BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications for Resource Consent Application **APP-2013016147.00** by The Department of Corrections – Whanganui for the discharge of stormwater and associated contaminants to water from the Whanganui Prison, Pauri Road, Kaitoke

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REPORT TO THE COMMISSIONERS

MR DAVID MCMAHON (CHAIR), MS SHARON MCGARRY AND MS ELIZABETH BURGE

SUPPLEMENTARY EVIDENCE TO SECTION 42A REPORT OF LOGAN ARTHUR BROWN – FRESHWATER AND PARTNERSHIPS MANAGER

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19 NOVEMBER 2020

A. Introduction:

1. My name is Logan Arthur Brown.

2. My qualifications and experience are outlined in my original s42A report dated 18 August 2020 and for brevity are not repeated here.

B. Fundamentals of dune lakes:

3. It is important to outline the fundamentals of dune lakes and the systems as this is the ultimate receiving environment. These points are covered in my original s42A report, and/or the JWS and are highlighted below:

    a. Lakes especially dune lakes effectively act as sinks for nutrients (agreed in the JWS – page 2). In the case of Lakes Pauri and Wiritoa this is more pronounced with the outflow from Wiritoa being intermittent in nature. Nutrients especially phosphorus that make their way into the lakes cannot effectively be exported. Taking for example Lake Horowhenua which has a permanent outflow, when we have an algae bloom the nutrients can be exported to the coast via the export of algae. When Lakes Pauri and Wiritoa experience algal blooms the outflow is likely dry and the nutrients can't be exported from the lakes.
    b. Even with reduced concentrations of nutrients in the stormwater discharge the discharge will still contribute to increasing the nutrient load within the lake (JWS – page 2). To ensure that the discharge no longer increases the load to the lake either these nutrients need to be removed from the lake i.e. harvesting, and/or made unavailable for plant growth i.e. flocculants, or inputs to the lake from other practices in the catchment reduced.
    c. Continuing to discharge nutrients even at a reduced load continues to add to the load within the lake, this contributes to the internal nutrient loads and continues to contribute to the legacy issues that need to be dealt with to improve water quality.

C. Flows into Lake Pauri and Wiritoa:

4. Paragraphs 39 and 40 of my s42A in relation to groundwater flows – need to be replaced by the new evidence provided by the applicant. It is unfortunate this this information wasn't provided with the s92 request dated the 3rd June 2020. Point 4 of the s92 request specifically requested the contour map of the groundwater levels that accompany the additional groundwater monitoring. This information is useful in terms of establishing the catchment that contributes inputs into the lakes.

5. There has been some discussion at the hearing which I believes requires a slight expansion on the conclusions reached in regards to inflows to the lake. This is around the removal of stormwater and an increase in the water residence time within lakes. Removal of the stormwater discharge from the lake would increase the residence time in the lakes and I agree with this statement. However, an increase in residence time is not necessarily a bad thing. The water from the Prison also brings with it additional nutrients and nutrient load to the lakes. This continues to contribute to the

nutrient load within the lakes. Therefore, if no stormwater was discharged there would be a reduction in the loads that make their ways to the lake assuming the load from the remaining catchment remains the same. Therefore, in this situation an increase in residence time would be accompanied with a decrease in the annual load that is discharged to the lake. As agreed within the JWS it is the load discharged to the lakes that is important in looking at drivers of in-lake processes.

6. Building on the removal of water from the system, within intervention work diversions of streams/groundwater and their associated nutrients is a recognised method for lake restoration. These works have been done in Lake Tutira to reduce the loading of phosphorus to the lake from a tributary that contributed a significant load of phosphorus, diversion walls have also been used in Lake Rotoiti with the Ōhau Channel to divert flows from Lake Rotorua straight to the outlet from Lake Rotoiti.

