Proposal for Lake Monitoring in Tasman District

July, 2022

Part 1: Introduction

Tasman has over 80 lakes (>1Ha[1]), of which the majority are alpine lakes within national parks. Of these alpine lakes, 28 are in the northern Kahurangi National Park (with the majority of these in the upper Takaka catchment) and 20 in the Buller catchment. A full list of lakes is provided in Appendix 1.

Lake Monitoring To Date:

Investigations of water quality to date has been focused on high-profile and/or at-risk lakes including the following:

1. Lake Otuhie – >99% native forest
2. Lakes Kaihoka 1 and 2 – 95% and 90% native cover, rest in extensive sheep farming
3. Lake Killarney – 65% urban, 35% pasture
4. Lake Rotoiti – 97.8% native forest and alpine, 2% pasture and 0.1% urban.
5. Lake Matiri – 100% national park; consent application for hydro-electric power scheme (Sorrell et al, 2007) .

In addition to Lakes Otuhie, Kaihoka (x2), Rotoiti, Rotoroa and Matiri[2] have had ecological assessment, the latter three using LakeSPI values (Schallenberg et al, 2013. In: Freshwater2020, Ministry for the Environment).

The only data available is from Shallenberg 2011[3] (as part of a mult-agency monitoring exercise with Otago University, DOC and NIWA). From this one-off survey Lake Otuhie was given interim classification as mesotrophic, Kaihoka Lake 1 was on the border of oligotrophic/mesotrphic and Kaihoka 2 was eutrophic. These are one-off surveys and as such only provide an indication.

The results of model trophic level index by Fraser and Snelder[4] published in MfE/StatsNZ's Freshwater 2020 Report (see Figure 1) classed the majority lakes in the Golden Bay, West Coast and a few in the parts of Tasman District as eutrophic/poor (this includes Lakes Otuhie, Kaihoka (1 and 2)

[1] "Specified lakes" (those considered for recreational water quality values) are those that have a perimeter of 1.5km or more under the NPS-FM 2017. For lakes in general, there is not universally accepted definition about the definition of a lake versus a pond. One distinction put forward by limnologists waterbody which can have wave action on the shoreline or where wind-induced turbulence plays a major role in mixing the water column. None of these definitions completely excludes ponds and all are difficult to measure. For this reason, simple size-based definitions are increasingly used to separate ponds and lakes. Definitions for *lake* range in minimum sizes for a body of water from 2 hectares (Williams et al 2004 and Moss et al 1996) to 8 hectares (Ramsar 2009). The term *lake* is also used to describe a feature which is a dry basin most of the time but may become filled under seasonal conditions of heavy rainfall.

[2] Assessment of Environmental Effects and consent monitoring for the HydroElectric Power Scheme now being built by Pioneer Energy.

[3] Schallenberg, Marc. June, 2011. Ecological Values and Condition of the Kaihoka Lakes and Lake Otuhie, Northwest Nelson. Otago University. Prepared for Tasman District Council.

[4] Fraser, C and Snelder, M. March, 2019. Spatial modelling of lake water quality state Incorporating monitoring data for the period 2013 to 2019.

and Matiri). However, both lakes Rotoroa and Rotoiti are in the “Excellent” class. The report accompaning the model says “Because of the limited number of lakes in the dataset used to develop the models, the models may have over-predicted in lowland areas with native catchments e.g., West Coast South Island”. And “The predictions are uncertain at the lake-scale and actual data should be used in preference to the modelled predictions when evaluating individual lakes”.

Figure 1a: Lake trophic level index (TLI3) for north-west part of Tasman District indicating the health of a lake based on concentrations total nitrogen, total phosphorus and chlorophyll-a (Freshwater 2020, Fraser and Snelder).

