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Tauhara II - Innovative Environmental Permitting for a New Geothermal Plant Adjoining the Taupo Urban Area

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ABSTRACT

In February 2010 Contact Energy Limited lodged a comprehensive resource consent application with New Zealand's Environmental Protection Authority (EPA) for the 250MW Tauhara II Geothermal Power Station Development east of Taupo Township. It was the first development application to be processed by the EPA through a new fast track consenting process designed for projects of National Significance.

This was a challenging project which involves developing New Zealand's largest geothermal energy project on the door-step of Taupo Township. It required a range of complex technical and urban interface issues to be considered, particularly associated with historical and potential additional subsidence, noise, landscape, shallow-geothermal and air quality effects. There are also a wide range of Maori landowning and cultural interests in the project area.

A number of innovative techniques were employed in the delivery of this project including facilitation of a Technical Focus Group (TFG) involving local Councils, the Department of Conservation and Maori members to guide and assess the draft consent documentation, and the development of a Steamfield Design Protocol to govern the on-going development of the steamfield works over time. Detailed conditions were also developed to allow an adaptive management approach to avoiding or mitigating any observed development impacts on important shallow geothermal resources (hot springs, fumaroles, thermotolerant vegetation, shallow heat users etc.). A Working Party approach successfully considered and agreed an offset approach for effects associated with Maori interests.

Resource consents were granted for the project in December 2010 and subsequently the innovative and inclusive consenting process won major project awards from the New Zealand Planning Institute, New Zealand Resource Management Law Association and the New Zealand Institute of Landscape Architects.

1. INTRODUCTION

The Wairakei-Tauhara Geothermal System is part of the Taupo Volcanic Zone in the North Island of New Zealand. It is a very large geothermal system and its development over the last 55 years has had a significant influence on New Zealand's geothermal energy journey, with Wairakei being the birth place of large scale geothermal electricity generation from liquid dominated geothermal resources. For years Tauhara was overshadowed by Wairakei, however over the last 15 years there has been an awakening as to the very large potential of the Tauhara resource, some of which has been developed and some of which has been granted resource consents and is awaiting development when the energy market conditions are right. This paper explores some of the permitting and consenting challenges at Tauhara and ways that these challenges have been met.

In particular, this paper describes a comprehensive environmental, social and cultural assessment and consenting approach for the Tauhara II Geothermal Development project undertaken by Contact Energy Limited (Contact Energy) between 2008 and 2010. The approach taken included a number of innovative techniques and utilized a newly developed streamlined consenting process, designed for proposals of national significance under New Zealand's Resource Management Act. The experienced project team comprised internal Contact Energy personnel and an external consultancy team, which together covered a wide range of management, legal, geothermal science, engineering, socio-economic, and environmental expertise.

The consenting process took a number of years of work and required careful planning and management throughout. Key resource management issues included extensive Maori land and cultural interests within the project area, along with a wide range of urban interface issues including:

a) A history of ground subsidence on parts of the Wairakei-Tauhara Geothermal System;

b) Considerable existing use of the shallow geothermal resource for domestic and tourism uses;

c) The existence of a number of significant geothermal features identified in the Waikato Regional Plan;

d) The proximity of a small number of rural-residential dwellings which were sensitive to noise emissions;

e) The proximity of urban environments in relation to modelled air discharge effects; and

f) Landscape and visual effects associated with both the power plant location and extensive steamfield area.

2. TAUHARA II PROJECT SETTING

2.1 The Wairakei-Tauhara Geothermal System

The Wairakei-Tauhara geothermal system is a large geothermal system in the Taupo Volcanic Zone, near Taupo, in the North Island of New Zealand. The general location of Wairakei and Tauhara are shown just to the north of Lake Taupo in Figure 1.

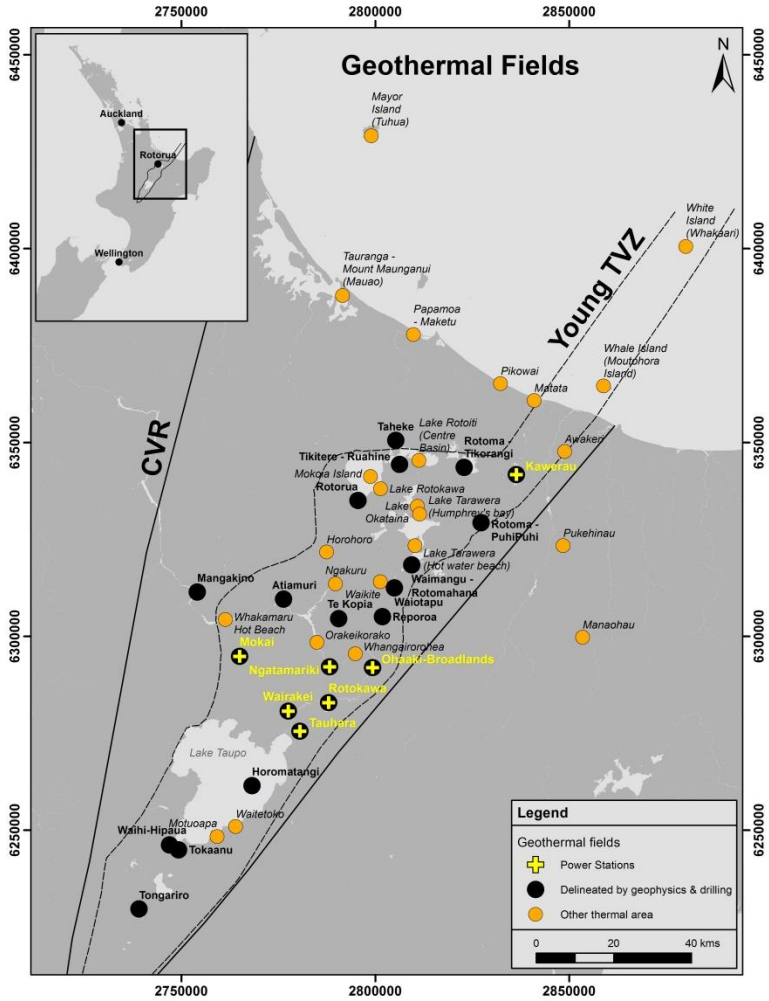

Figure 1 - Geothermal Systems in the Taupo Volcanic Zone. Insert top left identifies location relative to the North Island of New Zealand (Diagram courtesy GNS Science).

