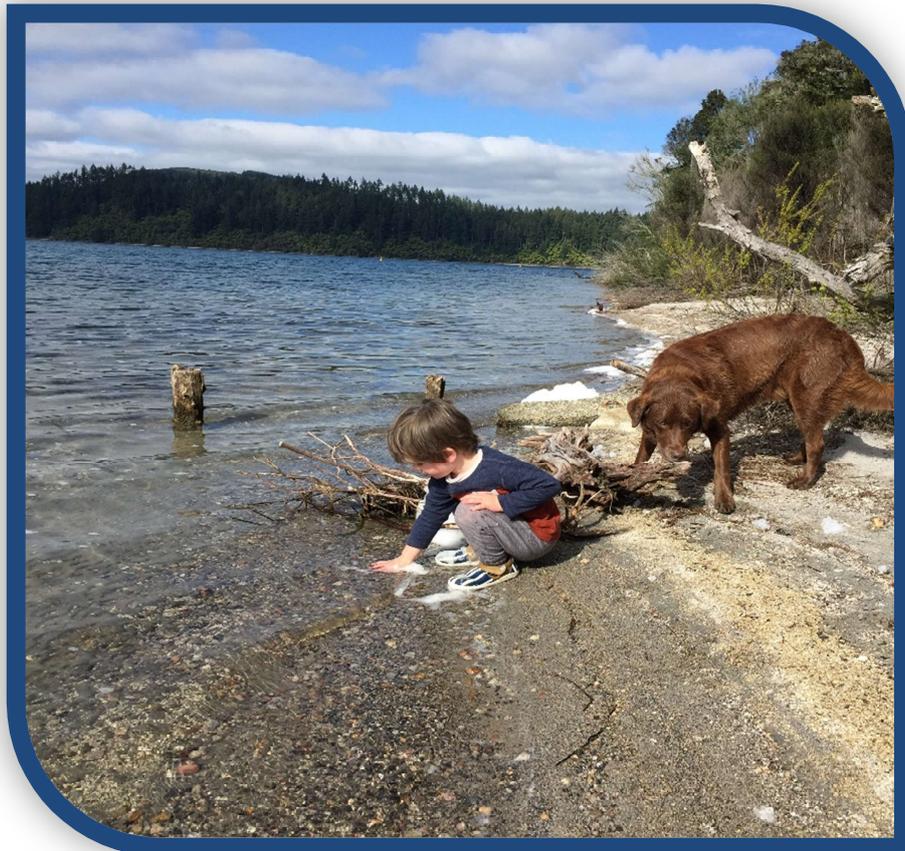




Rotorua Catchments Activity Science Delivery Plan 2020-2025



1 Background

A core focus of Bay of Plenty Regional Council's Rotorua Catchments Activity is managing water quality in the Rotorua Te Arawa Lakes, in accordance with the target Trophic Level Index set for each lake in the Regional Natural Resources Plan. An additional focus is achieving the vision for the lakes, as defined by the Strategy for the Lakes of The Rotorua District, set by the Rotorua Te Arawa Lakes Programme partnership. The Activity also undertakes work in Biodiversity preservation and management and soil conservation.

The Regional Council funds most of the Activity. However, some lake restoration projects implemented (excluding science and research) are also funded by the Crown, through the Deed of Funding for the restoration of the lakes catchments. This is a Funding Deed secured following the Crown's Treaty of Waitangi Settlement with Te Arawa (2005), which included a commitment to restoring the water quality of the Rotorua Te Arawa Lakes (Rotorua Te Arawa Lakes Programme).

Over the term of the Rotorua Te Arawa Lakes Programme, Science work in the Programme has been comprehensive and supported by the role of Chair of Freshwater and Lake Science. The Chair role was created and has remained in place since 2002 through a Memorandum of Understanding between the University of Waikato and the Bay of Plenty Regional Council. Following the Science Review undertaken as part of Plan Change 10 (related to nutrient management in Lake Rotorua) in 2019, it is clear that the work undertaken in the Programme has meant that lakes like Lake Rotorua are some of the best researched in the world.

However, there are still some science gaps and priorities that have been identified for the Rotorua catchments over the next five years, in particular to support the Council's policy work. Recent announcements by the government in relation to their Action for Healthy Waterways Package are clear; Council must get on and place limits on land use to protect water – through plan changes. Science will of course inform that policy work but the policy will not wait for perfect science

Therefore, the role of the science providers in the Rotorua Catchments Activity and this Science Delivery Plan is to determine research priorities, and ensure they are delivered and communicated as clearly as possible to our communities, so that our planning team may successfully carry out their work.

