BEFORE WAIKATO REGIONAL COUNCIL
HEARINGS PANEL

UNDER the Resource Management Act 1991 (**RMA**)

IN THE MATTER OF Proposed Plan Change 1 to the Waikato Regional Plan and Variation 1 to that Proposed Plan Change: Waikato and Waipā River Catchments

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DAVID KLEE

PRIMARY EVIDENCE ON BEHALF OF THE AUCKLAND/WAIKATO & EASTERN REGION FISH AND GAME COUNCILS ("FISH & GAME")

SUBMITTER ID: 74985

Hearing Block 1

Dated: 15 February 2019

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1. QUALIFICATIONS AND EXPERIENCE

1.1 My full name is David Klee.

1.2 I am employed as Game Bird Manager, based at Auckland/Waikato with Fish & Game

1.3 I have a BSc degree in Biology and MSc degree with first class honours in freshwater ecology, both at the University of Waikato.

1.4 I have been in my current role since October 2008 during which time I have been responsible for monitoring and managing wetland habitat in the Waikato Region. During my employment with Fish & Game I have run the population monitoring and research programmes for game birds at both national and regional scales. A large part of my portfolio includes managing habitat enhancement and restoration projects around wetlands, lakes and rivers. The majority of the projects I conduct are within the Waikato River catchment. During my employment with Fish & Game, I have also provided evidence for the Auckland/Waikato Fish and Game Council in statutory planning processes. This involves assessing notified resource consents applications, government policy statements, and statutory plans for their effect on game bird populations and recreational game bird hunting opportunities.

1.7 I am a member of the Waikato and Waipā Peat Lakes and Wetlands Accord groups,and sit on the Executive Committee of Waikato RiverCare.

1.8 I am familiar with the Waikato and Waipā River catchments generally, and specifically through various projects Fish & Game conducts in these catchments. Major work streams include habitat restoration and creation, predominantly for wetlands, and riparian margins on both private and public lands. As such, I have vast experience, and personal knowledge, of the opportunities and threats that these habitats face in the Waikato

Region. I have also managed several research projects encompassing these areas in recent years assessing the ecological integrity of wetlands and lakes in relation to game bird productivity and population dynamics.

1.9 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

1.10 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions, I have made in forming my opinions.

1.11 My opinions rely in part on the Evidence in Chief presented by expert witnesses appearing for the Director-General of Conservation (Dr Hugh Robertson and Dr Ngaire Phillips).

2. **SCOPE OF EVIDENCE**

2.1 My evidence supports the following of Fish & Game's submission points:

2.1.1 That the value of "Ecosystem health" include greater specificity to recognise the values and aspirations for wetlands and lakes – currently it only recognises extrinsic values of wetlands.[1]

2.1.2 That the use of rivers, lakes and wetlands for recreational hunting (and angling) be included in the value "Human health for recreation". [2]

2.1.3 The importance of a specific Objective for wetlands,[3] and also for the Whangamarino wetland. [4]

[1] V1PC1-204; FSPC1-384.
[2] PC1-10787.
[3] PC1-10790.
[4] V1PC1-223.

2.1.4 The Whangamarino wetland be recognised as an outstanding waterbody, for the purposes of the NPSFM.[5]

2.1.5 That a freshwater management unit (FMU) be created for the Whangamarino wetland.[6]

2.1.6 That Table 3.11-1 include narrative targets for wetlands generally, with numeric targets to be developed by 2025,[7] and include numeric targets for the Whangamarino wetland.[8]

2.1.7 That Table 3.11-1 include lake attributes (supporting those sought by the Director-General of Conservation).[9]

[5] PC1-11007; FSPC1-446.
[6] PC1-11007.
[7] FSPC1-374.
[8] FSPC1-446.
[9] FSPC1-374.

3 SUMMARY STATEMENT

Wetlands

3.1 The rate of wetland habitat loss in New Zealand has been dramatic and wetland ecological integrity is severely depleted. What remains is threatened, with some ecosystem types, communities, and species facing extinction.

3.2 The protection, enhancement and creation of new wetland habitat remains one of Auckland/Waikato Fish & Game's highest priorities.

3.3 In the Waikato Region it is estimated that a further 1.2% of remnant wetlands were completely lost, and 15% suffered partial loss, during the time period 2001 – 2016. This is likely to under-estimate the loss in wetland extent.

3.4 Wetlands, especially sensitive bog habitats, require specific management regimes different to other freshwater systems. There is a need for wetland specific water quality objectives, as well as greater monitoring, in order to ensure that objectives for wetlands are being achieved over time.

3.5 The Section 42A Report[10] suggests that the substantial reductions to catchment loads required by PC 1 will progress towards staged improvements of wetlands. I disagree. For reasons outlined in my evidence, in my opinion even if some reduction in catchment load is achieved, wetlands will continue to degrade and in some cases this damage will be permanent.

3.6 Wetlands are a natural sink for sediment and nutrients that get conveyed through river, systems and are therefore much more sensitive to high loads that exceed the wetlands ability to process them. Making small reductions to incoming catchment loads over time must not be confused with improving wetland ecosystem health. Under PC 1 as it stands, in my opinion wetlands including the internationally significant Whangamarino, will continue to degrade.

[10] At [489].

3.7 In my opinion, managing water quality in catchment alone is insufficient to safeguard the health and wellbeing of Whangamarino Wetland. Specific management actions to ensure hydrological functionality and reduced nutrient and sediment loads at specific times when the sensitive parts of the wetland are most susceptible will be required.

3.8 Whangamarino is one of the most studied wetlands in the country. There is enough information to set specific limits now that will ensure no further loss of this internationally significant wetland. It is both sensible and necessary to establish an FMU for Whangamarino Wetland.

3.9 I support the narrative targets[11] proposed by the Director-General and captured in the evidence of Dr Robertson for all wetlands, and the numeric[12] targets recommended specifically for Whangamarino Wetland. The approach presented will ensure that contaminants that are adversely affecting wetlands are reduced in the interim, numeric targets are set where sufficient information is already available, and data is collected to help inform more specific numerical attributes for all wetlands in the future.

3.10 There is a need to manage for the most fragile component of an FMU. This means that, even if a separate FMU is not created for the Whangamarino, there must be a high degree of confidence that limits for the whole catchment need to be sufficient to protect its values.

Shallow Lakes

3.11 Shallow lakes provide a significant resource for recreational gamebird hunting in the Waikato Region and these populations are closely linked to ecosystem health. Lakes which have flipped from submerged plant to algal dominated systems have often seen drastic reductions in the number of gamebirds available to recreational hunters which has required Fish & Game to instate more restrictive limits reducing hunter opportunity.

[11] Appendix 5, page 59 of Dr Robertson's primary evidence
[12] Appendix 7, page 61 of Dr Robertson's primary evidence

3.12 As it stands PC 1 does not provide a consistent or coherent approach to managing shallow lakes.

3.13 The four lake FMUS in PC 1 are defined solely by geomorphological origins. There is no evidence that suggests this approach can be used for defining management units as it does not encompass all necessary characteristics that fundamentally drive ecosystem processes in lakes. Alternative systems that incorporate multivariate analysis on factors that determine bio-geochemical and ecological dynamics of lakes provide a much better basis for defining lake FMUS and should be adopted. I present an alternative framework developed specifically for the Waikato Region and based on long term data, that could be used for this process.