The Wairakei Tauhara geothermal system is generally defined in two dimensions by the shallow (≈ 500m deep) electrical resistivity boundary zone (Pink shading in Figure 2). The Tauhara geothermal system encloses an area of about 50 km^2 being about twice the area of the Wairakei Field covering the area from Mt Tauhara to the Taupo town lakeshore and northwards to the Waikato River to near the Wairakei Power Station. Drill hole and downhole pressure data show that the Wairakei and Tauhara Fields are geologically and hydrologically connected.

Geochemical indications are that the Wairakei and Tauhara Fields are sustained by separate upflows of geothermal fluid but the merged boundary of the fields highlights the extent and connection (within about 500-700 m depth) of dispersed hot fluid in permeable formations. One interpretation of the southwest - northeast elongation of the resistivity boundary zone is that the shape reflects deep fault-controlled upflow parallel with the strike of the TVZ structural grain and shallower preferential channelling of inflows and outflows along those fault zones. The location of the system and the whole shape of the boundary zone reflect the hydrothermally altered rock above the hot fluid upflows and the probable location of the magmatic heat source within the crust.

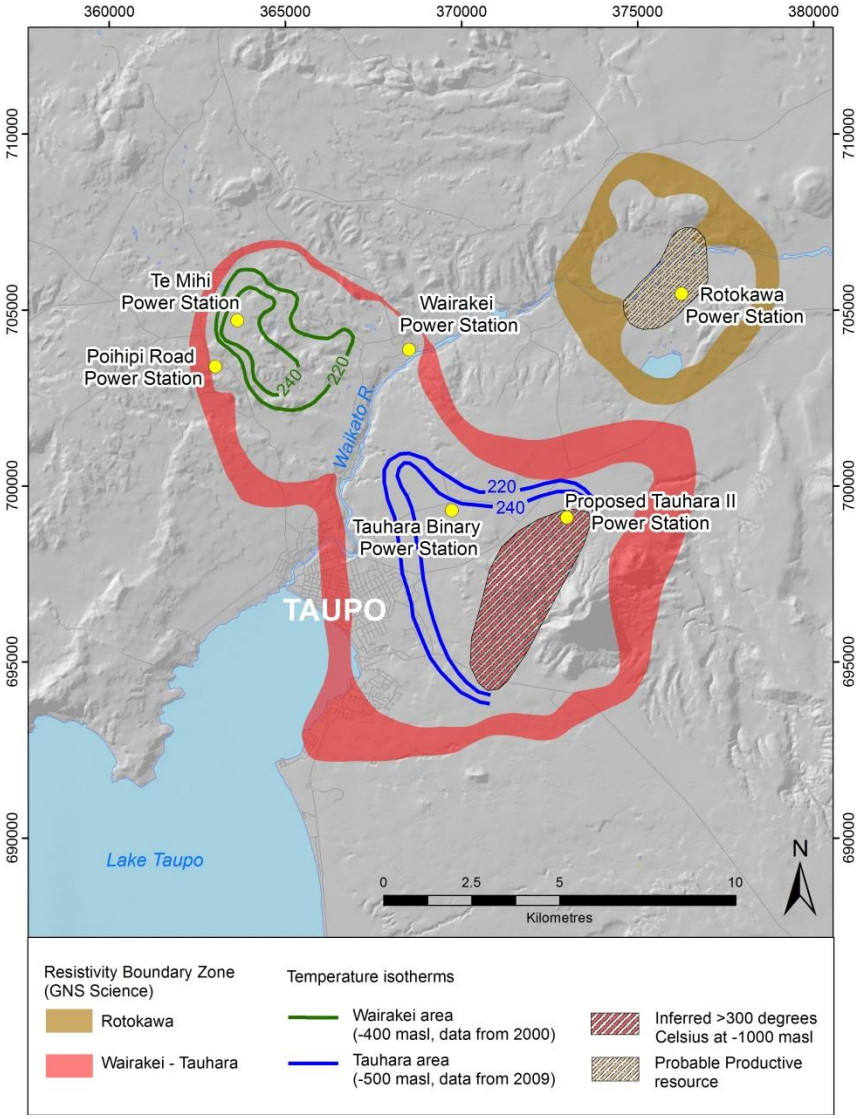

Figure 2 - The Wairakei-Tauhara Geothermal System showing resistivity boundary zones (pink), temperature isotherms (blue and green) and power station locations. The temperature isotherms are in degrees Celsius at an elevation of -500 masl, and the inferred red / grey hatched area in Tauhara is considered to have temperatures in excess of 300°C at an elevation of -1000 masl (Rosenburg et al 2010, Figure E1)

The primordial heat source(s) of the Wairakei-Tauhara system has almost certainly been augmented by numerous episodes of local magma generation and volcanism that occurred during its formation and evolution, including the large volume 26.5 ka Oruanui and 1.8 ka Taupo eruptions and at Tauhara Field those that created the Mt Tauhara dome complex (190 ka) and other rhyolite eruptions (eg Trig rhyolite ~28 ka). It is very likely that changes to the Wairakei-Tauhara Geothermal System were induced at the same time as the local volcanism by changes in tectonic stress, seismicity and heat flow.

