

Healthy Rivers: Wai Ora – Monitoring of attributes and actions

Technical Leaders Group 20 June 2016

Purpose

The purpose of this document is to provide advice on the monitoring regime that may be required following implementation of the policy mix contained within the proposed Healthy Rivers: Wai Ora Plan Change. The advice is based on TLG's understanding of the current (June 7th) policy mix being recommended by CSG to council and iwi decision-makers.

Waikato Regional Council already has a freshwater State of the Environment monitoring programme. TLG has been asked to provide CSG with an assessment of whether this existing programme is broadly fit-for-purpose going forward and whether there are specific areas that WRC should consider reviewing. We thank Mr Bill Vant of the WRC for sharing his knowledge and expertise with us.

The proposed policy mix seeks to drive changes at the property scale (e.g. improving practice on farms) with the expectation that these changes in practice will be reflected in reducing contaminant losses to aquifers, rivers and lakes. Having a robust monitoring regime to track changes and actions on the land will be a critical element in monitoring the implementation and effectiveness of the proposed policy mix. CSG has asked TLG to provide recommendations on the monitoring programme for these "on-farm" actions.

Proposed Healthy Rivers Attributes

Table 1. Summary of attributes.

Value	Attribute	Freshwater Body Types applicable in Waikato-Waipā	MfE guidance on attribute monitoring ¹
Human Health	<i>E. coli</i>	Lakes, rivers & lake-fed rivers	30 samples over 3 years
	Planktonic cyanobacteria	Lakes and lake-fed rivers	30 samples over 3 years
	Water clarity	Lakes, rivers & lake-fed rivers	None
Ecosystem Health	Phytoplankton	Lakes & lake-fed rivers	Monthly sampling ²
	Total Nitrogen	Lakes & lake-fed rivers	Monthly sampling ²
	Total Phosphorus	Lakes & lake-fed rivers	Monthly sampling ²
	Nitrate	Rivers & lake-fed rivers	Monthly sampling for at least 3 years
	Ammonia	Lakes, rivers & lake-fed rivers	Monthly sampling for at least 3 years
	Dissolved oxygen	Rivers (below point sources)	Continuous monitoring during high risk periods at representative sites
Mahinga Kai	<i>E. coli</i>	Lakes, rivers & lake-fed rivers	None
	Planktonic cyanobacteria	Lakes & lake-fed rivers	None

¹ Ministry for the Environment. 2015. A Draft Guide to Attributes in Appendix 2 of the National Policy Statement for Freshwater Management 2014. Wellington: Ministry for the Environment. 43 p.

² Mfe (2015) above refers readers to monitoring protocols in Burns et al. (2000).

Monitoring of macroinvertebrates (i.e. Macroinvertebrate Community Index = MCI) at representative sites throughout the catchment has also been highlighted in CSG recommendations as an indicator of stream health but is not included as an attribute.

Whangamarino Wetland has been identified by CSG as an important freshwater ecosystem that sits within the Lower Waikato FMU. Previous advice from TLG has identified the absence of Attributes specific for wetland values.

Current Waikato Regional Council Monitoring Programme

Details of Waikato Regional Council's environmental indicators programme can be found at: <http://www.waikatoregion.govt.nz/Environment/Environmental-information/Environmental-indicators/About-indicators/Environmental-indicators-programme/>.

In relation to freshwater, WRC monitor a wide range of quality and quantity indicators for groundwater, lakes, rivers and streams, and wetlands (see <http://www.waikatoregion.govt.nz/Environment/Environmental-information/Environmental-indicators/Freshwater/>).

Rivers and streams

WRC has one of the most comprehensive river water quality monitoring programmes in the country (Fig. 1). A total of 100 regional sites (Tulagi 2015a) and 10 Waikato River main stem sites (Tulagi 2015b) are sampled monthly for a suite of water quality parameters. This monitoring network has been relatively consistent since 1993. Within the Waikato-Waipā catchment there are 62 river water quality monitoring sites (Appendix 1).

In addition to the base SoE monitoring network WRC carries out a bathing beach survey every summer, alternating between Lake Taupo and Waikato River bathing beaches (16 sites). The survey involves more frequent (weekly) sampling of *E. coli*, Enterococci and faecal coliforms between December and February (inclusive) and is used for 'alert' monitoring. This dataset has not been used in Healthy Rivers as the requirement for 'swimmability' as defined by the CSG has been for all waterways to achieve this state all year-round. Instead the monthly data on *E.coli* and clarity from the 62 long-term monitoring sites spread throughout the catchment has been used.

