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Geoheat business guide in Aotearoa New Zealand

Navigating Technology Options & Resource Management

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

New Zealand Geothermal Association

Foreword: New Zealand Geothermal Association

Aotearoa New Zealand is blessed with an abundance of renewable geothermal energy.

The most familiar of these are the high-temperature geothermal resources (exceeding 150°C) that are located primarily within the Central North Island's volcanic region and at Ngāwhā in Northland. These have been extensively used for electricity generation and industrial direct use for over seventy years.

This Business Guide focuses on the less familiar but equally beneficial temperatures from 150°C down to 10°C that are present at the lower end of the geothermal spectrum.

In fact, at the lower end of the geothermal spectrum, shallow ground temperatures are influenced by solar radiation and are about 2°C above average air temperature. This means that geothermal is available everywhere. Across the country this ranges from about 10°C in the south and alpine areas to 18°C in the far north. These temperatures can be used for heating and cooling with a geothermal or ground source heat pump.

When ground temperatures become more than this 2°C above average air temperature, we start to see a greater geothermal influence. When the water in the ground reaches 30°C then the Resource Management Act (RMA) defines the water as 'geothermal water'.

These warm geothermal water resources (>30°C) are found throughout Aotearoa New Zealand. This includes the areas with high-temperature geothermal resources in the central North Island, along the Alpine Fault in the South Island, at numerous hot spring locations across the nation and at a depth of about 1 km nationwide.

The content of this guide focuses on the low- and medium-temperature applications of geothermal energy for the supply of heat energy, collectively referred to as Geoheat. It builds upon the significant contributions of the New Zealand Geothermal Association Geoheat Action Group and the broader Geoheat business community.

The purpose of this Guide is to provide businesses with a practical overview of two key areas:

- The range of technology options available for Geoheat applications, and

- The resource management and consenting process.

It shows how these topics work within New Zealand's rules, environment, and business context. It seeks to help businesses make informed decisions as they move toward cleaner operations and reduce their use of fossil fuels.

The New Zealand Geothermal Association are pleased to present this Business Guide and support our shared commitment to promoting geothermal heating and cooling (Geoheat) for the long-term benefit of Aotearoa New Zealand.

Kennie Tsui
Chief Executive
New Zealand Geothermal Association

About NZGA

The New Zealand Geothermal Association (NZGA), incorporated in 1992, is a non-political, non-governmental and not-for-profit organisation, with a focus on fostering a sustainable future for Aotearoa New Zealand through the use, development or protection of geothermal resources. The NZGA connects with global geothermal communities and is well positioned to positively influence geothermal initiatives on the national and international stages. Our vision is: "Fostering a sustainable future for Aotearoa New Zealand through geothermal".

The Association membership comprises ca. 580 individuals, as well as 41 corporate members, representing research organisations, Māori trusts, geothermal electricity generators, engineering consultants, technology companies and planning consultants. This diverse and skilled network of people work and live with Aotearoa's geothermal resources.

Acknowledgements

- Energy Efficiency and Conservation Authority (EECA) and NZGA
- GeoExchange NZ & Traverse Environmental
- Technical peer reviewers – Brian Carey (GNS), Penny Doorman and Freya Camburn (Bay of Plenty Regional Council) and Katherine Luketina (Waikato Regional Council)
- The Geoheat Action Group members and the Geoheat communities

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Executive summary

This Business Guide provides practical support for businesses in Aotearoa New Zealand to understand and apply Geoheat – the direct use of geothermal energy for heating and cooling. It focuses on low and medium-temperature applications and addresses two key areas: the range of available technology options, and the resource management and consenting process under the Resource Management Act 1991 ("RMA").

Geothermal resources are widespread across Aotearoa, extending beyond the well-known high-temperature fields of the central North Island. These resources include ambient and geothermally enhanced groundwater, as well as deeper thermal systems associated with fault zones, remnant volcanism, and the natural geothermal gradient. While high-temperature systems are typically used for electricity generation, Geoheat technologies enable the direct use of lower-temperature geothermal resources for industrial, commercial and building-scale applications.

Geoheat offers a locally sourced, renewable, and stable thermal energy supply that is independent of weather conditions. It supports long-term energy security, operational efficiency, and decarbonisation. When integrated with ground source heat pumps, which utilise warmth stored naturally in the ground and in large bodies of water, Geoheat systems can provide both heating and cooling with high energy performance and reduced demand on the electricity grid.

This Guide includes:

- A description of geothermal resource types, their geological distribution, and relevance to Geoheat applications.
- High-level technical guidance on direct and indirect use systems, including the role of ground source heat pumps ("GSHPs") and ground heat exchangers which transmit heat from underground ("GHXs"), and the importance of site-specific conditions
- A recommended development process, from desktop feasibility and test well drilling to system installation and monitoring.
- An overview of the RMA resource consent framework, including the distinction between regional and territorial authority functions, and the importance of early planning and engagement with mana whenua and other potentially affected parties.

Geothermal heat technology is one of several renewable energy options available to New Zealand businesses. Organisations are encouraged to undertake a robust feasibility assessment / options analysis to identify the most suitable technology for their specific operational needs and geographic location. This report focuses on geothermal heat technology and does not evaluate alternative renewable energy solutions.

The Guide emphasises that not all Geoheat applications require resource consent. Consent requirements vary depending on the location, scale and potential effects. Where resource consent is required, a structured and informed approach can reduce costs and avoid delays.

Case studies from Aotearoa and overseas illustrate the benefits and practicalities of Geoheat development across a range of sectors. The Guide forms part of a broader strategy to expand the uptake of Geoheat in Aotearoa and is jointly supported by the New Zealand Geothermal Association (NZGA) and the Energy Efficiency and Conservation Authority (EECA).

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nzga New Zealand Geothermal Association

Traverse Environmental

GeoExchange NZ

Geoheat business guide in Aotearoa New Zealand was produced by New Zealand Geothermal Association in collaboration with GeoExchange NZ and Traverse Environmental.

The purpose of this guide

For most businesses in Aotearoa New Zealand today energy security remains a core operational concern, especially in the face of rising costs, energy supply constraints – natural gas in particular - and the need to transition to renewable sources.

People often talk about solar, wind, and biofuels in Aotearoa New Zealand's energy transition, locally available geothermal energy for heating and cooling is a powerful, underutilised alternative.

Geoheat can be used as a standalone energy source or as part of an integrated hybrid system. It's efficient, proven, and worth consideration in your energy strategy and transition.

The guide introduces Geoheat, Geoheat technologies, discusses regulatory and planning aspects.

Don't let location hold you back - Geoheat opportunities exist far beyond Taupō, Rotorua and other well-known geothermal areas. This guide shows where Geoheat works as an effective low-carbon solution and why you should consider it.

Miraka, Taupō

Miraka's dairy processing plant at Mokai, near Taupō, is the world's first to use renewable geothermal steam to produce process steam that is piped to the factory providing nearly all its energy for spray-drying milk powder and significantly reducing its carbon footprint by 92% compared to conventional coal-fired operations.

What is geoheat and where do I find it?

Geoheat

We use ‘Geoheat’ to describe geothermal heating and cooling, which is different from geothermal electricity generation. Geoheat is thermal energy stored underground in water and rock. Geoheat applications use this energy directly for heating and cooling buildings as well as in commercial or industrial processes. It is a decentralised, local source of energy.

While we usually think of geothermal energy as being very hot, Geoheat is at whatever temperature that it is found in the underground (subsurface).

Usable Geoheat ranges from ambient groundwater temperatures to very hot temperatures in specific locations. A key feature, even with ambient groundwater, is that subsurface temperatures are stable 24/7, whereas surface temperatures change daily and seasonally. All subsurface temperatures are able to be used, it is just a question of the technology required to support the application.

Water is the primary ingredient for Geoheat in Aotearoa New Zealand. Ground water and surface water (streams, rivers and lakes) are both part of the water cycle, as shown in Figure 1 below.

Surface water

Water presents in lakes, rivers, streams, wetlands, snow, glaciers and rainfall (usually ambient temperature). Connected to groundwater via springs, wells, and aquifers.

Groundwater

Water presents underground, filling cracks and open spaces in sand, gravel and rock. Rain and snow soak into the ground, recharging the groundwater supply.

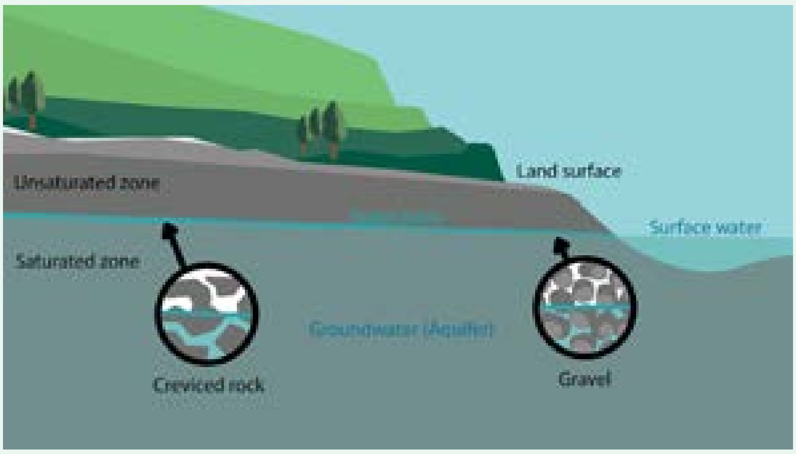


Figure 1 Groundwater schematic adapted from United States Geological Survey (public domain, 2019).

