

## 13 GEOTHERMAL RESOURCES



### Summary

#### Pressures

- The Ngawha springs are widely used for bathing. Baths have been excavated since 1908 in four separate areas. They have boarded sides and are fed through seepage in the bottom and/or sides. The bath waters have a small international and a large local reputation for their curative properties.
- Since July 1998, fluid from the Ngawha geothermal field has also been used for power generation.

#### State

- Human impacts on the Ngawha springs has meant that the location of the features has changed little, but the features themselves have been modified by bath excavation and mining operations in the early 20<sup>th</sup> Century.
- Monitoring, as required by the resource consent conditions, has significantly increased the knowledge base of the Ngawha springs area.

#### Doing well

- The resource consents granted for the power station in 1994 required the joint venture operators to undertake at least 12 months of further baseline monitoring in the Ngawha area before it could start abstracting geothermal fluid.
- Comprehensive ongoing monitoring of the environmental effects of the geothermal fluid take and power station were undertaken during the term of that consent.
- The consent conditions included establishment of a “peer review panel” and “community liaison committee” to increase both professional and community input into the monitoring of the resource and any effects of the power station.
- Applications were received by the Council in 2004 to renew the 1994 consents and increase the abstraction of geothermal fluid. As part of the consent and appeal process, additional investigations occurred and a trial was undertaken by the applicant to determine potential effects of injecting additional water into the geothermal field to maintain the reservoir pressure. The injection trial was undertaken to assess potential adverse effects on the springs. As a result of the trials and investigations, the Environment Court granted the consents in 2006.
- A revised comprehensive monitoring plan is currently being prepared to enable ongoing monitoring of the resource and the environment. Stringent consent conditions are imposed on the consents to ensure appropriate measures are undertaken to avoid and mitigate any potential effects on the environment.

### 13.1 Introduction

The Ngawha geothermal field is located approximately 5 km east of Kaikohe. It covers an area of between 25 to 50 km<sup>2</sup>, and is the only high temperature geothermal field in New Zealand outside of the Taupo Volcanic Zone.

