. FENZ is a classification system that groups surface water bodies based on similar ecological character (Leathwick *et al*., 2008), (Leathwick *et al*., 2010a). These freshwater management areas of similar ecological characteristics were set to reflect similar problems in relation to freshwater ecosystem health, ecological characteristics and values, and are therefore areas requiring similar management in this particular aspect.

By contrast, most NPS-FM 2020 attributes that apply to rivers don't discriminate between naturally different ecological characteristics and natural variation, except for two attributes: the suspended and deposited fine sediment. There are 4 suspended and deposited fine sediment classes with different thresholds based on the River Environment Classification (REC) system (Snelder et al., 2012). The classification system is a national classification that groups river segments based on their climate, topography and geology, which cause natural sediment levels to vary from place to place. These natural sediment levels (reference state) were estimated using a model-based approach. Modelling reference states was required to derive fine sediment attribute band thresholds for the NOF. This classification system recognises that streams with naturally high suspended and deposited sediment levels as a result of their natural characteristics can have different bottom lines from those with naturally lower levels. Each class has 4 state bands, which represent increasing levels of sediment as a result of human activities, and increased impact on ecosystem health ((Franklin *et al.*, 2019), and NIWA memo Franklin *et al.* 2020 on MfE website – currently not accessible).

Maps with the 4 TANK freshwater management areas based on the FENZ, and the NOF deposited and suspended fine sediment classes for the TANK catchments are shown in Appendix B.

NOF attribute sample statistics and application

Some of the NOF attributes have two sets of thresholds with different sample statistics. This has implications for setting objectives and triggering management responses: for example, what if the median and 95th percentile for nitrate fall in different attributes states, or what if on an annual reporting requirement, the extreme statistics vary from year to year (ammonia and nitrate toxicity) – when will a management response be triggered?

(1) Nitrate and ammonia toxicity:

- Two statistical criteria, annual sample median and annual 95th percentile (nitrate)/ maximum (ammonia): represent exposure under average conditions and during seasonal peaks.
- Freshwater objectives may be set to bring the lower set into a higher attribute state over time.
- Unclear: The annual reporting statistics means the highly variable statistical extremes are likely to change from year to year, indicating different current state related to seasonal peaks. Is one annual exceedance out of five years triggering a response? Or a three-in-five-year exceedance?

(2) Escherichia coli

- Four statistical measures represent a risk profile based on how often a threshold is exceeded, the mid-point and top range of *E.coli* levels.
- The E.coli attribute has 5 attribute states but no national bottom line. Bands D and E are considered not safe to swim.
- State is determined using a minimum of 60 samples over a maximum of 5 years.
- All four criteria are necessary to establish an attribute state, if one or more criteria can't be satisfied, a lower attribute state applies.

(3) Dissolved reactive phosphorus

- Two statistical criteria: median and 95th percentile.
- Numerical attribute state must be derived from the median of monthly monitoring over 5 years.
- Unclear: which state applies when statistical criteria are in different bands? Does the 95th percentile DRP concentration relate to ecological communities and ecosystem processes in the same way as the median (given the 95th percentile is mostly related to high flow events?)

(4) Macroinvertebrate community

- The macroinvertebrate attribute has three metrics (MCI, QMCI, ASPM)
- Unclear: which state applies when statistical criteria indicate different attribute states?
- The Technical Advisory Group (STAG 2020) states: *'Amend recommendation 10 from the primary report to clarify that: • MCI and QMCI should be assessed together, and the lower of the two results should apply. • ASPM is a separate metric and should be assessed separately' ;* (This is not in the NOF).

Confidently defining the extremes of a distribution (e.g., the 95th percentiles or maxima) is not possible for often highly variable water quality measures unless a very large number of data is available. There is already well recognised and considerable uncertainty when trying to define the centre of the distribution for a water quality variable (e.g., a mean or a median), and this uncertainty increases substantially at the extreme ends of the distribution which is far more sensitive to outliers and much harder to define with confidence. This means our estimate for a maximum or a 95th percentile will be highly uncertain, especially when based only on a maximum of 12 samples per year (i.e., an annual statistic based on monthly sampling). The gradings based on extreme statistics will therefore be highly variable among years, and not be a sensible statistic to use to trigger compliance action or policy direction (i.e. actions with big cost ramifications). For this reason, we propose using the 'extreme' statistics provided in the NOF attributes for guidance purposes only, e.g., in the context of producing action plans, when undertaking further investigations, or when modelling to try and mechanistically define the way a system works and how it will respond to different management scenarios. We would not, for example, consider a 'D' band in an extreme statistic for one out of five years to indicate a failure of existing policy, unless that attribute is also failing to meet the median targets, or if the median 95th percentile or maximum over five years with n=60 fails to meet the target.

Where there are several statistical criteria or metrics for one attribute, and it is not specified otherwise, the following approach could be used:

First priority management should focus on where all statistical criteria or metrics fail a target attribute state. The lower the inter-annual variability of criteria or metrics, and the higher the frequency of failing to meet the target over time, the higher the priority. The more inconsistent the criteria or metrics and if the baseline state of an attribute, i.e., the median statistic, meets the target, the lower the management priority.

2. SCHEDULE 26 ATTRIBUTES AFFECTED BY NPS-FM 2020

2.1. WATER CLARITY

The TANK Schedule 26 attribute water clarity (m) is corresponding to the NPS-FM 2020 attribute suspended fine sediment (Appendix 2A Table 8) both of which are measured as visual clarity using the black disc method. The council must identify limits on resource use that will achieve the target attribute state for the NPSFM Appendix 2A attributes.

Table 1:TANK PC9 attribute water clarity (m) for TANK freshwater management areas 1-4.

TANK	Visual clarity (m)	Value
FWMA 1	≥ 5	Outstanding trout fishery guideline
FWMA 2,3	≥ 3.75	Significant trout fishery
FWMA 4	≥ 1.6	Recreation, trigger value ANZECC, RRMP

Table 2: NPS-FM 2020 suspended fine sediment attribute, measured as visual clarity (m). REC class dependent attribute state bands. Band description: A: Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference condition. B: Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced. C: Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost. D: High impact of suspended sediment on instream biota. Ecological communities are significantly altered, and sensitive fish and macroinvertebrate species are lost or are at risk of being lost.

REC Class	A	B	C	D
3	≥ 2.95	≥ 2.57	≥ 2.22	<2.22
1	≥ 1.78	≥ 1.55	≥ 1.34	< 1.34
4	≥ 1.38	≥ 1.17	≥ 0.98	< 0.98
2	≥ 0.93	≥ 0.76	≥ 0.61	< 0.61

Differences between TANK Schedule 26 and NOF attribute

TANK Schedule 26: Guidelines were set to protect the identified values relevant to the TANK group such as trout fishing or recreation using thresholds that relate to the state of these identified values such as clarity. For the process of selecting the attribute thresholds see report Haidekker (2019), chapters 1.2.6 and 2.1.1. The TANK Schedule 26 has 3 thresholds, to protect outstanding and significant trout fishery, and recreation, which apply to the different freshwater management areas.

The NOF suspended sediment attribute state bands relate to the impact sediment has on the value ecosystem health (water quality). There are 4 suspended sediment classes with different thresholds. The classification system groups river segments of the River Environment Classification (REC) system based on their climate, topography and geology, which cause natural sediment levels to vary from place to place. This is reflected in the different natural reference condition of each class (band A). As a result of their natural characteristics the sediment classes have different modelled NOF band thresholds between bands A -D and bottom lines, the method is outlined in Franklin et al. 2020 (MfE) and (Franklin et al., 2019).

Effect on TANK Schedule 26

- The NPS-FM 2020 suspended sediment classes and their respective thresholds are river reach specific. The TANK management areas were defined by their *predominant* FENZ class, and for management purposes reaches that are in low proportions fall under the same management as the predominant FENZ class. The NPS-FM 2020 brings several NOF REC suspended sediment classes into each of the TANK surface water management areas. Therefore, with the implementation of the NPS-FM 2020 there are different water clarity targets when trying to achieve the same NOF bands within one TANK area.

  → The SOE sites in the lower main stem of the Ngaruroro and Tūtaekurī rivers are in NOF suspended sediment classes 1 and 4; upland tributary sites are in classes 1, 2 and 3; Karamū

and Ahuriri catchment and lowland tributary sites are in classes 1, 2.

- Class bands are very narrow, (e.g. REC SS class 1 has 44cm difference between band A and D, class 2 only 32cm). This results in 'extreme' band changes (between A and D) despite relatively minor absolute differences among some sites.

  → Out of 27 TANK SOE sites, 23 are either in band A or band D, only 4 sites are in band B and C.

- The NOF attribute bands for suspended sediment may not be reflecting the scale of anthropogenic impact of suspended sediment state at regional/local scale. Clearly impacted sites with significant land use effects and degraded water quality fall into NPS-FM 2020 state band A (condition similar to natural reference state) for suspended sediment (e.g., sites in the Karamū tributaries, and upland tributaries of the Ngaruroro and Tūtaekurī). This may lead to mixed messages when trying to identify where sediment needs to be managed.

