BEFORE THE HEARING PANEL

AT HAMILTON

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the Proposed Waikato Regional Plan Change 1 Waikato and Waipā River Catchments
AND	
IN THE MATTER	of Variation 1 to the Proposed Waikato Regional Plan Change 1 Waikato and Waipā River Catchments

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STATEMENT OF EVIDENCE OF KATHRYN JANE MCARTHUR FOR THE DIRECTOR-GENERAL OF CONSERVATION

BLOCK 2

3 May 2019

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Submission Number - 71759

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INTRODUCTION

1 My full name is Kathryn Jane McArthur.

2 I have been engaged by the Director-General of Conservation to provide evidence on freshwater management, water quality and ecosystem health, with a particular focus on streams and rivers, for the hearing on proposed Plan Change 1 for the Waikato and Waipā Rivers (PC1).

3 I am the Practice Leader – Water, at The Catalyst Group, an environmental consultancy based in Palmerston North.

QUALIFICATIONS AND EXPERIENCE

4 My qualifications and experience are set out in my Evidence in Chief dated 15 February 2019. Additionally, since that time, I have been engaged as a technical advisor for the development of a national report card for Freshwater Ecosystem Health, being led by the Ministry for the Environment.

CODE OF CONDUCT

5 I have read the Environment Court "Code of conduct for expert witnesses", and I agree to abide by it. I have prepared this Statement in accordance with that Code. I confirm that my evidence is within my area of expertise. I have not omitted to consider any material facts known to me that alter or detract from the opinions I express in this Statement. I have acknowledged the material used or relied on in forming my opinions and in the preparation of this Statement.

SCOPE OF EVIDENCE

6 The scope of my evidence for the Block 2 hearing includes:

I. Diffuse discharge management;

II. Point source discharges;

III. New policies and rules to protect īnanga spawning habitat; and

IV. Rules, Schedule C and Schedule 1 – Stock exclusion and setback widths.

ABBREVIATION LIST

Abbreviation	Full term
CFEP	Certified Farm Environment Planner
D-G	Director General of Conservation
DOC	Department of Conservation
FEP	Farm Environment Plan
GFP	Good Farming Practices
GIS	Geographic Information System
GMP	Good Management Practice
LAWF	Land And Water Forum
N	Nitrogen
P	Phosphorus
PC1	Proposed Plan Change 1 for the Waikato and Waipā Rivers
SNA	Significant Natural Area
WRC	Waikato Regional Council

DIFFUSE DISCHARGE MANAGEMENT

7 Diffuse discharges are the predominant source of nitrogen, phosphorus, sediment and microbial pathogens in waterways of the Waikato and Waipā River catchments. The PC1 approach relies on policies, rules, and farm environment plans (FEPs) to manage diffuse contaminants transported to water. With respect to the management of diffuse contaminants the s42A report[1] authors note that "*…certainly in the initial 10 year period, all four contaminants ought to be subject to real and enduring reductions*." I support the recommended changes to Policy 1 that provide clearer direction for the need to "reduce" diffuse discharges of the four contaminants and the requirement for Good Farming Practices (GFPs) as a minimum for all farming activities.

8 An approach for Policy 1 (a) and (b) is recommended by the s42A officers that relates to 'low', 'moderate' and 'high' levels of diffuse discharge. The recommended approach at (b) to 'moderate' or 'high' discharges references 2016 amounts. There are significant difficulties in establishing what are 'moderate' or 'high' levels of diffuse discharge

[1] Paragraph 284.

of contaminants other than nitrogen (i.e., phosphorus, sediment and microbial pathogens) at the property or enterprise scale, and further difficulties in proportionately comparing these contaminants to 2016 amounts. However, recommended Policy 1 clause (b) now references "*the water quality improvements required in the sub-catchment*". Table 3.11-1 would need to contain attributes and targets/states for all four contaminants for every sub-catchment for comparison with current state, in order to reference 'moderate' or 'high' discharges across the four contaminants to a required water quality improvement for a sub-catchment. Until the hearing panel have considered the joint witness statement for Table 3.11-1 and decided on the final scope of the table, the efficacy of this approach cannot be assessed.