3.14 Lakes are extremely difficult and expensive to restore once they have collapsed. Fish & Game is concerned that many lake sub catchments in PC1 that continue to have high quality lakes at greatest risk of decline, were given low priority rankings. The proposed amendments to lake sub catchment prioritisation[13] go some way to addressing these concerns. However, there are still some issues with the proposed re-prioritisation, for example, the use of outdated data. I support the evidence being presented by Dr Ngaire Phillips on behalf of the Director-General as it uses a more comprehensive and up-to-date classification system than is presented by Officers.

3.15 By implementing 'best practice' on farm management action, substantial reductions of nutrient loading are achievable for some lakes. Reductions in the order of magnitude described in my evidence have the potential to improve the ecosystem health of some lakes, and increase their NOF rankings.

3.16 Long-term targets for lakes are set at national bottom lines, despite some FMU classes and individual lakes having better attributes currently. This approach sets the bar very low and discounts the prospect of achieving long term improvements. My evidence shows that for some lakes, both short term and long-term improvements are achievable and realistic.

[13] Amendments to table 3.11-2 to alter seven sub catchments to Priority 1 [645] Section 42A Report.

4 FISH AND GAME VALUES

4.1 Gamebird hunting is predominantly enjoyed in wetlands, lake and river margins and provides significant benefits that should be represented in PC 1.

4.2 Hunting and angling are sports with multiple associated values. Fundamentally, ecosystem health is required to support harvestable populations. In terms of human use values, the sports equally represent food gathering and recreation.

4.3 The Auckland/Waikato Region provides for significant wildlife habitat and hunting opportunities. Hunters spend an average of 168,000 hours recreating in Auckland/Waikato Fish & Game Region's lakes, rivers and wetlands annually. Currently, the Auckland/Waikato Region sells approximately 7000[14] adult whole season game bird hunting licences. These figures underestimate total participation, as they do not take account of landowners who may legitimately hunt without a licence under Section 19 of the Wildlife Act, and tourist hunters who purchase their licence in another part of the country then travel to the Region to hunt.

4.4 Game birds are recognised and defined in the First Schedule to the Wildlife Act 1953. The current statutory basis and regime for game bird management by Fish & Game Councils is provided for under Part II of the Wildlife Act, together with annual Game Notices made under the Act.

4.5 Following the realisation in the 1940's that habitat was the essential key to wildlife management, Auckland/Waikato with Fish & Game's predecessor, the Auckland Acclimatisation Society, concentrated its licence income and its attention on wetland purchase, protection, restoration and enhancement (in that order). This policy was active at a time when thousands of hectares of wetlands were being drained with both local and central government subsidy and/or direct logistical support. Because of more than 60 years of such wetland saving

[14] Historically licence sales were as high as 12,000.

activity, Auckland/Waikato Fish & Game Council now has some 1,700 hectares of wetland in 20 titles and a large portion of total revenue collected from licence fees goes into maintaining and enhancing these areas. (Figure 1).

Figure 1: Fish & Game owned wetlands (red outline) in the Waikato Region.

4.6 The Waikato Region hosts several highly significant wetlands. Notable sites include the Whangamarino Wetland, the Waikato River Delta and the large network of shallow riverine and peat lakes. Combined, these habitats provide for most of the game bird hunting opportunity in the Region.

4.7 Licence sales are reliant on healthy game bird populations. Having a high abundance of game in a hunting area consistently outranks any other variable in hunter satisfaction and participation studies. Dabbling ducks are particularly significant as they constitute over 80% of a hunter's annual harvest in the Waikato Region (Barker 2018. unpublished data).

4.8 Game bird productivity and therefore healthy game bird populations are heavily reliant on having high quality freshwater ecosystems, in

particular healthy wetlands and shallow lakes with functional basal food webs that contain a high density and diversity of invertebrates. Waterfowl tend to breed and nest in areas with high invertebrate densities as high protein diets are crucial for several fundamental reproductive processes such as egg formation and duckling survival.

4.9 Wetland habitat availability and quality for game birds has declined in the Waikato Region over time, and continues to do so. This has led to a concomitant decrease in game bird populations reliant on these habitats. So, in addition to the *intrinsic* values of wetland systems, decreases in the extent and quality of wetland habitat also has adverse effects for recreational values.

5 WETLANDS

5.1 I have reviewed a draft of the evidence for Dr Hugh Robertson presenting evidence on behalf of the Director-General of Conservation. As stated in this section of my evidence, I agree with Dr Robertson's evidence on the importance of wetlands. I reiterate some of his comments.

5.2 The formal definition of wetlands in the RMA is wide and includes:

> *"permanently or intermittently wet areas, shallow water or land/water margins that support a natural ecosystem of plants and animals that are adapted to living in wet conditions."*

5.3 Within the bounds of PC1, there are approximately 16,000 ha of identified wetlands, the majority of which fall within the Lower Waikato FMU. This sub catchment also has many of the wetlands that have been afforded high priority status using an integrated ranking of biodiversity priorities for the Waikato Region (Leathwick 2016).

5.4 Wetlands are among the world's most productive and valuable ecosystems. Despite only covering 1.5% of the earth's surface they provide 40% of global ecosystem services (Zedler and Kercher 2005). Services include maintaining water quality and supply, regulating

atmospheric gases, sequestering carbon, protecting shorelines, sustaining unique indigenous biota, and providing cultural, recreational and educational resources (Dise 2009). As wetlands degrade, their ability to maintain ecosystem services reduces.

5.5 The negative impacts resulting from wetland loss and degradation include the loss of habitat for a diverse range of plants and animal species, and loss of ecosystem services such as flood storage, and filtering of nutrients and sediment from discharged water. Wetlands are ecotones that support both terrestrial and aquatic biota. They can be affected by a range of human disturbances, including alterations of nutrient supply, changes in hydrology, sedimentation, fire, vegetation clearance, soil disturbance, weed invasions (aquatic and terrestrial), and animal pest invasions (Clarkson et al. 2004a).

5.6 In New Zealand wetlands are the most under-represented ecosystem type when compared with pre-human settlement. By 2008, wetlands had declined to 10.1 percent (about 250,000 ha) of the estimated pre-human extent of 2,471,080. Only 4.9% in the North Island and 16.6% in the South Island remain. In the Waikato biogeographical region, less than 9% (by area) of wetlands remain. This is one of the highest rates and extent of loss in the developed world.[15] Of the remainder, in New Zealand, less than half are legally protected. The Ministry for the Environment specifically prioritises wetlands along with sand dunes as the only two specified ecosystems for protection of indigenous biodiversity on private land.[16]

5.7 Chapman (1996) identified wetland loss as one of the three major anthropogenic impacts on the lower Waikato River catchment. Analysis of change between 2001 and 2016 shows that wetland decline is continuing nationally, the level and the extent of which varies by region. In the Waikato it is estimated that a further 1.2% of remnant wetlands were completely lost and 15% suffered partial loss during this time period (MFE 2017). This figure underrepresents the total loss occurred, as 32% is categorised as 'unknown'. I am personally aware of several

[15] Globally about half of wetland areas have been lost.
[16] NZ Threatened Environments Classification (TEC); The National Priorities for the Protection of Indigenous Biodiversity on Private Land 'Protecting our Places' (MfE/DOC 2007): National Priority 2 *"Indigenous vegetation associated with sand dunes and wetlands"*.

sites, such as that captured later in my evidence, that have not been *completely* lost over that time, and not taken into account in this analysis. I am not aware of any formal monitoring by the Waikato Regional Council to truly quantify how much wetland is being lost.

