Nga Wai Ariki o Rotorua

Changing the Way We Manage the Rotorua Geothermal System

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Keywords: *geothermal system, Rotorua, sustainable management, geothermal surface features, system management plan.*

ABSTRACT

The current review of the Rotorua Regional Geothermal Plan and the development of a system management plan (SMP) for the Rotorua Geothermal System is involving a comprehensive process. The process so far has included reviewing and integrating complex datasets, taking into account evolving planning processes, providing for competing community values, and giving effect to a partnership approach under the Treaty of Waitangi (Te Tiriti). The focus of work to date has been on building an evidence-base to inform our management approach, which has included assessing the state or health of the geothermal system and the review of the Council-owned Rotorua geothermal reservoir model. One of the main challenges has been refining a protection area around the Whakarewarewa geyser field, and in translating modelling results into meaningful predictions and allocation limits that supports the objectives of the plans. Co-design of parts of the SMP with Māori, and wider community engagement, has been integral to the development of the SMP. These unique perspectives are reflected in the scope of the SMP, which extends beyond the traditional technical content, to include principles of management that reflect a te Ao Māori perspective. Protecting surface features and intergenerational customary uses, while providing for extractive uses, has required careful consideration in our long-term objectives. The identification of limits on use is one of the tools we will use to achieve these objectives. Managing community and industry expectations around increased use of geothermal within sustainable limits of the system, remains a challenge.

1. INTRODUCTION

The history of use and its impacts on the Rotorua Geothermal System, and the connection of Māori with the system, has been well documented in literature over many decades. This paper does not traverse this history in detail, but its review has taught us about the deep Māori connection with geothermal (Ngā Waiariki), the vulnerability of system to overuse, ongoing risks to surface features, and what we have to lose (Scott *et al*, 2016). This knowledge guides our future management decisions (Doorman *et al*, 2017).

The system has been managed in a similar way for over three decades. Management is guided by the Bay of Plenty Regional Policy Statement (RPS), and the Rotorua Regional Geothermal Plan, developed by the Bay of Plenty Regional Council (BOPRC) under the Resource Management Act 1991 (the RMA).

The current regional plan largely continued the management approach put in place by Central Government following the Rotorua bore closures in 1989, that were instigated in response to the collapse of the geothermal system through mismanagement, overuse and waste (Gordon *et al*, 2001, Scott *et al*, 2016). The plan was made operative in 1999 and is currently being reviewed by the Bay of Plenty Regional Council. A system management plan (SMP) is being developed in tandem, which is a requirement of the RPS.

