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Regional Government Strategy for the Sustainable Use and Development of the Kawerau Geothermal Field by Multi-Tappers in New Zealand

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ABSTRACT

The Kawerau Geothermal System in the North Island of New Zealand was first utilised for power generation in 1957. At this time all electrical power generation was controlled by the New Zealand Government. Over the next few decades the system was extensively developed by the Government.

More recently, electricity production has devolved from a State-owned activity towards private ownership. Notably in 2005, Ngāti Tūwharetoa Geothermal Assets (NTGA) purchased substantial Crown assets (as part of a historical settlement with the Crown) relating to the Kawerau Geothermal System. There are now four major consent holders using the geothermal resource, including Mercury NZ Ltd, NTGA, Geothermal Development Ltd, and Te Ahi O Māui Ltd.

Sustainable management of the resource is administered by the Bay of Plenty Regional Council (BOPRC) under the Resource Management Act 1991 (RMA). It allocates use of the resource through consents, with each consent holder having specific rights and obligations around the use of the resource, for a specific period of time.

The Kawerau geothermal resource is now one of New Zealand's largest developed geothermal resources. The field has consented takes of close to 200,000 tonnes per day with generation of close to 400MWe of electricity and a further 1000 MWth for direct industrial use.

To ensure cooperation between the multiple resource consent holders, and that the Kawerau Geothermal System is managed in an integrated and sustainable manner, BOPRC has worked with consent holders to develop a System Management Plan (SMP). The SMP is intended to provide an integrated approach to sustainable management of the Kawerau Geothermal System, and offer guidance to BOPRC in its decision making processes, in both the administration of existing consents, and the processing of new resource consent applications. This includes agreed operational protocols both amongst consent holders and between consent holders and BOPRC.

1. INTRODUCTION

The Kawerau Geothermal System is located to the north-east of the township of Kawerau, within the Bay of Plenty Region of the North Island of New Zealand (figure. 1).

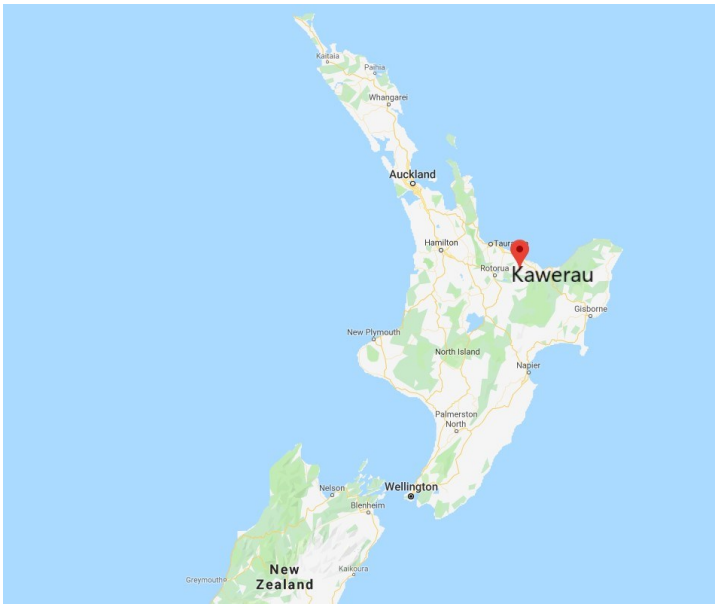

Figure 1: Location Map of Kawerau, Bay of Plenty, North Island, New Zealand (adapted google maps)

Geologically, the 22km^2 Kawerau Geothermal System is located at the southern end of the Whakatāne Graben (Milicich et al. 2015). Based on the inferred resistivity[1] boundary at a depth of 500 m, the Kawerau Geothermal System (fig 2.) extends over an area of approximately 35 km^2 (Bignall and Milicich 2012).