5.8 The Operative Waikato Regional Policy Statement (WRPS) directs that wetland quality and extent be maintained and enhanced.[17] This requires management to prevent further loss of wetlands through habitat destruction.

5.9 One of the environmental results anticipated under the WRPS for fresh water bodies is that *there is no reduction in extent or condition of wetlands, with some wetlands exhibiting physical, chemical, hydrological or biological improvements*.[18] However, as stated, this environmental result has not been met.

5.10 Appendix 2 to Dr Robertson's evidence sets out the ecological significance ("SNA") criteria of the WRPS. Wetlands in the Region meet criteria 4, being *"indigenous vegetation or habitat type that is under-represented (10% or less of its known of likely original extent remaining) in an Ecological District, or Ecological Region, or Nationally*".

5.11 Significance criteria based on extent of habitat or cover remaining (from pre-human predictions) is now widely accepted because extent remaining is considered to be a useful predictor of possible species loss (and extinction).[19]

5.12 Ausseil et al. (2011) developed an index using six measures of anthropogenic pressures known to impact wetland ecological integrity

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[17] Waikato Regional Policy Statement 3.16 (b) (vi):

"Riparian areas (including coastal dunes) and wetlands are managed to:
a) **maintain and enhance**:
i) public access; and
ii) amenity values.
b) **maintain or enhance**:
i) water quality;
ii) indigenous biodiversity;
iii) natural hazard risk reduction;
iv) cultural values;
v) riparian habitat quality and extent; and
vi) **wetland quality and extent.**"
(Emphasis).

[18] Waikato Regional Policy Statement 15.4.5. (h).

[19] Refer above footnote 5. National Priorities document.

("EI"): naturalness of the upper catchment cover; artificial impervious cover; nutrient enrichment; introduced fish; woody weeds; and drainage. A score of 1 is considered pristine while 0 is a complete loss. Nationwide, over 60% of wetlands measured at less than 0.5. The Waikato Region is dominated by intensive agriculture and contains wetlands with a mean ecological integrity of 0.35, one of the lowest in the country.[20] Values reflect general patterns of agricultural and urban development with the lowest measures found in biogeographic units characterised by warm, flat, fertile land favoured for agricultural development.

The need for active protection and management

5.13 Protection alone will not prevent further loss of wetland biodiversity. Effective conservation will also require active management and restoration to mitigate impacts of invasive species, fire, sedimentation, nutrient enrichment, and altered hydrology (Sorrell & Gerbeaux, 2004).

5.14 The protection, enhancement and creation of new wetland habitat remains one of Auckland/Waikato Fish & Game's highest priorities. In the past 10 years I have been involved in 47 discrete projects for such purposes, on DOC, Fish & Game, Waikato Regional Council and private land in the central Waikato Region. However, for every project completed in the Region, there appear to be other wetland sites being drained or degraded at an even faster rate.

5.15 The satellite images below give a visual example of the type of wetland losses that have occurred in the Waikato Region in the recent past (2004-2017). This area is located at the eastern part of the Kopuatai Wetland, a Ramsar site of international significance.

[20] In contrast, wetlands in Fiordland or Stewart Island that are predominantly managed as national parks have typically high ecological integrity indices at over 0.9. (Clarkson et al. 2004).

Figure 2: Edge of Kopuatai peat dome 26/8/2004 showing the start of wetland conversion activity.

Figure 3: The same site 5/2/2017 showing conversion of bog area to pasture.

5.16 Whilst wetland clearance is still occurring today in large peat bog areas, as stated, the true extent of wetland loss is unknown. Most of the wetland loss occurring is not as easy to recognise as in these images. More often, small pockets, particularly of ephemeral wetlands, are methodically drained and converted to pasture.

What makes wetland systems unique in terms of management

5.17 It is important to recognise that wetland systems are distinctly different from riverine and lacustrine systems in the patterns of degradation. Lakes and river systems have generally maintained their original extent, with various modifications such as alterations of course, damming, nutrient enrichment, sedimentation, etc. However, for wetland systems the most significant impact by far is reduction in aerial extent by clearance and drainage. Those portions of the wetland remaining are then further impacted by various factors such as nutrient inputs and sedimentation (Clarkson et al 2015). These pressures therefore have cumulative adverse effects, which the Regional Plan must recognise if it is to effectively manage degradation of wetland ecosystems in the Waikato catchment.[21]

5.18 Another cumulative matter which must be considered when managing wetlands is that contaminants do not get continually flushed out over a defined time, as in a river environment (which can improve rapidly once catchment concentrations are reduced). In wetlands, both concentrations and total loads are relevant.

5.19 Wetlands are a natural sink for nutrients and sediment so even if contaminants are discharged to wetlands at a lower levels, these will still contribute to the continued degradation of the wetland system if elevated above the wetland's capacity to process them. This can lead to ongoing and permanent declines in wetland ecosystem health. For example, once peat bogs become mineralised and exotic plant invasion occurs, this process is largely irreversible.

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[21] Waikato Regional Policy Statement, Method 11.1.2 (indigenous biodiversity):
*"Regional and district plans shall recognise that adverse effects on indigenous biodiversity within terrestrial, freshwater and coastal environments are **cumulative** and may include:*
…
b) reduction in the extent and quality of indigenous ecosystems and habitats;
…
f) effects of changes to hydrological flows, water levels, and water quality on ecosystems;
…
h) loss of ecosystem services;
…
i) loss, damage or disruption to ecological processes, functions and ecological integrity."

5.20 It is often difficult to discern the systemic degradation to wetland habitats through gradual changes to hydrology and increased sediment and nutrient loading. Measurable ecosystem responses such as changes to plant community composition occur on decadal scales Therefore, wetlands often experience a lag between when effects occur and when they are observed.

Are wetlands adequately recognised in the Ecosystem Health value?

5.21 I strongly support the recommendations in the Section 42A Report to bring references to wetlands (and lakes) into the value and use statements of PC 1, in response to the Director-General's submission, for reasons set out above.[22] I have been asked to comment on the recognition of wetlands in the "Ecosystem Health" value.

5.22 The "Ecosystem Health" value in proposed PC 1 describes wetlands as supporting ecosystem health:

> *Wetlands and floodplains provide water purification, feeding and breeding habitat for aquatic species, habitat for water fowl and other ecosystem services such as flood attenuation.*

5.23 This statement recognises extrinsic values (e.g. ecosystem services) and does not recognise the intrinsic values of wetlands. As drafted, the value does not reflect the importance of the health of wetlands themselves. In Fish & Game's submission, inclusion of extent, ecological integrity, hydrological integrity and water quality[23] are sought to characterise ecosystem health for wetlands. I consider this broader focus captures ecosystem health for wetlands, to ensure that wetlands, where represented, can support the values listed elsewhere under 'ecosystem health'.

5.24 For example *"water purification"* is not so much a value of a wetland, but rather a use that we attribute to wetlands. Clean water is just one of the parameters required to protect wetland health. Indeed, the role of

[22] Section 42A Report at [267].
[23] V1PC1-204.

wetlands to 'purify water' often leads to direct detrimental impacts on natural wetland systems because wetlands developed under much different nutrient and sediment regimes than what they are subject to today.

Wetlands and the Vision and Strategy

5.25 Wetlands play a fundamental role in the health of the catchment and River, and as such should be one of the key focus points of the catchment-based management required under the Vision and Strategy and the WRPS.

