BEFORE THE INDEPENDENT HEARINGS PANELS APPOINTED TO HEAR AND MAKE RECOMMENDATIONS ON SUBMISSIONS AND FURTHER SUBMISSIONS ON PROPOSED PLAN CHANGE 1 TO THE NATURAL RESOURCES PLAN FOR THE WELLINGTON REGION

UNDER	the Resource Management Act 1991 (the Act)
AND	
IN THE MATTER	of Hearing of Submissions and Further Submissions on Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region under Schedule 1 of the Act

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STATEMENT OF EVIDENCE OF ANTONIUS HUGH SNELDER

ON BEHALF OF GREATER WELLINGTON REGIONAL COUNCIL

TECHNICAL EVIDENCE – DEVELOPMENT OF NUTRIENT CRITERIA

HEARING STREAM 2 – OBJECTIVES

28 FEBRUARY 2025

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INTRODUCTION

1 My full name is Antonius Hugh Snelder. I am currently employed as an environmental management researcher and consultant. I have 35 years of experience in similar positions working for research agencies, consulting companies and regional councils. My role involves undertaking research and consulting to regional councils, central government and other organisations on issues concerning the management of land, water quality and water quantity.

2 I have read the submissions provided by submitters relevant to the Section 42A report on the development of the nutrient criteria to support Plan Change 1.

3 I have prepared this statement of evidence on behalf of Greater Wellington Regional Council (**the Council**) in respect of technical matters arising from the submissions and further submissions Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region (**PC1**).

4 This statement of evidence relates to the matters in the Section 42A Report – Objectives. Specifically, this relates to the development of the nutrient criteria for rivers as expressed in the target attribute states for dissolved inorganic nitrogen and dissolved reactive phosphorus (**nutrient outcomes**). These nutrient outcomes are set out in Objectives WH.O9 and P.O6 in PC1. Further context for these matters can be found in paragraph 42 to 45 of Dr Michael Greer's Statement of Evidence.

QUALIFICATIONS AND EXPERIENCE

5 I hold a Bachelor of Agricultural Engineering degree from the University of Canterbury, a post graduate diploma in hydrology from the University of New South Wales (Australia) and a PhD in environmental management from Lincoln University. I am a member of the New Zealand Freshwater Sciences Society and the New Zealand Hydrological Society. In my current and previous positions, I was the leader of many projects that have assessed water quality in freshwater environments, and the association between water quality and land use at catchment, regional and national scales. I have written several guidelines for the management of water quality and quantity and developed several tools for water management purposes. I have authored or co-authored 59 scientific publications in the field of water resources management, including those that address water quality.

6 I have 30 years of experience in the field of water quality management including many water quality studies, analyses, development of policy and advice and development of tools as well as many contributions to water quality research. I have led several studies that have developed nutrient concentration criteria for managing periphyton (i.e., algal) biomass in New Zealand's rivers. These criteria have been used by the council to set nutrient criteria for rivers as part of PC1. I have led many evaluations of nutrient concentrations in freshwater environments including rivers, lakes and estuaries and assessments of the degree to which concentrations would need to change to achieve desired environmental states.

CODE OF CONDUCT

7 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023 (Part 9). I have complied with the Code of Conduct in preparing this evidence. My experience and qualifications are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SCOPE OF EVIDENCE

8 My evidence addresses the use of criteria to define instream nutrient concentrations for managing periphyton (i.e., algal) biomass in the rivers that are included in PC1.

9 My evidence provides an overview of nutrient concentration criteria for rivers, a brief description of how the nutrient criteria that the Council has used were derived and work, a brief description of how the Council has applied the criteria, and finally my response to submissions made by the Victoria University Canoe Club and the Environmental Defence Society.

10 This evidence is limited to technical matters and I do not provide recommendations on matters of policy.

BACKGROUND CONTEXT

11 Plan Change 1 (**PC1**) to the Natural Resources Plan (**NRP**) for the Wellington Region implements the National Policy Statement for Freshwater Management (**NPS-FM**) 2020 for Te Awarua-o-Porirua (**TAoP**) Whaitua and Whaitua Te Whanganui-a-Tara (**TWT**). This

involves setting objectives, policies, rules and other methods to manage activities such as urban development, earthworks, stormwater, wastewater and rural land use.

