ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE OPERATIONS – LAKE ROTOITI

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ABSTRACT

Bay of Plenty Regional Council's Rivers and Drainage Group (now re-named the Environmental Hazards Group) and iwi partners Te Arawa Lakes Trust have jointly developed a Proposed Operational Strategy for Lake Rotoiti as part of a resource consent renewal process for the Okere Gates and Ohau Channel Weir structures. A wide range of potential operating options were investigated by the project partners including maintaining the status quo and conversion back to a more natural environment, without any lake control structures. Each option had merits and challenges and different stakeholders favoured different options depending on their unique perspectives.

This paper describes the operating options investigated. It outlines reasons why stakeholders favoured different options and the process the project partners went through to finally settle upon their proposed operating strategy. It details the impacts of the proposed operating strategy and the mitigation measures recommended offsetting adverse effects identified.

The paper will demonstrate how performance criteria were developed during consultation with a diverse range of stakeholders and how the proposed option was formulated using an assessment of environmental effects and best professional judgment.

KEYWORDS

Lake Rotoiti, Lake Rotorua, Okere Gates, Ohau Weir

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1 INTRODUCTION

Bay of Plenty Regional Council's (BOPRC) Rivers and Drainage Group applied for new resource consents for the Ohau Weir and Okere Gates in December 2009. The resource consents were for the placement and operation of the existing structures.

Ohau Weir is located on the entrance to Ohau Channel between Lake Rotorua and Lake Rotoiti. Okere Gates are located at the outlet of Lake Rotoiti which is at the headwaters of the Kaituna River. Figure 1 shows the location of the Ohau Weir and Okere Gates.

The structures were installed in 1982 (Gates) and 1989 (Weir) by the previous catchment authority, following widespread lake margin flooding during a period of very high lake levels in the 1960's and early 1970's and following works to increase the Ohau Channel capacity in 1972. It has been suggested that the lakes' increased catchment runoff volumes following post war vegetation clearance coupled with a wet climatic period led to the high lake levels at that time. In an effort to avoid both high and low lake levels, the level of Lake Rotoiti has been held in a fairly narrow 150mm range with a target level since resource consents for the structures were last issued in 1996.

Consultation occurred between early 2009 and late 2010 with the consent application being notified in September 2010. Formulation of the Proposed Operational Strategy (POS) was an iterative process that occurred during consultation with stakeholders. This paper discusses the steps taken by the Rivers and Drainage Group to finalise the POS for the Ohau Weir and Okere Gate structures. It describes:

- how performance criteria were developed
- operational options investigated
- impacts

Figure 1: Location of Okere Gates and Ohau Weir

2 PERFORMANCE CRITERIA

The Rivers and Drainage Group commenced the re-consenting process with an 'open mind'. In February 2009 the Rivers and Drainage Group invited stakeholders for their feedback on how well they thought the Okere Gates had worked and what their priorities would be for any future structure and its operation (AURECON, 2009). Responses were received from Te Arawa Lakes Trust (TALT), Western Bay of Plenty District Council (WBOPDC), Eastern Region Fish and Game (ERFFG) and Lake Rotoiti Community Association (LRCA).

Performance criteria were developed during consultation, which was undertaken during the first two of three stages of the project:

- Stage 1: involved formal consultation with TALT and Ngati Pikiao between February and December 2009 and consultation with other stakeholders between October and December 2009, prior to the preparation of the resource consent application (lodged with the Regional Council on 18th December 2009);
- Stage 2: involved further consultation with key representative stakeholders such as Rotorua District Council (RDC) and LRCA and this resulted in a revision of the consent application which was publicly notified on 11th September 2010.
- Stage 3: covered the notification and December 2010 hearing period.

2.1 STAGE 1 PRE-LODGEMENT

Consultation with TALT and Ngati Pikiao was the primary focus of Stage 1.

Consultation in the first stage recognised that the Rivers and Drainage Group needed to engage and consult with TALT, as owner of the lakebeds of the twelve Rotorua lakes. In addition Ngati Pikiao are part of Te Arawa and have strong historical and cultural affiliations with Ohau Channel, Lake Rotoiti and upper part of the Kaituna River, so it was appropriate that this iwi group be consulted with in the first instance as well.

Numerous hui with TALT and Ngati Pikiao were held between July and October 2009, to present the proposed performance indicators and measures to Ngati Pikiao and TALT. The Mauri Model (Morgan, 2006) was suggested as a framework that would recognise and have regard for cultural values and was used to help establish draft performance indicators and draft performance measures for use in evaluating different operational options.

Performance indicators are the physical evidence that a goal has been achieved (which can also be viewed as a benefit) e.g. there is no flooding. Performance measures, on the other hand represent the numerical target values that the model must achieve to satisfy the goals e.g. the maximum level that must be avoided to reduce risk of flooding.

Mauri is the binding force between the physical and spiritual, and it is the basis of kaitiakitanga as this is the ethic of working to enhance the mauri of all things around us. The Mauri Model integrates the intrinsic value of ecosystems (environmental), hapu (cultural), whanau (economic), and communities (social) using the indigenous concept of Mauri as the performance metric across all four sustainability dimensions. (Morgan, 2006). TALT had expressed in earlier meetings that it was not evident that integration of the four sustainability dimensions (or well beings) had been included in the previous resource consent process in 1996 and that it was to be included in this current Assessment of Environmental Effects (AEE).

The Rivers and Drainage Group went to great lengths to acknowledge and accommodate many of the cultural performance measures derived from the Mauri Model.

2.2 STAGE 2 POST-LODGEMENT

Stage 2 focused on refining the Proposed Operational Strategy (POS) particularly for Lake Rotoiti by defining the proposed lake level operation that had the widest community benefit, before public notification. To achieve this goal the Rivers and Drainage Group utilised the performance indicators and measures identified using the Mauri Model - and simplified them to a smaller subset that were then used in model optimisation to determine the POS for the Okere Gates to control Lake Rotoiti levels. Refer Appendix A.

Readers will notice that the performance measures and indicators set out in Appendix A show how various sectors and interest groups within the Lake Rotoiti community can have quite different expectations. For example boat owners have sought a very limited lake level operating range (No. 3). Hinehopu lakeside residents with low lying properties have sought markedly lower average lake levels (No. 6). Iwi have sought a wide lake level range (No. 1) at a lower level to provide more access to wider beaches (No. 2) and some environmental interests seek limited rate of lake level increases to protect the Dabchick population (No. 10). This provides a challenge to the optimization process to come up with an operational strategy that best addresses as many of these performance measures as possible.

The refined approach undertaken in Stage 2 included consulting with key representative stakeholders during public open days and in stakeholder meetings and applying best professional judgment to select a preferred option.

Following input received at the public open days and follow up meetings with stakeholders, the Rivers and Drainage Group decided on its preferred option, namely the 'D7', in June 2010. This option offered the widest community benefit and balanced the four well beings without adversely effecting the environment.

3 DESCRIPTION OF OPTIONS

A number of scenarios for the structures were considered during the development of this proposal.

3.1 LAKE ROTORUA OPTIONS

The proposal is to retain the existing stop log weir structure (Ohau Weir), the existing maximum and minimum lake levels and the current lake level range (610mm). Some operational flexibility is sought with respect to more timely removal and replacement of the stoplogs to improve management of the lake levels. However this operational flexibility will have negligible effect on Lake Rotorua levels compared to the current/status quo. Section 4 provides further information on why the status quo for Lake Rotorua was selected.