7. It has been noted that the discharge from Lake Pauri into Lake Wiritoa is thought to hug the bank and go straight to the outlet from Lake Wiritoa. This is inferring there is an impact on the ability of mixing of the stormwater with Lake Wiritoa. Based on my knowledge of the lake system, I struggle with the reasoning for this – the outlet from Lake Wiritoa is intermittent in nature, the lake experiences wind conditions and this would result in significant mixing of the water. The only time that we might not see mixing within the lake is when the lakes are stratified and this would result in mixing not occurring between the upper and lower levels of the lake (there is mixing within the stratified layers). However, when the lake mixes (also referred to as turning over) these two layers would mix.

8. Flow direction from Lake Pauri to Lake Wiritoa, it was agreed during the development of the JWS that the majority of the time the water flows from Lake Pauri to Lake Wiritoa. There was also agreement that in the JWS that a larger culvert sizing and maintenance would assist with ensuring the flow direction was from Lake Pauri to Wiritoa. The lack of maintenance around the current culverts under the access road results in a sediment mound in front of the culvert – this reduces the ability of the water to flow to Lake Wiritoa especially when the levels in Lake Pauri are low. Water flows back into Lake Pauri can and do occur and has been confirmed by submitters although this can be managed as identified in the JWS (refer Figures below for evidence of sediment deposition in front of the culverts).

9. The culverts under the access way will at times provide an impediment to fish passage. If one was to compare the culvert configuration against the National Fish Passage Guidelines these culverts wouldn't be able to meet the requirements. The current configuration of these culverts will result in a velocity barrier to fish passage. As covered above the modification and appropriate sizing of the culverts to ensure the flow of water from Lake Pauri to Lake Wiritoa will aid in the migration of fish species into Lake Pauri.

10. Wetlands and the ability to remove nutrients – I agree with Dr Keesing that wetlands have the potential to aid in the removal of nutrients from discharges. However, this removal of nutrients is very focused on nitrogen removal. This nitrogen removal is one of the reasons that we see constructed wetlands becoming more common in the landscape to reduce nitrogen concentrations within discharges. These wetlands at the start of their life remove phosphorus from the water column however, over time they become sources of phosphorus unless the sediment is removed from the

wetland. Given the time that these wetlands have existed I would expect that they release phosphorus into the lakes rather than remove it.

Figure 1: Stormwater outlet looking toward Lake Pauri.

Figure 2: Access way and culverts – photo taken on the same day as Figure 1 (note sediment deposition in front of the culverts creating a mound for water flow).

D. Sensitivity of the receiving environment (CAP) and the risk of the lake flipping:

11. Differences in capacity to assimilate pollution. There appears to have been a misunderstanding of my assessment against the One Plan water quality targets and that I have simply relied on the lakes and/or discharge quality and a comparison against the One Plan water quality targets. The One Plan water quality targets do not exist in isolation, there is ecological reasoning for the setting of those water quality targets. The nutrient targets (TN, and TP) have been set to manage phytoplankton levels (as measured through chlorophyll a). One could consider these a limit on a nutrient amount similar to a water allocation framework. The One Plan doesn't contain such an allocation framework for nutrients however, this does not prevent the science suggesting that such limits would be appropriate for the management of phytoplankton within these lakes.

12. When undertaking an assessment I first turn to the values that a site currently holds or is valued to hold. The minimum values to be considered are those that are contained in the One Plan and others that the community make us aware of. After this assessment one then turns to an assessment of the current water quality against the water quality in Schedule E of the One Plan. As I understand it there is no disagreement between experts that the majority of the values of the lake no longer exist or are compromised and that a number of water quality targets do not meet the One Plan deep lake water quality targets. In some resource consent hearings it has been evident that the values can be met (or met with proposed upgrades) however, the One Plan water quality targets are not (and will continue to not be). As the values are provided for, the science has shown that the water quality targets are too restrictive in terms of protecting the values. In other assessments the One Plan water quality targets have been met however, the values have not been provided for and further science work shows that the One Plan water quality targets are too lenient.