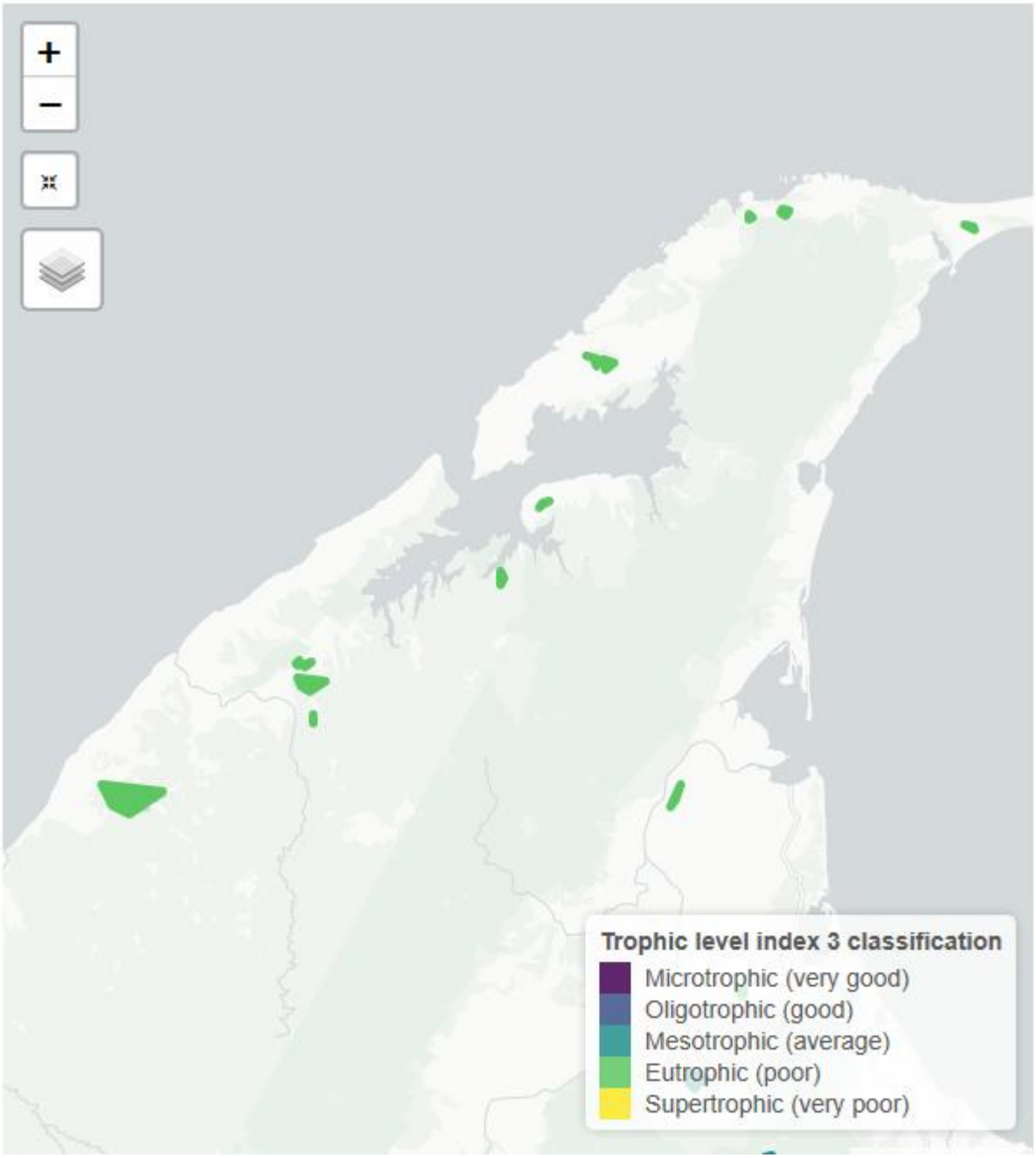
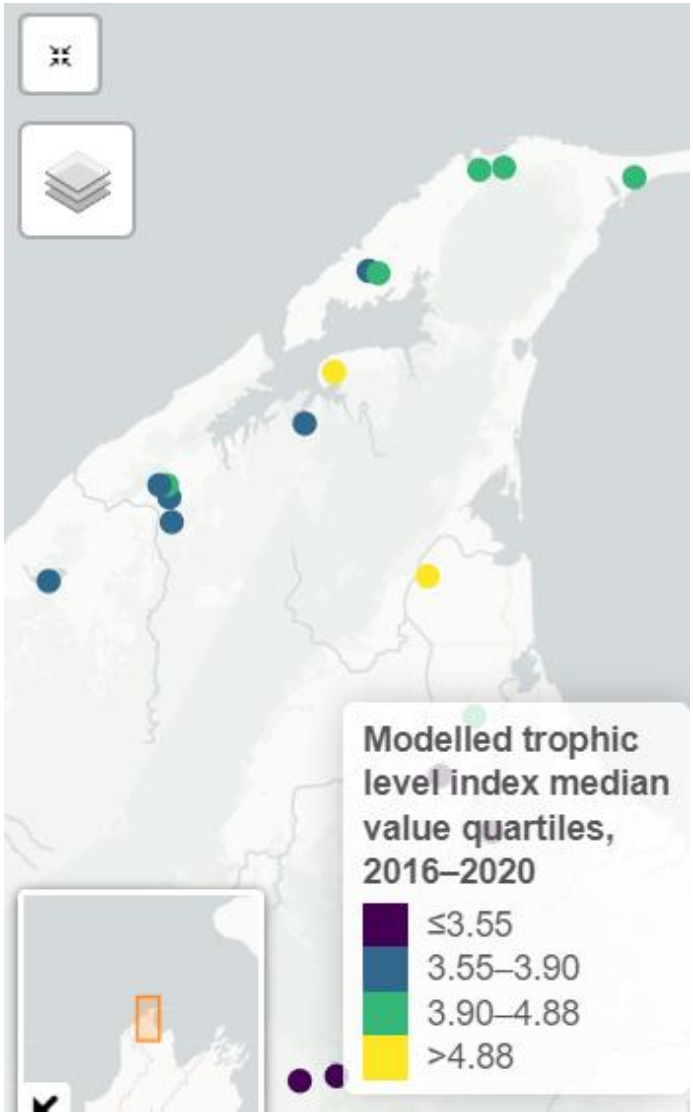