  → The SOE sites in the mid and lower mainstem Ngaruroro fail national bottom line specified in the NOF. Given natural sediment contributions are accounted for in the NOF classes, this means the sediment has to come into the main stem from anthropogenic sources. The SOE sites in the Ngaruroro tributaries are in the NOF band A, indicating minimal impact and conditions similar to reference condition.

  The NOF suspended sediment attribute is an assessment of whether sediment is likely to be causing problems to the instream ecosystem health at a site. This depends on local factors like gradient and flow, and in steeper source areas sediment moves through quickly and may not settle out, therefore deposited or suspended sediment problems do not become obvious in higher gradient streams for most of the time.

  TANK PC9 uses the SedNet model (Smith et al., 2020) to identify areas that are at high risk of losing sediment. SedNet predicts about a 230% increase in sediment load across the TANK catchments post-human colonisation. The model results show that the Ngaruroro tributaries lose on average more than 4 times, and up to 7 times the amount of sediment compared to pre-human times.

  It is important to be aware that the NOF attribute relates to instream sedimentation problems that may develop in other areas, further downstream, than the source (e.g., Ngaruroro main stem failing bottom line, but tributaries falling into band A, indicative of condition similar to reference state). SedNet is needed to predict the source of sediment, which may be in areas that are indicated as in good condition by the NOF attribute.

Options for Schedule 26

(1) Keep the TANK attribute water clarity with thresholds related to the values outstanding and significant trout fishery and recreation (5, 3.75 and 1.6m respectively):

Pro: Schedule 26 water clarity targets do not fail the NOF bottom line. The guidelines for outstanding and significant trout fishery (≥ 5 m and ≥ 3.75 m clarity respectively) are in band A across all NOF suspended sediment classes. The guideline for recreation (≥ 1.6 m clarity), which applies to the TANK area 4 (Karamū and Ahuriri catchments, and lowland tributaries) is in band A for reaches in NOF suspended sediment classes 2 and in band B for class 1. There are no other classes in TANK area 4. **This means that the TANK targets for all management**

areas fall either into NOF bands A or B. This maintains the stakeholder's objectives for the values identified in the TANK process if the NOF as seen is providing the correct management direction.

Con(s):

(*i*) Keeping the TANK targets but reporting under the NOF framework can lead to a confusing classification. Within the same TANK management areas that have one numerical target, the same target has different NOF bands in TANK area 4.

(*ii*) The TANK Group identified outstanding trout fishery as a value for the upper catchments of the Tūtaekurī and Ngaruroro, whereas the tributaries and the lowland areas were to be managed for recreation and ecosystem health. In meeting 39 the TANK Group discussed the ANZECC guideline of >1.6m clarity for recreation: this was not seen as sufficient to also protect Kaitiakitanga in water management areas 2 and 3. The TANK Group suggested taking the threshold of ≥3.75m clarity for significant trout fishery as a higher protection level instead of the ANZECC guideline ≥1.6m. This may be hard to achieve by 2040. NOF band A target is ≥1.75m clarity.

(2) Apply NPS-FM 2020 band A to the upper Ngaruroro and Tūtaekurī catchments (TANK area 1), and band B to the rest of the areas.

Pro: most direct adaptation of NPS-FM 2020

Con(s):

(*i*) Current state of most sites fall into band A, few into band D. This does not reflect the impact of erosion in the TANK catchments and could send out the wrong message that nothing is wrong (most sites currently fall into band A: natural or near natural state).

(*ii*) In catchments or subcatchments that are currently not measured, more lenient thresholds apply than the ones set by the stakeholder group in relation to values. That could potentially allow for degradation.

(*iii*) This option doesn't follow the 'critical value' method of the TANK process, in which an identified value with the most stringent guideline applies. This is the case for the trout fishery guidelines, which are more stringent than the A band for all REC sediment classes for the value ecosystem health.

(3) Apply a mix of TANK and NOF targets (could be problematic, and depends on how much confidence is in the NOF modelling for reference/natural condition)

Pro: The TANK Group identified trout fishery as a value for the upper catchments of the Tūtaekurī and Ngaruroro, whereas the tributaries and the lowland areas were to be managed for recreation and ecosystem health. In meeting 39 the TANK Group discussed the ANZECC guideline of >1.6m clarity for recreation: this was not seen as sufficient to also enable Kaitiakitanga in water management areas 2 and 3. It was suggested to take the threshold of ≥3.75m clarity for significant trout fishery as a higher protection level instead of the guideline ≥1.6m for recreation. It was discussed there may be problems to achieve 3.75m clarity in the main stem in the given timeframe. Having a new set of thresholds related to ecosystem health

with the NOF framework gives the opportunity to have a potentially more suitable target related to Kaitiakitanga. Aiming for NOF band A ≥ 1.78 m for class 1 (Ngaruroro main stem and most hill tributaries) represents a state of minimal impact of suspended sediment and ecological communities similar to natural reference conditions. This could be achievable in the timeframe given.

Con: The targets will not be uniform in TANK areas: If NOF bands are applied to TANK areas 2 and 3, there will be 4 different water clarity targets to manage towards.

Additional comments:

Area 2 Ngaruroro: The mid to lower main stem Ngaruroro fails the NOF bottom line for clarity. The main stem is the recipient of the cumulative effects from all upland tributaries, which is the greatest part of the catchment. Sediment management must be implemented in a significant area of the catchment before an increase in water clarity is likely to be achieved in the main stem. Realistically it needs a lot of time for sediment management to be rolled out across the catchment, and the measures have to take an effect (e.g., plants have to grow) before any changes in water clarity can be expected. The question is whether meeting the PPC9 targets in 20 years is realistic.

The PC9 target is ≥ 3.75 m (significant trout fishery), which was a request by members of the TANK Group to enable Kaitiakitanga in water management areas 2 and 3 (in lieu of the target >1.6m for recreation, see more detail in 'Option 3 for Schedule 26' above). Increasing the clarity in the main stem of the Ngaruroro River by more than 3-fold by 2040 seems unrealistic (while it could potentially be applied for area 3, the hill country tributaries). The threshold for NOF Band A for the suspended sediment class 1 of the Ngaruroro main stem is ≥ 1.78 m and represents a state of minimal impact of suspended sediment and ecological communities similar to natural reference conditions. Although there are uncertainties underlying the modelled NOF thresholds – the NOF target seems to be potentially more achievable within 20 years. The significant trout fishery target of ≥ 3.75 m could be applied as aspirational target.

Area 3: The hill country tributary targets (depending on the catchment size) could potentially be achieved sooner than the main stem target, i.e., by 2040. Also, the lowland tributaries and Karamū streams for example are much closer to the target (current state at SOE sites is around 1 m clarity, the TANK target is 1.6 m for recreation in the lowland TANK management area).

Area 4: Under the NOF some of the lowland tributaries are suspended sediment class 1 (Raupare, Ruahapia, Irongate streams and Clive River), while all other lowland SOE sites are in class 2. This means that the TANK 1.6 m target is in NOF band B for the class 1 streams, and the same 1.6 m target is band A for class 2 streams in the TANK lowland area, that are in the same catchment (Karamū) – which can be confusing.

For keeping consistency with the values-based approach of the TANK group it would be preferable to keep the PC9 > 1.6 m target, and to report them in the respective NOF bands A and B.

2.2. DEPOSITED SEDIMENT

The TANK Schedule 26 attribute deposited sediment cover (%) corresponds to the NPS-FM 2020 attribute deposited fine sediment (Appendix 2B Table 16) measured as % fine sediment cover, both of which use the SAM2 method (Clapcott et al., 2011).

Table 3: TANK PC9 deposited sediment (%).

TANK	% cover	value
All FWMA	< 20	Ecosystem Health (Clapcott et al., 2011)

Table 4: NPS-FM 2020 deposited fine sediment (% fine sediment cover) in REC class dependent attribute state bands. A: Minimal impact of deposited fine sediment on instream biota. Ecological communities are similar to those observed in natural reference condition. B: Low to moderate impact of deposited fine sediment on instream biota. Abundance of sensitive macroinvertebrate species may be reduced. C: Moderate to high impact of deposited fine sediment on instream biota. Sensitive macroinvertebrate species may be lost. D: High impact of deposited fine sediment on instream biota. Ecological communities are significantly altered, and sensitive fish and macroinvertebrate species are lost or are at risk of being lost.

REC Class	A	B	C	D
1	≤ 7	≤ 14	≤ 21	> 21
2	≤ 10	≤ 19	≤ 29	> 29
3	≤ 9	≤ 18	≤ 27	> 27
4	≤ 13	≤ 19	≤ 27	> 27

Differences between TANK Schedule 26 and NOF attribute

The TANK Schedule 26 attribute threshold for ecosystem health was more stringent than the amenity value when comparing the guidelines available at the time of stakeholder group process (Table 5).

