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Rotorua Geothermal Regional Plan

July 1999

Prepared by Environment B·O·P
Bay of Plenty Regional Council

RESOURCE MANAGEMENT ACT 1991

ENVIRONMENT B·O·P BAY OF PLENTY REGIONAL COUNCIL


ROTORUA GEOTHERMAL REGIONAL PLAN

It is hereby certified that this is the Rotorua Geothermal Regional Plan approved by resolution of the Council on the 20th day of May 1999.

The Council has further resolved that the Plan shall become operative on the 1st day of July 1999.

The Common Seal of the Bay of Plenty Regional Council was affixed hereto this 20th day of May 1999, in the presence of:





J E Keaney
Chairperson



J A Jones
Chief Executive

HOW TO USE THIS PLAN

There may be only some parts of this regional plan that you are interested in reading.

To find those parts quickly, the following guide gives a brief summary of what each section is about. The rule requirements of the plan are in Part III, Chapters 11 to 21.

Section 1 Introduction: Names the regional plan, gives its purpose and aim, sets out the reason and what it hopes to achieve, establishes plan boundaries.

Section 2 Statutory Framework: Discusses those matters of Part II (principles) and Part (III) (restrictions) of the Resource Management Act that the plan is required to give effect to. Environment B·O·P functions and duties are outlined, and the objectives, policies and methods used in the plan discussed.

Section 3 Policy Framework: Discusses the hierarchy of plans and how this regional plan fits into that structure.

Section 4 Relative Significance and Values: This section looks at the different values that the Rotorua geothermal resource represents, and what could be lost if there was no effective management of the field.

Section 5 Provisions of the Treaty of Waitangi: Considers Maori use of the geothermal resource, the claims and recommendations of the Waitangi Tribunal and the implications that treaty principles have.

Section 6 Previous Geothermal Management: Discusses the legislative history of the Rotorua geothermal field.

Section 7 The Rotorua Geothermal Resource: Provides an outline of the physical attributes of the field, what it consists of and how it functions.

Section 8 Field Closure Effects: Looks at the physical and resource use changes that have occurred since the bore closure programme of the 1980's.

Section 9 Equilibrium: Discusses the means by which the water levels and pressures in the field can be stabilised to provide for the sustainable protection of the resource and outlines the limits that need to be set to achieve this.

Section 10 Field use and Effects: Outlines current use and consumption of geothermal water and energy in the field, where abstraction is occurring, and changes in consumption and waste fluid disposal patterns and trends. Explains the mass/heat relationship of the resource and the relative impacts of different fluid disposal methods.

Section 11 Understanding the Rotorua Geothermal Resource: Considers what we need to know about the field in order to effectively manage it, describes the issues related to the quality of information and develops objectives and policy to ensure that quality monitoring, research and modelling information remains available to Environment B·O·P and the public.

Section 12 Sustaining the Rotorua Geothermal Resource: Describes the principle of sustaining the field to retain field potentials, attributes and qualities. It outlines the consequences of failing to achieve a viable sustained resource and considers issues, objectives and policy relating to sustainable management.

Section 13 Protecting Surface Activities and Features: Establishes the mechanism whereby field surface activity and features are identified and as appropriate protected. Protection relates to protection of an activity through setting minimum field pressure equilibrium and protection of features through establishing policy relating to destructive and inappropriate development.

Section 14 Quantifying Available Resource: Quantifies in terms of achieving sections 12 and 13 the net amount of geothermal water available for abstraction. Net mass available is related to location and to the maintenance of an established field pressure equilibrium.

Section 15 Protecting Authorised Users: Sets out a means to protect existing geothermal resource users, and provide them with continuity of supply, provided they are progressing towards compliance with the objectives and policies of the regional plan.

Section 16 Managing Unauthorised Users: Establishes a means to identify geothermal resource users that have no formal status and either bring them within the scope of the plan as authorised users or stop any illegal abstractions.

Section 17 Equating Allocation to Use: Covers the need to equate and limit resource taken by users to the actual use that they wish to make of their resource allocation.

Section 18 Transfer of Allocations: Establishes a means whereby particular resource consent allocations can be transferred.

Section 19 Controlling Environmental Effects: Sets out the mechanism to control and mitigate adverse effects on the field caused by users. The section covers in particular, abstraction effects, effects caused through geothermal fluid discharge and the control of the discharge of geothermal gas.

Section 20 Efficiency in Resource Use: Places an obligation on geothermal resource users to be efficient and prevent waste of geothermal energy.

Section 21 Administration of Resource: Provides for resource administration and the establishment of a Rotorua Geothermal Liaison Group to assist Environment B-O-P in the management and monitoring of the Rotorua geothermal resource. Provides for the establishment of a management partnership with iwi in the Whakarewarewa and Ohinemutu areas of the field.

Section 22 Monitoring and Review: Sets out the monitoring programme by which the effectiveness of the regional plan can be assessed.

Appendix One: Gives a glossary and definitions of words and phrases used in the plan.

Appendix Two: Outlines consultation details

TABLE OF CONTENTS

PART I BACKGROUND.....	1
1 Introduction.....	1
1.1 Citation.....	1
1.2 Purpose	1
1.3 Aim.....	1
1.4 Reasons for the Plan.....	2
1.5 Spatial Coverage	3
2 Statutory Framework.....	5
2.1 Introduction.....	5
2.2 Part II Matters	5
2.3 Part III Restrictions	6
2.4 Environment B·O·P Functions (Geothermal).....	8
2.5 Requirements as to Effects.....	9
2.6 Activity Classes.....	9
3 Policy Framework.....	13
3.1 Introduction.....	13
3.2 Geothermal Energy Act 1953	13
3.3 Resource Management Act.....	14
3.4 Plan Development	14
3.5 Plan Format	16
4 Relative Significance and Values.....	21
4.1 Introduction.....	21
4.2 Intrinsic Values.....	21
4.3 Biological Diversity.....	21
4.4 Ecological Uniqueness	21
4.5 Social, Cultural and Traditional Significance.....	22
4.6 Historic and Heritage Significance	22
4.7 Demographic Significance.....	22
4.8 Scientific Significance.....	23
4.9 Economic Significance	23
4.10 Tourism and Recreation Significance	24
4.11 Utility Significance	25
4.12 Local Significance.....	25
4.13 Regional Significance	25
4.14 National Significance	25
4.15 International Significance.....	26
5 Provisions of the Treaty of Waitangi	27
5.1 Introduction.....	27
5.2 Maori Geothermal Resource Use Rights.....	27
5.3 Maori Claims to Geothermal Resource Ownership	27
5.4 Preliminary Findings of the Waitangi Tribunal.....	28
5.5 Implications for the Regional Plan.....	28

6	Previous Geothermal Management	31
6.1	Introduction.....	31
6.2	Geothermal Energy Act 1953.....	31
6.3	Water and Soil Conservation Act 1967.....	32
6.4	Rotorua City Geothermal Empowering Act 1967.....	33
6.5	Rotorua Geothermal Management Plan 1988	33
6.6	Ministerial Directive 1986	34
6.7	Cabinet Directive 1986.....	34
6.8	Ministerial Directive 1989.....	35
PART II OVERVIEW OF RESOURCE INFORMATION.....		37
7	The Rotorua Geothermal Resource.....	39
7.1	Introduction.....	39
7.2	Location of the Rotorua Geothermal Field	39
7.3	Volcanic Origin.....	39
7.4	Geology	40
7.5	Hydrology.....	40
7.6	Chemistry.....	42
7.7	Natural Geothermal surface features.....	42
7.8	Fragility of Geysers and Springs	45
8	Field Closure Effects.....	47
8.1	Introduction.....	47
8.2	Physical Changes.....	47
8.3	Resource Use Changes.....	49
9	Equilibrium.....	55
9.1	Introduction.....	55
9.2	Rotorua Situation.....	55
9.3	Stability of the Rotorua Geothermal Field	56
9.4	Strategic Equilibrium.....	57
9.5	Selection of Minimum Aquifer Water Level	57
9.6	Selection of Critical Minimum Water Level Period.....	58
10	Field Use and Effects	59
10.1	Utility Use Information.....	59
10.2	Fluid Disposal.....	60
10.3	Changes in Waste Disposal Practices	60
10.4	Mass/Heat Relationships.....	61
10.5	Impact of Extraction/Disposal Systems on the Field	62
PART III MANAGEMENT ISSUES, OBJECTIVES, POLICIES AND METHODS		63
11	Understanding the Rotorua Geothermal Resource	65
11.1	Explanation.....	65
11.2	Issue	67
11.3	Issue	67
11.4	Issue	68

11.5	Objectives, Policies and Methods	69
11.6	Environmental Results Anticipated.....	70
12	Sustaining the Rotorua Geothermal Resource.....	71
12.1	Explanation	71
12.2	Issue	72
12.3	Objective, Policies and Methods.....	73
12.4	Environmental Results Anticipated.....	75
13	Protecting Surface Activities and Features	77
13.1	Explanation	77
13.2	Issue	79
13.3	Issue	79
13.4	Issue	80
13.5	Objective, Policies and Methods.....	81
13.6	Environmental Results Anticipated.....	84
14	Quantifying Available Resource.....	85
14.1	Explanation	85
14.2	Issue	86
14.3	Objective, Policies and Methods.....	86
14.4	Environmental Results Anticipated.....	88
15	Protecting Authorised Users.....	89
15.1	Explanation	89
15.2	Issue	89
15.3	Objective, Policies and Methods.....	90
15.4	Environmental Results Anticipated.....	93
16	Managing Unauthorised Users.....	95
16.1	Explanation	95
16.2	Issue	95
16.3	Objective, Policies and Methods.....	98
16.4	Environmental Results Anticipated.....	99
17	Equating Allocation to Use.....	101
17.1	Explanation	101
17.2	Issue	101
17.3	Objective, Policies and Methods.....	102
17.4	Environmental Results Anticipated.....	103
18	Transfer of Allocations	105
18.1	Explanation	105
18.2	Issue	105
18.3	Objective, Policies and Methods.....	106
18.4	Environmental Results Anticipated.....	107
19	Controlling Environmental Effects	109
19.1	Explanation	109
19.2	Issue: effects caused by the placement of geothermal bores.....	110

19.3	Issue: effects caused by the withdrawal of geothermal water.....	111
19.4	Issue: effects caused by the discharge of fluid to the environment.....	112
19.5	Issue: effects resulting from the discharge of geothermal gases.....	113
19.6	Objectives, Policies and Methods	114
19.7	Environmental Results Anticipated.....	119
20	Efficiency in Resource Use	121
20.1	Explanation.....	121
20.2	Issue	122
20.3	Objective, Policies and Methods.....	122
20.4	Environmental Results Anticipated.....	123
21	Administration of Resource	125
21.1	Explanation.....	125
21.2	Administration Responsibilities	125
21.3	Objective, Policies and Methods.....	126
21.4	Environmental Result Anticipated	127
22	Monitoring and Review	129
22.1	Introduction.....	129
22.2	Objective, Policies and Methods.....	130
22.3	Environmental Results Anticipated.....	130
PART IV APPENDICES		131
23	Appendix One: Glossary and Definitions	133
24	Appendix Two: Consultation Details	139
24.1	Consultation.....	139

FIGURES

Figure 1:	Location of Rotorua Geothermal Field.....	4
Figure 2:	Block diagram of Rotorua geology.....	41
Figure 3:	Location of the main thermal activity areas	44
Figure 4:	Monitor bore water level variations	48
Figure 5:	Location of production wells as at April 1987	52
Figure 6:	Location of known production wells - October 1993.....	53
Figure 7:	Rotorua Geothermal Bore Authorisation Flow Chart	97

PART I
BACKGROUND

1 Introduction

1.1 Citation

This regional plan shall be cited as the Rotorua Geothermal Regional Plan. It has been prepared to assist Environment B·O·P carry out its functions with respect to the Rotorua geothermal resource, in order to achieve the purpose of the Resource Management Act 1991.

All references in this regional plan to Environment B·O·P or Environment B·O·P shall be read as a reference to the Bay of Plenty Regional Council.

1.2 Purpose

The purpose of this regional plan is to promote the integrated and sustainable management of the Rotorua geothermal resource with all other resources in the Rotorua environment. Sustainable management is defined in section 5 of the Resource Management Act 1991 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.”*

1.3 Aim

The aim of this regional plan is to achieve the purpose by ensuring that the Rotorua geothermal resource retains its values and potentials, while:

- protecting geothermal surface features, and**
- protecting tikanga Maori, and**
- identifying and, as practicable, enhancing available geothermal resource, and**
- providing for the allocation of that resource for present and future efficient use, and**
- managing and controlling all adverse effects on the field, and**
- providing for efficient cost effective administration.**

1.4 Reasons for the Plan

1.4.1 Protecting the Waiariki (Geothermal Waters)

The Rotorua geothermal resource is unique. It means many things to many people and its beginnings extend into legend. It is home to unique plants and organisms and provides amazing spectacles as it drives fluid through its geysers, springs and vents. It encompasses and forms the very foundation of Rotorua City, and from it have evolved many social and commercial activities.

The geothermal resource is a taonga of great significance to Te Arawa. Te Arawa have for generations regarded the geothermal resource as a gift from the atua, and call it waiariki, water of the gods. For Te Arawa, wai-riki gives them physical and spiritual comfort; it is interwoven in their culture and traditions and is a major component of their tribal identity. Any activity that may adversely affect the mauri of the waiariki must be avoided or controlled.

1.4.2 Providing Structured Management

Over time it has become increasingly more obvious that the demands being placed on the Rotorua geothermal resource were having adverse effects, particularly on geothermal surface features and the potentials of the field reservoir itself. Diverse opinion has arisen on the extent of demands on geothermal energy from the field, the use priorities of the available resource and who should be involved in the management of available resource. Notwithstanding the divergent views and politics of who should do what, all agree that without a structured approach to the management of the Rotorua geothermal resource, the protection of field values will not be achieved.

1.4.3 Achieving Management Responsibilities

1.4.3(a) Environment B·O·P

The Resource Management Act 1991 places as a function of Environment B·O·P control of the taking, use, damming and diversion of geothermal water and control of the taking or use of geothermal energy. Environment B·O·P has a duty to actively achieve the purpose of the Act as set in Part II, to promote the sustainable management of natural and physical resources.

Following identification of conflicts between the use of a natural or physical resource and the protection of the resource from adverse effects, Environment B·O·P has a duty to consider whether a regional plan is required. With regards the Rotorua geothermal field, the main duty of Environment B·O·P is to resolve and manage the conflict between the required sustaining of field resource and the protection of natural geothermal surface features, and manage the effects of geothermal water and energy abstractions from the field. This regional plan will achieve the functions and duties placed on Environment B·O·P by the Act.

1.4.3(b) Tangata Whenua

In the exercise of their kaitiakitanga, and in recognition of their rangitiratanga over the waiariki of Rotorua, the tangata whenua of Te Arawa are responsible to protect the mauri of the waiariki of Rotorua for their future generations. In achieving this, kaitiaki have the responsibility of ensuring that the Rotorua Geothermal Regional Plan effectively reflects and integrates with the geothermal management requirements of tangata whenua.

1.4.3(c) Rotorua District Council

The Rotorua District Council is also bound by functions, duties and procedures set out in the Resource Management Act 1991. It is important that this regional plan gives guidance to the Rotorua District Council in their function as managers of the land and water surface over the Rotorua geothermal field. As the Rotorua Geothermal Regional Plan and the District Plan evolve together, an integration between district and regional plan policy will ensure that the collective values of the Rotorua geothermal resource are sustained, and the potentials for enhancing those values realised.

1.4.3(d) Public Duty

The Resource Management Act 1991 places a duty on people to avoid, remedy or mitigate any adverse effect on the environment arising from an activity carried on by an individual or on their behalf, whether or not the activity is in accordance with a rule in a plan, a resource consent, or an existing lawful activity or use. The policies of this regional plan will assist people to realise their duties with respect any adverse effect on the environment arising from an activity relating to the Rotorua geothermal resource.

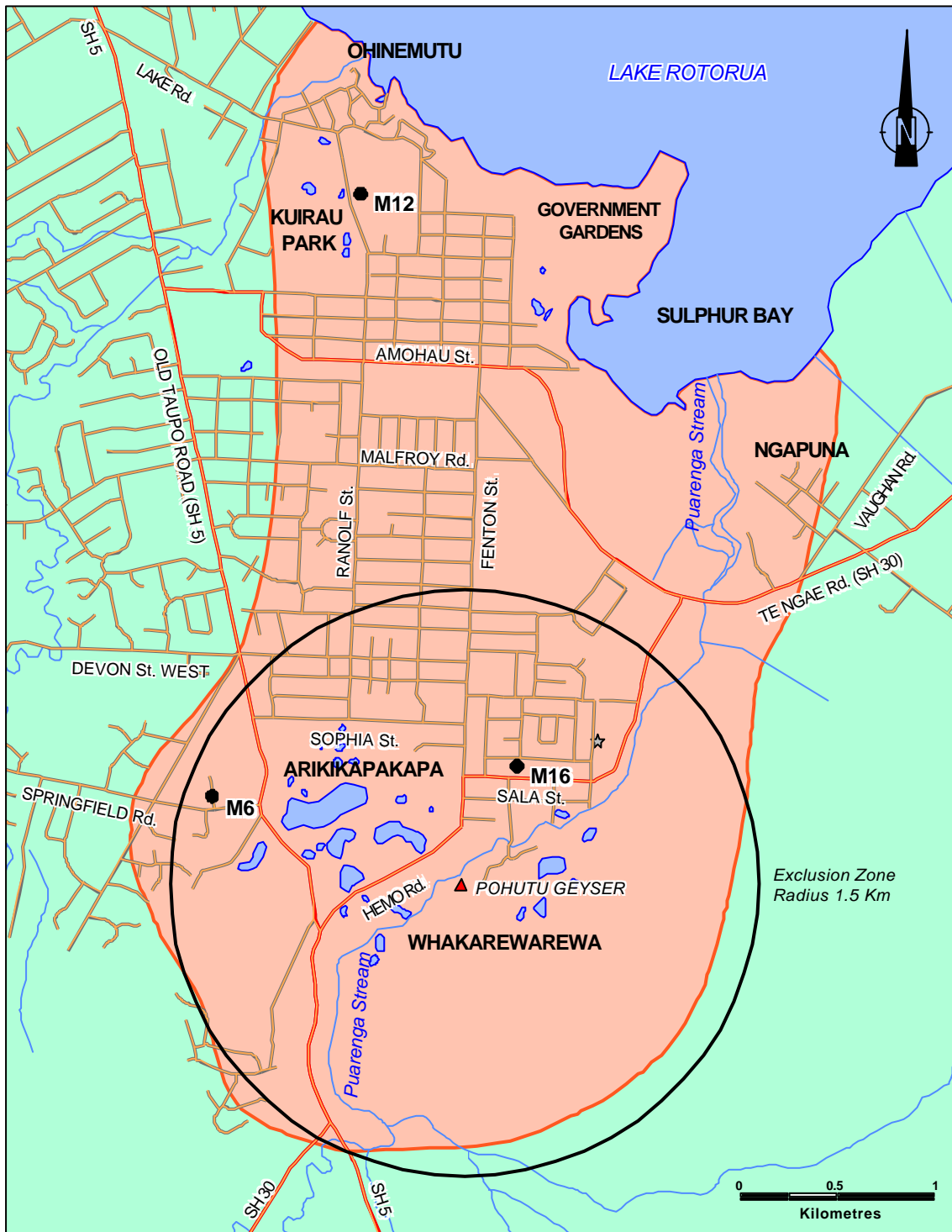
1.5 **Spatial Coverage**




The spatial parameters of the Rotorua Geothermal Regional Plan boundary will be the extent of the Rotorua geothermal field as defined by the greatest extent of the known resistivity boundary of the geothermal aquifer. A representation of the boundary from current resistivity (ohm/metre) measurements is shown on Figure 1.

The regional plan covers all geothermal water and geothermal energy taken, used or discharged on, over or into the extent of the geothermal field and includes geothermal water or energy conveyed outside the resistivity boundary.