There are two sites (Hamilton and Tuakau) where WRC has deployed equipment to continuously measure dissolved oxygen, pH, temperature and chlorophyll *a* (Tulagi 2015b). These two sites can be used to assess dissolved oxygen state as per the NPS-FM (e.g. summertime 7-day mean minimum).

At the 10 Waikato River sites the following Attributes are monitored on a monthly basis:

- Chlorophyll *a*
- TN
- TP
- Nitrate-N
- Ammonia
- Clarity

- *E. coli*

The other 52 sites on tributaries have the same suite of indicators with the exception of chl *a*.

In general, the spatial coverage of monitoring sites and data availability has not been a constraint to describing current state and trends and to the catchment modelling carried out as part of the Healthy Rivers process. There is a reasonable coverage of monitoring sites across the four river FMUs, with 21 sites in the Upper Waikato FMU, 10 in Central Waikato, 16 in Waipa and 17 in the Lower Waikato FMU. However, there is an important gap in the monitoring network along the Waikato main stem, with no monitoring sites between Waipapa Tailrace and Narrows Bridge. This is a distance of approximately 80 km, nearly 25% of the river length between Huka Falls and Port Waikato. A monitoring site at the Lake Karapiro tailrace would address this gap and provide valuable information for catchment contaminant accounting and for monitoring plan effectiveness.

Shallow lakes

Eighteen shallow lakes have been monitored and reported on by WRC (see <http://www.waikatoregion.govt.nz/Environment/Environmental-information/Environmental-indicators/Freshwater/Lakes/lake4-techinfo/>). In addition, Hamilton City Council monitors water quality in Lake Rotoroa (Hamilton Lake). The following Attributes are routinely monitored:

- TN
- TP
- Chlorophyll *a*
- Clarity

E. coli levels are not routinely measured in WRC's lake monitoring network.

In general, bi-monthly monitoring of lakes is considered adequate (Burns et al. 2000). However, the sampling frequency applied by WRC is variable (Table 2) and an alignment of sampling frequency would make analysis and reporting more robust.