The recommended guidelines of 20% (biodiversity) and 25% (amenity) should not be exceeded and provide the 'upper limits' at which instream values will be negatively affected. In the absence of further specification with regards to reporting requirements and statistical application this could be interpreted as maximum or 5-year 95th percentile as an upper limit.

Table 5: TANK Schedule 26 Deposited sediment thresholds for ecosystem health and amenity values. (Clapcott et al., 2011).

Value	**% fine deposited sediment cover**
Ecosytem health (biodiversity, fish)	< 20%
Amenity	< 25%

The NPS-FM 2020 deposited fine sediment attribute relates to the value ecosystem health (physical habitat). The 4 suspended fine sediment classes are based on the River Environment Classification (REC) system. The classification system groups river segments based on their climate, topography and geology, which cause natural sediment levels to vary from place to place. The spatial classification system means that streams with naturally high deposited sediment levels can have different bottom lines from those with naturally lower levels. The application of the attribute is the median of a minimum record length of 60 samples taken over 5 years monthly monitoring in run habitats.

Effect on Schedule 26

The dataset is not complete to a record length of 60 samples over 5 years monthly sampling. Therefore, there is no final comparison available with SOE data yet.

The TANK Schedule 26 threshold of 20% cover is close to the boundary between bands B and C for the NOF deposited sediment classes 2, 3 and 4 (19, 18, 19% respectively). These classes are predominantly in the Ngaruroro and Tūtaekurī catchments (see map Appendix B). Most of TANK area 4 (Karamū and Ahuriri catchments, lowland tributaries) are classed as naturally soft-bottomed in the NOF, which matches largely the FENZ classification underlying TANK area 4. For deposited sediment class 1 (the most stringent deposited sediment class), the 20% cover target is close to the threshold between bands C and D (21%) and apply to the south-eastern part of the Karamū/Clive catchment, coming from the Kohinurakau and Raukawa ranges, and are represented by 4 SOE sites (Awanui, Poukawa, Mangarau and Herehere streams).

Half of the SOE sites (5 out of 10) in streams classified as soft sediment in the NOF deposited sediment classification are in fact gravel bottomed.

The application of % deposited fine sediment cover data changes from maximum cover (average annual maxima over 5 years) in TANK Schedule 26 to the median cover over 5 years monthly samples. This means a median of 18 or 19% cover (NOF) is less stringent than 20% maximum cover.

(NB: The NOF bands seem very narrow for the error margin in the method: The SAM2 protocol (Clapcott et al. 2011) requires 20 observations, and the deposited sediment estimate is done in 5% steps (p.17). To confidently detect a certain effect size, the number of replicates were also determined in this report: 18 replicates are required to have a satisfactory statistical power (0.8) to detect a size of effect of 15% change in cover, and for a 10% effect size, 36 observations are necessary (p.63). The NOF bands are between 6 and 10% apart: is the error higher than the band differentiation?)

Options for Schedule 26

The data requirement of 60 samples will be reached in 3 years, grading of the sites for the deposited fine sediment attribute will therefore occur with the 2018-24 SOE data.

The problem that (1) several SOE sites in the TANK areas are classified as naturally soft-bottomed in the NOF deposited sediment classes but are in fact hard-bottomed in the field, and (2) there is some concern if the assessment method can differentiate between attribute bands show there is some uncertainty in the application the NOF fine sediment attribute.

Both the suspended and deposited fine sediment attributes are not developed to indicate where sediments need to be managed. Policy decisions and plan implementation should be based on SedNet modelling results rather than on these attributes. Reducing sediment loads based on most sensitive receiving environment (estuaries) could also confer enough protection for both the instream values of suspended sediment and deposited sediment, the state of which is currently undetermined.

2.3. MACROINVERTEBRATES

The TANK Schedule 26 attribute MCI, based on Stark and Maxted (2007), is corresponding to the NPS-FM 2020 attribute macroinvertebrates (Appendix 2B Table 14) second column (MCI).

The NOF MCI score for each of the bands thresholds is 10 score points higher in compared to the original index by Stark and Maxted (2007). This means that the minimum standard (bottom line) for MCI is raised from 80 to 90.

Two additional macroinvertebrate attributes were introduced in the NPS-FM 2020, the Quantitative Macroinvertebrate Index (QMCI) (Stark and Maxted, 2007) and the Average Score Per Metric (ASPM) which is a multimetric index consisting of %EPT abundance, EPT richness and MCI combined into a single score.

The QMCI score was developed alongside the MCI with quality class thresholds at >5.99/ 5 – 5.99/ 4-4.99 and <4 for excellent/good/fair/poor quality class (Stark and Maxted, 2007). These thresholds were raised by 0.5 score points for the NOF bands.

Table 6: Description of MCI quality classes in (Stark and Maxted, 2007): Excellent : clean water, Good: Doubtful quality or possible mild pollution, Fair: Probably moderate pollution, Poor: Probable severe pollution.

Band description for MCI and QMCI attribute state in the NPS-FM: A: Macroinvertebrate community indicative of pristine condition with almost no organic pollution or nutrient enrichment. B: Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. C: Macroinvertebrate community indicative of moderate organic pollution. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment. D: Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to (in)organic pollution/nutrient enrichment.

Band description for the ASPM score in the NOF:
A: Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions. B: Macroinvertebrates have mild-to-moderate loss of ecological integrity. C: Macroinvertebrates have moderate-to-severe loss of ecological integrity. D: Macroinvertebrates have moderate-to-severe loss of ecological integrity.

TANK

Excellent	Good	Fair	Poor	(Stark and Maxted, 2007)
≥ 120	≥ 100	≥ 80	< 80	MCI score

NPS-FM

A	B	C	D	NPSFM NOF 2020
≥ 130	≥ 110	≥ 90	< 90	MCI score
≥ 6.5	≥ 5.5	≥ 4.5	< 4.5	QMCI score
≥ 0.6	≥ 0.4	≥ 0.3	< 0.3	ASPM

Differences between TANK Schedule 26 and NOF attribute

The thresholds for each state band are raised in the NOF by 10 MCI score points compared to the original MCI quality classes by Stark and Maxted (2007), and the band description changed moderately from indicating extent of organic pollution in the original description by Stark and Maxted to a wider narrative on organic pollution and nutrient enrichment in the NOF.

Two additional indices, QMCI and ASPM, were introduced in the NPS-FM 2020.

It seems like the thresholds for the MCI and QMCI bands were raised on the basis of raising the bottom line mainly, and then all other bands were raised to maintain the bands evenly.

Key arguments for establishing a national bottom line for MCI of 90 were (STAG) :

> • *By definition, an MCI score below 90 indicates the waterbody is approaching a 'severely degraded' state. Members considered that a narrative description of 'severely degraded' was not appropriate for the threshold between 'C' and 'D' bands. In other words, members do not support establishing a management framework that allows communities to maintain a waterbody in a state approaching 'severely degraded'.*
>
> • *The discriminatory power of the MCI deteriorates as the value drops below 90, reducing the technical effectiveness of the metric.*
>
> • *Wherever possible, management aspirations for urban and rural environments should be consistent.*

This pragmatic approach has an uncertainty in the correlation of the thresholds with each MCI and QMCI band. The original MCI/QMCI thresholds were developed based on a combination of statistical approach and expert knowledge/professional judgement for the ring plains of Taranaki (development of the MCI summarised in (Clapcott et al., 2017)). If the raising of the indices for MCI and QMCI was a pragmatic approach for the bottom line to be set at a better state than severely degraded, and all other thresholds were raised equally to maintain the bands even, there seems to be a disconnect now between the band descriptions and respective thresholds. The raising of the bottom line for the sake of improving the worst-off condition, and subsequent raising of all other thresholds, means there is fairly limited scientifically based justification for the current thresholds of the attribute states. *There is no updated scientific justification behind that >130 is in fact pristine, >110 is mild organic pollution, >90 is moderate pollution, that relationship has not been tested to my knowledge.* HBRC's regional MCI model developed by Cawthron Institute (Clapcott and Goodwin, 2018) indicates some SOE sites are predicted to have lower MCIs compared to the NOF MCI bands.

Effect on TANK Schedule 26

1. <u>Effect on SOE site attribute state:</u>

The change in MCI thresholds mainly affect TANK areas 2 and 3 (mid- to lower mainstem Ngaruroro and Tūtaekurī, and hill country tributaries): the current state of more than half of the SOE sites is one attribute state band lower in the NPS-FM 2020 framework than in TANK Schedule 26 due to the increased thresholds: the current state therefore indicates higher organic pollution and nutrient enrichment under the NPS-FM 2020 compared to Schedule 26.

TANK area 1 (upper Ngaruroro and Tūtaekurī): The SOE sites in this area were indicating excellent conditions (reference sites) and are at the threshold between A and B bands (mild organic pollution or nutrient enrichment) in the NOF framework.

TANK area 2 (mainstem Tūtaekurī and Ngaruroro): SOE sites Ngaruroro at Fernhill and Tūtaekurī upstream of Mangaone were in band B (TANK), change to band C (NPS-FM 2020).