The depth parameter of the regional plan boundary includes any depth at which geothermal water and geothermal energy associated or connected to the Rotorua geothermal resource is intercepted.

FIG 1: LOCATION OF GEOTHERMAL FIELD, EXCLUSION ZONE AND MONITOR WELLS



LEGEND	
	Rotorua Geothermal Exclusion Zone
	Monitor Well
	Rotorua Geothermal Field Indicative Area

DISCLAIMER

This map shows an interpretation of the geothermal features of the Rotorua area. The small scale of this map has necessitated the omission of some small features and the exaggeration of others in the interests of clarity. The map should not be used for any work where site specific investigations should be made.

2 Statutory Framework

2.1 Introduction

The principal statute by which the natural and physical resources of the Rotorua geothermal field are managed is the Resource Management Act 1991. There are ancillary statutes which control other specific activities within this area, but these are (in general) remote from the functions of Environment B·O·P. This section discusses the statutory framework of Rotorua geothermal resource management in terms of the Resource Management Act alone.

2.2 Part II Matters

Part II of the Resource Management Act sets out those matters that Environment B·O·P is required to address while achieving its functions.

2.2.1 Matters of National Importance

Part II of the Act lists a number of matters of national importance which all councils must recognise and provide for while promoting the sustainable management of natural and physical resources, as follows:

- (a) *The preservation of the natural character of ... wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development:*
- (b) *The protection of outstanding natural features and landscapes from inappropriate subdivision, use and development:*
- (c) *The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
- (d) *The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:*
- (e) *The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga.*

2.2.2 Other Matters

As well as the matters of national importance the Act also lists a number of additional matters which all councils must have particular regard to in achieving the purpose of the Resource Management Act. They are as follows:

- (a) *Kaitiakitanga:*
- (b) *The efficient use and development of natural and physical resources:*
- (c) *The maintenance and enhancement of amenity values:*

- (d) *Intrinsic values of ecosystems:*
- (e) *Recognition and protection of the heritage values of sites, buildings, places or areas:*
- (f) *Maintenance or enhancement of the quality of the environment:*
- (g) *Any finite characteristics of natural and physical resources:*
- (h) *The protection of the habitat of trout and salmon.*

2.2.3 Treaty of Waitangi

The Resource Management Act makes specific reference to the Treaty of Waitangi:

In achieving the purpose of this Act, all persons exercising functions and powers under it in relation to managing the use, development and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

2.3 Part III Restrictions

Part III of the Resource Management Act 1991 sets the defaults on resource use activities where no regional or district plan is active. Part III provides that some activities may proceed unless the activity contravenes a requirement for a resource consent established by a regional plan. Restrictions applicable to this regional plan are:

2.3.1 Restrictions on Use of Land

Section 9 of the Act lists activities relating to land use. The section provides that specific land use activities may occur unless restricted by the rules in a plan. The restrictions relevant to geothermal surface features and associated ecologies are in the following subsections:

- (3) *No person may use any land in a manner that contravenes a rule in a regional plan or a proposed regional plan unless that activity is-*
 - (a) *Expressly allowed for by a resource consent granted by the regional council responsible for the plan; or*
 - (b) *Allowed by section 20 (certain existing lawful uses allowed)*
- (4) *In this section, the word "use" in relation to land means-*
 - (a) *Any use, erection, reconstruction, placement, alteration, extension, removal, or demolition of any structure or any part of any structure in, on, under or over the land; or*
 - (b) *Any excavation, drilling, tunnelling, or other disturbance of the land; or*
 - (c) *Any destruction of, damage to, or disturbance to the habitats of plants or animals in, on, or under the land; or*
 - (d) *Any deposit of any substance in, on or under the land; or...*
 - (e) *Any other use of land.*

In the context of these subsections, this regional plan restricts the placement, excavation, construction or installation of a geothermal bore, the destruction of habitats of plants and animals that have adapted to geothermal conditions, and the deposit of any substance on, into or under geothermal surface features.

2.3.2 **Restrictions on Taking of Water and Energy**

Section 14 of the Act lists the activities relating to water in general (including geothermal water) and surrounding heat or energy which may not be undertaken unless specifically allowed by a rule in a regional plan or by a resource consent. The restrictions relevant to geothermal water and surrounding heat or energy are as follows:

- (1) *No person may take, use, dam, or divert any -*
 - (a) *Water ...; or*
 - (b) *Heat or energy from water...; or*
 - (c) *Heat or energy from the material surrounding any geothermal water-*

unless the taking, use, damming, or diversion is allowed by subsection (3).
- (3) *A person is not prohibited by subsection (1) from taking, using, damming, or diverting any water, heat, or energy if -*
 - (a) *The taking, use, damming, or diversion is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan or a resource consent; or...*
 - (c) *In the case of geothermal water, the water heat or energy is taken or used in accordance with tikanga Maori for the communal benefit of the tangata whenua of the area and does not have an adverse effect on the environment, or...*
 - (e) *The water is required to be taken for firefighting purposes.*

In the context of these subsections, this regional plan restricts the taking, use, damming or diversion of geothermal water, heat, or energy.

2.3.3 **Restrictions on Discharges**

Section 15 of the Act lists the activities relating to the discharge of contaminants in general which may not be undertaken unless specifically allowed by a rule in a regional plan or by a resource consent. The restrictions relevant to the Rotorua geothermal area are as follows:

- (1) *No person may discharge any -*
 - (a) *Contaminant or water into water; or*

- (b) *Contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; or*
- (c) *Contaminant from any industrial or trade premises into air; or*
- (d) *Contaminant from any industrial or trade premises onto or into land -*

unless the discharge is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan, a resource consent, or regulations.

- (2) *No person may discharge any contaminant into the air, or onto or into land, from -*
 - (a) *Any place; or*
 - (b) *Any other source, whether moveable or not -*

in a manner that contravenes a rule in a regional plan or a proposed regional plan unless the discharge is expressly allowed by a resource consent or allowed by section 20 (Certain Existing Lawful Activities Allowed).

In the context of these subsections, this regional plan restricts the discharge of abstracted geothermal fluid into the geothermal aquifer and into any part of the environment, including discharge into surface drainage watercourses or to soakage onto or into land. The regional plan will also restrict the discharge of geothermal derived gas from production bores and, in time, prohibit the discharge of geothermal derived gas from unused bores and soakage holes.

2.4 Environment B·O·P Functions (Geothermal)

Section 30 of the Act sets out the functions of Environment B·O·P with regard to sustainable management of natural and physical resources. Those functions which relate specifically to Rotorua geothermal resource are as follows:

- (a) *The establishment, implementation, and review of objectives, policies and methods to achieve integrated management of the natural and physical resources of the region:*
- (b) *The preparation of objectives and policies in relation to any actual or potential effects of the use, development, or protection of land which are of regional significance:*
- (c) *The control of land for the purpose of...*
 - (iv) *The avoidance or mitigation of natural hazards:*
- (e) *The control of the taking, use, damming and diversion of water, and the control of the quantity, level, and flow of water in any water body, including-*

- (i) *The setting of any maximum or minimum levels or flows of water:*
- (ii) *The control of the range, or rate of change, of levels or flows of water:*
- (iii) *The control of the taking or use of geothermal energy:*
- (f) *The control of discharges of contaminants into or onto land, air, or water and discharges of water into water:*
- (h) *Any other functions specified in this Act.*

2.5 Requirements as to Effects

The Resource Management Act focuses on the effects of activities as rather than activities themselves. Accordingly, the objectives, policies and methods of this plan have been clearly directed towards the avoidance, remedy or mitigation of the adverse effects associated with the use and development of the natural and physical resources of the Rotorua geothermal field.

In the Resource Management Act 1991, unless the context otherwise requires, the term "effect", includes -

- (a) Any positive or adverse effect; and
- (b) Any temporary or permanent effect; and
- (c) Any past, present, or future effect; and
- (d) Any cumulative effect which arises over time or in combination with other effects -

regardless of the scale, intensity, duration, or frequency of the effect, and also includes -

- (e) Any potential effect of high probability; and
- (f) Any potential effect of low probability which has a high potential impact.

2.6 Activity Classes

The Resource Management Act recognises that the magnitude of adverse effects differs from activity to activity and may be sensitive to location and other factors (ie: effects may be far greater for some activities, in some locations, than they would be for others). To enable a controlled response sensitive to effects, the Act has set a number of levels of discretion that Environment B·O·P can use, ranging from permitted through to prohibited activities. Each of these classes relates to the anticipated magnitude of effects which will result from the proposed activity. All activities that are regulated within this regional plan have been grouped into one of the activity classes. The activity classes (as set by the Act) are as follows:

Permitted Activity: means an activity that is allowed by a plan without a resource consent if it complies in all respects with any conditions (including any conditions in relation to any matter described in section 108 or section 220) specified in the plan.

Controlled Activity: means an activity which -

- (a) Is provided for, as a controlled activity, by a rule in a plan or proposed plan; and*
- (b) Complies with standards and terms specified in a plan or proposed plan for such activities; and*
- (c) Is assessed according to matters the consent authority has reserved control over in the plan or proposed plan; and*
- (d) Is allowed only if a resource consent is obtained in respect of that activity.*

Discretionary Activity: means an activity -

- (a) Which is provided for, as a discretionary activity, by a rule in a plan or proposed plan; and*
- (b) Which is allowed only if a resource consent is obtained in respect of that activity; and*
- (c) Which may have standards and terms specified in a plan or proposed plan; and*
- (d) In respect of which the consent authority may restrict the exercise of its discretion to those matters specified in a plan or proposed plan for that activity.*

Non-Complying Activity: means an activity (not being a prohibited activity) which -

- (a) Contravenes a rule in a plan or a proposed plan; and*
- (b) Is allowed only if a resource consent is obtained in respect of that activity.*

Prohibited Activity: means an activity which a plan expressly prohibits and describes as an activity for which no resource consent shall be granted; and includes any activity prohibited by section 105(2)(b) of the Historic Places Act 1993.

The order in which these activities have been placed above signifies their corresponding level of expected adverse environmental effects, from acceptable for permitted activities up to unacceptable for prohibited activities.

This means that:

- (a) Wherever an activity is described in this regional plan as being a prohibited activity then no resource consent shall be granted for that activity.*

- (b) Whenever an application has been made for a non-complying activity, in assessing whether that activity will have any adverse effects, Environment B·O·P shall in all instances apply the tests set in section 105(2)(b) of the Resource Management Act 1991, and, if a grant of consent is deemed appropriate, shall attach any conditions it deems appropriate.

3 Policy Framework

3.1 Introduction

The Rotorua Geothermal Regional Plan is part of a hierarchy of policy statements and plans. It is important to note that each of the policy statements and plans must not be inconsistent with any of those at a higher level. This regional plan must also have regard to any management plans or strategies of other Acts and regulations. Section 66 and 67(2) of the Resource Management Act in particular sets out the documents, statements and plans that Environment B·O·P shall have regard to in the preparation of this regional plan.

3.2 Geothermal Energy Act 1953

The only current residual effect of the Geothermal Energy Act is the public health and safety provisions in respect to geothermal bores. This function is currently administered by the Geothermal Inspectorate of the Ministry of Commerce.

3.2.1 National Policy Statement Requirements

The Resource Management Act requires in section 67(2) that this regional plan shall not be inconsistent with any national policy statement developed under section 55.

3.2.2 Proposed Regional Policy Statement

The Rotorua Geothermal Regional Plan is required by sections 66(2)(a) and 67(2)(c) of the Resource Management Act to have regard to the Proposed Environment B·O·P Regional Policy Statement. This regional plan shall not be inconsistent with the policy provisions of the proposed regional policy statement.

In developing this regional plan, regard has been had to the policy requirements of the Proposed Environment B·O·P Regional Policy Statement.

3.2.3 Regional Plans

There was only one regional plan, the Environment B·O·P Transitional Regional Plan active at the time that this regional plan was developed. Regard was had to inconsistencies between general authorisation No.6 in the Environment B·O·P Transitional Regional Plan and policy in this regional plan. The general authorisation, formed under section 22 of the Water and Soil Conservation Act 1967, provided for:

"...the taking and use for any purpose of natural water (excluding geothermal energy) from any underground source within the boundaries of Rotorua City as at September 1969..."

The general authorisation was designed to complement the taking of energy under the Geothermal Energy Act 1953. As the management of geothermal resource under both the Water and Soil Conservation Act and the Geothermal Energy Act is now superseded by the Resource Management Act, the policy of the general authorisation is no longer required.

The area covered by the general authorisation does not conform to the resistivity boundary of this regional plan and the operation of the general authorisation is inconsistent with the purpose and principles of Part II of the Resource Management Act.

In preparing this regional plan regard has been had to other regional plans and strategies, many of which are still in preparation. Particular regard has been had to the Proposed Regional Land Management Plan and the Regional Land Transport Strategy.

3.2.4 Rotorua District Plan

In preparing this regional plan regard has been had to the policy development of the Rotorua District Plan which was under review.

3.3 Resource Management Act

The Resource Management Act provides for a hierarchical set of policy statements and plans that must be complementary and contain synchronised policy directives.

3.4 Plan Development

3.4.1 Introduction

Consultation during the development of the regional plan ranged from open public meetings to the identification and technical assessment of issues at workshops. The whole process required rigorous consideration of alternative management techniques, policy structures, and reasoning as prescribed by Section 32 of the Resource Management Act 1991. The following lists in brief the consultation and references accessed during plan development. A more detailed account of the consultation outcomes are set out in Appendix Two.

3.4.2 Consultation

- 3.4.2(a) Project Initiation: Early 1991;
- 3.4.2(b) Technical Report Released: October 1992;
- 3.4.2(c) Public Meeting: 17 February 1993
- 3.4.2(d) Inhouse "Think-Tank" Workshop: 18 February 1993
- 3.4.2(e) Registration of Unregistered Geothermal Users: 27 March 1993
- 3.4.2(f) First Interest Group Workshop: 29 June 1993

- 3.4.2(g) Geothermal Meeting with Te Arawa Representatives: 15 July 1993
- 3.4.2(h) Peer Review Workshop: 30 September 1993
- 3.4.2(i) Second Interest Group Workshop: 20 October 1993
- 3.4.2(j) Environment B·O·P Workshop: Morning 16 November 1993
- 3.4.2(k) Adoption by Resource Planning Committee: Afternoon 16 November
- 3.4.2(l) Further consideration of amendments by Resource Planning Committee: 14 December 1993
- 3.4.2(m) Adoption by Environment B·O·P 16 December 1993

3.4.3 **Reports and References**

In compiling this regional plan, the following documents were referenced:

- 3.4.3(a) The Resource Management Act 1991.
- 3.4.3(b) The Proposed Environment B·O·P Regional Policy Statement.
- 3.4.3(c) Rotorua Geothermal Field: Response of field since closure (1987 - 1992), Environment B·O·P Technical Publication No. 7, October 1992.
- 3.4.3(d) Preliminary Report on the Te Arawa Representative Geothermal Resource Claims (WAI 153), Waitangi Tribunal Report: 7WTR
- 3.4.3(e) Treaty of Waitangi Claims and the Geothermal Resources of the Bay of Plenty; Report to the Bay of Plenty Regional Council, Raukura Consultants, June 1993.
- 3.4.3(f) Geothermal Overview Report 1991; Environment B·O·P Technical Publication No. 4, August 1991.
- 3.4.3(g) Geothermics Special Issue 1992; Rotorua Geothermal Field, Edited by Rick Allis and Tom Lumb, Pergamon Press.
- 3.4.3(h) Inventory of New Zealand Geothermal Fields and Features; Houghton BF, Lloyd EF, Keam RF and Johnston DM, 2nd Ed. 1989, GSNZ Misc. Publication No. 44.
- 3.4.3(i) Inventory of Important Geological Sites and Landforms in the Bay of Plenty Region; Kenny JA and Hayward BW, 1st Ed. 1993, GSNZ Misc. Publication No. 70.
- 3.4.3(j) Taking the Waters, Early Spas in New Zealand; Rockel I, GPO 1986.
- 3.4.3(k) Tourism Sector in the Rotorua District Economy, Prepared for RDC by APR Consultants, December 1991.
- 3.4.3(l) Rotorua District Economic and Business Development Plan, August 1992.
- 3.4.3(m) Geothermal Resources, a policy and management framework, Ministry of Energy, 1986.

3.5 Plan Format

3.5.1 Contents of Regional Plans

Section 67 of the Resource Management Act sets out the matters that a regional plan may provide for, with reference to Part I of the Second Schedule to the Act. The section also specifies matters that shall be stated in a regional plan:

- (a) *The issues to be addressed in the plan; and*
- (b) *The objectives sought to be achieved by the plan; and*
- (c) *The policies in regard to the issues and objectives, and an explanation of those policies; and*
- (d) *The methods being or to be used to implement the policies, including any rules; and*
- (e) *The principal reasons for adopting the objectives, policies, and methods of implementation set out in the plan; and*
- (f) *The information to be submitted with an application for a resource consent, including the circumstances in which the powers under section 92 may be used; and*
- (g) *The environmental results anticipated from the implementation of these policies and methods; and*
- (h) *The processes to be used to deal with issues which cross local authority boundaries, and issues between territorial authorities and between regions; and*
- (i) *The procedures to be used to review the matters set out in paragraphs (a) to (h) and to monitor the effectiveness of the plan as a means of achieving its objectives and policies; and*
- (j) *Any other information that the regional council considers appropriate; and*
- (k) *Such additional matters as may be appropriate for the purpose of fulfilling the regional council's functions, powers and duties under this Act.*

Environment B·O·P has followed the directions of section 67 in the structure of this regional plan.

3.5.2 Plan Issues

Following public consultation and workshop deliberations, an array of issues were identified. The process of solving those issues is set out in Part III of this regional plan, that process being relative to the functions of Environment B·O·P as set out in Section 30, and the means and tests as prescribed by Sections 32 and 65 to 70 of the Resource Management Act 1991.

3.5.3 Objectives, Policies and Methods

This regional plan contains the means by which Environment B·O·P will be managing the requirements of Part II of the Resource Management Act, the restrictions of sections 12, 14 and 15 of the Act, and its functions under section 30 of the Act. These means are in the form of objectives, policies and methods of implementation.

Establishing objectives, policies and methods is in accordance with section 67 of the Act, which stipulates that all regional plans must state:

- (b) *The objectives sought to be achieved by the plan; and*
- (c) *The policies in regard to the issues and objectives, and an explanation of those policies; and*
- (d) *The methods being used or to be used to implement the policies, including any rules.*

For the purposes of this regional plan, each of these is defined as follows:

- (a) An objective is a desirable and achievable condition or position towards which effort is to be directed. Progress towards an objective needs to be regularly evaluated.
- (b) Policies define the boundaries within which decisions can be made, and they guide the development of courses of action directed towards the accomplishment of objectives. They are guides to action.
- (c) Methods (of implementation) describe the procedure or course of action to be followed, in accordance with the policies, in order to achieve the objective. They detail what is to be done and by whom.

Methods may include the making of rules. However, in this regard it is important to note the restrictions of Section 68 of the Act (Regional Rules), as follows:

- (1) *A regional council may, for the purpose of -*
 - (a) *Carrying out its functions under this Act (other than those described in paragraphs (a) and (b) of section 30(1)); and*
 - (b) *Achieving the objectives and policies of the plan -*
include in a regional plan rules which prohibit, regulate or allow activities.

The limiting terminology of the Act is "*other than those described in paragraphs (a) and (b) of section 30(1)*". This restricts Environment B·O·P to the making of rules (as a method of implementation) for all issues within the Rotorua geothermal field area that relate to the balance of functions set out in section 30, but must defer to policy and methods (such as advocacy) other than rules to avoid, remedy or mitigate issues that fall into section 30(1).

With regards the purpose of this regional plan, the restriction means that Environment B·O·P can not set rules:

- (a) To achieve the integrated management of natural and physical resources, or
- (b) In relation to any actual or potential effects of the use, development, or protection of land which are of regional significance.

This regional plan can however set:

- (a) Policy to require the Rotorua District Council to exercise its function under section 31(b) of the Act to: "*...control any actual or potential effects of the use, development, or protection of land, including for the purpose of the avoidance or mitigation of natural hazards...*", and
- (b) Rules to establish: "*...The control of land for the purpose of... The avoidance or mitigation of natural hazards:..*".