12 PC1 defines Target Attribute States (**TAS**) for the attributes in Appendix 2A and 2B of the NPS-FM 2020 and establishes provisions that will contribute to the achievement of those TAS. TAS are set for 16 part-Freshwater Management Units (**part-FMUs**) that subdivide the TAoP into 5 parts and the TWT into 11 parts.

13 Clause 3.13 of the NPS-FM 2020 (amended February 2023) requires regional councils to set appropriate instream concentrations and exceedance criteria (hereafter nutrient concentration criteria), or instream loads, for nitrogen and phosphorus. The NPS-FM refers to these nutrient concentration criteria as nutrient outcomes (**NOs**) and these have the same function as NPS-FM 2020 Appendix 2A attributes. However, unlike Appendix 2A attributes, the NPS-FM 2020 does not define a state framework from which NOs can be selected. Instead, Clause 3.13 requires regional councils to define their own NOs. Each part-FMU is represented by a river water quality monitoring site to which an NO applies. Measurements that have been made by past monitoring at these sites have been used in the determination of these NOs.

14 These NOs must be defined to achieve the TAS for any nutrient attribute, and any attribute affected by nutrients, and at a minimum, must set instream concentrations and exceedance criteria, or instream loads, for nitrogen and phosphorus that will allow the TAS to be achieved for periphyton, dissolved oxygen, submerged plants, fish, macroinvertebrates, and ecosystem metabolism. In setting instream concentrations and exceedance criteria, or instream loads, for nitrogen and phosphorus under this clause, the regional council must determine the most appropriate form(s) of nitrogen and phosphorus to be managed for the receiving environment.

15 The NPS-FM 2020 states that the relevant river attributes that are affected by nutrients include periphyton (measured as chlorophyll a), Macroinvertebrates (measured as Macroinvertebrate Community Index (**MCI**) score; Quantitative Macroinvertebrate Community Index (**QMCI**) score, Macroinvertebrate Average Score Per Metric (**ASPM**)), Dissolved oxygen, Ecosystem metabolism (measured as gross primary production (**GPP**) and ecosystem respiration (**ER**)), and Fish (measured as Fish Index of Biotic Integrity (**F-IBI**)).

16 The Council used guidance provided by MFE (MFE 2022) to define nutrient concentration criteria for rivers that comply with the requirements of the NPS-FM and that, under PC1, become NOs in the NRP. The details of how that guidance was interpreted and used is set out in detail in Greer et al. (2023). Briefly, given the timeframes associated with PC1, the Council elected to use the first strategy set out in MFE (2022), which is to use existing published criteria to define the nutrient concentration criteria for the 16 river sites that represent the part-FMUS of the TAoP and TWT (Strategy 1)**.** The Council identified two sets of existing published nutrient concentration criteria, Snelder and Kilroy (2023) and Canning et al. (2021). The Snelder and Kilroy (2023) nutrient concentration criteria pertain to TAS for periphyton biomass. The Canning et al. (2021) nutrient criteria pertain to TAS for macro-invertebrates (**MCI scores**).

17 The MFE (2022) guidance does not recommend how to choose which set of published criteria should use when implementing Strategy 1. However, both MFE (2022) and Greer et al. (2023) note that the Canning et al. (2021) criteria only provide for a TAS that corresponds to the national bottom line (i.e., the C/D band threshold). These criteria would not allow NOs to be set for TAS other than the national bottom line, which is the lowest acceptable condition nationally and therefore inconsistent with the macroinvertebrate community health outcomes sought for many of the part-FMUs in the TAoP and TWT. For this, and other reasons set out in Greer et al. (2023), the Council chose to use the Snelder and Kilroy (2023) nutrient concentration criteria. The underlying assumption is that by managing nutrients to achieve periphyton TAS they will achieve the TAS set for all other attributes affected by nutrients.

IMPLEMENTATION OF THE NUTRIENT CRITERIA

18 Defining nutrient concentration criteria is complex because many factors are involved in determining how nutrients affect attributes in rivers. The approach to defining nutrient criteria of Snelder and Kilroy (2023) has been developed over many years and is based on modelling the relationship between peak periphyton biomass (as defined by the NPS-FM periphyton attribute) and the key factors that drive periphyton growth rates and biomass accrual in rivers including the median concentration of the nutrients nitrogen and phosphorus.