Figure 1b: Lake trophic level index (TLI3) for north-west part of Tasman District indicating the health of a lake based on concentrations total nitrogen, total phosphorus and chlorophyll-a (MfE/StatsNZ 2022).



Part 2: Proposed Monitoring Programme

2.1 Objective:

The over-arching objective of this programme is **to assess the state of water quality at-risk lakes** and **provide data to inform lake water quality remediation** where needed in Tasman District. This is likely to be done by undertaking sufficient monitoring to feed into modelling. Given the current risk to Tasman's lakes, it is unlikely that on-going long-term sampling for trends is necessary.

2.2 Network Design:

2.2.1 Site selection for water quality sampling is based on the following criteria:

1. **Risk to water quality/ecology** – this based on pressure (land use and land cover) ie the higher percentage of pasture or urban in the catchment of the lake, the higher the risk. Some consideration was given to the model output published in Freshwater 2020 by MfE (Fraser and Snelder, 2019) ie if the model described the lake as eutrophic or in higher bands for chlorophyl-a or total nitrogen.
2. **Size** – generally only lakes >1 Ha were included. Lake Killarney is an exception to this being slightly under this cut off (0.8 Ha) as it is a high profile and has suffered a decline in water quality.
3. **The lake is natural (not dammed) <u>and</u> within public land**. This is because Council's primary responsbility is for managing public resources. Even though lakes such as the Cobb Reservoir are artificial, they have such high recreational use they were considered.

Table 1. List of candidate lakes for monitoring ranked from highest to lowest risk to water quality (this risk is mostly on the basis of proportion of pasture cover in the catchment):

	Lake[5]	Area (Ha)	Pasture cover %	Algal blooms evident[6]	Comment
1	Lower Aorere – old river channel	4.5	85	No	
2	Base of Farewell Spit	0.9	80	Yes	
3	Dune Lake (Whahariki East)	2.9	80	Yes	History of cattle access
4	Island Lake (Whahariki West)	2.1	70	No	
5	Sinkhole near Stoney Creek, Craigieburn Farm	1.5	70	Yes	catchment area likely to be very small
6	Hudson St, Rakopi	1.3	50	Yes	
7	Sinkhole at end of Long Plain Road[7]	1.1	45	Yes	
8	Killarney[8]	0.8	35	Yes	Supertrophic, algal blooms
9	Kaihoka Lake 2	6.8	33	No	Higher risk than K1 and much higher Chl-a
10	Kaihoka Lake 1	5.3	30	No	Low cost to sample this along with K2
11	Lake Mangarakau				
12	Otuhie[9]	85	0	No	A few cattle grazed under tall scrub

[5] Locations listed in Appendix 2.
[6] From aerial photos
[7] There is smaller sinkhole lake nearby that is very much smaller and with 100% pasture cover in the catchment. We could take a few samples on occasion while samplers are there.
[8] This lake is unusual having 65% urban land cover
[9] It would to include this as a useful 'calibration' of the model as there are few or no lakes of this type in the programme. It's catchment is essentially 100 covered in native bush, but the model assessed it as eutrophic.

All these lakes happen to be in Golden Bay. There was no deliberate attempt to consolidate monitoring effort to one part of the district.