2.2 Wairakei Resource Development History

The large scale use of geothermal energy in New Zealand emerged as a result of the rapidly increasing demand for electrical energy post World War II. By the end of 1948, the New Zealand power supply situation had deteriorated to such an extent that the Government initiated a focused geothermal investigation programme. A Geothermal Advisory Committee (GAC) reporting directly to Cabinet was set up in mid-1949. The thermal area at Wairakei was seen to have quite some potential. The steam field and potential power station sites were on Crown land and the topography of the area, together with cooling water available from the Waikato River indicated a relatively straightforward power development.

In May 1953, Cabinet approved in principle the construction of a 35 MWe power plant and a 6 ton/year heavy water distillation plant for the supply to the United Kingdom Atomic Energy Authority (UKAEA). In 1956 the UKAEA withdrew from the heavy water distillation facility which resulted in additional power turbines being procured to replace the distillation vessels taking the generating capacity of the 'A' station power plant to 69 MW. The design and procurement for 'A' station was continuing in parallel with the steam winning. Steam winning progressed so satisfactorily that extensions to the power station were proposed in 1956. Two additional 11.2 MW high pressure (HP) turbines were to be installed in the 'A' station and a 'B' station was to be constructed comprising three 30 MW mixed pressure (MP) turbine generators. This took the installed capacity to 192.6 MWe.

Power generation commenced on 15 November 1958. Construction and commissioning of the Wairakei Power Station continued through until October 1963 when the last 30 MWe turbine generator was operational. Changes occurred in the early 1980's with the decommissioning of the four high pressure turbine generator sets reduced the installed capacity to about 157 MWe.

The 55 MWe Poihipi power station was built in 1996, the 15 MWe Wairakei binary cycle power plant was added in 2005 and the 166 MWe Te Mihi plant was constructed between 2011 to 2013 and began generating in 2013. Te Mihi comprises two 83MWe mixed pressure turbine generator units. With Te Mihi on line the original Wairakei steam turbine plant has reduced load and produces about 114 MWe giving a total effective installed capacity of 333 MWe from the Wairakei stations at the end of 2014. All the plants are owned by Contact Energy and operated off an integrated steam supply and reinjection system – refer to Figure 2 for power station locations.

2.3 Tauhara Resource Development History

At Tauhara, four wells (TH1 to TH4) were drilled by the Ministry of Works and Development, commencing in 1964, which indicated that a productive geothermal resource with reservoir temperatures of around 260-265^{o}C was located in the northern part of the Tauhara Geothermal Field. Interest in the Tauhara resource saw a small steam supply to the Department of Conservation nursery in operation using TH2 from the early 1980's through to 2006 and some interest from Taupo Electricity Limited which resulted in a shallower well TH5 being drilled in 1991. The wells (TH1 to TH4) underpinned resource consent applications lodged by Contact Energy in 1996 for a geothermal development project on the North Tauhara Field (Tauhara I). Consents were granted in 2001 after an extensive Regional Council Hearing processes followed by an Environment Court process which ultimately resulted in the consents being granted. Utilising the Tauhara I consents a 20 MWth direct heat supply to timber drying kilns at the Tenon Mill was developed in 2006 (replacing a gas fired boiler heat supply), and the Tauhara Binary "Te Huka" Power Station, a 23MWe binary power plant, was commissioned in 2010.

In 2006 Contact Energy drilled TH12 in east Tauhara which intersected geothermal fluid with temperatures close to 300^{o}C, indicating high quality geothermal resource potential in this eastern part of the Tauhara field. Further exploration drilling in 2008 confirmed that a considerable resource was available at high temperatures suitable for electricity production, and accordingly the Tauhara II Geothermal Development Project was conceived, sized at about 250 MWe. See Figure 2 for power station locations.

2.4 Project Team Experience under the Resource Management Act 1991

The successful Tauhara II consenting process built on a background of geothermal resource management knowledge and experience gained by members of the project team over a period of 20 years, since the enactment of New Zealand's Resource Management Act in 1991 (RMA). This experience involved overseeing a range of environmental improvements and energy projects at Wairakei beginning with reinjection investigation work in 1987, the commissioning of the Poihipi Power Station in 1997, a long consenting journey for the initial Tauhara I project between 1995 and 2001, and the building of the Wairakei Binary Plant in 2005. During this same period the geothermal policy and planning framework guiding the sustainable management of geothermal resources in the Waikato Region was evolving (Luketina 2010), in tandem with the consideration of new resource consent applications lodged in 2001 to enable the continued operation of the Wairakei Power Station (Contact Energy 2001). This resulted in considerable complexity around the Wairakei renewal applications which although lodged in 2001 were finally granted in 2007 as discussed in Daysh and Chrisp (2008).

The considerable time, uncertainty and costs involved in both the Tauhara I and Wairakei Power Station resource consent processes led to the need for a different approach for consenting geothermal projects, particularly those near urban environments where complex resource management and competing interests are in play. The New Zealand Government introduced new legislation through the Resource Management Amendment Act 2005 which expanded the powers of the Minister for the Environment to "call-in" proposals of national significance to be heard by a specially appointed Board of Inquiry. This process was successfully utilized for Contact Energy's Te Mihi geothermal power station which was progressively commissioned from 2013, where the consenting process took less than two years to complete as reported in the decision of the Te Mihi Board of Inquiry 2008. These Board of Inquiry provisions were developed further through the introduction of the Resource Management (Simplifying and Streamlining) Amendment Act 2009 which, among a number of significant legislative changes, required Boards of Inquiries hearing proposals of national significance to make a decision on the application within 9 calendar months of their public notification for submissions. As discussed below, the Tauhara II Geothermal Development Project was the first proposal of national significance to be heard under this new time-bound consenting process.

3. ENVIRONMENTAL PERMITTING FOR PROPOSALS OF NATIONAL SIGNIFICANCE IN NEW ZEALAND

3.1 Resource Management Act 1991

3.1.1 Purpose and Principles

The purpose of the RMA is *"to promote the sustainable management of natural and physical resources"*. The term 'sustainable management' is defined in Section 5 of the RMA as:

"…managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while -

a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment."