5.26 That wetlands are an integral component was considered in the Integrated Assessment of the modelled scenarios. In considering the benefits of Scenario 1 wetlands were an environmental indicator[24], and the CSG recognising the following impact at 100% of Scenario 1: [25]

> *"increased base flow in wetlands will have significant benefits through increased biodiversity, increased customary resources, increased sense of identity and increased food sources".*

5.27 However, as outlined in the next section of my evidence, I do not consider that 'Scenario 1' will have these significant benefits for wetlands without direct commitment to the restoration and protection of existing wetlands in PC 1.

Wetland outcomes

5.28 As notified, PC 1 aims to reduce catchment nutrient, sediment and microbial discharges, but fails to set specific goals for restoring and protecting wetlands. Inherently, this approach assumes that sub-catchment water quality targets, if met, will be adequate to protect and restore wetland ecosystem health. The technical assessments underpinning this assumption have not been tested but appear to be based on assumptions. This leaves a large degree of uncertainty.

[24] Section 32 Report, p 72.
[25] Section 32 Report p 73.

5.29 The reasons this approach was adopted (as stated in the Section 32 Report) were that the TLG advised setting limits for wetlands based on existing knowledge, monitoring data and research would not be a feasible option at the time. Additionally, the NPSFM did not include an attribute for wetlands, and the setting of a national objective was some way off.

5.30 The Section 42A Report[26] suggests that sections 3.1 and 3.7 of the Operative WRP already provide for wetland management activities. This is partially correct but fails to acknowledge that these sections do not provide a framework for managing contaminant loading of wetlands. Ms Marr deals with this in her planning evidence. Moreover, the previous Regional Plan has failed to protect the ecosystem health of wetlands in the Region.

5.31 I agree with Dr Robertson's characterisation that there is a "missing element" in PC 1 (i.e. the limited direction for addressing water quality impacts on wetlands). Although Dr Robertson cannot recommend numeric attributes for all wetlands at this stage, I agree the more specific narrative attributes that he suggests, would provide more guidance as to the outcomes sought for wetlands.

5.32 I agree that further plan changes will need to refine wetland attributes, but this plan must also ensure that the ecosystem health of wetlands is protected in the interim. Narrative attributes should be inserted into PC 1 to ensure that this occurs. Norton et al. (2010) concluded that It is critical for regional plans have defined and measurable objectives to;

- Increase clarity and therefore certainty for environmental outcomes;
- Provide a basis for managing cumulative effects;
- Provide clarity about future resource availability and the conditions likely to be imposed on resource users;
- Give an ability to manage multiple types of activities that affect water quality in addition to managing point-source discharges, such as non-point discharges from land uses, water takes,

[26] Section 42A Report paragraph 311.

diversions, dams and riverbed works (i.e., the integration of water quality, quantity and land management); and

- Give an ability to measure attainment of objectives and thus properly monitor the effectiveness of plan provisions through time.

5.33 In the absence of numeric objectives, I agree that tight narrative objectives would provide much needed guidance for scientists, as well as other professionals, when interpreting what the plan is trying to achieve, as well as monitoring, and then measuring, achievement.

6 WHANGAMARINO WETLAND

Whangamarino Wetland - Outstanding status

6.1 Within the Waikato catchment and bounds of PC 1 there are specific sites of significance for recreational game bird hunting and habitat that require special attention.

6.2 Whangamarino Wetland refers to the ~7290 ha wetland complex, the second largest freshwater wetland in the North Island. It includes a range of wetland types (bog, fen, swamp, marsh), and associated sections of Pungarehu Stream, Whangamarino River and Maramarua River.

6.3 Whangamarino Wetland includes land administered by the Department of Conservation, land owned by Fish & Game, and private land. Whangamarino accounts for approximately 20% of current extent of remnant wetland habitat in the Region. Whangamarino Wetland was originally 103km^2 in area. Conversion to pasture, beginning in 1917, has resulted in an approximately 30% decrease in area. In 2014, wetland extent was 65.5 km^2.

6.4 Whangamarino Wetland is one of six wetlands in New Zealand on the Ramsar list of protected sites due to its highly diverse and nationally significant flora and fauna. It is home to a number of threatened species including the nationally endangered Australasian bittern (*Botaurus poiciloptilus*), the nationally critical swamp helmet orchid (*Anzybas*

carsei) and the giant cane rush (Sporodanthus ferrugineus). These species are at risk of being displaced by continuing drainage and land use change (Beard, 2010).

6.5 The Section 32 Report states that the Whangamarino wetland has highly significant values and as such should be accorded a priority in respect to addressing matters related to nitrogen, phosphorous, sediment and microbial pathogens through PC 1. The Report acknowledges that without significant management, this area will continue to degrade and potentially the values that make it internationally significant could be lost. The Report also acknowledges the loss of hydrological functioning of the wetland and the efforts DOC and Fish & Game have undertaken to restore minimum wetland water levels to improve the ecohydrology of the wetland.[27]

6.6 Whangamarino Wetland fulfils the ecological value criteria for significance in the operative WRPS (set out above). It is recognised as a priority wetland in the Waikato Conservation Management Strategy. I agree with Dr Robertson's evidence that it meets the NPSFM (and operative WRPS definition) of an Outstanding Water Body.

6.7 Despite the ongoing degradation of Whangamarino and associated loss of habitat, it is still home to an estimated 20,000 waterbirds, 239 wetland plant species and 18 species of fish (Beard, 2010).

6.8 Whangamarino Wetland is classified as a site of national significance for recreational game bird hunting in the Auckland/Waikato Sports with Fish & Game Management Plan 2011 (the Fish and Game Plan). This is the highest status available and only the Kopuatai Wetland is afforded the same classification when it comes to recreational hunting in the Auckland/Waikato Region.

6.9 Without question, Whangamarino Wetland is one of the most popular and significant sites for recreational game bird hunting in New Zealand. Fish & Game own and administer approximately 700 Ha across several different parcels within the wider Whangamarino Wetland system. These areas have been maintained and enhanced in order to create

[27] Section 32 Report page 100.

game bird habitat and hunter opportunity. The North and Central Shepherd wetlands off Island Block Road total 77 and 59ha respectively and were purchased by Fish & Game 1975/6. The Cocks Wetland consists of 248ha. The remaining title is the 354ha Eastern Whangamarino.

Figure 2: Fish & Game administered land in Whangamarino Wetland.

6.10 Fish & Game land currently facilitates 179 permanent balloted hunters, and itinerant hunters also access the block under permit. On average over the last four years the Fish & Game owned areas of the wetland facilitated 275 hunters and approximately 750 hunter days annually.

6.11 Whangamarino Wetland was once described as being the heart of the 'Waikato duck factory', holding some of the largest aggregations of game birds in the Region. Recreational game bird hunting is decreasing in the Whangamarino Wetland. This can be witnessed by the increasing number of abandoned hunting structures and decreased hunter use of Fish & Game wetlands over the last 20 years. Population levels of several key species are also decreasing, as are harvest rates (Klee unpub. data 2017). Whangamarino Wetland now has poor waterfowl production, with 8 of 11 sites counted producing no juvenile

birds. Overall production of waterfowl is now lower within Whangamarino Wetland than most other sites in the Waikato (Garret-Walker 2014).