In Aotearoa New Zealand, the Resource Management Act (RMA) defines geothermal energy as "energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water". It defines water as geothermal when it is 30°C and over. But temperatures below 30°C are still useful and still considered as Geoheat; **Geoheat is available everywhere**. This point will be expanded upon in the following sections, especially in relation to geothermal or ground source heat pump technologies.

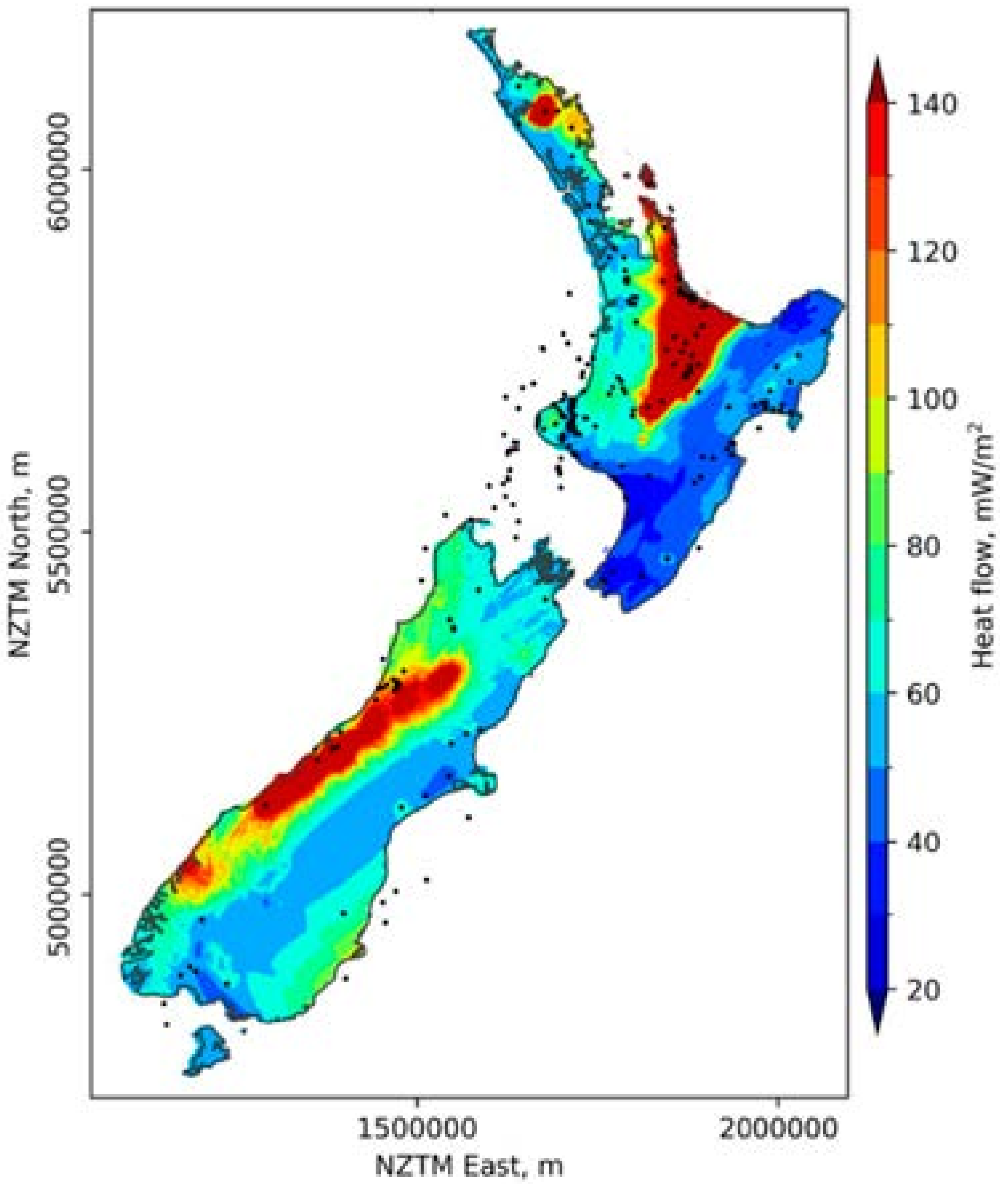


Figure 2 - New Zealand Heat Flow Map (Kirkby et al 2024) GNS Science

Aotearoa New Zealand is fortunate to have abundant geothermal resources, many of which remains underutilised for on-site heating, cooling and energy use. While geothermal systems are geologically complex and site-specific, there are several broadly recognised sources of geothermal heat in Aotearoa New Zealand. These help explain the distribution and temperature of geothermal resources across the country:

Magma Rising Toward the Surface

One of the most prominent geothermal regions in Aotearoa New Zealand is the Taupō Volcanic Zone (TVZ), where the earth's crust is unusually thin, estimated to be as little as 12 km thick in some areas. The tectonic setting allows magma to rise closer to the surface, heating surrounding rock and underground water. This phenomenon accounts for the extremely high geothermal gradients and very hot geothermal fields in the central North Island, where temperatures of up to 340°C are reached at depths of less than 4 km.

Fault Zones

Tectonic movement along plate boundaries can create zones of increased permeability, allowing deeper, warmer fluids to rise toward the surface. The uplift of deeper warmer formations to shallower levels brings warmer temperature underground formations closer to the surface. This tectonic activity contributes to geothermal anomalies in places like the West Coast of the South Island, along the Alpine Fault, where heat may be conducted or convected upward through fractured rock. Hot springs, particularly in the South Island, are associated with faults and tectonic features.

Remnant Volcanism – Legacy Heat from Extinct Systems

Some areas, such as the Western Bay of Plenty, Hauraki and the Coromandel Peninsula, have residual geothermal heat from extinct or dormant volcanic systems. Although these areas may not have the extremely high temperatures of active volcanic zones, moderate-temperature geothermal resources (less than 80°C) are still present and potentially usable for low-to-medium-heat applications, such as process heat, covered cropping, bathing, or water and space heating.

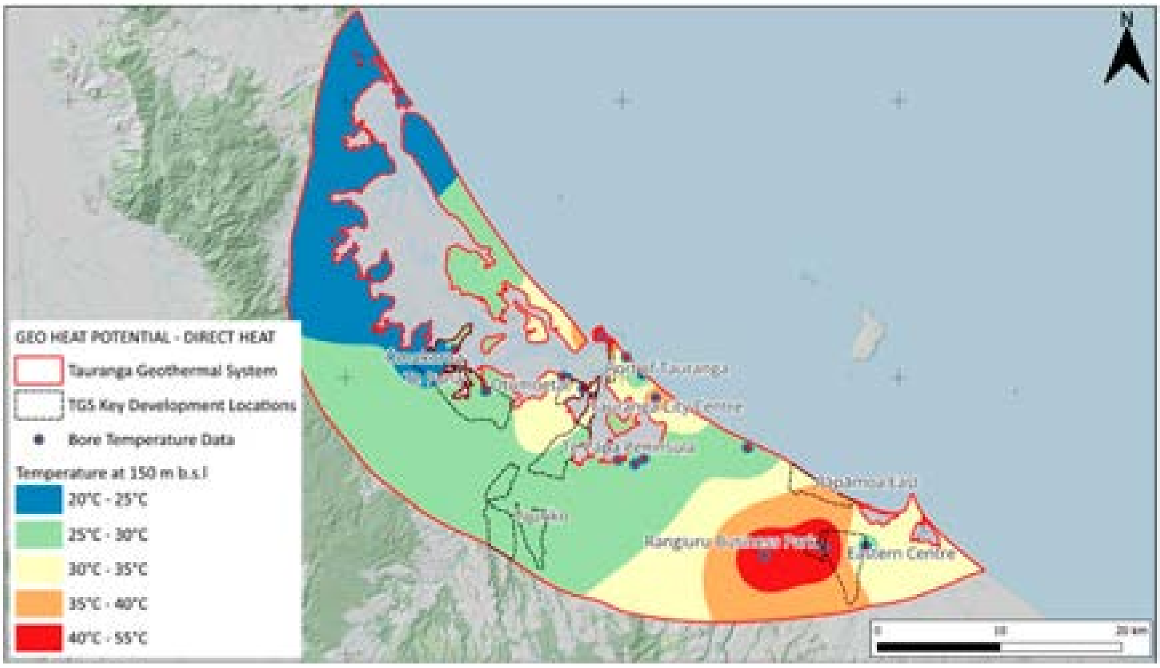


Figure 3 - Interpolated temperature at 150 m below sea level across the Tauranga Geothermal System. GeoExchange NZ, 2024.

Subsurface Temperature Gradient – Heat from Earth's Interior

Everywhere on Earth, temperatures increase with depth, a phenomenon known as the geothermal gradient. In Aotearoa New Zealand, this gradient varies significantly by location, ranging from 25°C to 300°C per kilometre. Taranaki is an interesting example to illustrate this point; there are no geothermal surface features like springs in the region, but due to significant oil and gas exploration (usually 1-2 km deep) borehole temperatures can exceed 100°C, with the highest recorded temperature being 172°C in New Plymouth town[1]. Once non-productive for oil and gas use the wells could offer access to temperatures useable for Geoheat use.