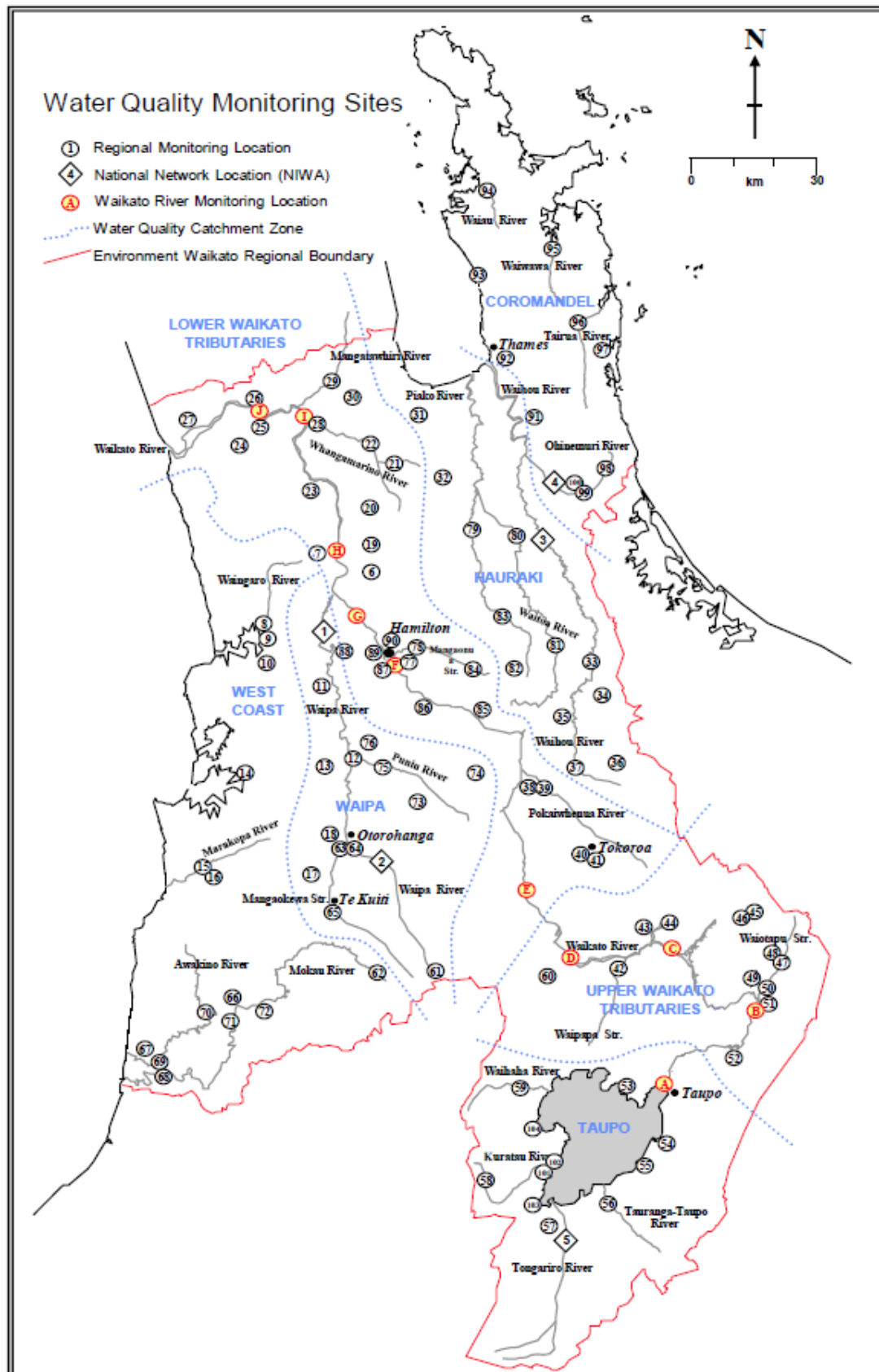


Figure 1. Map of Waikato Regional Council river water quality monitoring sites. See Appendix 1 for site names. Reproduced from Vant (2013).

Table 2. Details of WRC’s lake monitoring network. Reproduced from <http://www.waikatoregion.govt.nz/Environment/Environmental-information/Environmental-indicators/Freshwater/Lakes/lake4-techinfo/>. Note that lakes Harihari and Taharoa fall outside the Waikato-Waipā catchment.

Lake name	Frequency	Period
Horseshoe Lake	Bi-monthly	2014
Lake Areare	Bi-monthly	2014
Lake Hakanoa	Bi-monthly	2002-2014
Lake Harihari	3-6 per year	2010-2014
Lake Mangahia	2-3 per year	2010-2013
Lake Mangakaware	2-6 per year	2011-2014
Lake Maratoto	Bi-monthly	2002-2014
Lake Ngaroto	1-2 per year	2011-2013
Lake Ohinewai	2-3 per year	2010-2014
Lake Okowhao	0-3 per year	2010-2014
Lake Otamatearoa	2-3 per year	2010-2011
Lake Rotomanuka	Bi-monthly	1995-2014
Lake Rotoroa (HCC)	Bi-monthly	1995-2013
Lake Serpentine East	Bi-monthly	2002-2013
Lake Serpentine North	Bi-monthly	2002-2014
Lake Serpentine South	2-8 per year	2010-2014
Lake Taharoa	2-3 per year	2010-2012
Lake Waahi	Bi-monthly	1995-2014
Lake Waikare	Bi-monthly	1996-2014
Lake Whangape	Bi-monthly	2002-2014

In a previous report to the CSG on shallow lakes the TLG made the following observations:

- Lakes monitored by WRC are a subset of all lakes and this will always be the case given the large number of lakes in the catchment.
- Given the recommendation to have four lake FMUs (riverine, peat, volcanic, and dune) a more detailed analysis should now be undertaken by WRC on the adequacy of their current lake water quality monitoring network to represent these FMUs and the variability within them.

Cyanobacteria

WRC has carried out routine monitoring of planktonic cyanobacteria cell counts since late 2003 and biovolume since 2010. This monitoring is done in conjunction with a number of other agencies, including three municipal water supply agencies (Watercare, Hamilton City Council, and Waikato District Council).