TANK area 3 (hill country tributaries Tūtaekurī, Ngaruroro): SOE sites in Taruarau, Ohara streams: change from band A (TANK) to band B (NOF), Maraekakaho changes from band C to D, below bottom

line. All other sites were >110 comply with NOF band B, which matches the stakeholder target.

TANK area 4 (lowland tributaries and Karamū and Ahuriri catchments sites) mainly stay in band D or in one case (Ohiwa Stream) move from C into band D.

2. MCI attribute targets:

The targets for MCI (including hb-MCI (hard bottom streams) and sb-MCI (soft bottom streams) where applicable) notified in Schedule 26 were:

Zone 1 (upper Ngaruroro and Tūtaekurī, reference sites): MCI ≥ 120 (excellent condition, clean water).

The MCI score of 120 is in band B under the NPS-FM 2020, indicating a state of mild organic pollution or nutrient enrichment. The MCI score would need to be 130 or higher to indicate pristine condition with almost no organic pollution or nutrient enrichment.

The SOE reference sites, with mainly native vegetation in DOC estate upstream, are just at, or just below the NOF band A/B threshold. What are the potential reasons for the reference sites to be at or below the reference condition?

(1) The existing native vegetation is not true 'reference condition', e.g., still regenerating or impacted by pests and may not provide the full extent of functions it originally had e.g., regarding retention of sediment and nutrients and providing shade.

> *N.B. The native vegetation in the Kaweka ranges (upstream of these sites) is secondary forest after the original forest cover was burnt down progressively since colonisation, and then burnt further and also grazed in times of European colonisation* (Department of Conservation: Kaweka Forest Park & Puketitiri Rerseves https://www.doc.govt.nz/Documents/parks-and-recreation/tracks-and-walks/east-coast-hawkes-bay/kaweka-fp.pdf). *The current vegetation (some of which is tussock, not forest) could therefore be considered as still compromised or regenerating and may not provide the full extent of functions it originally had e.g., retention of sediment and nutrients, providing shade. There may also be problems like introduced pests that slow or hinder the regeneration of forest cover. In this context, it could be realistic that the sites are at the threshold between band A and B.*

(2) The new NOF MCI thresholds may not be representative for the attribute state at a regional scale. HBRC had a regional MCI model developed by Cawthron Institute, which is based on the FENZ river classification (Clapcott and Goodwin, 2018). The Band A/B threshold recommended for FENZ class C6 reaches (Ngaruroro at Kuripapango, Whanwhana and Tūtaekurī at Lawrence Hut) is 120 (Clapcott and Goodwin, 2018). Other pristine sites (Mohaka upstream Ripia, which is in native forest, no forestry or other land use influence) are also just close to the threshold (MCI 129.5). This could mean that this 'regional error' could follow through all band thresholds.

Zone 2 and 3 (mid- to lower main stems Ngaruroro and Tūtaekurī, hill country tributaries): MCI ≥ 100 (good condition, possible mild pollution). The MCI score of 100 is in band C under the NPS-FM 2020, indicating a state of moderate organic pollution or nutrient enrichment. The MCI score would need to be 110 or higher to indicate mild organic pollution/nutrient enrichment. This is consistent with local land use – and would be improved by stock and riparian land management.

Zone 4 (lowland tributaries and Karamū, Ahuriri catchments): MCI ≥ 90 (Fair: Probable moderate pollution). This MCI score is band C at the threshold to band D, the bottom line under the NPS-FM 2020. The current water quality state is generally poor and consistent with local land use and historic

impact of drainage systems. These catchments need significant investment including for riparian land management and stormwater management.

The raising of the threshold scores changes the bands the SOE sites are in, but it will not change priorities in management: Sites indicating poor water quality are in band D, below bottom line in both frameworks, the TANK schedule 26 and the NOF.

3. Additional macroinvertebrate attributes: QMCI and ASPM

The NPS-FM 2020 requires new macroinvertebrate attributes as additional ways of measuring macroinvertebrate communities, to give a better picture of the health of those communities.

A calculation of the MCI, QMCI and ASPM with 2008-13 and 2013-18 SOE data showed that the 3 macroinvertebrate attributes for a single site fall into (generally 2) different attribute state bands. In two instances (Taruarau, Poporangi) the 3 macroinvertebrate indices each fall into different bands (A, B, and C band).

Sites in TANK area 4 (lowland tributaries and Karamū, Ahuriri catchments) that are below bottom line are consistently in band D across all 3 macroinvertebrate attributes.

Options for Schedule 26

1. Keep TANK thresholds (MCI score) and adapt attribute state description:

TANK area 1 MCI ≥ 120, TANK areas 2 and 3 MCI ≥ 100, TANK area 4 MCI ≥ 90

→ Band objectives for TANK areas 1, 2 and 3 will move to lower quality band description (more organic pollution and nutrient enrichment).

→ TANK area 3 generally in NPS-FM 2020 band B (same as in the TANK plan) due to better current state than the threshold.

→ TANK area 4 remains the same.

2. Keep TANK attribute state objective (band) and change thresholds to more stringent NPS-FM 2020 thresholds

Assuming the stakeholder discussion and decision making was based on the descriptive state of organic pollution and nutrient enrichment and not on the score itself, the thresholds or targets would need to be updated to the more stringent NPS-FM 2020 thresholds to give effect to the descriptive state bands in Schedule 26.

TANK area 1 MCI ≥ 130, TANK areas 2 and 3 MCI ≥ 110, TANK area 4 MCI ≥ 90

→ the distance to the desired state or target increases particularly in TANK areas 2 and 3.

→ The target is not met in 5 out of 11 SOE sites in TANK areas 2 and 3, an increase by 2 sites from the TANK Schedule 26, one of which is then below bottom line (Maraekakaho Stream).

→ TANK area 4 (lowlands tributaries and Karamū and Ahuriri catchments) has one additional site that fails bottom line (now 11 out of 12 SOE sites are in band D).

The Freshwater Science and Technical Advisory Group (STAG, 2020) recommended that:

• MCI and QMCI should be assessed together, and the lower of the two results should apply.

• ASPM is a separate metric and should be assessed separately.

• The national management framework should rely on the updated MCI scores.

For schedule 26: Apply TANK MCI targets for 2040 and the full application of NOF macroinvertebrate thresholds long-term?

2.4. DRP

The TANK Schedule 26 attribute DRP is corresponding to the NPS-FM 2020 attribute dissolved reactive phosphorus (Appendix 2B Table 20). The thresholds for the bands used in TANK Schedule 26 were taken from the report 'Instream plant and nutrient guidelines' (Matheson et al., 2016), and relate to the risk of algal cover exceeding recreational guidelines (<30%) (critical value).

Table 7: Dissolved reactive phosphorus (DRP) bands from TANK Schedule 26 and the NPSFM 2020. Band narrative (Matheson et al., 2016): Risk exceeding 30% algal cover (recreational value) A: very low risk, B: low risk, C: moderate risk, D: high risk.
Band narrative NOF:A: Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to DRP enrichment are expected. B: Ecological communities are slightly impacted by minor DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates. C: Ecological communities are impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macro-invertebrate and fish taxa, and high rates of respiration and decay. D: Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DRP enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost.

TANK

A	B	C	D	30% algal cover risk
≤ 0.003	≤ 0.006	**≤ 0.015**	> 0.015	(Matheson et al., 2016)

NPSFM

A	B	C	D	Ecosystem health
≤ 0.006	≤ 0.01	≤ 0.018	> 0.018	Median
≤ 0.021	≤ 0.03	≤ 0.054	> 0.054	95th percentile

Differences between TANK Schedule 26 and NOF attribute

DRP attribute state bands were not available at the time of the TANK stakeholder group process (NPS-

FM 2014). The thresholds for bands were taken from (Matheson et al., 2016) and represent algal growth risk categories 'very low, low, moderate and high risk' , thresholds that were used for BBN modelling for the relationship with periphyton abundance. The NPS-FM 2020 attribute state bands for DRP concentration are more broadly related to reference condition, eutrophication, primary production, macroinvertebrate community and fish, and functional aspects of stream health. The bands include macrophyte dominated streams.

The NPS-FM 2020 attribute band thresholds for DRP concentration are higher (less stringent) than in Mattheson *et al.* (2016) for periphyton cover (related to 30% cover for recreational values).

The 95th percentile of DRP concentration was added as additional metric to the median in the NPS-FM 2020. The numeric attribute state is to be derived from the median of monthly monitoring over 5 years for both metrics.

There is no bottom line for the DRP attribute in the NOF.

Effect on TANK Schedule 26

The numerical DRP targets in TANK Schedule 26 related to algal cover are corresponding to the NPS-FM 2020 bands (with extended description). TANK area 1 DRP target ≤0.003 mg/L is in NPS-FM 2020 band A, TANK areas 2,3 and 4 DRP target ≤ 0.015 mg/L is between NPS-FM 2020 thresholds B and C.