Whangamarino FMU

6.12 The Section 42A Report[28] reiterates the Section 32 Report and acknowledges that future changes will need to address wetlands, and the need for FMUs relating to specific wetlands. In my opinion, this delay will only lead to further degradation and decline of wetlands in the interim.

6.13 Despite the universal acceptance of the significance of Whangamarino Wetland and acknowledgments that it is continuing to degrade, it is not recognised in proposed PC 1 with its own FMU. The Section 32 Report[29] acknowledges that the NPSFM and RPS require the identification of FMUs and appropriate water quality limits and targets but goes on to state that establishing an FMU for Whangamarino was not considered appropriate at this juncture due to a lack of guiding wetland attributes in the NPSFM and insufficient technical data to help inform limits. It concludes that managing contaminants in the wider catchment is enough and will give effect to the NPSFM.

6.14 In its submission to the CSG, the TLG provided the following summary points:

- Given the paucity of monitoring data it is not possible to determine current state with respect to potential attributes. This is a significant barrier and may require CSG to consider narrative objectives for a wetland FMU rather than numeric objectives (i.e. limits), even for those attributes that may have numeric descriptors (e.g. E. coli).

- With respect to the N, P and sediment contaminants we have severely limited scientific research upon which we could robustly

[28] Paragraph 490, page 89 Section 42A Report.
[29] Section 32 Report page 99.

develop ecosystem health attribute tables and limits for the Whangamarino.

- Given the points above, the TLG could not currently provide the technically robust information needed to determine a full suite of attributes, current state or numeric limits for a separate FMU covering the Whangamarino wetland and its catchment.

6.15 The key points above (reiterated throughout the Section 32 and Section 42A Reports) are a lack of data and understanding of effects in Whangamarino currently, coupled with an inability to set robust ecosystem health attributes. I disagree.

6.16 Officers agree with the conclusions made by the CSG and consider that the considerable reductions in contaminant inputs from contributing catchments required under PC 1 will progress towards staged improvements of Whangamarino Wetland[30]. Again I disagree with the analysis made by the Officers. Even if the 10% reduction targets in PC1 are realised, Whangamarino wetland will continue to remain a sink for nutrients and sediment and the ecosystem health of the wetland will continue to decline. Making small reductions in river catchment loads must not be confused with improving the ecosystem health of downstream wetlands.

6.17 Another reason Officers cite in recommending not to give Whangamarino Wetland its own FMU is that the recent Section 128 review of the flood scheme will lead to further sediment reductions.[31] The consent sets targets of 5% and 10% reductions by 2023 and 2033 respectively. It should be noted that these are not consent limits. Whilst it is hoped that identified management actions will lead to some improvements there is still some uncertainty, captured in an adaptive management framework that will determine when and how much reduction will actually occur. Even if the targets are achieved, 90% of the large sediment load which is being artificially channelled into Whangamarino will continue for the foreseeable future. The new

[30] Section 42A Report [489].
[31] Section 42A Report [490].

consent conditions cannot be relied upon to improve the ecosystem health of Whangamarino.

6.18 Whangamarino Wetland is one of the most intensely monitored and studied wetlands in the country. The amount of technical information available surpasses what is available for many of the other FMUs in the Region. Whilst the development of wetland attributes are still in their early stages for wetland systems in New Zealand generally, in my opinion there is enough information to set attributes for Whangamarino. Several of the tributaries flowing into Whangamarino are monitored for sediment and nutrient loads and a number of recent studies have modelled sub catchment loads (Jacobs 2015). The evidence of Dr Robertson details the monitoring data currently available for Whangamarino.

6.19 Quantitative limits to maintain the ecological integrity of wetlands in New Zealand have been developed in recent years. Clarkson et al. 2015 derived a wetland condition index based on US EPA standards that consider biotic and abiotic factors governing the ecological integrity of wetlands. They concluded that there is a significant resource of data to quantify limits to maintain the ecological health of wetlands in New Zealand.

6.20 Campbell (2016) presented options to the CSG regarding the inclusion of a specific FMU for Whangamarino. He sought advice from MFE who gave the following feedback regarding wetland attributes in the NPSFM and whether it would be appropriate to give Whangamarino FMU status:

- *Protecting the significant values of wetlands as is required in the NPSFM implies that any fresh water quality/ quantity degradation in the region cannot be at the expense of the significant values of the wetland. Therefore, they cannot be ignored in FMU's.*

- *While the NPSFM does not (yet) include attributes for wetlands, this doesn't mean regions couldn't or shouldn't be deciding values and setting objectives for wetlands now. If wetland attributes with national bottom lines are adopted in the NPSFM,*

and objectives have been set below that national bottom line, they will need to be amended in the next regional plan review.

- *It is consistent with the NPSFM for the council to manage the Whangamarino Wetland in a particular way to achieve particular values and objectives, and therefore to draw an FMU around the Whangamarino Wetland catchment. This may be necessary to manage its significant values. It could also be managed as its own outstanding water body, though even if it's not an outstanding water body, the council must protect its significant values. It's up to the council to identify those values in the plan.*

- *A wetland FMU could realistically only be managed by including the whole catchment that flows into it. And when setting limits that achieve objectives in the wetland, you will need to check that those limits also achieve the objectives in the rivers of the catchment. That is, the limits for the whole catchment will need to be sufficient to protect the most fragile component of the FMU.*

- *If there are particular values about a water body (such as Whangamarino Wetland) that are different to those of the wider catchment these should be managed differently. The 4 compulsory values could be managed through those set for the wider catchment (as long as they are sufficient to protect the most fragile component as mentioned above) and additional values could be set for the wetland itself that covers the extra value of it (these wouldn't necessarily be applicable to the wider catchment streams).*

6.21 This feedback reiterates that it is entirely appropriate, consistent with the NPSFM and may in fact be necessary to develop an FMU for Whangamarino to protect its significant values and that this must include its entire catchment.

6.22 I agree with the evidence of Dr Robertson and his assertion that river attributes in Table 3.11-1 lack a number of critical parameters and are

therefore insufficient at addressing contaminants that are known to be impacting on ecosystem health of Whangamarino Wetland.

Actual and potential (including irreversible) effects of contaminants in Whangamarino wetland

6.23 Whangamarino wetland is vulnerable to increased fluctuations in water levels. At low water levels, it is vulnerable to "drying out". At high water levels, the wetland is vulnerable to the increased sediment and nutrients delivered through floodwaters. Blyth *et al.* (2013) found a relationship between flood water levels and changes in vegetation within the wetland. There have been significant changes to vegetation community structure over time caused by physico-chemical changes to the wetland through alterations to hydrology, sediment and nutrient dynamics. High sediment and nutrients loads, particularly TP, causes nutrient enrichment of wetlands and disrupts the natural succession of vegetation and formation of peat soils. The mineral content of the peat in bogs is typically very low because they are disconnected from upland sediment sources. Mineral content in Waikato peat bogs is often <5% (Clarkson et al., 2004).

6.24 Soil TP concentrations are tightly linked with sediment deposition rates in Whangamarino Wetland. There has been an apparent shift in sedimentation rates and sediment characteristics with a rapid increase in sediment accumulation since the mid-1980s in Whangamarino (Gibbs 2009). Areas of wetland with high soil TP typically have a high abundance of introduced plant species. Since 1963, grey willow and manuka have invaded a large area of Whangamarino which has negatively affected natural peat forming process in those parts of the wetland (Blyth *et al*. 2013). Given the current rate of advancement it is likely that significant decreases in the extent of bog habitats will occur in relatively short (5-10 year) timeframes, if management changes are not implemented to significantly reduce further sediment deposition and eutrophication.