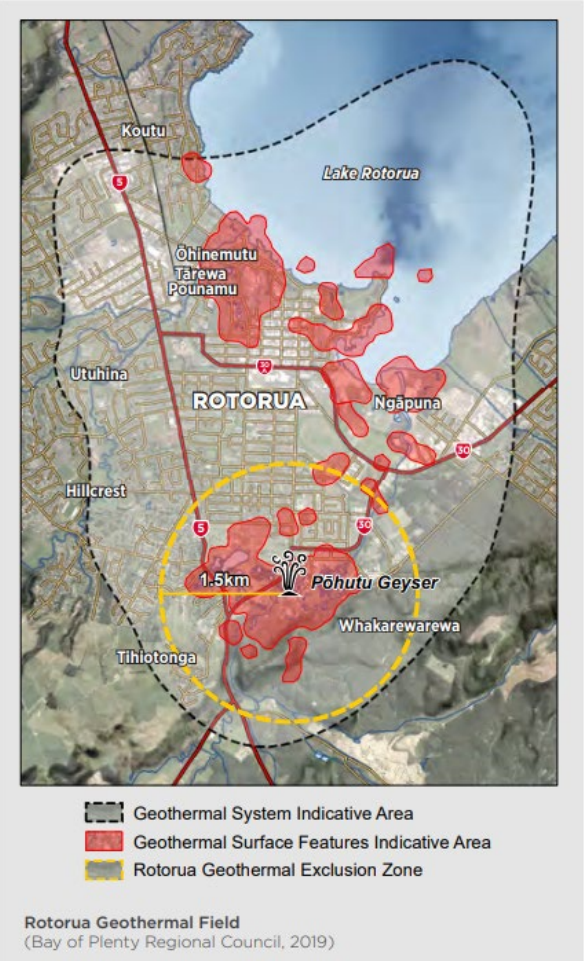


Figure 1: Rotorua Geothermal System

After 30 years of relatively stable management, we now need to review our approach. We know that current management approaches have worked well to support the geothermal system recovery and retain the system in a stable state. Retaining much of this current management approach is easily defendable. However, we now have an opportunity and a political mandate to make some positive changes.

The environmental, social, economic and political landscape in Aotearoa New Zealand has changed dramatically since 1999. We face both a climate and biodiversity crisis, and as a consequence there are conflicting pressures and priorities for management. There has long been interest in geothermal as a

cheap renewable source of energy and increased geothermal use will likely play a critical part in the transition to a carbon zero economy.

At the same time, rare geothermal habitats are depleted and are still being reduced. Many of our geothermal surface features have already been lost through historical energy projects (e.g., hydro and geothermal). Those remaining, including the geyser field in Rotorua, which is arguably the most outstanding natural geyser in Aotearoa, face ongoing threat from increased pressure for geothermal use. Balancing these competing uses is complex, and to date there is little guidance from Central Government about how to navigate this challenge.

Another more recent shift in thinking relates to the Treaty of Waitangi (Te Tiriti o Waitangi, Aotearoa New Zealand's founding document). The Treaty is front and centre of all discussions on environmental management, and giving effect to Treaty principles, and partnership between the Crown and Māori (indigenous people), is no longer a consideration but is a 'given' in all planning processes (Doorman *et al*, 2020). This is particularly evident in Rotorua, where geothermal remains integral to the wellbeing of Māori, and the health of the system is intimately connected to the wellbeing of communities.

From a resource perspective, the Rotorua system is yet to (and may never), fully return to its 'natural state'. This suggests we may need to rethink our objectives for the system and refine the way we measure progress against the objectives. It is time to apply a new lens to management of the system.

2. REVIEWING THE REGIONAL PLAN

2.1 Resource Management Act 1991

The review of a regional plan follows a statutory process, set out in s65 and Schedule 1 of the RMA. The law lays out a statutory minimum requirement, including an assessment of the current plan (s35); an assessment of the costs and benefits of management options (s32); notification of a Proposed Change to the Regional Plan Change; submissions/further submissions; hearings and appeals (in accordance with Schedule 1).

Typically, these processes are time consuming and costly, as the law requires a substantial evidence base to support regulatory requirements, and a high level of involvement of the community, in particular Māori. Plan review processes can be litigious, and as such councils often invest considerably in building an evidence base for the plan and testing their thinking with their community early.

2.2 The Rotorua regional plan review process

The Rotorua regional plan review is following the steps laid out in the RMA. However, we are also following well accepted best practice and taking additional steps to involve the community and partner with Māori in development of the management approach. Key steps to date:

1. A stock take of our existing knowledge and review of effectiveness and efficiency of the current regional plan and management approach and identification of any key failures of the plan (BOPRC, 2001)

2. Identifying the values associated with the system, including the unique relationship of Māori with geothermal.

3. Reviewing and building our understanding on the current health of the geothermal system (Bay of Plenty Regional Council Environmental Summary Report 2019).

4. Starting to reflect Mātauranga Māori (e.g. Māori knowledge) and a Māori world view of the resource in its management, and begin to co-design part of the document with Māori (Nga Wai Ariki o Rotorua: He Kohikohinga, 2020).

5. Drawing on modelled predictions, monitoring and state and trend data, to identify sustainable limits to allocation (Scott *et al* 2020, Scott & Seward, 2022, Burnell, 2022).

6. Assessment of costs and benefits of different management approaches, including natural environment, social, cultural and economic cost and benefits (Barnes, 2021).