The following sites are included in the monitoring programme. The responsible agency is given in parentheses:

- Waikato River at Ohakuri (WRC)
- Waikato River at Maraetai (WRC)
- Waikato River at Karapiro (WRC)
- Waikato River at Hamilton Gardens (Hamilton City Council)
- Waikato River at Tuakau (Watercare)
- Waikato River at Huntly (Waikato District Council)³
- Lake Hakanoa (WRC)
- Lake Ngaroto (WRC)
- Lake Rotoroa (HCC)
- Lake Waahi (WRC)
- Lake Waikare (WRC)
- Lake Whangape (WRC)

In addition, Mighty River Power monitors cyanobacteria in tailraces of lakes Ohakuri, Maraetai and Karapiro as a condition of consent.

WRC's senior water quality scientist Bill Vant indicated the multi-agency approach to cyanobacteria monitoring was not without risk, as the sharing of information and commitments to monitoring appear to be based on an informal "gentlemen's handshake". TLG agrees.

The most recent monitoring data and any current warnings can be found at:

<http://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Rivers/Waikato-River/Algal-Blooms-in-the-Waikato-region/>

Stream macroinvertebrates

Government is currently working to incorporate the Macroinvertebrate Community Index (MCI) into the NPS-FM. This could involve requiring regional councils to monitor macroinvertebrates, identify areas of poor ecosystem health and incorporate actions to improve macroinvertebrate scores in their management of land and water resources. CSG has provided a clear directive to maintain a robust regional macroinvertebrate monitoring programme. It is unclear to TLG how information from WRC's macroinvertebrate programme (see <http://www.waikatoregion.govt.nz/Environment/Environmental-information/Environmental-indicators/Freshwater/River-and-streams/riv3-keypoints/>) might be utilised in implementation of the Healthy Rivers Plan Change.

The macroinvertebrate sampling network is a combination of 40 long-term sites (10 or more years of annual data), a set of random sites selected to provide an unbiased estimate of the regional condition of streams on developed land (60 sites sampled once each year for 3 years—180 sites in total), and a set of 24, annually-sampled reference sites in undeveloped (native forest) catchments (Collier & Hamer 2012). The sites include wadeable hard-bottom streams with stony beds, and wadeable soft-bottom streams with beds dominated by sand and silt. Sampling originally spanned

³ WDC has not provided data to WRC in the last couple of years so this site may have been dropped (Bill Vant, pers. comm.).

mid-November through to March, but since 2002 all sampling has been conducted over January-March.

TLG consider the current macroinvertebrate sampling programme to be appropriate to monitor state and trends for this important indicator of Ecosystem Health, but believe further thought needs to be given to how this information can be used to target actions in the catchment in order to improve fresh water values.

Whangamarino wetland

Given the absence of any agreed attributes for wetlands, TLG is not able to provide recommendations on a suitable attribute monitoring regime for Whangamarino Wetland. We understand that a working group convened by MfE is currently working on the development of a set of attributes for wetlands for use within the NPS-FM framework. There will, of course, be continued monitoring of streams that enter the wetland as part of the river and stream monitoring network.

Monitoring change at the property scale

WRC has a long history of monitoring a range of practices on farm. For example, the Council operates a monitoring regime for farm dairy effluent. In 2014-15, WRC assessed 453 dairy farms (out of ~4400) for compliance with farm dairy effluent rules. However, the scope and scale of the Healthy Rivers plan change constitutes a very significant challenge for monitoring and reporting on a much-increased suite of practices on farms and other properties across the 1.1 million hectare catchment over the next ten years. No regional council in the country has faced an implementation challenge on the scale that WRC and its industry partners are now contemplating.

The most recent example of a large-scale catchment programme to track farmer change to meet environment objectives is the Upper Waikato Sustainable Milk Project (Brocksopp et al. 2015). This WRA and Dairy NZ co-funded project delivered Sustainable Milk Plans to 650 dairy farmers in the Upper Waikato FMU between 2012 and 2015. Nearly 6000 individual actions were implemented by farmers under this voluntary scheme. A small subset of those actions was able to be linked to reductions in contaminant losses (N and/or P) based on published literature and expert opinion. On average, farmer actions were predicted to reduce N loss at the catchment scale by 8% and P loss by 21% (Burger et al. 2015).