3.2 LAKE ROTOITI OPTIONS

Seven options for Lake Rotoiti operations were developed and modelled as described below.

The starting point for Options 1 to 5 were to use a MIKE11 hydraulic computer model to simulate several physical set-ups such as weirs and then assess output (flow and level) to see how well they satisfied various performance criteria. The report written for the Rivers and Drainage Group by Aurecon in March 2009 assessed the impacts of the Status Quo option and Options 1 to 3 on Lake Rotorua and Lake Rotoiti levels and outflows in to the

Kaituna River. Later, Aurecon produced Options 4 and 5 using the same model MIKE11 model.

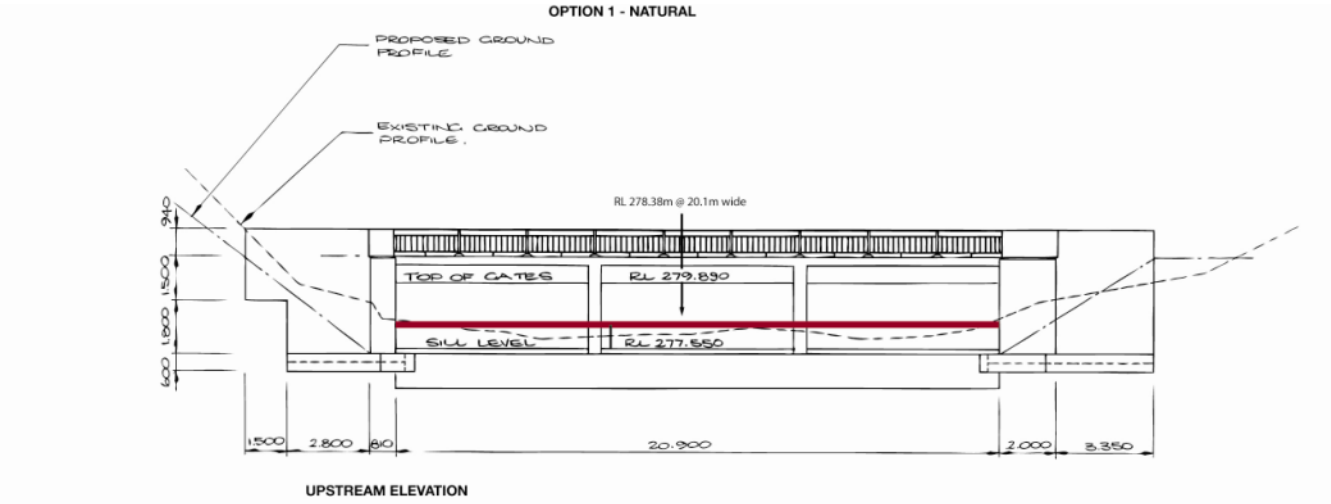
In contrast, the starting point for Options 6 and 7 were to use a computer optimization model that used performance criteria as its goals. The aim of optimization was to formulate a rule (or rating) curve(s) that would do very well satisfying as many of the performance criteria requested.

Status Quo - Retain the Okere Gates and operate as per the existing resource consent.

Many stakeholders particularly Lake Rotoiti boat owners, called on the Rivers and Drainage Group to retain the status quo. This was because the current consent target level gave boat owners more certainty regarding draft depths and jetty access (boat owners indicated that draft issues arose when lake levels dropped below RL279.10)[1]. Other stakeholders such as lake side property owners were concerned that any departure from the current status quo target level would lead to lake margin flooding (when lake levels rose above RL279.20) or de-valuation of properties during droughts when unsightly mudflats and lake weed appears and jetties/boatsheds become un-useable.

Option 1 – 'Natural' – install a stop log structure at Okere Gates that approximately replicates the natural rock ledge that existed prior to the construction of the gates. Refer Figure 2.

Figure 2: Peer reviewed natural Option 1 schematic (April 2010).

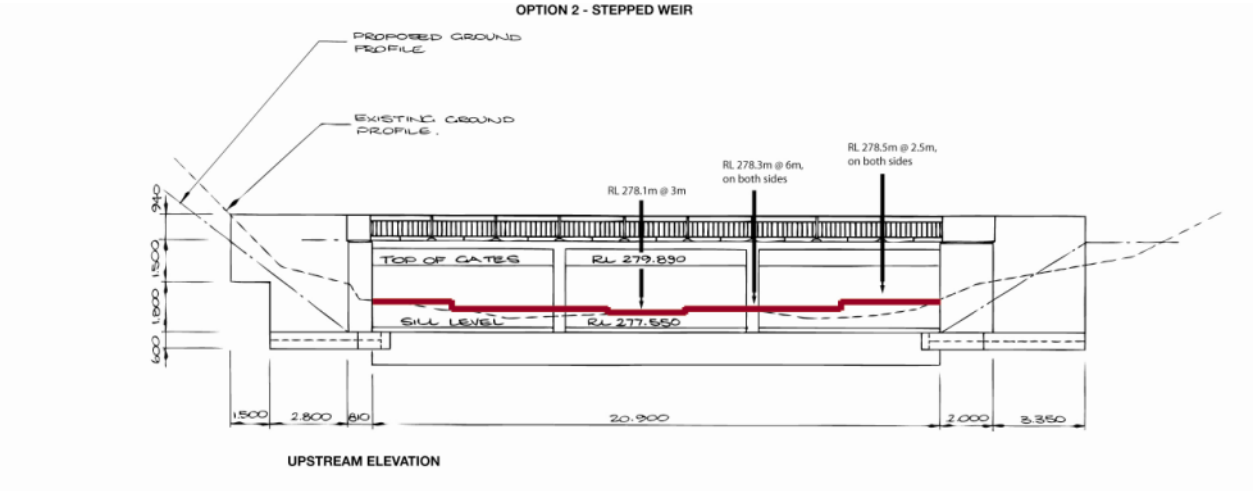


The Rivers and Drainage Group put Option 1 up for discussion because it represented the Groups best estimate of how Lake Rotoiti water levels would fluctuate if a pre-gates regime were to be re-instated. This option would have reduced operational/maintenance costs of the Okere Gates. The more natural regime may have also resulted in a wider and more diverse band of lake margin wetland and more seasonally exposed beaches. However this natural option would have also increased the risk of lake margin property and infrastructure flooding and very low lake levels during very dry seasons/droughts as it is an uncontrolled flow structure.

Option 2 – replace the Okere Gates with a stepped weir structure that broadly aims to maintain current target levels. Refer Figure 3.

Figure 3: Stepped weir Option 2 schematic.

[1] Note that all levels are RL with respect to Moturiki Datum (OPUS, 2010).