3.5.4 **Matters, Standards and Terms**

The plan uses an array of methods and means to achieve the objectives and policies of each section. These include obligations that the plan will place on Environment B·O·P, obligations that will be placed on all people who wish to interact with the geothermal resource and specific obligations that the plan places on resource users. There are new requirements for resource consents to be sought particularly for the discharge of spent geothermal fluid into the environment. Terms and conditions have been established to ensure that over time there will be a shift towards achieving the aspirations of the plan without undue stress on those who are required to take some action.

3.5.5 **Monitoring and Review**

3.5.5(a) Monitoring

Environment B·O·P is obliged monitor the effectiveness of the plan as a means of achieving its objectives and policies. This is necessary so that should there be any defects in the methods and means set, or any new, improved or more cost effective ways of achieving the objectives and policies, these can be incorporated either by special review or at the time of formal review. Environment B·O·P is also obliged to keep a summary of all written complaints received by it during the period of the plan concerning alleged breaches of the plan, and set out how it has dealt with each such complaint.

3.5.5(b) Review

This regional plan is to be reviewed five years after the date on which the plan became operational. It may be reviewed earlier and does not cease to be operative by virtue of being due for review, or while it is being reviewed.

4 Relative Significance and Values

4.1 Introduction

This section considers the wide range of values that the Rotorua geothermal resource represents. The full value of the resource is far greater than the sum of the parts represented here, however it is necessary to consider specific values to identify their importance when establishing the policy framework of this regional plan.

4.2 Intrinsic Values

For many thousands of years before mankind first found it and gave it names and uses, the Rotorua geothermal field existed. It operated under natural laws and in and around it evolved features and ecologies. The simple unique worth of the field in its natural state is the value that can most easily be lost by human interaction and interference with the field, in particular its surface features. We must acknowledge, whether we like to or not, that the single most destructive force that can devalue the intrinsic worth of the field is "development" by mankind. What we perceive as necessary or desirable alterations of the field from our perspective may in effect cause environmental degradation and destruction. The intrinsic value of the resource can only be protected from us by us. This is a primary function of this plan.

4.3 Biological Diversity

The unique biologies that have evolved in and around surface springs and other geothermal phenomenon have value from two main perspectives.

Firstly is the value that any evolved creature has to the genetic pool of nature and the qualities that diverse lifeforms give to the environment.

Secondly is the potential value that genetic material and diverse lifeforms have to mankind, to better understand natural processes that may lead to improved and new commercial opportunities. As an example, bacteria that can thrive at extremes of temperature and live in chemical mixtures that would be toxic to other life have been found and assessed for use in industrial processes.

4.4 Ecological Uniqueness

The unique environment around geothermal surface features has provided microclimates and microcosms in which unique plants and fauna evolve and interact in ways that can not be found in many other places. Apart from genetic values there are unique ecological dynamics of specie interaction that add to nature and provide unique material, information and opportunities from which to learn.

4.5 Social, Cultural and Traditional Significance

The structure of Rotorua City is based on the Rotorua geothermal field, even the townscape itself expresses an orientation relative to the geothermal surface features and the availability of geothermal energy. For as long as mankind has been present in the Rotorua area the warmth and utility given by the heated ground and hot water resources have been very much appreciated, and have served as a focus for local prestige and mana.

The social identity provided by the geothermal attributes of the field have been interwoven with cultural values. These are particularly strong for Te Arawa, who have lived for generations with waiariki that gives spiritual and physical comfort. For those Te Arawa iwi who live on the field, waiariki has become interwoven into culture and traditions and is a major component in their identity.

The spiritual essence of waiariki brings healing and therapeutic effects to those who understand and respect the powerful forces that have gathered at Rotorua. Many thousands of people have over hundreds of years gained relief from bathing in waiariki.

From this has evolved a traditional history associated to many of the geothermal features of the field. Most of these are taonga and are to be valued and respected.

4.6 Historic and Heritage Significance

The first Te Arawa people to enjoy the geothermal assets of the Rotorua field settled in the area around 500 years ago. For generations the geothermal taonga was enjoyed by all who came to Rotorua. The therapeutic values of the waters were well known to Maori when the first Europeans arrived.

The latter (European) history of the Rotorua area and its geothermal field is well recorded in historic research works, in particular "Taking the Waters, Early Spas in New Zealand" by Ian Rockel (1986).

The heritage remaining includes the Maori communities of Whakarewarewa and Ohinemutu and the Victorian setting of Government Gardens and the Bathhouse and the spa now known as Polynesian Spa which traces its origins prior to 1882. These form an integral part of the national heritage of New Zealand.

4.7 Demographic Significance

Taking the water has signified relief for people with arthritic ailments, particularly suffered by senior citizens. The improved quality of life for those who have access to warm baths has, over time, resulted in people moving to Rotorua to take advantage of the therapeutic geothermal values.

Demographic statistics suggest that the attraction of geothermal therapeutic facilities, amongst other factors, has led to a higher than average number of Rotorua citizens being in the 60+ age group (1991 census).

4.8 Scientific Significance

Whakarewarewa is one of only two major geyser fields in the world that exist in their natural state. The systems that form and power the natural features on the field have attracted significant scientific research effort over many years.

Research effort on the Rotorua field has furthered the evolution of geothermal systems theories and has led to the development of a sophisticated field model.

The Geological Society of New Zealand have identified the entire Rotorua field as being of international significance and currently at risk due to exploitation of the geothermal resource or other influences such as ongoing volcanism. (GSNZS Misc Publication No 44, 1989). Individual features on the field, including Pohutu Kereru, Prince of Wales Feathers, Te Horu, Waikorohihi and Mahanga Geysers have also been registered as being of international significance as has Roto-a-Tamaheke. Other features, including Korotiotio, Kuirau Lake, Ngamokoaiakoko, Ngapuna Spring, Ngarearatuatara, the Oorea group of springs, Papakura "Geyser", Parekohoru, Puapua, Rachael Spring and Waikite Geyser have been classified as being of national scientific, scenic or educational importance. Features of regional scientific, scenic or educational value have also been classified, these include Government Gardens, the Ohinemutu-Kuirau Spring System and the Waiora (non-active) geyser.

In addition there is the ecological significance of plants and animals that have adapted to live within the unique geothermal environments about the Rotorua field.

Specialist bacteria have evolved to live within geothermal springs and pools, some of which are at high (near boiling) temperatures and contain concentrations of chemical reagents that would be toxic to the majority of other lifeforms.

All these elements of the field, both features, systems and ecological components combine to create a significant and valuable scientific and educational resource.

4.9 Economic Significance

The Rotorua geothermal resource forms a major part of the economic structure and potential of Rotorua City and beyond.

The geothermal components of the Rotorua economy can be considered from four main perspectives; direct tourist related ventures, indirect linkages, energy use and therapeutic potential.

Direct tourist related ventures include attraction facilities where tourists can "look at" geothermal features and "sit in" geothermal mineral pools and baths. Such "Geyserland" attractions form an integral part of the packages of experience that Rotorua has to offer visitors. Relative to the potentials involved, the "look at and sit in" attractions currently available could be further developed and further novelty attractions provided.

Indirect linkages from the tourist industry include accommodation and restaurant businesses, souvenir enterprises and the like. These create further jobs and flow-on economies creating a multiplier effect on the transmission of wealth through the local economy. Indirect linked activities are highly vulnerable to any development complacency inherent in the development and maintenance of the primary attractions.

Energy use creates economies through enhancing lifestyles and property values and providing a relatively low cost local energy alternative. Although maintaining geothermal systems for heating buildings and water can be expensive to establish, geothermal energy use can reduce dependence on alternative fuels with beneficial environmental effect. On the other hand, the Rotorua community will need to decide in the not too distant future whether the economy and well being of the area will be best served by using geothermal resource for household heating or to generate tourist dollars.

Therapeutic and medicinal use of geothermal heat and mineral fluids are amongst the old and valued remedies. There is potential for further development in therapeutic and medicinal uses, particularly in the health spa arena.

Together these aspects generate wealth and wellbeing, and form an integral part of the tourism potential of New Zealand. In 1988/89 tourism in Rotorua returned between \$192 and \$321 million (depending on linkages and multipliers) as tourist expenditure. This in turn provided jobs for 3,500 to 4,000 people. Although the geothermal resource represents only part of this tourist expenditure picture, it is a significant and unique part.

With astute investment and efficient use of available geothermal resource there is good potential for enhanced economic prosperity from the Rotorua field.

4.10 Tourism and Recreation Significance

Rotorua is one of the key tourist attraction areas in New Zealand. Tourism forms one of the major economic bases of the Rotorua area, beginning with early spa. The attraction to the Rotorua area is perceived as a package of experiences including the Rotorua lakes, Maori cultural attractions, geothermal features and baths, fishing, farm and wildlife exhibits and outdoor pursuits. Both natural and manmade geothermal attractions feature high on the list of things tourists visit in Rotorua. It is a priority for the Rotorua tourist promoters that visitors are encouraged to stay longer to enjoy more of the attractions that the region provides.

In 1989/90, there were a total of some 1.67 million visitor nights spent in the Rotorua district; 56% were New Zealand visitors and 44% were overseas tourists. In 1991, 360,000 people visited Whakarewarewa.

The amenity and recreational values of geothermal resources are also of significant value to the local Rotorua community, particularly the use of geothermal baths available to the general public. The educational value associated with the formation of geothermal surface features and the displays of volcanic information are also of value.

4.11 Utility Significance

In 1993 there were 503 users on the Rotorua field that had authorised geothermal bores or were licenced access to geothermal resource. Many other people, particularly those who live on the Whakarewarewa Reserve have used the resource for cooking and heating for many generations. The value of the heat and of bathing in mineral pools has given benefit to many thousands over the years.

In dollar terms the heat use of the resource saves users many thousands of energy dollars per year, and savings are able to be used in the local economy.

4.12 Local Significance

The people of Rotorua live intimately within the presence of the field and well know the assets and liabilities that it can bring. The field and its surface attributes bring tourists that form a large sector of the local economy. It provides unique opportunities for enterprise, many of which have not yet been explored. In terms of local potentials and economic values the resource is of extreme significance to the Rotorua community.

The field also brings responsibilities, the main one being the cumulative liability to ensure that those attributes that the field brings to Rotorua are not destroyed in the process of their use. In this respect the Rotorua geothermal resource has not benefitted by the confused way in which those responsibilities were met in the past.

Of all people, those who will benefit most from the effective operation of the Rotorua Geothermal Regional Plan will be the people of Rotorua. It will serve to protect considerable local investments while protecting the viability of those investments into the future.

4.13 Regional Significance

The regional significance of the resource relates mainly to the tourist attraction that the features of the field give to the regional package that can be offered to overseas and domestic visitors. Having one of New Zealand's main attractions within the region adds to the destination desirability of the Bay of Plenty.

The significance of the geothermal surface features in terms of their intrinsic values must also be noted, any degradation of features would cause adverse effects on the regional tourist trade and would compromise the conservation efforts and ideals of a large number of local and regional citizens.

4.14 National Significance

Rotorua enjoys the status of having the highest throughput of overseas visitors per year with Whakarewarewa being the most visited tourist attraction in New Zealand. The Rotorua geothermal field and its features and potentials are a national treasure and require protection in the national interest.

4.15 International Significance

The array of geysers and other geothermal surface features, together with unique ecologies make the Rotorua geothermal field of high international significance in terms of scientific and conservation values. The fact that the field is visited and enjoyed by many thousands of overseas visitors per year attests to that significance. The field has been measured and probed by many international experts and is providing the basis for the evolution of many geothermal models and volcanic and geologic theories.

5 Provisions of the Treaty of Waitangi

5.1 Introduction

Under the Resource Management Act 1991, Environment B·O·P and all persons achieving the purpose of the Act, and exercising functions and powers in managing the use, development, and protection of natural and physical resources (including the Rotorua geothermal resource) shall take into account the principles of the Treaty of Waitangi. In evolving this plan Environment B·O·P has taken into account the treaty principles.

5.2 Maori Geothermal Resource Use Rights

The Resource Management Act 1991 sets out a protection for the continuation of the use of geothermal water, heat or energy that is taken or used in accordance with tikanga Maori for the communal benefit of the tangata whenua of the area, providing that the taking or using does not have an adverse effect on the environment.

Environment B·O·P is also required to have regard to any relevant planning document recognised by an iwi authority affected by the regional plan.

5.3 Maori Claims to Geothermal Resource Ownership

In June 1993 the Waitangi Tribunal issued a preliminary report on Te Arawa representative geothermal resource claims. With respect to the Rotorua geothermal field, the findings sought by the claimants were:

- (a) That the geothermal resource in the hot pools and springs and other geothermal surface manifestations within the Whakarewarewa claimants land at Whakarewarewa village including the Rahui Trust land are a taonga of the Whakarewarewa claimants. They have rangatiratanga over them and act as kaitiaki of them;
- (b) That the claimants interest in the resource is not confined by traditional or pre-Treaty technology or needs, but includes the development of the resource for economic benefit and by modern technology;
- (c) That the Crown has failed to provide (in the Resource Management Act 1991) a system according the claimants interest in the resource a sufficient priority and for permitting proper scope for the exercise of authority by the claimants in relation to the management of the resource;
- (d) That it would be contrary to the principles of the Treaty of Waitangi for the Crown to impose a system for resource rentals and itself to take benefit from the utilisation of the geothermal resources in the fields subject to claim without first determining and giving effect to the interest of the claimants;

- (e) That it would be contrary to the principles of the Treaty of Waitangi for the Crown to permit Environment B·O·P to notify a management plan in respect of any geothermal field the subject of claim without determining and giving effect to the claimants beneficial interest in the field and their right to exercise authority in relation to the field to the fullest extent reasonably practicable;
- (f) That the Resource Management Act 1991 is in breach of the Treaty in not retaining in the Crown a power to perform its Treaty guarantee in relation to the geothermal resource.

5.4 Preliminary Findings of the Waitangi Tribunal

In brief the preliminary findings of the Waitangi Tribunal were:

- (a) That the Resource Management Act be amended to ensure that all persons exercising functions and powers under it shall act in a manner that is consistent with the principles of the Treaty;
- (b) That the Crown places a moratorium on the grant of resource consents, or the notification or making of regional plans until the hearing and determination or other disposition of the claims;
- (c) That discussions between the Crown and claimants on the matter of the sharing of royalties and resource rentals be conducted.

5.5 Implications for the Regional Plan

The Waitangi Tribunal have made these preliminary findings to the Crown., however there have been no directives from the Crown to Environment B·O·P as a result.

Environment B·O·P is obliged to operate under the Resource Management Act 1991 and could be considered to have compromised its duties if it did not exercise its function to protect what is an extremely vulnerable resource. The responsibilities and liabilities of managing the Rotorua geothermal resource currently lies with Environment B·O·P. Environment B·O·P will seek to be able to deliver the Rotorua geothermal resource to any future manager in a condition that is sustainable for future generations. Environment B·O·P will operate to carry out any directions from the Crown on this matter.

Notwithstanding resource ownership negotiations, and in accordance with the directions set in the Resource Management Act 1991 and the Bay of Plenty Proposed Regional Policy Statement, Environment B·O·P will seek to establish a partnership of management relationship with Tangata Whenua. This will be primarily for the geothermal resource and the hot pools and springs and other geothermal surface manifestations within the Whakarewarewa and Ohinemutu areas of the field. The purpose of this partnership will be to oversee any partnership matters that the Tangata Whenua or Environment B·O·P consider require attention including:

- (a) The registration and protection of geothermal taonga, and
- (b) The determination of who has the right to claim geothermal use rights under Section 14 (3)(c) of the Resource Management Act 1991, and
- (c) Resolution of the concerns and matters of importance to tangata whenua noted at the Geothermal Meeting with Te Arawa Representatives on 15 July 1993.

6 Previous Geothermal Management

6.1 Introduction

Over the past 50 years there have been many and varied management and control efforts applied to the Rotorua geothermal resource. Geothermal issues were controlled over time by a number of Acts and Regulations as well as a local Empowering Act, Cabinet and Ministerial directives.

To this must also be added the results of a recent Environment B·O·P technical report and decision by the Special Hearings Committee.

This section introduces in chronological order, the various pieces of legislation and policy which have influenced the issuing of geothermal licences, permits and consents for the Rotorua Geothermal Field. Where applicable, commentary has been made relevant to specific legislation.

6.2 Geothermal Energy Act 1953

The Geothermal Energy Act 1953 made provision for the control of the tapping and use of geothermal energy and for vesting all such energy in the Crown. Key sections of the Act were:

6.2.1 Interpretation

The Geothermal Energy Act 1953 defined geothermal water as having a temperature greater than 70°C.

6.2.2 Licences for use of geothermal energy

The Geothermal Energy Act 1953 required a person sinking a bore or tapping, taking, using, or applying geothermal energy for any purpose to have a licence granted by the Minister of Energy. Exceptions to this were:

- (a) where the above was required for the purposes of survey, investigation, test, or measurement;
- (b) where the above was required for domestic purposes and if the bore was under 61 metres in depth;
- (c) where geothermal energy on or under land is being used for any purpose at the commencement of the Geothermal Energy Act 1953 or has been used for any purpose at any time before the commencement of the Geothermal Energy Act 1953, geothermal energy on or under that land may thereafter be used for that purpose to a similar or lesser extent unless the Minister, having regard to the public interest, otherwise directs.

6.2.3 Revocation of licences

The Geothermal Energy Act 1953 provided that licences may be revoked due to:

- (a) non compliance with licence conditions;
- (b) operations under the licence may become a danger to persons or property in the vicinity;
- (c) operations under the licence, in the opinion of the Minister, affecting detrimentally other specified bores or the supply of geothermal energy for other specified purposes or a specified tourist attraction.

6.2.4 Delegation of power to grant licences

The Minister was empowered to delegate to the council of any borough or county his power under the Geothermal Energy Act 1953 to grant licences.

6.2.5 Regulations

Allowed for the making of regulations, which may be necessary or expedient in full effect to the provisions of the Geothermal Energy Act 1953 and for the administration thereof.

6.2.6 Geothermal Energy Regulations 1961

These regulations are still in force having been transferred into the Health and Safety in Employment Act 1992. They are administered by the Ministry of Commerce.

6.3 Water and Soil Conservation Act 1967

The Water and Soil Conservation Act (W&SCA) placed the management of the nation's water resources under the control of Regional Water Boards. The Bay of Plenty Catchment Commission being at that time the Regional Water Board for the region. The major management tool of the W&SCA was the water right. In respect of geothermal water, the W&SCA legislation required:

- (a) All abstractors and users of geothermal resources (excluding domestic) to hold water rights;
- (b) All geothermal discharges to be controlled by water rights.

The major problem was that water required for reasonable domestic needs was exempted from control by the water right process. This meant that geothermal fluid abstracted for domestic purposes or for use in heat exchangers could not be controlled. The Bay of Plenty Catchment Commission faced this problem in regard to management of the Rotorua Field where the majority of geothermal use was for domestic purposes. An amendment to the W&SCA in 1981 clearly defined geothermal fluids above 70°C as water resources and thus under the control of Regional Water Boards.

The W&SCA also allowed, under section 22, for the establishment of general authorisations. These are more fully discussed below.

6.4 Rotorua City Geothermal Empowering Act 1967

This Act enabled the Rotorua City Council to make provisions for the control of the tapping and use of geothermal energy in the City of Rotorua. This delegated the power to issue licences and make bylaws for geothermal bores to the Rotorua City Council. Essentially this Act replaced the Geothermal Energy Act 1953 within the confines of Rotorua City.

6.4.1 Commentary

Despite the requirement to licence geothermal bores within its area, Rotorua City, for the 19 years in which it had responsibility, did not issue any licences. Essentially there was little or no control of the drilling and exploitation of the Rotorua Geothermal Field. This was the major contributing factor in the Crown revoking the Rotorua City Geothermal Energy Empowering Act in 1986.