At the national scale the Sustainable Dairying: Water Accord provides an example of an industry scheme to monitor and report on farmer practice changes that will enhance fresh water quality. The Accord covers approximately 11,500 dairy farms and tracks performance in riparian, nutrient, effluent and water use management. In 2014-15, 75% of farmers (8600) provided detailed nutrient management information to their dairy companies so that nutrient losses could be estimated and reported.

Lessons learnt from both the Accord and the Upper Waikato Sustainable Milk Project suggest some important principles for monitoring practice change through delivery of tailored farm plans:

- The delivery of tailored property plans must start with a 1:1 conversation between the land owner and their plan advisor
- The advisor must have appropriate training in the assessment of relevant practices and the application of appropriate actions

- Every commitment by the land owner needs to be recorded, given a completion date and followed up by the advisor with the completed actions also recorded
- Commitments and completed actions should be classified into different categories so that actions resulting in reduced contaminants can be separated from “educational” or “intangible” actions (NB. All actions will contribute to behaviour change, but possibly not immediately)
- There needs to be an independent audit of completed actions to provide confidence in the data
- A methodology for converting property-scale actions into catchment reductions in contaminant losses should to be defined and agreed prior to reporting. However, it is likely that this methodology will evolve over time (e.g. with OVERSEER versions), so this evolution needs to be explicitly accounted for in the methodology.

Conclusions & Recommendations

- With the exception of an 80km stretch on the Waikato main stem from Waipapa to the Narrows, TLG considers that the existing WRC river monitoring network has a spatial coverage that is sufficient to detect state and trends in water quality and provide a robust picture of progress towards meeting freshwater objectives in the proposed plan change.
Recommendation: Establish a monitoring site at the Lake Karapiro tailrace measuring the same suite of parameters as the other Waikato River main stem sites. Adding this site would aid in catchment accounting for contaminants and improve WRC’s ability to monitor plan effectiveness.
- WRC currently undertakes weekly bathing beach surveillance monitoring over summer for *E.coli* in addition to the more extensive monthly monitoring programme used to evaluate the Human Health value as per the NPS-FM.
Recommendation: This surveillance monitoring is important for public health reasons and should be continued.
- Lakes monitoring is currently conducted on a small sub-set of lakes in the catchment and such monitoring lacks a consistent methodology. A review is required to ensure lakes monitoring is fit-for-purpose, with respect to the Healthy Rivers plan change, while remaining pragmatic.
*Recommendation: Review the adequacy of the current lake monitoring network to represent water quality state and trends across the four lake FMUs. This should include an alignment of sampling frequency and consider how *E.coli* can best be included.*
- Stream macroinvertebrates are monitored at representative sites (including reference sites) throughout the Waikato-Waipapa catchment and used as an indicator of ecosystem health.
Recommendation: Continue this macroinvertebrate monitoring and give further thought to how the monitoring results may be used to show co-benefits arising from implementation of property plans targeted at the four contaminants.
- Monitoring of planktonic cyanobacteria along the Waikato River and in shallow lakes has been defined using a risk-based approach for contact recreation. This is appropriate.

Recommendation: The multi-agency approach should have a more formal agreement put in place between the parties to protect the current monitoring regime.

- Whangamarino Wetland is not currently monitored, but the TLG is not able to make recommendations on monitoring due to the lack of defined Attributes.

Recommendation: WRC should keep a watching-brief on the national initiatives to develop a set of attributes and attribute tables for wetlands and their incorporation into the NPS-FM. At that point, studies will be required to derive a set of appropriate attribute limits for protection of Whangamarino values.

- Tailored property plans will result in a wide range of mitigations being implemented and changed practices occurring on farms. These actions will be important 'lead' indicators of the effectiveness of the plan and therefore need to be recorded and their completion verified. A methodology to estimate contaminant reductions from observed actions must be defined and agreed to enable modelling of contaminant reductions at catchment or sub-catchment scales.

Recommendation: WRC develop a central database and system for on-line entry by certified farm planners of relevant farm data, farm environment plans and implemented actions.

References

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- Vant, B. 2013. Trends in river water quality in the Waikato region, 1993-2012. Waikato Regional Council Technical Report 2013/20. 40 p.