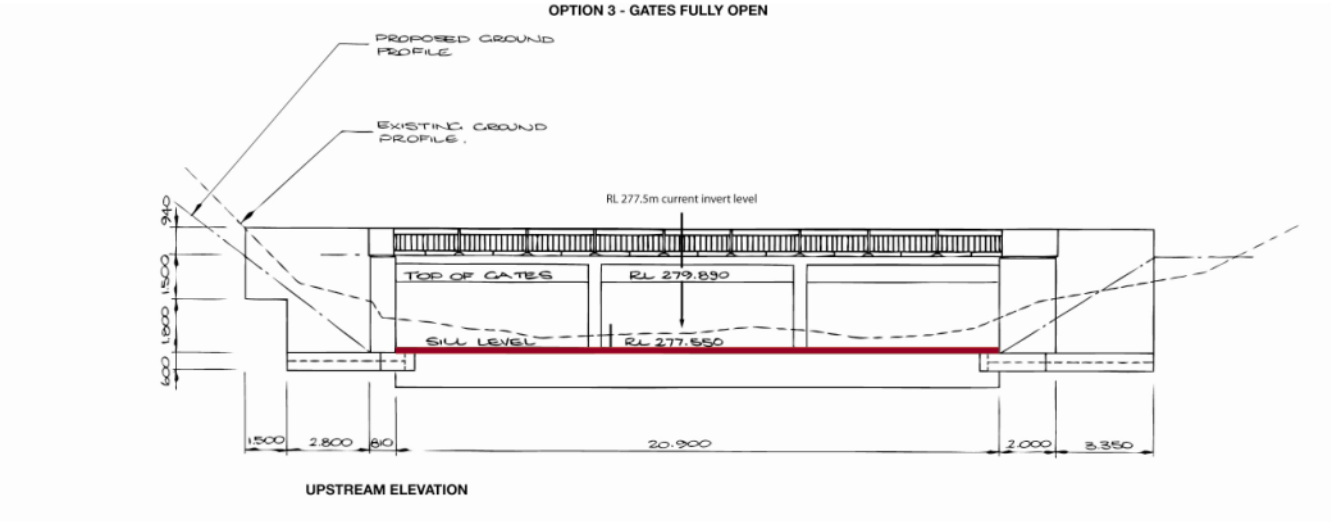


The 'advantage' of a stepped weir is that it allowed a reasonable flow depth over the lowest section of weir for low flows, but still utilised the full width of channel available for high flows. A wide level range would have resulted but maximum and minimum values would have been lower than that associated with Option 1. Flooding and droughts would have become more frequent. The benefits and disadvantages are similar to those described for Option 1 above.

Option 3 – retain the Okere Gates but keep the radial gates permanently fully open. Refer Figure 4.

Some stakeholders expressed a desire to return Lake Rotoiti levels to a more 'natural' lake state but did not necessarily wish for the Okere Gates to be removed. Retaining the gates is useful when gate flows need to be reduced quickly, for example in downstream emergency situations at the Okere Falls or in very dry seasons/droughts when lake outflow can be carefully constrained.

Figure 4: Radial gates fully open Option 3 schematic

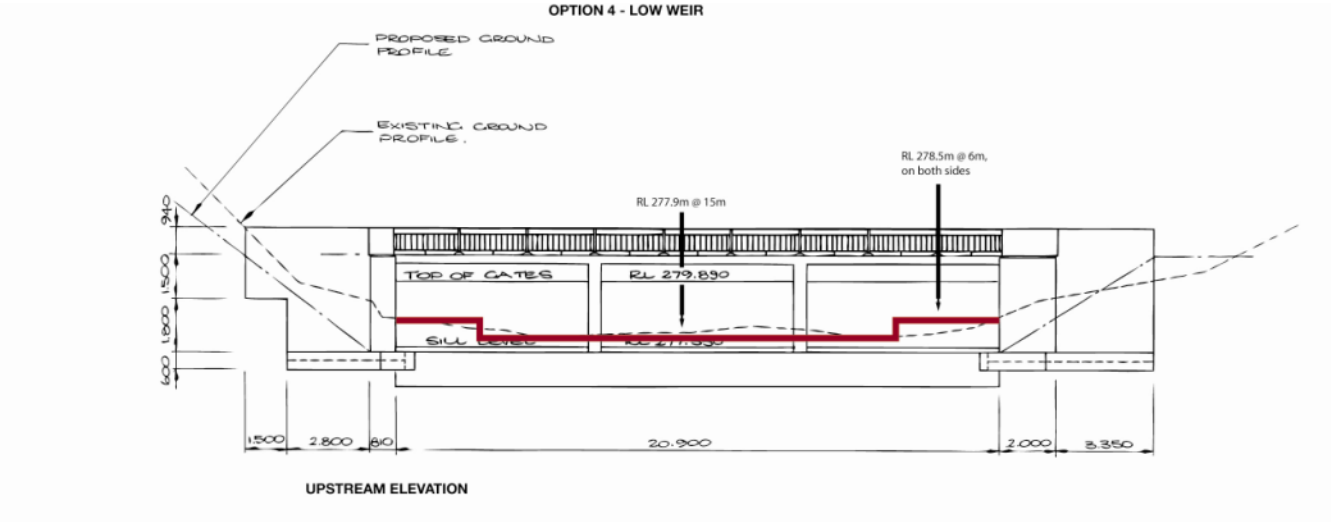


Option 4 – Low Weir – replace the Okere Gates with a low stepped weir at the location of the existing Okere Gates. The lowest invert in Option 4 is lower than that modelled in the original stepped weir (Option 2 above). Refer Figure 5.

In August 2009, the Rivers and Drainage Group asked Aurecon to model a further option on behalf of Ngati Pikiao. Based on anecdotal evidence, Ngati Pikiao's Dr Morgan asserted that Option 4 better represents Lake Rotoiti water levels prior to the gates installation in 1982. Dr Morgan was concerned that the historical data held by BOPRC for Lake Rotoiti

levels were in fact too high by approximately 500mm (OPUS, 2010). However average water levels produced by the Option 4 model are lower than the modelled natural (Option 1) and historically recorded water levels. Lower lake levels would restore some lake edge beaches which held cultural significance to Ngati Pikiao.

Figure 5: Peer reviewed low weir Option 4 schematic (November 2009)



Thus, in September 2009, the Rivers and Drainage Group asked Aurecon to model an additional option:

Option 5 – Option 5 modelled the pre-gate scenario using the original cross-sections i.e. prior to any channel excavation (prior to 1981). Preliminary modeling of this option underestimated the lake level of Lake Rotoiti due to difficulties in modelling rapidly varying flow and a more accurate technique for modelling was identified by developing a rating curve from a number of steady state runs.

A key finding of the Aurecon Report, 2009, was that the gates appeared to be underutilised and all the options investigated could be simulated by implementing a different operating regime for the control gates than currently allowed or consented. Hence given the gate flexibility that was available Rivers and Drainage Group decided to use an optimisation computer model that could formulate a rule curve that best satisfied multiple performance criteria. Performance of any optimised options could then also be compared with the preceding MIKE11 modelled options and status quo.

During September and October 2009, Hydrologics Inc undertook optimisation modelling of gate operations using early draft performance indicators and measures, and provided the first significant optimised option for consideration, namely the Version 6:

Option 6 - Hydrologics Version 6 - This comprised the latest optimisation modelling up to October 2009 and was included in the December 2009 AEE.

Between December 2009 and May 2010 the Rivers and Drainage Group carried out several additional optimisation model runs to develop its final optimised solution and many of these were used in consultation. Optimisation modelling sought to identify the best rule (or rating) curve that enabled as many of the objectives represented by the performance measures to be achieved. The simplified set of performance measures listed in Appendix A represented the spectrum of goals most stakeholders wished to achieve.