Reasons for <u>exclusions</u> of lakes on this list:

- **Lake Rotoiti** – the only real risk to this lake other than pest plants/algae is from contamination from Black Valley Stream, the major input from an urban area to the lake. As urban development increases there will be an increasing need to reinstate some level of monitoring of this stream. Testing of sewer connections is probably wise, given the number of cross connections that happen.
- **Lake Rotoroa** – the risk could be described as extremely low. Any contamination from leakage from septic tanks from the batches around the outlet and the very small amount of runoff from extensive farmland feeds into McCaa Stream would be quickly swept downstream into the Gowan River.
- **Cobb Reservoir** - very little threat to that apart from wastewater from a few batches.
- **Teetotal lake** – this lake has public access and recreational values. It is artificial. Department of Conservation allows a very limited number of stock to graze in a little part of the lake's catchment.
- **Lake Rototai** is also really small 0.6 Ha, with very little farmland and is a very odd one with very low acidity, so it can't be a good control for Killarney. A recent subdivision consent restricts farming activity around the lake.
- **Artificial ponds/lakes in the Moutere Hill country** - There are a very large number these ponds/lakes that may collectively have an impact on waterways downstream (particularly water temperature, dissolved oxygen and nutrients). Monitoring of those lakes would require at least 10-20 lakes to be representative. This would be a study in itself.

2.2.2 Ecological monitoring:

This would involve the LakeSPI protocols. This would involve a more limited set of lakes as it is very expensive (needs a consultant, divers, at least 4 people, 10+ hours for one lake).

Comments from Waikato RC:

Network Design: Depends on what you are trying to achieve. Having a clear objective for your water quality monitoring program, makes site selection process easier. We have now implemented a probabilistic spatially balanced monitoring network. For this approach, we gave every lake in the region an equal probablity to be included in the network. This resulted in an unbiased network.

It is important to have reference sites in your monitoring network. There is a general paucity of lake reference sites across the country, and often results in a biased assessment in the the SOE reports towards more degraded lakes. Also, it is useful to benchmark long-term trends of degraded (or at risk) sites to reference sites.

2.3 Attributes:

Below are the parameters used for water quality in the modelling by Ministry for the Environment. The TLI is calculated from all the variables listed in the table below except ammoniacal nitrogen.

Variable type	Variable	Abbreviation	Units
Physical	Secchi depth	SECCHI	m
Chemical	Total nitrogen	TN	g m^{-3}
	Total phosphorus	TP	g m^{-3}
	Ammoniacal nitrogen	NH4N	g m^{-3}
Phytoplankton	Chlorophyll *a*	CHLA	g m^{-3}
Water quality index	Trophic Level Index	TLI3	unitless

Advice for Monitoring of Shallow lakes (from Environment Southland):

- Don't necessarily need to follow the full national protocol (Burns et al), but do profiling and deploy continuous water quality meters to confirm whether the water column in well mixed all year round in these lakes. (Continuous sensors can be rotated across shallow lakes on an annual basis).
- Take a surface and bottom measurements with the water quality meter but only collect surface water samples to send to the lab.
- Consider water level sensors in all the shallow lakes to get a better understanding of lake volume to do some box modelling to predict water quality under particular inflow conditions.
- Monitor small inflows.

2.4 Number of samples:

Lake water quality modelling as reported by Ministry for the Environment/StatsNZ in April 2020 required at least eight samples over a five year period.

Comments about sampling frequency from Deniz Ozkundakci from Waikato RC:

The modelling approach Waikato RC have taken is to calculate historical and current TLI values for a large set of NZ lakes. We have spent a lot of time with the uncertainty analysis, which you may find useful.

Monthly monitoring is often not enough to fully evaluate the state of the lake, especially in smaller shallow lakes.

Caution against using model requirements to determine sample size (and sampling frequency). The Fraser and Snelder model number '8 samples in a 5 year period is absolutely arbitrary, which is

barely two samples a year. This will not give you any meaningful information from a policy point of view (ie NPS-FM guidance).

What would your approach to sampling be in this situation with a limited budget? I have attached two draft memos and a slide show that I presented to our monitoring people. In these two memos, I have calcualted the required annual samples size for lake water quality monitoring and the required number of monitored lakes to meet our policy monitoring requirements.

Would you consider doing LakeSPI? What is the cost of this? We are only doing LakeSPI sporatically. A lot of our lakes are de-vegetated anyway. These are expensive. We pay c. $3000-5000 per lake, depending on travel time and overnight trips. NIWA is the only provider at the moment.

West Coast RC are considering sampling four times total: once in late summer (highest risk time with lakes that may stratify) then late autumn just after mixing occurs at stratified lakes. Repeat over two years. They would only do LakeSPI as a one off exercise given the expense, and only then where there is very good justification.