7. Development of a draft management approach for the system, including principles of management.

This process is not linear, and in some cases each of these steps has taken many years to complete and will be ongoing. Engagement with Māori, the community and key stakeholders is embedded in the process

2.3 Relationship of the system management plan and the regional plan change

While the regional plan will contain formal policy and rules, to guide resource consents, the Rotorua System Management Plan will provide a high-level whole system management approach, including broad principles of management, as well as operational guidance. For this reason, it has been developed in tandem with the plan review process and the principles in the SMP should ultimately be reflected in policy.

3. USE AND SYSTEM STATE AND TRENDS

The development of the plan review and SMP has involved consolidation of a complex mix of information, including resource consents and patterns and trends in use, monitoring and modelling, some of which are described in more detail below.

3.1 Patterns and trends in use in Rotorua

Sustainable customary use of geothermal by Māori for bathing, healing, cooking etc. is still part of everyday day life in Rotorua, especially in the communities of Ngāpuna, Whakarewarewa, Ōhinemutu and Tārewa Pounamu. These uses have continued for hundreds of years and do not require a resource consent from BOPRC.

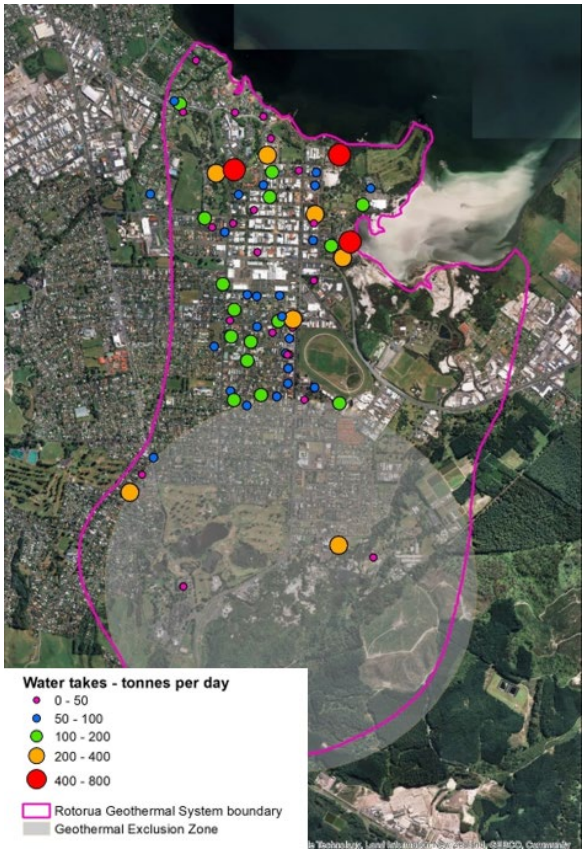
Other uses of geothermal water and energy require a resource consent from Council, of which there are currently about 120. The majority are for production/reinjection systems, although some still discharge some waste geothermal water to land, lake, streams or district council storm water or sewer systems. Forty consents are for downhole heat exchangers (DHX), mostly within the 1.5km Mass Abstraction Exclusion Zone (Figure 1).

Uses include geothermal fluid for bathing and wellness, particularly for commercial use (e.g. hotels, motels, the Polynesian Spa), but also for private use. However, the majority of use of the resource is for space and water heating, including about 400 private homes, commercial properties, the hospital and municipal buildings (e.g. the Rotorua Lakes

Proceedings 44th New Zealand Geothermal Workshop
23 - 25 November, 2022
Auckland, New Zealand
ISSN 2703-427

Council's Rotorua Aquatic Centre and the Rotorua Events Centre). Commercial uses account for over 75% of the total volume allocated.

The patterns of use have been subject to discussion by the community. The current planning framework and commercial pressures have resulted in a feeling that geothermal has become a 'rich man's' resource. While some Māori commercial entities have large consented takes, local people or hau kainga have been less able to access the resource. Central Government have identified that energy poverty and energy security for Māori are matters that need to be addressed. However, enabling greater access by hau kainga will also require a change in policy direction, including prioritisation of use for customary, communal and domestic uses, and addressing financial constraints to access (see section 6.4).