6.25 Vegetation mapping 1963-2014 illustrates the extent of habitat change over that time. It indicates substantial incursions of manuka in sensitive

bog areas.[32] Both the percentage covers of carex sedgeland, and sedges and wirerush decreased substantially. Carex sedgeland was displaced mostly by seasonal adventives, grasses and crack willow. Sedges and wirerush were displaced mostly by manuka and grey willow (Reeves 1994). The rate of vegetation change has slowed since 1977 but is continuing today. The main vegetation change since then has been the ongoing increase in percentage cover of grey willow. Grey willow was found to displace all other vegetation classes except kahikatea at Whangamarino Wetland (Reeves 1994).

6.26 As the mineralised area of the wetland continues to grow, and carex sedgelands shrink in extent, the availability of nesting habitat for game birds also decreases as they are reliant on dense ground nesting cover. Both indigenous and rank exotic grasses provide most nesting sites for mallards in the Waikato Region (Shepherd et al. 2018).

Wetland Types in the Whangamarino

6.27 The various wetland types found in Whangamarino Wetland have diverse degrees of sensitivity to differing hydrological, sediment and nutrient regimes. The sensitive raised bog in Whangamarino Wetland is in relatively pristine condition (good water quality) and is of high ecological significance. This wetland type is at high risk particularly due to increased nutrient and sediment loading during flood events. It is important to note that nutrient and sediment loading in sensitive wetland areas are intertwined with water levels in the wetland. During non-flood periods, the majority of contaminants are contained in river channels and get conveyed through the wetland downstream. When water levels rise, velocities slow and sensitive areas of the wetland get inundated. This leads to deposition in those environments. For this reason, an annual reduction in nutrients and sediment load may do little to protect the most sensitive parts of the wetland if most of those reductions occur during low flow conditions. Thought needs to be given to managing contaminants under fluctuating water level regimes and at times when sensitive parts of the wetland are most susceptible.

[32] The greatest rate of vegetation change occurred between 1963 and 1977.

Effects of sediment in the Whangamarino

6.28 Sediment deposition rates in the wetland are at levels which can seriously impact aquatic invertebrate production. The continual influx of sediment and nutrients is detrimental to ecosystem health especially basal food web components. Sedimentation impacts include increased turbidity that reduces the depth of the photic zone and increases sediment fallout which may cover primary producers and invertebrates. Excessive sediment input can change aquatic foodwebs and nutrient pathways in wetlands (Gleason and Euliss 1998).

6.29 Excessive sediment loads can bury seeds and invertebrate egg banks that are vital for maintaining healthy ecosystem functioning within wetlands and provide important food sources for game birds. Experiments in the prairie pothole region of North America have shown that burial depths of just 0.5cm/y can cause a 91.7% and 99.7% reduction in total seedling and invertebrate emergence respectively (Gleason et al. 2003).

6.30 Fish & Game with the University of Waikato, studied 8 sites in Whangamarino Wetland. These sites were characterised by depauperate macroinvertebrate communities and average macroinvertebrates abundance was consistently lower in Whangamarino Wetland than the overall abundance (for both sweep and benthic samples) at all other sites in the Waikato Region. Crustacea, Hemiptera and Oligochaeta were particularly under represented (Garret-Walker 2014). In my opinion, high levels of sediment accumulation occurring in the wetland is having a serious impact on invertebrate community composition and abundance within parts of Whangamarino Wetland. The lack of vital food web constituents will have implications for higher order consumers, particularly dabbling duck species.[33]

6.31 The proposed policy wording in the plan fails to acknowledge issues around water quantity in Whangamarino Wetland. The Lower Waikato

[33] In the Waikato, mallard duckling populations have a positive association with benthic Oligochaetea and sweep Crustacea, which are both underrepresented in Whangamarino (Garret-Walker 2014).

Flood Scheme included the lowering of the Lake Waikare and the diversion of water from Lake Waikare into the Whangamarino Wetland. In the natural situation, the discharge from Lake Waikare into Whangamarino Wetland would have been infrequent. Therefore, the extra water and associated sediment and nutrient load discharged from Lake Waikare to the Whangamarino Wetland is additional to Whangamarino's natural catchment. There is a need to integrate the management of water quality and water quantity in the Whangamarino.[34]

6.32 I have been involved in the development Catchment Management Plan (CMP) for Waikare and Whangamarino as Fish & Game's representative on the stakeholder's group. The CMP identifies many worthwhile actions that could contribute to improvements in the catchment, however there is no certainty that identified actions will implemented. In my experience, non statutory plans of this nature have failed to deliver outcomes that lead to environmental improvements in the Waikato Region. Further tangible narrative and numeric objectives are required in PC1 that give some statutory obligation to achieve desired outcomes identified in the CMP.

7 SHALLOW LAKES

7.1 Lakes often require specific management actions in order to arrest their further decline and begin a trajectory of improvement. As for wetlands there is a legacy issue where internal processes of nutrient recycling will continue to occur even after external sources begin to

[34] Objective B4 (water quantity) NPSFM requires water quantity management to protect the significant values of wetlands and outstanding freshwater bodies. The Section 32 Report at [203] discusses and acknowledges these issues and the likelihood of further loss of sensitive wetland types, for example:

"As a result of flood water diversion, storage and controlled release, the hydrological regime of Whangamarino Wetland is significantly altered and nutrients and sediment are trapped within the Wetland and without careful management, the full range of wetland types present in the Whangamarino Wetland will continue to degrade with the potential loss of bog ecosystems in particular. In this respect the preparation of the Lake Waikare and Whangamarino Wetland catchment plan for this area is a critical management approach."

reduce. Once systems collapse and change to a turbid algal dominated state it becomes exponentially more difficult and expensive to restore these to clear water macrophyte dominated systems. Despite some considerable effort on some lakes, I am not aware of a single lake in the Waikato where aquatic submerged plants have been successfully restored. The Section 42A Report[35] highlights that lakes are particularly vulnerable, and difficult and expensive to restore if they become degraded. I agree with this statement and therefore arresting further decline of the relatively few high-quality lakes in this Region must be prioritised with immediate and specific management actions in their catchments.

7.2 Much like wetlands, the Waikato Region possess a large and diverse set of lakes including 96 lakes greater than 1 ha in size. Seventy one of these are shallow lakes with a maximum depth of 10m or less. Fifty nine lakes have been identified within the bounds of PC 1and have been classified into peat (35), riverine (15), volcanic (5) and dune (4).

7.3 The water quality of the lakes in the Waikato Region is of concern. A key cause of the decline in water quality is the increase in nutrients entering lakes due to land use practices. The decline in water quality has seen a concomitant decrease in biodiversity (Vant and Jenkins 2016). Most of the shallow lakes in the Region have gone through trophic shifts from clear-water macrophyte to turbid algal dominated systems, although a small proportion of lakes still maintain high degrees natural character. The Waikato's shallow lakes provide a significant resource in terms of game bird hunting opportunities and habitat.

7.4 Factors that have been identified as contributing to the ongoing decline of Lakes in Waikato are;

- High loads of diffuse nutrient, sediment and bacteria from catchment runoff;
- Internal recycling of nutrients;
- Pest fish;

[35] At [645].

- Reduced water levels through drainage and water control structures associated with flood schemes;
- Exotic weed beds leading to oxygen depletion; and
- Removal of marginal buffers and agricultural development in lake margins.

