Annexure 4: Water Quality

Introduction

[1] Dr A Snelder, Land Water People Ltd ('LWP'), was engaged by ORC, to evaluate the most up to date available data on water quality in the region and to grade each site into relevant attribute bands as designated in Appendix 2A and 2B of the NPS-FM 2020.[1] He said that this work had been undertaken for records up to June 2020 and reported on in a document entitled *State of Lake and River Water Quality in the Otago Region* which was provided by LWP to the Council in January 2021.[2]

[2] This document or report presented the results of the study but did not provide any interpretation of the results.

[3] Later in May 2021, Dr Snelder produced a second report entitled *State and Trends of River and Lake Water Quality in the Otago Region 2000–2020* authored by Ms R Ozanne, Freshwater Science Team for ORC (the 'State and Trends Report').[3] This second report describes the state and trends in water quality in rivers and lakes across Otago on a site-by-site basis relative to targets in the National Objectives Framework ('NOF') of NPS-FM 2020.[4]

[4] Note all references to the NPS-FM in this annexure are to the NPS-FM 2020.

[5] We have prepared the following edited version of the Executive Summary of the State and Trends Report as an overview of ORC's water quality monitoring

---

[1] Snelder, EiC dated 19 February 2021 at [7]-[9].
[2] Snelder, EiC dated 19 February 2021 at [7]–[9].
[3] Snelder, statement of evidence in reply dated 20 May 2021 at [4].
[4] Snelder, statement of evidence in reply dated 20 May 2021 at [6].

and sampling programme and the trends and patterns which have emerged from this programme:

The Programme

State analysis was undertaken based on water quality samples collected over a five-year period from 1 July 2015 to 30 June 2020 and compared to the five-year period 1 July 2012 to 30 June 2017, which is defined as the baseline state (NPSFM, 2020).

The water quality analysed represented 10 physico-chemical and microbiological variables and biological indicators for 124 monitoring sites in the region. The sites included ORC monitored river sites (110), NIWA monitored National River Water Quality Network (NRWQN) sites (5) and ORC monitored lake sites (9 lakes, 22 sites/depths). While all variables were evaluated for state and trends at all sites (when sufficient data was available), the State and Trends Report describes only river state and trends for the variables that specifically relate to the NPSFM 2020; chlorophyll-a, total nitrogen, total phosphorus, ammoniacal-nitrogen, nitrate, suspended fine sediment, macroinvertebrate community index (MCI), macroinvertebrate average score per metric (ASPM), dissolved reactive phosphorus and E. coli. Sites were graded as an NOF Band (A, B, C, D, and for E. coli) (for NOF Criteria) for each variable based on a comparison of the assessed state with the relevant criteria.

Trend analysis was carried out for 10-year and 20-year periods ending on 1 September 2020 for all site and water quality variable combinations that met a minimum requirement for numbers of observations.

Individual site trend estimates were aggregated, to provide an overall picture of trends for the region.

The results

> For the 10-year trend period the predominant trend direction was variable by water quality analyte[5] but the 20-year trends were predominantly degrading for all variables apart from ammoniacal nitrogen.
>
> The most obvious pattern associated with the assessment of water quality state was that almost all sites passed the NOF criteria for ammoniacal-N toxicity and nitrate toxicity. There were obvious spatial patterns associated with the variation in grades, with water quality being best at river and stream reaches located at high or mountainous elevations under predominantly native cover. These sites tend to be associated with the upper catchments of larger rivers (e.g. Clutha River/Matau-Au) and the outlets from large lakes (e.g. Hawea, Wakatipu and Wanaka).
>
> Water quality is generally poorer at sites located on smaller, low-elevation streams that drain pastoral or urban catchments.
>
> *The trends*
>
> There is a lack of detailed information held by ORC on local or catchment scale land use change or land management practice changes. This severely limits ORC's ability to comment on drivers of trends evident across Otago. This is likely to be addressed by requirements in the NPSFM 2020, which requires that freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

[6] With respect to attribute states and bands of water quality, the report describes these in the following terms:[6]

> …. the NOF in NPS-FM 2020 defines categorical numeric attribute states in four (or five) attribute bands designated A to D (or A to E, in the case of the E. coli attribute). These bands represent a graduated range of support for environmental values from high (A band) to low (D or E band). For most attributes, the D band represents a condition that is unacceptable (with the threshold between the C and the D band being referred to as 'bottom line') in any waterbody nationally. In the

---

[5] An analyte is a substance or chemical constituent which is of interest in an analytical procedure.
[6] State and Trends Report at [4.1.1].