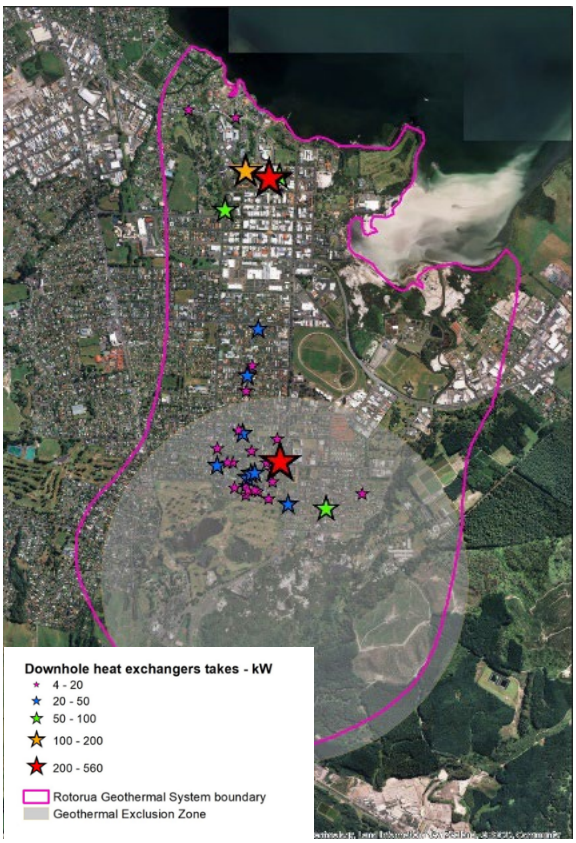


Figure 2: Distribution of resource consents in Rotorua

3.2 Monitoring trends in system health

Understanding the current state of the resource has been a key part of the plan change process. In 2019 BOPRC developed a Science Snapshot report that summarises current uses, monitoring and the health of the system (BOPRC, 2019).

The backbone of BOPRC's geothermal monitoring program is the 5 geothermal monitoring wells and the surface feature monitoring program, which involves monitoring 36 surface features across the Rotorua system. These features are specially selected as good indicators of what is happening on the shallow exploited geothermal aquifer (the part of the system that people are using). The program uses the following key indicators of a 'healthy' system:

- Active surface geothermal features are close to their 'natural state'.
- The shallow geothermal aquifer water level is in a range where surface features will be sustained.

The monitoring data (water levels, temperature and flows and sometimes chemistry) was recently reviewed to identify long term trends (Scott *et al*, 2021). Key findings were that some surface features have returned to their 'natural' state, some have decreased in activity, and some are still changing or further recovering (e.g. Papakura geyser). The assessment also showed that the system responds to climatic variations.

These trends are crucial to setting objectives for the system. While the current plan seeks to retain a 'strategic equilibrium', evidence that the system is still changing

justifies a management approach that enables further recovery of the surface features. This includes anticipating how much further change is likely or even wanted by the community, and the point at which the system may reach its 'natural state'. We know that future changes will be smaller and harder to track down and predict than those seen post-bore closure program, but we also know that even small changes in the geothermal aquifer could be devastating for the surface features (geysers are particularly fragile). This uncertainty is difficult to address in policy, and to message to the community.

3.3 Reservoir modelling

Numerical reservoir modelling plays an important role in identifying numerical allocation limits. As part of the plan review, BOPRC had their Rotorua Tough2 Reservoir Model reviewed by GNS and updated with current production and reinjection data (Burnell 2022). Scenarios have included assessing potential impacts of increased use of geothermal under different regimes on the geothermal aquifer. It also modelled the resulting heat flow changes on the main thermal areas, like Kuirau-Ōhinemutu. How the system might respond to a reduction in takes was also explored.