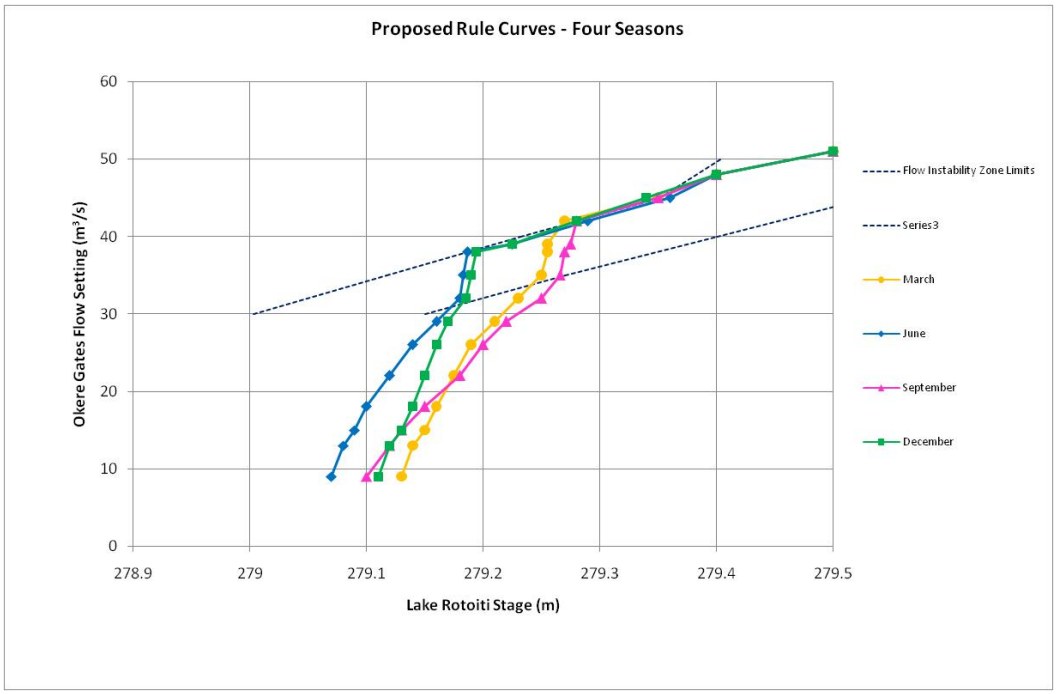
All the above options are outlined in more detail in the BOPRC Rivers & Drainage Group, July 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application".

During May 2010, Hydrologics Inc. and the Rivers and Drainage Group developed and refined its final optimised option plus an associated operating strategy proposal. This optimised operational option for the Okere Gates is referred hereafter as the Proposed Option (D7).

Option 7 – Proposed Option (D7) utilises the existing gates to control lake levels, and was developed by manual adjustment of a set of monthly lake level/discharge curves (also known as rule or rating curves) originally derived from the optimisation model. An example of monthly rule curves is shown in Figure 6. Application involves reading the Lake Rotoiti level off the Okawa Bay recorder, entering that value along the x—axis of the rule curve and then reading off the y-axis to determine what the Okere Gates flow should be set to.

The adjustment process took account of environmental, technical and operational constraints, in particular, the physical inability of the control gates to control the lake outflow as the gates are opened wider and wider and the flow regime changes from an orifice flow to a free discharge. This change in flow regime does not occur as a sharp change, rather there is a gradual transition which is marked by unstable flow conditions with the lake outflow hunting continuously between the two flow regimes until the free discharge regime with the gates clear of the water surface profile is firmly established.

Figure 6: Typical monthly rule curves for the Proposed Option (D7)



Optimisation modelling was forced to always satisfy three rules which are:

i) That Kaituna River flows never drop below 7.9 cumecs to satisfy minimum ecological requirements

ii) That Lake Rotoiti water quality must not deteriorate as a result of the proposed option (also a performance measure as indicated in Appendix A)

iii) That outflow from Okere Gates must always be greater or equal to Ohau Channel flows (This is important for maintaining and improving water quality in Lake Rotoiti and preventing nutrient leakage around the Ohau Diversion Wall placed in the

Okere Arm of Lake Rotoiti in 2008 between the outlet of the Ohau Channel and the Lake outlet at Okere Gates.)

By the time the consent was notified in September 2010, four options were identified as representing the spectrum of options considered and of most interest to stakeholders. They were the natural (Option 1), low weir (Option 4), the status quo and optimised proposed option (D7). A consistent 10 year period with the same measured rainfall and inflows to both Lake Rotorua and Rotoiti was used in the different model simulations. The impact that each option had on water quality was modeled independently by Waikato University (Hamilton, 2010).

Figure 7 shows the level hydrographs for each of the options selected and used for comparison purposes in the AEE. Figure 8 shows peak values measured or modeled for each of the four options.

Figure 7: Comparison of simulated levels for different Lake Rotoiti operational options compared with status quo (measured data) from 1998 to 2007

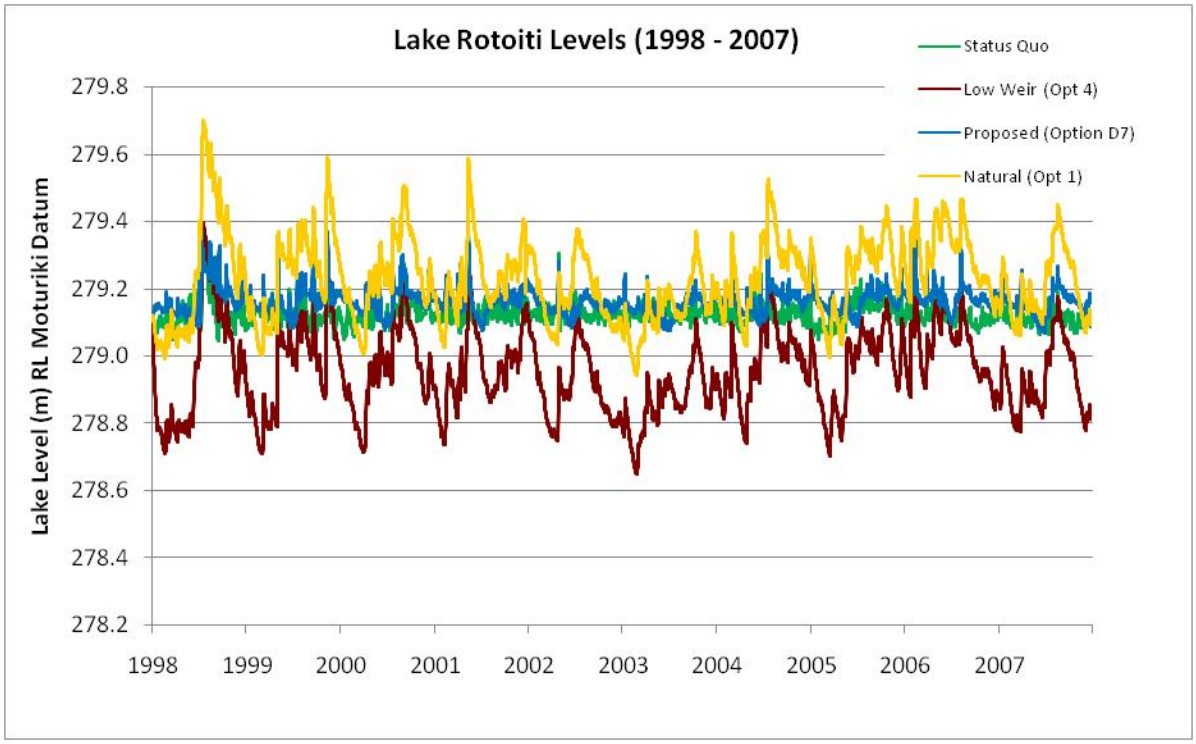
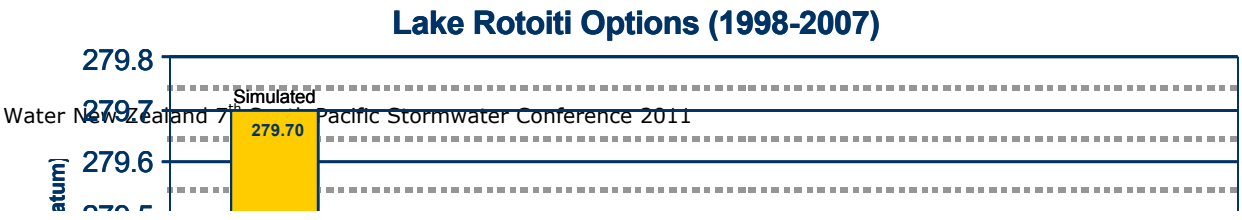