> case of the NO_3N (toxicity) and NH_4N (toxicity) attributes in the NPS-FM, the C band is unacceptable, and for the DRP attribute, no bottom line is specified.
>
> The primary aim of the attribute bands is as a basis for objective setting as part of the NOF process. The attribute bands are intended to be simple shorthand for communities and decision makers to discuss options and aspirations for acceptable water quality and to define objectives. Attribute bands avoid the need to discuss objectives in terms of technically complicated numeric attribute states and associated numeric ranges. Each band is associated with a narrative description of the outcomes for values that can be expected if that attribute band is chosen as the objective. However, it is also logical to use attribute bands to provide a grading of the current state of water quality; either as a starting point for objective setting or to track progress toward objectives.

[7] The water quality monitoring took account of a range of factors. These include the degree to which the attribute states can be measured with precision, the effects of variability in river flows, seasonal variations, whether trend assessments are adequately distributed over time, and the use of statistical models for determining trends and trend rates.

[8] Nine confidence levels were used to describe trends for improving water quality ranging from *"virtually certain"* (to improve) to "*exceptionally unlikely*" (to improve).[7]

[9] Localised information on water quality, trends and patterns was provided for each of the Freshwater Management Units ('FMU's) established by ORC across the region. These FMUs give effect to NPS-FM 2020 and incorporate the concept of ki uta ki tai (from the mountains to the sea).[8]

[10] There are five FMUs, Clutha/Mata-Au, Taieri, North Otago, Dunedin Coastal and Catlins. The Clutha/Mata-Au FMU has been divided into five sub-

---

[7] State and Trends Report at [4.2.12 Table 2].
[8] State and Trends Report at [2.2].

areas, or 'rohe', for a more tailored water management approach in these areas identified as the Upper Lakes rohe, Dunstan rohe, Manuherekia rohe, Roxburgh rohe and Lower Clutha rohe.

[11] What follows are our synopses of the report's findings on water quality and trends in each of the FMUs/rohe.

Upper Lakes rohe[9]

[12] For the majority of sites in this rohe, water quality is excellent and is the best in Otago.

[13] The exceptions are at Bullock Creek (an urban stream running through Wanaka township) where periphyton and bacterial water quality are below the national bottom line and in the Rees, Makarora and Quartz creeks where localised bacterial water quality is below the national bottom line.

[14] Trend analyses for rivers in this rohe show an "*exceptionally unlikely*" improving trend for NH_4N and nitrate (measured as NNN) toxicity in the Matukituki River and a "*virtually certain*" improving trend for total phosphorous ('TP') in the Dart and Matukituki rivers.

Dunstan rohe[10]

[15] For the majority of sites in this rohe, water quality is excellent.

[16] The Cardrona River has "*exceptionally unlikely*" or "*extremely unlikely*" improving trends for *E.coli*, total nitrogen ('TN'), NNN, and Semi-Quantitative Macroinvertebrate Community Index ('SQMCI') with similar trend assessments applying to turbidity in Mill Creek, Luggate Creek and the Kawarau and NNN in Luggate Creek. The NNN trend for the Cardrona River is identified as possibly

---

[9] State and Trends Report at [49].
[10] State and Trends Report at [59] and [60].

being linked to increasingly intensive land use associated with irrigation in the lower Cardrona. Mill Creek has improving trends in dissolved reactive phosphorous ('DRP'), *E.coli*, NNN, TN and TP. The report notes that the reasons for these trends have been difficult to assess in the absence of accurate information on changes in land use and land management practices around the river.

Manuherekia rohe[11]

[17] For the Manuherekia River, while water quality is excellent for all attributes measured above Falls Dam, bacterial water quality deteriorates downstream of the dam to below the national bottom line at Ophir and Galloway. Bacterial water quality is also below the national bottom line at all tributary sites (Hills Creek, Thomsons Creek and the Poolburn) with Thomsons Creek and Poolburn also having poor water quality below the NPS-FM bottom line across all attribute states other than toxicity. The poor water quality in Thomsons Creek is likely to be replicated in all creeks originating in the Dunstan Mountains as these tributaries flow over productive farmland towards the Manuherekia.

[18] In terms of trends, there are a number of sites in tributaries in this rohe which have degrading water quality below the national bottom line which, when combined, are likely to be contributing to the degrading trends in the main stem of the Manuherekia.

[19] Dunstan Creek also has degrading trends for *E.coli*, NNN and turbidity and Ophir has an "*exceptionally unlikely*" improving trend for *E.coli*.

[11] State and Trends Report at [69].

Roxburgh rohe[12]

[20] For the majority of sites in this rohe, water quality is good with the NPS-FM's A band being achieved for most attributes.

[21] Suspended fine sediment is below the national bottom line in the Teviot and Benger Burn, most likely due to the input of sediment into these waterways from wind-driven wave resuspension at Lake Onslow.