9 Notwithstanding the difficulties and uncertainties identified above, I support the approach recommended, if that uses the current state and degree of improvement necessary across contaminants in each sub-catchment. In my opinion, it is a more effects-based way to determine where discharges of all contaminants are 'moderate' or 'high' at the sub-catchment scale, and thereby prioritise where discharge reductions are needed on a contaminant by contaminant basis. Such an approach would have the benefit of providing clear direction to focus FEP development on sub-catchment water quality outcomes, by reducing the risk of contaminant losses on a farm by farm basis.

POINT SOURCE DISCHARGES

10 Point source discharges also contribute contaminants to water in the Waikato and Waipā River catchments. To ensure point source discharges do not individually or cumulatively (along with diffuse discharges) contribute to degradation of the freshwater values identified in PC1 (e.g., ecosystem health, mahinga kai, swimmability), Policy 10 could directly reference Table 3.11-1 rather than the current reference to only the four contaminants. To provide for ecosystem health Table 3.11-1 needs to contain all relevant contaminants (as identified in my Block 1 evidence in chief and following the outcomes of expert conferencing). Alternatively, Policy 10 could include direct reference to the values within the policy, although in my view the outcome with respect to ecosystem health and other values is less certain with this approach.

11 Policy 11 (a) references the potential for 'toxic effects' from point source discharges. Toxic effects may occur beyond ammonia or nitrate toxicity (currently the only toxic effects considered within Table 3.11-1) and I have recommended consideration of other toxicants more widely in my evidence in chief for Block 1[2]. Toxic effects from point sources may include those resulting from discharges containing metals, metalloids and other toxicants. At the time of writing this evidence, experts are currently considering an approach to including additional toxicants in Table 3.11-1 to provide for ecosystem health. The revised Table 3.11-1 following conferencing may assist in the redrafting of Policy 11 in relation to toxicants, depending on the degree of adoption of expert recommendations on Table 3.11-1 by the hearing panel.

Point source discharge 'off-sets'

12 Policy 11 includes consideration of water quality 'off-sets', potentially including alternative locations for off-setting water quality effects that cannot be avoided, remedied or mitigated. The use of off-sets in resource management is usually applied to biodiversity off-setting, for which best-practice guidance and principles have been developed by and for regional councils (Maseyk et al. 2018) and central government (NZ Govt. 2014). Off-sets are a values-based approach whereby there is a need to generate a gain in values that are adequate to fully balance the losses in that same value (*Dr F. Maseyk, pers. comm.*[3]). In my view, what is proposed in Policy 11 appears to be contaminant trading, rather than a true off-set.

13 According to Maseyk et al. (2018) the principles[4] of biodiversity off-setting are:

a) Limits to off-setting,

b) No-net-loss and preferably a net-gain,

[2] Paragraph 93 and Appendix 2, evidence in chief of Kathryn McArthur.
[3] Dr Maseyk is the Practice Leader – Conservation Science at The Catalyst Group and lead author of the best practice guidance on biodiversity offsetting for Regional Councils.
[4] Based on the international BBOP principles: Business and Biodiversity Offsets Programme (BBOP) 2012. Standard on Biodiversity Offsets. BBOP, Washington D.C http://bbop.forest-trends.org/

c) Landscape context,

d) Additionality,

e) Permanence,

f) Ecological equivalence,

g) Adherence to the mitigation hierarchy,

h) Stakeholder participation,

i) Transparency,

j) Science and traditional knowledge, and

k) Equity.

14 These principles are relevant to the proposed off-setting policy considerations for point source discharges in PC1; however, Policy 11 does not recognise most of these principles. In particular, it does not recognise, Limits to off-setting, No-net-loss, and Additionality and only partially deals with the other relevant principles that could be applied in a water quality context.