Figure 8: Comparison of simulated ranges for different Lake Rotoiti operational options compared with status quo (measured data) from 1998 to 2007



4 IMPACTS

Impacts of the POS on Lakes Rotorua and Rotoiti are described as follows.

An analysis of the impacts of retaining (status quo) and removal of the Ohau Weir control structure was investigated for Lake Rotorua. Retaining the status quo is proposed for Lake Rotorua, because it has fewer adverse effects than the alternative option of removing the Ohau Weir structure. For example lower lying lake margin infrastructure including RDC stormwater, drainage, wastewater pumping and reticulation rely on predictable lake levels. The Ohau Weir also allows navigation of Lake Rotorua and Ohau Channel virtually all year around. (BOPRC, 2010a).

For Lake Rotoiti the POS is based on the proposed optimised option (D7). Table 1 shows Lake Rotoiti levels produced by the proposed option (D7) model for *each year* over the period 1998 to 2007 in terms of % time spent in each level band. Figure 9 shows a bar chart denoting the same 'proposed option distribution' which is the % time spent in each level band for the *total 10 year period*.

Figure 9 also shows the POS bar chart with the % time allowed in each level band on an annual basis. The POS represents the lake level target range for each level band which can vary from year to year as indicated in Table 1.

Table 1: Lake Rotoiti levels produced by the Proposed Option (D7) as % time in each level band between 1998 and 2007

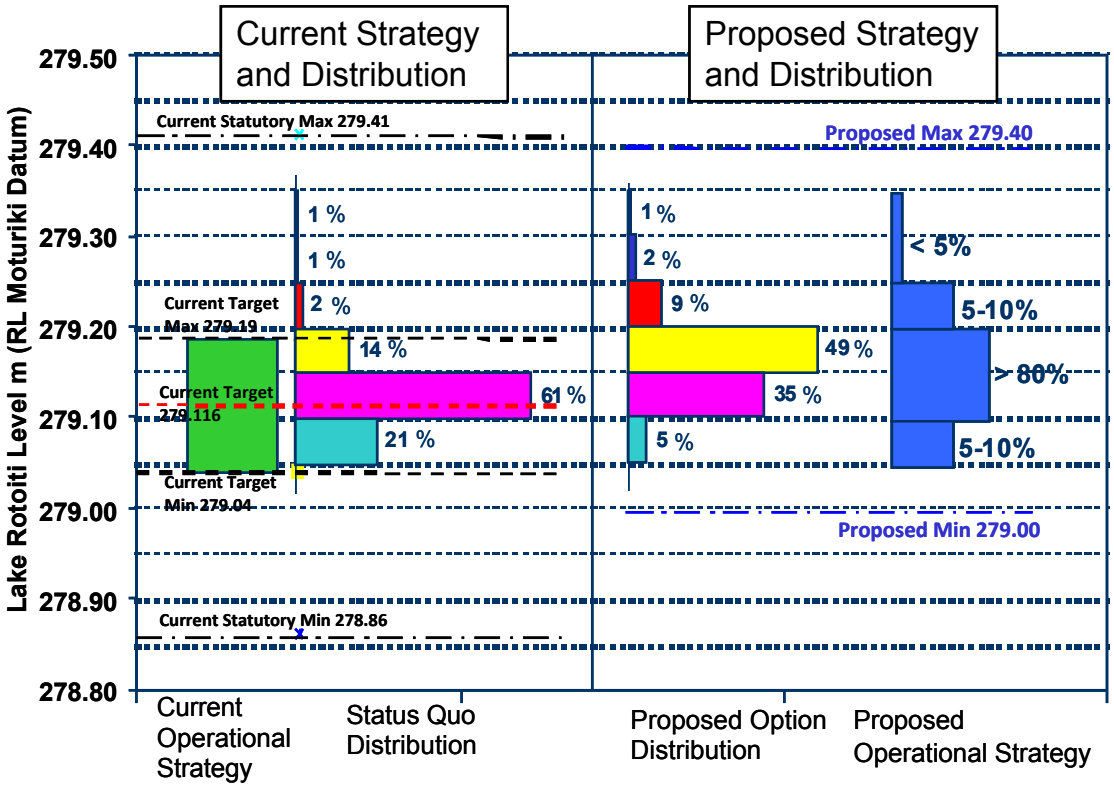
Level Band (m RL)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Greater than 279.25	13%	5%	4%	2%	1%	0%	2%	0%	4%	1%

279.20 – 279.25	10%	8%	7%	11%	2%	4%	10%	11%	12%	12%
279.10 – 279.20	72%	83%	83%	83%	93%	87%	85%	85%	84%	79%
279.05 – 279.10	5%	4%	6%	4%	4%	9%	2%	3%	1%	8%
Total	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

The Proposed Option (D7) is used to quantify the effects of the POS relative to the current or status quo lake level operations. The POS distributes lake levels more naturally over a slightly wider range as indicated by the distribution of the Proposed Option (D7) in Figure 9.

For the 10 years of modelled data between 1997 and 2008 for the Proposed Option (D7) shows marginal increases in lake level. In option D7 the median lake level is 39mm higher than the status quo median level, and the minimum lake level is 26mm higher than the status quo minimum level. Potential effects of these modest increases in lake levels are discussed below.

Figure 9: Comparison of current operational strategy and distribution with proposed option and proposed operational strategy for Lake Rotoiti.



4.1 EFFECTS ON STORMWATER AND DRAINAGE INFRASTRUCTURE

RDC confirmed that there were no issues for roading or drainage systems abutting Lake Rotoiti associated with the status quo operations.

Several low lying areas around Lake Rotoiti have a history of poor drainage. However, based on historical median lake levels (1906 – 81), these areas were worse off prior to

Okere Gates being constructed, being approximately 38mm higher than status quo median levels. In some areas such as Hinehopu, at the eastern end of Lake Rotoiti, poor drainage is an existing problem, known to be compounded by high groundwater levels and tectonic settlement.