Science Delivery Plan objectives

The objectives of this science plan are:

- 💧 To identify Regional Council science delivery priorities for the next five years and ensure those are scheduled to be delivered.
- 💧 To ensure that long term monitoring is in place and being undertaken to as, best as possible, meet future needs – beyond five years.
- 💧 To ensure acknowledgement and integration of Mātauranga Māori.
- 💧 To provide fit for purpose and timely, but not necessarily perfect, science which will support Council's policy development obligations and day-to-day operational decision-making within an appropriate budget.

2 **How we know we are delivering science the Catchment needs?**

The Rotorua Catchments Activity employs appropriately qualified staff and consultants to ensure that science needs are defined, and adapted to meet the ongoing and changing needs of the Regional Council and the Programme partnership.

External factors such as climate change and economic drivers will influence our environment and change the focus of our work into the future. We need to make sure we understand the emerging drivers of change and adapt our research programme as required.

Day to day, science delivery is overseen by Regional Council managers and the Water Quality Technical Advisory Group. The Water Quality Technical Advisory Group is an assembly of various technical experts, who meet regularly to advise on technical specifications and appropriateness of science outputs.

Alongside ensuring the specifications and deliverables of science projects are appropriate, a role of the Technical Advisory Group is to keep abreast of international research and emerging challenges in the Rotorua catchments. This enables them to provide advice to on adapting science deliverables to respond to these.

To date the Water Quality TAG and the involvement of the University of Waikato in the Rotorua catchments has enabled us to understand emerging and future research needs and appropriately accommodate these in our Science deliverables, and this will continue to be a core function of these parties.

The relationship with the University has also provided a continuous stream of research funding which has enabled development of a range of research tools that are now used to inform decisions within Catchment policy and management. Securing additional funding is vital for sustaining the world-class research programme for our catchments.

3 **Science communications**

The value of good science communication cannot be underestimated. While the outputs of science research projects inform Regional Council decision makers and the Rotorua Te Arawa Lakes Programme Partnership, in both statutory and non-statutory roles, good science communication also enables the community to better participate in decision-making and planning processes about their environment.

The Programme has a Communications Plan that includes things like social media communication and public events, including science presentation evenings. These initiatives are aimed at getting the community involved and inspired by lake restoration, and the plan is regularly reviewed and managed by the Rotorua Catchments Manager.

A core function of the role of the University of Waikato, through the Memorandum of Understanding with the Regional Council, is to:

- 💧 Promote education and understanding to the community, and
- 💧 Organise and participate in technical forums involving a range of organisations, to discuss environmental management and restoration.

The University report on their activities in respect of these functions in their Annual Report.

4 Science providers and funding

Science research and communication within the Rotorua Te Arawa Lakes may be wholly, part or not funded by the Regional Council.

A core requirement of the partnership with the University of Waikato is to bring other science funding streams into the lakes catchment, through student scholarships and grants, i.e. Ministry of Business Innovation and Employment.

The funding agreement with the University provides funding for postgraduate research projects and for the work of the Chair of Lake and Freshwater Science, which includes advising on research and science, communicating science outputs to our communities and maximising alternate funding streams to our catchments, e.g. through Crown and corporate funding.

Other investment in research in the catchment also comes from special interest groups and industry such as the Lakes Water Quality Society, Tarawera Ratepayers Association and industry groups such as Dairy NZ and Beef and Lamb NZ. Regional Council from time to time comes on board - part funding the research activities of these special interest and industry groups, acknowledging the wider benefit of research to the community and its objectives.

In terms of those who can undertake research which supports the priorities of our catchments. There are a variety of options nationally and internationally. Once research deliverables are defined the most suitable, available parties can be engaged to deliver that. They may include:

- 💧 The University of Waikato including academic staff, undergraduate and post-graduate students.
- 💧 Regional Council staff.
- 💧 Crown Research Institutes such as GNS, Research and NIWA can also carry out projects.
- 💧 Tangata whenua: iwi authorises, and hapū/whānau groups.
- 💧 Appropriate qualified independent consultants.

5 Scheduled Deliverables as at 2020

The Rotorua Catchments Activity has a large number of science research projects because of previous research questions and lake conditions, as well as research needs that come out of specific science “think tanks” responding to the Environment Court and specific lake water quality issues.