15 Additionality is an important concept with respect to off-setting and is a relevant consideration should the hearing panel decide to include an off-set approach in PC1. An off-set must achieve gains in values (e.g., water quality or biodiversity) above and beyond gains that would have occurred anyway in the absence of the off-set. This requires evaluating the change in value under both a 'with off-set' and a 'without off-set' scenario to estimate the amount of *additional* gain that can be attributable to the off-set action. Only the amount of gain that can be demonstrated to be additional should count towards the overall off-set (Maseyk et al. 2018). In the case of PC1, gains in water quality must be *additional* to what would already be required under the PC1 regime. Off-setting for a point source discharge in an alternative location could not be attributed to gains in water quality that could reasonably already be expected under PC1, i.e., mitigations that would result in water quality improvements on land already required to make improvements in water quality (e.g., farm land). It is difficult to see how gains in water

quality that were *additional* to the PC1 approach would be realised or technically feasible, particularly without an allocation regime in place.

16 I maintain the view that what is currently proposed is 'contaminant trading', not off-setting. Without a contaminant allocation regime in place I am sceptical of the technical feasibility of the approach, or whether any point source off-set would provide *additional* water quality gains, beyond the requirements of PC1 to manage diffuse discharges. Given the above, I am not convinced off-setting of point source discharges would achieve the objectives of PC1 and the Vision and Strategy.

INDIGENOUS FISH SPAWNING HABITAT

17 Large-bodied galaxiid fish (i.e., banded kōkopu, giant kōkopu, shortjaw kōkopu, kōaro and īnanga) spawn within riparian vegetation when it is inundated by spring tides (in the case of migratory īnanga) or autumnal freshes. Eggs develop within the humid conditions of the riparian vegetation and hatched larvae are washed into rivers and streams on subsequent tides/freshes.

18 Maintaining or restoring adequate and vegetated riparian margins is key to enabling successful spawning and recruitment of galaxiid fish in the Waikato and Waipā River catchments and thereby providing for ecosystem health. There are a number of activities which adversely affect riparian spawning and habitat, including stock access, cultivation of margins, earthworks, production forestry, encroachment of pasture and weed species and bank and channel alteration as a result of drainage or flood protection works. This evidence focusses on the effects of stock access to river and stream margins and cultivation setback requirements and should be read in conjunction with the evidence of Drs Stewart and Robertson with respect to lake and wetland ecosystems.

19 As discussed in my evidence in chief for Block 1[5], many indigenous fish are threatened or at risk nationally as a result of multiple stressors, including loss of spawning habitat. Indigenous fish are a critical component of ecosystem health and protection of their spawning

[5] Paragraphs 52-61 and Table 1, evidence in chief of Kathryn McArthur.

habitat is a key requirement to ensure these fish persist and are sustained into the future in the PC1 catchments.

20 Water quality is only one aspect of ecosystem health. National work to define a framework for ecosystem health identifies the five core components of ecosystem health as: aquatic life, water quality, water quantity, physical habitat and ecological processes (Clapcott et al. 2018).

21 Protecting spawning habitats of indigenous fish through PC1 will assist in aligning PC1 with the current national definition of ecosystem health for aquatic life, physical habitat and some ecological process components, as well as water quality.

NEW POLICY AND RULE FRAMEWORK TO PROTECT ĪNANGA SPAWNING HABITAT

22 The Director-General's (D-G's) submission identified that a new policy and rule framework is required to protect īnanga spawning habitat. The s42A report notes that īnanga spawning habitat is better left to the FEP process[6] and does not recommend adopting the D-G's submission[7]. Although Certified Farm Environment Planners (CFEPs) may adequately identify issues with respect to farming operations and water quality effects, most are unlikely to be competent in identification of ecological and biodiversity values, including spawning habitats (*P. Taylor[8], pers. comm.)* without specific guidance on these matters within PC1.