In achieving the purpose of the Act, all persons exercising functions and powers under it in relation to managing the use, development, and protection of natural and physical resources are required to recognize and provide for a range of specified matters of national importance (Section 6), have particular regard for a list of other matters (Section 7) and take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi). The purpose and principles underpin the legal basis of all resource management plans and decisions on development applications.

3.1.2 Regional and Local Planning and Decision Making

The RMA is primarily implemented by Regional Councils, whose primary functions relate to the management of water and air and coastal environments, and Territorial Authorities (District and City Councils) whose primary function relates to land use planning. Luketina (2000) describes the application of the RMA in relation to geothermal resource management. A hierarchy of National Policy Statements, National Environmental Standards, Regional Policy Statements, Regional Plans and District Plans developed through public consultation and submission processes control and guide development under the RMA. New geothermal electricity projects or any significant changes to existing geothermal projects in New Zealand of any scale invariably require the preparation and approval of resource consent applications. Depending on the issues and actual or potential environmental effects of any given proposal, resource consent applications may be publicly notified and any person (apart from trade competitors) can make a submission opposing or supporting the application.

Outside the "call-in" process described for proposals of national significance, hearings are held by the relevant Council where both the applicant and any submitters can present their case, and a decision is made by a hearings panel of elected Councilors and/or certified independent commissioners. The local decision can be appealed to the Environment Court by the applicant or any submitter which re-hears the case and issues a final decision, which may be appealed to the New Zealand High Court in relation to points of legal interpretation only.

3.2 Resource Management (Simplifying and Streamlining) Amendment Act 2009

3.2.1 Overview

After nearly 20 years of practice under the RMA a significant amendment was legislated in 2009 with the passing of the Resource Management (Simplifying and Streamlining) Amendment Act 2009. As described in Ministry for Environment (2009):

The Resource Management (Simplifying and Streamlining) Amendment Act 2009 represents the single biggest review of the RMA since 1991. The review began in November 2008 and was centred around eight major themes:

a) reducing the ability for the RMA to be used for making frivolous, vexatious or anti-competitive objections and appeals

b) reducing the cost and time it takes to make decisions on proposals of national significance

c) establishing an Environmental Protection Authority (EPA) to process applications for proposals of national significance in a timely and efficient manner

d) improving plan development and plan change processes to reduce the time and cost associated with preparing and changing policy statements and plans

e) improving the resource consent process to reduce the cost and time faced by applicants while maintaining an appropriate level of public participation

f) streamlining the preparation, and improving the effectiveness of, national instruments including national policy statements and national environmental standards

g) improving the effectiveness and deterrent effect of enforcement and compliance mechanisms

h) increasing the efficiency and workability of RMA decision-making processes.

3.2.2 Environmental Protection Authority

The New Zealand Environmental Protection Authority (EPA) has a number of functions including:

a) Administration of applications for proposals of national significance under the RMA;

b) Regulation of new organisms (plants, animals, GM organisms) and hazardous substances and chemicals;

c) Managing the environmental impact of activities in New Zealand's offshore exclusive economic zone and continental shelf (EEZ), including prospecting for petroleum and minerals, seismic surveying and scientific research.

d) Managing the Emissions Trading Scheme and New Zealand Emission Unit Register,

3.2.3 Proposals of National Significance

Since its establishment in 2009 the EPA has administered 15 proposals of national significance including eight roads of national significance, two wind farm proposals, a coastal salmon farm, a prison proposal, an intermodal inland port and urban development proposal, an integrated catchment management plan and irrigation scheme proposal, and the Tauhara II Geothermal Development Proposal (which was the first case considered and determined under the 2009 Amendment Act). The Te Mihi Power Station proposal (Board of Inquiry 2008) was administered by the Ministry for the Environment under the previous legislation.

Proposals of national significance require the Minister for the Environment's approval for them to be referred to a Board of Inquiry or the Environment Court for a Decision. Section 142(3) of the Act sets out the matters for consideration:

> *142 (3) In deciding whether a matter is, or is part of, a proposal of national significance, the Minister may have regard to—*
>
> *(a) any relevant factor, including whether the matter—*
>
> *(i) has aroused widespread public concern or interest regarding its actual or likely effect on the environment (including the global environment); or*
>
> *(ii) involves or is likely to involve significant use of natural and physical resources; or*
>
> *(iii) affects or is likely to affect a structure, feature, place, or area of national significance; or*
>
> *(iv) affects or is likely to affect or is relevant to New Zealand's international obligations to the global environment; or*
>
> *(v) results or is likely to result in or contribute to significant or irreversible changes to the environment (including the global environment); or*
>
> *(vi) involves or is likely to involve technology, processes, or methods that are new to New Zealand and that may affect its environment; or*
>
> *(vii) is or is likely to be significant in terms of Section 8 [relating to the Treaty of Watangi]; or*
>
> *(viii) will assist the Crown in fulfilling its public health, welfare, security, or safety obligations or functions; or*
>
> *(ix) affects or is likely to affect more than 1 region or district; or*
>
> *(x) relates to a network utility operation that extends or is proposed to extend to more than 1 district or region;*
>
> *(b) any advice provided by the EPA*

4. INNOVATIVE ENVIRONMENTAL PERMITTING TECHNIQUES USED FOR TAUHARA II

4.1 Overview

A comprehensive suite of consents were applied for, including changes to conditions for existing geothermal developments on the Wairakei-Tauhara Geothermal System to achieve integrated management of the resource under one Wairakei-Tauhara geothermal System Management Plan. The application was lodged on 19 February 2010 with the Environmental Protection Authority. Following the completeness review there was no section 92 request for further information, which is sometimes required when applications do not cover all relevant matters requiring assesment. The Minister for the Environment determined that the project was a matter of national significance and directed that the application be heard by a Board of Inquiry, the direction being notified on 17 April 2010. A hearing was held in Taupo over six days between 13 September and 6 October. A draft decision was issued on 20 October, and the final decision was issued on 22 December 2010.