13. We also have the situation that we have here in that neither the values are provided for nor the water quality targets are not met. At face value showing that water quality needs to move closer to the One Plan water quality targets to provide a level of protection to the values the lakes should hold. There is no one size fits all, and any assessment needs to be undertaken on the information that is held for the receiving environment and based on the merits of the application.

14. At para 46 of legal submissions it is suggested that I have undertaken an assessment on a principled approach. This is not correct, all of my evidence is undertaken complying with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. My assessment is undertaken on the application in front of me, the knowledge of the lakes and the processes that drive water quality within them (including in-lake processes), and the further information that is presented during a consenting process.

15. The information provided at the hearing has clarified a number of questions although still raises a number of uncertainties. Dune lakes act as sinks for nutrients and therefore the management issues that arise with this process are a matter of fact and do not really on any value judgements. How these nutrients are managed to ensure that the values within the lakes are provided for is one of the reasons that during expert conferencing undertaken in September 2019 a number of alternative options were considered by the experts. It is only recently that the Department have

advocated for these options with the circulation of their evidence. This has provided limitations on the ability to test the certainty that these proposals will provide.

16. The process of flipping can be caused by high sediment loads as noted by Dr Keesing. However, it can also be caused by the presence of high algal abundance. The process of flipping effectively is the result of material of some description preventing sunlight from reaching the majority of macrophytes that are present within the lake. The lack of sunlight results in the death of the majority of macrophytes, and subsequently algal species dominate the lake preventing macrophytes from establishing. The experts agree that Lake Pauri and Wiritoa (as do other lakes in the Region) do show a seasonal pattern of algal growth that show that flipping is a possibility – this pattern is explained further below.

17. Nutrients are one of the main factors that lead (especially phosphorus for cyanobacteria species) to excessive algal concentrations and can result in flipping. This is the very process that started in Dudding Lake in November 2018. Monitoring showed high pH (above 10) at the water surface, an algal bloom, low clarity (0.53 m) and a bottom layer that had very low levels of dissolved oxygen. Independent advice from Dr Max Gibbs confirmed that the lake was in the early stages of flipping. Horizons increased monitoring to monthly and sought advice and options to prevent this from occurring including the use of Emergency provisions of the RMA to add flocculants to the lake. These same patterns were also seen in the water quality monitoring from Lakes Pauri and Wiritoa in November 2018 with pH above 9.5 at the water surface, high algal biomass, low clarity (0.57 m), and low dissolved oxygen levels in the lake bottom. None of these lakes completed the process to be algal dominated however, all showed patterns that suggested it was about to occur. This is why monitoring in these lakes was also increased to monthly. The water quality data collected to date and the external advice received very much supports that the lakes were at risk of flipping.

18. For clarity the term flipping should only be used in relation to a change from a macrophyte dominated lake to an algal/sediment dominated lake. Flipping is generally considered to be a change in a permanent state.

19. Comment has been provided throughout the hearing that the nitrogen concentrations in the discharge will dilute the in-lake concentrations. However, this continues to ignore that these lake systems are sinks – continuing to add nutrients into the lake that holds them adds to the internal nutrient load and the on-going build-up of nutrients within the lake. This is important in relation to the internal nutrient load, those nutrients that are discharged to the lake effectively create the future on-going internal nutrient load. Without reducing the external load the internal nutrient load will only become larger (unless in-lake interventions ae undertaken to reduce the internal load).

20. It has been mentioned during the hearing that if the Prison stormwater was to be removed from the lakes, the lakes would continue to degrade. The other side to this is if all other activities in the catchment ceased and the Prison stormwater was the only input to continue the lake water quality would also continue to degrade.

E. Weed harvesting:

21. Weed harvesting is a recognised method to reduce nutrient levels within a lake system as used within some the lakes within the Rotorua Lakes and to break in-lake processes as proposed in Lake Horowhenua.