The Rotorua model has limitations due to uncertainties in the input data for the model, in addition to the intrinsic uncertainties on the numerical modelling process *per se*. For the Rotorua model, the main sources of uncertainty in data input are in geoscience and wellbore data, with no data below 250 meters depth, limited and low-quality production and reinjection data, and limited heat flow data. Another key issue is the intrinsic limitations in using geothermal numerical models, that are designed to understand broader reservoir processes in the subsurface, to inform changes at individual surface features. We are acutely aware that small hydrological changes may be within the errors of the Rotorua geothermal model.

Another challenge is translating modelled predictions into 'real world' scenarios that can be understood and visualised by the community and linked to system objectives. To address this Scott & Seward (2022) have compared historical heat loss calculations and observations to modelled predictions. In simple terms they compared predicted declines in heat flow (e.g. of 10%) with the observed state of surface features when the system was in a known state of decline or stress (Scott & Seward, 2022). This analysis has not been done before and provides a useful 'yard stick' to gauge the magnitude of effects and the implications of modelled scenarios in a 'real-world' context.

3.4 Localised effects and efficiency

Although limits to use will continue to be necessary and a precautionary approach required, more efficient allocation and use of geothermal will support the sustainable management of the Rotorua Geothermal System. A number of projects contribute to a shift towards greater efficiency:

- Modelled impacts of different production systems on the geothermal aquifer (Clearwater and Franz, 2021).
- Improved processes and the development of an app to allocate the correct amount of heat and mass for an efficient use of the geothermal resource (Peng and Moore, 2021).
- Implementing continuous metering to minimise uncertainties around actual use (Barber *et al*, 2017, Zuquim *et al*, 2022).
- Development of education material for users on simple measures they can take to save geothermal heat and mass.
- Research into the implications of reinjection of bathing water as a way to further reduce losses to the system (Sajkowski, 2022).

This body of work has pointed to a policy framework that enables efficient uses, requires sufficient information on use, and a review of the current consenting processes.

4. MĀTAURANGA MĀORI AND TE AO MĀORI PERSPECTIVES ON THE STATE OF THE SYSTEM

The management of the Rotorua system by BOPRC, including monitoring, has been very 'euro-centric'. There are gaps in BOPRC's knowledge of the resource, and Māori are currently not able to fulfil their role as kaitiaki or guardians, or to participate as partners in its management.

For example, Mātauranga Māori (or Māori knowledge) about changes in surface features over time and the health of the system is not something that has factored in BOPRC's monitoring programs or management decisions. Typically, council perspectives on the system tends to be compartmentalised, while the Māori world view (te Ao Māori) takes a more holistic approach, that sees the deep connection of the environment and people.

A critical part of the process has been the establishment and ongoing engagement with a local hau kainga representative group (Te Ahi Kaa Roa), with the purpose of providing oversight and input, and to work alongside BOPRC in the development of the regional plan and SMP. The Roopu has captured the views of hau kainga in a report by Te Ahi Kaa Roa Roopu and Elva Conroy, *Ngā Wai Ariki o Rotorua: He Kohikohinga* (2020). The report focusses on hau kāinga perspectives on the health or mauri of the system, and the geothermal taonga, and how this is connected to the health and wellbeing of people.

The work complements the mainstream science outputs described above and has informed our understanding of the resource. This is one of the first time that this kind of work has been supported by BOPRC and resourced appropriately. Building on this knowledge and applying it to decision making will require further work, considerable changes in BOPRC procedures and potentially changes in management structures (see section 6.6).

5. COMMUNITY ENGAGEMENT PROCESS AND OUTPUTS

Community engagement is a statutory requirement during the development of a regional plan (Doorman *et al*, 2020). A comprehensive approach has been taken, beginning early in the process, starting first with Māori, and ensuring robust engagement at all key milestones. This included over several years:

- Public open days, public presentations.
- Community and stakeholder meetings and workshops, with web-based feedback.

Proceedings 44th New Zealand Geothermal Workshop
23 - 25 November, 2022
Auckland, New Zealand
ISSN 2703-427

- Multiple targeted meetings or hui with Māori.
- Establishment of Te Ahi Kaa Roa Roopu (as above).