While there will always be on-going science questions, this Science plan aims to ensure that these issues are prioritised and progressed to conclusion. Due to funding needs and limited access to expertise, some science questions will be shelved or removed from our listings if they are seen as a lower priority or the cost far outweighs the benefit of delving into some projects.

There are three schedules of research projects defined by this Science Delivery Plan, as below. The schedules themselves are provided as appendices to this Plan.

- 💧 Schedule 1: The Main Research Programme covering all the lakes and having connection to other specific lake or programme research listings below. These research and science communication projects are lead and delivered by the University of Waikato under the Memorandum of Agreement between with the Regional Council.
- 💧 Schedule 2: Lake Rotoehu Research Actions came out of a 2018 TAG group meeting as a result of the lake returning to having regular harmful algal blooms since about 2015. While this research is being undertaken, the Regional Council is also making changes to its alum dosing programme to aid in resolving the bloom issues. Making management changes to the operation in itself is a research project, and will enable assessment of options and the ability to undertake “adaptive management” to optimise performance.
- 💧 Schedule 3: The Plan Change 10 Science Projects (Table 2) have been recommended as part of the Plan Change 10 Science Review undertaken in 2018. A total of 48 projects have been recommended. Due to limited resourcing, only High Priority projects will be carried out. Accordingly 24 research projects related to the Plan Change 10 Science Review are programmed for action within this plan.

Research needs for the Government’s recently released Action for Healthy Waterways Package, including a new National Policy Statement are included in Schedule 1. Due to the requirements of the package, particularly around notifying plan changes, there is limited time to undertake much further research work and so priorities have been set to reflect the most essential needs.

6 Updates to this Plan

To ensure this plan remains up-to-date and relevant to Catchment Activity and Rotorua Te Arawa Lakes Programme needs, it will be reviewed by staff at the start of each financial year. The appended tables outlining priority projects may also be updated as required.

Schedule 1. Main Projects, University of Waikato Science Deliverables (Funding Agreement)

Project no.	Title	Description	Delivery Date	Who	Priority
1	Tarawera Modelling	1D modelling of Lake Tarawera to confirm nutrient reduction targets.	1 September 2020	UoW Chair. This has been contracted John Abell (Canada) to deliver. Chair to manage delivery.	H
2	Present to community modelling of Lake Ōkaro	Project to connect land use model and lake model to inform land use impact of scenarios on Lake Ōkaro has been completed. Outputs now required to be presented to community.	1 September 2020	UoW Chair. This has been contracted John Abell (Canada) to deliver. Chair to manage delivery.	M
3	Lake Rotoiti modelling	Test the impact of removing the Ohau wall once Rotorua is at TLI target	1 September 2021	UoW Chair to confirm capacity to deliver to date. BOPRC will otherwise contract.	L
4	PC 10 Science Review Actions	Deliver to or close out High Priority actions from 2019 Science Review.	Refer separate schedule	Refer separate schedule	M - 4 year window
5	Lake Rotoehu workshop actions	Deliver to or close out actions from 2019 workshop.	Refer separate schedule	Refer separate schedule	H
6	Sediment TAG meetings	Convene ongoing	Ongoing	BOPRC	L
7	WQTAG meetings	Convene ongoing	Ongoing	BOPRC	M
8	Phytoplankton limitations study	Proposal to be prepared by University.	1 September 2020	UoW - Grant Tempero	M
9	Lake Rotorua sediment follow up work	As per contract with University.	1 September 2020	UoW - Grant Tempero	M
11	Complete 12 lake nutrient budgets and then NIWA to estimate the sediment recycling	Nutrient budgets using the latest data to provide most up to date estimate of nutrient inputs to each lake - reported to WQTAG.	1 September 2020	UoW and NIWA - Chris McBride and Piet Verberg	H
17	Arsenic speciation	Fate of arsenic in water and food chain. Surrogate for geothermal P and critical public info.	1 September 2020	UoW	M
22	Geothermal inflow tracers	Summer student has differentiated geothermal inflows from others. Work to now be presented to community.	1 September 2020.	UoW - Chris McBride	M
23	Nitrogen and water isotope tracers	Southland and Rotorua site.	Project started Oct 2018 to be completed Sept 2021.	UoW - Chair with external funding (MBIE)	H
24	Radio carbon as an alternative to water dating tool	Develop improved tracers of contaminant source and fate, including during events.	Project started Oct 2018 to be completed Sept 2021.	UoW - Chair with external funding (MBIE)	H
25	Improvements to stream flow estimation	Improving estimates of high flows and ephemeral flows.	Ongoing	UoW - James Dare PhD	L
28	Citizen monitoring	Begin shift from sampling to monitoring station(s). Carried out with funding from Tarawera Ratepayers.	Ongoing	UoW and Tarawera Ratepayers.	
29	Chris McBride PhD	Uses buoy and other data to improve lake models in NZ and potentially China.	Ongoing	UoW - Chris McBride PhD	
31	Kākahiki model work	Lake modelling is included in a project to assess role of kākahiki in water quality.	Start Oct 2018 finish Sept 2021	UoW/NIWA - Sue Clearwater	L
34	Rotorua community presentations	Ongoing programme of science presentations from UoW and other science providers to keep community informed of research.	Ongoing - next presentations August 2020	UoW - Chair to lead.	H
35	Tarawera Catchments: Water and nutrient flows	Water balance, land use scenarios for consultation, model scenarios, evaluate REC2 sub-catchments in one catchment.	Confirm Completion Date	UoW - Nicola Kaelin	H

