Before A Hearing Panel

Under	the s 80A and Part 4 of Schedule 1 to the Resource Management Act 1991
In the matter of	Proposed Change 1 to the Regional Policy Statement for the Wellington Region

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HEARING STREAM 5

STATEMENT OF EVIDENCE OF CHARLOTTE LOCKYER ON BEHALF OF WELLINGTON WATER LTD

3 November 2023

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INTRODUCTION

1. My full name is Charlotte Amy Lockyer.

2. I am a Principal Consultant – Hydrology, at SLR Consulting. My role involves providing technical advice to clients in the matters of hydrology, water resources, stormwater management and stormwater quality.

3. I have prepared this statement of evidence on behalf of Wellington Water in respect of hydrology related matters arising out of Wellington Water's submissions relevant to hearing stream 5. I have considered the Plan Change 1 (PC1) provisions as notified, Wellington Water's submissions, the section 42A reports on PC1 and the evidence of Stuart Farrant.

Qualifications and mExperience

4. I have 15 years' experience working in water resources. My most recent employment is at SLR Consulting, in their Hydrology and Hydrogeology team since July 2023. Prior to that I worked at Cardno/Stantec (Cardno was acquired by Stantec in 2021) as Practice Lead – Water Resources. I hold a Bachelor of Science degree with Honours in Physical Geography and a Bachelor of Commerce and Administration, from Victoria University of Wellington.

5. I have experience in a range of water resource fields and worked on numerous projects around the region in the role of technical lead or technical reviewer. Recent project experience includes technical expert in the development of a council's stormwater management framework; technical expert to various councils regarding resource consent applications for water abstraction or discharge to water; evaluation of the effectiveness of hydraulic neutrality policy; stormwater water quality monitoring and reporting; and Stage 2 stormwater discharge consent application including the development of a stormwater management strategy to improve and enhance the quality of stormwater discharges.

6. I have developed guidance manuals for councils including Wellington Water's 'Reference Guide for Design Storm Hydrology' which stipulates how to estimate design storms in ungauged urban catchments for the purpose of sizing or discharging stormwater runoff into Wellington Water's network; and Wellington Water's 'Managing Stormwater Runoff' publication explaining the drivers for hydraulic neutrality and approved detention solutions.

7. I am a member of Water New Zealand and the New Zealand Hydrological Society.

Code of Conduct

8. I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023. I have complied with the Code in preparing my evidence and will comply with it while giving oral evidence. My qualifications as an expert are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of 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

9. My statement of evidence covers the following matters:

    9.1 Provisions relating to hydraulic neutrality;

    9.2 Provisions relating to undeveloped state; and

    9.3 Provisions relating to hydrological control.

HYDRAULIC NEUTRALITY

10. The s 42A report has recommended adding a hydraulic neutrality requirement to Policy FW.3, and a corresponding new definition of hydraulic neutrality (at paragraphs 473 and 474).

11. For the reasons that follow, I support this, but consider it should be refined.

12. The principle of hydraulic neutrality has been incorporated into Wellington Water's Regional Standards for Water Services for approximately 6 years. Their publication 'Managing Stormwater Runoff', first drafted in 2019, was developed to explain the principle of hydraulic neutrality to the community and provide Approved Solutions for implementation.

13. Hydraulic neutrality was introduced as one tool to assist in managing the risk from flooding during rare flood events. The intention is to cap the peak flow from a property post-development, to that from a property pre-development, to minimise the risk of flooding to people and property downstream. Hydraulic neutrality is focused on rare flood events, as the

primary stormwater network is typically designed to convey stormwater runoff from the lower intensity more frequent rainfall events.

Event Magnitude

14. Wellington Water currently requires new development (greenfield or infill development) to be hydraulically neutral in events up to a 1% annual exceedance probability (AEP) rainfall, including the predicted impacts of climate change. This is managed through review of the 10% and 1% AEP rainfall events. These are equivalent to a 1 in 10-year average recurrence interval (ARI) and a 1 in 100-year ARI, respectively. Using the Wellington Water definition, which is well understood and implemented across the four cities, the peak flow from a developed site should not exceed the peak flow from the undeveloped site in the 10% and 1% AEP event.