This direct connection with the community has enabled Council to provide updates on plan development, information on relevant science, consenting processes and other matters of interest. More importantly, engagement has guided the proposed management framework.

Key themes to have emerged from community engagement (which included stakeholders, resource consent holders, community interest groups, Government agencies and commercial entities etc.) are:

- Questions about the certainty of science informing limits on allocation and about the adverse effects of various activities.
- General support for the protection of geothermal surface features i.e., these are a treasure or a taonga and their health comes first.
- General support to provide for the needs, values and aspirations of tangata whenua.
- A desire for increased use of geothermal and the tension of competing interests e.g., energy security versus protection of our taonga.
- Resistance to the concept that the resource is not unlimited.

Themes from engagement with Māori while similar to those above, highlighted the following specific matters:

- Alienation of tangata whenua from use of the resource and the need to establish priorities which allow for traditional and customary uses (ie. a shift away from dominance of commercial uses).
- Use of mātauranga Māori, intellectual property rights and participation in monitoring and management.
- Geothermal is still part of everyday life of hau kainga.
- People, the environment, and geothermal are interconnected - ngā waiariki is a treasure or taonga - not only a 'resource'.
- Loss of connection and mātauranga - no opportunity for kaitiakitanga or to build mātauranga – need to build capacity and capability to ensure a partnership approach.
- Expectation of a partnership approach, including co-management, co-governance, or transfer of BOPRC powers under the RMA to iwi.

6. HOW THIS WORK IS REFLECTED IN OUR PROPOSED MANAGEMENT APPROACH

The technical outputs and feedback obtained from community engagement and through co-design with Māori, has informed the development of a draft management framework, as outlined below.

6.1 Vision and objective

Typically plans have been a tool to manage use and development activities, and to maximise extractive use of the resource. But our focus is now on the care of the geothermal taonga, and the connections to the health and wellbeing of people. It leads us to a vision **te mauri o ngā waiariki** – this is about restoring and preserving the balance between geothermal, the wider environment, and the community.

This approach draws on similar concepts used in the National Policy Statement for Freshwater (NPSFM) that has the objective of **te mana o te wai**. *Te Mana o te wai is* mandated for freshwater and provides a continuum of uses but this has not previously been applied in the geothermal space.

The proposed objective seeks to move beyond maintenance of the system, to promote continued change and potentially further enhancement. It is very difficult to predict at what point the system is considered 'fully recovered' or even completely 'stagnated' (i.e. what is natural variability and what is sustained changes), which presents a planning challenge.

6.2 Principles of management or tikanga

While principles are not something typically included in a regional plan, the SMP provides an opportunity to provide high level guidance on our management intent and an agreed way to behave (i.e. tikanga).

The following principles proposed for the SMP are summarised below:

- Interconnectedness (reflecting the te Ao Māori perspective).
- Sustainability, balance and reciprocity (to ensure management provides for future generations).
- Intergenerational relationships (to value to knowledge passed down by generations).
- Collective knowledge (recognising that we must draw on all value sets and knowledge in decision making, including Mātauranga Māori).
- Fairness and equity (to address the imbalance currently seen in the use of the resource)

These principles need to be refined and agreed in partnership as they are the fundamental basis for management.

6.3 Our management strategies

We propose a suit of management tools to achieve our objectives. Some of these will be embedded in the SMP and some will be translated into specific policies and rules in the regional plan. These are described below:

6.3.1 Knowledge based decision making

The BOPRC understanding of the system has been built upon decades of monitoring of the geothermal aquifer. While this is hugely valuable, Māori have hundreds of years of observation, captured in oral history, songs and stories and more recently in reports supporting Treaty settlements, resource management processes and iwi management plans. As we move towards partnership, we need to also draw on Mātauranga Māori to inform decision making. This is a significant shift from our current management approach. A te Ao Māori approach also directs us to including socio-economic indicators on the health of the geothermal system and the wellbeing of the community. This will be supported through operational changes, such as resourcing of

Proceedings 44th New Zealand Geothermal Workshop
23 - 25 November, 2022
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Mātauranga Māori monitoring and research, Māori oversight of system management and also partnership structures in management (see below).