Project no.	Title	Description	Delivery Date	Who	Priority
36	Identifying control points for freshwater contaminants in Te Arawa Lakes Catchments NZ	This study will integrate a combination of isotope tracer, data-driven and catchment model approaches to determine how hot spots and hot moments can be identified to mitigate the environmental impact of pollutants without decreasing the productivity of pastoral farming systems. This proposed Ph.D. study has potential to better understand of when and how water contaminants being exported from land-to-water as basis for mitigation options.	Ongoing PhD. Connect with community by 1 Sept 2020.	UoW - Meti Yulianti PhD	H
37	Understanding attenuation	Request summary from Greg Barkle on what we need to do to understand soil, riparian and wetland attenuation better.	By September 2020.	Andy B (work with UoW)	M
39	Reviewing Rotoehu geothermal loads and separate non-geo loads	Brief to be agreed with UoW.	Agree on brief by 1 September 2020	BOPRC Andy B and Anthea from UoW	M
40	Annual report to council	Annual report on research programme presented to council as required by Clause 5.9	Due April annually	UoW Chair	H
41	Professor's Research Plan	Key part of the Fresh water chair agreement to provide visibility to council and community of research programme and how that will move the Catchments forward. This will also form the basis to plan for additional funding to support research.	Due now - outstanding.	UoW Chair	H
43	Tarawera Catchment Science for NPS-FM	Separate table of research needs for NPS-FM	Refer separate schedule.	BOPRC - James Dare	H

Schedule 2. Lake Rotoehu Research Actions

Action No.	Description	Person Responsible	Due Date
1	Confirm long term sustainable nutrient loads	UoW - Chris McBride	Done
2	Estimate internal nutrient load	UoW - Chris McBride	Done
3	Recommend sewage reticulation	BOPRC - Andy	Done
4	Consider the compliance with NPSFWM management targets	BOPRC - James	Done
5	Sample Waitangi Stream discharge (as part of consent)	BOPRC - James	Underway (James to double check)
6	Consider resuming stream monitoring to see how LUC is affecting inflows.	BOPRC - James	Done
7	Check if water quality decline coincides with forest harvest images.	BOPRC - Helen/Gretchen	Sep-20
8	Take account of Overseer estimates and attenuation in actions 1 and 2.	UoW - Chris McBride	Covered in 1,2
9	Load calculation by sub catchment, and comparison with Overseer estimates to estimate actual attenuation (recommence stream monitoring?)	UoW - Chris McBride	On hold - not a priority
10	More detailed analysis of geothermal load	UoW - Grant Tempero to prepare Offer of Service	1-Sep-20
11	Detailed analysis of internal loading	UoW - Chris McBride	Covered in 1,2
12	Separate the non-geothermal estimate from the geothermal load estimate.	As above - Action 10	As above - Action 10
13	Estimate pre 1990 TLI	UoW - Chris McBride	Completed
14	Has forest harvesting brought in a C load that effects lake sediments? Review buoy data	On hold - not a priority	On hold - not a priority
15	Clarify the catchment area in the Action Plan (two differing estimates)	BOPRC	Done - 4713.63 ha
16	Monitor properties to check if current land use is compliant with Rule 11.	BOPRC - Land Management	December 2020
17	Benchmark/allocate nutrient losses to the remaining land for more accurate catchment losses.	BOPRC - Andy to check with Penny whether necessary	December 2020
18	Keep numbers relative between science monitoring and future overseer changes.	BOPRC - new info to Chris as required.	Ongoing
19	Manage weeds to prevent blocking of flow and prevent pH increase from hornwort.	BOPRC - Justine	Ongoing
20	Turn dosing down to zero, or levels around 2013/14, using adaptive management and monitoring.	BORPC - Andy	Done - turned off.
21	5. Determine spatial extent (sediment survey) and biogeochemical drivers of Fe-rich sediments releasing P (experimentation), including SO4 monitoring.	UoW - Chair	TBA
22	Continue koura monitoring.	BOPRC - Ian Kusabs	Ongoing - continue reporting to community.
23	Check satellite images to see if WQ decline was related to harvest periods.	BOPRC - Helen/Gretchen	1-Sep-20
24	To better understand what changed TLI until 2014 then led to the decline since 2015 (this will be related to budget and modelling actions).	Refer Action 21	Refer Action 21
25	Update nutrient budgets, apply lake model if appropriate or redo budget.	Refer Action 1,2,10,11	Refer Action 1,2,10,11
26	Stop alum dosing and monitor over 2018/19 summer and autumn.	Done	Done
27	Investigate improvements to alum options.	New consent application in progress.	New Consent application in progress.