At Hinehopu, Ruato Bay and perhaps in some other low lying areas, stormwater can 'back up' in streams under the status quo. Under the POS 'backing up' may increase marginally, and so commensurate mitigation such as installation of drainage trenches may be required.

Additional groundwater monitoring is currently being undertaken by the Rivers and Drainage Group at Hinehopu. Owners of holiday baches along Tamatea Street, Hinehopu have submitted that groundwater levels around their properties are linked to the level of Lake Rotoiti, and if lake levels rise above RL 279.10m, then flooding may occur.

To address this concern, the Rivers and Drainage Group undertook a preliminary groundwater study to assess the link between groundwater levels at Tamatea Street baches and lake levels (BOPRC, 2010b). The results of the preliminary ground water study, based on four weeks of monitored data (using transducers), indicated that there may be a link. However, that study was based on a limited data set and further investigations are required in order to provide greater certainty on the causal link between lake levels and groundwater and to provide an opportunity to monitor the effects of proposed mitigation. The Rivers and Drainage Group has offered, as a condition of the consent, for a further 12 months monitoring to occur in order to fully investigate this issue, and for mitigation options to be presented to the Regional Council if the causative link is confirmed. This is coupled with a formal review process if agreement cannot be reached on the appropriate mitigation measures to be installed.

It is noted that some septic tanks in low lying areas like Hinehopu's Tamatea Street do not currently comply with the minimum required clearance between the bottom of their soakage beds and the water table. Performance of non-compliant septic tanks may be negatively affected by lake levels under the POS. However existing reticulated sewerage areas around Lake Rotoiti are unaffected by lake level, and RDC plans to complete its sewerage system network to include low lying areas currently with septic tanks, including Hinehopu by 2012. It is widely accepted that drainage has historically been (pre gates) , and currently is an issue in the Hinehopu area particularly in Tamatea Street (OPUS, 2010). The 'natural' Option 1, then which spends more time than the status quo and POS in the higher level bands is therefore not desirable.

During consultation local iwi expressed concerns that the Okere Gates had caused water levels in the Ohau Channel to rise and thus cause flooding of adjacent properties. However OPUS confirmed that Ohau Channel water levels are not affected by the presence of the Ohau Weir. Instead, channel water levels are controlled primarily by the geometry and frictional characteristics of the channel, and to a lesser extent, by the downstream level of Lake Rotoiti (BOPRC, 2010a). On this basis the POS may cause a marginal increase in Ohau Channel water levels by virtue of the median Lake Rotoiti level rising by 39mm.

Possible minor increases in Ohau Channel levels could be addressed by clearing drains leading into the channel as part of regular Kaituna Catchment Control Scheme monitoring and maintenance, or by constructing a low bund along the narrow reach at greatest risk of inundation. Such measures could reduce the risk of inundation in places adjacent to the Ohau Channel that already occurs under current operations. The bund would provide

mitigation for any possible minor incremental increases in inundation. If required, flapgates can be installed at locations where the bund crosses over existing field drains.

Based on the proposed small changes in lake level, the minimal stormwater infrastructure around the lake and feedback received from RDC, it is not expected that the POS will have an adverse impact on stormwater infrastructure.

4.2 EFFECTS ON RECREATION

4.2.1 TRADITIONAL PURPOSES

Some stakeholders have asserted that the POS panders to boat owners, but ignores consequences for those around the lake who use it for traditional purposes. The Rivers and Drainage Group disagrees and the record of consultation shows it has attempted to respect all stakeholders and their interests and needs.

The Rivers and Drainage Group has acknowledged cultural performance criteria, including traditional purposes, throughout the consent process. The POS was selected based on a simplified set of performance measures that reflected the four well beings, consultation with key representative stakeholders, best professional judgment and that which gave the widest community benefit. The effect of the POS on traditional purposes is expected to be the same or marginally better than the status quo.

4.2.2 NAVIGATION

Navigation throughout Lake Rotoiti will not be adversely affected by the POS. Navigation throughout Lake Rotorua and Ohau Channel will not be adversely affected by retaining the Ohau Weir and the status quo for Lake Rotorua.

Commercial and recreational boating activity in Lake Rotoiti is unlikely to be affected. Proposed lake levels will be less than RL279.10m (279.05m to 279.10m) for approximately 5% of the time (which equates to approximately 18 days per annum). Under the status quo lake levels in this lower range occurred up to 21% of the time.

Any lowering of the median water level in Lake Rotoiti as would be the case if the low weir (Option 4) were selected would make access to some western basin and Ohau Channel areas marginal for larger craft at times (OPUS, 2010).

It is considered that commercial boating on Lake Rotorua will be unaffected by the POS. The Ohau Weir allows for more predictable levels and assists tourism ventures.

4.2.3 JETTY AND OTHER STRUCTURES

The Rivers and Drainage Group physically surveyed private and public structures around the edge of Lake Rotoiti. The POS will slightly improve access to private and publicly owned structures around the edge of Lake Rotoiti (boat ramps, jetties and boat sheds) for much of the year, compared to the status quo. There may be a period in the late autumn / early winter when lower lake levels result in these structures being marginal for some users, however this is likely to coincide with periods of lower use. For comparison purposes it is worth noting that under the low weir option (Option 4) Lake Rotoiti levels would remain below RL279.10m for up to 88% of the time (for period 1998 to 2007), rendering many lake edge structures unusable for a majority of the time. These periods compare with the natural (Option 1) which would remain under RL279.10m for up to 17%

of the time and the POS which will remain between 5 – 10% of the time between RL279.05m and RL279.10m (OPUS, 2010).

As the proposed operations are largely similar to the status quo in Lake Rotoiti and are status quo for Lake Rotorua, these operations will allow structures on both lakes to continue functioning much as they have since 1996.

4.2.4 RAFTING AND KAYAKING

Modelling has taken into account the flow range required by commercial rafters of between 13 and 26 cumecs. Modelling assumes flows are available daily between 8am and 5pm, seven days a week. Under the POS there is marginally more commercial rafting days available on the Kaituna River compared with the status quo.

Recreational kayakers will be largely unaffected by the changes of the POS. It is worth noting that kayakers use the river over a much wider range than commercial rafters (BOPRC, 2010a)

4.2.5 FISHING

There is not expected to be any adverse impact of the POS on aquatic fauna such as koura, kakahi, or trout. There may be a very slight increase in spawning habitat for common smelt through an increase in the extent of submerged sandy beaches.

4.2.6 TOURISM

It is anticipated that there will be minimal effects on tourism, as operations on the lakes will largely continue as per the status quo. Any potential effects on Lake Rotoiti tourism (e.g. Fishing and effects on lake structures) will be minimised further by scheduling lower lake levels in autumn and early winter. No significant effect is likely to result from the POS, since there is less time in the lower RL279.05m to RL279.10m range than the status quo.

4.3 EFFECTS ON ECOLOGY

Assessing the effects of the proposed POS on ecology focused on: aquatic plants, aquatic fauna, birds, wetlands and the Kaituna River.

4.3.1 AQUATIC PLANTS

The location and composition of aquatic plant communities is strongly influenced by the range, duration and frequency of water level fluctuations. For example, native turf communities that occur on the edges of lakes typically have most diversity when water level fluctuations have a range of about 1 m and occur in cycles shorter than 2 months.

The POS would not cause any adverse impact on existing aquatic plant communities and the small increase in water level fluctuations under the POS is expected to slightly favor native aquatic plants in some parts of the lake.