Current (baseline) state at SOE sites:

<u>TANK area 1</u>: Tūtaekurī at Lawrence Hut in A band in NPS-FM 2020 (just in B band with TANK threshold). Otherwise no change.

<u>TANK area 2:</u> (mid-, lower main stems Tūtaekurī , Ngaruroro): all sites move up one band. Tūtaekurī upstream Mangaone and at Puketapu stays in the same band, Tūtaekurī at Brookfield Bridge moves above bottom line: band D → band C.

<u>TANK area 3:</u> upland tributaries: No changes except for Mangatutu stream: SOE reporting period 1008-13 TANK band D → NPS-FM 2020 band C (just at NPS-FM 2020 band C/D threshold 0.018), in the SOE reporting period 2013-18 in D band for both, TANK and NPS-FM 2020 (0.02 mg/l).

<u>TANK area 4:</u> lowland tributaries, Karamū and Ahuriri: all in band D - no changes.

<u>DRP 95th percentile:</u> Overall, the picture of highest DRP concentration and high priority areas does not change. Most of the sites that are below bottom line in DRP median concentration are also in the D band for the 95th percentile. Most sites with lower median DRP concentrations (above bottom line) are in a better band for the 95th percentile than for the median.

Options for Schedule 26

1. Keep TANK target thresholds, change attribute state description to NPS-FM 2020 if necessary:

No changes in TANK objectives (targets), but current state and target partly in better bands (state description) e.g., for lower Ngaruroro and Tūtaekurī, and one reference site (to band A).

All sites below bottom line remain the same in NPS-FM 2020 bands (except Mangatutu Stream: TANK band D → NPS-FM 2020 band C).

→ No changes in management for sites below bottom line or priority catchments.

2. Adopt NPS-FM 2020 thresholds as short-term target 2040 (where baseline state doesn't meet target state) and keep TANK thresholds (more stringent) as long-term target.

The state description for each band includes two metrics, the median and 95th percentile with respective thresholds. Often the current state for the metrics is in different bands for the same reporting period. It needs clarification if one metric takes precedent (e.g., median DRP), or if the lower band is counted towards a site meeting the target. The bands for the median nutrient metric were derived using the statistical relationships between multiple ecosystem health metrics and median nutrient concentration. By contrast, the 95th percentile was calculated from the LAWA dataset by correlating medians with standard deviations (STAG, 2019). Therefore, it can be assumed that there is more confidence in the median rather than the 95th percentile metric regarding the stressor-response relationship.
The DRP the numeric attribute state is calculated from the median of monthly monitoring over 5 years for both metrics, extreme year-to-year changes that make management decisions difficult are less likely to occur (as opposed to the year-to-year reporting requirement for toxicity). In the context of the above we could primarily base first priority management on the failing of the median metric, and the 95th percentile can help to rank further at-risk catchments.

2.5. NITRATE TOXICITY

Differences between TANK Schedule 26 and NOF attribute

The nitrate concentration thresholds (median and 95th percentile) for each state band are the same for the TANK attribute (which used NPS-FM 2014/17) and NPS-FM 2020. But the national bottom line for nitrate toxicity was strengthened in the NPS-FM 2020 to protect 95% of species from toxic effects (up from 80%) by moving the bottom line: it is now between B and C, where it was previously (NPS-FM 2014/17) between C and D.

Effect on TANK Schedule 26:

There are no changes in attribute state bands for the baseline state at SOE sites.

The Karewarewa Stream is in the B band for median nitrate concentration, but in the C band for the nitrate 95th percentile, which is now below bottom line under the NPS-FM2020.

2.6. AMMONIA TOXICITY

Differences between TANK Schedule 26 and NOF attribute

As for nitrate toxicity, the ammonia concentration thresholds (median and maximum) for each state band are the same for the TANK attribute (which used NPS-FM 2014/17) and NPS-FM 2020. But the national bottom line for ammonia toxicity was strengthened in the NPS-FM 2020 to protect 95% of species from toxic effects (up from 80%) by moving the bottom line: it is now between B and C, where

it was previously (NPS-FM 2014/17) between C and D.

While the bands for the baseline state do not change, there are now 3 streams below the new bottom line: Taipo, Karewarewa and Awanui are in in C band for ammonia maximum concentration under the NPS-FM2020.

2.7. DISSOLVED OXYGEN

The dissolved oxygen attribute (Table 17) is in the proposed TANK Schedule 26, the target being NOF band A for TANK areas 1, 2 and 3. Area 4 (lowland tributaries) target is NOF band C.

The baseline state could not be established yet, as continuous DO is currently not recorded routinely at SOE sites.

3. NEW ATTRIBUTES AND ATTRIBUTE APPLICATIONS

3.1. FISH

Time and cost intensive fish assessments have been unaffordable for inclusion in the regular SOE monitoring programme. HBRC is working on new methods using e-DNA to assess fish communities in Hawke's Bay. Currently, there is no data to analyse against the NOF and set targets.

3.2. ESCHERICHIA COLI (E.COLI)

TANK schedule 26 doesn't include the 95th percentile for *E.coli*. This is a compulsory metric in the NOF, it stipulates that the attribute state must be determined by satisfying all numeric attribute states. The addition of this metric into the TANK Schedule is consistent with the NOF. There is no further impact on Schedule 26, as the application otherwise remains the same: The attribute state is determined using 5 years of monthly samples (year-round) and fits the requirements of the NOF.

4. INFORMATION ON OTHER SUBMISSION POINTS

4.1. PERIPHYTON

[120.159] Ngati Kahungunu Iwi Incorporated and DOC [123.132]

> 'Amend periphyton biomass attribute states to: Delete >50 - max 1 p.a. Amend the periphyton biomass attribute for the upper Tutaekuri River to make attribute states for periphyton consistent.
>
> Reason: There are only two sites at which periphyton biomass is monitored in the TANK catchments (lower Ngaruroro and upper Tutaekuri Rivers). The attribute state to provide for ecosystem health at these sites is set at the NPS FM B band of 120mg/m2 'max 1 p.a.' The application of the attribute is 'max 8% exceedance over three years of monthly observations'. It is assumed the 'max 1 p.a.' means to allow one exceedance of the attribute state in any year. If this is the case it is greater than the 8% exceedance over three years from monthly monitoring (which is 2.6 observations exceeding the attribute state over three years). Having both terms specified in Schedule 26 is confusing as it is unclear which exceedance threshold applies (i.e., 2.6 over 3 years or once per year, or 3). It is unclear whether periphyton biomass at the NPs FM B band will be adequate to protect ecosystem health in the upper Tutaekuri River. 50 mg/m2 chlorophyll a is associated with a good state of benthic biodiversity (Biggs), whereas 120 mg/m2 is more closely aligned with trout habitat outcomes in the literature. This is better reflected by the 20% periphyton cover attribute for the upper reaches of both rivers, which equates to an excellent state of ecological condition (ecosystem health). Both attribute states for periphyton should be consistent.
>
> The two sites for periphyton biomass may not be representative of the 'FMUs' managed for periphyton. However, the risk of this approach is mitigated by the inclusion of a periphyton cover attribute for all rivers in the two catchments (see below). MfE guidance accepts that periphyton cover may be used in place of periphyton biomass and this approach is supported.'

(1) *Delete >50 mg Chla/L* **- Amend.**

'>50 and ≤ 120 mg/L' corresponds to NOF band B. PC9 stipulates to maintain or enhance water quality, therefore any biomass less than 50 also applies. Can delete >50 for clarity of the matter.

(2) *Delete max 1 p.a.* **– Accept in part.**

The periphyton criteria restrict exceedance to once per year *on average* over 3 years *minimum* record length. This is defined as *approximately* 8% of samples exceeding (accurate calculation is 8.̄3 %), to account for years without and other years with more than one exceedance over the monitoring period (MfE, 2018)*. Concur that the term 'max 1 p.a.' is inaccurate.

Replace 'max 1 p.a.' by 'exceeded no more than 8% of samples' as in NOF.

(3) *Amend periphyton biomass attribute for upper Tūtaekurī River* **– Accept in part**

Error in Schedule 26 table: should be *lower* Tūtaekurī River. This is then consistent with periphyton biomass monitoring sites in lower main stems Ngaruroro and Tūtaekurī (TANK area 2) and FMU sites.

Replace *upper* Tūtaekurī River by *lower* Tūtaekurī River.