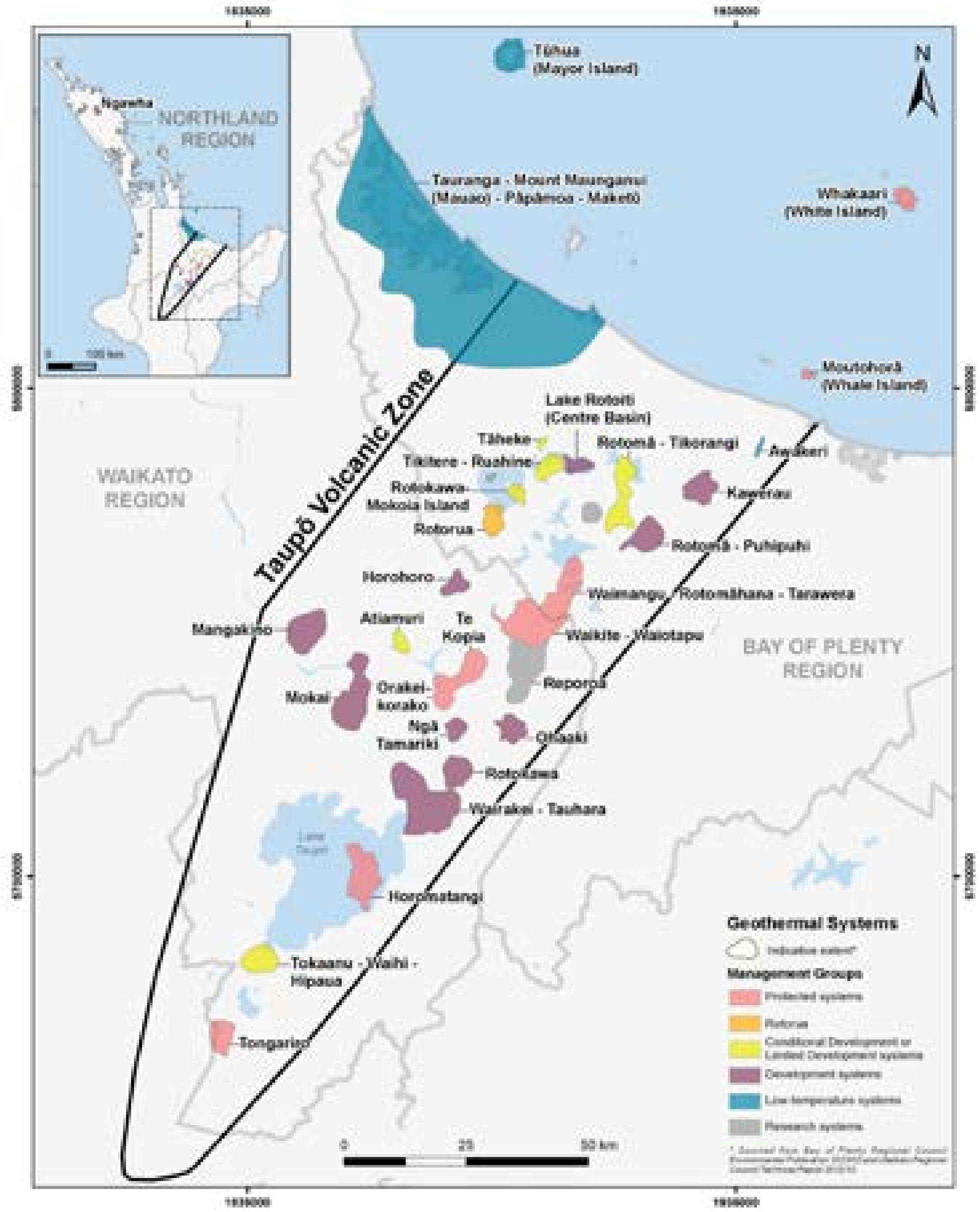


Figure 4 - Upper North Island Regional Councils' Geothermal System Classification, GNS Science

1 Source: A.G. Reyes (2007), Abandoned Oil and Gas Wells: a reconnaissance study of an unconventional geothermal resource. GNS Science Report 2007/23.

What are the benefits of Geoheat?

Reliable supply – 24/7 heat, independent of weather

Unlike many other renewable energy sources, Geoheat is not weather dependent. It provides constant, uninterrupted thermal energy 24/7, offering businesses a higher level of energy security. This makes it ideal for operations that rely on continuous heating or process heat throughout the year.

Operational efficiency – lower running costs

While Geoheat systems may require higher capital costs, their efficiency delivers lower operating costs than direct electrification or air source heat pumps (ASHP) using ambient air temperature. Industrial waste heat is another efficient source of available thermal energy. Many Geoheat systems can now compete directly with existing gas systems. For many businesses, this means achieving emissions reductions without increasing energy bills, a crucial balance in today's operating environment.

Supports electrification – with lower grid demand

Geoheat complements electrification strategies by reducing pressure on local and national electricity grids. Ground source heat pumps, which are commonly used to harness Geoheat, are more efficient than conventional ASHPs using ambient air temperature (however, their efficiency may be lower than using waste heat directly from industrial processes.) This means businesses can transition away from fossil fuels while using less electricity, resulting in lower grid loads and reduced energy costs. The more businesses adopting Geoheat in Aotearoa New Zealand, the more electricity capacity remains available for other users.

Sustainable and low-carbon

Geoheat is a renewable energy resource with near-zero carbon emissions. We have avoided saying zero carbon, as electricity is required to operate Geoheat system pumps and the Aotearoa New Zealand electricity grid is not currently 100% renewable. With intelligent system design that protects and monitors the natural heat source, Geoheat is sustainable over the long term.

Locally sourced – enhancing energy independence

Because Geoheat is drawn from the ground beneath or near a site, there's no need for fuel transportation or reliance on external supply chains. This localised approach to energy can significantly improve long-term energy security and reduce exposure to supply disruptions or price volatility.

The geothermal spectrum

Table 1 - The Geothermal Spectrum relevant to the New Zealand context

Temperature range	Category	Key Points
>150 °C	High-Temperature Geothermal	• Power generation and heavy industrial applications. • Site specific, e.g. 215-350°C is used by industry at Kawerau.
30–150 °C	Low-Temperature Geothermal	• This category and ambient groundwater are the temperatures mostly considered in this guide. • Useful for heating directly or combined with a Ground Source Heat Pump (GSHP) and Industrial GSHP.
≥30 °C	RMA-defined Geothermal Water	• The temperature threshold that requires geothermal consent under NZ law.
18–29 °C	Geothermally Enhanced Groundwater	• These temperatures are influenced by geothermal activity but not RMA classified. • These enhanced temperatures boost GSHP efficiency for heating (see Figure 7).
12–18 °C	Ambient Groundwater	• Range depends on geographic location and closely reflects the average annual air temperature. • Useful thermal source for standard GSHP. • Lower temperatures can be used for direct cooling.

TierPoint's Spokane data center, Washington, USA.

The data centre taps into the Rathdrum Prairie Aquifer approximately 30m underground. Capitalising on the aquifer's naturally cool, stable temperature, this system avoids the need for refrigerants or traditional chillers, leading to significant energy savings and environmental benefit.

Is my application suitable?

What sets Geoheat systems apart is the source of thermal energy. However, the equipment used to convert that energy into usable heating is often the same or very similar to that used in other heating and cooling systems. For example, the internal components of a ground source heat pump (GSHP) closely resemble those of an ASHP.

Geoheat suitability depends on two key factors: your temperature needs and your site's geothermal resource. The following sections cover resource characteristics, while Table 2 describes temperature delivery capability.

Table 2 - Summary of Geothermal Heating Technologies

Technology	Temperature range	Best use cases
Direct use of geothermal heat	~30° to 150°C+*	Space heating, domestic hot water, baseload industrial heating, and industrial processes.
Standard GSHP	Up to ~65°C	Primarily used for space heating, domestic hot water, and low-temperature industrial processes.
High temperature GSHP	~65°C to ~90°C	Low-temperature industrial processes, hot water, heating, drying.
Very high temperature GSHP	Up to ~160 - 180°C	Medium temperature industrial processes, steam, heating, drying.

*The RMA defines geothermal as groundwater temperatures above 30°C. We have chosen to end the temperature range at 150°C as anything below this is classified as low temperature geothermal in New Zealand. Of course, higher temperatures are used directly in Kawerau and Taupō but more often these higher temperatures are reserved for electricity generation.

Direct and indirect applications

Direct use

Direct use systems use the Geoheat resource directly in the heating application. A common example is a geothermal hot spring that uses geothermal water as the heat source for the pools or baths. Modification of the original source temperature with a heat pump is not required. This means that the source temperature needs to be higher than or matched to your temperature demand.

Alternatively, if peak temperature demand is higher than the available resource, Geoheat could still be used directly for baseload heating and then boosted to the required temperature as required. Baseload heating is often the majority of energy consumption for a site, especially one with intermittent peaks.

Nature's Flame, Taupō

Nature's Flame in Taupō receives around 18 MW of renewable geothermal heat via a 1.2 km pipeline from Contact Energy, they use 125 °C hot water to dry waste wood for pellet production—allowing the plant to reach full capacity without burning any of its own product.