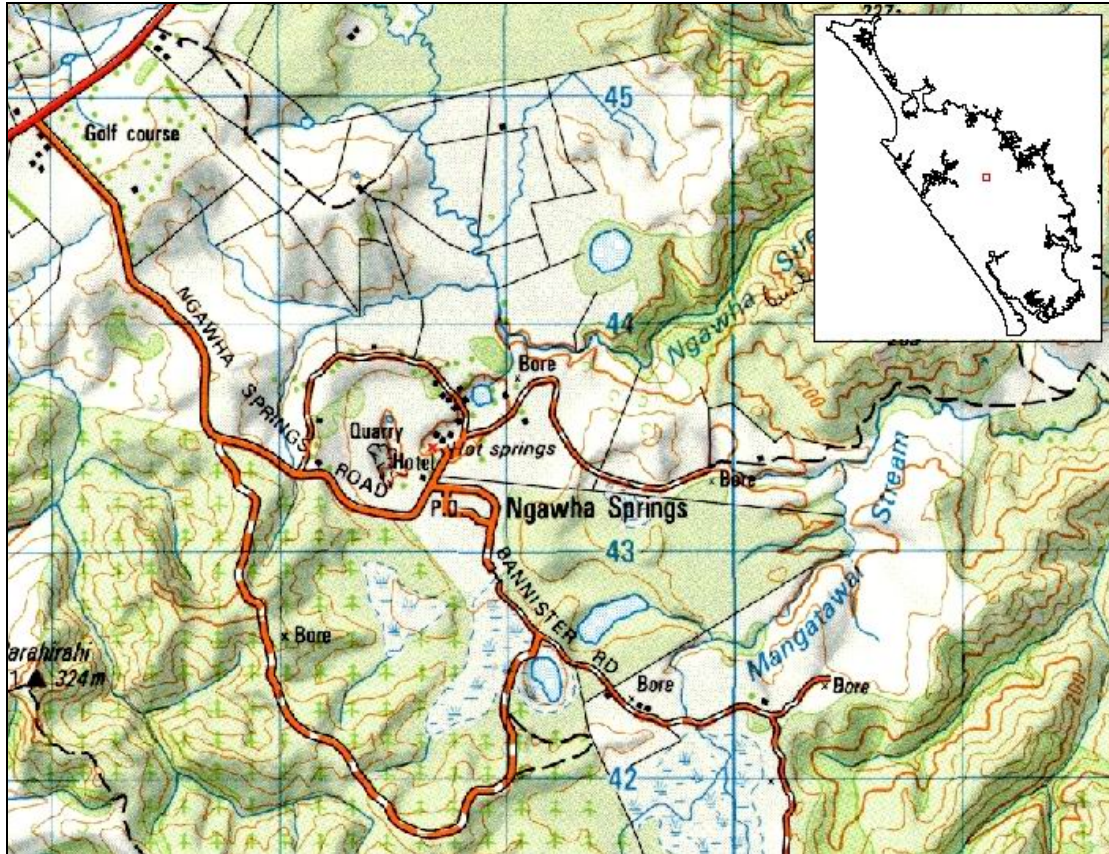


Figure 1: Map of Ngawha geothermal field.

The geothermal field lies within a small topographic basin and is centred on the town of Ngawha Springs. At the surface, the geothermal system consists of hot water springs and gas seepages. The productive reservoir consists of the permeable volume within the greywacke basement, which is thought to be more than 1000 m thick (Gibson 1992).

There are about 20 hot springs in the area, many of which are used as baths. Most of these occur in a small area in Ngawha Springs. They are a sacred taonga to the local hapu and all of Ngapuhi.

The waters in the springs are typically between 40 to 50°C, slightly acidic and give off a weak smell of hydrogen sulphide. The water chemistry includes high concentrations of boron, ammonia and bicarbonate, and mercury mineralisation. Given its water chemistry, and its geology, the Ngawha geothermal field is quite different to other geothermal fields in New Zealand.

The earliest phase of geothermal exploration at Ngawha concluded in 1964 with one deep bore being drilled (NG1) (Gibson 1992). The former Ministry of Works drilled more exploration deep wells from 1977 to 1983. Some characteristics of these wells are given in Table 1 (below).

Table 1: Characteristics of exploration deep wells drilled at Ngawha from 1977 to 1983 (Thain 1985)

Year drilled	Well number	Total depth (m)	Maximum temp (°C)	Flowing enthalpy (kJ/kg)	Flow rate (kg/s)
1977	NG2	1253	236	980	30
1981	NG3	1470	228	980	30
1978/79	NG4	1353	237	970	110
1978	NG5	1281	250	-	-
1978	NG7	1316	189	-	-
1982	NG8	1184	218	890	65
1979	NG9	1000	227	970	65
1981/82	NG11	1209	225	960	90
1982	NG12	658	229	980	105
1982/83	NG13	2333	300	970	145
1982	NG15	431	175	-	-
1982	NG18	1362	244	950	30
1982	NG20	1644	260	2000	13

Most of the wells were discharged and tested for short periods, but were then left virtually untouched for a decade, before the existing power development was proposed. Two new wells were drilled in 2007, which are not presented in this table.

### Regional Policy Statement objectives

There are no objectives in the Regional Policy Statement (RPS) for Northland (NRC 2002a) specific to geothermal resources. However, the objectives pertaining to water quality and quantity (including lakes, streams and groundwater), land and biodiversity are all relevant to the Ngawha geothermal field.

For more information on these objectives check out the relevant sections of this report or the RPS which is available on the Regional Council website.

### Issues relating to geothermal resources

The key issue relating to the geothermal field is how much geothermal fluid can be used for power generation without significantly affecting the existing geothermal springs in the Ngawha Basin and the surrounding environment.

Maori and spa baths with Lake Tuwhakino at upper left (right). Photo courtesy of Tricia Scott.





## 13.2 What are the pressures on geothermal resources?

Historically, the thermal waters at Ngawha Springs were used for bathing. Maori history tells of the waters being used for bathing warriors. The spring system also attracted considerable scientific and commercial interest in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries because of the accompanying mercury deposits, which were unprofitably mined during two periods. These mining operations substantially modified the landscape surrounding Ngawha springs (Sheppard and Johnston 1984).

Currently, the springs are still used for bathing. Baths have been excavated since 1908 in four separate areas. They have boarded sides and are fed through seepage in the bottom and/or sides. The bath waters have a small international and a large local reputation for their curative properties.



Baths at Ngawha Springs (right).  
Courtesy of Tricia Scott.