*(MfE, 2018) p. 12:

> *'In simple terms, for most rivers in New Zealand, the periphyton criteria restrict the exceedance of specified biomass threshold to once per year, based on monthly sampling (ie, approximately 8 per cent of samples). Inter-annual variation in accrual period length, however, means that a biomass threshold may be exceeded more than once a year over short monitoring periods (eg, periods of oneto-two years) but the site may meet the objective over the longer term (for details, see Snelder et al., 2013). The average year is, in fact, notional and no actual year of monitoring data will be 'average'. The Freshwater NPS specifies the frequency criteria, in terms of the long term (ie, multiple years), with thresholds being exceeded on average once each year, or in approximately 8 per cent of samples based on monthly sampling. Objectives are met at a site if the biomass threshold is not exceeded any more frequently than the specified exceedance frequency.'*

[120.160] Ngati Kahungunu Iwi Incorporated and DOC [123.133, 123.134]

> Amend periphyton cover attribute state to (tracked changes provided): Periphyton cover (~~seasonal max,~~ %PeriWCC)
>
> Delete 'seasonal max' from the attribute so the value of Uu is provided for year-round. Delete reference to Uu from the Application column. Delete Recreation as the critical value and amend to replace with Uu (the most stringent value). Resolve inconsistencies in Schedule 26 and appropriately acknowledge Ngati Kahungunu values and attributes.
>
> Reason: Periphyton cover (using the Weighted Composite Cover %PeriWCC) method of Matheson et al. (2012) and (2016) is a useful method to address the adverse effects of periphyton cover on ecosystem health and recreational use of rivers. The annual maximum applied to the upper Ngaruroro and upper Tutaekuri" Rivers is supported as periphyton can form nuisance growths at any time of the year when flow and nutrient conditions are suitable, adversely affecting ecosystem health. 20% cover equates to excellent ecological condition and is appropriate for these waterbodies.
>
> It appears the freshwater value with the most stringent periphyton requirements in the lower Ngaruroro and Tutaekuri rivers and tributaries is either Uu or recreation. The Application column notes that monthly observations all year are required for Uu, however the critical value is stated as recreation and the attribute states 'seasonal max %PeriWCC'. There appears to be some inconsistency as to what the most stringent application of the attribute is and for which value. The NPS FM requires at Policy CA{e)(iii) that the objective must be adopted for the most stringent value. The most stringent value is Uu, which can occur at any time of the year, therefore this is the period when the periphyton cover attribute should apply. This inconsistency between values needs to be resolved in Schedule 26 and Ngati Kahungunu values and attributes appropriately acknowledged.

(1) *Delete seasonal max'* **- Accept in part.**

PeriWCC is assessed monthly year-round. The term seasonal max specifies that the reporting period should start 1st July and end 30th June to avoid half summer seasons in different years in the dataset: algal cover maxima tend to occur predominantly between November and April, and to determine the annual maximum these months should be treated as one season although this includes two calendar years. This is a technical detail for analysis and can be deleted from the plan. It does not change the fact that algal cover is monitored year-round and therefore gives effect to monitoring compliance with Uu and recreation values.

4.2. MACROPHYTES

Submission 120.135:

Schedule 26 – attribute states: macrophytes	Support in part	Not all macrophytes create adverse effects (e.g., indigenous macrophytes can be positive indicators of ecosystem health). Submerged nuisance macrophytes (e.g., invasive weeds) however can adversely affect ecosystem health and dissolved oxygen. This should be clarified in the wording of the attribute. Nuisance macrophytes may also have adverse effects on other lowland streams in the TANK catchments, these streams should be included alongside the Karamū catchment. Macrophytes are not included as attributes for the lowland streams in the Ngaruroro, Tūtaekurī or Ahuriri catchments. Schedule 26 should be amended to include all lowland rivers and streams to reduce the potential effects on ecosystems health from nuisance macrophyte growth.	Amend the attribute to: 'Submerged nuisance macrophytes'. Amend FMU to include all lowland rivers and streams in the TANK catchments, not just the Karamū.

123.162
p. 374
Schedule 26 – attribute states: periphyton biomass and Schedule 26 - attribute states: periphyton cover
… There are no periphyton attributes specified for the Karamū (lowland tributaries) or Ahuriri catchments and it is unclear whether this will protect freshwater values. The risk of this approach may be mitigated by managing for macrophytes as the dominant primary producers in soft-bottomed streams.
Schedule 26 – attribute states: macrophytes
p. 375
Not all macrophytes create adverse effects (e.g., indigenous macrophytes can be positive indicators of ecosystem health). Submerged nuisance macrophytes (e.g., invasive weeds) however can adversely affect ecosystem health and dissolved oxygen. This should be clarified in the attribute.
Nuisance macrophytes may also have adverse effects on other lowland streams in the TANK catchments, these streams should be included alongside the Karamū catchment. Macrophytes are not included as attributes for the lowland streams in the Ngaruroro, Tūtaekurī or Ahuriri catchments. Schedule 26 should be amended to include all lowland rivers and streams to reduce the potential effects on ecosystems health from nuisance macrophyte growth.

Macrophytes are an important and natural part of the structure and function of stream ecosystems. Particularly in lowland streams they provide key habitat and cover for macroinvertebrates and fish, where often stable habitat in form of hard bottomed stream beds is missing. Anthropogenic changes from natural conditions like lack of shade normally provided by riparian vegetation, hydromorphological changes and an increase in nutrient availability, as well as the introduction of exotic macrophyte species, lead to a change in the role of macrophytes: they can grow faster and reach high biomass 'nuisance levels', which means they clog the channel, trap sediment, and can cause severely low levels of dissolved oxygen in the water. The combination of the three factors, but most strongly the shade and hydromorphological conditions, lead to faster colonisation and growth rates particularly of non-native species {Mouton, 2019 #336}, which then outcompete native macrophytes. While under high shade levels all macrophytes grow slower, particularly exotic species do not have the competitive advantage over native species, in fact native species can then show higher biomass accumulation. Providing shade does not prevent exotic species to establish, but their growth is likely to be constrained. This can facilitate the development of a more diverse submerged macrophyte community, which includes native species, and a decrease in susceptibility of these streams to invasion (Kankanamge et al., 2019). To provide shade in form of riparian vegetation allows macrophytes to grow at a slow, healthy level, to provide important structures and functions in streams, and can allow for more diverse assemblages including native macrophytes.

5. OTHER INFORMATION REGARDING SCHEDULE 26 ATTRIBUTES

5.1. TURBIDITY

Turbidity was measured in Nephelometric Turbidity Unit (NTU) until recently. The NEMS specified the use of FNU (Formazin Nephelometric Units) not NTU in (NEMS, 2017) which affects long-term data to calculate trends. It also affects setting the baseline state for Schedule 26: To complete the 5 years data range to report on this attribute will take until the SOE reporting period 2018-24 is completed.

When calibrating sensors to stock Formazin solutions, different sensors can return different results. As a result, turbidity records from different sensors are not necessarily comparable, resulting in a need for standardisation. Once the measurements are calibrated, turbidity can be used as a proxy indicator for suspended sediment concentration (SSC) and suspended sediment load.

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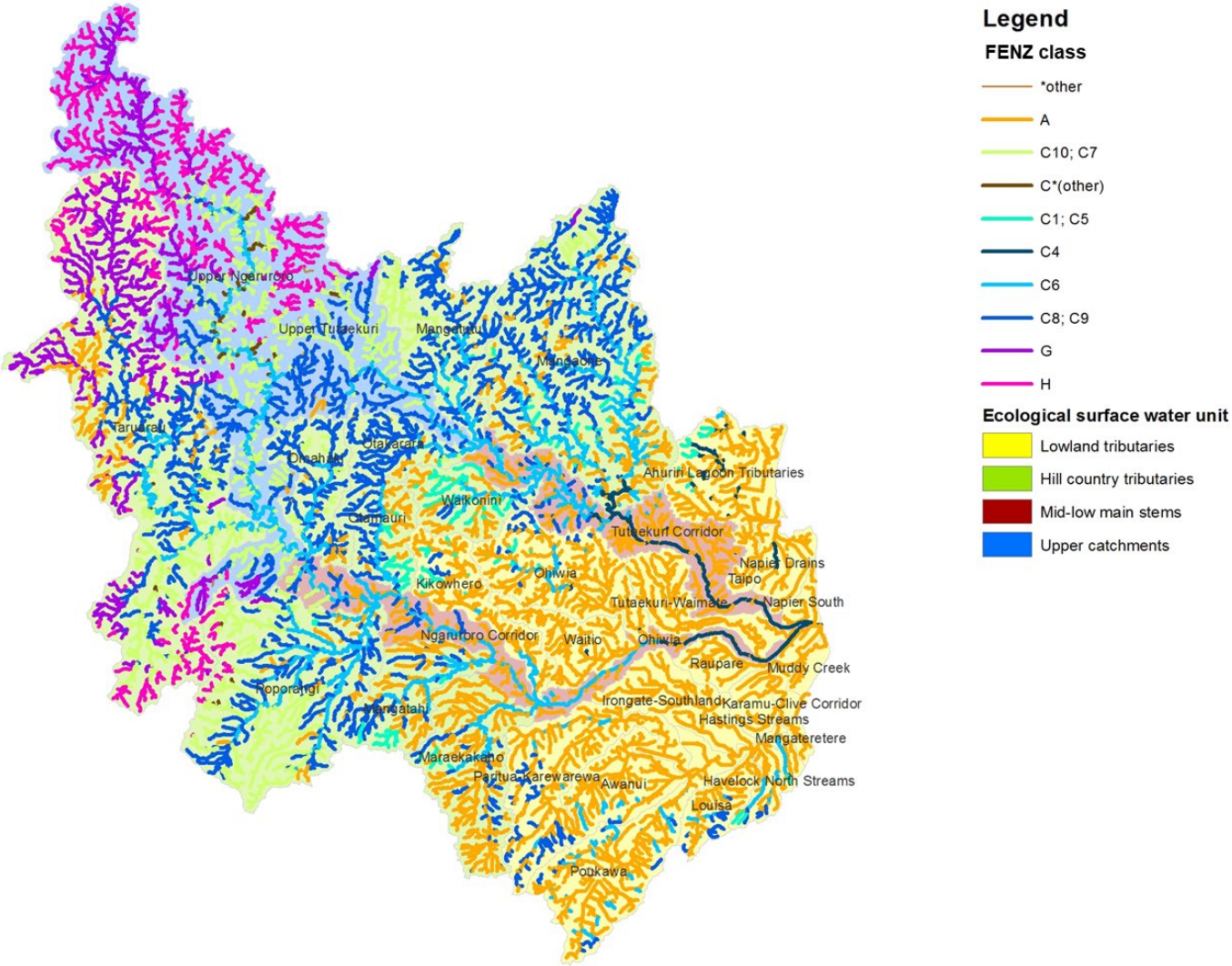
APPENDIX A: COMPARISON OF ALL ATTRIBUTES IN TANK PC9 TO NPS-FM 2020

