Geothermal guideline 4

Managing geothermal discharges in Rotorua

This guideline, developed by Bay of Plenty Regional Council, provides broad options to manage geothermal discharges. It does not replace an assessment of effects required as part of a resource consent process or predetermine the outcome of that application.

Geothermal use in Rotorua

Rotorua Geothermal System (Ngā Wai Ariki o Rotorua) has been used by Māori for sustainable customary practices for hundreds of years. More recently, geothermal wells have been widely used to extract heat or water for space and water heating, and bathing.

Overuse of geothermal in the past has changed the geothermal aquifer and destroyed or damaged precious geothermal surface features (ngāwhā), such as geysers and hot springs. Geothermal use is now carefully managed under the Bay of Plenty Regional Council Regional Plan. Under the plan, all geothermal takes and discharges (except those for customary practices) require a resource consent from Bay of Plenty Regional Council.

See the video *Rotorua system – geothermal monitoring programme* https://youtu.be/feUbsy6Uyro for more information on management of geothermal surface features in Rotorua.

Managing the effects of use

Geothermal surface features are driven by pressure in the geothermal aquifer. The effect of geothermal takes on aquifer pressure depends on how much (and how quickly) geothermal water and heat is taken from the aquifer, and how water is reinjected to the aquifer.

Geothermal takes include down hole heat exchangers (DHX), surface water and heat takes, and production injection systems. Production injection systems and surface takes result in discharges of geothermal water, either through reinjection of water back into the geothermal aquifer, or discharges to the surface environment.

This guideline outlines best practice to manage the effects of geothermal discharges. You may also like to refer to our other guidelines on Geothermal Production Systems, Maintaining Your Geothermal Well and Efficiency.

Geothermal discharges from sustainable customary practices

Sustainable customary practices, such as diversion of geothermal surface water for bathing, follow the tikanga of hau kāinga (the cultural guidelines of the local people from an area). This can include filtering bathing water, using natural bathing products, and tikanga around bathing for women during their menstrual cycles. Often bathed-in water will flow back into, or flow over land and back to the area it was sourced from, or to a surrounding geothermally influenced areas.

These takes and discharges do not need a resource consent from Bay of Plenty Regional Council. Where these discharges individually or as a group create an adverse effect on the environment (e.g. on water quality) a resource consent, or a group consent may be needed.

Reinjection of geothermal water

Reinjection is the most important strategy to maintain aquifer pressure and where reinjection is not possible a resource consent may not always be granted. The way geothermal water is reinjected also determines the effects on the geothermal aquifer. Best practice for reinjection is outlined below:

REINJECTION PRACTICES
Reinjection to the same aquifer as production, at the same or similar depth.
Establishment of reinjection wells 'downstream' of geothermal surface features, where possible.
Reinjection temperature a minimum of 60°C, ideally between 80 and 90°C.
Reinjection temperatures no greater than 90°C to reduce water loss through the venting of steam.
Setbacks between reinjection wells and significant surface features of 150-225m where possible, depending on the size of the take.
Maintenance of geothermal well casing to avoid adverse effects of reinjection on shallower aquifers and uncontrolled discharges resulting from well blow outs.
Reinjection wells 'downstream' of neighbouring production wells, where possible.
Monitoring (spot-measurements) of the discharge, or continuous metering of take and discharge volumes and rates for large discharges.
Transition to DHX where reinjection of water (for heat takes) is not feasible for the reasons referred to in Constraints to reinjection below.
Identify back-up temporary discharge option in the event that rejection is not possible (e.g. well failure).

Constraints to reinjection

Reinjection is usually possible (although it may increase costs) and only in limited circumstances should a discharge alternative be considered. Reasons reinjection might not be technically feasible include:

- Site constraints (e.g. access, property boundaries, proximity to other production wells, setbacks from surface features or infrastructure).
- Increased risk of hydrothermal eruption in high pressure zones (a report from a SQEP is necessary to demonstrate this).
- Where the reinjection rate and temperature create a risk that the well starts discharging ('livens up' the reinjection well), instead of receiving the reinjection water under gravity, and it is not technically feasible to manage this risk.

In these cases, the use of production-injection systems to extract heat only from the system are not sustainable long term and options to transition to a DHX should be explored.

See also WorkSafe's guidelines – *Self-managing shallow geothermal well systems.*

Exceptions to reinjection

Situations where a requirement for reinjection could be waved include:

- Some of the take is for bathing water (see below).
- Surface discharge of geothermal water to reinstate or enhance a surface feature, where this outweighs the adverse effects of non-reinjection.
- Small, consented takes from a geothermal well (<10 t/day) for customary community purposes, e.g., mineral bathing, where costs of treating and reinjecting water outweigh the adverse effects of non-reinjection on the system and the receiving environment.

Discharging water that has been bathed in

Discharge of geothermal bathing water can affect the geothermal aquifer, groundwater, other surface receiving environments and cultural values. Bathing water has usually been cooled, may be diluted by town supply water that is added, and it may be contaminated by human pathogens and bathing products.