Since July 1998, fluid from the Ngawha geothermal field has also been used for power generation. The field is “tapped” by a single power station, which was constructed by a joint venture between Top Energy and the Tai Tokerau Maori Trust Board, the Ngawha Geothermal Resource Company Ltd (NGRC).

The 1994 consent allowed up to 10,000 tonnes of geothermal fluid per day to be taken from two “production wells”, which is used to generate around 11 MW (gross) of electricity. The used fluid is then returned to the ground via two “re-injection wells”.

In November 2006, the Environment Court granted consents to increase the extraction of geothermal fluid up to 775,000 tonnes per month (approximately 25,000 tonnes per day), increasing the total power production to approximately 25 MW (gross).

The abstraction of geothermal fluid has the potential to result in physical and chemical changes to the existing geothermal features in the Ngawha Basin. Discharges from the geothermal power station also have the potential to have adverse effects on air quality and terrestrial and aquatic ecosystems.



New development as part of expansion granted by consent in 2006 (right).

### 13.3 What is the state of our geothermal resources?

There were several surveys of the Ngawha springs and the chemistry of their waters through the 1900s. For more detail on the findings check out the geothermal resources section of the Regional Council's 2002 State of the Environment (SOE) report (NRC 2002b), available at the following link:

<http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/2002-State-of-the-Environment-Report/>

The resource consents granted for the power station in May 1994 required the joint venture to undertake at least 12 months of further baseline monitoring in the Ngawha area before it could start abstracting geothermal fluid. The joint venture collected more than 18 months of comprehensive data before the production wells were purged and commissioning of the power station began (Scott *et al.* 1998).

For a summary of the key findings from that baseline monitoring check out the 'geothermal resources' section of the 2002 SOE report (NRC 2002b), available at the following link:

<http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/2002-State-of-the-Environment-Report/>



Lake Waiparaheka.

During the baseline monitoring period, a new species of mudfish, called Northland mudfish (*Neochanna heleioides*), was discovered at two sites in Northland – near Kerikeri airport and in the Ngawha Catchment. It is an ephemeral wetland species and was considered to be critically endangered because of low numbers. A population of this mudfish species was found in one of the catchments immediately adjacent to the

geothermal power station site, in the Department of Conservation (DOC) wetland below pond NG9.

Subsequent monitoring has identified a further area adjacent to the power plant, Bannister's Swamp, where the mudfish species has been discovered. However, mosquito fish (*Gambusia affinis*) have also been identified, which may provide a threat to the population in that area. The viability of the population resident in the DOC wetland below NG9 demonstrates the apparent resilience of this species to geothermal emissions.

One of the requirements of the 1994 consents was the development of a comprehensive programme to monitor the effects of the activities associated with the power station. This included monthly monitoring of the baths and other geothermal features in the area to determine any changes to the geochemistry and temperatures relative to baseline monitoring, and regular monitoring of selected locations considered representative of the receiving environment for the effects of any discharges from the power station operation. This receiving environment monitoring included the water quality of streams, the chemical composition of soil and plants and the biodiversity of selected sites within the area of influence of the power station activities. In addition, gas monitoring was undertaken to provide an ongoing assessment of concentrations.

Data from this monitoring was compared to baseline data and presented in six monthly reports. The reports were reviewed by a panel of experts in the respective fields, who made recommendations for any management or operational changes to the power station if required (NZE 1998 to present).

As part of the 2004 consent renewal and expansion applications all the data collected from the geothermal features and the receiving environment for discharges over the term of the existing consent was reviewed along with additional monitoring undertaken at the request of the Regional Council to provide further information for processing the consent. This review showed no significant variation in the geological and environmental features of the site relative to the baseline monitoring (Kingett Mitchell 2003; NRC 2004).



### 13.4 What is being done?

The Ngawha geothermal field is currently “tapped” by a single user – Ngawha Geothermal Resource Company Ltd, which operates a small scale power station that generates around 11 MW (gross) of electricity, and is currently undertaking expansion of the plant to increase production to 25 MW (gross).