Table 3 - Direct use advantages and disadvantages

Advantages	Disadvantages
Very high system efficiencies are possible.	Limited to heating only (or cooling only if a cold water source).
No requirement for a heat pump.	Location specific - areas where the Geoheat source temperature aligns with those required by the heating application.
Low operating energy inputs (often just pumping costs).	The ground cannot be used for thermal storage or as a thermal battery.
	May require very deep drilling to access desired temperature.

Indirect use

Indirect systems use the Geoheat resource as a starting point for heating and / or cooling. For example, a nominal 15°C Geoheat source (groundwater) could be used by a ground source heat pump (GSHP) to heat or cool a building. Similarly, a nominal 50°C Geoheat source (geothermal water) could be used by a high temperature GSHP to produce higher temperatures (~160°C), including steam, for an industrial process. Heat pump capabilities are covered in more detail in the next section.

Lust Tomatoes, Slovenia

Groundwater at 30–40°C is sourced from a 1,500-metre-deep well and fed into a 2,000 kW ground source heat pump. The system delivers 65–80°C maintaining ideal growing temperatures, achieving a 72% operational cost saving compared to the previous gas boiler used for temperature boosting.

Christchurch Airport

Ambient groundwater at 13–14°C is extracted from 122–127 metre-deep wells to supply ground source heat pumps that provide efficient heating and cooling for the airport facilities.

Table 4 - Indirect use / heat pump assisted advantages and disadvantages

Advantages	Disadvantages
Can be applied almost anywhere.	The GSHP requires electrical energy, although less than an ASHP.
GSHP enables greater control over temperature delivery.	Not as efficient as direct use systems.
Includes heating and cooling, often simultaneously.	
More efficient than ASHPs.	
More potential applications than direct use systems.	
Usually requires shallower wells than direct use systems.	

Indirect use vs direct use

In this example, identical greenhouses are located in the same geographic location, and both require 70°C heating to maintain optimal growing temperatures 24/7.

The greenhouse on the left has a shallower well that accesses 15°C, they use a GSHP to boost the 15°C source temperature to 70°C required. This is an indirect use of Geoheat.

Whereas the greenhouse on the right has opted to drill deeper and access 100°C, meaning they can directly heat their greenhouse. This is direct use of Geoheat.

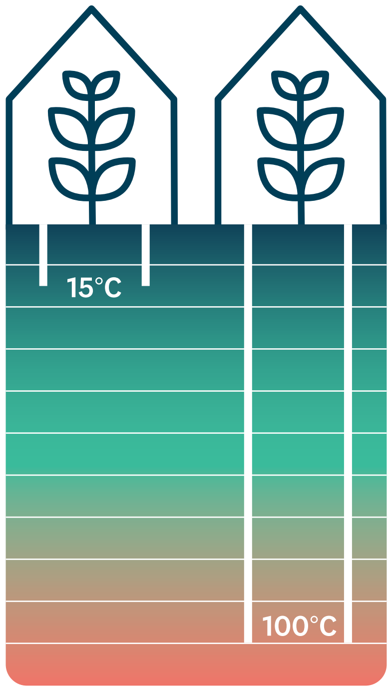


Figure 5 - Indirect vs direct use

Geothermal or ground source heat pumps

A heat pump is a device that transfers heat from a source (such as the ground, water, air or other sources) to provide heating or cooling at a destination. It operates on the principle of the vapor-compression refrigeration cycle, which involves four main components: an evaporator, a compressor, a condenser, and an expansion valve with a refrigerant working fluid.

Most people know ASHPs from their use in residential and small to medium sized commercial buildings. A GSHP works in the same way using the vapor compression refrigeration cycle described above. It achieves a higher Coefficient of Performance (COP) because its source of thermal energy is the temperature stable Geoheat, rather than the more variable ambient air temperature. Note that in industry heat pumps often use waste heat from sources such as chillers, rendering, dryers, process wastewater and other sources. The warmer the source temperature for a heat pump, whether from waste heat or geothermal groundwater, the higher the efficiency in heating mode.

How a heat pump works

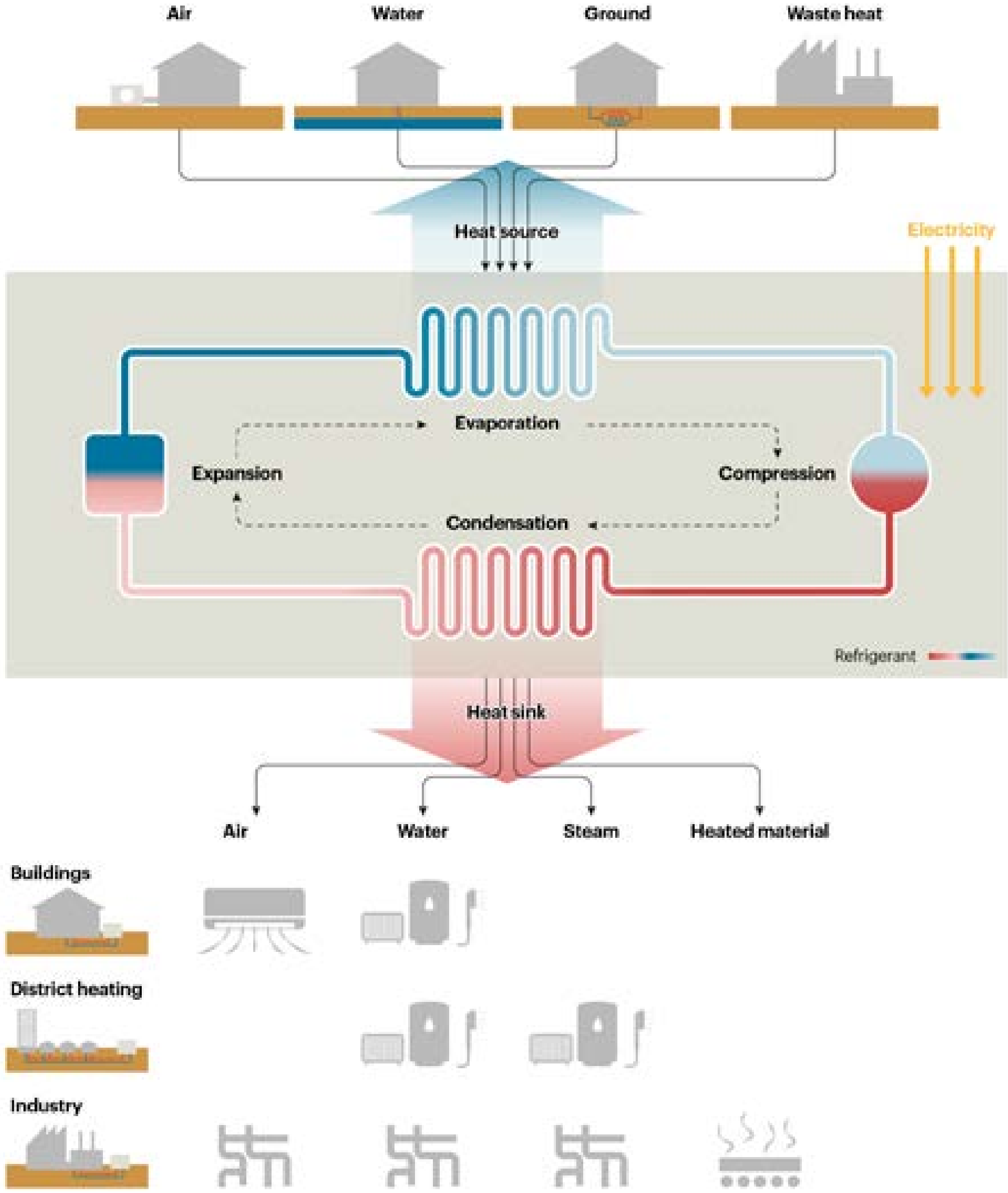


Figure 6 - IEA (2022), How a heat pump works, IEA, Paris https://www.iea.org/reports/the-future-of-heat-pumps, Licence: CC BY 4.0

The system uses electricity mainly for the compressor and circulation pumps. Energy consumption is determined by the temperature gap between the Geoheat source and the heating application. This simply means the bigger the gap, the more electrical energy is needed.

$$\text{COP} = \frac{\textit{Heat output (kW)}}{\textit{Power input (kW)}}$$

As a result, the higher the COP, the more efficient the system. In contrast to ASHPs, which are dependent on outside temperatures that fluctuate, GSHPs use constant, stable ground or groundwater temperatures.

Typically, a GSHP operates with COPs of 4 to 6, whereas an ASHP typically has a COP of 2 to 4, that can reduce significantly during defrost cycles on cold mornings or in heatwave events. Higher GSHP efficiency means lower annual energy costs, reduced carbon emissions and smaller electrical capacity needs.

If you require heating, the higher the geothermal source temperature (or waste source) used as a starting point, the more efficient the heat pump. This correlation is presented in Figure 7.