[22] Given that climatic conditions are unlikely to change to any extent, there is an "*exceptionally unlikely*" improving trend for the Lake Onslow generated sediment in these waterways.

Lower Clutha rohe[13]

[23] In this rohe, there is generally poor water clarity and high bacteria and nutrient concentrations.

[24] Attributes below the national bottom line are *E.coli* at 12 of the 15 monitoring sites, suspended solids at 7 of the sites and DRP at 4 of the sites. Lovells Creek which flows into Lake Tuakitoto (a large freshwater wetland) scores poorly across all attribute states reflecting intensively grazed pasture with some scrub and plantation forestry. The lake itself also scores below the national bottom line for TP, TN and phytoplankton, with this unlikely to improve as the lake is shallow with poor flushing flows.

[25] In the Pomohaka catchment, bacterial water quality is severely degraded at all monitoring sites other than the lower Waipahi. The Heriot Burn, Crookston Burn, Waiwera River and Waipahi at Cairns Peak each have a range of attributes

---

[12] State and Trends Report at [76].
[13] State and Trends Report at [86] and [87].

which score below the national bottom line and all contribute to the degradation of the downstream main stem of the Pomohaka.

[26] On a positive note, ORC has been working with local groups to improve bacterial water quality with the aim under Plan Change 6AA to strengthen provisions for farm effluent management.[14]

[27] Over the last 10 years there have been far fewer degrading trends compared with the longer 20-year term in this FMU. The Heriot Burn has a "*virtually certain"* improving trend for *E.coli* and TN, the Wairuna "*virtually certain*" improvements in NH_4-N and DRP and the lower Pomohaka "*virtually certain*" improvements in DRP.

[28] On the other hand, the Waitahuna continues to have degrading trends for a range of attributes.

The Taieri FMU[15]

[29] The water quality in this FMU is generally good with the exception of DRP and periphyton. Notwithstanding this overall position, the tributaries in the Lower Taieri have some of the poorest water quality in the region with five sites failing to meet the national bottom line for *E.coli* and the Owhiro Stream having the worst level of compliance with NOF attribute states for any site in the FMU. This small stream flows across the Taieri plains where there are intensive areas of agriculture. Lake Waihola is also an eutrophic lake with attribute bands consistent with this condition.

---

[14] See comment below about the implementation of this plan change having been delayed.
[15] State and Trends Report at [98] and [99].

[30] While there have been improvements in attribute trends for some rivers (Stonehenge and Waipata) in this FMU, there are degrading trends for a number of waterways, particularly in the Lower Taeiri at Outram.

Dunedin Coast FMU[16]

[31] In this FMU, the Kaikorai Stream has an ammonia toxicity band below the national bottom line, the only site in Otago at this level. *E.coli* is below the national bottom line in seven of the eight sites monitored, as is TN at four of the sites. Bacterial water quality is severely degraded at all sites other than the Waitati River.

[32] Over the last 10 years, the trend analysis in this FMU has been for more improving trends than degrading trends.

North Otago FMU[17]

[33] For the North Otago FMU, all sites other than the Kauru and Upper Shag have at least one attribute below the national bottom line. For the 16 monitored sites, four have "D" bands for DRP, eight "D" bands for *E.coli* and four "D" bands for periphyton. MCI is mainly in the "C" or "D" bands. Oamaru Creek (an urban stream) has the most "D" bands with the Waiareka and Awamoko Creeks also having mainly "D" bands.

[34] We have noted what appears to be an apparent inconsistency between the trend information provided in the text of the report for this FMU and what is stated in the Summary. The text states that there have been many "*exceptionally unlikely*" improving trends over the 10 and 20 year periods, including the Clifton Falls (*E.coli*), Waianakarua (*E.coli*, NNN and TN) and Waiareka Creek (DRP and TP). Conversely, the summary states that there have been fewer degrading trends for rivers in this FMU over the last 10 years compared with the last 20 years with

---

[16] State and Trends Report at [107].
[17] State and Trends Report at [116].

the Waianakarua having three "*extremely likely*" or "*exceptionally unlikely*" improving trends.

Catlins FMU[18]

[35] While the Catlins FMU could be expected to have good water quality because of the intact nature of the headwaters and native vegetation, cleared valleys allow intensive farming activities. Bacterial water quality is degraded in the Owaka and Tahakopa rivers.

[36] There have been no degrading trends over the last 10 years with three "*extremely likely"* or "*very likely*" improving trends in the same period listed for NH_4N, DRP and turbidity.

Otago Region as a whole[19]

[37] There are 46 sites at rivers across the region where attributes do not meet the NPS-FM bottom line for *E.coli*, 40 sites which do not meet the NPS-FM bottom line for suspended fine sediment and 14 sites where DRP is in band "D". In addition, there are 25 sites (for TN) and 23 sites (for DRP) which are elevated above the 20% exceedance criteria in the MfE guidance criteria for managing NPS-FM periphyton attribute states in rivers.