As discussed in the previous section, the resource consents granted in 1994 for the power station required the consent holder to undertake baseline monitoring in the Ngawha area before it could start taking geothermal fluid. In addition to this monitoring, the resource consents also:

- Restricted the take to 10,000 tonnes per day instead of the 35,000 tonnes per day originally applied for by the joint venture.
- Required comprehensive ongoing monitoring of the environmental effects of the geothermal fluid take and power station.
- Required the establishment of a “Peer Review Panel”. This panel is made up of three professionals with expertise in geothermal reservoir management, geothermal chemistry, and terrestrial and aquatic ecology, and a representative of the tangata whenua. The main purpose of the panel is to critically review reports on the various monitoring programmes required by the consents, consent compliance and the effects of the take/operation of the power station on the surrounding environment, and the sustainability and characteristics of the Ngawha geothermal field.
- Required the establishment of a “Community Liaison Committee” made up of representatives of the tangata whenua of Ngawha, thermal pool operators, local residents, downstream water users and the Far North District Council and Northland Regional Council.

The term of the consents was also reduced to 10 years (from the commencement of the consents) instead of the 35 years applied for.

These strict requirements were imposed on the resource consents to:

- Protect the geothermal springs/features in the Ngawha Basin and the sustainability and characteristics of the Ngawha geothermal field.
- Minimise any environmental effects of the take and power station.

The new consents granted in November 2006 include continuation of all of the above requirements, except that:

- The take has been increased to approximately 25,000 tonnes per day (775,000 tonnes per month),
- The term of the consents is for 20 years, with provision to review under Section 128 of the RMA, and
- Further baseline and ongoing monitoring of the receiving environment is required in new areas proposed to be used in the expansion.

The new consents also require the consent holder to maintain pressure of the geothermal reservoir within +1.5 bar and -1 bar of the existing reservoir pressure. In order for the consent holder to maintain this pressure and avoid effects on the geothermal springs, the consents include re-injection of the fluid extracted and injection of an additional 3000 tonnes of water per day to maintain the pressure in the geothermal reservoir.



Part of the drilling equipment with discharge pond in background.

## Monitoring

Monitoring over the 10-year term of the previous consent has shown that no significant changes to the local environment have occurred in terms of air, water and soil quality that could be attributed to the discharges from the power station over the period of its operation.

Over the period of the previous consent, monitoring was conducted for:

- Ecosystems (including receiving water quality, vegetation surveys and surveys of eels (*Anguilla* sp.), mudfish and other fauna).
- Springs and streams receiving thermal fluids (bath temperature and chemistry, stream flow variations).
- Groundwater (levels, temperature and chemistry).
- Temperature and pressures in the geothermal reservoir.
- Lakes (levels, temperatures and chemistry).
- Air quality (chemistry).

A survey of the wetland area immediately below the outlet from the NG9 holding pond in September 1999 established that some vegetation had been damaged or killed as a result of early discharges from the pond. These areas have since recovered (Silvester 1999).

The Pond Management Plan (NZE 2007a) for the expanded power plant includes re-injection of almost all wastewater generated during operation and maintenance activities. This reduces the need for discharges from the ponds and enables protection of the potentially sensitive receiving environment, which is a habitat for the critically endangered black mudfish species.



Some Ngawha residents and geothermal pool operators have raised concerns that there may have been some cooling of the pools. However, comparison of long-term temperature records did not show any cooling of the spring outside of natural variation. Reservoir modelling and additional investigations undertaken indicate that maintenance of reservoir pressure will mitigate adverse effects on spring flows, temperature and chemical composition.

Concerns have also been raised about offensive odour, which has been attributed to the power station. Continuous hydrogen sulphide monitoring records confirm that there have been high levels recorded, but that those levels were not outside the range recorded during the baseline monitoring period.

Ongoing comprehensive monitoring is required as a condition of the consent to ensure that no adverse effects on the springs occur as a result of the increased extraction.

A revised environmental monitoring programme has been developed in accordance with the requirements of conditions in the new consents, and the area of monitoring has been expanded to include the wider area affected by the expansion of the power station (NZE 2007b). Monitoring frequency is dependent upon the specific type of monitoring and the activities occurring at the site and ranges from, for example, daily monitoring in the event of any pond discharge to monthly and six-monthly chemical monitoring of streams and of geothermal features including the springs, and annual ecological monitoring.

Reporting of the results will continue to be six-monthly, and results will be reviewed by the Peer Review Panel, as well as by Regional Council staff. In the event of any discharges to the receiving environment, reporting will be undertaken at the time of, and throughout the duration of, the discharge to enable Regional Council compliance monitoring and liaison with respect to any recommended actions, if required. During the construction phase of the expanded power station additional monitoring has been undertaken to minimise and mitigate any environmental effects.

## 13.5 References

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