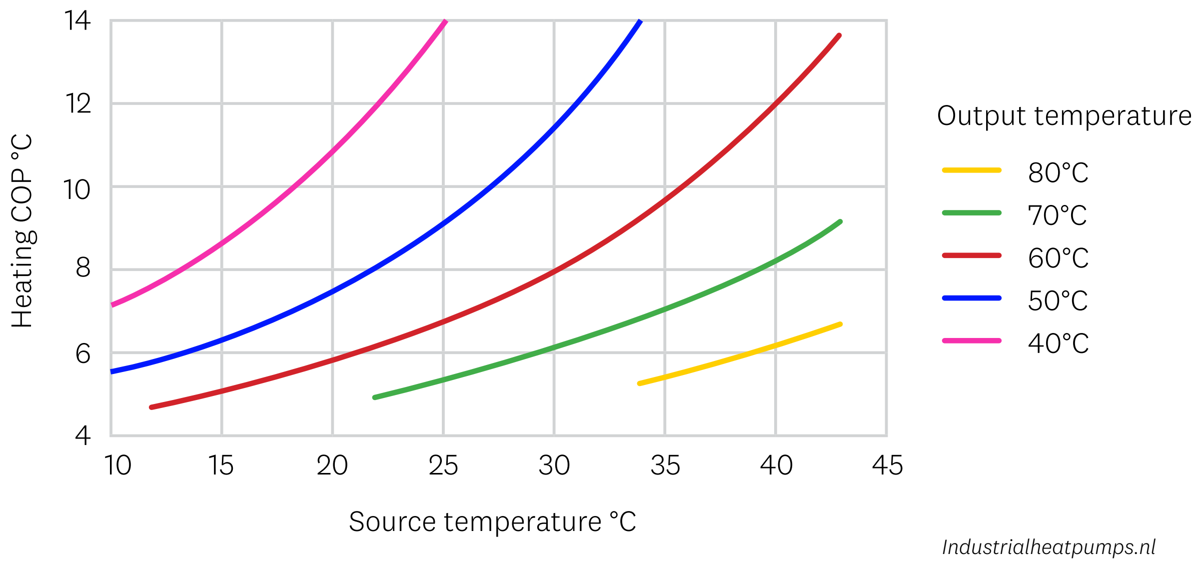


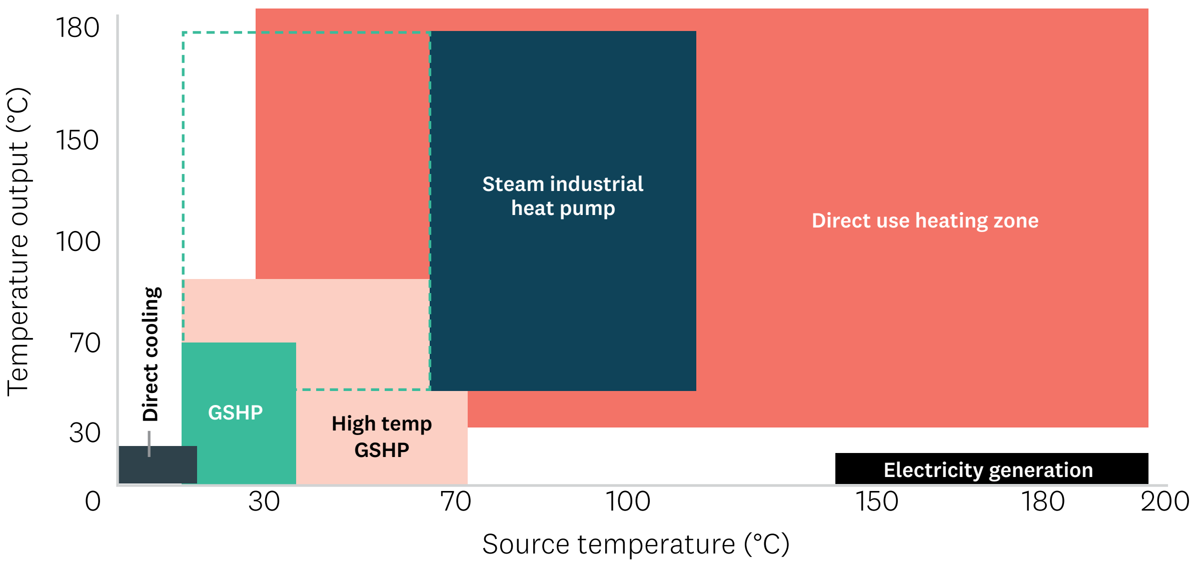
Figure 7 - Influence of geothermally enhanced groundwater on system performance. Adapted from industrialheatpumps.nl / Operating Principle / Coefficient of Performance

Industrial heat pumps / very high temperature heat pumps

Very high temperature or industrial heat pump technology has made remarkable advances. Industrial heat pumps can provide energy at temperature levels of 200°C and industry experts expect temperatures of 280°C within this decade.[2] High-temperature heat pumps are seen as an important technology for accelerating global decarbonisation, driving rapid investment, research, and commercial progress.

Heat pumps generally have a maximum single-stage temperature lift of around 70°C. Relying on ambient air (at roughly 15°C) alone struggles to efficiently achieve temperatures near or above 100°C without additional stages. To achieve higher temperatures, an industrial heat pump either needs to be a multistage system or use enhanced temperatures (geothermal or waste heat) as the starting source temperature.

Higher source temperatures mean better efficiency, lower costs, and simpler systems. ASHPs cost more to buy and run, plus require complex maintenance. However, ASHPs are not typically used in industry and are mainly used in residential and commercial building settings.



	X (°C)	Y (°C)	Comment
Direct cooling	1-15	15	
GSHP	10 - 40	70	Capable of heating and cooling
High temperature GSHP	10 - 75	90	Capable of heating and cooling
Steam industrial heat pump	10 - 50 50-100	180	10-50 source will require two phase heat pump , hence the dotted line. With high source it is only one phase.
Direct Use heating	30-200	30-200	
Electricity	120 - 200	NA	

Figure 8 - A visual representation of operational ranges (based on historic figures[3])

[2] Source: High-Temperature Heat Pumps: Review and New Developments for Steam Generation, Dr. Cordin Arpagaus, Institute for Energy Systems IES, 2024

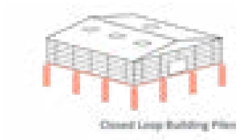
[3] Source: European Heat Pump Association AISBL, (2024) https://www.ehpa.org/wp-content/uploads/2022/12/Industrial-Heat-Pumps-overview.pdf

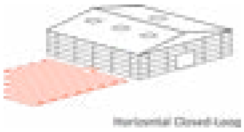
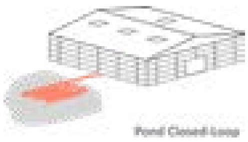
Types of ground heat exchangers

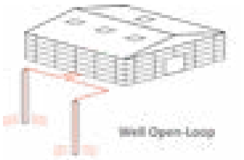
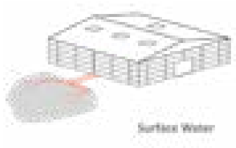
As a generic term, ground heat exchanger (GHX) applies to the infrastructure that is installed in the ground. Table 5 summarises a selection of Geoheat extraction technologies that use geothermal and non-geothermal water and briefly explains how they work.

These GHX are an important component of both ‘direct’ and ‘indirect’ Geoheat systems. Whether you need an open or closed loop extraction system may have implications for resource consent requirements (see later sections covering the resource consent process).

Table 5 - Summary of GeoHeat extraction options

Type	Figure	Description
Closed loop		Closed vertical GHXs are typically installed in wells 50 to 200 metres deep but could be deeper in certain applications. These systems use a polyethylene (PE) pipe filled with a water-antifreeze (or brine) mixture that by circulating around either absorbs heat from (heating) or rejects heat to (cooling) the ground. A GSHP then delivers heating and/or cooling as required by the application. GHXs are highly efficient, suitable for various building sizes and types, including space-limited and different lithologies and can have high initial costs. They can be installed beneath buildings, are a form of thermal energy storage and perform best when they have a mix of heating and cooling.
		Vertical closed-loop systems can also be installed in the existing building infrastructure and integrated into building piles. Often called energy piles, these systems are generally only able to cover some of the building’s heating and cooling requirements. The performance of these systems is determined in particular by the soil moisture and whether the piles are located in the groundwater zone. The advantage of these systems is that they can be installed at relatively low additional cost if a foundation is required anyway. In addition to the building, the base plate and earth-covered side walls can also be thermally activated.

Type	Figure	Description
Closed loop		A closed horizontal GHX is typically installed to a depth of 1-2 metres. Types include surface, trench and spiral collectors. They utilise the seasonal temperature fluctuations in the ground and are suitable for areas with plenty of space, such as rural residential areas. They work best in clayey, moisture-rich soils that allow for optimal heat transfer and regeneration. They can be a capital cost effective heating and cooling solution for rural residential properties that have suitable areas of land available.
		In areas with accessible bodies of water, a closed loop GHX can also be submerged and anchored to concrete supports to ensure proper positioning above the pond bottom. Installation is quicker and less costly compared to other types of closed loop GHX. Minimum water body depths of 2-3 metres are required while the water body needs to be sufficiently large (and permanent) for the heating and cooling requirements of the application. Installation can be relatively quick and easy using PE loops or purpose built plate heat exchangers.