22. In order to establish the actual volume of weed that needs to be removed from the lakes a number of parameters need to be confirmed in order to have certainty the proposed measure will be effective. These include:

    a. Volumes of water that are discharged from the stormwater network including during dry weather flows;
    b. The concentration of nutrients over the discharge events (including if these are during dry weather flows);
    c. The loads of nutrients that are discharged to the lakes, and the proportion of the loads that are discharged to the two lakes (may be fixed with flow going in only one direction);
    d. The nutrient concentrations of the weed that is the target of the macrophyte harvesting, this nutrient concentration will vary depending on the macrophyte species that is targeted within the lakes.

23. The other parameters that need to be considered in terms of weed harvesting is the ability to be able to undertake these works. I am currently the project lead for the Lake Horowhenua weed harvesting programme and although these two programmes have different outcomes in mind for weed harvesting some of the practicalities for being able to undertake such works are not necessarily straight forward. These include:

    a. Consenting of the weed harvesting operation;
    b. The requirements to be able to launch and retrieve the weed harvester from the lakes and the likely need for a suitable boat ramp (which may require consenting);
    c. The end use of the macrophytes especially given the biosecurity concerns with hornwort (Pauri and Wiritoa) and *Vallisneria australis* (Wiritoa only – only known lake with this species in the region). Both of these species being contained in the Regional Pest Management Plan 2017-2037 and having associated rules with their movement.
    d. Consideration of the effects of the harvesting on the native macrophytes within the lake. The weed harvester does not discriminate between exotic and native macrophytes and therefore effects on native macrophytes need to be considered. These effects on native macrophytes may well be positive but needs to be understood prior to undertaking the works.

F. Azolla:

24. A fern species that has the ability to fix nitrogen from the atmosphere and add to the internal load (plant grows, use nitrogen from the atmosphere, then die releasing the nitrogen into the lake). This ability for some lake plant species to be able to fix nitrogen from the atmosphere is one of the reasons that much (but not all) lake management focuses on the management of phosphorus inputs into lake systems.

G. Barriers to fish passage:

25. Barriers to fish passage in some of the catchment have been assessed. The outlet from the Kaitoke catchment is a permanent outflow with the permanent flows being driven from the discharge from Lake Kaitoke and then intermittent discharges from Lake Wiritoa. Within the catchment and close to the coast the Vector Gasline had created a barrier to fish migration, this barrier was previously fixed (Vector undertaking the works with advice from Horizons). However, due to the nature of the substrate (sand) this has meant that the fix has not been permanent (refer Figure 3). However, at this location in the catchment the stream is tidal and during the high tides this is no longer a barrier to fish passage.

26. There are other known barriers in the catchment that will be restricting fish passage. Horizons has recently been successful in receiving Central Government funding for the establishment of a fish passage and monitoring team whose focus on the next 3 years will be on identifying barriers within the region, prioritising those for remediation and working with barriers owners to remediate these (with the ability to co-fund these fixes). However, given our current knowledge of barriers within the region we expect to find a significant number of barriers within the region.

Figure 3: Previous fish pass fix on the Vector gasline. The constructed fish pass has created another perch due to sand substrate downstream. The perch disappears on during the high stage of the tidal cycle.

H. Trout and trout stocking in the lake:

27. Taranaki Fish and Game has confirmed that the last time that trout were stocked to Lake Pauri was 1991 and in Lake Wiritoa 2014 for a kids fishing promotion. Feedback from Fish and Game is that the last stocking event wasn't successful as a result of high water temperatures and deoxygenated bottom water of the lake.

I. Lake Restoration options and time to recover:

28. Flocculant -initial work has been undertaken to identify the volumes of flocculant that would be needed in Lakes Pauri and Wiritoa. In terms of timescale to see effects of this intervention if would be seen reasonably instantly as the phosphorus is bound to the flocculant. This will see a reduction in phosphorus in the water column – maintaining this on-going state will require a reduction in the external load to the lakes. The addition of flocculant could be considered a short term intervention.