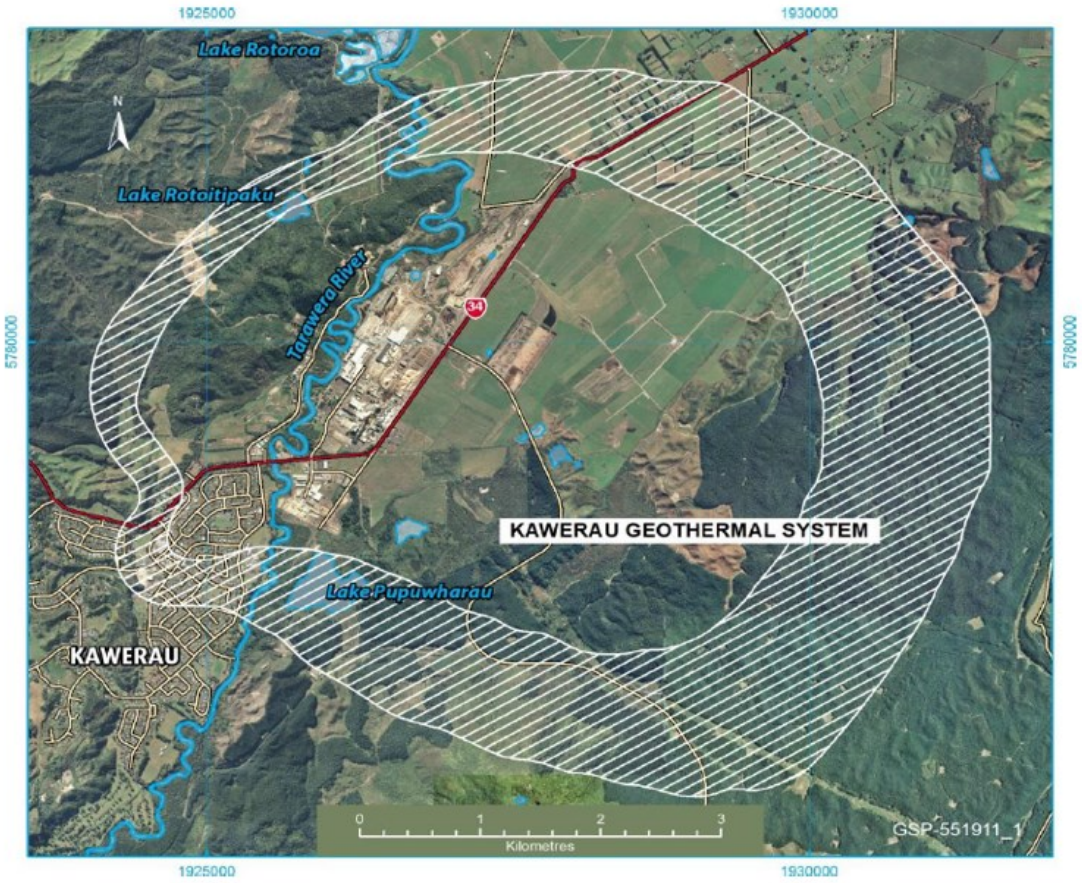

Figure 2: Location of Kawerau Geothermal System (Based on inferred resistivity boundary) (Milicich et al. 2015)

This area of active extension, faulting and regional subsidence is due to the intersection of the Taupo Volcanic Zone (TVZ) NE-striking active rift with the N-trending strike-slip faults of the North Island Shear Belt. Downfaulting of the Mesozoic greywacke basement within the Whakatāne Graben over the last ~ 1 million years has resulted in a 1-2km depression. This has been infilled with a sequence of locally-erupted rhyolite. Dacite and andesite lavas, ash-flows (ignimbrite) and lacustrine sediments. Geothermal activity is estimated to have occurred over the last 320 000 years (Bignall and Milicich 2012).

1.1 History of Development

Exploration and scientific surveys by the Department of Scientific and Industrial Research and the Public Works Department, instigated geothermal development by Tasman Pulp and Paper Company. The 17 wells drilled up until 1957, provided steam for process heat with any excess used to generate 8 MW of electricity. To date over 70 wells have been drilled in the field with 16 currently used as production bores and another 17 for reinjection. The rest have been either abandoned or are used as monitoring wells (Milicich et al. 2015).