Geothermal water is sometimes sourced from a hot spring or hot pool, or a geothermal production well. An example of how geothermal water is taken using a well, used for bathing, and then reinjected, is shown in Figure 1.

See also our guideline on Geothermal Production Systems.

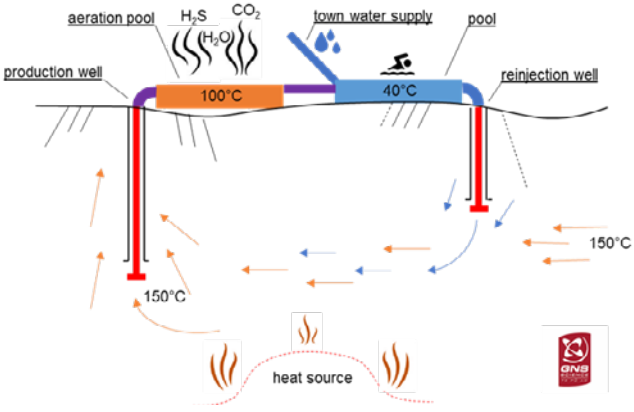

Figure 1: Schematic drawing of a production-reinjection take, with reinjection to a hot aquifer after use. Note that each take in Rotorua will have a different configuration and the aquifer conditions will change too.

Potential effects from discharging bathed in geothermal water

Pathogens

Bathing can release human pathogens into geothermal mineral pools. The risk to health depends on the outflow temperatures, residence time of the water, flow, the rate of discharge, the number of bathers, types of microorganisms present, pH of the water and degree of dilution. For example, there is a lower risk of contamination if water is flowing through a pool while bathing, but there may be elevated levels of human pathogens if bathing water is discharged after some time.

Where bathing water is to be reinjected, the risk of contamination to the geothermal aquifer, geothermal surface features and to the users downstream depends on the reinjection rate, temperature, aquifer conditions, chemistry, and pathogens present. The risk is minimal for small takes, where reinjection is into zones of the aquifer >100 degree. For takes with a potentially high pathogen load, filtering is recommended prior to reinjection

When the water is discharged to land or surface water, the risk of contamination will reduce through dilution and soil filtration, but in some cases additional filtration is also advised. A filter with pores of 0.45 µm or less is recommended.

Private pool owners are responsible for the quality of the water in private pools. Commercial pool owners are responsible for the quality of the water in commercial pools and compliance with the NZ Standard for pool water quality. Rotorua Lakes Council Geothermal Safety Bylaw has additional requirements related to the public safety aspects of bathing in geothermal pools, including the discharge of hydrogen sulphide, access, signage and pipework.

Chemistry

Geothermal water is usually cooled before bathing, either in a cooling pond or tower, or by adding town supply water. Adding town water dilutes geothermal water, potentially affecting the chemistry of the aquifer if reinjected, or the ecology of the receiving surface environment.

Modelling shows that the effects of reinjecting diluted water are negligible for small volumes, but could be a concern for reinjection of more than 300t/day. The ideal mixing ratio to minimise the effects on the chemistry of the aquifer is 1:1 geothermal to town water.

For more information see the report *Effects of reinjecting diluted mineral pool water into the Rotorua geothermal system* (GNS, 2022) available on Bay of Plenty Regional Council's website.

Temperature

Reinjection of cooled bathing water could potentially cause localized cooling of the aquifer. For small takes, the effect would be minor. For larger takes, reheating of water prior to reinjection is necessary for pressure support and to reduce the impact on neighboring wells.

In the wrong place heat can be a contaminant. Discharge of warm water into a cooler environment can potentially impact surface features or change the ecology of the receiving environment.

Effects on land

Surface discharges of geothermal water can cause local flooding, alter water courses or change the natural state of surface features. Shallow soakage can also lead to slumps or subsidence and pose a risk to infrastructure. Effects will depend on the rate and volume of discharge.

For more information see the report *Effects of reinjecting diluted mineral pool water into the Rotorua geothermal system* (GNS, 2022) available on Bay of Plenty Regional Council's website.

Effects on the sewer

Geothermal water can be corrosive, and even a small amount can put additional pressure on sewer infrastructure. Adding geothermal water to the sewer increases treatment costs and the load of nitrogen to the lake. Large discharges, and discharges with a high geothermal sediment load (e.g. geothermal mud treatments) are of particular concern because they inhibit the wastewater treatment processes and add heavy metals to the biosolids. Rotorua Lakes Council currently allows small volumes from private geothermal pools to be discharged to the sewer, but these volumes need to be managed.

If you are seeking a geothermal consent from Bay of Plenty Regional, and you intend to discharge to the sewer, you will need to provide confirmation of approval from Rotorua Lakes Council for this discharge as part of your application, and prior to the regional resource consent being granted.

You may also be asked by Rotorua Lakes Council to:

- Obtain a trade waste consent for geothermal discharges to the sewer
- Prepare a waste management plan
- Maintain or upgrade your private service line connecting to the Rotorua Lakes Council sewer
- Pay the costs of treatment
- Move to treat and reinject more water, especially flow through from commercial pools.