15. This is similar to Kapiti Coast District Council's (KCDC) approach which requires peak flows from a development to be no greater than the pre-development peak flow in the 1 in 2-year, 1 in 5-year, 1 in 10-year, 1 in 50-year and 1 in 100-year modelled flood events. KCDC have adopted a lower threshold for hydraulic neutrality (to include the 1 in 2-year and 1 in 5-year ARI events). I believe this is because the primary network has greater constraints and subsequently, less conveyance capacity (i.e., pipe size, coastal and alluvial plains resulting in flat topography through the urban area, high water table etc.)

16. Within the Wairarapa, there is limited council owned reticulated network. It is understood that most properties are required to provide on-site stormwater disposal. Therefore, stormwater runoff is largely managed on-site.

17. The definition recommended in the s 42A report does not refer to a magnitude storm event, for example up to the 1% AEP event including the predicted impacts of climate change. Without referencing a magnitude storm event, the required storage detention is infinite.

Flow vs Volume

18. The s 42A Officers report notes the purpose of hydraulic neutrality is to control peak flow. Paragraph 472 states "Its purpose is primarily to reduce flood risk created by additional stormwater runoff as a result of urban development and impervious surfaces" and Paragraph 954 states "Hydraulic neutrality is a mechanism for addressing stormwater peak

flowrates to reduce the risks of flooding downstream through the use of stormwater detention…".

19. I agree with those statements. Hydraulic neutrality primarily focuses on attenuating the peak flow.

20. However, the definition recommended in the s 42A report includes reference to managing stormwater volume, whereby the fully developed site does not exceed the modelled peak stormwater flows and volumes released from the site in an undeveloped state.

21. Flow is different from volume. Flow is an instantaneous measurement, e.g., litres per second, whereas volume is the total quantity of water over time.

22. In significant flood events, most damage to people and property is due to the peak flow and the velocity of floodwaters. This is managed through the standard definition of hydraulic neutrality, without reference to volume.

23. Including volume within the definition is problematic because it requires all runoff from the developed site to be retained on site.

24. The impacts of this include:

    24.1 Significantly reducing the ability to develop areas and meet urban growth requirements as the landcover and soils have been significantly altered overtime and have reduced capacity to retain this volume;

    24.2 The required storage volume and site area required for storage will be large, and often prohibitive to development; and

    24.3 The S42 report implies that the quantity (volume) of stormwater runoff should be managed via hydrological control. Incorporating volume within the definition of hydraulic neutrality causes the hydrological control policy to be redundant, as the flood hydrograph (peak flow and volume) cannot change.

Summary

25. In summary, I support the principle of hydraulic neutrality though do not support the definition recommended in the s 42A report due to inclusion of volume and no limitation to the magnitude storm event. I would support an alternative definition as follows:

Hydraulic neutrality: means managing stormwater runoff from subdivision, use and development through either on-site disposal or storage detention, so that peak stormwater flows ~~and volumes~~ are released from the site at a rate that does not exceed the modelled peak flows ~~and volumes~~ from the site in an undeveloped state, in the 10% AEP and 1% AEP modelled design rainfall events including the predicted impacts of climate change.

UNDEVELOPED STATE

26. The s 42A report has recommended adding a new definition of undeveloped state (at paragraphs 971 and 974). For the reasons that follow, I support this, but consider it should be refined.

27. The definition of undeveloped state is applied to (a) greenfield development, and (b) brownfield and infill development. Modelled runoff from a fully developed site is to be reduced to that occurring prior to development, assuming pastoral or urban open space land cover.

28. For brownfield and infill development, the definition is likely to result in an improvement.

29. For greenfield development where the land cover may be vegetated i.e., forest or scrub, the requirement to reduce runoff from a fully developed site to pastoral or urban open space land cover will allow for greater runoff than prior to development. This is because vegetation allows for greater interception and evapotranspiration of rainfall than grass cover.