[38] The 20 year trends across the region are predominantly degrading for all variables apart from ammoniacal nitrogen, while the predominant trend in the 10 year trend period varies depending on the water quality attribute.[20]

---

[18] State and Trends Report at [122].
[19] State and Trends Report at [123].
[20] State and Trends Report at [15.2].

Other Evidence

[39] As one the witnesses who gave evidence on water quality, Dr D Olsen for OWRUG was critical of the water quality analysis in the Skelton Report claiming this to be fragmentary and in some cases inaccurate.[21] He did not comment, however, in his written evidence on either the *State of Lake and River Water Quality in the Otago Region* report or the State and Trends Report as they had not been produced at the time he filed this evidence.

[40] However, when questioned during the hearing on the reports which he had read subsequently, he said that he did not agree with the State and Trends Report in that ORC did not have information available to explain environmental issues in the region, their locations and their causes. He said from his time working for the Regional Council, he was aware that there was a land cover database which could have been used to identify the effects on attribute states from changes in land use. Catchment studies had also been undertaken at that time to try and understand the consequences of land use changes.[22]

[41] Dr Olsen said that this information would have assisted with the interpretation of the drivers of the analytics in the two reports. For example, he said that there were reasons to explain why there were low attribute states in a number of the waterways referred to in the reports. These included Bullock Creek in Wanaka (which is an urban stream) and Thomsons Creek and Hills Creek in the Manuherekia rohe (where positive trends could be expected following the progressive conversion to spray irrigation in their catchments).[23]

---

[21] Olsen, EiC at [58].
[22] Transcript Dunedin WKS 1-3 (Olsen) at 1239 and 1240.
[23] Transcript Dunedin WKS 1-3 (Olsen) at 1242.

[42] Having said this, he agreed with Mr Maw that conversions did not automatically mean improved quality in water courses as these were often accompanied by intensification in land use.[24]

[43] He agreed also that while there was a connection between the use of water and the water quality in the receiving water bodies, this relationship could be complicated which made the development of rules to manage the relationship quite complex. When asked if he considered that there was sufficient scientific information available to meet the December 2023 deadline for the new land and water plan, he said that there should be although he qualified this by saying that, as he had not been employed by the Regional Council for around three years, he could not be sure.

[44] Dr Olsen agreed with the court that the work to develop specific water quality attribute limits to give effect to the NPS-FM was yet to be done.[25]

[45] He confirmed that implementation of Plan Change 6AA had been delayed although he said that he did not know why.[26,27]

[46] When questioned on the first of the two reports by counsel for OWRUG, Dr Snelder agreed that while there were a range of attributes states which met the NPS-FM "A" band, many did not.[28] His only questioning on the State and Trends Report was from the court seeking understanding of some of the graphic representations in this report.

---

[24] Transcript Dunedin WKS 1-3 (Olsen) at 1243.

[25] Transcript Dunedin WKS 1-3 (Olsen) at 1253 and 1254.

[26] Transcript Dunedin WKS 1-3 (Olsen) at 1256 and 1257.

[27] The ORC website notes that Plan Change 6AA amends the date at which certain water plan rules controlling discharge contaminant concentrations and rules on nitrogen leaching come into force from 1 April 2020 to 1 April 2026, by which time a new Land and Water Regional Plan will supersede the current water plan rules.

[28] This questioning focused on water quality in the Manuherekia and Taieri FMUs/rohe where OWRUG's membership is primarily based.

Consideration

[47] Dr Olsen was critical of the claim made in the second report that there was a lack of detailed information held by ORC on local or catchment scale land use change or land management practice changes. We note from our reading of the State and Trends Report that it did in fact provide at least a limited explanation of the drivers for water quality issues in many of the waterways (including for example why Bullock Creek in Wanaka has low attribute states). While the report refers to a lack of *detailed* information, we did not take this to mean that ORC holds *no* information.

[48] What can be seen from the summaries we have provided for the water quality in each of the FMUs/rohe and for the Otago region as a whole, is that while there are attributes which are positive in some waterways in some of the FMUs/rohe, the negatives are more numerous than the positives.

[49] Whether the ORC holds or does not hold adequate information was debated throughout this hearing. The debate was largely disconnected from the wider question as to the purpose for which the information is to be used i.e. is it to write a new regional plan or is it to assess applications for resource consent under the RWP? We have discussed the RWP elsewhere in the decision and will not repeat what we said there. We conclude this section by echoing the findings in the executive summary of the State and Trends Report: there is (currently) a lack of detailed information held by ORC on local or catchment scale land use change or land management practice changes.