TANK PC9			NPS-FM 2020				
Schedule 26 Attribute	**Critical value(s)**	**Thresholds**	**NOF attribute**	**Value (component)**	**Thresholds**	**Appx 2A /2B TANK PC9**	**what changed?**
Water clarity (Black disc, m)	Trout fishery Recreation	5, 3.75, 1.6 m	Suspended fine sediment (Black disc, m)	Ecosystem Health (Water quality)	4 classes between 2.95 and 0.61 m	2A	4 REC based suspended sediment classes (acknowledges natural differences)
Turbidity	Trout fishery Ecosystem health (Water quality)	between 0.7 and 5.6 ntu	---	---	---	TANK PC9	Change in method (NEMS update): Turbidity unit now FNU (not NTU) , will affect long-term data (trends) and no baseline state until 2018-24 report.
Deposited sediment	Ecosystem health (Physical habitat)	20%	Deposited fine sediment	Ecosystem Health (Physical habitat)	4 classes between 7 and 27%	2B	4 REC based deposited sediment classes (acknowledges natural differences)
Periphyton biomass	Ecosystem health (Aquatic life)	120 mg/m2 at FMU sites	Periphyton biomass	Ecosystem health (Aquatic life)	50, 120, 200 mg/m2	2A	No change
Periphyton cover	Ecosystem health, Recreation	20% 30%	---	---	---	TANK PC9	No change
Cyanobacteria cover	Human contact	20%	(only planktonic)	---	---	TANK PC9	No change
Macrophytes	Ecosystem health (Aquatic life)	50% CAV	---	---	---	TANK PC9	No change
Macroinvertebrates MCI	Ecosystem health	120, 100, 80 (index)	Macroinvertebrates MCI	Ecosystem health (Aquatic life)	130, 110, 90 (index)	2B	Index raised by 10 score points across all bands.
---	---	---	Macroinvertebrates QMCI	Ecosystem health (Aquatic life)		2B	New
---	---	---	Macroinvertebrates ASPM	Ecosystem health (Aquatic life)		2B	New
DIN (median)	Ecosystem health (algal growth risk, estuary EH)	0.05, 015, 0.3, 0.444 mg/L	---	---	---	TANK PC9	No change
DRP (median)	Ecosystem health (algal growth risk)	0.003, 0.015 mg/L	DRP (median)	Ecosystem health (Water quality)	0.006, 0.01, 0.018 mg/L	2B	Thresholds change: higher, and narrower bands

TANK PC9			NPS-FM 2020				
Schedule 26 Attribute	**Critical value(s)**	**Thresholds**	**NOF attribute**	**Value (component)**	**Thresholds**	**Appx 2A /2B TANK PC9**	**what changed?**
---	---	---	DRP (95th %ile)	Ecosystem health (Water quality)	0.021, 0.03, 0.054 mg/L	2B	New 95th %ile added to the numeric DRP state bands.
Nitrate (median)	Ecosystem health	same thresholds as NPS-FM2020	Nitrate (median)	Ecosystem health (Water quality)		2A	The bottom line is now between B and C, rather than C and D.
Nitrate (95th %ile)	Ecosystem health	same thresholds as NPS-FM2020	Nitrate (95th %ile)	Ecosystem health (Water quality)		2A	The bottom line is now between B and C, rather than C and D.
Ammonia (median)	Ecosystem health	same thresholds as NPS-FM2020	Ammonia (median)	Ecosystem health (Water quality)		2A	The bottom line is now between B and C, rather than C and D.
Ammonia (max)	Ecosystem health	same thresholds as NPS-FM2020	Ammonia (max)	Ecosystem health (Water quality)		2A	The bottom line is now between B and C, rather than C and D.
E.coli	Uu, recreation, human health	4 numeric attribute states	E.coli	Human contact	4 numeric attribute states	2A	No change
DO (continuous data) 7-day mean min	Ecosystem health		DO (continuous data) 7-day mean min	Ecosystem health		2B	No change, but have to wait for baseline data. Currently no routine contiuous DO recording at SOE sites.
DO (continuous data) 1-day min	Ecosystem health		DO (continuous data) 1-day min	Ecosystem health		2B	No change, but have to wait for baseline data. Currently no routine contiuous DO recording at SOE sites.
Temperature	Ecosystem health	increments from reference state	---	---	---	TANK PC9	Baseline (continuous temperature) data assessment started, 5 years not complete yet. 2018-24 reporting period.
pH			---	---	---	TANK PC9	No change
BOD			---	---	---	TANK PC9	No change
Heavy metals etc			---	---	---	TANK PC9	No change