Type	Figure	Description
Open loop		Open loop groundwater systems require an aquifer of sufficient quality and capacity to sustainably supply groundwater to a heat pump, which then typically re-injects it into the aquifer. This process benefits from the stable temperatures of the groundwater (10°C to 14°C) and its high heat capacity, resulting in high COPs. The drilling depth is determined by the aquifer and the water table. An appropriate distance between the extraction and reinjection wells is important to avoid recirculation of the heated or cooled water. In addition to quantity, groundwater quality is also important as poor quality groundwater will damage the installed infrastructure, leading to increased maintenance costs. Water analysis and specialised expertise are required for system design.
		If surface water is available, it can be used as a source via an open loop system with heat exchangers similar to those described above. Open surface water loops usually require a secondary heat exchanger. The suitability of a surface water source depends on its availability, the source size and the sensitivity of the receiving ecosystem to temperature fluctuations and different water chemistry.

Source: *The Geoheat Potential of the Tauranga Geothermal System*, GeoExchange NZ, 2024.

How do I access geothermal resources?

Whether a Geoheat system uses the geothermal resource directly or indirectly and as an open or closed loop system, it is necessary to drill a well, or series of wells, to access it. The number and depth of wells is determined by:

- The underlying geology (rocks) and hydrogeology (groundwater);
- The temperatures being sought, especially if direct use is an option;
- The groundwater flow rates and quality being sought, especially if an open loop system;
- The requirements of the heating application e.g. heat pump assisted or direct use.

Drilling costs scale directly with depth. The deeper you go, the more you spend. While deeper wells deliver higher temperatures, shallow wells paired with heat pumps often provide superior return on investment (ROI) with significantly lower risk.

Drilling is conducted by drilling contractors, many of whom drill water bores. Drilling is a significant investment, especially for deep wells or if multiple extraction and reinjection wells are required. When well constructed and maintained, wells will last for many decades. In the case of closed loop systems, it can be expected for it to still be operating in 100+ years.

For most Geoheat projects, drilling activities carry a significant amount of capital investment and careful assessments are required in the project design phase prior to incurring such costs.

Engaging with a design specialist enables different modelled ROI scenarios for your application to be made based on best available subsurface data and your heating and cooling requirements.

It is also important that you understand your legal responsibilities to access, take and use geothermal energy, as discussed in the following sections covering the resource consent process.

Audi factory, Hungary

A 2,400-metre-deep geothermal well provides direct heat at temperatures between 100 and 105 °C. This system delivers 82,000 MWh of thermal energy annually, resulting in a CO_2 savings of 17,000 tonnes per year.

This process assumes you've had a preliminary discussion with an experienced technology specialist or provider who indicated that a Geoheat system has sufficient potential to warrant a formal (paid) assessment. Although there is no 'sweet spot' for Geoheat systems, examples of why the technology may not be appropriate for a site include:

- No access or difficult / expensive access to the Geoheat resource; and
- A small thermal requirement such that energy savings from an efficient heating and cooling system is unlikely to provide a suitable ROI.

It is recommended that an experienced technology specialist includes the Geoheat assessment as part of a comparison with other viable alternatives.

Step 1. Desktop feasibility

The first step is a desktop feasibility study that develops a concept design of the site's heating and cooling requirements and then conducts a preliminary feasibility by comparing Geoheat and other option(s), such as biomass fuels, air-sourced heat pumps, waste heat recovery heat pumps, electric boilers and any other applicable options. It draws on publicly available geological and hydrogeological data to assess the availability of Geoheat at a given site. This includes evaluating subsurface temperature profiles, aquifer locations, known fault lines, historical drilling data, and local energy demand.

While high-level, this stage can still provide a strong early indication of potential system types, scale, budget and estimated return on investment (ROI). It should provide sufficient system for a Board / management team / owner to make a decision as to whether to progress to the next step

Step 2. Detailed design and test well

Building on recommendations from the desktop assessment, this step gathers the additional information required for a detailed design and business case. This may include more detailed modelling of the heating and cooling requirements of the site as well as a test well to confirm the availability of the Geoheat resource.

The test well is usually integrated into the final system as an operational bore, but its construction does carry financial risk. If the subsurface conditions do not meet expectations (e.g., temperature too low, flow rates insufficient), the investment becomes a sunk cost. To mitigate this, the Geoheat specialist uses all available data, modelling, and local geological knowledge seeking to reduce uncertainty - though it's important to acknowledge that comprehensive subsurface data is not available across all of Aotearoa New Zealand. This level of exploratory risk is a known and accepted aspect of Geoheat projects globally.

It is important to note that some exploratory works may require resource consent and it is recommended tocheck with your local council and/or planning advisor to make sure you are aware of the rules.

Step 3. Final design and documentation

Assuming the additional investigation and modelling works at Step 2 confirm the key assumptions about subsurface conditions from the desktop analysis, the project moves into final design and documentation. This includes optimising system specifications based on measured data and selecting the preferred system in consultation with the client, considering both technical performance, sustainability and commercial factors. The final product will be a documented project ready for procurement and installation.

Step 4. Resource consents

Although listed here as Step 4, resource consent should be conducted in parallel with the technical feasibility and design and follow a similar increase in detail.

Geoheat systems that involve drilling wells, a water take (surface, groundwater or geothermal water), reinjection or discharges, generally require resource consent under the Resource Management Act (RMA).

The resource consent process is fundamental to a successful Geoheat project and is discussed in more detail in later sections of this guide.

Step 5. Installation and commissioning

With resource consents in place and design finalised, the system proceeds to installation. This includes drilling additional production and reinjection bores, installing heat exchangers, pumps, and control systems, and integrating the Geoheat system with the facility's existing infrastructure. Once installed, the system is commissioned. This involves testing and optimisation to ensure it meets expected performance levels and operates reliably.

Step 6: Monitoring and maintenance

Monitoring and maintenance will sustain performance expectations and extend the operating life of Geoheat equipment.

Like ASHPs, GSHPs require general check-ups by a certified technician. However, GSHPs are renowned for their durability and lower maintenance requirements when compared to ASHPs; their equipment is kept indoors whereas ASHPs are outdoors and exposed to the elements.

For both indirect and direct installations annual pump checks and servicing are recommended. Some geothermal water has a high mineral content, meaning that filter changes and checking pipes for corrosion may be required in your maintenance schedule. Your site-specific maintenance needs will be established by your design team.

Your resource consents will specify environmental monitoring requirements (measuring groundwater flow rates and temperature) and this data will need to be reported to the regulatory body.

Step 7: Decommissioning

Removal and decommissioning of a Geoheat system needs to be carried out by a professional to ensure all underground pipework is removed safely and the well is fully abandoned or the wellhead securely closed in. This should be in accordance with best practice standards and conditions of resource consent.

Resource consents for Geoheat

Geoheat, or geothermal energy, is a renewable resource that can support a wide range of business and industrial applications. Like any natural resource, it must be managed carefully to ensure it remains available for future use, and to avoid adverse effects on the environment or on other users.

In Aotearoa New Zealand, geothermal water and heat are managed under the RMA. While there are no ownership rights to geothermal resources, landowner approval is needed to access land that you do not own for activities such as drilling.

In areas where Geoheat resources are already heavily used, new users may need to demonstrate how their activities can be integrated alongside existing operations. This is done through a process called resource consent. Resource consents are used to authorise activities that are not already permitted by a regional or district plan, or by a national environmental standard.

Not all Geoheat uses require resource consent. In many regions, small-scale or low-impact activities may be permitted as of right, without the need for an application. Whether consent is needed, and what information is required, depends on factors such as the scale of use, the location, and the potential effects on the environment or nearby users. For example, a closed loop GSHP or GHX is not likely to require resource consent because there is no take or discharge of geothermal fluids. However, resource consent may be required for drilling the well to enable this heat exchange.

Councils have a key role in managing geothermal resources and Geoheat activities:

- **Regional councils** focus on the sustainable management of natural and physical resources. They oversee matters such as:
  - Taking geothermal or freshwater
  - Using geothermal energy
  - Extracting heat from material surrounding geothermal water
  - Discharges to land, air, or water (e.g. steam, cooling water)
  - Constructing geothermal wells or bores

- **Territorial authorities** (district and city councils) focus on land use and development. They manage:
  - Structures and infrastructure for accessing and using geothermal resources (e.g. pipelines)
  - Construction-related effects such as noise, earthworks, and protection of significant sites
  - Operation and maintenance of supporting infrastructure

Before starting a project, it is recommended that you check with your local council to confirm whether consent is required and what standards apply. Planning early can help streamline approvals and avoid unnecessary delays.