Contact Rotorua Lakes Council for more information about discharges to the sewer.

Cultural effects

The cultural effects of disposing of bathing water can only be assessed by tangata whenua. Some things that may be considered as part of a resource consent application include:

- Tikanga that preserves different states and places for different activities
- Mixing of different water (e.g. geothermal and fresh water, geothermal water from different sources).
- Impact on the mauri of the aquifer or receiving environment
- Impacts on sustainable customary practices, such as bathing
- Location of the take and discharge (e.g. is water reinjected to the same places it was extracted?)
- Tikanga applied to bathing (e.g. is this a commercial operation, with a large number of users?)
- Impacts of reinjection of town supply water on mauri
- Impacts of non-reinjection on receiving environment and sensitive areas.

Whakarewarewa Oil / Box baths. Photo: Elva Conroy

Options for discharge of bathed in geothermal water

A resource consent for a geothermal water take (production injection system or surface take), will also need a consent for the discharge of geothermal water, and will need to show how adverse effects will be managed. Discharge options are below. Note: In some cases a combination of options might be considered most appropriate.

OPTION TO DISPOSE OF BATHED IN WATER	EFFECTS (POSITIVE AND NEGATIVE)	EXAMPLES OF MANAGEMENT AND MITIGATION OPTIONS
Reinjection of all bathed in water (including diluted water)	• Supports geothermal aquifer pressure • No contaminant loads to land, lakes and streams • Localised cooling of aquifer (proportional to the reinjection rate and aquifer conditions) • Potential effect on aquifer chemistry (proportional to the reinjection rate and aquifer conditions) • Low risk of pathogens (proportional to pathogen load in the discharge and aquifer temperature)	• Reheating of bathed in water for pressure support 60-80°C, especially for discharges over 100t/day • Filtering (or alternative treatment) of bathed in water for larger takes to reduce contaminants • Monitoring of bathing facilities for contaminants Note: Some of these mitigation measures may not be required for small takes for customary or communal uses)
Discharge of bathing water to sewer **Note: This can include a mixed option of partial discharge to sewer and partial reinjection of bathed in water**	• Any pathogens in the bathing water will be treated • Cultural concerns over reinjection of bathed in water potentially reduced • Potential net loss of water from the aquifer and loss of pressure support	• Minimise effects on the sewer system by limiting discharges to the sewer to small discharges only • Offset net loss of water to the aquifer through reinjection of equivalent amount of heated town supply water (60-80°C) • Provide additional pressure support to the aquifer through the reinjection of additional heated town supply water

OPTION TO DISPOSE OF BATHED IN WATER	EFFECTS (POSITIVE AND NEGATIVE)	EXAMPLES OF MANAGEMENT AND MITIGATION OPTIONS
Discharge of bathing water to sewer *continued* **Note: This can include a mixed option of partial discharge to sewer and partial reinjection of bathed in water**	• Adverse impacts on sewer infrastructure and waste water treatment processes, leading to additional costs • Environmental contaminant loads transferred elsewhere via wastewater treatment plant	• Manage the potential effects of reinjecting town supply water by modelling chemistry and temperature effects for discharges > 300t/day • Reduce the volume discharged to sewer, by limiting discharges to sewer to bathed in water with a high contaminant load, and reinjecting flow-through bathing water • Approval is required from Rotorua Lakes Council for discharges to sewer, prior to granting of regional resource consents
Discharge of bathed in water to surface water	• Net loss of water from the aquifer, loss pressure support • Contamination of surface environment from human pathogens and other geothermal contaminants • Risks from natural geothermal microbes in non-geothermal areas • No impact on sewer system and wastewater treatment process	• Filtering prior to discharge • Limit to small discharges only • Encourage continuous flow through of water in pools • Control rate and volume of discharge to receiving environment to accommodate the load, encourage dilution, and reduce risk of flooding, or damage to surface features • Ensure compatibility between the discharged geothermal water and the receiving water (chemically and thermally) • Integrate discharge structure to the receiving environment
Discharge of bathed in water to ground soakage	• Net loss of water to the aquifer, loss pressure support • Risk of local subsidence or ground collapse • Possible interference with surface features • Potential for groundwater contamination • No impact on sewer and wastewater treatment process	• Limit to small discharges only • Geotech advice outlining how local subsidence or ground collapse and erosion will be avoided • Control rate and volume of discharge to reduce risk

Who to talk to for more information?

Contact **Bay of Plenty Regional Council** for more information on geothermal discharges. You can also contact:

- **Rotorua Lakes Council** – for discharges to Rotorua Lakes Council Sewer
- **Komiti Nui o Ngāti Whakaue** – for an assessment of the cultural impacts of your geothermal resource consent application
- **Tūhourangi Tribal Authority** – for an assessment of the cultural impacts of your geothermal resource consent application
- **Te Arawa Lakes Trust** – for an assessment of the effect of discharges to the lake