30. The definition only addresses land cover. It does not prescribe the undeveloped state soil conditions which will influence the ability of rainfall to infiltrate through soil. Current wording is open to interpretation.

Summary

31. In summary, I support the inclusion of a definition of undeveloped state though suggest clarification of wording to improve the hydrological outcomes and freshwater ecosystem health. I would support an alternative definition as follows:

> **Undeveloped state:** In greenfield development, it is the existing land cover and soil infiltration characteristics prior to clearance for development. In brownfield or infill development, it is the modelled grassed (pastoral or urban open space) state of the site prior to

urban development with soil infiltration characteristics consistent with urban development at site.

HYDROLOGICAL CONTROL

32. Hydrological control is to manage stormwater runoff (flow peak and volume) in very frequent rainfall events. Capturing and retaining low intensity rainfall and the initial burst of rain in a flood event assists in reducing the contaminant load conveyed to a water body (through retention and potentially treatment on-site) and scour due to a reduction in the discharge from a piped stormwater network.

33. I support the principle of hydrological control as a means to manage the effects of stormwater runoff volume and water quality on stream ecosystem health. However, I do not support the proposed policy (Policy FW.X Hydrological Control for urban development – regional plans) in its recommended form (paragraph 972 of the s 42A report). Despite my experience, I find the policy wording unclear and difficult to interpret. Further, I consider that implementing the policy will require significant (and potentially prohibitive) effort, without materially improving the outcomes compared with alternative approaches. The reasons for my perspective are as follows:

Continuous flow modelling

33.1 The policy is requiring continuous flow modelling to estimate the annual runoff volume and frequency of exceedance of the 2-year ARI. It is not clear to me whether the policy is requiring this to be done as part of the regional plan, or by developers when seeking consent. Modelling of this nature would typically require a specialist consultant to undertake. While this is possible, the availability of specialist consultants and the cost to develop such modelling would be prohibitive for many developments. Alternative approaches, such as employed by Auckland Council and Waikato Regional Council require the retention of a rainfall depth for volume control and water quality treatment. This avoids the requirement to develop a continuous flow model while achieving similar benefit. For example, Auckland Council requires retention of at least 5 mm runoff depth for volume reduction, alongside other controls for water quality detention and flow management.

33.2 In nearly all instances, the continuous flow models would be uncalibrated so there would be a high degree of uncertainty in

model results. It is in my opinion that the advantages of developing an uncalibrated model would not outweigh a more simplistic regional approach similar to Auckland Council or Waikato Regional Council focused on rainfall retention.

33.3 The more complex approach of continuous flow modelling requires additional resources to review the model and proposed solution. This would increase the burden on the Regional Council and/or territorial authority/Wellington Water.

Mean annual runoff volume

33.4 The policy refers to the modelled mean annual runoff volume. A mean is the average, therefore heavily influenced by outliers (floods or droughts) across the modelled period. A more representative statistic is the median.

33.5 I assume that the 'modelled mean annual runoff volume' referred to in the policy, is a measure of the average runoff volume over 365 days (or the modelled mean annual flow multiplied by the number of seconds in a year). This is an uncommon measure in New Zealand and open to misinterpretation. This measure can only be estimated through the development of a continuous flow model.

1 in 2-year ARI

33.6 The policy refers to the 1 in 2-year ARI. Two formulas can be used to convert an AEP to an ARI: the simple formula (1/AEP) and the correct formula ($1/(-\log_e(1-AEP))$). For events rarer than a 1 in 20-year results are similar; for smaller more frequent events results are different and the simple formula is incorrect. Many practitioners/developers do not realise there are differences. Referring to an AEP would avoid potential misunderstanding. A 1 in 2-year ARI is equivalent to a 39% AEP or an event exceeded on average 0.5 times per year.

33.7 The policy refers to the 2-year ARI flood event alongside the channel forming flow or bankfull flow. The 2-year ARI flood event defines the magnitude event to be modelled. The reference to the channel forming flow and bankfull flow adds complication to the policy and this supporting information would be better placed in an explanation.