APPENDIX B: MAPS

(1) TANK water quality areas with FENZ classes



Legend

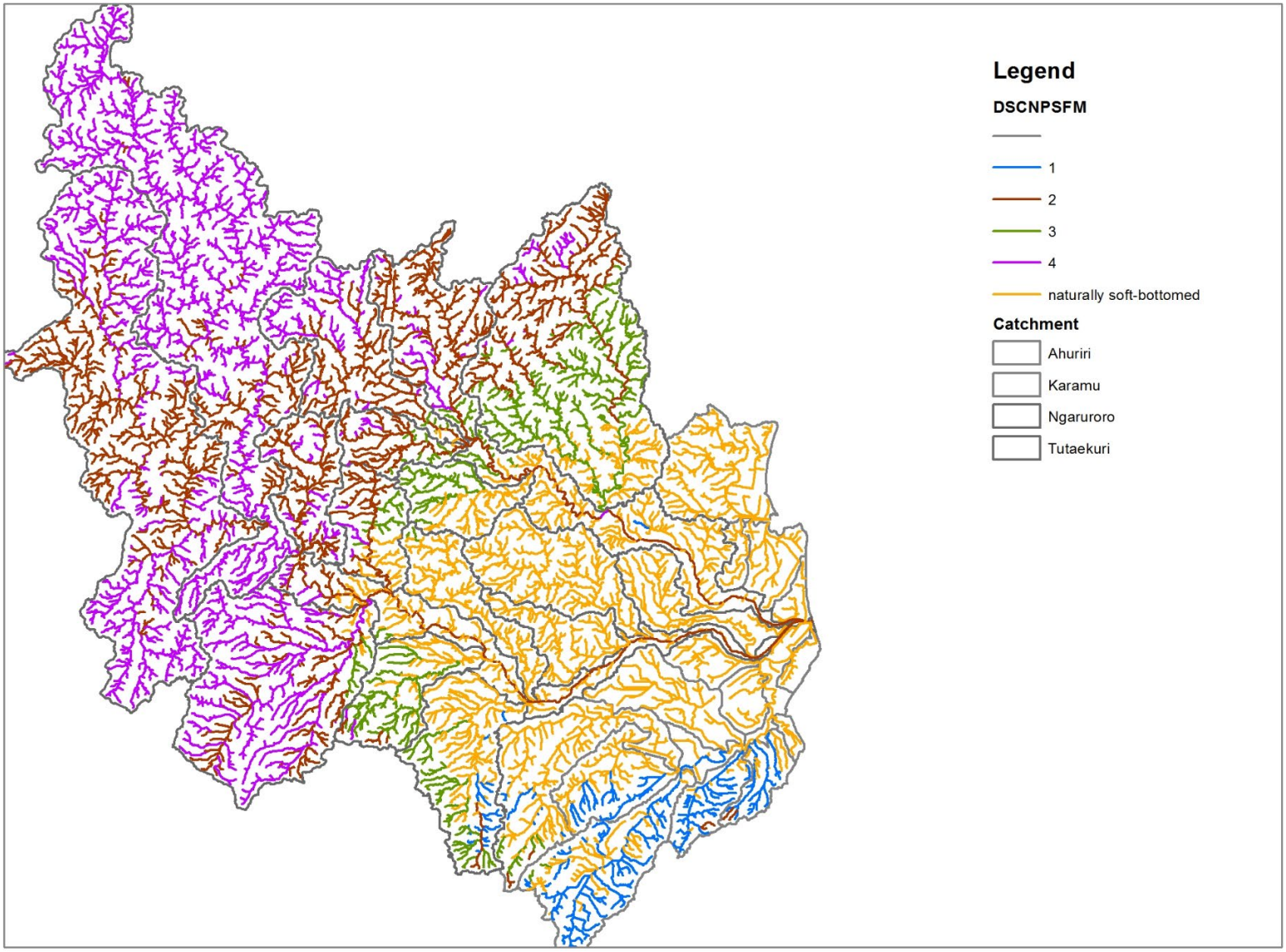
FENZ class

- *other
- A
- C10; C7
- C*(other)
- C1; C5
- C4
- C6
- C8; C9
- G
- H

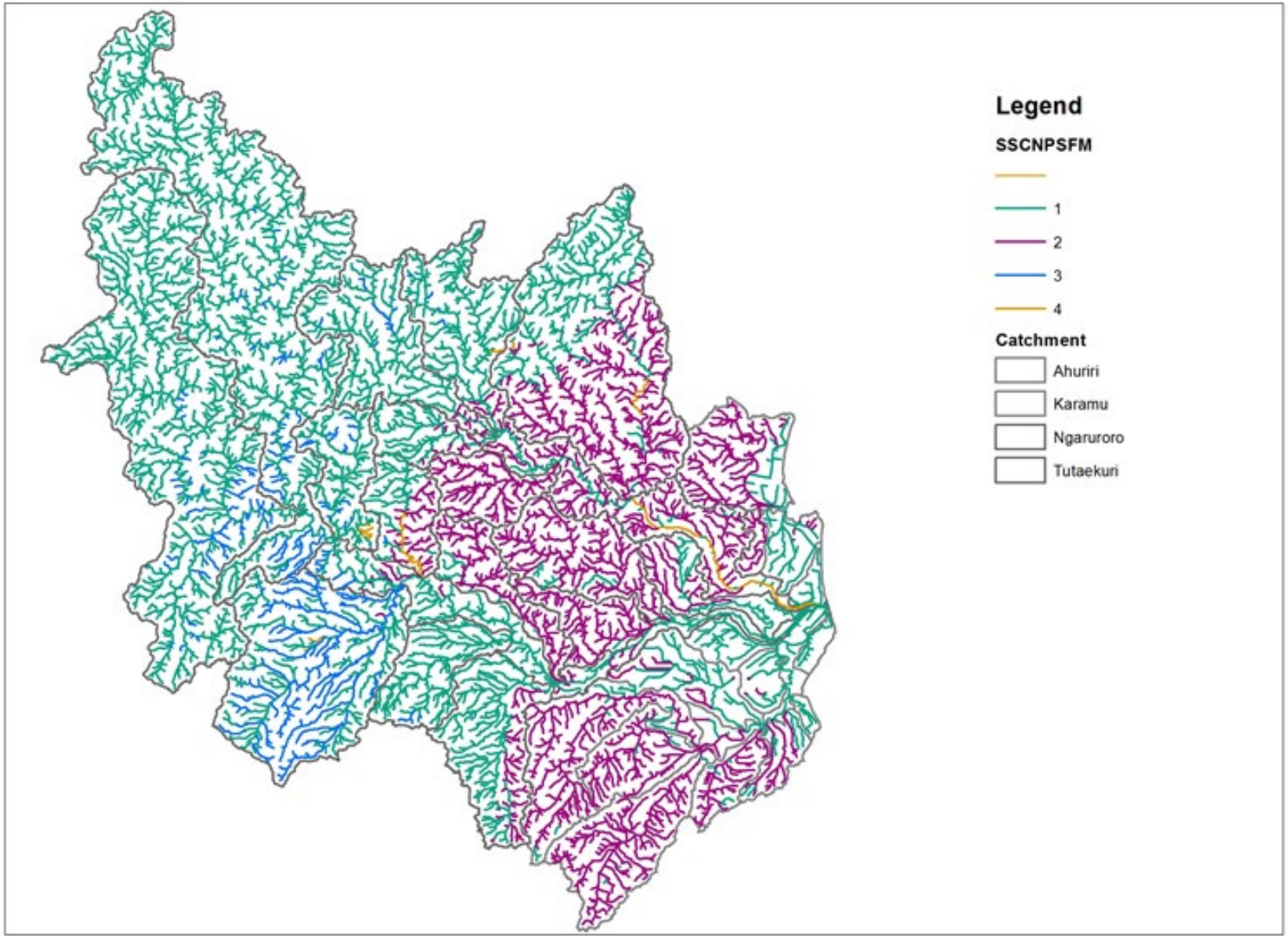
Ecological surface water unit

- Lowland tributaries
- Hill country tributaries
- Mid-low main stems
- Upper catchments

(2) NPS-FM 2020 deposited sediment classes



(3) NPS-FM 2020 suspended sediment classes



APPENDIX C: SEDNET MODEL RESULTS FOR EROSION IN THE TANK CATCHMENTS

*Due to the reason that pre-human sediment load excludes net bank erosion, comparison is only made on hillslope erosion types (Landslide, earthflow, gully, surficial).

Catchment/Subcatchment	Pre-human hillslope erosion(tonnes)	Contemporary hillslope erosion(tonnes)	Contemporary vs. Pre-human Hillslope erosion difference (tonnes)	Contemporary vs Pre-human Hillslope erosion difference (%)
Ahuriri	**8,081.7**	**54,986.8**	**46,905.1**	**580.4**
Ahuriri Lagoon Tributaries	7,486.2	50,574.2	43,088.1	575.6
Awatoto	0.2	0.5	0.2	98.2
Napier Drains	15.4	24.4	9.0	58.3
Napier Hill	17.2	17.3	0.1	0.3
Napier South	0.5	0.9	0.3	69.5
Taipo	562.1	4,369.4	3,807.3	677.4
Te Awa	0.1	0.2	0.1	50.1
Karamū	**7,345.8**	**46,602.7**	**39,256.9**	**534.4**
Awanui	1,089.3	7,719.1	6,629.8	608.6
Hastings Streams	2.1	2.5	0.5	22.0
Havelock North Streams	699.6	3,230.6	2,531.1	361.8
Irongate-Southland	278.5	2,292.1	2,013.6	723.0
Karamū-Clive Corridor	8.9	14.2	5.2	58.8
Louisa	629.0	1,394.8	765.7	121.7
Mangateretere	60.7	354.4	293.7	483.7
Muddy Creek	1.0	1.8	0.8	72.0
Paritua-Karewarewa	3,379.2	27,590.2	24,211.0	716.5
Poukawa	1,195.1	4,000.1	2,804.9	234.7
Raupare	2.3	3.0	0.7	29.4

Catchment/Subcatchment	Pre-human hillslope erosion(tonnes)	Contemporary hillslope erosion(tonnes)	Contemporary vs. Pre-human Hillslope erosion difference (tonnes)	Contemporary vs Pre-human Hillslope erosion difference (%)
Ngaruroro	**198,013.2**	**554,379.4**	**356,366.2**	**180.0**
Kikowhero	1,002.5	6,703.4	5,700.9	568.6
Mangatahi	3,260.5	13,075.2	9,814.7	301.0
Maraekakaho	1,528.3	5,724.6	4,196.3	274.6
Ngaruroro Corridor	3,571.6	17,766.7	14,195.1	397.4
Ohiwia	5,940.2	39,669.7	33,729.5	567.8
Omahaki	6,675.6	19,101.4	12,425.8	186.1
Otamauri	3,498.7	18,985.0	15,486.2	442.6
Poporangi	27,090.2	57,340.7	30,250.5	111.7
Taruarau	49,986.0	154,393.0	104,407.0	208.9
Tūtaekurī-Waimate	1,867.2	16,191.5	14,324.3	767.1
Upper Ngaruroro	90,719.1	179,928.1	89,209.0	98.3
Waitio	2,873.1	25,500.1	22,627.0	787.6
Tūtaekurī	**90,314.3**	**333,658.6**	**243,344.3**	**269.4**
Mangaone	35,828.0	158,251.7	122,423.7	341.7
Mangatutu	14,756.9	44,865.8	30,108.9	204.0
Otakarara	2,785.0	7,547.9	4,762.9	171.0
Tūtaekurī Corridor	9,093.1	61,612.6	52,519.5	577.6
Upper Tūtaekurī	24,120.1	45,302.9	21,182.8	87.8
Waikonini	3,731.2	16,077.6	12,346.4	330.9
TANK	**303,755.1**	**989,627.6**	**685,872.5**	**225.8**