2.5 Budget:

2.5.1 Water quality monitoring:

Total cost using a consultant **$92k.** Bi-monthly sampling for 2 years (12 sets of samples) using modified Burns protocol for a year at 11 sites (see list above). If a Council monitoring officer or summer student could be used for all of this work the cost would be $62k. This includes lab analysis but not reporting.

Requires a non-motorised boat, 2 people and some specialized equipment (eg van Dorn samplers, secchi disc).

Total cost based on: 4 days (36.5 hours) of field work/round for 2 personnel = (experienced consultant technician @ $120/hour ($4380/round) + $70/hour for support person ($2555/round)). This includes: sampling time 27.5 hours (2.5 hours/lake), 7 hours driving per round, 2 hours prep and dispatch to lab; Sample analysis **$8k**.

The average cost of one sampling event per lake for Waikato Regional Council is about $1k/day ($12k/year). This is based on 2 council staff for 8 hours @ $40/hr, 100km @ 50c/km, cost of motorized vessel running, lab sample analysis (but no data analysis). Bases on 11 sites and 12 sampling events, this would equate to a total cost of $132,000.

Reporting costs could be **$15k**. 12 days x $150/hour.

2.5.2 LakeSPI sampling at the above sites. In the order of $5k per lake[10].

Notes: West Coast RC (Jonny Horrox) have experience and have offered to join forces. They have an Exo-sonde (with Chl-a probe), van dorn sampler etc and have offerred to loan it to us. Many West Coast lakes are very similar to those in Golden Bay/NW Nelson coast. Jonny really supports Lake SPI,

[10] Waikato Regional Council quotes $3-5k, depending on travel time and overnight expenses.

but has stated that its beyond their budget. Lake SPI is good in that it only needs doing once every few years.

3.0 References:

Fraser, C; and Snelder, T. March, 2019. Spatial Modelling of Lake Water Quality State – Incorporating Monitoring Data from 2013 to 2017. Land Water People Ltd.

Moss, Brian; Johnes, Penny; Phillips, Geoffrey (1996). "The monitoring of ecological quality and the classification of standing waters in temperate regions". *Biological Reviews*. **71** (2): 301–339. doi:10.1111/j.1469-185X.1996.tb00750.x. Archived from the original on 2013-01-05.

Ramsar "Information Sheet on Ramsar Wetlands (RIS)". Ramsar Convention on Wetlands. Archived from the original on March 4, 2009.

Schallenberg M, De Winton M, Verburg P, Kelly D, Hamill K, & Hamilton D (2013). Ecosystem Services of Lakes. In J Dymond (Ed), Ecosystem services in New Zealand – Conditions and trends (pp203–225). Lincoln, New Zealand: Manaaki Whenua Press. 203–225.

Sorrell B, Phillips N, Wells R, Sykes J 2007. Lake Matiri assessment prepared for New Zealand Energy NIWA Client Report: CHC2007-089. 35 p

*Williams, Penny; Whitfield, Mericia; Biggs, Jeremy; Bray, Simon; Fox, Gill; Nicolet, Pascale; Sear, David (2004). "Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England" (PDF). Biological Conservation. **115** (2): 329–341. doi:10.1016/S0006-3207(03)00153-8. Archived from the original (PDF) on 2011-09-12.*

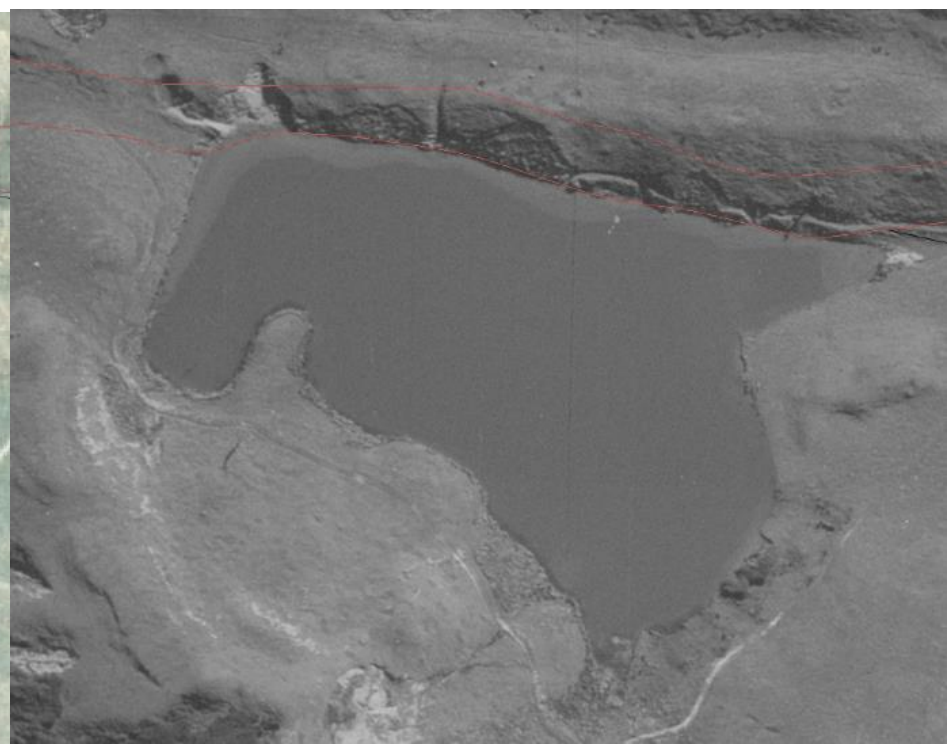
Appendix 1: Images of Dune Lake, Whahariki over time