The leading paragraph of the Act states:

“Whereas it is expedient to enable the Rotorua City Council to utilise and control geothermal energy in the City of Rotorua for the benefit of the inhabitants of the city and accordingly to grant authority for the reticulation, licensing and control of geothermal energy in the city or in any specified part of the city and to control the sinking of bores for the purpose of obtaining geothermal energy in the city.”

The attitude of the Rotorua City Geothermal Energy Empowering Act focused exclusively on the utility use of the geothermal field, with no apparent concern for the benefits or detriments from that use which may have accrued to the field, its geothermal surface features, the region or nation.

The Act also required that all users of geothermal energy apply to the Rotorua City Council for a licence within three months of the enactment of the Act. **There were no apparent exceptions to this as compared to the Geothermal Energy Act 1953 within which prior usage and domestic usage were exempt from licensing.** It may be argued that failure to apply for a licence at this time, may negate the prior usage claim under the Resource Management Act 1991, sections 418, and the Geothermal Energy Act 1953, sections 9(1)b and 9(1)c for some current geothermal sites.

6.5 Rotorua Geothermal Management Plan 1988

In 1986, the Rotorua geothermal field was considered under severe stress and this resulted in Government action and forced closure of bores. Recognising the need for management of the field, the Bay of Plenty Catchment Board prepared a Management Plan for the Rotorua Geothermal Field.

Under the W&SCA, water management plans were not explicitly recognised. Therefore the plan had no legal status and could not be used as evidence in water right hearings. The Rotorua Geothermal Management Plan was not formally adopted by the Bay of Plenty Catchment Board.

6.6 Ministerial Directive 1986

This notice published in the NZ Gazette 2 October 1986 and signed by R. J Tizard, Minister of Energy:

Pursuant to section 9A (4) of the Geothermal Energy Act 1953, the Minister of Energy hereby revokes the delegation issued to the Rotorua City Council on 31 January 1968 permitting the Rotorua City Council to exercise his power under section 9 of the Geothermal Energy Act to grant licences to any person to sink bores or to take, tap, use or apply geothermal energy within the city of Rotorua.

6.6.1 Implication

The control and responsibility for management passed to the Crown and the Geothermal Energy Act 1953 became the controlling legislation for geothermal usage in Rotorua City.

6.7 Cabinet Directive 1986

At the meeting on 6 October 1986, on the recommendation of the Cabinet Development and Marketing Committee, Cabinet:

- (a) agreed that the powers delegated to the Rotorua District Council under Section 9A (1) of the Geothermal Energy Act 1953 be revoked;
- (b) agreed that all geothermal wells situated within 1.5 kilometres of Pohutu geyser be closed by 1 December 1986 **except for those specially excluded by the Minister of Energy on the grounds that he is satisfied that an alternative fuel source is unavailable or that hardship may be incurred;**
- (c) agreed that all Government agencies in Rotorua which are users of geothermal energy from bores beyond a 1.5 kilometre radius of Pohutu geyser be required to convert to alternative fuels as soon as possible;
- (d) agreed that by 1 April 1987 all bore users in the Rotorua metropolitan area are to be licenced in terms of the Geothermal Energy Act 1953 and a royalty imposed on their use of geothermal energy.

6.7.1 Commentary

Geothermal was defined as per the Geothermal Energy Act 1953 as being temperatures over 70°C and depth over 61 metres. Thus bores within the 1.5 kilometre zone whose temperature was less than 70°C and whose depth was less than 61 metres were exempt from closure. Also by definition, these shallow wells were not required to be licenced.

The requirement for licensing within the Rotorua metropolitan area is also interesting as this area did not totally enclose the Rotorua Geothermal Field and thus geothermal bores to the east of the Puarenga Stream escaped licensing requirements.

6.8 Ministerial Directive 1989

The directive was published in the NZ Gazette, 16 February 1989. and signed by the Minister of Energy, D J Butcher:

Pursuant to section 9(1) (b) of the Geothermal Energy Act 1953, I hereby direct that it is in the public interest that all existing bores and bores to be sunk in the future which are 61 metres or less in depth and which are within the 1.5 kilometre radius of Pohutu Geyser in Rotorua, and from which geothermal energy is tapped, taken, applied or used or will be tapped, taken, applied or used, be subject to the following licensing regime from 3 March 1989:

Licences to tap, take, use or apply geothermal energy will only be granted when the Minister of Energy is satisfied that there will be:

- (a) no fluid withdrawal, and*
- (b) no heat withdrawal from those parts of the system where there is a stable downhole temperature of 100 degrees celsius or more, as determined to the satisfaction of the Geothermal Inspector.*

6.8.1 Implications

The implications of this notice are clear, in that:

- (a) all bores in the 1.5 kilometre abstraction exclusion zone, both existing and future, require licences, and
- (b) only down hole heat exchangers are permitted, and
- (c) no heat exchanger will be allowed to be placed in sections of the wells where temperatures exceed 99 degrees Celsius.

PART II

OVERVIEW

OF RESOURCE

INFORMATION

7 The Rotorua Geothermal Resource

7.1 Introduction

This section is intended to give a general overview of the technical background of issues within the Rotorua Geothermal Field. For more detailed technical information, readers are referred to the Geothermics Special Issue Rotorua Geothermal Field and the Environment B·O·P publication Technical Publication No 7 "Rotorua Geothermal Field Response of field since closure (1987 - 1992)".

7.2 Location of the Rotorua Geothermal Field

The Rotorua Geothermal Field, if delineated on the location of surficial features and geothermal bores, has an area of approximately 12 square kilometres.

Electrical resistivity surveying suggests that the area of the geothermal field at around 500 metres depth is between 18 to 28 square kilometres and that it extends 2 kilometres northwards into Lake Rotorua and 2 kilometres south of Whakarewarewa. The boundary of the field is described in Figure 1 by the hatched lines.

The Rotorua Geothermal Field differs from other fields in that information concerning the first 200 metres is relatively well established, however information on the deeper parts of the Field is very sparse.

7.3 Volcanic Origin

The Rotorua Geothermal Field, like the majority of geothermal fields in the Bay of Plenty Region, is associated with the Taupo Volcanic Zone (TVZ). The TVZ has resulted from the melting of crustal materials associated with subduction of a continental plate. This molten crustal material or magma is buoyant and melts to the surface to form volcanic chains.

Rainfall infiltrates to great depths (ie several kilometres) where it is heated by the shallow magma and the surrounding heated country rock. This heated rainwater, at great pressure, then rises (usually slowly) to the surface, passing through the overlying rock strata. The overlying rock strata is also heated by the hot rising rainwater. As the rainwater becomes heated it dissolves and accumulates mineral salts and gases, and may undergo changes in acidity or alkalinity. At this stage it becomes geothermal fluid.

A geothermal field occurs where this rising fluid approaches close to or reaches the ground surface. The surface of the area is often, but not always, characterised by the presence of hot springs, fumaroles, mud pools and steaming ground.

7.4 Geology

The Rotorua geothermal field is located in the southern part of the Rotorua caldera which collapsed after the eruption of the Mamaku Ignimbrite some 140,000 years ago (Wood 1992). This ignimbrite forms the base of the shallow aquifer systems exploited by wells in the Rotorua Field. Above the ignimbrite lie the Rotorua City rhyolite domes, shown on Figure 2, which form a north-south ridge extending from the Pukeroa dome (Hospital Hill) in the north, where the rhyolite outcrops, toward Whakarewarewa. Both the rhyolite and ignimbrite are capped by poorly permeable lake sediments (siltstones, sands, gravels and a fine volcanic-derived material) which were deposited when the lake outlet was dammed at the northern outlet by an eruption of breccia about 50,000 years ago.

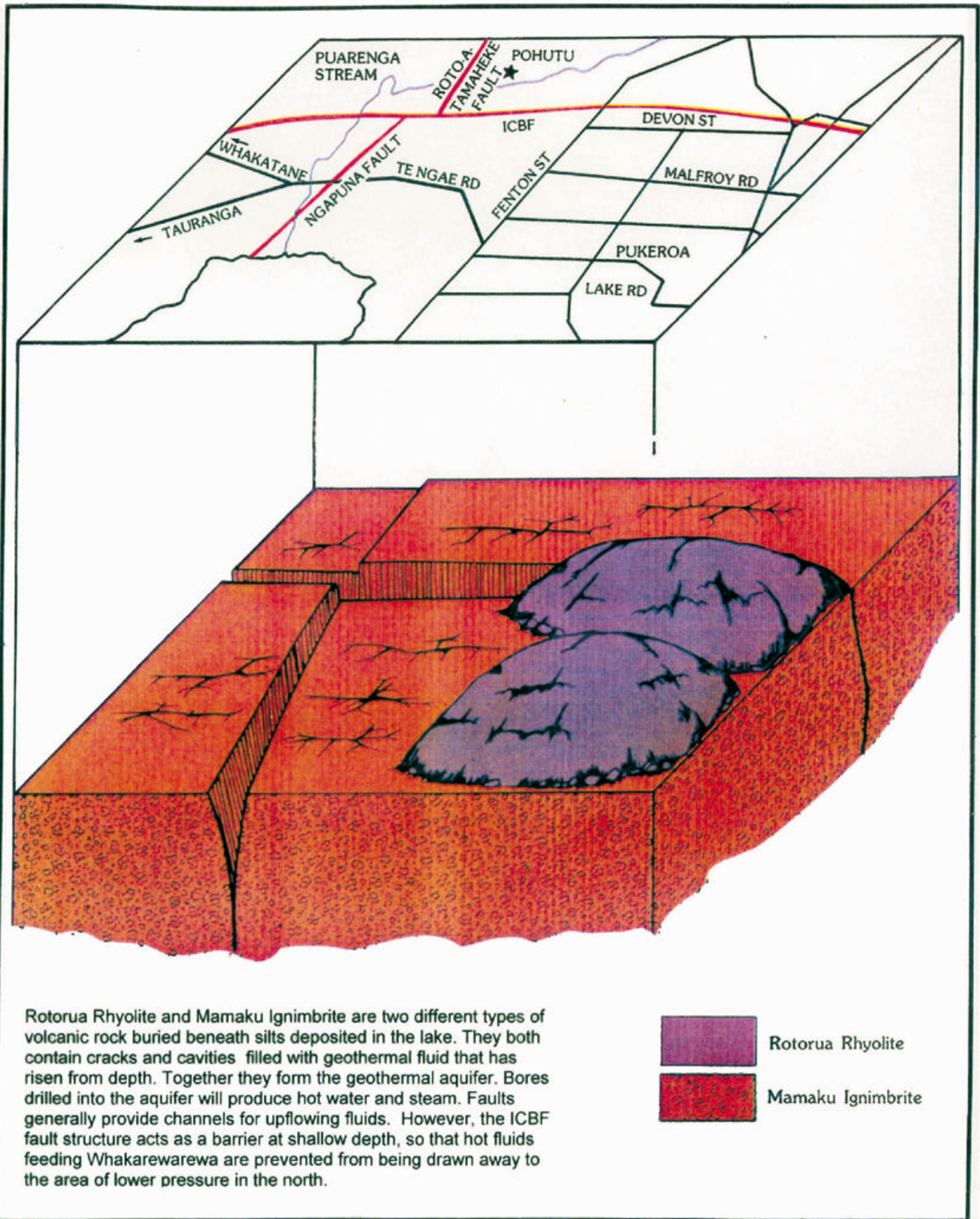
Surface thermal activity migrated extensively as the lake level varied. Temperature adjusted water levels of wells tapping the rhyolite aquifer (the main geothermal aquifer) are currently about 280 metres above sea level. This is approximately the level of Lake Rotorua. Future alterations of lake levels may have to be reviewed with regards to possible impacts on the Rotorua geothermal field.

In the southern part of Rotorua, a major fault called the Inner Caldera Boundary Fault lies north-east, south-west. This is intersected by two other faults, the Ngapuna and Roto-a-Tamaheke faults.

7.5 Hydrology

The flow of fluids is largely controlled by the geological/geomorphic structure of the area, and is also strongly affected by the nature of the fluid. As mentioned above, the Rotorua geothermal field is thought to be similar to other large high temperature fields nearby. While there are likely to be deep high temperature aquifers, the following discussion will only deal with the known part of the field, in the ignimbrite and rhyolite aquifers down to depths of 200 to 300 metres.

The principal aquifers used for hot water production lie within the ignimbrite and in the overlying rhyolite domes. Hot fluids appear to ascend from depth in the south part of the field to enter via the Ngapuna and Roto-a-Tamaheke faults. Hot fluids also enter the rhyolite domes from the ignimbrite in the east and in the north near Kuirau Park.



Rotorua Rhyolite and Mamaku Ignimbrite are two different types of volcanic rock buried beneath silts deposited in the lake. They both contain cracks and cavities filled with geothermal fluid that has risen from depth. Together they form the geothermal aquifer. Bores drilled into the aquifer will produce hot water and steam. Faults generally provide channels for upflowing fluids. However, the ICBF fault structure acts as a barrier at shallow depth, so that hot fluids feeding Whakarewarewa are prevented from being drawn away to the area of lower pressure in the north.

FIGURE 2

Block diagram of Rotorua geology

There is a distinct pressure gradient between the area around Whakarewarewa and the rhyolite aquifers to the north; this is attributed to the Inner Caldera Boundary Fault, which appears to form a barrier between areas of higher permeability to the south, around Whakarewarewa and in the rhyolites to the north. Movement of hot water within the ignimbrite and rhyolite aquifers is generally from south to north. The hot thermal waters interact with cold fresh water aquifers to the west and with the waters of Lake Rotorua in the north and northeast.

Shallow and deep groundwaters are present in the field. The level of Lake Rotorua exerts one of the strongest influences on groundwater in the north. In the south, the Puarenga stream locally controls groundwater. The shallow groundwater responds strongly to rainfall. Recently, with the reduction in soakage, and advent of shallow wells, there has been a general cooling and a change in chemistry of these waters.

The Mamaku Ignimbrite to the west provides a continuous flow of very clean shallow groundwater (age about 100 years), over the top of deeper groundwater aquifers which are continuous with the exploited geothermal fluid. The water from these aquifers is between 50 and 100 years old.

Mixing of geothermal and groundwater takes place in the upper part of the geothermal aquifer. The sedimentary layers are not continuous, and in places permit vertical flow, and surface discharge. Geothermal waters can react with the rocks, altering them to form the clays and muds of geothermal areas.

The local details of near surface hydrology are modified by natural drainage such as streams, by trenching for deep drainage, by soak holes (for hot or cold water) and by alteration of surface runoff by sealing such as roads, paths and roofing.

7.6 Chemistry

Deep geothermal fluid tends to be alkaline, chloride rich, and saturated (or supersaturated) with silica. It also contains dissolved gases (such as H_2S and CO_2), and other dissolved material giving a unique signature which can be used to deduce their origin. When mixed with ground water, or when boiled the composition will change. As it boils, gas comes out of solution and mixes with the steam and then rises upwards encountering oxygen rich groundwater. As the H_2S gas is oxidised, it forms acid solutions which are aggressive, and may attack rock, well casings and grouts. These waters are often referred to as acid-sulphate waters.

The chemistry of the liquids may be examined, and compared with the chemistry of the groundwater and the deep geothermal water, to develop a picture of the processes taking place.

7.7 Natural Geothermal surface features

The surface activity in Rotorua is divided into several major areas, each with local features. The location of these areas are described by Figure 3. The major displays are at Whakarewarewa in the south, with Ohinemutu, Government Gardens, Kuirau Park, Sulphur Flats and Ngapuna giving less active displays in the north and Arikikapakapa in the south having steaming ground. Minor displays also occur in some other localities.

In the Ohinemutu area, most features are clear, alkaline springs. There are seepages to the shallow lake bottom. A geyser is believed to have once played in this region. At Kuirau Park, features are cooler, and consist generally of acid or only weakly alkaline water, and mud pools, suggesting steam heated waters, and various degrees of mixing of steam heated waters and alkaline source waters. A possible deep secondary source has been noted in this area.

Features at Ngapuna, Sulphur Flats, Government Gardens area tend to be weakly acidic. Rachel Spring, and Blue Bath are the major alkaline features in this area. The main acid feature is Priests bath within the Polynesian Pools complex.

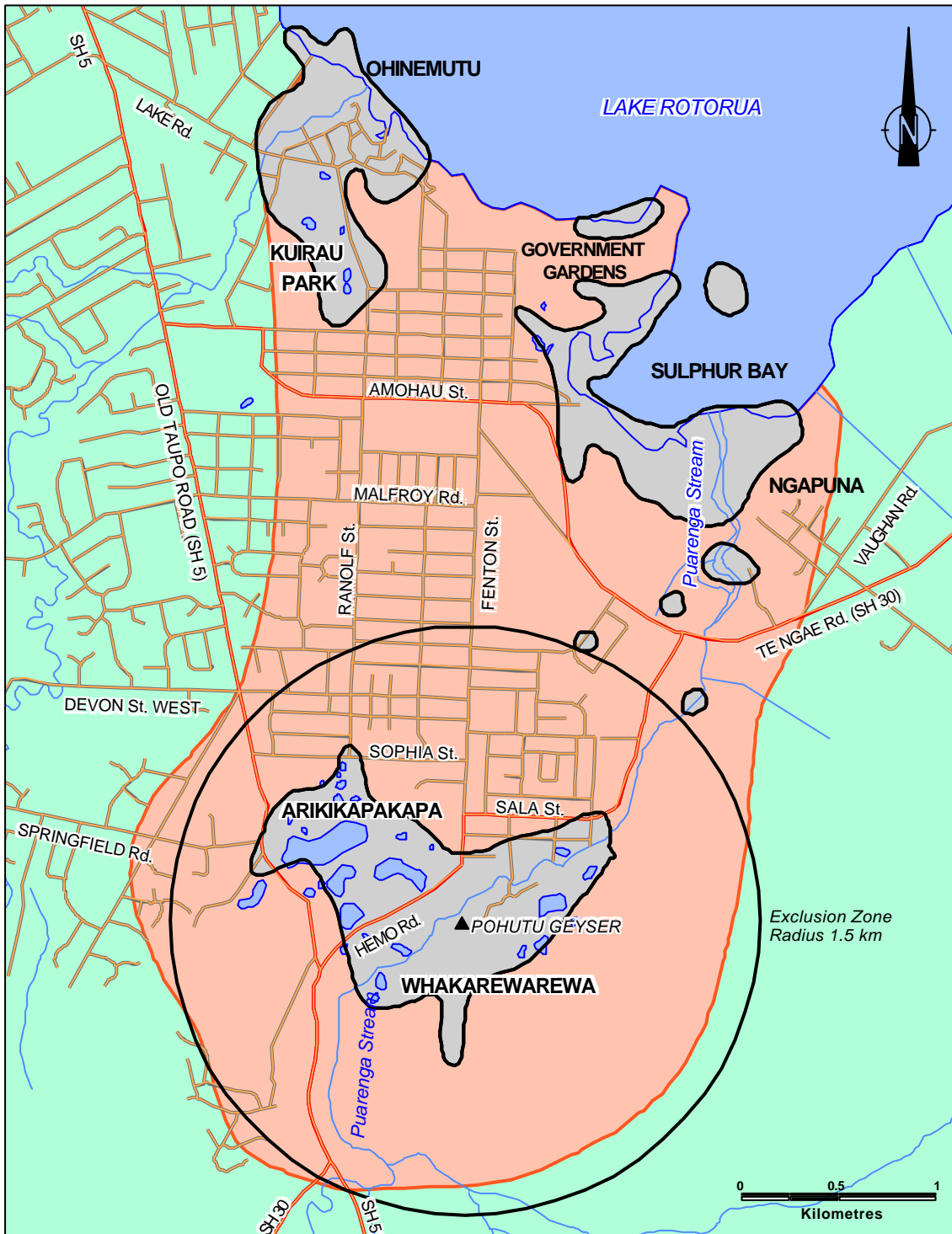
The Arikikapakapa reserve is an extensive area of steaming ground, mud pools and acid features. This does not, however, attract much public interest.

Whakarewarewa has the most active and attractive thermal features. It has several reliable geysers (Pohutu, Mahanga, Waikorihiki and Prince of Wales Feathers). These features are fed by alkaline chloride waters, and are sensitive to small changes in pressure of the source fluids. Geyser activity is now generally restricted to Geyser Flat.