Impacts of lake collapse on recreational hunting opportunity

7.5 An example of how changes in lake ecosystem health can impact on the availability of recreational game bird species can be seen at Lake Whangapae. Lake Whangape is the second largest (1450ha) shallow riverine lake in the Waikato Region and was one of the last lakes of its type in the Waikato to exhibit complete macrophyte collapse. Up until recently Lake Whangape was one of only 5 lakes identified as and 'outstanding water body' in the Region, the only Riverine lake to afford such status, with the remainder being dune or peat lakes (Taylor 2004).

7.6 In 1982 Lake Whangape was the only large lake in the lower Waikato basin that still supported extensive aquatic plant beds. It was observed to have good water quality with low concentrations of suspended sediment, total phosphorous and chlorophyll *a*, although occasional algal scums were observed on the water surface (Boswell et al.1985). Since that time nutrient, sediment and phytoplankton concentrations have continued to increase with concomitant reductions in water clarity. Between 1985 and 2004 complete aquatic plant collapse occurred. In 2004 the lake underwent several changes in macrophyte community composition and spatial coverage due to increased eutrophication and illegal water level manipulation. The lake is now considered hypereutrophic.

7.7 An example of game bird responses to changes in lake ecosystem health can be seen with black swan at Lake Whangape. Black swan are large bodied native herbivorous game birds. They thrive in areas with abundant submerged vegetation. In the Waikato Region, black swan numbers remain healthy on the southern hydro lakes and harbours with high eel grass biomass.

7.8 Fish & Game have been monitoring black swan and paradise shelduck populations since 1984 by conducting annual trend flights. Lake Whangape historically held up 11000 swan, although 5000-6000 was a more typical number. During the monitoring period, all other riverine shallow lakes had already collapsed and Lake Whangape was the last significant habitat for swan in the Waikato Region, often responsible for more than half of the birds counted. During the 10-year period 1985-1995 when the Lake's macrophyte communities were in a state of flux, swan populations oscillated accordingly before stabilising for a short period in the early 2000s. Once final macrophyte collapse occurred in 2004, swan numbers collapsed along with it. Numbers now average less than 200. Due to the reduction in the central Waikato black swan population post the collapse of Lake Whangape, Fish & Game were required to set more restrictive regulations reducing the daily bag limit from 3 swan per hunter per day to 1.

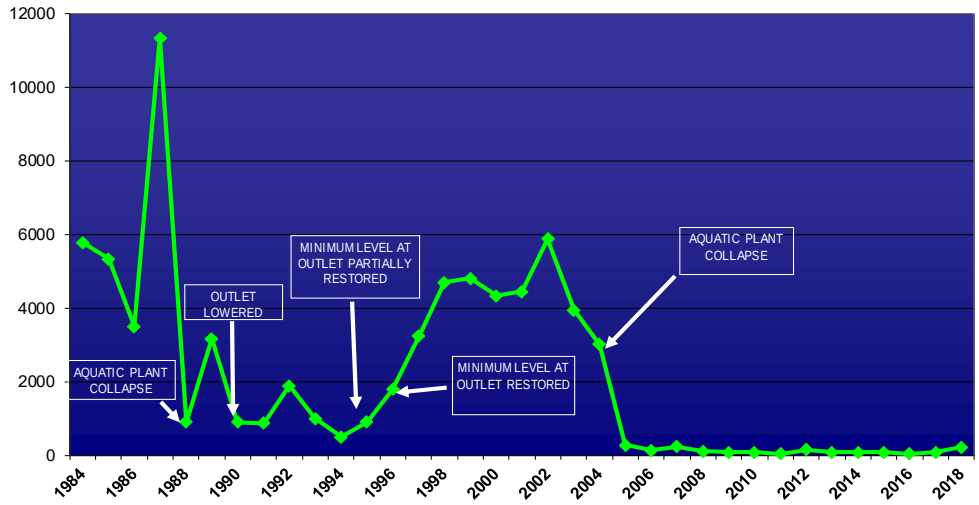

Figure 3: Black swan numbers counted on Lake Whangape during annual aerial surveys.

Shallow Lake Classification system in PC 1

7.9 In my opinion the plan fails to provide a comprehensive framework for managing lakes in the Waikato and Waipā catchments.

7.10 By combining shallow lakes into 4 collective management classes based purely on geomorphological and lake formation processes, individual lakes with heterogenous physical properties, water quality parameters and management needs are lumped together into a single management unit. Therefore, in my opinion PC 1 fails to recognise hydrogeomorphic features of individual lakes and specific management requirements of their catchments. The processes used to form lakes thousands of years ago have little relevance to required management actions to arrest their further decline or improve them in today's environment, so it is difficult to understand why this classification system was chosen.

7.11 Only two options were presented by the TLG to the CSG for consideration. Either all lakes were to be put into a single FMU category or lakes could be divided into 4 separate categories. Other classification systems do not appear to have been considered.

7.12 The Section 42A Report rejects the Director-General's submission requesting that each lake should have its own FMU based on the impracticalities of including every lake (as defined by the RMA) in the plan and in the absence of submitters providing a list of lakes that require their own FMUS. [36] I agree that it would be difficult, but could be achieved for the 59 known and documented natural lakes in the catchment. These lakes are well defined in several reports and documents e.g. Dean-Spiers et al. (2014). In my opinion this approach would achieve the best outcomes for lakes in the Region long-term. I am sympathetic to the view of the Officers especially given the lack of consideration lakes have had to date in the process and the limited options presented to the CSG.

7.13 Categorising lakes into classes may therefore be necessary and historically in the Waikato, lake formation has been used to do this. More recently, Ozkundakci (2015) came to the conclusions that "*despite some merit of using mode of lake formation as a classification scheme, it may be limited to specific questions and problems that require a coarse classification based on geo-morphological*

[36] At [491].

characteristics. There is currently no evidence to suggest that such a coarse classification may be suitable for defining, for example, manageable units for lake restoration approaches or assessing ecosystem health" (emphasis added).

7.14 The classification process for lakes is a multivariate problem (i.e. several lake characteristics contribute to a lake's response pattern) and cannot be solved by using a univariate approach.

7.15 By taking a holistic approach and using 14 variables that have well documented relationships with in lake bio-geochemical and ecological dynamics, multivariate statistical analysis on 73 Waikato lakes identified 12 lake classes that were significantly different in their structure and characteristics (Ozkundakci 2015). The study utilised a comprehensive dataset that has been consistently collected across a large number of Waikato lakes.

7.16 Table 1, from Ozkundaci (2015) provides and alternative classification systems for lakes in PC 1. This table highlights that lakes from the same geomorphological origin often fall into different lake classes. For the reasons outlined above, in my opinion this type of approach, based on several lake features will provide for a much more coherent and robust approach to lake classification. Using lake characteristics that are essentially fixed and cannot change significantly over management and ecological time scales, a representative long-term monitoring network can also be designed.