23 In my view, protection of īnanga (and other large-bodied galaxiid) spawning habitat is more certain as an outcome if PC1 guides the FEP process via policies and rules with respect to identifying spawning habitats and defining the minimum standards for stock exclusion and setbacks in these areas. Waikato Regional Council (WRC) have predictive īnanga spawning information available via GIS layers. It would be preferable if riparian spawning areas are identified and

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[6] Section 42A report, block 2, paragraph 926.
[7] Although I can find no specific s42A recommended amendment to the FEP approach which acknowledges īnanga spawning habitat.
[8] Peter Taylor is the Practice Leader – Catchment Management for The Catalyst Group and an experienced Farm Environment Plan practitioner with expertise in wetland and river values: https://docs.wixstatic.com/ugd/4e9949_f492e55521894fc59887d845e5a75f72.pdf

protected more widely for all riparian spawning galaxiid fish across the Waikato and Waipā catchments through minimum standards in PC1. In my opinion, this targeted approach is better aligned with providing for the ecosystem health value in PC1 than general provisions and reliance on CFEPs to identify these values individually on farms. For example, WRC's 'biodiversity boosters' GIS layer underpinning the aquatic SNA work of Collier et al. (2010), in combination with predicted lower river īnanga spawning GIS layers, could be used effectively to target streams for minimum standards with respect to stock exclusion and setback distances that protect riparian spawning habitat.

STOCK EXCLUSION, RIPARIAN BUFFERS AND SETBACKS

24 Riparian management (including stock exclusion, buffers and setbacks) has multiple benefits for water quality, including: nutrient and contaminant interception and processing, shading, input of wood and leaves to stream ecosystems, and enhanced fish and invertebrate habitat (Parkyn 2004; McKergow et al. 2016). Stock access and cultivation in riparian margins are two activities that can have adverse effects on freshwater values and water quality.

25 Stock exclusion, setbacks and FEPs are the primary methods by which PC1 intends to achieve reductions in contaminants entering water in the Waikato and Waipā River catchments. Schedule C provides stock exclusions and setbacks from waterbodies relating to slope. S42A officers have recommended including an undefined slope minimum (Schedule C (1)) for stock exclusion from waterbodies. For new fencing, stock exclusion is required (a) 1 metre from the outer edge of the bed for land with a slope of less than 15 degrees; and (b) 3 metres from the outer edge of the bed for land with a slope between 15 and 25 degrees.

26 Adverse effects of livestock access to freshwater ecosystems include:

a) Consumption of plant matter;

b) Trampling of riparian plants and fish habitat, and subsequent compaction of soil (pugging and consequential loss of sediment to water);

c) Nutrient inputs and microbial contamination from urine and faeces; and

d) Stream bank erosion from vegetation removal and trampling (thereby exacerbating sediment and associated contaminant transport to freshwater).

Effects on riparian spawning habitat

27 A key issue with respect to stock exclusion, beyond the obvious and well-documented adverse effects on water quality discussed below, is the impact stock grazing and trampling can have on the potential for indigenous fish to spawn successfully in riparian margins. This occurs through two mechanisms: trampling of riparian spawning habitat, eggs and larvae and vegetation removal via grazing.

28 Cultivation of land adjacent to waterways can also impact on riparian spawning habitat through direct disturbance of spawning areas and removal of vegetation. Setback distances for cultivation should be aligned with those for stock exclusion in waterbodies with riparian spawning habitat for indigenous fish. Other regional plans have addressed this issue. For example, in the Auckland Unitary Plan cultivation setbacks are 20 metres from rivers and streams (and 30 metres from lakes) in the rural zone.

29 Stringent stock exclusion to avoid effects on indigenous fish spawning habitat (īnanga) was applied in Plan Change 4 to the Canterbury Land and Water Plan for īnanga spawning habitat. Rule 5.71 states “The use and disturbance of the bed (including the banks) of a lake or river by any farmed cattle, farmed deer or farmed pigs and any associated discharge to water is a prohibited activity in the following areas: (1) …inanga spawning habitat.”