6.3.2 Managing within sustainable limits

All use has an adverse effect in the system, whether it is taking water out of the system, or taking too much heat in some areas, but the difficulty is knowing how much energy can be used sustainably.

The vision of Te mauri o nga wai ariki is about restoring and preserving balance, and only 'taking' when we can without damaging the natural balance between the aquifer and surface features. To identify these safe 'operating limits' for the Rotorua system, we have consolidated all of the technical input described above to identify system wide limits relating to gross take and net loss of geothermal water from the aquifer, and system wide limits to taking of heat.

These limits are still being confirmed and discussed with the community and are anticipated to be subject to robust debate and challenge.

6.3.3 Spatial tools to manage surface features

While system-wide limits are necessary, it is also important to take particular care in certain parts of the system, for example when a proposed activity occurs in close proximity to sensitive features. Expert assessments have been carried out using the criteria included in Appendix F of the RPS (Bay of Plenty Regional Policy Statement, 2014). Areas or zones where surface expression is most concentrated can then be identified and more scrutiny applied through the consenting process within these areas (e.g., for takes over a certain size or within a certain distance of features). This also provides people with greater certainty, by indicating areas where activities are more enabled.

Geyser Protection Area

The Geyser Protection Area is proposed to manage activities in proximity to the fragile geyser field in Whakarewarewa. These taonga are very sensitive to changes in temperature and pressure, and by maintaining conditions that protect geysers, we protect other primary surface features by default. The current plan contains a 1.5km Mass Abstraction Exclusion Zone around Pohutu geyser, and this has been effective. However, the delineation of the boundary has been questioned in the past, so BOPRC has reviewed its extent, drawing of geological information, current distribution of consents, extent of surface features, etc. While some minor amendments are likely, this process has built confidence in the appropriateness of the long-established exclusion zone boundary.

Sensitive Management Areas

To develop a more nuanced management approach in other parts of the system, two other areas are proposed to be delineated. The data that informed the Sensitivity Management Areas so far are the location of primary geothermal features with different buffer sizes around them, geophysical (resistivity) contours and temperature of the system at subsurface. The policy approach will be precautionary and guide case by case assessment of effects, with more control on the size of takes, density of takes and proximity to surface features, while enabling low impact and customary uses.

This approach is new and will require further refinement. One point of contention may be the extent of the zone (e.g. options include, but are not limited to, buffers of 100 or even 300 meters around primary features). The approach and ongoing implementation would need to be developed and agreed in partnership with the specific communities within the villages.

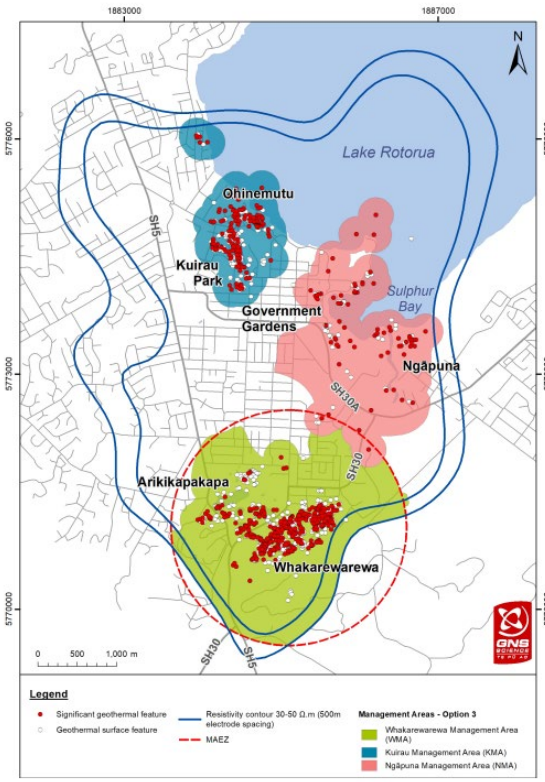

Figure 3: Distribution of surface features with an indicative buffer of 225 meters.