The largest single physical feature at Whakarewarewa is Lake Roto-a-Tamaheke. This area has intermediate chloride values. Just north is a set of springs near the Puarenga Stream with much higher chloride concentration, while due south of Geyser Flat is a set of lower chloride springs near Ngawha Crater. This illustrates the local variation in the chemical constituents of the water emerging from the geothermal surface features resulting from the mixing processes taking place and the different routes that the geothermal water, steam and gas takes in reaching the surface.

Extensive areas of sinter and hydrothermal alteration show that hot springs used to exist along a previously higher lake level. Also recorded are sinter beds within diatomaceous sediments below the present sinter surface at Roto-a-Tamaheke. These constitute evidence that thermal activity has been present in Rotorua for the past 20,000 to 50,000 years.

FIG 3: LOCATION OF MAIN AREAS OF THERMAL ACTIVITY



LEGEND

<p>○ Rotorua Geothermal Exclusion Zone</p> <p>■ Area of Thermal Activity</p>	<p>■ Rotorua Geothermal Field Indicative Area</p>
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DISCLAIMER

This map shows an interpretation of the geothermal features of the Rotorua area. The small scale of this map has necessitated the omission of some small features and the exaggeration of others in the interests of clarity. The map should not be used for any work where site specific investigations should be made.

7.8 Fragility of Geysers and Springs

There are three main types of surface discharge: fumaroles, geysers and springs. A fumarole discharges only steam and gas, which comes from geothermal water at some level below the surface, far enough for the water not to be able to discharge. A spring occurs when the water is easily able to discharge, because of its pressure and the water level - it is an overflow. A geyser can be regarded as a spring that has a water level that is too low to allow it to discharge continuously - it is below overflow level. The timing of the geysering action, of discharge in sudden, short bursts, is governed by refilling of chambers that were emptied by the last discharge, which in turn is related to the water level and temperature of the geothermal aquifer. In scientific terms, the geyser is an unstable type of discharge that marks the transition between a spring and a fumarole. There is only a limited range of conditions that allow geysering, which is why geysers are so rare: these conditions are the existence of the chambers, and necessary water temperature, level and gas content.

The significant point to note is the importance of the pressure and water level to the existence of the springs and geysers. As they are essentially overflow structures, where pressure and water level is low, the rate of discharge will be reduced. In the case of a geyser, the lowering of pressure and water level may be such that geysering conditions can no longer be created. The demise of geysers in New Zealand, such as those associated with the Wairakei and Spa Fields, as a result of pressure reductions are well documented.

Geysers and springs are features that are also sensitive to small changes from other sources. These sources include groundwater, rainfall, barometric pressure, and other effects.

Variations in barometric pressure were correlated with discharge events at Rachel pool. Hot springs have deeper, near boiling water balanced by the hydrostatic head of the upper parts of the water column. A reduction in the hydrostatic head either by removal of water, or by heating can induce the spring to move from flowing to splashing or more vigorous discharge. Rachel Spring in the Government Gardens had a new discharge flume inserted about 300mm below the previous level and the immediate result was an increased discharge, violent and continuous boiling. The fragility of geysers relative to the cumulative effect of natural pressure changes and pressure changes caused by seasonal use of mass must be emphasised. This threat is always present although the shift to reinjection should lessen the risk.

8 Field Closure Effects

8.1 Introduction

Strengthening concern over the effect of geothermal fluid withdrawal on the Whakarewarewa area led the Government to take emergency measures in 1986.

This included a shutdown of all bores within a radius of 1.5 kilometres of Pohutu Geyser and closure of all Government Department bores in Rotorua. Some closures occurred in 1986, but the majority occurred in the period June 1987 to March 1988. The closure program was essentially complete by the end of 1988.

A resource rental (geothermal royalties) regime was imposed by the Ministry of Energy and became effective from 1 April 1987. The charges were set at a deliberately high level in line with the Governments mandate to preserve the Rotorua Geothermal Field. A large number of bores were closed, upgraded or moved to reinjection by their owners during the time high rentals were instigated by the Crown.

The Environment B·O·P technical report "Rotorua Geothermal Field Response of Field Since Closure" summarised the impact of the Closure and the following discussion is drawn from that document. The closure of bores and the imposition of the resource rental regime (cumulatively referred to as the Closure) led to significant changes in the Field in respect of:

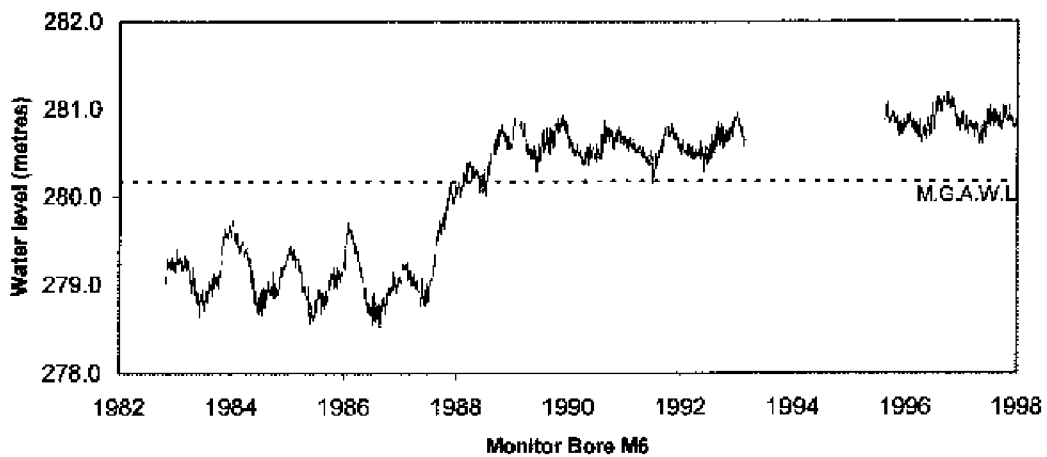
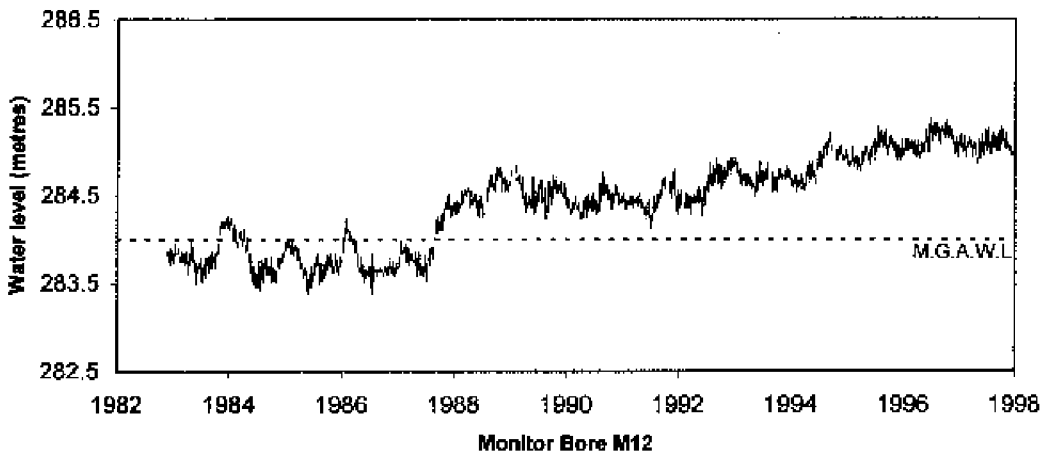
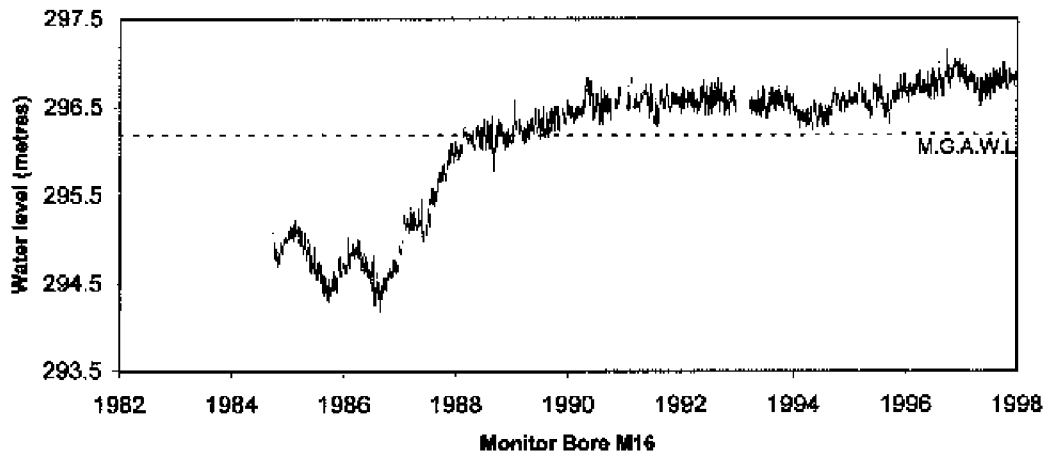
- (a) Physical characteristics, and
- (b) Resource use characteristics.

8.2 Physical Changes

Figure 4 shows plots of water level variation in three monitor bores (M6, M12 and M16) for the period 1983 to 1993. These plots assist in illustrating the points in the following discussion.

Cycles of geothermal aquifer water level change coinciding with winter/summer drawoff cycles were evident in all monitor wells with records over the time 1982 to 1987. These cycles were not induced by changing rainfall and occurred at a time when it was known that consumers varied their withdrawal from summer to winter.

FIG 4: MONITOR BORE WATER LEVEL VARIATIONS FOR THE PERIOD 1983 TO 1998. NOTE: M.G.A.W.L. IS THE MINIMUM GEOTHERMAL AQUIFER WATER LEVEL.



Closure occurred progressively from 1986 onwards accelerating with the enforced closure programme in mid 1987. This was important as many believe the start of the Closure to be the enforced bore closure programme which neglects the closure of Government Department bores and voluntary bore closures that occurred earlier. During this period rainfall was low with little variation.

Since Closure, the annual variability in water level of the geothermal aquifer (ie the seasonal cycling) has been about two thirds of its previous value. Therefore it is considered that even if rainfall is the cause of all the present variability, some other effect such as withdrawal made a contribution to this earlier.

Prior to Closure, seasonal fluctuations in aquifer water level were occurring around an annually declining value. Following Closure, aquifer water levels have fluctuated seasonally around an apparently uniform annual level. The Rotorua Geothermal Field, under the 1992 withdrawal conditions was considered stable in this respect.

After Closure, pressure gains of around 0.2 bars (corresponding to 2 metres in water level) were made in various parts of the field and were essentially complete by the end of 1988.

For the period 1984 to 1990, it was calculated that the natural mass/fluid outflow from Whakarewarewa increased by approximately 2750 tonnes/day. For the same period, the increased chloride flux in the Puarenga stream indicated an increase of deep geothermal water inflow of at least 950 tonnes per day.

Changes in the play of features in Whakarewarewa can not be clearly determined apart from the data for Pohutu eruption frequencies which show definite improvement. Increase in flow from geothermal surface features such as Lake Roto-a-Tamaheke (at Whakarewarewa), Rachel Spring (Government Gardens) and Kuirau Lake (Kuirau Park) were noted. The general pattern is one of increased discharge and increased deep geothermal input.

The decisions by the Government to close Government bores, close bores within 1.5 kilometres of Pohutu Geyser and impose the resource rental regime appear to have been cumulatively successful in increasing the geothermal aquifer pressure and the recovering of geyser and other spring activity in Rotorua.

8.3 Resource Use Changes

Large changes in geothermal resource use occurred between 1985 and 1992. Changes occurred in respect of:

- (a) Magnitude;
- (b) User type;
- (c) Spatial location.

8.3.1 Magnitude

Large scale changes in the magnitude of geothermal use occurred between 1985 and 1992 and these are summarised as:

PARAMETER	1985	1992
Total withdrawal	29,000 tonnes per day	9,500 tonnes per day
Net withdrawal	27,500 tonnes per day	4,400 tonnes per day
Reinjection	1500 tonnes per day	5,100 tonnes per day
Soakage	27,500 tonnes per day	4,400 tonnes per day
Domestic withdrawal	14,000 tonnes per day	3,100 tonnes per day
Commercial withdrawal	15,000 tonnes per day	6,400 tonnes per day
Number of production wells	376	141
Commercial wells	188	65
Domestic wells	188	76
Number of users	1800	503
Domestic users	1512	402
Commercial users	288	101
Unknown use	Unknown	Unknown

It is clear from the table that significant reductions have occurred in well numbers, users and amount of fluid withdrawn between 1985 and 1992. The majority of these changes having occurred between 1985 and 1988. Indeed in the table, only the value for reinjection has increased and the reasons for this are discussed in a subsequent section.

Associated with the reductions were:

- (a) Closure of some domestic bores with large numbers of users. In one case, 95 users;
- (b) Major shift to reinjection, and shallow wells;
- (c) Bore sharing and group heating schemes became more common;
- (d) Use of down hole heat exchangers has increased.

8.3.2 User Type

The following table illustrates the changes in user type between 1985 and 1992.

PARAMETER	1985	1992
Domestic withdrawal	48 percent	33 percent
Commercial withdrawal	52 percent	67 percent
Domestic wells	50 percent	54 percent
Commercial wells	50 percent	46 percent
Domestic users	84 percent	80 percent
Commercial users	16 percent	20 percent

In terms of number of wells and users, the change in percentage between domestic and commercial use was relatively small. The proportion of commercial wells declined by four percent and the proportion of commercial users increased by four percent.

The most significant change occurred in the percentage of the total withdrawal represented by each use. Domestic use of geothermal fluid in 1985 was equivalent to that of commercial use, however, estimates for 1992 show that domestic use is now only 33 percent of total withdrawal. This indicates that majority of the domestic bores shut down probably abstracted only small volumes of fluid.

It can be expected that, over time, the proportion of the total fluid withdrawal taken by commercial interests will continue to increase. The introduction of transferrable consents will contribute to this increase.

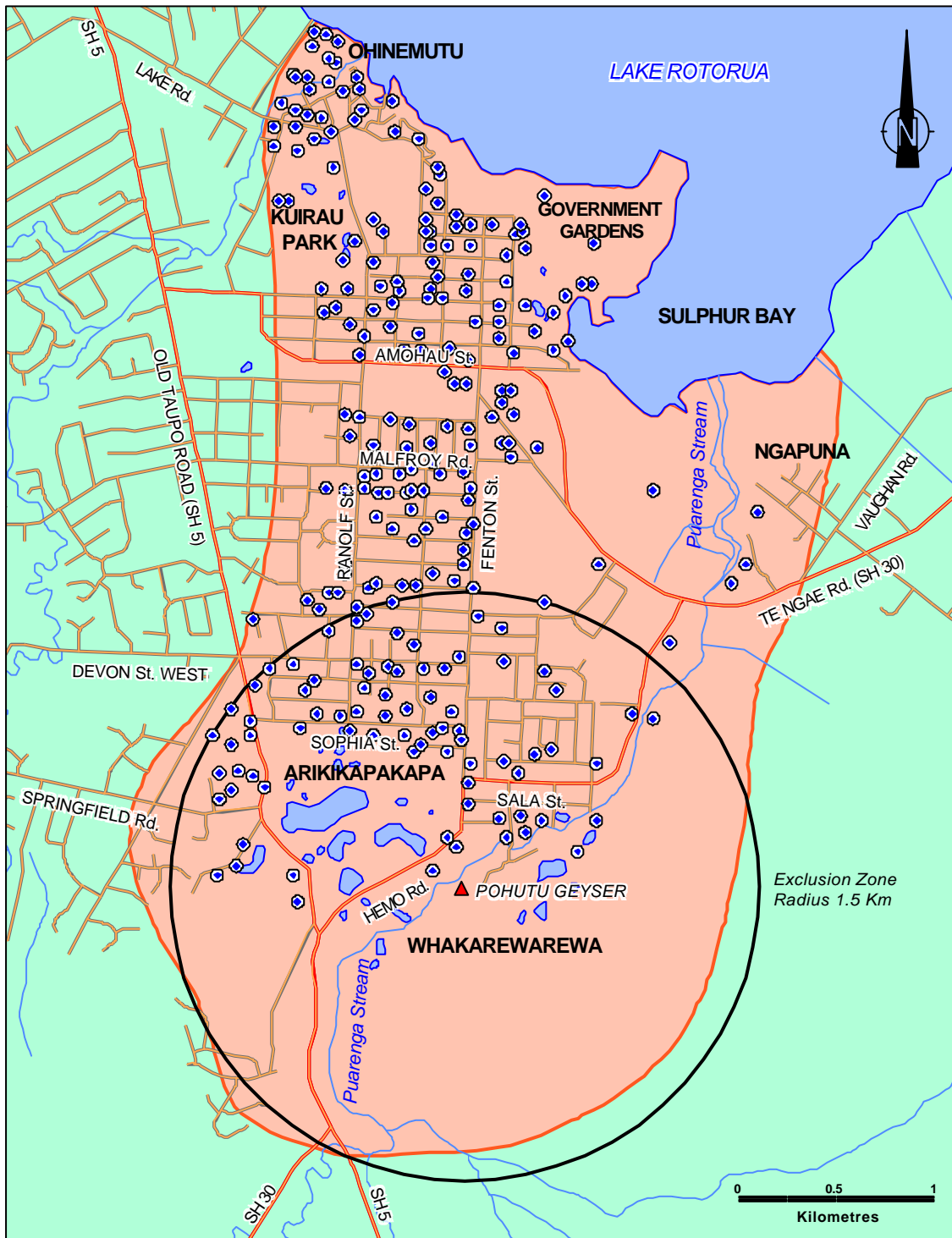
8.3.3 Spatial Location




Figures 5 and 6 show the distribution and density of production bores in 1987 and in 1992. The impact of the 1.5 kilometre extraction exclusion zone is immediately apparent with only down hole heat exchangers now located within the zone. Also evident is a significant reduction in density of geothermal bores between Malfroy and Devon Streets where a large number of domestic bores were shut in response to the imposition of the resource rental regime not as a result of compulsory closure. The density of domestic bores in this Southern City reduced from 22 per square kilometre to 6 per square kilometre between 1985 and 1992.

It can be noted that the density of bores associated with motel/hotels along the west side of Fenton Street did not apparently decrease between 1987 and 1995.

This reflected the ability of the commercial facilities to pay the resource rentals.