30 Īnanga spawning habitat was defined for Canterbury using the methods of Greer et al. (2015). It is my understanding that WRC staff have developed a predictive GIS layer of īnanga spawning for the lower Waikato River (Dr B. David[9], pers. comm.) and have GIS information

[9] Dr Bruno David is a Freshwater Ecologist with Waikato Regional Council.

on spawning habitat for some non-diadromous galaxiid populations associated with riverine lakes.

31 Where riparian areas are known or predicted to be utilised for galaxiid spawning, stock exclusion, larger setbacks (for both stock and cultivation) and preferably riparian restoration should be required, regardless of stream size or flow permanence (i.e., intermittent or ephemeral/headwater streams). As stated above, WRC have developed GIS layers predicting where there are critical areas for riparian fish spawning, supported by empirical evidence (e.g., David et al. 2019). Further WRC projects are ongoing, using dogs to find fish eggs and better define spawning habitats (Dr B. David pers. comm.). The current GIS information should be used for PC1 to target stock exclusion, wider setbacks (including for cultivation) and preferably riparian restoration in PC1 for all waterways in these areas to ensure the critical aspects of ecosystem health associated with sustaining indigenous fish populations in the Waikato and Waipā river catchments are captured.

32 The D-G's submission identifies that sheep and goats should also be excluded from high value water bodies (i.e. outstanding water bodies and wetlands), consistent with the DOC (2017) guidelines. While sheep and goats have less affinity for directly entering water than other stock and are less likely to cause bank erosion and slumping as they are lighter, their camping and browsing habits mean they can have an adverse effect on indigenous vegetation in riparian margins and wetland edges, thereby affecting spawning habitats (Hickford and Schiel 2011). For this reason, I support their exclusion, along with other livestock, from riparian spawning habitats, lakes and wetlands. This is consistent with the recommendations in the evidence of Dr Stewart for exclusion of all stock from riverine lakes and Dr Robertson with respect to wetlands.

Effects on water quality

33 The section 42A report[10] identifies that stock exclusion is one of the key mechanisms in PC1 for reducing microbial contaminants entering water, along with reductions in sediment and associated phosphorus.

34 While stock exclusion is clearly important with respect to the water quality improvements anticipated by PC1, stock exclusion must be effective to ensure that water quality outcomes are realised. Setback distances from water bodies and (preferably vegetated) riparian buffers are needed that provide effective reductions in the risk of contaminants reaching water, not just from the direct effects of stock in waterways, but also through providing effective buffers between farmland, cultivated land and water to reduce overland flow of contaminants and erosion from de-vegetated, cultivated or stock-trampled river banks.

35 Where livestock are concentrated, areas of farms can become 'critical source areas' for contaminant transport to water, disproportionately contributing greater contaminant loads (McDowell et al. 2013). Management of critical source areas will be needed in FEPs in addition to stock exclusion, setbacks and vegetated buffers if water quality improvements are to be realised at the sub-catchment and whole-of-catchment scale.

36 Small streams contribute 77% of the national contaminant load of N and P (McDowell et al. 2017). Management of small streams to reduce contaminant transport is therefore a critical component of PC1 to reduce contaminant loads across the catchment. The LAWF fourth report, recommendation 41 states: "Councils should impose riparian setback and management rules over and above GMP requirements in catchments with specific water quality issues, where this is an effective way of managing a particular issue. Councils should also consider catchment-specific riparian management rules for critical source areas and areas of specific ecological, social or cultural value." The Waikato and Waipā River catchments certainly meet these requirements with respect to values and water quality issues.

[10] Paragraph 855.