7.17 **Table 1:** Summary table listing the lake class memberships of 73 lakes used in the present analysis. Historically used lake typology of each lake is denoted in parentheses. (From Ozkundakci 2015)

Lake class	Lake name (historically used lake type)
1	Blue (volcanic), Lower Tama (volcanic), Upper Tama (volcanic), Taharoa (dune), Rotokawa (geothermal), Orotu (volcanic), Ngapouri (volcanic), Ngahewa (volcanic), Rotongaio (volcanic), Rotowhero (geothermal)
2	Rotongaro (riverine), Rotokawau (peat), Rotongaroti (riverine)

3	Cameron (peat), Patake (peat)
4	Kainui (peat), Koromatua (peat), Mangahia (peat), Whakatangi (peat), Ohinewai (riverine), Kaituna (peat), C (peat), Maratoto (peat), Okowhao (riverine)
5	Rotokauri (peat), Kopuera (riverine), Rotoroa Hamilton (peat), Kimihia (riverine), Hakanoa (riverine), Ngaroto (peat)
6	Waiwhata (riverine), Rotopataka (peat), Serpentine North (peat), Okoroire (peat), Serpentine East (peat), Ngarotoiti (peat), Areare (peat), Mangakaware (peat), Serpentine West (peat), Rotomanuka (peat), Ruatuna (peat), Hotoananga (peat), Tunawhakaheke (peat), Pikopiko (peat), Waiwhakareke(peat)
7	Tutaeinanga (volcanic), Rotokura (volcanic), Whangioterangi(geothermal)
8	Numiti (dune), Rotongata (peat), Harihari (dune), Rotoroa Kawhia (dune)
9	Parangi (dune), Otamatearoa (dune), Puketi (dune), Rotokotuku (peat), Rototapu (dune)
10	Waahi (riverine), Waikare (riverine), Whangape (riverine)
11	Arapuni (hydro), Maraetai (hydro), Karapiro (hydro), Waipapa (hydro), Aratiatia (hydro), Ohakuri (hydro), Atiamuri (hydro), Whakamaru (hydro)
12	Rotopounamu (vocanic), Hinemaiaia (hydro), Kuratau (hydro)

Targets for Lake FMUS

7.18 The proposed long-term attributes chosen for the 4 different lake FMU classes are currently set at NPSFM bottom lines for chlorophyll, TN, TP and Cyanobacteria. Proposed PC 1 does require that there is no further decline in water quality, but for lakes that currently exceed these bottom line values it does not require any further improvement over an 80-year timeframe. This sets the bar very low and it is difficult to reconcile how the proposed attributes will achieve the Vision and Strategy.

7.19 The Section 42A Report cites[37] the Section 32 Report[38] and highlights the complex nature of restoring lakes and the size of the task to

[37] Paragraph 627, page 111 of Section 42A Report.
[38] Section 32 Report pages 68 and 69.

achieve bottom lines. I agree that in some instances, especially large, shallow hypereutrophic lakes achieving improvement will be difficult. Conversely, there are several lakes in the region that have excellent restoration potential. The proposed plan fails to capitalise on the ability to set targets for those systems that could be improved through relatively simple management actions.

7.20 PC 1 fails to leverage off pre-existing information that identifies ‘quick wins’ for lakes, which require the most urgent remedial actions to halt further decline. It is important to set both short and long-term targets for lakes, as there is often considerable lag between management actions being implemented and in-lake water quality improvements being realised. This is even more critical for lakes they are close to the tipping point of submerged plant collapse.

7.21 There is a significant amount of information available on several monitored lakes as outlined in Appendix H and I of the Department of Conservation’s submission that would allow realistic targets to be set for those systems. Many of these lakes already have identified management actions ready to be implemented.

7.22 The Section 42A Report does not canvas proposed short-term lake targets submitted by the Director-General or comment on lakes that are already above the proposed attributes set at NOF bottom lines. From the limited analysis on lakes in the Section 42A Report it appears the Officers reached the conclusion that improving any lakes in the short to medium term is simply too difficult.

7.23 The Director-General of Conservation has submitted amended lake attributes in Table B in Appendix I of their submission for lakes where adequate information exists and was provided to CSG. Many of these lakes have current attributes which sit above the proposed targets in the four lake FMU classes contained in the proposed plan. It is counterproductive to set targets that are worse than current state for attributes and lakes that have enough information and opportunity for improvements now. Therefore, Fish & Game support the inclusion of Table B.

7.24 The approach outlined in DOC's submission and further quantified of the evidence of Dr Ngaire Phillips allows for greater precision by identifying lakes that already have attributes above NOF bottom line and setting realistic targets that reflect their current state.

Nutrient Reduction Potential

7.25 Nutrient reduction targets that are highly achievable, could encourage improvements for lakes. Vant and Jenkins (2007) have quantified the nutrient reduction potential for 44 shallow lakes in the Waikato Region, they concluded that by simply using 'best practice' farm management an average reduction of 7% N and 18% P could be achieved. For some lakes the reduction of P is between 30-40% including some sensitive peat lakes. If other potential practices such as improved riparian management, winter feed pads and reduced winter grazing on steep slopes are implemented then average reductions would be in the order of 36% N and 39% P.

7.26 These reductions alone may be insufficient to improve the condition of some lakes, but conversely could improve the state for less degraded systems substantially over the next 80 years. This highlights the need to identify lakes on a case by case basis and set relevant achievable targets.

Improving ecosystem health of Shallow Lakes-an example

7.27 Lake Rotomanuka is a complex of two lakes, located about 12km south of Hamilton City. It is identified as a significant wetland under 3.7.7. of the WRP. The lake was formerly a single water body, but through drainage has become two separate lakes that are hydrologically linked by a 10ha wetland. Vant and Jenkins (2007) estimate that reductions of 42% TP and 49% TN are feasible through potential land management actions.

7.28 Scenario modelling has shown that a 50% reduction in external TN and TP load across the catchment moved Lake Rotomanuka's simulated NOF classification out of the bottom line (D) to a C value.

The three scenarios tested projected to establish Lake Rotomanuka at the upper end of the C-band for total nitrogen and move the median total chlorophyll *a* concentration right on the border between C and D. For status quo scenarios, outputs clearly failed to meet the national bottom line (Lehman et al. 2017).

7.29 These results indicate that for some of the Waikato's lakes it is feasible to improve water quality to the extent where they could achieve higher NOF bands over relatively short time frames providing they get adequate attention and resourcing to implement management options.

Prioritisation of lakes

7.30 PC 1 prioritises sub catchments based on degree of degradation and those with the greatest gap between current water quality and the targets receiving the most upfront attention. I understand the rationale for this approach. However, it is not appropriate for lakes.

7.31 The Section 42A Report confirms that "*one of the limitations of PC1 is that it does not take specific account of existing quality and vulnerability for subcatchments which include highest ranked lakes*"[39] and "*highly ranked or vulnerable lakes should be re-prioritised in line with section 8B of the RPS… and the technical ranking system developed by Wildlands 2011.*"[40] The Officers share concerns around the vulnerability of lakes and difficulties with restoring lakes once collapsed and have suggested a number of changes to Table 3.11.2 in order to alter 7 sub-catchments to priority 1.[41]

7.32 I support the Officers' rationale for the proposed changes and agree with the re-prioritisation in part. However, there are still several issues with the planned amendments. For example, new monitoring information has been collected on previously data-deficient lakes which has not been incorporated in the amended priorities. Two dune lakes (Puketi and Rotoiti) remain priority 3 despite both having significant submerged plant communities.

[39] At [644].
[40] At [645].
[41] At [645].

7.33 I believe that the proposed prioritisation frameworks presented in the evidence of Dr Ngaire Phillips constitutes a more logical approach, using up to date data and should be adopted. Similar to the development of lake FMUs, lake prioritisation should take a more holistic view and consider a range of variables.

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