More recently, electricity production has devolved from a State-owned activity towards private ownership. Notably in 2005, Ngāti Tūwharetoa Geothermal Assets (NTGA) purchased substantial Crown assets (as part of a historical settlement with the Crown) relating to the Kawerau Geothermal System. The Kawerau geothermal resource is now one of New Zealand's largest developed geothermal resources. The field has consented takes of close to 200,000 tonnes per day with generation of close to 400MW$_e$ of electricity and a further 1000 MW$_{th}$ for direct industrial use (Harvey pers com. 2019).

1.2 Resource Users

There are now four main consent holders using the geothermal resource, including Mercury NZ Ltd (previously Mighty River Power), NTGA, Geothermal Development Ltd (GDL), and Te Ahi O Māui Ltd (TAOM) (refer fig. 3). Both GDL and TAOM are developments owned by Eastland Generation.

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1 Resistivity quantifies how strongly a material opposes the flow of electric current. A low resistivity indicates a material that readily allows the flow of electric current. In geothermal exploration, low resistivity indicates the potential of geological material to contain or have potential to contain geothermal fluid.

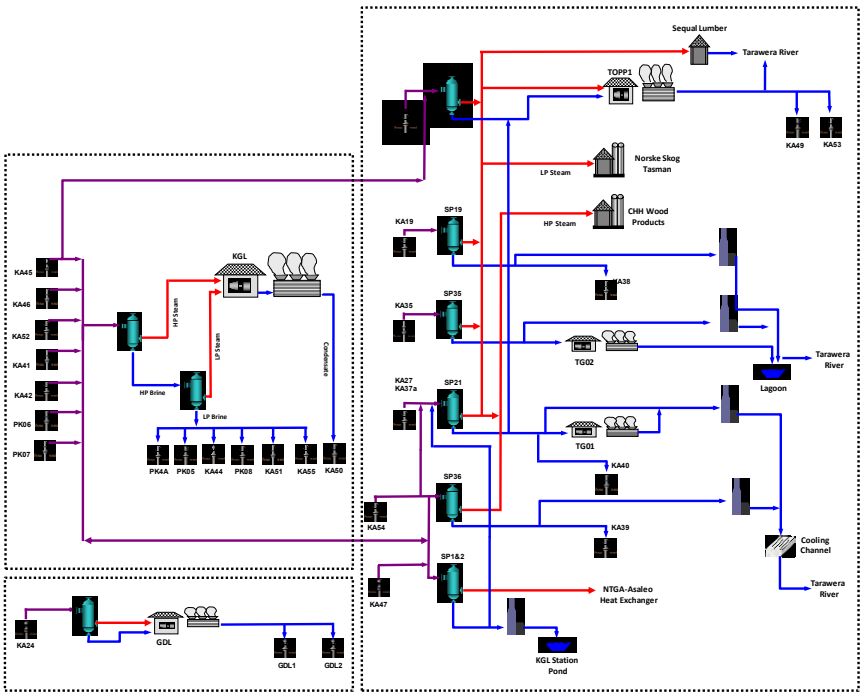

Figure 3: Schematic of Kawerau Steam Field layout (not including Te Ahi O Māui Ltd project)

Due to the intricate nature of business interests within the Kawerau area with their intimate reliance on geothermal energy and steam, all consents who have a direct impact on the reservoir have the following condition in their consent:

> *XX.X The consent holder shall retain the use of a calibrated (pressure and temperature) and validated (peer reviewed) geothermal reservoir numerical model ("Kawerau Reservoir Model") and a 3D subsidence model ("Kawerau Subsidence Model") for the Kawerau Geothermal System.*

Conversely, Mercury's take and discharge consent 63295 states the following:

> *14.6 For the purpose of enabling the sustainable management and efficient use of the Kawerau Geothermal Field, the consent holder shall make available to any third party who intends to seek resource consents to abstract geothermal fluid from the Kawerau Geothermal Field ("Potential tapper"), the Kawerau Reservoir Model PROVIDED THAT the Consent Holder shall not be required to make such a model available unless and until the Potential Tapper becomes a party to the Steamfield Management Agreement relating to the Kawerau Geothermal Field.*

The Steamfield Management Agreement is a commercial agreement administered by the Steamfield Tappers Management Committee (STMC) of which all consent holders are parties to. This is a commercial agreement that has sustainability of the resource as its primary focus whilst also facilitating access to the numerical reservoir model. The Regional Council has no stake in the STMC, but clear lines of communication with committee members and an understanding that has the STMC reviewing any activities that has the potential to impact on the field prior to presenting to Council and or the PRP.