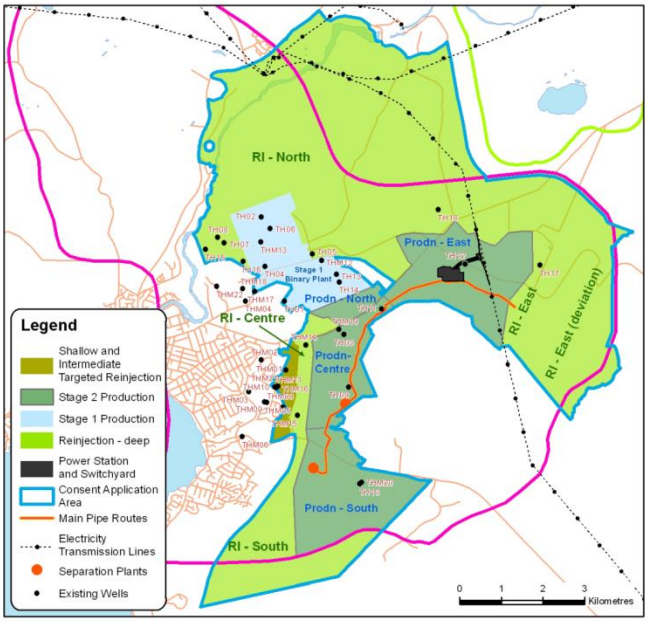

Figure 3 Tauhara II Geothermal Development Project showing the Tauhara wells, consented fixed project elements and the proposed steamfield management approach. The Taupo urban area lying between the consented area and Lake Taupo is also illustrated (Contact Energy 2010)

4.2 Experienced Multi-Disciplinary Project Team and Peer Review Focus

A feature of the Tauhara II resource consenting process was the strong integration between the Contact Energy senior management and legal teams, the Wairakei based operations, environmental and specialist technical staff, and a very experienced external consultancy and peer review team sourced from a range of organisations and disciplines. All of the core project team and selected peer reviewers had significant background and experience in geothermal resource management issues generally, and in particular the development, environmental and community issues associated with the Wairakei-Tauhara Geothermal System.

Environmental Management Services Limited were appointed lead consultants and planners, geo-science input and advice was provided by GNS Science Limited, project feasibility engineering was undertaken by Sinclair Knight Mertz Limited, resource modelling was the responsibility of the University of Auckland, the environmental and landscape design was prepared by Isthmus Group and the legal team was led by Barrister Trevor Robinson.

Contact Energy also commissioned a number of external peer reviews of important reference and technical reports that were to be submitted in support of the resource consent applications. The peer reviews were undertaken by recognized geothermal experts from within New Zealand and some were reviewed by internationally recognized experts from other nations. The process was rigorous and the peer reviewers provided letters detailing the scope of the review that was undertaken, the findings from their review and the study authors outlined how they had responded to the peer review comments.

4.3 Baseline Studies and Resource Management-Led Design

The project was 'resource management-led' in that the design was integrated with the analysis of the resource management issues which would be tested when the resource consent applications were heard and determined, and integrated across the different professions. Baseline assessments (landscape, archaeology, noise, air quality, geothermal science) of the existing environment were carried out and a number of alternative development scenarios tested against the baseline information to select the project for consenting.

Workshops were held with the different professions as the design was developed. The design was tailored to address the issues, and to coordinate the work of the different professions toward the 'best' outcome. For instance the trunk pipeline alignment was staked out on the ground by a team comprising engineers and landscape architects to ensure that a route was chosen which minimised the visual effect while achieving a practicable engineering solution. Similarly mitigation measures were designed to coordinate the overlap between professions. For instance surplus spoil at the power station site was contoured by the landscape architects to help integrate the power station into its landscape setting.

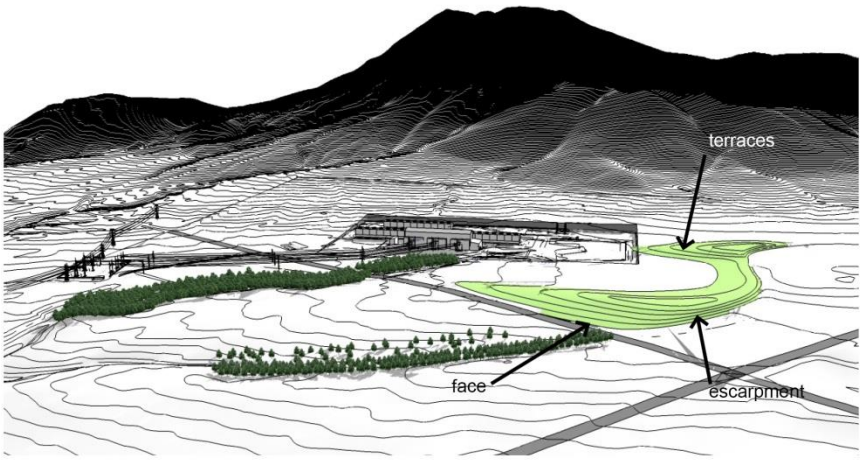

Figure 4 Proposed land form sculpturing steamfield landscape design protocol from the visual and landscape assessment.