Jan-Mar 2019 (Source: ET2 Tasman District Council)

Dec 2015 (Source: ET2 Tasman District Council)

Nov 2004 (Source: ET2 Tasman District Council)

1940's (Source: ET2 Tasman District Council). Note: erosion in the catchment



21 October, 2019 (Source: Google Earth)

4 April, 2019 (Source: Google Earth)

28 March, 2019 (Source: Google Earth)

22 September, 2018 (Source: Google Earth)

2 November, 2004 (Source: Google Earth)

Appendix 2: Key Stats about Lakes in Tasman. From FENZ (c/- Susie Wood, Cawthron).

NAME	Catchment	East NZMG	North NZMG	GEOMORPHIC Class	Max Depth (m)	Lake Area (Ha)	Lake Elevation (m)	Natural cover (%)	Urban % cover	Pasture % cover	Landuse Pressure
"Mangarakau Swamp trib"	West Coast	2466576	6060568	B	8.07	1.7	29.29	0.9953	0	0	1.05
"Moutere pond1 u-s Neudorf Rd"	Moutere	2509839	5994862	D	8.36	1.0	67.77	0.3074	0	50.3	3.06
"Moutere pond2 u-s Neudorf Rd"	Moutere	2509926	5995310	D	14.84	2.7	57.07	0.3116	0	46.63	0.86
Lake Peel	Takaka	2476616	6006698	G	26.05	4.7	1353.06	0.9953	0	0	0.63
Luna Lake	Motueka	2465167	5977198	G	26.05	2.9	1229.51	0.9953	0	0	2.44
"Moran Creek trib upper"	Takaka	2476930	5988765	G	12.59	1.7	1205.88	0.9953	0	0	2.86
"Moran Creek trib lower"	Takaka	2477352	5988824	G	26.05	4.0	1174.93	0.9953	0	0	1.38
Lake Aorere	Aorere	2453877	6016369	G	27.64	7.4	1035.8	0.9953	0	0	1.60
Little Sylvester Lake	Takaka	2478447	6010606	G	18.13	7.6	1358.51	0.9953	0	0	0.24
Lake Cobb	Takaka	2469139	6016640	G	25.41	13.2	1089.26	0.9951	0	0	7.76
Camp Lake	Takaka	2470204	6014456	G	13.56	2.8	1269.77	0.9953	0	0	6.92
Iron Lake	Takaka	2477696	6011174	G	26.05	6.0	1452.52	0.9953	0	0	0.62
Lake Lillie	Takaka	2477305	6012405	G	24.75	2.3	1386.66	0.9953	0	0	0.37
Diamond Lake	Takaka	2477253	6013275	G	19.26	6.0	1235.05	0.9953	0	0	0.98
Ruby Lake	Takaka	2475082	6014363	G	27.64	3.8	1312.06	0.9953	0	0	1.03
Lake Lockett	Takaka	2478452	6014061	G	26.28	27.4	1285.44	0.9953	0	0	0.15
Cobb Reservoir	Takaka	2481051	6009403	D	106.72	237.0	808.91	0.9938	0	0	46.71
Lake Sylvester	Takaka	2478768	6011038	G	28.55	27.7	1329.03	0.9953	0	0	0.09
	Takaka	2453323	6021724	G	18.43	2.1	939.95	0.9953	0	0	31.77
	Takaka	2459373	6025847	G	27.64	1.4	1118.28	0.9731	0	0	8.70
Round Lake	Takaka	2467565	6017044	G	25.47	3.9	1294.29	0.9953	0	0	0.19
"Burgoo Stream"	Aorere	2470587	6021609	L	18.92	1.6	507.11	0.9951	0	0	4968.93
"Upper Waingaro"	Takaka	2474146	6019163	G	27.64	6.3	1273.48	0.9953	0	0	2.10
Lake Stanley	Takaka	2477217	6022089	L	38.03	73.4	761.27	0.9951	0	0	267.13
Lake Sparrow	Takaka	2477713	6025486	G	27.64	2.8	1435.45	0.9953	0	0	0.79
	Takaka	2480762	6022809	G	13.89	6.9	951.8	0.9953	0	0	286.13
Lake Lindsay	Takaka	2479354	6024523	G	18.38	5.7	1083.98	0.9953	0	0	32.54
	Takaka	2481127	6025096	G	27.64	3.4	1361.79	0.9953	0	0	0.88
Adelaide Tarn	Aorere	2471579	6029309	G	26.05	1.2	1256.27	0.9953	0	0	6.45
	Takaka	2474135	6028669	G	26.29	4.1	1113.29	0.9953	0	0	4.05
Lake Clara	Aorere	2472782	6034336	G	26.05	4.3	1342.14	0.9953	0	0	0.14
Boulder Lake	Aorere	2474487	6034587	G	13.82	44.4	981.39	0.9952	0	0	86.42
Roding Dam (NelsonCC)	Nelson	2532238	5983198	D	37.82	1.0	218.66	0.9927	0	0.34	1956.94
Lake Otuhie	West Coast	2460759	6057768	L	9.10	84.7	4.75	0.9921	0	1.29	81.02
"Tucker's Dam"	Moutere	2515027	5998779	D	12.71	1.9	42.63	0.3093	50.59	15.01	3.06
"AwaAwaRd Dam"	Moutere	2515372	5997911	D	14.74	1.6	53.59	0.3054	12.3	43.67	2.43
"Craigieburn Farm Sinkhole", Stoney Ck	Takaka	2493011	6029331	D	8.73	1.5	70.87	0.3913	0	67.91	0.00
"Lake Mangarakau"	West Coast	2466472	6061703	B	9.70	15.3	14.32	0.9953	0	0	9.29
"Mangarakau lodge lake"	West Coast	2466356	6062314	S		2.0	19.8	WETLAND			WETLAND