FIG 5: LOCATION OF PRODUCTION WELLS AS AT 1987

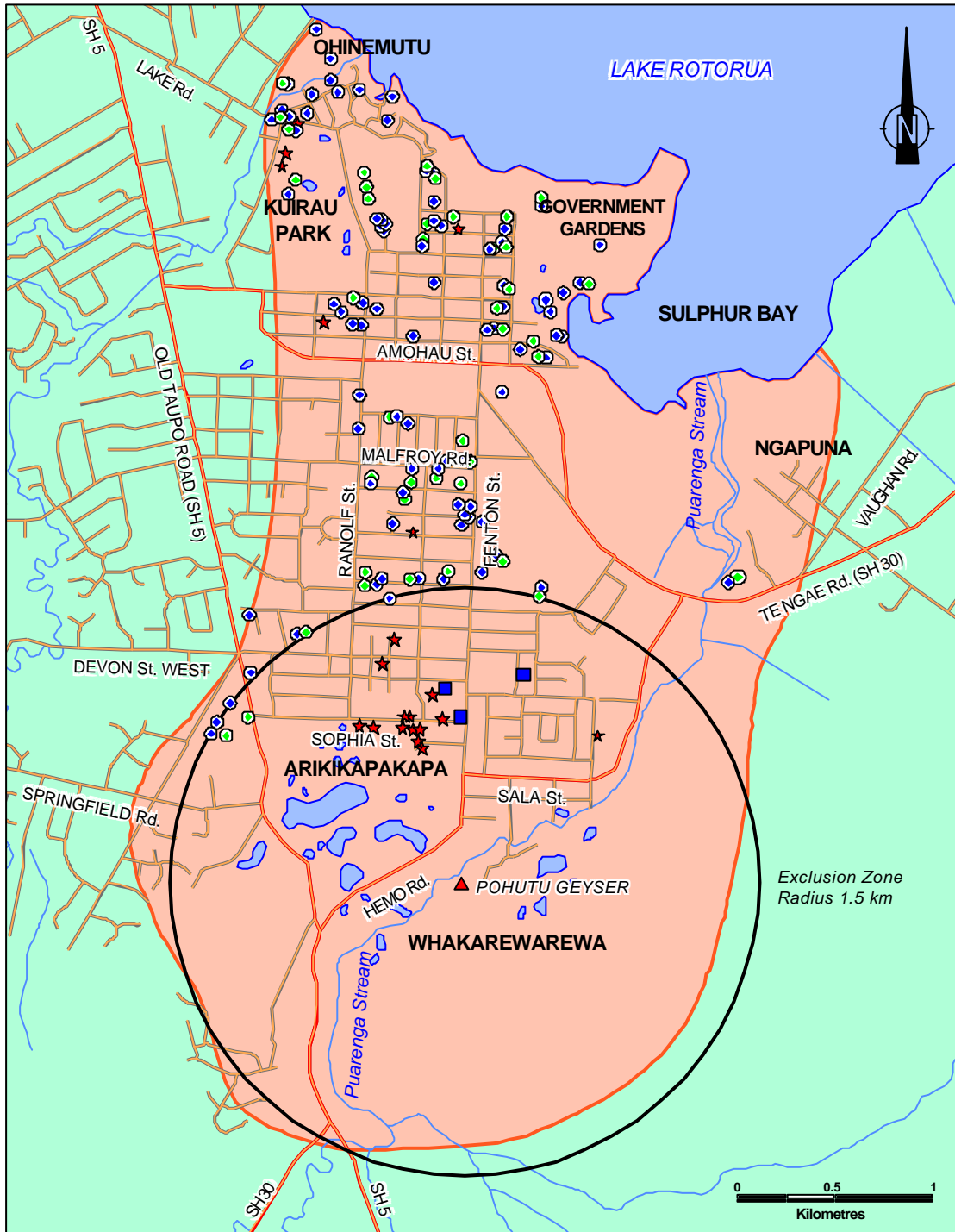








LEGEND	
	Rotorua Geothermal Exclusion Zone
	Production Well 1987
	Rotorua Geothermal Field Indicative Area

DISCLAIMER

This map shows an interpretation of the geothermal features of the Rotorua area. The small scale of this map has necessitated the omission of some small features and the exaggeration of others in the interests of clarity. The map should not be used for any work where site specific investigations should be made.

FIG 6: LOCATION OF KNOWN PRODUCTION WELLS AS AT JULY 1998



LEGEND	
	Rotorua Geothermal Exclusion Zone
	Production Well 1998
	Down hole heat exchanger
	Rotorua Geothermal Field Indicative Area
	Reinjection Bore
	Bore < 70 deg and < 61 m

DISCLAIMER

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9 Equilibrium

9.1 Introduction

An equilibrium in a geothermal system occurs when there is a balance between inflows to and outflows from the reservoir. In the case of the Rotorua Geothermal Field, inflows are represented by geothermal fluid flowing up from the deep geothermal aquifer, whereas outflows are both natural discharge (springs, fumaroles, geysers and discharge to Lake Rotorua) and artificial discharge (bores and down hole heat exchangers).

The balance in the system is represented by the geothermal aquifer water level. Alteration of either inflows or outflows will result in a new water level.

The system may take some time to readjust to the alteration in inflows or outflows, and thus the water level may be rising or falling for this period of time. During this time, the system can be considered to be unstable. When readjustment is complete, the water level (i.e. the balance) will remain steady at a new level. If inflows had exceeded outflows, then this new level would be higher than the original level whereas when outflows exceed inflows, the new level would be lower.

9.2 Rotorua Situation

The Rotorua Geothermal Field differs from the above simple model in that many of the natural outflows are overflows controlled by the water level in the geothermal aquifer. Therefore, in simple terms, as the water level in the geothermal aquifer falls, the outflow through springs and geysers also reduces.

Conversely, as the water level in the geothermal aquifer rises, the outflow through the springs increases.

The high permeability structures in the Rotorua Field will freely supply fluid (at least to the extent experienced i.e. prior to the Closure), and as demonstrated by responses to rainfall and reduction in withdrawal due to the Closure, respond quickly to pressure transients.

The pressure drawdown of the resource during the period prior to Closure indicates that either the resource decreased in temperature, or else that the rate of outflow exceeded the rate of inflow to the aquifer. Temperature profiles indicate that temperature fluctuations were not responsible for the total variations in water level, so it is concluded that the rate of outflow exceeded the rate of inflow.

Since the natural geothermal features are essentially overflow structures, when the pressure in the aquifer declined, the rate of overflow reduced.

The recently developed model of the Rotorua Geothermal Field commissioned from Industrial Research Limited also indicates that very little storage exists within the geothermal aquifer and therefore any change in equilibrium is quickly expressed as change in flow from geothermal surface features.

9.3 Stability of the Rotorua Geothermal Field

For the period 1982 to 1986, monitoring of the geothermal aquifer water level indicated that the Rotorua Geothermal Field was not stable as the average annual geothermal aquifer water level was declining from year to year. The complete reason for this is not fully understood, however the drawoff from the bores was clearly having an effect in reducing levels, and the natural surface flow was declining.

The reduction of total withdrawal from 31,000 tonnes/day in 1985 to 9,500 tonnes/day in 1992 and the reduction in net withdrawal from approximately 29,000 tonnes/day to 4,400 tonnes/day has resulted in an estimated increase in flow at Whakarewarewa of between 950 and 2750 tonnes/day. The expected improvements in the field behaviour since bore closure are now believed complete and the Field is essentially stable relative to current production/reinjection regime. The geothermal aquifer water level is seasonally fluctuating around an apparently uniform annual level. The Field can be considered to have adjusted to a new equilibrium.

Variability now occurring in the Rotorua geothermal field is made of two components, a seasonal variation in the pressures recorded in the wells (Bradford 1992a) and a possible reducing pressure and reduced spring flow south of the inner caldera boundary fault. This latter component was predicted by Turner (1987) as following a rainfall low ten years ago. The 1992/93 year had a rainfall deficit, reflected in the ground water response. The test for Turners hypothesis must await a continuation of the cycle through the rainfall increase observed in the late 1980's, followed by a rainfall decline observed in the early 1990's.

Given the existing stable levels, affected by rainfall, with minor seasonal cycling, and with a very quick response to changes in withdrawal, the indications are that the Field is producing at a level where variations in output of natural features will be affected by meteorological changes. Therefore if there is no change in withdrawal, all such changes must reflect either meteorology or a change in supply conditions.

Hence, as it can be concluded that:

- (a) The Rotorua Geothermal Field pressure is stable at the current level of withdrawal.
- (b) Activity at Whakarewarewa, as represented by the activity of Pohutu Geyser and outflow to Puarenga Stream, has stabilised at its highest level since careful monitoring began in 1987.
- (c) To maintain this level of stability and sustainability, the level of withdrawal (as measured by its impact on Whakarewarewa) should not exceed that currently existing.

9.4 Strategic Equilibrium

As detailed above, the Rotorua Geothermal Field appears to be stable, although the geothermal aquifer water level is still subject to small fluctuations as a result of seasonal production drawoff, barometric pressure and rainfall. Strategic equilibrium is the average of the fluctuations over a nominal range through which the geothermal aquifer water level can fluctuate in response to the above factors. Such fluctuations are natural and must be accounted for in any management strategy.

Environment B·O·P (the Bay of Plenty Regional Council), however, must be alerted if the geothermal aquifer water level fluctuates over a greater range than can be expected as a result of the above factors. This may herald the beginning of a period of Field instability which would require early management action to minimise any potential environmental effects.

9.5 Selection of Minimum Aquifer Water Level

The Bay of Plenty Regional Council has been monitoring and recording water levels in a number of geothermal bores located in the Rotorua Geothermal Field.

The minimum level was taken as the minimum level the geothermal aquifer water level fell to during the five years between 1989 and 1993. As the data is recorded every 15 minutes, this is the lowest level recorded for any 15 minute period during the five years. This minimum point is a result of the cumulative effect of a number of factors such as winter drawdown, low rainfall and barometric pressure which combine to depress the geothermal aquifer water level. Therefore by selecting this point, it is reasonable to assume that most fluctuations of the geothermal aquifer water level will occur above this point. Concurrently, if the geothermal aquifer water level declines below this point for an extended period of time, then it is reasonable to assume that a significant effect is being experienced in the field.

The current designated monitor bores are M6, M12 and M16. The minimum geothermal aquifer water levels in those bores are:

M6 = 280.174 metres above Moturiki datum,
M12 = 283.995 metres above Moturiki datum,
M16 = 295.873 metres above Moturiki datum.

These levels are illustrated by the dotted lines entitled Minimum Geothermal Aquifer Water Level on each of monitor bore water level variation plots in Figure 4. The location of the current three monitor bores are shown in Figure 1. The actual bores used may change if there are any difficulty accessing or recording water levels. The water level in any new bore selected would be calibrated to ensure a continuity of water level data.

9.6 Selection of Critical Minimum Water Level Period

New Zealand generally experiences a six to ten day weather cycle. Therefore it is reasonable to assume that if an effect on the geothermal aquifer water level continues for greater than 20 days, it is unlikely to be connected with barometric pressure or localised short term climatic events.

10 Field Use and Effects

10.1 Utility Use Information

This section gives an outline comparing the main types, areas and percentages of utility use of the Rotorua geothermal resource in 1992.

10.1.1 Domestic Use

Domestic users are located mainly in two areas:

- (a) Southern City (an area bounded by Old Taupo Road, Fenton Street and Amohau Street) and
- (b) Ohinemutu.

61 percent of domestic bores dispose of spent geothermal fluid by soakage compared to commercial usage where 42 percent is disposed to soakage.

10.1.2 Commercial Use

Commercial use falls into three broad categories:

- (a) Tourist accommodation and other commercial usage; and
- (b) Health and therapeutic use.
- (c) Enjoyment and recreation use.

10.1.2(a) Tourist Accommodation and other Commercial Usage

Based on 1992 data, 5 Hotels, 44 Motels and 2 Motor Camps outside the 1.5 kilometre exclusion zone utilise geothermal fluid. This represents 55 percent of all commercial use.

The majority of these users are located along Fenton Street, Hinemaru Street and Lake Road.

The 5 hotels and one of the motor camps reinject spent geothermal fluid whereas only 60 percent of motels using geothermal fluid/energy reinject spent geothermal fluid.

The remaining commercial users include a wide range of activities such as taverns, swimming pools, nurseries, churches and commercial buildings. Almost all of this group of users are located in or near the Rotorua Central Business District.

10.1.2(b) Health and Therapeutic Use

Rotorua and Queen Elizabeth Hospitals utilise geothermal fluid and energy. Both institutions use geothermal energy for general domestic purposes such

as space heating and water heating. Queen Elizabeth Hospital makes use of the geothermal fluid for its therapeutic value. Both institutions dispose of geothermal fluid by reinjection.

10.1.2(c) Enjoyment and Relaxation Use

The Maori communities of Whakarewarewa and Ohinemutu have been using bathing springs and pools for enjoyment and recreational bathing for centuries. The longstanding use of geothermal fluid for enjoyment and recreational bathing is continued today at many sites in Rotorua, including hotels, motels and the Polynesian Spa. Polynesian Spa occupies a site in Government Gardens with springs and pools that have been used, firstly by Maori and later by Maori and Europeans. Early Europeans developed the site into Priest's and Rachael Baths and later Pavilion and Ward Baths.

10.2 Fluid Disposal

In the Rotorua Geothermal Field, waste geothermal fluid is generally disposed of by two methods:

- (a) Reinjection;
- (b) Soakage.

10.2.1 Reinjection

This is where the waste geothermal fluid is returned to the geothermal aquifer from which it was obtained. The return of the fluid helps to sustain the pressures within the geothermal aquifer. In terms of the simple equilibrium model developed above, reinjection represents another inflow to the Field which if equivalent to the amount withdrawn for production, maintains the balance in the Field and thus the geothermal aquifer water level remains at about the same value.

As the reinjected fluid is significantly cooler than the fluid in the geothermal aquifer, there is a risk of cooling the aquifer. The proper siting of production and reinjection wells to each other will reduce this risk and the attendant pressure gains will provide a net benefit to the Rotorua Geothermal Field.

10.2.2 Soakage

This refers to the process of discharging waste geothermal fluid to shallow groundwater through soak wells. These wells are generally about 10 metres deep. The waste then moves through the groundwater to eventually discharge in Lake Rotorua (either directly or indirectly through streams and surface drains). This method of disposal does not have any effect on the pressures in the geothermal aquifer.

10.3 Changes in Waste Disposal Practices

The following table illustrates the change in disposal of geothermal waste between 1985 and 1992.

PARAMETER	1985	1992
Reinjection volume	1,500 tonnes per day	5,100 tonnes per day
Soakage volume	27,500 tonnes per day	4,400 tonnes per day
Reinjection percentage	5 percent of total withdrawal	54 percent of total withdrawal
Soakage percentage	95 percent of total withdrawal	46 percent of total withdrawal

There was a large increase in the volume of fluid being reinjected between 1985 and 1992, however the more important factor is the increase in the percentage of total withdrawal being reinjected from five percent to 54 percent.

The huge increase in percentage of fluid being reinjected was due to the resource rental regime put in place by the Government. A fifty percent rebate of the resource rental was offered to those who moved to reinjection.

This shift to reinjection would have had positive effects through maintenance of Field pressure and reduction of geothermal contamination of the groundwater and surface streams.

10.4 Mass/Heat Relationships

Temperatures within geothermal bores vary across the Rotorua Geothermal Field. As a result, some bore users can obtain their energy requirements from a lesser volume of geothermal fluid than can others. The Bay of Plenty Regional Council must take this into consideration if it is to equitably allocate mass between users.

The relationship between mass and available heat for any particular bore is determined by the heat content of the geothermal fluid. The heat content of a fluid can be described by its enthalpy and enthalpy is related to temperature. A formula used for determining available heat energy is:

$$\text{Heat available (kW)} = \text{Mass flow rate (kg/sec)} \times (\text{Enthalpy (kJ/kg) of feed temperature} - \text{Enthalpy of discharge temperature}).$$

The following examples illustrate how the enthalpy and the rate at which mass is extracted influence the quantity of available heat energy.

Example One; a geothermal well which supplies geothermal fluid to a heat exchanger at 1 kg/sec (86 tonnes /day) at a temperature of 200°C and after passing through the heat exchanger, the fluid has cooled to 80°C for reinjection. The available heat would be calculated as approximately 510 kW.

Example Two; a well supplies geothermal fluid at a rate of 3kg/sec (258 tonnes/day) at a feed temperature of 200°C and is cooled to 80°C for reinjection. The available heat is approximately 1270 kW.

Example Three; a well supplies geothermal fluid at a rate of 1kg/sec (86 tonnes/day) at a feed temperature of 140°C and is cooled to 80°C for reinjection. The available heat is approximately 250 kW.

From the above examples it can be seen that the heat available from any given well is dependent on both mass flow rate and temperature. In recognition of this, the Bay of Plenty Regional Council commissioned a report relating use (e.g. space heating, pool heating, domestic hot water heating) to actual heat energy requirements in kilowatts. This will allow a more equitable allocation of geothermal water between uses.

10.5 Impact of Extraction/Disposal Systems on the Field

Different systems of extraction and disposal have differing effects on the Field.

These effects may be in terms of reservoir pressure, environmental impact or efficiency of abstraction. Depending on variables, such as location and standard of maintenance, these systems generally impact the Field in the following order, with the least harmful first.

10.5.1 Downhole heat exchanger

As no geothermal fluid is brought to the surface through downhole heat exchanger systems, potential environmental impacts are minimised. For small yield requirements, downhole heat exchanger systems tend to be more environmentally efficient in matching energy extraction to required energy needs. Energy yield can be better controlled by limiting fresh water throughflow. Energy not transferred by the exchanger remains in the field enhancing the environmental efficiency of the system.

It is understood that down hole heat exchangers (DHE) systems cause detrimental pressure changes in two phase (i.e. steam/water) zones. This is the reason for restrictions in the 1.5 kilometre mass abstraction exclusion zone on installing further DHE systems where geothermal fluid temperatures are 100 degrees Celsius and above.

Downhole heat exchangers have been shown to cause detrimental pressure changes in two phase (i.e. steam/water) zones. This is the reason for restrictions in the 1.5 km mass exclusion zone on installing DHX units where geothermal fluid temperatures are 100 degrees Celsius and above.

10.5.2 Abstraction with reinjection of waste fluids by bores

A minor effect on field pressure. The risk of potential environmental impact (e.g. gas and fluid leakage) increases with geothermal fluid brought to the surface.

10.5.3 Abstraction with discharge of waste into shallow soakage

There is a significant effect on field pressure as the geothermal fluid is abstracted with no balancing reinjection. Impacts on the environment occur, with warming of shallow groundwater and geothermal fluid contamination of groundwater and surface water courses.

PART III

MANAGEMENT ISSUES,

OBJECTIVES, POLICIES AND

METHODS

11 Understanding the Rotorua Geothermal Resource

11.1 Explanation

If the Rotorua geothermal resource is to be effectively managed, then managers will need to have good quality knowledge about the resource. Firstly, there is parameter information that tells us fundamental facts about the resource, such as where it is, how deep it is and how much energy it produces. Secondly, there is dynamic information which tells us about changes in resource characteristics over time, such as fluid and pressure gradients, movements and changes, changes induced by fluid or energy abstraction and how these may occur as a result of user interaction with the field.

The quality of the information field managers have will determine to a large extent management precision. Quality can be affected by such matters as the accuracy of data measurement, the length of time over which data is gathered, the resources available for monitoring, the sophistication of models and the theoretical quality of interpretations and conclusions drawn from data gathered. As technology and theoretical understandings develop, our ability to use contemporary information more precisely increases.

Environment B·O·P has a variety of different tools with which to monitor and predict changed in field characteristics. These include; a field model, the monitoring of water level data for trends, information from bore construction and testing and the monitoring of chemical and thermal changes across the field.

11.1.1 Field Model

It is possible over time to build up a sophisticated picture or a model of the field by assembling together all of the information gathered into a structured formula.

A geothermal field model is an array of interrelated equations operated by a computer programme. Into this programme is placed data about the field, for example, information about geothermal pressures at various depths and locations, volumes of natural and extracted outflow, reservoir geology, data about how the geothermal fluid moves both vertically and horizontally within the field reservoir.

The model is basically a sophisticated geothermal fluid/pressure budget analyser that can be used to predict the effect that an abstraction or injection of fluid and/or energy will have on the surrounding geothermal resource at any location and time. It can also indicate the (cumulative) effect of many such activities and probable effects that may be induced on surface activities. It is the means by which the relative equilibrium of the field can be assessed against the net changes in inflows and outflows of geothermal fluid and energy.

The model needs to be calibrated on observed data and its output results adjusted to parallel results that have been observed to happen.

11.1.2 Monitoring Water Level Trends

Much of the historical data about the field is in the form of recorded changes in water levels at various monitor bores across the field. As water level is a primary indicator of the state of the field at any one point in time, the observation of graphed trends in water levels give an unsophisticated and direct picture of the field and what is happening in the geothermal aquifer. Fluctuations in water levels indicate natural changes such as barometric pressure fluctuations, rainfall influences and tidal flux. Fluctuations in water levels also indicate changes caused by utility drawoff as daily and seasonal changes.

11.1.3 Information from Bore Construction and Testing

Information gained by drilling geothermal bores can help fill in the geologic picture of the structures that form the geothermal aquifer. This can help show the location of faults and boundaries between different geologic formations. This information helps determine how rapidly geothermal fluid and geothermal pressure changes can be expected to move through the field.