4.4 Comprehensive Resource Assessment including a Major Subsidence Investigation Programme

Comprehensive resource assessments were undertaken, including a significant subsidence investigation programme as part of preparation for the consent application. The work encompassed the preparation of reports in 23 separate activity areas that were divided into five major groupings as detailed below:

1. **Project Reference Reports**
   - Tauhara II Geothermal Development Project – Project Description (Stanfield et al 2010)
   - Planning Assessment (Chrisp 2010)
   - Geoscience Report (Rosenberg et al 2010)
   - Wairakei-Tauhara Modelling Report (O'Sullivan and Yeh 2010)
   - Subsidence Report (Bromley et al 2010 / 151)
2. **Above Ground Effects Assessment Reports**
   - Landscape and visual assessment (Lister and Coombs 2010)
   - Environmental Noise assessment (Hunt 2010)

- Assessment of emissions to air (Noonan et al 2010)
- Transportation assessment (Prosser and Harries 2010)
- Archaeological Assessment (Clough and Farley 2010)

3. Below Ground Effects Assessment Reports

- Surface and Shallow Hydrothermal Effects Management (Bromley et al 2010 / 266)
- Building and Infrastructure Effects (Booth and Benefield 2010)
- Land Discharges Assessment (Williamson 2010)

4. Economic and Climate Change Assessment Reports

- Assessment of Benefits (Hunt 2010)
- Regional Economic Development Assessment (Bevin 2010)
- Carbon Footprint for the Tauhara II Geothermal Development (Drysdale 2010)
- Climate Change (Renwick 2010)

5. Management Plans and Steamfield Design Protocol

- Steamfield Design Protocol (Contact Energy 2010)
- Stormwater Management Plan (SKM 2010)
- Erosion & Sediment Control Plan (SKM 2010)
- Hazardous Substances Management Plan (SKM 2010)
- Construction Traffic Management Plan (Traffic Design Group 2010)
- Draft Construction Environmental Management Plan (Contact Energy 2010)

Figure 5 Mount Tauhara and northern surrounds with the Tauhara II Power Station site on the sloping farmland area at the base of Mt Tauhara.

With regard to the subsidence assessment, the work undertaken is documented in (Brockbank et al., 2011 and Bromley et al 2010 / 151). The studies focused on two known anomalies in the northern Tauhara area, near Spa Valley and Rakaunui Road, plus one centered on Crown/Invergarry Road junction in eastern Taupo (Bromley et al., 2009). The Spa and Rakaunui anomalies had been recognized from early leveling surveys during Wairakei development, and so some ongoing subsidence effects within these anomalies had been anticipated (Allis et al., 2009), but the Crown anomaly commenced much later; it was first noticed in 2001. Because of its proximity to urban and industrial properties, and its late arrival, it was of greater concern. Investigations from 2009 to 2011 (including geotechnical core drilling and testing) into the causes of these anomalies revealed pockets of highly compressible material, at depths ranging from about 50m to 300m.

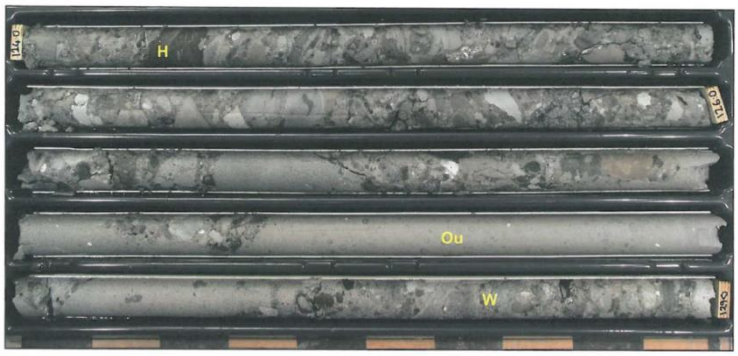

Figure 6 Example core of Crown breccia from 124 - 129m depth in THM16. Labelled component fragments are H (Huka Falls Formation mudstone), Ou (Oruanui Formation tuff), and W (Waiora Formation tuff). Core is 6 cm x 1 m.

The results of the studies were widely circulated, discussed openly with community representatives including the technical focus group, and published in peer reviewed literature (Bromley et al., 2013). With the acquired knowledge from the investigation, more reliable predictions of possible future subsidence were derived using models based on simulated pressure and temperature changes for the proposed Tauhara II development. Detailed "adaptive management" resource consent conditions were developed and proffered providing for pressure management and a commitment by the consent applicant, Contact Energy, to make good any adverse effects, if they did occur. This provided sufficient assurance to the Board of Inquiry that the subsidence effects had been, and would be adequately remedied.

The Board of Inquiry decision (BOI 2010) recognized the comprehensive nature and quality of the subsidence investigation work identifying in paragraph 209 *"As a consequence of earlier consents, Contact was required to investigate the magnitude and cause of ground subsidence, especially differential subsidence, in the Taupo area. This has resulted in a comprehensive, multi-disciplined programme of ground and building surveys and extensive drilling. The technical evidence presented by participants in the programme is of very high quality and has assisted us."*

4.5 Steamfield Design Protocol

The project is in a sensitive landscape setting on the outskirts of Taupo and near the base of Mt Tauhara, a recognised Outstanding Natural Feature of particular significance to tangata whenua. An integrated design approach included baseline analysis of the existing environment and tailoring the design to avoid or address issues. For instance the power station was located on the opposite side of a low ridge north of Taupo, thereby reducing visibility, and adjacent to an existing National Grid transmission line.

'Best practice' and innovative design measures were undertaken including:

- An architectural brief for the power station building that emphasises horizontal elements in counterpoint to the cone of Mt Tauhara;
- Contouring of surplus spoil near the power station to echo the horizontal terraces of the pumice plain;
- Selecting an unobtrusive route for the main pipeline corridor following the topography;
- Specifying low reflective colours for the pipelines and power station matched to the landscape. (A best fit match was made to seasonal landscape colours observed over a year);
- Designing a comprehensive landscape planting plan to integrate the power station and other steamfield elements into the landscape. The planting was designed to reinforce the existing landscape patterns (such as re-vegetating watercourses, shelterbelts, woodlots) and integrate steamfield elements into the landscape rather than simply screen them.