37 Cultivation of land adjacent to waterways can also exacerbate and accelerate the transport of sediment and phosphorus to water (Basher et al. 1997). Microbial contaminants can also be problematic if the cultivation is for grazing of forage crops. Setback distances and vegetated riparian margins can alleviate many of the effects of cultivation on water quality and should be consistent with stock exclusion setbacks and buffers.

Appropriate setback widths

38 None of the slope and setback distances recommended by the s42A officers for PC1 appear to be supported by clear empirical evidence. In determining an appropriate setback width, the New Zealand literature is varied and equivocal as the width required for trapping of particulate nutrients in surface runoff through riparian buffers varies as a function of slope, soils, drainage/hydrology, vegetation and mode of contaminant transport (Collier et al. 1995; Parkyn 2004; Quinn and McKergow 2007; McKergow et al. 2016).

39 However, there are some key conclusions that can be drawn from the literature on riparian management: slope is an important factor – steeper land requires wider buffers, small headwater streams are important for ecosystem health (Greenwood et al. 2012) and for water quality contaminant reductions (McDowell et al. 2017) and wider is usually better for contaminant removal (Parkyn 2004).

40 Slope is a key factor affecting the severity of the impacts of stock access on water bodies, primarily through increased erodibility and rates of nutrient runoff (DOC 2017). Slope is also a primary consideration for effective sediment and nutrient removal using riparian buffers (Parkyn 2004). Steep hill country terrain reduces the effectiveness of riparian buffers to trap sediment. Generally, buffer widths will need to widen as the slope length, angle and clay content of the adjacent land increase and as soil drainage decreases (Collier et al. 1995).

41 McKergow et al. (2016) in their review of riparian management in New Zealand note that targeting headwaters (e.g. upstream of Dairy ‘Accord waterways’) may be logistically challenging but will have significant

water quality and habitat benefits (Greenwood et al. 2012; McKergow et al. 2016). This is supported by the findings of McDowell et al. (2017) that the majority of nutrient loads to freshwater enter small rivers and streams.

42 Parkyn (2004) reviewed the New Zealand and international literature on the effectiveness of riparian buffer zones, reporting that in studies of perennial ryegrass filter strips the first 5 metres were critical for particulate sediment removal and that 20 metre filter strips were able to remove 90% of sediment along with sediment-bound and particulate nutrients due to increased infiltration within the wider buffer. Removal of sediment did not appreciably increase beyond 10 metre wide filter strips, although consideration of clogging by fine sediment over time was needed for a 10 metre strip and wider strips (>10 metres) remove more nutrients.

43 Smith (1989) in a New Zealand study, found removal of more than 80% of suspended sediment and particulate nutrients for vegetated filter strips of 10-13 metres, with dissolved nutrient removal of 67% (N) and 55% (P). Parkyn (2004) notes that improving the infiltration capacity of vegetated buffer will improve the removal of dissolved nutrients. Infiltration capacity is improved through root structures of vegetation in buffer zones. Planting of large trees on the edge of grass filter strips increases the effective width contributing to nutrient removal via the root structure of large trees extending beyond the retired buffer width.

44 Parkyn's (2004) review also reported sediment and total phosphorus removal rates increase (between 53% and 98%) with increasing buffer width (4.6 metres to 27 metres). Most larger sediment particles will be removed within 5 metres of grass buffer, although 10 metres was needed to remove finer particles. Ten to 30 metre wide buffers can be effective at removing large amounts of soluble nitrate, particularly if forested.

45 Riparian buffer zones in headwaters and associated with wetlands can provide even higher rates of dissolved nutrient removal: "Gilliam (1994) called for an effort to protect ephemeral and intermittent stream channels as well as wetlands, as these are areas that initially receive surface runoff and where shallow groundwater seeps into surface

water, and thus may be some of the most important areas for preserving water quality." (in Parkyn 2004).

46 For Auckland Council, Parkyn et al. (2000) recommended a buffer width of 10 to 20 metres as the minimum necessary for the development of sustainable indigenous vegetation with minimal weed control, and to achieve many aquatic functions.