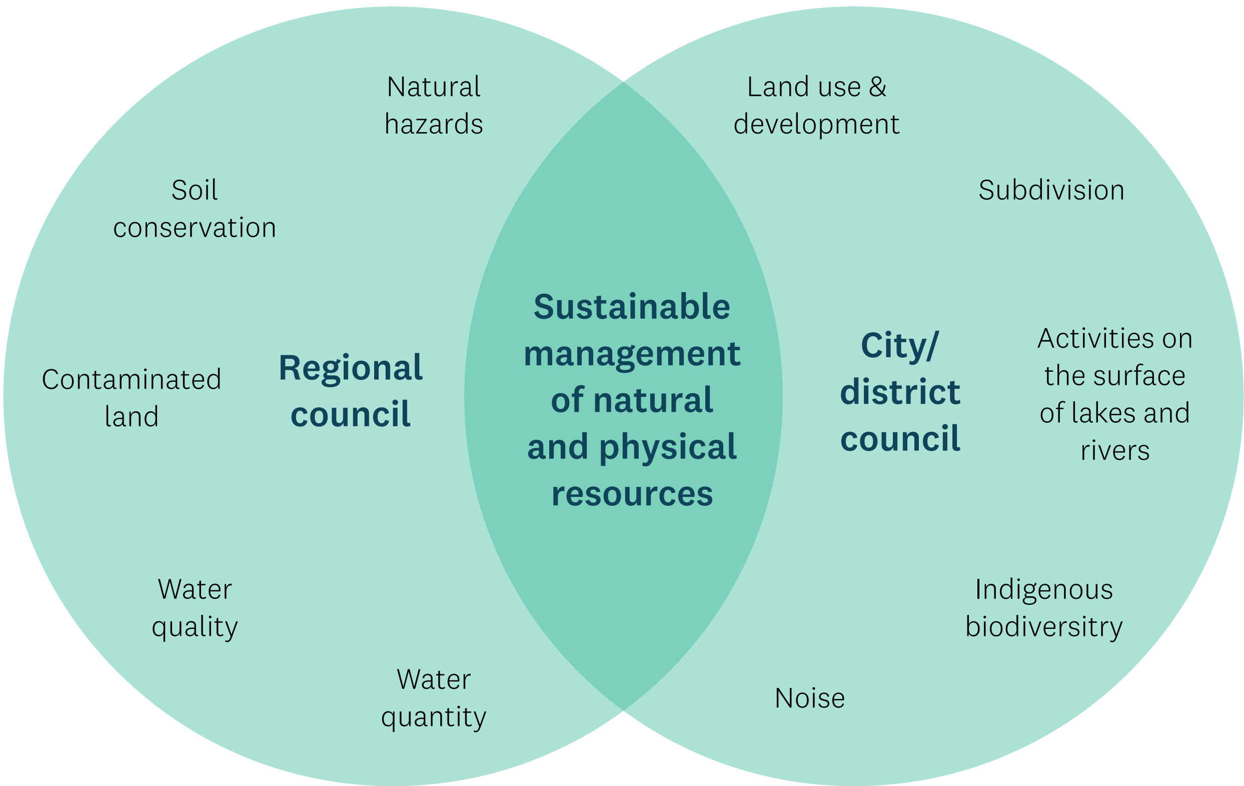


Figure 9 - Council responsibilities

The resource consent process

Understanding the resource consent process and the reasons for it can help to reduce time and costs. We recommend seeking early advice from your local regional and district councils as a good place to start.

The following sections are intended to provide a high-level overview of the resource consenting process, as illustrated in Figure 4.

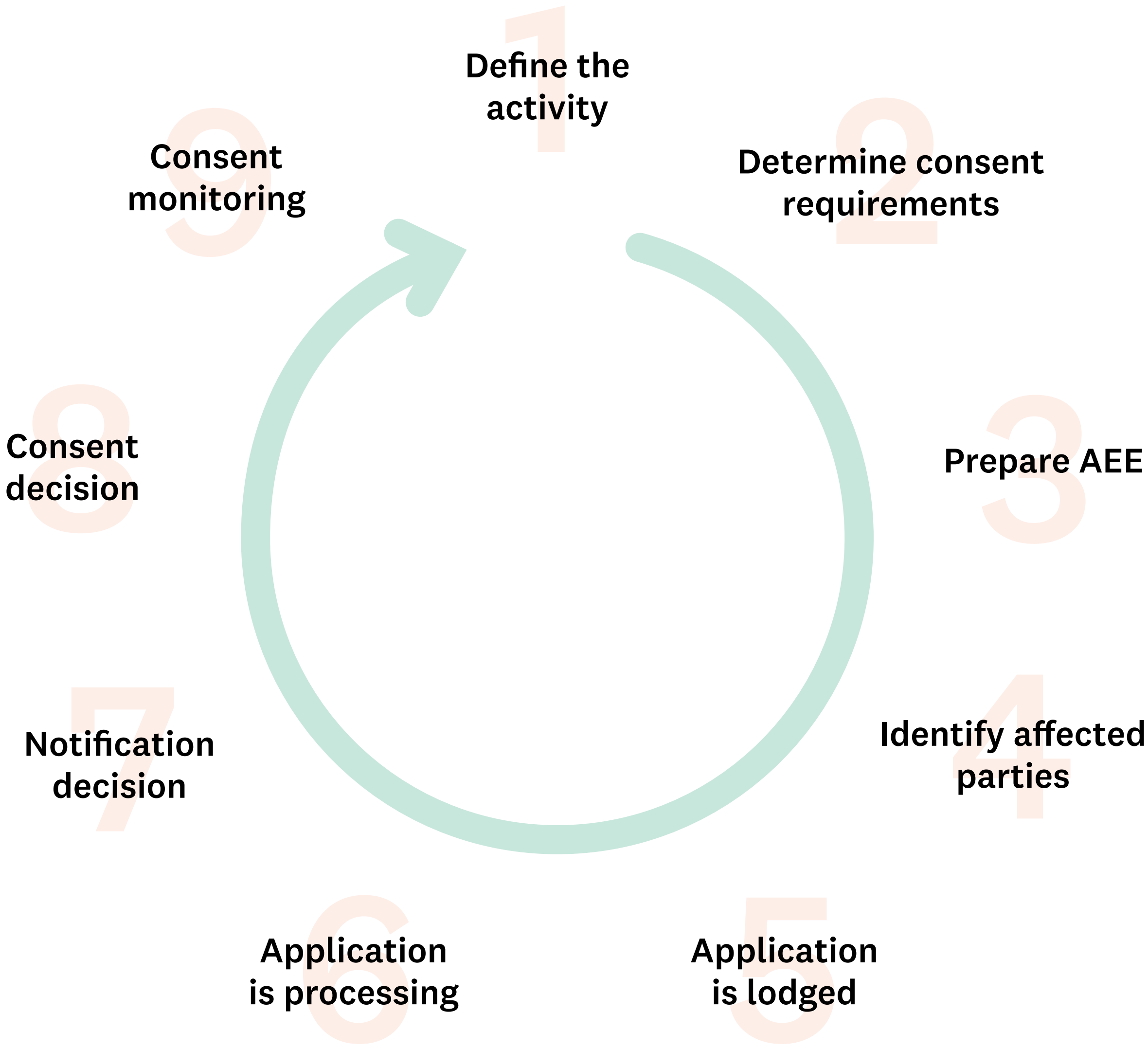


Figure 10 - Resource consenting process

Resource management advice is available from your council, your planning team, or planning consultants. The following sections of this report won't give specific planning advice, but will help you understand the consenting process and when to get professional help.

It is also noted that the following sections describe the standard resource consent application route. For significant projects, there are other options available for gaining resource consent, including the fast-track approvals regime. These options are not covered in this guide.

It is also highlighted that the Government has announced that the RMA will be replaced with two new acts that clearly distinguish between land-use planning and natural resource management, while putting a priority on the enjoyment of private property rights. Details on the replacement legislation are not available at the time of writing.

Step 1: Define the activity

Start by clearly defining your proposed activity for the resource consent process. While detailed design isn't needed, you need to be clear on basics like location, volumes, and discharges. Poor estimates can lead to costly and time consuming consenting problems later.

You should define where, how much and for what purpose you wish to use Geoheat, and what types of activities will be required to support your intended use. Clarity on this early will ensure that the right resource consents are applied from the beginning.

Resource management frameworks differ between regions and districts. It is important to determine the regional council and district council relevant to your proposal to identify the planning rules that apply.

Resource consent applications don't require landowner permission, but consents don't grant land access rights. Plan early: identify where you'll place surface structures like pipes and drilling pads and secure any necessary landowner agreements.

Step 2: Determine if resource consent is required

With your activity clearly described, the next step is to confirm whether the proposed activity requires resource consent under the relevant regional and district plans. The regional council where the activity is located can help with determining this and can direct you to the relevant objectives, policies and rules in the relevant regional plan.

You may also wish to seek planning advice to assist with this part of the process. The NZGA Companies Directory can assist in identifying appropriate experts and independent planning consultants and can be found on the NZGA website https://www.nzgeothermal.org.nz

In some cases, your proposed use of Geoheat may be a permitted activity and no resource consents may be required; it will depend on the region, specific location, nature and scale of your proposal. In other cases, small changes in design or approach may reduce consenting requirements.

Table 6 below provides a summary of the activity statuses that may be applied by the regional plan or district plan to a proposed use of geothermal resources:

Table 6 – Activity status and associated resource consent requirements.

Activity status	Is resource consent required?	Comments
Permitted	No	There are often specific conditions or performance standards which need to be met
Controlled	Yes	The consent authority must grant resource consent for a controlled activity but can impose conditions on that consent relating to the stated matters to which control is limited.
Restricted discretionary	Yes	The consent authority must limit the matters that they will consider when assessing the application and are only able to impose conditions on a consent in relation to these matters if granted. Consent can be declined.
Discretionary	Yes	Consent can be granted with conditions or declined. If granted the consent holder must comply with the requirements and conditions of the consent.
Non-complying	Yes	The consent authority may decline or grant the consent, with or without conditions. However, the consent can only be granted if the activity has no more than a minor effect on the environment or will not be contrary to the objectives and policies of the plan.
Prohibited	Application for resource consent cannot be made	No application for resource consent may be made for the activity and the consent authority must not grant a consent for it.

Depending on the scale of the activity, it may be beneficial to arrange a pre-application meeting with the relevant council(s). Pre-application meetings are particularly recommended for complex proposals or where you don't have access to an experienced planning consultant.