29. Catchment wide interventions - although these do not deal with the internal load they do reduce the external load that is discharged to the lake. These are required to be undertaken with in-lake interventions. Catchment wide interventions work on a much slower approach, some can be done through a non-regulatory approach working with landowners and other will require changes to regulatory tools. There is also the time between implementation of an action and the time that this takes to be seen in the lake. This is dependent on the action and can vary depending on groundwater lag times, and the time to establish the intervention i.e. plant growth etc. Catchment wide interventions could be considered medium to long term interventions.

30. Weed harvesting – covered in detail through the hearing process and depending on the level of macrophytes removed will dictate the load of nutrients that are removed from the lakes. The load of nutrients removed will dictate the timescale at which water quality changes will be seen. Some of the other benefits such as recreational benefits come immediately with harvesting i.e. no macrophytes in the way when boating and recovery of native macrophytes will be dependent on the growth seasons.

31. Aeration – not covered in much detail throughout the hearing although is used to prevent stratification within the lakes. Preventing stratification prevents the deoxygenation of the bottom waters and the processes that result in the release of phosphorus from the sediment on the lake bed. This is considered in an in-lake intervention.

32. Depending on the restoration options chosen for the lakes will dictate the time scale at which improvements can occur. There can be reasonably quick interventions which will result in reasonably quick water quality improvements. Others will take longer to implement and will be on a long term scale in terms of seeing changes in the lake.

J. Additional benefits of weed removal:

33. Removal of vegetation which if not removed eventually rots and then results in a large deoxygenated layer within the lake as the organic matter breaks down;

34. Establishment of native vegetation is encouraged once exotic vegetation mass is reduced, this is competition being reduced. Both Lakes Pauri and Wiritoa still have native macrophytes present and therefore a seed source is present for the germination of these species. Re-establishment of these species will occur reasonably fast once this competition is reduced;

35. Depending on the level of removal can reduce the internal nutrient load and the legacy load; and

36. Floating hornwort beds during photosynthesis raise pH levels resulting in the release of phosphorus from the lake bed sediment especially in the shallows of the lake.

K. Fish habitat in the lake:

37. Para 62 "However, the area that is available to be used by aquatic organisms can become limited due to internal lake processes. These can be decreases in dissolved oxygen concentrations or saturation at the bottom of lakes when they undergo stratification and/or when high pH is experienced at the lakes surface as a result of photosynthesis from algae. Appendix 2 shows that in Lake Pauri during stratification, below five metres from the water surface low dissolved oxygen concentrations can occur. Also, in the top few metres high pH can occur. This means there is limited habitat available for fish to be able to use between the low dissolved oxygen and the high pH areas at certain times of the year."

L. Lakes380

38. Lake Pauri and Wiritoa were sampled as a part of the Lakes380 programme on 29 July 2020. Results from this work will eventually be summarised online at https://lakes380.com/lakes/lake-wiritoa/ and https://lakes380.com/lakes/lake-pauri/

M. Conditions:

39. Monitoring of TN and TP in the sediment is undertaken to establish and understand the internal nutrient load within the lake. Lake Pauri and Wiritoa experience in-lake conditions (high pH, and/or low dissolved oxygen) that mean that phosphorus can be released from the sediment.

40. Proposed condition 16 in relation to riparian plantings and maintenance – the applicant has proposed changes to the planting "The planting must be maintained (including annual weed control and an annual program to replace dead plants) by the consent holder for the term of this consent three years following the completion of planting." A condition requiring only a time limit for maintaining plants is not considered best practice. The most recent requirements in regards to consent

conditions is the Te Ahu a Turanga – Manawatū Tararua Highway project – the most recent requirements are "Riparian planting must achieve an 80% canopy cover within five years following the completion of planting' with requirements for minimum plant sizes (at planting). Follow on conditions require that if this coverage isn't achieved then maintenance is required until this coverage is achieved. This ensures that the conditions are designed with outcomes in mind. That is that the riparian planting establishes itself and those proposed benefits are realised.