Action No.	Description	Person Responsible	Due Date
28	Review seiche currents, use biofish data and possible thermistors to establish currents.	Max Gibbs has provided dosing advice.	Max Gibbs has provided dosing advice.
29	Continue low dose alum application as operated prior to 2014.	Done	Done
30	Investigate whether an alternative option is possible to prevent sediment nutrient release, such as "bubble curtain" or lake dosing.	Aeration trial complete, current focus on dosing.	Aeration trial complete - current focus on dosing.

Schedule 3. Plan Change 10 Science Review High Priority Recommendations

Action no.	Recommendation	Who (Lead Agency)	Delivery date	Priority
5	Increase high flow sampling events to provide more robust load estimates and inform concentration-discharge analyses. Results indicate contaminants may be responding differently at different parts of the hydrograph (e.g. base flow versus high flow). Accurate high flow measurements would provide more certainty around high flow predictions, while also benefiting regression load estimates.	BOPRC - James Dare PhD?	2032	H
6	Improve continuous flow measurements. Continuous flow records can provide useful data for additional analysis. Installation of water level loggers is a relatively simple task, enabling flow-water level relationships to be developed for non-hydrology sites. This data could also increase certainty around some of the spot gauging data which appears to be biased towards low flows in recent years.	BOPRC - James Dare PhD? Grant Tempero assisting with field work.	2032	H
8	Identify hydro-chemical signatures to clarify contaminant sources and pathways. The identification of discrete hydro-chemical signatures could provide information about the source and pathway of contamination, allowing for targeted mitigation methods to be applied.	UoW - James and Meti PhD's.	2032	H
10	DONE. Complete development of NDMS (Nutrient Data Management System). The N accounting system must be able to accurately and reliably track changes to allocations arising from N buy outs, trading between properties and shifts within properties.	BOPRC	Done	H
11	Work with OVERSEER® Limited to improve the N loss predictions in the Rotorua Catchment and the model's reliability.	High rainfall trials in Rotorua Catchment delivered. BOPRC will continue to work with Overseer and other Councils as new versions released.	On going	H
12	Investigate catchment attenuation and the uncertainties in measured loads, modelled loads and groundwater travel times. Same as action 37 in Schedule 1.	BOPRC to request summary from Greg Barkle on what we need to do to understand soil, riparian and wetland attenuation better.	By September 2020	H
16	Model ensemble, including multiple models with different process representations of internal load (nutrient recycling). This approach would likely generate a wider, but potentially more realistic, range of potential outcomes resulting from management strategies.	UoW recommendation. UoW need to advise how they will deliver this within timeframe and existing budget to determine whether it goes ahead.	2022	H
18	More detailed uncertainty estimation, including Monte Carlo (MC) or Bayesian Markov Chain Monte Carlo techniques, to further improve confidence in outputs by generating an envelope of expected outcomes.	UoW	Awaiting Ōkaro model trial work as a test case.	H
19	Coupled catchment-lake modelling, including a catchment model such as the Soil and Water Assessment Tool (SWAT), capable of modelling the role of contaminant mobilisation and delivery as well as associated mitigation options.	UoW recommendation. UoW need to advise how they will deliver this within timeframe and existing budget to determine whether it goes ahead.	Awaiting Ōkaro model trial work as a test case. As well as Meti isotope research PhD.	H
20	There is little that can be done to refine historical information on stocking rates and nitrogen losses. However, routine monitoring of groundwater at key locations would allow future nitrogen concentration changes over time to be quantified. Initially, concentrations are expected to increase as groundwater affected by high nitrogen drainage from recent land use intensification arrives at the monitoring sites, but as mitigation measures take effect they are expected to decrease.	BOPRC - Andy to check bore monitoring underway.	Ongoing	H
24	Investigate seasonal phytoplankton nutrient limitation.	UoW	First year report due 2019.30.03. If continued for further 2 years final report in 2022.03.30	H
28	Improved monitoring data for Olsen P (via soil tests and preferably in a maintained database) for all farms (potentially at block level for use in OVERSEER®).	BOPRC - CSA assessment records.	Ongoing	H
29	Maintain the current soil testing frequency as suggested in the NMP template, with the expectation that soil Olsen P will decrease by 1-2 units per year once the mitigations are implemented.	BOPRC - Andy to check with Steph	Ongoing	H