Bore test results show thermal (temperature) variations and changes and are important with respect to the safety and thermal production (energy) that a bore may provide. Thermal profiles down a bore shows how the temperature of geothermal fluid can vary with depth. Chemical testing allows prediction as to the origin of bore mass and can suggest ways and means to reduce corrosion caused to pipework, and the management of dangerous geothermal gases.

11.1.4 Management Tools

Environment B·O·P has in place a monitoring programme to gather information about the Rotorua geothermal field and its aquifer. An array of monitor bores are used to provide much of this information and Environment B·O·P staff and commissioned experts compile the results into useable form. It is important that the continuity of this data is maintained and that the quality of data is kept to a high standard.

Although the Rotorua geothermal resource model is held to be the main tool by which an understanding of effects caused by abstraction and injection activities can be predicted, it is only one of a number of tools and methods available to Environment B·O·P. It is also dependent on the capture of quality data from the various monitoring systems. The model is the means to bring together theory and results into a singular representation.

To attempt to manage a resource as complex as the Rotorua geothermal resource without a relatively refined dynamic precision tool, such as a field model, would likely become expensive and an unwarranted gamble on the accuracy of management decisions. Differences between expert opinion, lay opinion and vested interest would likely develop into indefensible, even ineffectual management with ad hoc decisions being made.

This would be a threat to the sustainability of the Rotorua geothermal resource and the precision with which decisions on resource consent applications are made. It would also compromise decision consistency.

Essentially, a good operating field model, backed with monitored and analysis data achieves two main management functions. Firstly, it gives a relatively accurate scientific picture of the dynamics of the field reservoir and secondly, it provides a management tool to enable more sound analysis of cause and effect relationships to be made. This would also enable more precise decisions on resource use.

Because the field model is able to utilise current data, can be adjusted to current calibration from that data, and has a programme that can be adjusted to reflect current scientific theory, it is a dynamic tool able to provide a current best practicable assessment of field characteristics. Information itself is a dynamic commodity, it evolves over time and that evolution should be better targeted towards answering the questions that will be raised by management requirements for the field in the future.

11.2 Issue

The information available to Environment B·O·P may not be of sufficient quality to enable effective management of the field.

11.2.1 Preferred Option

To ensure, with testing and ongoing relationship evaluation, that the information available on field characteristics is of a quality sufficient to enable effective management of the Rotorua geothermal field.

11.2.2 Principal Reason

Much of the information available to Environment B·O·P on field performance monitoring prior to 1989 is inherited. Since 1989, Environment B·O·P has, via consultants and its own monitoring effort, worked to ensure data continuity and has conducted comparative analysis to test whether previous results support current data trends. In effect, previous monitored information is continually tested against current data and evolving theoretical understandings of how geothermal fields work. Information gathered over time can be further tested, refined and adjusted by theoretical and mathematical models. It is best when this process is part of the development of current understandings about the dynamics of the Rotorua geothermal field rather than a separate process. Environment B·O·P does not have unlimited resources and it must be clearly understood that resources diverted to separately revisit and rework previous data will not then be available for current monitoring and research effort.

11.3 Issue

That without a current model of the Rotorua geothermal field, Environment B·O·P's ability to protect, cause and effect relationships will be limited and uncertain.

11.3.1 **Preferred Option**

To continue, as resources permit and research and monitoring data becomes available, evolving and developing a quality field management model, tested by peer review.

11.3.2 **Principal Reason**

Environment B·O·P is at present developing the model for the Rotorua geothermal field. The process will test data against the trends and will ensure that the model reflects more precisely the scientific theories relating to geothermal fields. To understand the dynamics of the Rotorua geothermal field, the field model is invaluable as a management tool.

Formal research and modelling methods have inbuilt quality assessments, usually in the form of test calibrations and calculations on margins of error. The confidence with which research and modelling results can be used relates directly to such quality assessment techniques. Well constructed research will include an assessment of margins of error, and will be further tested by peer review.

Lay interpretations can be both fascinating, but also dangerous, particularly when they are presented as substantiated theory or results. That is not to say that lay interpretations should be dismissed, simply that they need to be considered as conceptual interpretations rather than substantiated research. In promoting management techniques it is in the interest of Environment B·O·P and the community that information about the field model be made openly available.

11.4 **Issue**

There may be specific types of information that should be researched further in order to enhance the confidence and precision with which the regional plan can operate.

11.4.1 **Preferred Option**

That Environment B·O·P will target resources for the gathering of information about the Rotorua geothermal resource that will enhance precision and confidence in the field model and the Rotorua Geothermal Regional Plan.

11.4.2 **Principal Reason**

Parameter information about the Rotorua geothermal resource is evolving all the time in relation to monitoring and research work, modelling, further resistivity work and other detection and interpretive research efforts. Over time further unknowns will be quantified and give a higher confidence to understanding field parameters. However, reasonable field management does not require total and absolute knowledge of field parameters, what is required is an undertaking to review field management techniques in this regional plan as good quality parameter information becomes available.

Dynamic information about the Rotorua geothermal field is also evolving particularly as monitoring research continues and better modelling interactions are understood. Understanding changes in field energy and pressure patterns are vital to the detection of effects. Effects can be natural such as changes in rainfall, atmospheric pressure, ambient temperature, or induced changes such as seasonal variations, geothermal drawoff, reinjection and quenching during the installation of a new bore.

The way that the field reacts to effects also varies depending on local field geology, especially lateral transmissivity and known barriers, such as the inner caldera boundary fault. The best practical means that Environment B·O·P currently has to bring together the dynamic relationships between natural and induced effects with the fluid hydraulics and field geology is a field model. The field model allows dynamic interactions to be expressed interactively giving a "moving" picture of what is happening in the field. This can then be related to actual measured field effects giving further calibration to the model. The model is growing and the picture we have of the field is becoming clearer as further information becomes available. As the model develops it will assist in planning the field monitoring programme.

11.5 Objectives, Policies and Methods

11.5.1 Objective

Best practicable cost effective management of data and information precision and confidence.

11.5.2 Policies

- 11.5.2(a) To obtain best practicable quality field data and information.
- 11.5.2(b) To achieve best practicable field management precision and confidence.
- 11.5.2(c) To keep management expenditure to a practicable minimum.
- 11.5.2(d) To ensure measured data used in field management is of the highest practicable quality.
- 11.5.2(e) To provide field model information, at cost, to any interested party.
- 11.5.2(f) To exercise caution with regards the use of historical data and information for field management purposes

11.5.3 Methods of Implementation

11.5.3(a) Research

Environment B·O·P will:

- 11.5.3(a)(i) Continue field monitoring and research, and make resources available in accordance with the requirements of the Resource Management Act 1991 (section 35).
- 11.5.3(a)(ii) Upgrade, as appropriate, the current field model of the Rotorua geothermal resource.

- 11.5.3(a)(iii) Ensure that data input to the field model is of a defined high quality.
- 11.5.3(a)(iv) Design, establish, calibrate and maintain a dynamic mathematical model of the Rotorua geothermal resource.
- 11.5.3(a)(v) Direct monitoring resources, as appropriate, towards calibrating and testing the field model.
- 11.5.3(a)(vi) Ensure that research and model information is to be made available, at cost, to any interested party.
- 11.5.3(b) Review
- Environment B·O·P will:
- 11.5.3(b)(i) Seek to enhance current field management and field monitoring techniques.
- 11.5.3(b)(ii) Annually review the Rotorua geothermal field monitoring and expenditure programme.

11.6 Environmental Results Anticipated

- (a) Best practicable understanding of field dynamics, resulting in a greater precision in setting environmental protection measures on resource consents.
- (b) Enhancement of field precision and confidence giving more targeted environmental protection.
- (c) Best practicable understanding of cause and effect relationships across the field resulting in an ability to better assess the environmental effects of activities that may alter field parameters.
- (d) Open provision of information so that developers and Environment B·O·P can better predict the environmental impacts that a development proposal may have, and means to avoid, remedy or mitigate unacceptable effects.

12 Sustaining the Rotorua Geothermal Resource

12.1 Explanation

In general terms sustaining the Rotorua geothermal resource means to manage the resource so that its potentials are safeguarded and its values are retained and protected. This requires a sound understanding of field dynamics, and also an appreciation of the consequences of not achieving a defined sustainable balance between the renewal of the resource and its use.

The Rotorua geothermal resource is a limited, vulnerable but renewable resource. It is common sense that only if the Rotorua geothermal resource is managed to ensure that it continues, can the present and future social, economic and cultural expectations that people have of the resource be met.

There has already been a lesson on the consequences of excessive and uncontrolled draw-off from the field. The problems of the mid 1980's were due mainly to the absence of a sound understanding of field characteristics by users, the lack of any protective structure for geothermal surface features, coupled to the absence of judicious and efficient management of the use of the geothermal resource.

Part II of the Resource Management Act 1991 promotes the principle of sustainable management and sets clear tests and parameters against which management options and choices in the regional plan will need to be measured. This places quite rigorous obligations on both administrators and the public.

With respect to the principles of the Resource Management Act 1991, sustainable management also requires the managing of adverse effects that may compromise the natural qualities and potential of the resource and the surrounding environment. The energy driving the Rotorua geothermal resource is renewed from the deep heat source beneath the field, however the rate at which energy moves up to into the surface of the field is relatively constant. In this context, the resource is a resource that is renewing itself but at a rate that is limited; once the rate of drawoff from the field (from bores and natural springs) exceeds the sum of natural recharge plus recharge from reinjected fluid, the potential of the field, in terms of field water levels and pressure, decreases. If this happens the resource is being "mined" and many of its values will begin to diminish, or may be destroyed.

For management purposes, the geothermal field, its surface features, and geothermal abstraction need to be considered as an integrated system, for the most part relying on the good performance of each other for continued sustenance. It is within this concept that the success of resource sustainability and sustainable management needs to be assessed.

Sustainable management of the Rotorua geothermal resource is therefore the concept of sustaining a limited but renewable geothermal resource by ensuring that it retains its values and potentials, while:

- (a) protecting geothermal surface features, and
- (b) identifying available geothermal resource and providing for the allocation of that resource for present and future efficient use, and
- (c) managing and controlling all adverse effects on the field, and
- (d) protecting tikanga Maori.

To help achieve sustainable management of the Rotorua geothermal resource, Environment B-O-P has developed the concept of a strategic equilibrium. Strategic equilibrium is the state of field balance where water levels and associated pressures in the geothermal aquifer oscillate above a defined minimum geothermal aquifer water level set by Environment B-O-P. This is in effect a minimum aquifer level which would activate remedial control of the resource (section 128(1)(b) of the Resource Management Act).

The debate and opinion on exactly where the defined minimum geothermal aquifer water level should lie will vary with different viewpoints and interests. As field manager, Environment B-O-P is bound by the Resource Management Act 1991 and the policy of this regional plan. These essentially require that field equilibrium be established above a defined minimum water level, to provide a protective buffer to ensure healthy activity of geothermal surface features. The current equilibrium of the field has been arrived at more through fortuitous result, than precise management. Notwithstanding how the present equilibrium was engineered, it appears to have established at a level that is achieving good feature protection. Until sound evidence to the contrary is available, Environment B-O-P will preserve the status quo with regards net available abstraction from the field. That is, that the current artificial equilibrium of the field be adopted as the base strategic equilibrium.

12.2 Issue

The Rotorua geothermal resource is vulnerable to irreversible destruction, this must be prevented to sustain its values and potentials.

12.2.1 Preferred Option

To sustain field water levels by ensuring that the strategic equilibrium is restored to a level that reflects optimal reinjection, protects geothermal surface features from the adverse effects of abstraction and development, yet provides for the limited and controlled net abstraction of heat from the field reservoir.

12.2.2 Principal Reason

The Rotorua geothermal resource has been described as a vulnerable but renewable resource that is now altered from its original state. Two main aspects of this alteration have been observed. Firstly that when mass abstraction exceeds a certain value, the display of the geothermal surface features begins to decline, and secondly, that there is a strategic water level/field pressure at which the geothermal surface features can display with a healthy vigour, and at the same time limited net mass abstraction can continue.

The key indicator of the state of the field at any point in time is the water level measured in wells monitoring the geothermal aquifer. This water level is influenced primarily by fluid abstraction and reinjection, and meteorological factors, such as long term rainfall trends. These factors can be shown to alter water levels across the geothermal aquifer. The strategic equilibrium is a tool which can be used to keep track of changes and medium term trends in the field water level.

These field water level changes and trends can then be related to geothermal water abstraction figures, and field model information, to assist in predicting ongoing effects of abstraction and reinjection against the background of natural field water level fluctuations. This information can then be assessed to indicate whether the values and potentials of the field are being sustainably managed relative to plan policies.

As new data is collected and the understanding of the geothermal field improves, field management options may be reviewed. Using the predictive qualities of strategic equilibrium trends, geothermal fluid use and model information, the ability to sustain the Rotorua geothermal resource should be enhanced.

12.3 Objective, Policies and Methods

12.3.1 Objective

A strategic equilibrium designed to sustain the features, values and potentials of the Rotorua geothermal resource into the future.

12.3.2 Policies

- 12.3.2(a) To restore and maintain the Rotorua geothermal field at an optimal strategic equilibrium.
- 12.3.2(b) To restore the features, potentials, and values of the Rotorua geothermal resource for present and future generations.

12.3.3 Methods of Implementation

12.3.3(a) Strategic Equilibrium

Environment B·O·P will:

- 12.3.3(a)(i) Establish Minimum Geothermal Aquifer Water Levels measured in calibrated field monitor bores to avoid or remedy adverse effects on fluid outflow from geothermal surface features.
- 12.3.3(a)(ii) Monitor the minimum geothermal aquifer water levels for the field relative to field data and model scenarios to provide an ongoing information base relating the minimum geothermal aquifer water levels and the natural outflow from geothermal surface features.
- 12.3.3(a)(iii) Use the field model to measure the effects any proposed resource use activity may have on the strategic equilibrium and the minimum geothermal aquifer water level.

12.3.3(a)(iv) Initiate a plan change in accordance with the First Schedule to the Resource Management Act 1991 to vary the minimum geothermal aquifer water levels at any time that field data and field model information provides evidence that the current minimum geothermal aquifer water level is no longer accurate relative to the requirement to sustain the established strategic equilibrium, or protect natural surface features.

12.3.3(b) Rules and Conditions

12.3.3(b)(i) Unless and until changed in accordance with the procedures of the First Schedule to the Resource Management Act 1991, the Minimum Geothermal Aquifer Water Level is:

- (a) a measured water level in Monitor Bore M6 of 280.174 metres relative to Moturiki Datum, or
- (b) a measured water level in Monitor Bore M12 of 283.995 metres relative to Moturiki Datum, or
- (c) a measured water level in Monitor Bore M16 of 295.873 metres relative to Moturiki Datum.

Environment B·O·P may at any time specify ancillary or replacement Monitor Bores. Any ancillary or replacement Monitor Bore shall be calibrated relative to the Minimum Geothermal Aquifer Water Level to ensure accurate continuity.

Pursuant to Section 68(7) of the Resource Management Act 1991, this rule shall effect under Section 130 the exercise of existing resource consents for activities which contravene this rule on the date from which this plan becomes operative.

A consent holder shall be deemed to have complied with the provision of this rule if, on public notice of an abstraction restriction issued by Environment B·O·P pursuant to rule 12.3.3(b)(ii) of this plan, a consent holder complies with the abstraction restriction requirements of the public notice.

12.3.3(b)(ii) Every new and existing resource consent granted to authorise the abstraction of geothermal water, heat or energy from the Rotorua geothermal field shall be subject to the following condition:

ABSTRACTION RESTRICTIONS

Stage 1 Voluntary Reduction

Should the water level in the geothermal aquifer decrease and remain for a period of 20 consecutive days at or below the minimum geothermal aquifer water level in any two of the designated field monitor bores, Environment B·O·P may publicly notify a stage 1 voluntary reduction request. The request will invite geothermal resource users and managers to initiate voluntary constraints on the abstraction of geothermal water (including geothermal mass) from the Rotorua geothermal aquifer for a period not exceeding 30 days.

Stage 2 Ten Percent Reduction

If, following a stage 1 voluntary reduction period, the water in the geothermal aquifer remains at or below the minimum geothermal aquifer water level in any two of the designated field monitor bores, Environment B·O·P may publicly notify a stage 2 ten percent reduction notice. The notice may apply generally over the whole field, or to a specifically defined part or parts of the field. From the date specified in the public notice, the Grantee shall reduce abstraction of geothermal water (including geothermal mass) by ten percent. For the purposes of this condition, the ten percent reduction shall be measured as a ten percent decrease of current geothermal mass abstracted irrespective of resource consent allocation. The ten percent reduction requirement shall remain in force for a period of 30 days.

Stage 3 Specified Percentage Reduction

If, following a stage 2 ten percent reduction period of 30 days, the water in the geothermal aquifer remains at or below the minimum geothermal aquifer water level in any two of the designated monitor bores, Environment B·O·P may publicly notify a Stage 3 specified percentage reduction notice. The notice may apply generally over the whole field, or to a specifically defined part or parts of the field. The notice will specify a percentage reduction requirement up to but not exceeding thirty three percent. From the date specified in the public notice, the Grantee shall reduce abstraction of geothermal water (including geothermal mass) by the percentage specified in the notice. For the purposes of this condition the specified percentage reduction shall be measured as a percentage decrease of current geothermal mass abstracted irrespective of resource consent allocation. Different specified reduction percentages may apply to designated parts of the field. The specified percentage reduction requirement shall remain in force for a period not exceeding 60 days.

Pursuant to Section 68 (7) of the Resource Management Act 1991, this rule shall affect, under Section 130, the exercise of existing resource consents for activities which contravene the rule, for the stages and periods specified herein.

A notice issued to activate a stage 3 specified percentage reduction shall be limited to a percentage not exceeding thirty three percent, for a period not exceeding 60 days.

12.4

Environmental Results Anticipated

- (a) The Rotorua geothermal field water level (and pressure) will be stabilised at a strategic equilibrium, above a defined minimum geothermal aquifer water level.
- (b) The features, values and potentials of the Rotorua geothermal resource will be protected.
- (c) Any activity that may or would compromise the established strategic equilibrium, and thereby the field environment, will be tested by the resource consent application process.

- (d) The field environment will be better protected because existing and new resource consents can be adjusted to sustain the established strategic equilibrium.

13 Protecting Surface Activities and Features

13.1 Explanation

Geothermal surface features are a major asset of the Rotorua geothermal resource. They have significant values to the Rotorua community and to the nation. In their own right they are the sentinel indicators of the state of field pressure.

The "health" of the field is paramount in ensuring the continuity and consistency of both surface feature and utility assets. All geothermal surface features on the field are driven by the release of geothermal fluid either as liquid, steam or gas. Liquid 'charges' operate the geysers whereas fumaroles emit gas or steam or both.

Field monitoring data gathered from 1985 to 1995 shows clearly a relationship between the water levels in the Rotorua geothermal aquifer and the performance of geysers in the Whakarewarewa geyser field. Generally during prolonged periods of low aquifer water levels a marked drop in geyser display frequency occurs; the main objective of this plan is to maintain water levels in the Rotorua geothermal field aquifer to restore the display frequency of the geysers.

Surface activity is the expression of geothermal potential from the field out onto the surface. Associated with surface activity is the formation of geothermal surface features usually by deposition of silica, sulphur and other materials precipitating or ejecting from geothermal fluid. Geysers, fumaroles, sinter cones, tomos, mud pools, hot and cold springs and pools, steam and gas vents, all form part of the Rotorua Geothermal scene.

The location of surface activity in Rotorua is divided into several groupings, that generally align with known thermal upflow zones. The main centre of activity and features is Whakarewarewa on the southern edge of the field. Other significant upflow zones occur at Kuirau Park on the west of a rhyolite dome, and about the shore of Lake Rotorua at Ohinemutu, Government Gardens, Sulphur Bay and Ngapuna.

Together, the areas of geothermal activity in Rotorua form a very valuable set of assets for the people of Rotorua City. The main asset being the geysers in Whakarewarewa.