Step 3: Prepare an Assessment of Environmental Effects

An Assessment of Environmental Effects ("AEE") must accompany any resource consent application.

The AEE must identify any actual or potential environmental effects and may require technical input depending on the scale and nature of the activity.

A planning consultant experienced with geothermal resources and consent applications can assist in preparing an AEE and in coordinating technical contributions to support the application where these are required.

Technical assessments may be required to demonstrate that the geothermal energy resource is viable for the intended use (e.g., temperature, flow rate, sustainability). This could involve drilling, sampling, and modelling.

An important aspect of the RMA is that the AEE should be commensurate with the scale of the activity; a small scale, low risk activity (such as some GSHPs and GHXs) can have a relatively simple AEE, where a large-scale activity will require a much more comprehensive approach.

Some of the key elements that will determine the nature of your AEE include:

- The scale and nature of the proposed activity
- Site location and proximity to sensitive features
- The applicable planning framework
- Nearby resource users

Some of the aspects that may need to be considered by your AEE include:

- Take, use and discharge of geothermal water, freshwater (surface or groundwater (including heat exchangers)
- Cultural impact assessments and kaitiakitanga considerations
- Effects on nearby geothermal surface features or other resource users
- Discharge impacts on land, water quality or ecosystems
- Visual, earthworks, traffic, and amenity effects
- Reliance on by-products from other consent holders
- Efficient use of the resources

Step 4: Identify potentially interested/affected parties

Engage in a meaningful way with interested and affected parties - it's good practice for all applications and essential for large-scale projects with the potential for significant effects.

Start engagement early, and don't wait for formal lodgement. Consultation isn't legally required but helps by:

- Addressing concerns upfront
- Strengthening your application
- Avoiding processing delays

While councils identify affected parties officially, people prefer hearing about proposals directly from applicants. Early engagement prevents surprises and builds trust.

Who may be considered an interested/affected party?

Potentially interested/affected parties may include:

- Immediate neighbours or landowners adjacent to the proposed activity
- Iwi / hapū with cultural interests in the site
- Other consent holders or users of the same resource
- Local community groups, including recreational users
- Government departments or agencies managing public conservation land nearby

These parties may be affected by any aspect of the proposed activity including environmental, cultural, visual or operational effects arising from the activity.

Effects of trade competition are specifically excluded from consideration under the RMA.

Recognising Māori Interests in geothermal resources

Many natural resources, including geothermal resources, are considered taonga (treasures) by many iwi and hapū. These resources carry deep cultural, spiritual and historical significance.

Te Tiriti o Waitangi / Treaty of Waitangi must be considered when using geothermal resources and in Geoheat development. The principles of partnership, participation and protection inform how Māori interests are recognised in the resource management process.

Statutory acknowledgements and planning frameworks

Some iwi and hapū have formal statutory acknowledgements relating to geothermal fields established through Treaty settlement processes. These must be recognised in resource management decisions and are often reflected in regional and district plans.

These can be identified by:

- Reviewing council planning maps and seeking guidance from planning staff at the Council
- Referring to iwi management plans
- Consulting with relevant iwi or hapū

Engagement with Mana Whenua

Early and meaningful engagement and the development of relationships with mana whenua is strongly encouraged. Your local council can provide advice about who to contact. This can help identify:

- Cultural values associated with geothermal features and surrounding areas
- The presence of significant sites that require protection
- What monitoring may be needed during physical works
- Opportunities for collaboration

It is useful for the council to understand any engagement you have undertaken. Include a summary of this with your application including outlining any changes you have made to the application to address parties concerns.

Essity, Kawerau

The removal of the old and the installation of the new Yankee Dryer. This was an integral part of Essity's $20m project completed in 2025 to remove the use of Natural gas from one of their paper machines and replacing it with 100% geothermal steam.

Step 5: Lodging your application

Lodging your application with the council is straightforward; each council will have its own process to follow, but usually there is a form to fill out to ensure they have all the basic information they need to process your application.

The cost of preparing and processing resource consents are met by applicants. Most councils won't start processing your application until you have paid a deposit.

The first thing the council will do is determine if your application includes all the minimum required information (RMA section 88), so it pays to check you have everything covered before you lodge. The council will return your application as incomplete if something important is missing.

Step 6: Application processing

Once your application has been accepted as complete and your deposit paid, the council will start processing your application.

There are time limits that councils should meet when processing applications. Processing can be paused by Councils if more information is requested (under s.92 of the RMA). If this happens, your application and processing timeframes will be placed on hold until you provide a response.

Step 7: Notification

The RMA requires councils to determine whether an application for resource consent must be publicly or limited notified. This determination is made on a case-by-case basis, depending on the scale, nature, and potential effects of the proposed activity.

In general, activities with limited effects on the environment are unlikely to require notification. This is expected to apply to most Geoheat activities. Non-notified applications will be decided by the Council.

For activities with broader potential impacts, the council will assess whether notification is necessary. There are two types of notification under the RMA:

- **Limited notification** may occur where the council considers that the activity may have minor or more than minor adverse effects on specific individuals or parties.
- **Public notification** is required if the council determines that:
  - The activity is likely to have more than minor effects on the environment, or
  - There are special circumstances that warrant public involvement.

If an application is notified, the following process applies:

- Notified persons or the general public (depending on the type of notification) may make submissions on the proposal.
- Submitters can request to be heard at a hearing.
- If a hearing is held, both the applicant and submitters have the opportunity to present their views before independent commissioners or hearing panel members.

Early engagement with potentially affected parties may reduce the likelihood of notification, by enabling issues to be identified and resolved before your consent is lodged.

Step 8: Consent decision

Once consideration of the application is completed, a decision will be made on your resource consent. If granted, the consent forms a legally binding document.

Step 9: Consent monitoring

Consent conditions will usually be applied to an approved resource consent. These are ongoing requirements that consent holders have a legal obligation to meet.

Some conditions you are likely to see on a resource consent for geothermal resource use include:

- That the activity is carried out as described in the resource consent application
- Limits on the volume of geothermal water taken or the total heat taken
- Data collection, monitoring and reporting (e.g. metering of use, temperatures etc)
- Review clauses enabling councils to update conditions

It is important to make sure that you can comply with the conditions of a consent, as these will be an ongoing legal requirement you must meet. While you can apply to change consent conditions, this will take time, effort and cost, and you must have a good case to do so.

Consent conditions are an important method councils use to manage the effects of activities and they will check for ongoing compliance.

This may involve a council officer reviewing information provided by you as the consent holder, or it may involve site visits and checks. It depends on the nature of your activity.

Building up a good track record of meeting your obligations and managing your activity well is important.

Residential Ground Source Heat Pump, New Zealand

Simultaneous heating and cooling, supplied by Stiebel-Eltron.

“What makes this system special is that during summer cooling, the “waste” heat is recovered and used to heat the pool, spa, and domestic hot water. This setup achieves a system COP of over 7, which is outstanding.”

Resource consent lapse and duration

Lapse period

Resource consents usually expire after 5 years if not used. You can apply to extend this deadline, but once a consent lapses, you'll need a completely new application.

Consent duration

Generally, land use consents apply indefinitely for a new building, however land use consents for drilling a geothermal well may have an expiry timeframe applied to ensure that the work is completed within a set time period.

Resource consents authorising the take, use and discharge of resources (such as water and geothermal water) can be granted for a maximum period of 35 years.

Some regional plans specify shorter consent durations based on location or resource constraints. Other consent durations will be determined on a case-by-case basis. Usually, the council will look for a high degree of certainty that actual and potential effects can be well managed to grant a full 35-year consent.

Applying to replace an expiring resource consent is the same process as applying for a new one.

If you lodge your application to replace a resource consent 6 months before it expires, you can keep using your existing resource consent even after it expires, while the council considers your application (s.124 of the RMA).

Glossary of terms

Assessment of Environmental Effects (AEE) – A report required with all resource consent applications that identifies and evaluates potential impacts of the proposed activity on the environment.

Direct use - The use of geothermal energy directly as heat (or cooling), without converting it to electricity.

District plan – A document prepared by a territorial authority that sets out policies and rules for land use and development within a district.

Geothermal energy (as defined by the RMA) – means energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water

Geothermal water (as defined by the RMA) – means water heated within the earth by natural phenomena to a temperature of 30 degrees Celsius or more; and includes all steam, water, and water vapour, and every mixture of all or any of them that has been heated by natural phenomena

Indirect use - The use of thermal energy as a source for geothermal or ground source heat pump technology to deliver desired temperatures.

Permitted activity – An activity that does not require resource consent, provided all relevant plan standards and conditions are met.

Regional council –The regulatory authority responsible for managing natural and physical resources such as water, air, and geothermal energy within a defined region.

Regional plan – A document developed by a regional council outlining how natural and physical resources are to be managed.

Regional policy Statement - A document developed by a regional council which provides an overview of the resource management issues of the region and policies and methods to achieve integrated management of the natural and physical resources of the whole region

Resource consent – Formal permission granted by a council to carry out an activity that may affect the environment and is not otherwise permitted by a plan or national environmental standard.

Statutory acknowledgement – A formal recognition of the cultural, spiritual or historical association of Māori with a site or area, arising from Treaty settlements.

Territorial authority – The regulatory authority responsible for managing land use and development in their city or district.

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