1.2 Resource Management Framework

Sustainable management of the resource is administered by the Bay of Plenty Regional Council (BOPRC) under the Resource Management Act 1991 (RMA). The RMA is New Zealand's primary legislation for the sustainable management of the environment. Under the Act, the Regional councils have the responsibility of managing the taking of geothermal water and energy and geothermal discharges to land, air and water. These functions are guided by regional planning documents including the Regional Policy Statement, which provides overall direction, and regional plans which contain detailed rules.

The Regional Policy Statement (RPS) requires overall sustainable management of the geothermal resource and does this by classifying geothermal systems, from Protection to Development. The Kawerau Geothermal System is classified as Development System, which provides an enabling framework for development. The RPS also requires integrated management through the development of a System Management Plan.

1.3 Resource Consents

The resource is allocated through resource consents (permits), with each consent holder having specific rights and obligations around the use of the resource, for a specific period of time (https://www.mfe.govt.nz/more/acts-and-regulations/resource-management-act-1991).

The consenting process is guided by both the RMA, regional planning documents and is designed to put controls on activities that may have an adverse effect on the environment. In the case of consents granted to take, use and discharge geothermal fluid within

the environs of the Kawerau geothermal field, all applications are required to have their potential effects on both the reservoir and surface features numerically modelled and a cultural impact assessment made. Due to the potential impact on, and significance economically and culturally, of the Kawerau geothermal field, all recent consents have been publically notified (allowing the community to make submissions on the resource consent applications and appeal councils allocation decisions) and ratified via Environment Court hearings (https://www.boprc.govt.nz/environment/resource-consents/).

All geothermal take and discharge consents associated with the Kawerau Field are overseen by an independent Peer Review Panel (PRP). The PRP consists of three experts suitably qualified and experienced in geothermal resource monitoring, geothermal reservoir management or related environmental effects. The purpose of the PRP is to assist the Regional Council to fulfil its functions in respect to the exercise of these consent and any effects on the reservoir. The decision on whether to act on any recommendations from the PRP will rest with the Regional Council after consultation with the relevant consent holder(s).

1.4 System Management Plan

To give effect to the RPS a System Management Plan (SMP) has been developed, as required by the RPS. Typically elsewhere in New Zealand SMPs have been prepared by applicants as part of resource consent applications, or by Council for systems with many users (such as Rotorua). For Kawerau, there is already a high level of existing use, by more than one resource consent holder, with relatively long term, sizeable consents recently granted. This brings unique issues for the management of the system, for example modelling, monitoring, assessing impacts, attributing cause and effect, consistent processes etc.

For this reason the SMP for Kawerau was developed in collaboration with consent holders, and is more akin to a multi operator protocol. It is intended to provide an integrated approach to sustainable management of the Kawerau Geothermal System, and offer guidance to BOPRC in its decision making processes, in both the administration of existing consents, and the processing of new resource consent applications. This includes agreed principles and processes, and operational protocols both amongst consent holders and between consent holders and BOPRC. The SMP is considered a 'Living Document' reflecting the changing nature of both the field and the operators.

The SMP provides a high level overview of the geology and geothermal resource and guidance through issues via an alliance with commercial contracts via consenting conditions. The SMP can also be used to modify consents to provide a balanced and fair framework for geothermal management across the field. Currently the balance of responsibility on the field has localized issues mainly the user's obligation while BOPRC takes onus regarding field wide concerns (Kawerau SMP, 2018).