19 It is generally found that modelled relationships between nutrients and peak periphyton biomass are significant but weak (i.e., uncertain at the site level). The weakness is because

of the complexity of the underlying mechanisms and the fact these cannot be accurately accounted for in the model. This was true for the models that Snelder and Kilroy (2023) used to define nutrient criteria to achieve periphyton TAS. Consequently, the criteria do not define a nutrient concentration that will ensure that a peak periphyton biomass threshold will not be exceeded at a specific location. Rather, the criteria define a nutrient concentration that limits the risk that a peak periphyton biomass threshold will be exceeded at any location. The risk is referred to as the under-protection risk (**UPR**) and is a choice that the user of the criteria (and ultimately, the "decision maker") must make. This approach means that if a criterion pertaining to a specified peak biomass threshold is applied over many locations, it is expected that the threshold will be exceeded at a proportion of those locations that is defined by the chosen UPR. Importantly, the locations at which the threshold will be exceeded cannot be known, only the proportion is knowable.

20 Another feature of the criteria of Snelder and Kilroy (2023) is that they vary spatially. This is because the other factors that contribute to peak periphyton biomass are spatially variable. The other factors include temperature and sunlight that contribute to the rate of growth of periphyton and the frequency of high and low river flows that determine the available "accrual period" (i.e., the period that periphyton biomass can increase without being disturbed by high flows). The criteria of Snelder and Kilroy (2023) provide for this spatial variation by deriving separate criteria for each of 21 environmentally distinct classes. The classes are defined by a national river classification system called the River Environment Classification (**REC**). REC classes discriminate appreciable differences in factors that control peak periphyton biomass including temperature, sunlight and the frequency of high and low river flows. The criteria therefore account for the fact that expression of nutrient impacts is strongly dependent the environmental conditions and the concentration criterion for a given TAS differs between REC classes because of this.

21 Another feature of the criteria of Snelder and Kilroy (2023) is that the concentrations vary for sites that are shaded and unshaded. This is also an acknowledgment of the fact that the expression of nutrient concentrations on biomass is strongly dependent the environmental conditions. The models underlying the criteria quantify the effect of shading on peak periphyton biomass and this allows different concentration criteria to be defined for shaded and unshaded locations.

22 The Council has set NOs based on dissolved inorganic nitrogen (**DIN**) and dissolved reactive phosphorus (**DRP**) at 16 sites the represent the part-FMUs of TAoP and TWT. These values

are set out in set out in Tables 8.4 and 9.2 of PC1 and are shown below for DIN in Table 1. This process started by considering the periphyton biomass thresholds (i.e., TAS) that had been defined for these sites by the respective Whaitua Implementation Programmes (**WIP**). For some of these sites, the current periphyton attribute state exceeded the TAS (**Table 1**), which indicates that a reduction in current nutrient concentrations is required. For all sites, the criteria of Snelder and Kilroy (2023) were used to derive the nutrient concentration criteria to achieve the periphyton TAS in three steps that are described below. For those sites where the current state nutrient concentration was less than the derived nutrient concentration criteria, the NO was defined by the current state otherwise the nutrient concentration criteria was used.

23 The first step in the use of the criteria of Snelder and Kilroy (2023) was to assign each of 16 monitoring sites to the appropriate REC class using a national database of rivers. The second step used the criteria of Snelder and Kilroy (2023) to obtain the nutrient concentration criteria to achieve periphyton TAS that has been set for each site. The criteria for shaded sites were used because council assumed that the sites would be shaded except for the Hutt River at Boulcott, which is too wide for riparian planting to provide shade across the river channel. At this point the criteria are defined for several levels of UPR and therefore the third step was to choose the UPR level for each site.

24 The choice of UPR is a value judgement for which it is difficult to provide technical guidance. The NPS-FM is silent about this aspect of setting nutrient concentration criteria and only limited guidance around this step is provided by MFE (2022). It is important to note that all environmental criteria are subject to under-protection risk. The reason that the need to choose a UPR does not always arise in the use of many criteria is that the value judgement about the acceptable level of risk is implicitly made as part of defining the criteria. It is important to note that all criteria involve the risk of not achieving the target, it is just not explicitly stated by many existing environmental criteria. The criteria of Snelder and Kilroy (2023) make the risk of not achieving the target state explicit in order to be very transparent about the uncertainties associated with their criteria. The guidance provided by MFE (2022) for choice of UPR is for councils to "*provide the demonstrable process that sets out how and why they made their under-protection risk decision*".