33.8 The policy wording of part (a) ii and (b) ii is difficult to interpret. As a water resource scientist specialising in hydrology, I find the wording unclear. I believe the intention is to state:

> The modelled 39% AEP peak flow from the site in an undeveloped state shall not occur more frequently than on average once every 2 years after fully developed, as far as practicable.

Effects

33.9 The policy requires the same provisions on a development even if the development is discharging into an engineered concrete channel or highly-modified water course where there may be no risk of scour and/or minimal ecological biodiversity.

33.10 If the policy wording within part (a) ii was to remain, it should also refer to 'or via a stormwater network that discharges to a stream' to capture instances where a greenfield development may be upstream of an urban area and discharge into the stormwater network prior to release into a stream:

> (a) ii. the modelled mean annual exceedance frequency of the 2-year Average Recurrence Interval (ARI) so-called 'channel forming' (or 'bankfull') flow for the point where the fully developed area discharges to a stream, or via a stormwater network that discharges to a stream, must not exceed the mean annual exceedance frequency modelled for the same site and flow event arising from the area in an *undeveloped state*.

Summary

34. In summary, I support the principle of hydrological control though do not support the proposed policy wording. My recommendation is that the policy be rewritten to require retention of rainfall to manage the effects of stormwater runoff (volume and quality) on freshwater ecosystem health. The rainfall depth retained should be appropriate to manage the effects of stormwater runoff from small, frequent rainfall events.

35. The development of technical guidance for stormwater management in urban development (Method FW.X) is strongly supported. This should be in addition to changes to the hydrological control policy for the reasons noted above.

RESPONSE TO EVIDENCE

36. In the statement of evidence of Stuart Farrant dated 30th October 2023, he referred to Auckland Council and Waikato Regional Council's stormwater retention policy. In response to two points he raised:

36.1 Paragraph 42: "Retention depths are often hard to achieve in large scale centralised devices and typically promoted at a lot scale (private devices)…"

The hydrological control principle is to encourage lot scale retention to mimic natural evapotranspiration and infiltration. Regardless of whether a retention policy is based on continuous flow modelling (as recommended in the s 42A report) or on rainfall depth (as I recommend), the on-site retention solutions through soakage, rainwater tank reuse or other means, will be similar.

36.2 Paragraph 43: "Requirements to achieve a specified retention depth are currently based on limited calibrated modelling which looks solely at gauged stream flows and catchment rainfall to estimate the proportion of rainfall to be retained. This is often undertaken on already highly modified land (historically cleared for farming) and is not considered representative of natural undeveloped conditions."

I am unable to comment on how the specified retention depths were derived in Auckland or Waikato, nor on the limited model calibration Mr Farrant refers to. However, determining the retention depth from a calibrated rainfall-runoff model is a reasonable approach and the analyst is able to reasonably estimate the proportion of quickflow (surface runoff) from baseflow (infiltration through soils). Conversely, the proposed policy requires developers to estimate flows and volumes from a continuous flow model which would be uncalibrated.

Mr Farrant's evidence refers to specified retention depths being based on limited calibrated modelling, often on already highly modified land. The proposed policy for hydrological control requires comparison to the undeveloped state, defined as the grassed (pastoral or urban open space) state of the site prior to urban development. My interpretation of this definition is that it may be modified land, i.e., urban open space. It is not requiring control to

the natural undeveloped state. So the calibrated models from modified land referred to, may be relevant.

SUMMARY

37. I support the principles of hydraulic neutrality and hydrological control, however the current policy wording is likely to result in confusion and misinterpretation. I recommend that the hydraulic neutrality definition is revised to incorporate an event magnitude(s) and removal of references to volume. I recommend that the undeveloped state definition is revised to improve hydrological outcomes and freshwater ecosystem health. I recommend that the hydrological control policy is redrafted as a policy to manage the effects of stormwater runoff (volume and quality) on freshwater ecosystem health, and that specific rules related to implementation of the policy are developed via amendments to the Natural Resources Plan.

Charlotte Lockyer
3 November 2023