2. CHALLENGES OF MANAGEMENT ON A MULTI TAPPER DEVELOPMENT SYSTEM – A CASE STUDY

2.1 Case study: Geothermal Well KA35

The Te Ahi O Māui Ltd project involved the drilling of production and reinjection bores on Maori owned land to the west of Kawerau and the commissioning late 2018 of a 25MW Ormat geothermal power station. This was carried out after thorough modelling of potential effects and the establishment of a rigorous monitoring process, due to the relative unknown nature of the western area of the field that this project is based in. Contemporaneously, instrumentation associated with KA35, an established NTGA production bore that intersects the eastern edge of the TAOM production zone, indicated a sharp enthalpy decline. Routine checks of all measurement systems associated with KA35 showed no abnormalities in their operation. Concerns were raised that due to structural controls in this area production from the nearest TAOM bore had the potential to induce a cold down flow that could have field wide implications.

Both BOPRC and the STMC were notified of the situation as per the SMP as below, and agreed upon protocols initiated, as documented and agreed by Council and all operators in the SMP.

> ***Processes to be followed***
>
> *In the event that properties of the Kawerau Geothermal reservoir vary to a material degree from those predicted and this variation is likely to result in a material adverse effect, the following broad process will apply:*
>
> *1 The Consent Holder/s will notify BOPRC at the earliest opportunity of the variance they have identified.*
>
> *2 The Consent Holder/s will, in consultation with each other as necessary, assess the likely cause of the variation and likely responses necessary to mitigate the effect/resolve the issue.*
>
> *3 An explanation of the suspected cause and preferred management response will be agreed by consent holders.*
>
> *4 The preferred approach will be evaluated by the PRP in discussion with consent holders.*
>
> *5 If consent holders cannot agree, they will separately and in a timely manner propose their alternative management responses for consideration by the PRP.*
>
> *6 Following approval by BOPRC, the PRP's recommended response will be put in place, in accordance with specified timeframes that reflect the urgency of the issue.*
>
> *7 Monitoring will be undertaken by consent holders in order to assess the success of the response (and potentially updates to model/s), with any necessary changes following the broad process above.*

If the consent holder does not implement the response which BOPRC considers appropriate, having regard to the PRP's recommendations, then the consent holder must be in a position to justify its position to the satisfaction of Council. Where a response cannot be agreed then appropriate RMA processes will be followed.

Where BOPRC considers it appropriate to depart from a recommendation of the PRP, it will provide appropriate supporting documentation to justify this approach.

As per agreed processes, BOPRC facilitated a meeting between all the users to discuss both the issue and preferred management response. Likely causes were tabled by all users and assessed by the PRP as per flow chart in fig. 4. As all users considered themselves to be either directly affected, or likely to be, in a worst case scenario, the 'multiple user profile on the flow chart was employed.