Action no.	Recommendation	Who (Lead Agency)	Delivery date	Priority
30	Ensure good capture (preferably in a maintained database) and monitoring of the state of Farm Dairy Effluent (FDE) storage and land application data.	BOPRC - Consent information in Accela	On-going	H
31	Continue to maintain connections with phosphorus mitigation research and promote and support mitigation research within the Lake Rotorua Catchment, to assess the local applicability of phosphorus mitigations (for example, detention bunds).	BOPRC - Catchment Groups and Detainment Bunds	Ongoing	H
32	Support the development of multiscale spatial approaches to prioritising phosphorus (and nitrogen) mitigation placement to better target phosphorus sources, phosphorus form and phosphorus loss pathways.	BOPRC - NMP's identify and action CSA's. Catchment Groups and detainment bunds.	Ongoing	H
36	Target phosphorus reductions alongside nitrogen reductions (i.e. a dual nutrient reduction approach) given that the phosphorus load target is not achievable through phosphorus "by-catch" associated with nitrogen focussed mitigation alone.	BOPRC - as above	Ongoing	H
37	Build on the existing Nutrient Management Plan template to increase the quantitative and measurable capture of phosphorus nutrient inputs, mitigations and outputs, similar to nitrogen capture.	BOPRC - as above	Ongoing	H
39	Monitor and report phosphorus mitigation implementation and loss data (initially via nutrient budgets in the NMP) for all farms in the Lake Rotorua Catchment and refine the criteria around the collection, recording, storage of data, as well as NMP implementation monitoring and auditing.	BOPRC - as above plus NDMS Stage 3 covers collection, storage and recording of data and monitoring.	Ongoing	H
40	Develop Council's geospatial database to include implemented phosphorus mitigation actions and phosphorus losses through time.	BOPRC - as above.	Ongoing	H
41	Investigations to improve our understanding of sediment sources and phosphorus concentrations in particulate phosphorus from gauged and ungauged catchments, e.g. sampling of settleable sediment to differentiate areas with relatively higher total phosphorus concentrations associated with the sediment.	UoW - long term strategic, consider in research grant applications.	Flow on from Lakes 380, this can be part of the 2020 MBIE bid in March 2020.	H
42	A major fraction of the anthropogenic phosphorus load is in the particulate form, much of which is transported during storm events. Additional storm event monitoring would be helpful to better quantify total phosphorus loads to the lake.	BOPRC - James and Meti PhD's.	2032	H
44	Improving our estimates of geothermal inflows to Lake Rotorua. One part of this is to incorporate chloride as part of the analysis suite for the lake, Ōhau Channel outflow and inflowing streams.	BOPRC - James to confirm Chloride has been added to regular sampling.	Ongoing	H
46	Better quantification of the extent to which particulate phosphorus derived from the human activity in the catchment is bioavailable and its contribution to internal phosphorus release from lake sediments.	Won't affect our approach to minimising sediment discharge to the lake through regulation and other mechanisms. May be considered as part of long term research of UoW.	Flow on from Lakes 380, this can be part of the 2021 MBIE bid.	H