The flexible elements (steam-pads, wellheads and connecting pipelines) posed a particular challenge because the configuration of such elements can only be determined as the steamfield is progressively developed through the 35 year consent term. The solution was a 'Steamfield Design Protocol' which contains a range of illustrated design principles and measurable standards to assist certification. Matters covered by protocol include: alignment of connecting pipelines to fit landform; contouring and rehabilitation of the earthworks associated with pipelines and access tracks; fencing and management of land adjacent to pipelines; separation distance of steam-pads from dwellings; contouring of surplus spoil around steam-pads; and planting to reduce prominence of well-heads and pipelines.

The Board of Inquiry noted in their decision*"…the careful design and landscaping of the fixed and flexible elements of the development." (paragraph 274)*

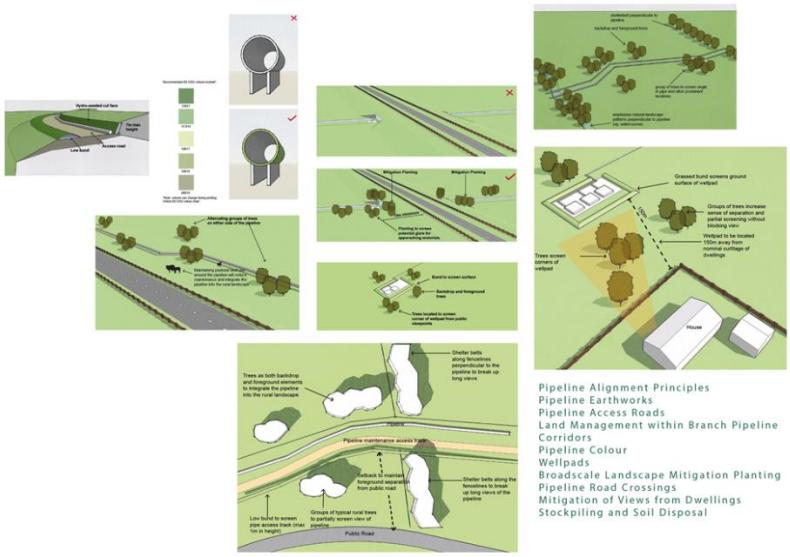

Figure 7 Design Features contained in the Steamfield Design Protocol by Landscape and Urban Designers Isthmus Group

4.6 Technical Focus Group Process

The technical studies to support the application were the culmination of several years of effort in the lead up to the application. As these studies progressed the Technical Focus Groups provided a forum to disseminate preliminary results and to develop a deeper understanding of the most prominent issues. Participants at these workshops included the project management team, technical study authors and representatives from the regulatory agencies (Taupo District Council and Waikato Regional Council), the Department of Conservation and iwi and hapu. A series of day long technical workshops were convened by Contact Energy through 2009 where the technical authors presented final drafts of their reports and outlined the investigation work they had undertaken, the results of their assessments and their recommendations. An interactive discussion regarding issues requiring further clarification assisted and informed the finalization of the study reports and management plans described in section 4.4 above.

This process enabled the relevance of all aspects of the technical programme to be tested by the Technical Focus Groups and many issues of concern were able to be addressed well before the hearing.

4.7 Adaptive Management Approach for Shallow Geothermal Effects

Adaptive management is embedded into the resource consent conditions enabling management of aspects that were recognized as requiring management through changing circumstances. System Management Plans including discharge strategies are a part of the consent conditions where the plans submitted with the consent application are implemented and then periodically reviewed to ensure they maintain relevance guiding sustainable management and wise utilization of the Tauhara Geothermal System. The plan reviews are peer reviewed by an independent Peer Review Panel that is established to assist the Waikato Regional Council exercise its statutory sustainable management functions under the RMA.

Adaptive management is also used in circumstances where there might potentially be some change in management approach required with time but where the management action was not required at the time of grant of consent. One such area was shallow and surface effects. An assessment was undertaken of the potential effects of the Tauhara II development on surface and shallow geothermal effects, such as hot springs, heated ground, hydrothermal eruptions, and groundwater (Bromley et al., 2010). The potential for adverse effects from induced micro-seismicity was also considered.

Monitoring recommendations were discussed, adapted and incorporated into the consent conditions through interaction with the Technical Focus Group and other interested parties. The key behind the acceptability of these conditions was the use of the monitoring data in an adaptive management process, whereby injection, in particular would be modified seeking to remedy adverse effects if they were deemed to require attention through the consent term. An example was a monitoring condition for the Waipahihi Source Spring, a spring considered of some value from the consultation undertaken. The approach uses a novel combination of chloride content and flow rate to ascertain whether or not observed changes are due to geothermal pressure changes or rainfall effects, and this is then used as a trigger for adaptive management of reservoir pressures through targeted reinjection, but only if required.

Importantly for Contact Energy, the establishment of a priority of effects management was defined for the practical management of uncertain outcomes, with physical subsidence coming first in terms of the hierarchy of importance for managing potential adverse effects.

4.8 Consultation and Agreement with Submitters

Appointing an independent ‘Friend of Submitters’ was an innovation suggested by Contact which was introduced for Tauhara II that has been adopted by others for subsequent Board of Inquiry projects . Mr Hamish Hey, a planning consultant, was appointed to the role. He was able to:

- Outline the nature of the project and potential issues to submitters;
- Guide submitters through the documentation, and steer them to relevant parts; and
- Inform submitters of the RMA processes.

At the direction of the Board, Contact also took part in a series of pre-hearing meetings with submitters. The Board appointed independent facilitators who were able to arrange the meetings and broker agreements. A proactive approach was taken to addressing and resolving submitter concerns including commissioning further analysis, assessments and photomontages, and proposing additional design measures and conditions.

Of the 60 submissions received, 24 were withdrawn prior to the hearing. Contact continued pro-active consultation during the hearing. Of the 16 submitters who took part in the hearing, matters had been resolved with all but 3 by the conclusion of the hearing.