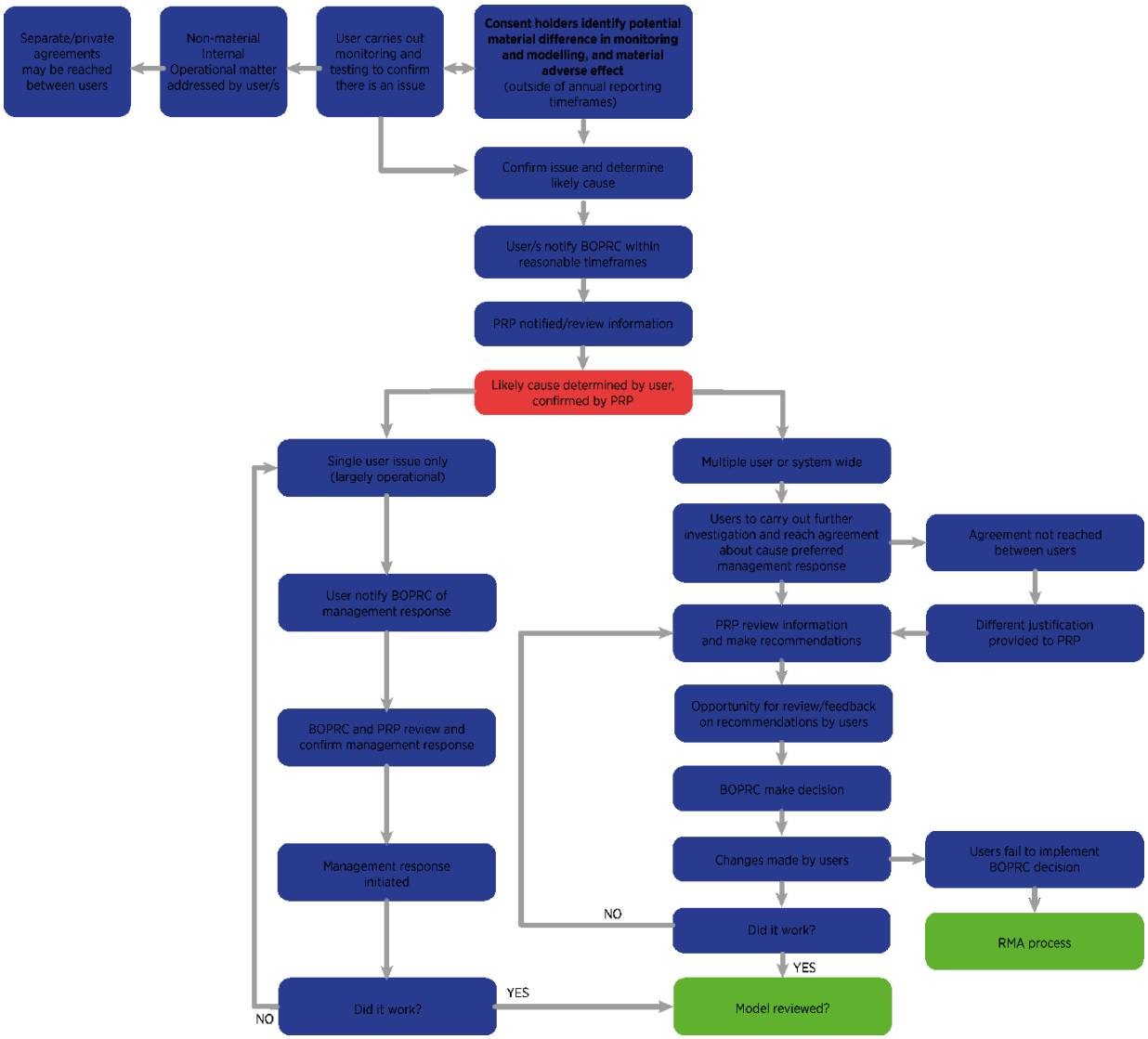

Figure 4: Flow chart from SMP delineating the means to address a material adverse effect as part of adaptive management process

Regular meetings between the users' technical experts and the PRP were then organised to discuss the data as it evolved over time. PRP recommendations were implemented following approval by BOPRC. This methodology was then repeated as per the SMP until a positive management response was achieved. Depending on causality, 'solutions' tabled ranged on a continuum from do nothing, to shut down the plant until a long term solution could be resolved.

Further analysis of instrumentation associated with KA35 indicated that a steam flow meter that had been checked a number of times given the decline observed, and was also calibrated during the statutory plant outage was found to be faulty. The transmitter had a defect causing it to wander in a linear fashion in its electrical conversion of current to output.

Whilst the 'issue' turned out to be technical in nature, the situation allowed the ability for all concerned to assess the SMP process for dealing with such a problem. While external commercial agreements such as the STMC did inhibit certain aspects, the SMP procedures turned out to be robust and fair.

CONCLUSION

Kawerau Geothermal System is unique. As a Development System, with multiple consents for large takes supporting an extensive electricity and direct heat use industry, there is potential for exploitation and competition to the detriment of the system. As such a System Management Plan was developed for integrated and sustainable management of the system, to ensure consistent implementation of consents, and to ensure cooperation between users. In the case study presented, the positive resolution of complicated issues has been achieved, guided by legislation, expert scientific analysis of data, collaboration and processes delineated in the SMP.

ACKNOWLEDGEMENTS

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