4.3.2 BEACHES

Beaches around Lake Rotoiti have cultural significance and Ngati Pikiao wish to see the width restored at several locations such as Ruato Bay and Hinehopu.

Comparison of beach widths under each of the four options shows that the low weir (Option 4) and natural (Option 1) produce the widest increases compared with the POS and status quo. Increases in beach width are due to the wider lake level ranges associated with Options 1 and 4 (OPUS, 2010).

Beach formation is controlled by a dynamic between water level fluctuations, duration, frequency, wave exposure and growth of aquatic and terrestrial plants. Under the POS, terrestrial sandy beaches will be slightly narrower in the short term (due to an average water level increase) and very slightly wider in the long term (due to a slight increase in water level fluctuations). However, wider terrestrial beaches will only be exposed when water levels are dropped in May -July. Rivers and Drainage Group will restore the loss of beach width where it is physically possible to do so such as at Ruato Bay and Hinehopu by judicious herbicide application.

4.3.3 FISH AND KOURA

Lake Rotoiti is a very important recreational and cultural fishery, particularly for rainbow trout, smelt, koaro, koura (freshwater crayfish) and kakahi (freshwater mussel). Smelt is a major food source for rainbow trout, so there was interest by some stakeholders in using the operating regime to optimize smelt spawning habitat. This focused on increasing the amount of submerged sandy beaches during the spawning season (spring –summer).

Koura, kakahi and koaro are relatively insensitive to small changes in water depth. They have a wide depth range, are mobile and do not have any particular requirements to spawn in shallow water that could be impacted by small increases in the range of water fluctuations.

There is not expected to be any measureable adverse impact of the POS on aquatic fauna such as koura, kakahi, or trout. There may be a very slight increase in spawning habitat for common smelt through a slight increase in the extent of submerged sandy beaches. The natural option would have resulted in larger beaches that might have benefited smelt spawning.

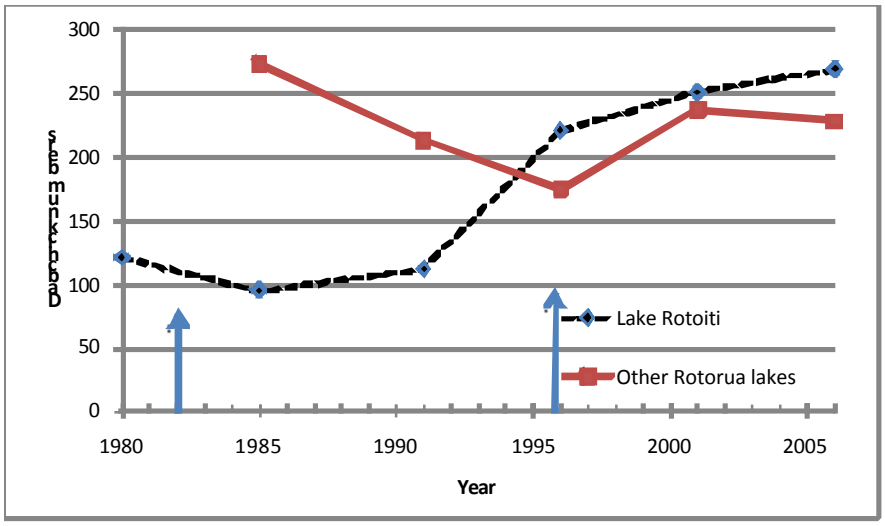
4.3.4 BIRDS

Lake Rotoiti is a very important site for a large number (17 species) of birds. In particular it has a large population of Dabchick. This endemic grebe is a threatened species and 15% of the world Dabchick population lives on Lake Rotoiti – the highest population anywhere. Dabchick nests are bulky, partially floating rafts, usually anchored to rushes or jetties. They have little buoyancy and are very sensitive to inundation by waves or increasing water levels.

Dabchicks have done very well with the stable water levels provided under the status quo operations. The increase in population is shown in Figure 10.

Considerable thought was given to setting operating rules to protect dabchick. The Rivers and Drainage Group settled on taking a conservative approach and limiting the rate of water level change during the breeding season to what occurred under the status quo, i.e. <6 cm rise over a 25 day period. This avoided any adverse effects on the Dabchick population.

Figure 10: Number of Dabchick adults on Lake Rotoiti and all other Rotorua Lakes (arrows show when Okere Gates were installed in 1982, and when current management regime began in 1996)



4.3.5 WETLANDS

Lake Rotoiti is adjoined by five nationally important wetlands. In assessing the potential effects of the proposal on wetlands the Rivers and Drainage Group focused on Hinehopu wetland in the east because it was the most likely to be hydraulically connected to the lake. The extent to which the wetlands water levels are influenced by the lake water levels was not fully determined but increased water levels and water level fluctuations are expected to be generally positive for wetlands hydraulically connected to the lake (e.g. Hinehopu), with any effect being minor.

4.3.6 LAKE WATER QUALITY

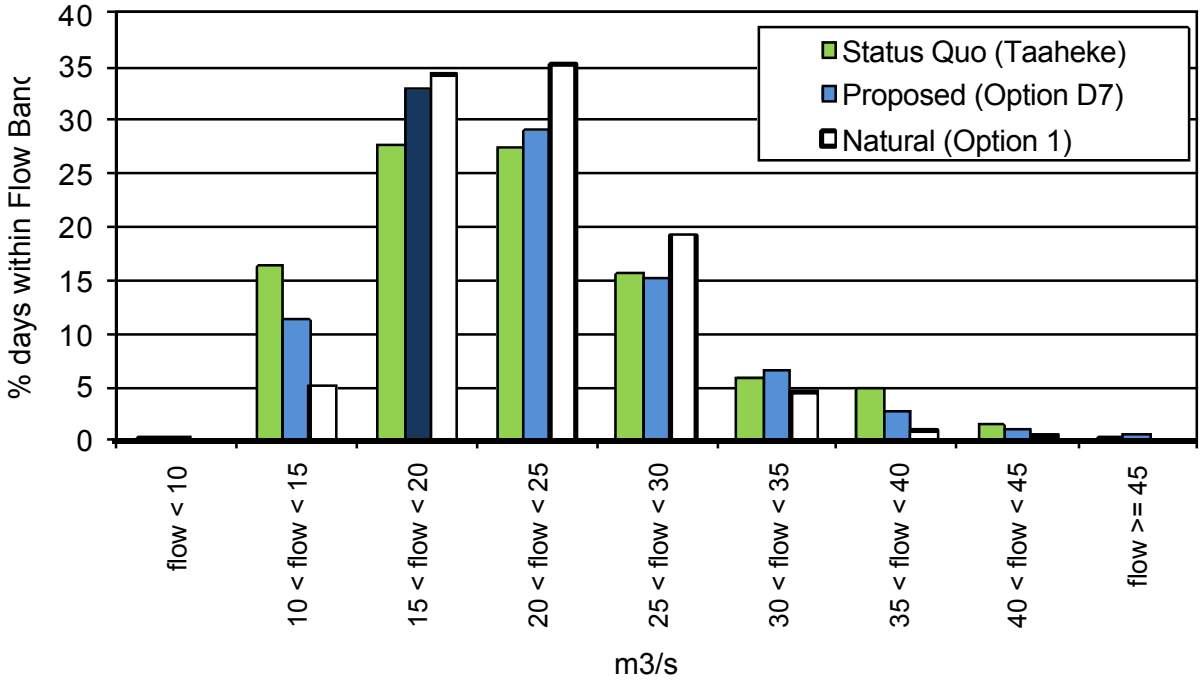
Improving lake water quality is a very important target for Lake Rotoiti. Considerable effort was put into ensuring that the operation of the Okere Gates did not compromise the effectiveness of the Ohau Diversion Wall at diverting 'dirty' Lake Rotorua water directly to the Kaituna River. Water quality modeling showed that allowing a wider water level range with more flexibility in how the Okere Gates operates improves the effectiveness of the diversion wall. Overall, the water quality benefits of the POS compared to the status quo were positive but very small (Hamilton et al, 2010).