The Board noted: *“…in the context of a nationally significant project, we were pleasantly surprised at the extent to which agreement had been reached.” (paragraph 88)*

Figure 8 Public Open Days were held at the Taupo Motorsport Park in December 2009 before the applications were lodged. Project Team members and technical specialists were available to answer questions from interested parties and members on any issues of concern or where project clarification was required.

4.9 Maori Working Party Agreements

Maori issues were particularly important with this project because:

- The Wairakei-Tauhara geothermal system is regarded as a taonga tuku iho by the Wairakei and Tauhara hapu of Ngati Tuwharetoa;
- The geothermal field is particularly associated with Mt Tauhara which is the ancestral maunga for Nga Hapu o Tauhara. The mountain backdrops the power station site and steamfield areas;
- There are several hapu who exercise kaitiakitanga over the field; and
- There is substantial Maori land within the steamfield area managed by Ahu Whenua trusts.

Contact already had an established relationship with Wairakei hapu because of the existing geothermal power project at Wairakei. A Working Party formed during the Wairakei reconsenting project (2001-2007) was re-established during the Tauhara II project to further cement the relationship. Two representative groups representing Maori interests on the Tauhara side of the geothermal system were established and were a focus of consultation between Contact and Tangata whenua. These were the Tauhara Whanau Whanui Working Party and Nga Hapu o Tauhara. A series of hui were organised by the Working Party to discuss and resolve matters relating to Contact's use of the geothermal resource. Through this process comprehensive Kaitiakitanga conditions were developed and agreed including the establishment of Kaitiaki Trusts, a Geothermal Kaitiaki Reference Group and appointments to the Peer Review Panel, which oversees the consents for Waikato Regional Council.

Submissions were received from a number of Maori entities including individual hapu, hapu collectives, Ahu Whenua trusts, and the Tuwharetoa Maori Trust Board which represents the iwi. Some submissions were initially critical of the degree of consultation by Contact. However by the end of the hearing agreement had been reached with all groups with the exception of one land-owning trust. From Contact's perspective this was achieved by a combination of: a willing and pro-active attitude by the parties; the use of working party processes; further design of mitigation measures, and conditions of consent; and on-going processes to monitor and manage the geothermal field.

The Board noted:"*In summary we conclude that the arrangements made between Contact and the Maori parties …address, to the extent possible within the framework of the Act, the concerns of Maori." (paragraph 167)*

Figure 8 A pōwhiri (traditionally used to welcome visitors on to marae - the sacred space or courtyard in front of wharenui) and Contact Energy's Craig Stephenson speaking at a consultation meeting, Waipahihi Marae, Taupo.

5. CURRENT PROJECT STATUS

Contact already had two existing developments on the Tauhara sector of the field when consents for Tauhara II were granted. The operating consents for the existing facilities at the Tenon heat supply and the Te Huka power plant were integrated into and replaced by the new consents granted for Tauhara II. This approach meant that the field could be managed in a unified way and has resulted in a simpler more streamlined day to day management processes for compliance.

At the time consents were granted for Tauhara II, Contact was already underway with an expansion of operations at Wairakei through the construction of the Te Mihi power plant, which has recently been completed. It was considered likely at the time of application that construction crews would move directly from Te Mihi to Tauhara II but since 2011, when consents were granted, the electricity demand in New Zealand has been relatively flat. Although the need for immediate construction of major new plants has diminished and will not proceed until market conditions change, the new consents have provided an opportunity for improvement of the Te Huka plant. Te Huka is a two unit Ormat binary plant which was commissioned as a 23MWe plant in 2010 and was later modified and uprated to 26MWe capacity in 2011 when increased fluid volumes became available under the new Tauhara take consents.

Further development of the Tauhara resource is expected to occur as market demands require, based on the principles set out in the original application.

6. CONCLUSION

The Tauhara II Geothermal Development Project secured resource consents in December 2010 after a short hearing conducted by a Board of Inquiry convened under New Zealand's special provisions for proposals of national significance. A very experienced core project team carefully designed the consenting process which included a substantial subsidence investigation programme which clarified the causes of the subsidence in and around the Taupo Urban area and the development of unique and best practice resource consent conditions. This will ensure that when the consents are fully utilized they will accord with the *sustainable management of New Zealand's natural and physical resources*, which is the purpose of the Resource Management Act 1991.

It is considered that other geothermal development projects and the wider geothermal community can be informed by the processes and outcomes associated with the successful environmental permitting of the Tauhara II project as detailed in this paper, in the following ways:

1. By noting the strong multi-disciplinary nature of the Tauhara II consenting team which comprised a wide range of very experienced planning, engineering and scientific experts, and with a mix of client and consultancy input.

2. Through potential benchmarking in other country's environmental legislation of the special New Zealand environmental legislation regarding "simplifying and streamlining" consenting processes for "Proposals of National Significance".

3. By reference to the thorough planning undertaken before the applications for resource consents were lodged, including the preparation of a number of baseline assessments (landscape, archaeology, noise, air quality, geothermal science), followed by an in-depth subsidence investigation programme, preparation of a comprehensive geoscience report, and further development of and scenario modelling via the long established Wairakei-Tauhara model.

4. Through possible adoption of the "Steamfield Design Protocol" approach prepared to deal with the environmental effects and uncertainties of the flexible steamfield elements of the project, given the very large consent area near Taupo Township and the long (35 year) development and consent period.

5. By engaging with a "Technical Focus Group" comprising central and local government regulatory agencies and representatives of local communities' (including indigenous peoples) as a means of seeking agreement on key issues, prior to the formal applications being lodged and the hearings held.

6. By the adoption of a clearly defined "adaptive management approach" utilizing monitoring data to inform potential future management changes and the use of a "System Management Plan" which requires regular review and input from an independent Peer Review Panel to oversee the ongoing management of the project.

7. Through the development of agreements with community groups (including where relevant, indigenous peoples) to ensure they have a meaningful and on-going role in geothermal projects as they evolve.

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