NAME	Catchment	East NZMG	North NZMG	GEOMORPHIC Class	Max Depth (m)	Lake Area (Ha)	Lake Elevation (m)	Natural cover (%)	Urban % cover	Pasture % cover	Landuse Pressure
"Mangarakau Dry Rd"	West Coast	2466048	6062350	B	6.39	1.6	18.36	0.9953	0	0	5.63
Druggans Dam	Aorere	2479339	6048687	D	26.71	17.3	257.57	0.9953	0	0	1.99
"Happy Valley Lake" Parapara	Aorere	2481788	6046120	R	22.46	2.0	258.43	0.9953	0	0	163.14
"Appos Creek Lake1 Aoere Goldfields	Aorere	2480861	6051565	R	25.78	1.3	76.03	0.8997	0	20.88	4.11
"Lower Aorere - Old River Channel"	Aorere	2478645	6058050	B	4.54	4.3	3.35	0.3093	0	85.72	1500.43
"Bone Creek Lake" Wanganui Inlet	Whanganui Inlet	2472796	6065238	B	7.44	4.5	9.62	0.9953	0	0	100.89
"Hudson St, Rakopi"	Whanganui Inlet	2474186	6067677	W	8.07	1.3	13.92	0.5441	0	54.35	0.00
Kaihoka Lakes	Whanganui Inlet	2475887	6072437	B	15.99	5.3	52.35	0.9491	0	29.01	1.31
Kaihoka Lakes	Whanganui Inlet	2476321	6072297	B	11.50	6.8	37.47	0.8941	0	33.6	0.72
Whaririki Lake West (Island Lake)	Whaririki	2480997	6077205	W	5.95	2.1	17.67	0.9219	0	28.71	10.56
Whaririki Lake East (Dune Lake)	Whaririki	2482182	6077371	W	8.63	2.9	37.11	0.4988	0	58.34	0.00
"Farewell Spit Base"	Farewell Spit	2488327	6076904	W	6.98	1.8	12.47	0.3244	0	82.14	1.92
"Farewell Spit 2"	Farewell Spit	2493306	6077098	W	3.61	4.0	9.33	0.9763	0	0	0.00
"Farewell Spit 3"	Farewell Spit	2493719	6076940	W	4.56	1.8	7.55	0.9938	0	0	0.00
"Farewell Spit 4"	Farewell Spit	2493590	6077821	W	3.02	1.4	17.45	0.9918	0	0	0.00
"Farewell Spit 5"	Farewell Spit	2494670	6077258	W	2.97	2.1	8.08	0.9939	0	0	0.00
Eight Mile Dam	Buller	2454909	5921927	R	19.43	4.4	422.32	0.9953	0	0	23.04
Lake Ella	Buller	2476030	5901410	G	24.66	6.0	1541.06	0.9953	0	0	0.83
"Ella Range Lake S"	Buller	2475054	5907761	G	26.05	1.8	1747.47	0.9953	0	0	0.00
"Ella Range Lake N"	Buller	2474908	5908106	G	17.49	1.1	1739.72	0.9953	0	0	0.00
"East Waiau Pass"	Buller	2482515	5901555	G	14.83	2.5	1914.8	0.9953	0	0	0.00
Lake Constance	Buller	2481977	5903451	G	25.99	88.5	1317.02	0.9953	0	0	1.62
Blue Lake	Buller	2481689	5905266	G	27.41	2.9	1190.78	0.9953	0	0	261.10
	Buller	2486963	5902131	G	27.64	3.9	1831.81	0.9953	0	0	0.09
	Buller	2484310	5907523	G	27.64	2.2	1801.43	0.9953	0	0	0.09
	Buller	2475730	5913656	G	24.66	1.1	1535	0.9953	0	0	0.24
	Buller	2457436	5928000	L	18.56	5.5	691.02	0.9953	0	0	2.84
Lake Rotoroa	Buller	2480437	5927243	G	135.90	2361.5	420.71	0.9951	0	0.06	38.38
Hinapouri Tarn	Buller	2488611	5923381	G	26.05	4.3	1598.42	0.9953	0	0	0.17
	Buller	2488921	5923600	G	25.47	1.5	1578.25	0.9953	0	0	0.79
Lake Angelus	Buller	2488917	5924452	G	21.76	19.0	1646.48	0.9953	0	0	0.02
	Buller	2489175	5924374	G	16.67	2.0	1655.18	0.9953	0	0	0.23
	Buller	2489900	5924277	G	26.05	1.4	1574.73	0.9953	0	0	0.16
	Buller	2488093	5929276	G	9.61	1.1	1009.91	0.9953	0	0	0.00
"Arnst Basin - Peanter Peak"	Buller	2496766	5922044	G	17.17	1.0	1687.15	0.9953	0	0	0.28
"Paraumu Tarn, Arnst Basin"	Buller	2497288	5922838	G	26.29	5.4	1647.36	0.9953	0	0	0.01
"4th Basin, Robert Ridge"	Buller	2491104	5925352	G	27.41	1.3	1519.69	0.9953	0	0	0.16
"4th Basin, Robert Ridge"	Buller	2491890	5926830	G	25.47	1.4	1551.68	0.9953	0	0	0.07