47 The key conclusions from the literature on effective riparian buffers is that buffers need to be vegetated (at least with rank pasture grasses for sediment and particulate/adsorbed nutrient removal), a 5 metre buffer width will remove a substantial proportion of large sediment particles, but for fine sediment at least 10 metres width is needed. Some soluble nutrients and most particulate nutrients will be removed from a 10 metre strip, although larger proportions of nutrients, including greater amounts of soluble nutrients will be removed from buffers 20 metres in width (except where drainage and groundwater flows bypass riparian strips) and 20 metres is needed for sustainable riparian vegetation. Intermittent, ephemeral and headwater streams (and wetlands) are critical areas for effective riparian removal of nutrients.

48 Importantly, Parkyn (2004) also notes that optimising the filtration effectiveness of riparian buffers also requires improved land use practices over the broader landscape, to reduce nutrient influx to the riparian zone.

RECOMMENDATIONS FOR STOCK EXCLUSION, RIPARIAN BUFFERS AND SETBACKS

49 The inclusion of small waterways (including headwater, intermittent and ephemeral streams) is critical to ensuring impacts on freshwater ecosystem health and water quality are reduced or avoided (Storey et al. 2011; Greenwood et al. 2012; McKergow et al. 2016; McDowell et al. 2017). Where this is not practicably achievable everywhere, targeted approaches should be used to exclude stock from small streams and drains which contain significant indigenous fish species and spawning habitats as a minimum. For example, this could apply in the sub-catchments of the Waikato and Waipā Rivers that are identified

as priorities for protection[11] and in biodiversity 'hotspots' (such as the tributaries of lakes Waikare, Whangape and Waahi) identified through WRC's aquatic SNA project (Collier et al. 2010). There is empirical evidence to support the protection of the tributaries of these lakes as they are critical for recruitment of large-bodied galaxiid fish (giant and banded kōkopu and a proportion of the īnanga population) into the Waikato River from populations which no longer migrate to the sea (David et al. 2019). These lake tributary streams were identified as priorities for restoration in the Waikato River Restoration Strategy (Neilson et al. 2018) and specific recommendations for lake riparian buffer zones and stock exclusion are contained in the evidence of Dr Stewart. Additionally, Dr Stewart identifies ephemeral waterways as critical pathways for contaminant transport to water.

50 For river and lake margins where īnanga and other large-bodied galaxiids are known or predicted to spawn a 20 metre setback distance is needed to ensure available and functioning spawning habitat and sustainable riparian vegetation. The recommendation should be supported through policies and rules in PC1 and implemented through FEPs, Schedule C and Schedule 1. Dr Robertson provides evidence for setback distances and stock exclusion in relation to wetlands.

51 Outside of these areas, I recommend exclusion of cattle, horses, deer and pigs from *all* rivers and streams and for new fencing (Schedule C (2)) a minimum setback of 10 metres from permanent rivers and streams to ensure more effective buffering of contaminant transport, along with identification and management of critical source areas in FEPs. For intermittent, ephemeral or headwater rivers and streams new fencing should be setback a minimum of 5 metres, although wider setbacks and buffers will be more effective at reducing contaminant transport to water.

52 I support Dr Stewart's recommendations for the identification of ephemeral streams in FEPs and identification of effective mitigation strategies to prevent contaminant losses via these in all rivers and streams as well as those associated with lake catchments.

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[11] Paragraph 46, evidence in chief of Kathryn McArthur.

53 I do not support the option of the s42A officers to provide for stock exclusion in Schedule C (6a) "where the bed is predominantly unvegetated and comprises exposed fine sediment, sand, gravel, boulders or similar material or aquatic vegetation". In pastoral systems, the visible bed of a river or stream can become very small as pasture encroaches on the stream channel and its width is reduced (Figure 1). If these small streams, smothered by pastoral vegetation, are not recognised as requiring stock exclusion (through a lack of historical exclusion or riparian management) they will continue to provide pathways for diffuse contaminants from land and little suitable habitat for aquatic life.