25 The council chose UPR values at each representative site by comparing the current median DIN and DRP concentrations at sites where the periphyton TAS represents an improvement from current state to the unshaded nutrient concentration criteria obtained from Snelder

and Kilroy (2023) for several UPRs. The UPR that required (in the absence of shading) an "achievable" reduction in DIN and DRP concentrations across most of the sites was chosen. That UPR was then used to select NOs for all sites based on the potential for future shading. Achievable reductions were defined as those that did not require concentrations to reduce below those measured at the three sites in the PC1 area that are in reference condition (i.e., >85% of the catchment upstream of the site is in a natural state). The resulting NOs for the 16 sites and DIN and DRP are set out in Tables 8.4 and 9.2 of PC1 and are shown below for DIN in Table 1.

26 The guidance provided by MFE (2022) suggests that the criteria of Snelder and Kilroy (2023) should be validated to the extent possible to be confident that these are suitable. Validation uses observations of nutrient concentrations and peak periphyton biomass at monitoring sites and performs an analysis to assess whether these observations are consistent with the criteria. I performed two validation exercise for the council. First, I attempted to validate a previous set of criteria defined by Snelder et al. (2022) and concluded that these were too permissive. Second, I repeated the validation for the criteria of Snelder and Kilroy (2023), which were developed specifically because the validations performed on the criteria of Snelder et al. (2022) indicated they were too permissive. The second validation exercise (Snelder 2023) showed the newer criteria (Snelder and Kilroy, 2023) were more consistent with the monitoring site observations. The second validation exercise included an analysis of the uncertainty of the validation. The validation is uncertain because it was performed with a small set of monitoring sites. The monitoring sites represent a statistical sample of all rivers in the Region and therefore any conclusions drawn from this sample is subject to statistical sampling error (i.e., uncertainty). The conclusion of this validation was that the new criteria (i.e., Snelder and Kilroy 2023) are consistent with the monitoring data within the inherent uncertainty in both the observations of peak biomass and the uncertainty in the criteria themselves.

27 Based on the above, it is my opinion that the Council has set nutrient criteria in a defensible manner that is consistent with the guidance provided by MFE (2022) for implementing NOs based on Strategy 1. In following the guidance, the Council has used the most appropriate and credible existing published criteria. The validation exercise confirms that we can be confident, to the extent possible given the available data, that the criteria are applicable to rivers in the Greater Wellington region. The approach to choosing the UPR taken by the Council is pragmatic and robust. The approach produced NOs that are

achievable in the sense that they are not less than reference conditions. This is necessary and appropriate because the process used to define the criteria only considers the concentration required to achieve the TAS with a given level of risk of exceedance (**i.e., UPR**) and does not consider whether they are achievable. I also consider that the Council has set out how and why they used this process in a manner that is consistent with the guidance provided by MFE (2022).

28 In my opinion, the use of the Snelder and Kilroy (2023) criteria to set NOs is the most defensible approach at this point in time. While many river attributes are affected by nutrients, quantitative relationships between attribute states (e.g., periphyton biomass, measures of invertebrate health) that are consistent with conceptual models of the mechanisms of effect, and that can be derived from measured data, and have only been derived for periphyton. Very simple relationships between nutrient concentrations and measures of invertebrate health such as those of Canning et al. (2021) exist. However, I consider that these are a poor basis for setting criteria because the underlying model does not represent conceptual models of the mechanisms of effect. This means that these criteria have very high levels of uncertainty concerning whether the criteria will achieve the intended TAS. In contrast, validation of the Snelder and Kilroy (2023) criteria shows that the criteria are consistent with the TAS. There are also a number of serious statistical issues associated with the use of simple relationships between nutrient concentrations and measures of invertebrate health that are described in detail in Snelder (2022).

Table 1. Periphyton baseline and TAS and Nutrient Objectives and baseline for DIN for the 16 monitoring sites that represent each Part-FMU including 5 in TAoP and 11 in TWT.