Appendix 1. Current WRC river and lake monitoring sites in the Waikato-Waipapa catchment. Waikato River main stem sites are highlighted in ***bold italics***. Sites marked with ‘*’ are administered by NIWA as part of the National River Water Quality Network.

FMU (# of sites)	Site (letter/number relates to Fig. 1)
Upper Waikato (21)	<i>Waikato @ Taupo Gates (A)</i>
	<i>Waikato @ Ohaaki Bridge (B)</i>
	<i>Waikato @ Ohakuri tailrace (C)</i>
	<i>Waikato @ Whakamaru tailrace (D)</i>
	<i>Waikato @ Waipapa tailrace (E)</i>
	Kawaunui @ SH5 (48)
	Little Waipa @ Arapuni-Putaruru Rd (38)
	Mangaharakeke @ SH30 (43)
	Mangakara @ SH5 (49)
	Mangakino @ Sandel Rd (60)
	Mangamingi @ Paraonui Rd (40)
	Otamakokore @ Hossack Rd (46)
	Pokaiwhenua @ Arapuni-Putaruru Rd (39)
	Pueto @ Broadlands Rd (52)
	Tahunaatara @ Ohakuri Rd (44)
	Torepatutahi @ Vaile Rd (51)
	Waiotapu @ Campbell Rd (47)
	Waiotapu @ Homestead Rd (50)
	Waipapa @ Tirohanga Rd (42)
	Whakauru @ SH1 (41)
	Whirinaki @ Corbett Rd (45)
Middle Waikato (10)	<i>Waikato @ Narrows Bridge (F)</i>
	<i>Waikato @ Horotiu Bridge (G)</i>

	Karapiro @ Hickey Rd (85)
	Kirikiroa @ Tauhara Dr (90)
	Mangakotukutuku @ Peacock Rd (87)
	Mangaone @ Annebrooke Rd (77)
	Mangaonua @ Hoeka Rd (78)
	Mangaonua @ Te Miro Rd (84)
	Mangawhero @ Cambridge-Ohapo (86)
	Waitawhirwhiri @ Edgecumbe St (89)
Lower Waikato (17)	Waikato @ Huntly Bridge (H)
	Waikato @ Mercer Bridge (I)
	Waikato @ Tuakau Bridge (J)
	Awaroa @ Otua Rd (27)
	Awaroa @ Rotowaro-Huntly Rd (7)
	Komakorau @ Henry Rd (6)
	Mangatangi @ SH2 (30)
	Mangatawhiri @ Lyons Rd (29)
	Mangawara @ Rutherford Rd (19)
	Matahuru @ Waiterimu Rd (20)
	Ohaeroa @ SH22 (25)
	Opuatia @ Ponganui Rd (24)
	Waerenga @ Taniwha Rd (21)
	Whakapipi @ SH22 (26)
	Whangamarino @ Island Block Rd (28)
	Whangamarino @ Jefferies Rd (22)
	Whangape @ Rangiriri-Glen Murray (23)
Waipa (16)	Kaniwhaniwha @ Wright Rd (11)

	Mangaohoi @ Maru Rd (74)
	Mangaokewa @ Te Kuiti (65)
	Mangapiko @ Bowman Rd (76)
	Mangapu @ Otorohanga (63)
	Mangatutu @ Walker Rd (73)
	Mangauika @ Te Awamutu (13)
	Ohote @ Whatawhata-Horotiu Rd (88)
	Puniu @ Bartons Corner Rd (75)
	Waipa @ Mangaokewa Rd (61)
	Waipa @ Pirongia-Ngutunui Rd (12)
	Waipa @ Otewa (2)*
	Waipa @ SH3 Otorohanga (64)
	Waipa @ Whatawhata (1)*
	Waitomo @ SH31 Otorohanga (18)
	Waitomo @ Tumutumu Rd (17)
Riverine lakes (5)	Lake Hakanoa
	Lake Ohinewai
	Lake Okowhau
	Lake Waahi
	Lake Whangape
Peat lakes (9)	Waiwhakareke (Horseshoe Lake)
	Lake Areare
	Lake Mangahia
	Lake Mangakaware
	Lake Maratoto
	Lake Ngaroto

	Lake Rotomanuka
	Lake Rotoroa
	Lake Rotopiko (Serpentine lakes)
Volcanic lakes (0)	None
Dune lakes (1)	Lake Otamatearoa