6.4 Prioritising use

Within the vision *Te mauri o nga wai ariki* is an implied hierarchy of needs, where we provide first for taonga, and then for people's needs. Managing the system within sustainable limits means that there are potentially competing demands for its use. Equity and fairness are principles that underpin the new management approach. This directs us to an allocation framework that prioritises use as follows:

- Allocation first for the protection and enhancement of geothermal taonga.
- Ongoing and enhanced customary use, for the benefit of tangata whenua, in accordance with tikanga Māori.
- Future growth of and restoration of access to geothermal by mana whenua for customary communal use such as marae and papakainga.
- Community/municipal facilities (e.g. public pools, churches, non-profit organisations).
- Individual and group heating schemes for commercial and domestic users.

There are some legal constraints to this approach, as the RMA essentially works on a 'first in first served' basis. But possible

Proceedings 44th New Zealand Geothermal Workshop
23 - 25 November, 2022
Auckland, New Zealand
ISSN 2703-427

tools include using a consenting hierarchy to enable certain uses, and a more prescriptive approach for others.

6.5 Integrated monitoring and management

In the past the way we monitor and report on the state of the system is not integrated (i.e., it does not include consideration of all knowledge sets) or easily accessible transparent, and it is non-inclusive of Māori and Mātauranga Māori or even the wider science community. This signals the possible establishment of a Management Review Group (akin to a Peer Review Panel for development systems like Kawerau) to provide regular, integrated and independent oversight into the mauri/health of Rotorua Geothermal. This would be a shift from the status quo, which is quite internally focussed (i.e., reporting to the community is limited) and intermittent. A more inclusive approach would be a step This is a step towards a partnership approach, but other partnership options are discussed below.

6.6 Partnership

Māori have made clear that they never ceded ownership or management of the geothermal system to Government, and that they have an expectation of a Treaty partnership (at least) in geothermal management. It is not within the scope of this paper to address the complex constitutional, legal or Treaty issues that underpin this. However Central Government is directing Local Government to fulfill its Treaty obligations when discharging its resource management functions.

The continuum of partnership ranges from operational partnership (e.g., a mātauranga monitoring program), to co-management (e.g., day-to-day decision making, such as reporting on the state of the system) to co-governance (e.g., joint decision making on policy through joint Committees of Council or something similar). The RMA also provides the ability for councils to completely transfer some of their powers to iwi.

It is not likely that these changes will be instantaneous, as their success will depend on building capacity and capability within both BOPRC and iwi. An adaptive and evolving approach therefore needs to be developed and designed in collaboration. Ongoing resourcing of Māori to participate meaningfully in a partnership approach will also be necessary.

7 CONCLUSION

Developing a regional plan and SMP for the Rotorua geothermal system after 30 years of stable management is a complex process that is not without challenges. Through multiple technical and expert reports, BOPRC has built an evidence base to support the planning framework, including options for allocations limits. BOPRC has also engaged with the community and to work with Māori as kaitiaki and treaty partners. This co-design of parts of the SMP with Māori, and wider community engagement, has been integral to the development of the SMP. These unique perspectives have led to a new way of thinking about management and are reflected in the scope of the SMP, which extends beyond the traditional technical content, to consider how the health of the natural environment is interconnected to the wellbeing of people.

ACKNOWLEDGEMENTS

This report draws on a wealth of knowledge that has been accumulated on the Rotorua Geothermal System over more than thirty years. We are very lucky to have a geothermal community that is passionate about the Rotorua geothermal system and its unique and vulnerable values. Many experts (both past and present), in particular the Ahi Kaa Roa Roopu and GNS Science, have contributed over many years to the development of the Rotorua Geothermal Regional Plan, and continue to provide input to inform its review. Thanks also to our wider project team within BOPRC, for their collaboration, expertise, teamwork, and comradery. This work could not progress without their contributions.

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