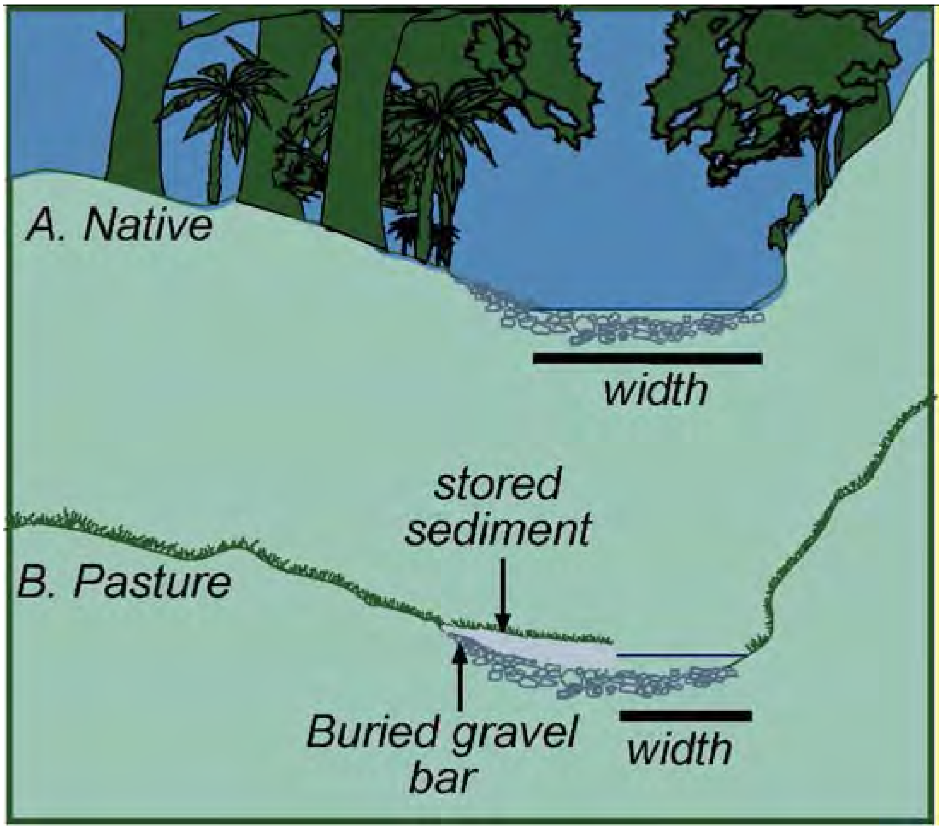

Figure 1. Change in stream channel width from native forest (A) to pasture (B), where pasture grasses trap sediment resulting in narrow and incised channels. (Reproduced from Parkyn (2004), following Davies-Colley (1997)).

54 The D-G's submission requests a 10 metre fencing setback for cultivation from permanent rivers, lakes and outstanding waterbodies and 5 metre cultivation setbacks from intermittent rivers and wetlands. In relation to Schedule 1 the submission requests that setbacks for grazing and cultivation on sloping land be evaluated in relation to soil

type to ensure an appropriate setback distance is achieved (noting a 20 metre setback for sloping land of 20 degrees or more could be appropriate).

55 In my opinion, there is no scientific justification for differing cultivation and stock fencing setbacks in PC1. Minimum riparian buffer widths (e.g., 10 metres) are recommended above, based on maintaining sustainable riparian vegetation, providing stream shading and habitat, as well as effective filtering of contaminants. I recommend cultivation is subject to the same buffer widths as recommended above for stock exclusion.

56 These recommendations should be considered in addition to those for lakes (and lake tributaries) and wetlands in the evidence of Drs Stewart and Robertson.

Kathryn Jane McArthur

3 May 2019

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