NAME	Catchment	East NZMG	North NZMG	GEOMORPHIC Class	Max Depth (m)	Lake Area (Ha)	Lake Elevation (m)	Natural cover (%)	Urban % cover	Pasture % cover	Landuse Pressure
"Paratitahi Tarn"	Buller	2497260	5923474	G	17.17	1.5	1668.79	0.9953	0	0	0.00
Lake Rotoiti	Buller	2496210	5930959	G	40.48	964.4	595.53	0.9935	0.12	2.11	51.71
Teetotal Pond	Buller	2494735	5936005	R	18.58	1.2	614.11	0.9920	0	6.36	0.09
Additional Lakes Not Identified by FENZ											
Lake Matiri	Buller	2454460	5949925			55.0	385	0.9950	0	0	0.00
Lake Caslani (Maruia Valley East)	Buller	2448878	5922900			2.0	300	0.9950	0	0	0.00
Long Plain Road End sinkhole1	Takaka	2489400	6032232			1.1	113	0.5500	0	45	
Long Plain Road End sinkhole2	Takaka	2489778	6032157			0.5	85	0.0000	0	100	
"Craigieburn Creek sinkhole"	Takaka	2493253	6027223			0.5	120	0.0000	0	100	
Lake Killarney	Takaka	2493818	6039365			0.8	6.5	0.0000	0.65	0.35	
Lake Rototai	Takaka	2494730	6040095			0.6	10	0.6300	0	0.37	

Artificial Lakes

Primary FENZ Class	
A	Warm, shallow, mod size
B	Warm, mod shallow, small
C	Warm, shallow, very small
D	Mild, deep, large
E	Mild, mod depth and size
F	Mild, shallow, small
G	Cool, mod shallow, small