Part-FMU	Site	Periphyton TAS	Baseline periphyton state	Current periphyton state (mg Chla /m²)	Existing NO (mg/L)	NO for DIN requested by submitters (mg/L)	Percent reduction from existing NO
Taupō	Taupō S. @ Plimmerton Domain	N/A			1.03	1.0	3%
Pouewe	Horokiri S. @ Snodgrass	B	D	C	0.64	0.6	6%
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.	B	-	A	0.48	1	0%
Takapū	Pāuatahanui S. @ Elmwood Br.	B	-	-	0.33	0.6	0%
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot	B		A	0.92	0.6	35%
Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Whakatikei R. @ Riverstone	A	-	-	0.15	0.3	0%
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	B	D	B	0.2	0.3	0%
Te Awa Kairangi rural streams and rural mainstems	Mangaroa R. @ Te Marua	B	D	C	0.44	0.3	32%
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	C	-	-	0.24	0.6	0%
Waiwhetū Stream	Waiwhetū S. @ Whites Line East	C	-	-	0.56	1	0%

Part-FMU	Site	Periphyton TAS	Baseline periphyton state	Current periphyton state (mg Chla /m^2)	Existing NO (mg/L)	NO for DIN requested by submitters (mg/L)	Percent reduction from existing NO
Wainuiomata urban streams	Black Ck @ Rowe Parade	C	-	-	0.5	0.6	0%
Wainuiomata rural streams	Wainuiomata River D/S of White Br.	C	D	C	0.17	0.3	0%
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels	C	-	-	0.42	0.6	0%
Korokoro Stream	Korokoro S. @ Cornish St. Br.	B	-	-	0.26	0.6	0%
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge	C	D	B	1.14	0.6	47%
Wellington urban	Karori S. @ Mākara Peak	C	-	-	1.29	0.6	53%

SUBMISSIONS CONCERNING THE NUTRIENT CRITERIA

29 The submissions made by the Environmental Defence Society and the Victoria University Canoe Club seek that NOs for DIN for some sites be set at values that are lower than set out in Tables 8.4 and 9.2 of PC1. Both the Environmental Defence Society and Victoria University Canoe Club have suggested values of 0.3 mg/L for some sites. Both submitters have requested that NOs for DIN are no higher than 1.0 mg/L. The changes sought by the submitters would result in NOs that are lower for five sites, and associated part-FMUs, that are shown in Table 1.

30 I disagree that the alternative DIN concentration criteria proposed by Environmental Defence Society and the Victoria University Canoe Club are necessary. The best information we currently have about DIN concentrations to achieve the periphyton TAS is the criteria of Snelder and Kilroy (2023). The Council has used these criteria, assuming that shading is also implemented at most sites. The lower concentrations sought by the submitters would decrease the risk that the periphyton TAS will not be achieved. However, the submitters have provided no technical justification for the alternative concentration criteria. In addition, I consider that the Council has used a robust process to choose an appropriate level of risk that the periphyton TAS will not be achieved (i.e., choice of UPR). There is no reason to consider that this risk should be lowered.

31 While I generally disagree with adopting the DIN targets proposed by the Environmental Defence Society and Victoria University Canoe Club, I agree with their submissions that the DIN nutrient outcome should not be set above 1.0 mg/L for those sites where an improvement in periphyton biomass is required. The modelling undertaken by Snelder and Kilroy (2023) indicates that 1.0 mg/L of DIN represents the saturating concentration. The saturating concentration means that the growth of periphyton is not limited by availability of nutrients. This means that we cannot expect periphyton biomass to decrease unless DIN concentrations are reduced to less than 1.0 mg/L. Wellington urban is the only part-FMU where the NO for DIN is greater than 1.0 mg/L. The process for setting NOs described in the Statement of Evidence of Dr Greer requires that the NOs for DIN and DRP are set to the saturating concentration where criteria obtained from Snelder and Kilroy (2023) are above the saturating concentration and where periphyton TAS are not being achieved or are at risk of not being achieved. This suggests that the NO for DIN in this part-FMU should be reduced.

CONCLUSION

32 In conclusion, it is my opinion that the Council has set nutrient criteria in a robust and defensible manner that is consistent with the guidance provided by MFE (2022) for implementing NOs based on Strategy 1.

33 With the one exception noted below, I generally disagree with the submissions from the Environmental Defence Society and Victoria University Canoe Club seek that NOs for DIN for some sites be set at values that are lower than set out in PC1. The Council has used a robust process and the best available information to set nutrient NOs and there is no justification for lowering these. I do however agree that the NO for DIN for the Wellington urban part-FMU should be lowered to 1.0 mg/L to be consistent with the process for setting NOs described in the Statement of Evidence of Dr Greer.

DATE: 28 FEBRUARY 2025

ANTONIUS HUGH SNELDER

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