4.3.7 KAITUNA RIVER

The POS may be slightly positive for the Kaituna River because it will provide a slightly more natural flow regime and reduce extreme flow events in the Kaituna River compared to the status quo. Refer Figure 11. This could reduce downstream erosion with possible improvements in water clarity. Any effects on river ecology are expected to be negligible.

The way in which the Okere Gates are operated has negligible effect on the quality of water passing through the gates and flowing down the Kaituna River. River water is most influenced by diffuse pollution from further downstream (McIntosh, 2010).

Figure 11: Histogram of flow scenarios at the outlet to the Kaituna River



5 CONCLUSIONS

The Ohau Weir and Okere Gates consent application was complicated both technically and operationally and by virtue of the need to satisfy many conflicting performance criteria. However despite these challenges the Proposed Operational Strategy for Lakes Rotorua and Rotoiti was derived from performance criteria developed out of extensive consultation with all stakeholders over the period 2009 – 2010.

5.1 PERFORMANCE CRITERIA

Initial performance criteria were developed by the Rivers and Drainage Group and its partner Te Arawa Lakes Trust during Stage 1 in 2009. In Stage 1 the Rivers and Drainage Group used the Mauri Model to develop an extensive list of performance criteria that was formulated at various hui hosted by TALT and one of its main iwi groups Ngati Pikiao.

In Stage 2 the Rivers and Drainage Group and TALT simplified the list of performance criteria and consulted with the wider group of key representative stakeholders including Rotorua District Council and the Lake Rotoiti Community Association. The aim of consultation was to identify a preferred operational option that would have the widest community benefit by satisfying the simplified performance criteria.

5.2 OPTIONS

For Lake Rotorua the proposal is to retain the Ohau Weir and existing operational strategy.

For Lake Rotoiti eight potential operational options (including the status quo) were investigated. In the end four options were selected for further investigation and presented in the Rivers and Drainage Groups AEE report that was notified in September 2010. Selected options were the natural (Option 1), low weir (Option 4), status quo and optimised option (D7)

Hydrologics Inc, used the list of simplified performance criteria to formulate an optimised operation that produced the widest community benefits. The final optimised option selected by the Rivers and Drainage Group is the proposed option (D7). The optimised option (D7) became the basis of the POS that was applied for in the consent application

and notified in September 2010. The optimised option D7 incorporates monthly rule (or rating) curves that will guide lake level operations throughout the year.

5.3 IMPACTS

The POS for Lake Rotorua will be to retain the status quo. Numerous adverse impacts would arise if the Ohau Weir were to be removed such as increasing navigation risk by lowering water levels in Lake Rotorua and Ohau Channel.

Impacts of the POS on Lake Rotoiti were assessed. Overall adverse effects for stormwater, drainage, recreation and ecology are expected to be either minor or able to be mitigated.

If time in the higher water level band in Lake Rotoiti increases the flood risk issue at Hinehopu, then consent conditions allow for time reduction in that level band or implementation of alternative structural mitigation such as construction of drainage trenches. Similarly for Mourea, if inundation of the Ohau Channel floodplain occurs then consent conditions provide for bunding of the channel bank if requested by the landowners.

Restoration of beach widths that are culturally significant to Ngati Pikiao at Ruato Bay and Hinehopu will be mitigated by judicious application of herbicide on encroaching vegetation at these locations.

ACKNOWLEDGEMENTS

Te Arawa Lakes Trust for allowing the Rivers and Drainage Group to partner with it throughout the consenting process.

Stakeholders who have volunteered much of their own time to work with the Rivers and Drainage Group in efforts to identify the best operational strategy for the Lakes Rotorua and Rotoiti.

Paper reviewers Phil Wallace (RiverEdge Consulting Ltd), Gary Williams (Waterscape) and Rob Kelly (Aurecon Consultants Ltd)

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Appendix A Lake Rotoiti Performance Measures

Table A1: Lake Rotoiti Performance Measures and Indicators

No.	Performance Measures	Wellbeing	Performance Indicators/Benefits
Lake level Related PM's			
1	Lake Rotoiti levels (fluctuate approximately 350mm +/- 100mm)	Environmental	Native aquatic plant community maintained and enhanced Lake Rotoiti shore margin erosion reduced Wetland health, extent and diversity maintained and enhanced Trout and inanga/smelt population and health maintained Aquatic weed does not increase at lake margins
		Social	Access for social swimmers to lake from public beaches maintained or improved Quality of established fishing & angling maintained
		Economic	Lake tourism venture (ecotourism) growth maintained Function, integrity of and access to Manupirua geothermal pools maintained and improved
		Cultural	Access to traditional fishing/kai sources and recreational areas for local iwi maintained Kai availability for hakari (manakitanga) is maintained and enhanced
2	Beaches	Cultural	Provide more access. Important to local iwi at specific locations
3	Limited range for Lake Rotoiti levels (RL270.041 – RL279.191m)	Social	Current boat access and navigability maintained Visual appeal of lake surrounds not reduced under a narrow lake level range Bad smells resulting from weed strandings and decomposition is minimized
		Economic	Lakeside property values are not adversely effected.
4	Minimum Lake Rotoiti level (no less than RL279.041m)	Social	Access to landing platforms and lake shore jetties are not adversely effected Water supply (intakes) from lake is maintained
5	Maximum lake Rotoiti level for lake shore flood protection (no more than RL279.191m)	Social	Groundwater and Ohau Channel/lake levels remain low improving drainage at Te Takinga/Mourea
		Economic	Lake levels have not increased risk of flooding to lake side properties and infrastructure e.g. roads
6	Maximum Lake Rotoiti level for Hinehopu Drainage (no more than RL278.9m)	Social	Lake water level at Hinehopu maintained 600mm below septic tank outlets and soakage fields Lake water level at Hinehopu maintained such that drainage at Hinehopu Gold course improved Risk of culverts under highway backflowing and associated property problems reduced at Hinehopu and Ruato
Kaituna River Flow related PM's			
7	Kaituna River flow range (from 13 to 26cumecs during business hours)	Economic	Kaituna River flows are maintained for water sport & recreation (kayaking/rafting)
8	Maximum Kaituna River flows 40cumecs	Economic	Kaituna River flooding is not worsened by Okere Gates outflows
Other PM's			
9	Water quality	Environmental	Lake Rotoiti water quality continues to improve and Ohau Diversion Wall effectiveness not compromised
10	Ecological rate of Lake Rotoiti level increases (less than 0.12m	Environmental	The NZ Dabchick population remains stable and robust

	per month)		