The Rotorua geothermal field contains New Zealand's one remaining area of major geyser activity that display in their natural state. To lose the Whakarewarewa geysers would be a devastating event, particularly to the international scientific community, the New Zealand tourist economy and to the whole Rotorua economy. The loss of the geysers through over exploitation and imprudent management would be a negligence that would certainly not reflect well on the people of the region. It would also be contrary to the principles of the Resource Management Act 1991. As a consequence it is proposed that the geothermal surface activities, features and associated ecologies of the Whakarewarewa area be acknowledged as outstanding natural features,

consequently requiring protection under section 6(b) of the Resource Management Act 1991.

To retain even the current level of protection for the Whakarewarewa geysers it is essential that the abstraction exclusion zone established in a 1.5 kilometre radius about Pohutu Geyser be retained. The Whakarewarewa area is to be acknowledged as containing outstanding natural features and is to be protected.

The protection of the surface activity and features of the Rotorua geothermal resource sustains not only the activity and associated features themselves but also the whole array of values, aspirations, investments and livelihoods that emanate from their existence. From the aspect of tourist based economics alone, the opportunity cost of the loss of geothermal activity would be many millions of dollars per year, lost not only to Rotorua, but to the regional and national economies also.

There is well documented information relating the changing levels of activity in geothermal surface features to the withdrawal of geothermal fluid. It was only after the monitoring programme began to provide quality data that trends were clearly detected, some of which had been hidden within the patterns of natural fluctuations. The large recovery of surface activity from 1988 onwards attests to the effectiveness of the bore closure programme.

Using monitoring data there is now good confidence that the erratic behaviour of the geyser field in the mid 1980's was a direct result of the amount of geothermal fluid being withdrawn from the Rotorua geothermal resource. Changes in the activity of a number of geothermal activities and features since the closure of bores in 1987–88 has undoubtedly indicated a recovery. The water levels in the geothermal reservoir recovered to fluctuate around a consistent annual level and the general pattern across the field is one of increased discharge activity and increased deep geothermal input.

From the results and observations made there is a high confidence of the cause and effect relationship between utility withdrawal of fluid from the field and the activity of geothermal surface features. It follows that the long term protection of the activity of geothermal surface features is directly related to the maintenance of a relatively consistent strategic equilibrium of field potential, not withstanding natural and seasonal fluctuations.

The current field equilibrium is arbitrary, having resulted by chance rather than design. This raises the issue as to whether the current level of field pressure is an effective and sufficient buffer for the protection of the geyser field. Given the high values of the geysers, a further increase in field pressure may be required. This would however result in a further decrease in resource available for allocation. It is therefore proposed that any strategic equilibrium defined under Environment B-O-P policy be qualified so that it is set at a level that provides for the sustained display of field geysers and springs.

This regional plan requires a two way strategy that firstly protects feature forming activity, resulting automatically from maintaining field potentials at a healthy level, and secondly protects geothermal surface features from unnatural physical degradation, unauthorised interference and insensitive development.

13.2 Issue

The geothermal surface features of the Rotorua geothermal resource have not been adequately assessed for qualities requiring protection. The Whakarewarewa thermal area is not adequately protected.

13.2.1 Preferred Option

That in the absence of a definitive assessment of those field qualities and values requiring protection, protection will be given to all geothermal surface features. The geothermal surface activities, features and associated ecologies of the Whakarewarewa area are acknowledged as outstanding natural features, consequently requiring protection. To achieve this the established 1.5 kilometre radius mass abstraction exclusion zone around Pohutu Geyser will be retained.

13.2.2 Principal Reason

There has been extensive effort to identify and register geothermal surface features of the Rotorua geothermal resource. Publications have assessed and classified more well known features in terms of importance and vulnerability. The information compiled in this and other works should be brought together and further developed. In particular an assessment needs to be made to determine which features of the Rotorua geothermal resource would qualify as outstanding. This is particularly important as once identified, outstanding natural features are required to be protected under section 6(b) of the Resource Management Act. The proposition has also been put that the Rotorua geothermal field itself is, in its entirety, of international importance and at risk due to exploitation of the geothermal resource or other influences.

The need to respect and protect geothermal features as taonga is a matter of deep concern for Te Arawa people. For over 600 years Te Arawa iwi have been resident in the Rotorua area, in particular Ngati Wahiao/Tuhourangi and Ngati Whakaue. It is a matter of urgency that geothermal taonga and the mauri of geothermal water be protected and respected.

In the absence of definitive information regarding which features require protection, the default suggested is to regard all geothermal surface features as having qualities worthy of protection until information proves otherwise.

13.3 Issue

Geothermal aquifer water levels will need to be managed to ensure healthy geothermal activity continues so that geothermal surface features are protected.

13.3.1 Preferred Option

To manage the water level in the field aquifer at a level that ensures the restoration of geothermal surface feature outflow activity.

13.3.2 **Principal Reason**

Without adequate field pressure, indicated by the water level in the geothermal aquifer, geothermal surface features would cease to maintain water levels or fluid outflows. Field pressure is the driving force beneath fluid discharged from features. The vulnerability of geothermal surface features to declining field pressures has been demonstrated in the mid to late 1980's.

The geysers at Whakarewarewa are elevated above the geothermal aquifer water levels of the main utility abstraction areas. This adds a further dimension of vulnerability, as hydraulic gradients cause the movement of fluid from elevated areas to compensate for fluid removal elsewhere in the field. Whakarewarewa, being at the highest elevation of the field, is very sensitive to changes in aquifer water levels and pressure drops in the field.

13.4 **Issue**

There is no control over the hazard risk or physical destruction of field features caused through development or inappropriate interference. Some natural surface features associated with the field have been, and continue to be, damaged by inappropriate activities and fluid abstraction

13.4.1 **Preferred Option**

To require a resource consent for any activity that would or may cause a potential geothermal hazard or have an effect on any natural surface feature, and to discourage development that would interfere with the scenic or amenity value of geothermal surface features, provided that it be made a prohibited activity to interfere with or cause destructive effects on any outstanding natural geothermal feature.

It should be noted that geothermal hazards associated with geothermal bores are controlled by the Geothermal Energy Regulations 1961 under the Health and Safety in Employment Act 1992. All geothermal bore drilling and installation activities, both for new bores or replacement bores, require consent from the Chief Geothermal Inspector, Energy and Resources Division, Ministry of Commerce.

13.4.2 **Principal Reason**

To a large extent Rotorua City overlies the major portion of the Rotorua geothermal field. It is inevitable that development of the city would cause changes to, even over, geothermal features. In the 1950's the Arikikapakapa golf course was developed over heated ground at Arikikapakapa and State Highway 5 was realigned by filling in an area of mud pools. This reflects a lack of formal protective management for the natural geothermal features of the field.

As the hazards of interfering with geothermal surface features have become better understood and the actual vulnerability of those geothermal surface features that add real value to the tourist base of the Rotorua economy more apparent, the Rotorua community have come to recognise a need for a more thorough formal assessment of development effects.

Altering and interfering with geothermal phenomena can cause risk from geothermal hazard, ranging from the re-emergence of fumaroles and gas emission to hydrothermal eruption. To avoid, remedy or mitigate such risk and to protect geothermal surface features from physical degradation, any activity that will interfere with or cause effect on any natural geothermal feature will require a resource consent. Interference with geothermal surface features comes primarily from two main sources; inappropriate structures and site development adjacent to features, and interference and damage to the natural hydrology and deposition forms of features particularly geysers, springs and hot lakes.

13.5 Objective, Policies and Methods

13.5.1 Objective

The protection of geothermal surface features, the restoration of geothermal surface features outflow activity and the avoidance or mitigation of natural geothermal hazards.

13.5.2 Policies

- 13.5.2(a) To identify, protect and, where practicable, enhance the intrinsic, ecological and tourist values of the geothermal surface features of the Rotorua geothermal resource.
- 13.5.2(b) To protect the intrinsic, ecological and tourist values of the geothermal surface features of the Rotorua geothermal resource by advocating the establishment of policy in relevant planning documents that would require formal resource consent assessments and tests be applied on the effects of each development on geothermal surface features present in the development area.
- 13.5.2(c) To avoid, remedy or mitigate natural hazard caused by interference with geothermal activity or geothermal surface features, formal resource consent assessments and tests are to be applied on the effects of development on geothermal surface features present in a development area, with particular regard to the effects of development on geothermal hazard risk.
- 13.5.2(d) To require the provision of formal planning assessment of the effects of development on geothermal hazard risk in relevant planning documents.
- 13.5.2(e) To define and protect outstanding natural geothermal activity and geothermal surface features of the Rotorua geothermal field.
- 13.5.2(f) To ensure that geothermal taonga identified and named by tangata whenua are respected and afforded appropriate protection.
- 13.5.2(g) To ensure that any use or development of the Whakarewarewa area is evaluated with particular regard to the protection of the outstanding natural features of the Whakarewarewa area.

- 13.5.2(h) To require protection of geothermal adapted ecologies within the Rotorua geothermal resource.
- 13.5.2(i) To retain a mass abstraction exclusion zone, measured as a 1.5 km radius from Pohutu Geyser.
- 13.5.2(j) To ensure that any adjustment to the minimum geothermal aquifer water level pursuant to clause 12.3.3(a)(iv) of this plan provides for a level of outflow from surface features that meets the requirements for their protection.
- 13.5.2(k) To require that the total quantity of heat extracted by authorised down hole heat exchangers within the abstraction exclusion zone about Pohutu Geyser is not increased.
- 13.5.2(l) To promote the rehabilitation of the natural character and outflow activity of natural geothermal surface features and associated ecologies by encouraging the effective reinjection of bore abstracted geothermal water.

13.5.3 **Methods of Implementation**

13.5.3(a) Protection of Surface Features

Environment B·O·P will, in liaison with Rotorua District Council, advocate that Rotorua District Council:

- 13.5.3(a)(i) Provide in the Rotorua District Plan for the protection of future options relating to all geothermal surface features and associated ecologies within the Rotorua geothermal resource.
- 13.5.3(a)(ii) Provide in the Rotorua District Plan for the formal assessment of the effects on the intrinsic, ecological and tourist values of the geothermal surface features that may occur as a result of subdivision and land development.
- 13.5.3(a)(iii) Environment B·O·P and the Rotorua District Council will, in consultation with agencies and interest groups, including the Department of Conservation and the tangata whenua having local geothermal rangitiratanga, establish and maintain a register of all natural geothermal surface taonga features and associated natural ecologies within the boundaries of the Rotorua geothermal resource. The register will:
- (a) Identify, catalogue and describe each natural surface feature and its associations to groups of geothermal surface features,
 - (b) Include natural ecologies associated to or dependent upon surface feature activity,
 - (c) Name geothermal taonga identified by tangata whenua,
 - (d) Include both active and inactive natural geothermal surface features,
 - (e) Assess and describe the sensitivity of each natural surface feature to field pressure change and land development, and the protective measures needed to ensure the feature is sustained,
 - (f) Include a description of any historic and cultural associations to each feature with respect to its heritage value,

- (g) Include, as practicable, quality scientific information of relevance to each feature in particular an assessment of outflow rates of geothermal fluid,
 - (h) Include location maps and other information presentations to ensure that the register can provide "user friendly" quality information and be an effective planning device for developers and the public.
- 13.5.3(a)(iv) Require the effective reinjection of bore abstracted geothermal water.
- 13.5.3(b) Rules
- 13.5.3(b)(i) The following activities shall be administered as activities that increase the risk of natural hazard, and have an adverse effect on the environment. They shall be regulated as discretionary activities requiring a land use consent:
- (a) Any interference with the natural geothermal fluid outflow from a geothermal surface feature, and;
 - (b) Any interference with the physical structure of a geothermal surface feature, and;
 - (c) Any destruction of a geothermal surface feature including excavation, and;
 - (d) Any placement or deposition of any substance, including fill or waste material on, into or under any geothermal surface feature ;
- shall be considered as activities causing natural hazard requiring avoidance or mitigation, and as having an adverse effect on the environment, and shall be discretionary activities requiring a land use consent from Environment B·O·P.
- 13.5.3(b)(ii) The bore abstraction of geothermal water within the geothermal mass abstraction exclusion zone, being that area circumscribed by a circle of 1.5 kilometre radius measured from the centre of Pohutu Geyser, shall be considered as having an adverse effect on the environment and is a prohibited activity.
- 13.5.3(b)(iii) With respect to the provisions of section 14.3(c) of the Resource Management Act 1991, the bore abstraction of geothermal water from the Rotorua geothermal field is deemed to have an adverse effect on the environment.
- 13.5.3(b)(iv) The total quantity of heat extracted by authorised down hole heat exchangers within the geothermal water abstraction exclusion zone shall not be increased.
- 13.5.3(b)(v) Any minimum geothermal aquifer water level set by Environment B·O·P under this regional plan shall be set with regard to the protection and preservation requirements of outstanding natural features, the natural character of geothermal wetlands and other natural features of the Rotorua geothermal resource including associated natural ecologies.

13.6 Environmental Results Anticipated

- (a) All natural geothermal surface features and associated ecologies within the Rotorua geothermal resource, will be identified and catalogued.
- (b) Outstanding natural geothermal surface activities, features and associated ecologies of Whakarewarewa geysers area will be effectively protected.
- (c) Geothermal taonga will be protected and respected.
- (d) The natural character of geothermal wetlands within the Rotorua geothermal resource area will be preserved.
- (e) The intrinsic, ecological and tourist values of the surface features of the Rotorua geothermal resource will be protected and possibly enhanced.
- (f) All outstanding surface features and associated ecologies within the Rotorua geothermal resource will be defined and actively protected.
- (g) Rotorua geothermal geysers and springs will exhibit healthy displays and outflows.

14 Quantifying Available Resource

14.1 Explanation

Having established a need to secure a quality understanding of the Rotorua geothermal resource, and adopted the principles of managing the field so that its values and potentials are sustained and features protected, resource available for utility activities must be addressed. Utility activities include use of geothermal resource for heating buildings, thermal baths and pools, and other commercial and industrial uses.

Initially the concept that environmental considerations were to be given precedence over the use of geothermal resource for utility purposes was not widely accepted. However, as people have come to understand the fragility of the geysers, and the reality that bore abstraction of mass does directly affect geyser performance, the community has increasingly supported a preference for the protection of surface features. What must be acknowledged however, is that the field, its features and its utility potentials are all inextricably linked and that the only realistic aspect that can be controlled is the artificial abstraction of geothermal resource (both mass and energy) for utility purposes. It is utility abstraction that causes effects and as field managers, local authorities are required to avoid, remedy or control those effects.

It is now about 100 years since the first use of extracted mass from the Rotorua geothermal resource occurred. For much of that history, the majority of effects appear to have been relatively benign. It is fair to say that until the late 1970's not much attention was paid to effects, the resource appeared quite limitless, and it appeared that a user simply had to sink down a bore and that was that. Discharges went into drains and everything appeared rather well organised. What was not recognised was the delicate system of balances within which the field exists. Balances between inputs and outputs, hot water and cold water intrusion, abstraction and pressure drop, pressure changes and changes in surface feature activity. Today these interactions are more apparent.

People now also understand that without a precautionary management strategy that sets an amount of abstraction that the field can tolerate without stress, it is only a matter of decades before the resource would be quenched, and for geyser and spring outflows, only a matter of a few years.

Current modelling and research has indicated that the field can sustain without significant stress, a net utility abstraction totalling around 4,000 to 5,000 tonnes per day. This relates to the current field status where total withdrawal is 9,500 tonnes per day with 54% reinjection giving a net withdrawal of 4,400 tonnes per day. The effects of abstraction however, are not uniform across the field, but relate to proximity to outflow zones and geothermal surface features.

Feedback from the field monitoring programme, consent information, trends in measured data and the field model will be the tools by which potential local and cumulative effects will be able to be calculated and evaluated. To date the management of the field by Environment B·O·P has followed on from the government initiative which lead to the bore shutdown zone 1.5 kilometres around Pohutu Geyser.

To retain the equilibrium of the Rotorua geothermal resource at a relatively stable state, with healthy activity from geothermal surface features, net available abstraction will need to be carefully controlled and related to an equilibrium (strategic equilibrium) based on established geothermal aquifer water levels. With field stability accomplished, there is a potential that more resource may become available as use efficiencies and reinjection increases.

14.2 Issue

There is a serious uncertainty about the actual amount of geothermal resource now available for utility abstraction, and whether there will be major increases or decreases in resource availability in the future.

14.2.1 Preferred Option

That a controlled moratorium on any further net mass abstraction from the Rotorua geothermal resource be established, provided that as quality information about the Rotorua geothermal resource becomes available, allowing better precision relating effects to location, net mass or energy available for abstraction across the field will be quantified accordingly. A relationship will be established linking net energy/mass abstraction from the field to the cumulative reinjection effort. As an interim control, the total net mass abstraction from the field will not exceed 4,400 tonnes per day.

14.2.2 Principal Reason

The setting of a maximum net amount of geothermal resource available from the Rotorua field is one of the key management functions of this regional plan, it sets an interim balance between strategic equilibrium and feature protection on the one side and use, availability, distribution, effects and efficiencies on the other. The issue expresses the conceptual change now required, that not only has the ability to take increasing amounts of geothermal water from the field stopped, but that the amount that is taken will now be steadily reduced as reinjection policies take effect. Over the longer term the net mass abstraction from the field will tend towards zero, whereas the energy potential harvested from the field will remain the same, possibly increasing as indicators permit.

14.3 Objective, Policies and Methods

14.3.1 Objective

A measure of available resource that relates to the maintenance of the strategic equilibrium, protection of natural geothermal surface features and ecologies, the cumulative effort for efficient resource use, and control of environmental effects.

14.3.2 Policies

14.3.2(a) To establish the net measure of available resource.

- 14.3.2(b) To establish procedures for the review and variation of the net measure of available resource, with particular regard to:
- 14.3.2(b)(i) The maintenance of the strategic equilibrium, and;
- 14.3.2(b)(ii) The protection of natural surface features and ecologies, and;
- 14.3.2(b)(iii) The cumulative effort for efficient resource use, and;
- 14.3.2(b)(iv) The control of environmental effects.

14.3.3 **Methods of Implementation**

14.3.3(a) Establishing Available Resource

Environment B·O·P will:

- 14.3.3(a)(i) Establish an initial total net amount of geothermal water available for utility abstraction.
- 14.3.3(a)(ii) Initiate a change to the plan to vary the total net amount of geothermal mass available for utility abstraction at any time that the review procedure of Section 14.3.3 (a)(iii) indicates that a variation is required.
- 14.3.3(a)(iii) Establish a review procedure by which assessment of the total net amount of geothermal water available for utility abstraction will be made using quality information including:
- (a) Current analysis of trends in monitored information,
 - (b) Information from the field model,
 - (c) Environment B·O·P's requirement for the maintenance of the strategic equilibrium,
 - (d) Environment B·O·P's requirement for the effective protection of natural geothermal surface features and ecologies,
 - (e) Results of cumulative effort for efficient resource use and,
 - (f) Environmental effects, including positive effects through the establishment of down hole heat exchangers.
- 14.3.3(a)(iv) Define a relationship between mass abstraction activities and energy abstraction activities.
- 14.3.3(a)(v) Define the relationship between mass abstraction activities and energy abstraction activities in order to provide trends towards using more efficient geothermal utility systems, such as down hole heat exchanger systems.
- 14.3.3(b) Rule
- 14.3.3(b)(i) The initial net amount of geothermal water (mass) available for utility abstraction shall not exceed an accumulated total of 4,400 tonnes per day.

14.4 Environmental Results Anticipated

- (a) A defined, maximum authorised amount of nett geothermal water available for utility abstraction without reinjection is achieved.
- (b) Utility users are provided with an incentive to improve the efficiency with which they take and use geothermal resource from the Rotorua geothermal resource, thereby conserving the field and limiting environmental impacts.
- (c) Environment B·O·P will have a defined and regulated tool for reviewing the amount of geothermal water available for utility abstraction, leading to better control of environmental impacts.
- (d) The potential to make further resource available as model information, efficiencies in resource use and reinjection frees up further geothermal water or energy.
- (e) The potential to further restrict the amount of geothermal water available for utility abstraction should the policy requirements of this regional plan relating to:
 - (i) Environment B·O·P's requirement for the maintenance of the strategic equilibrium, and
 - (ii) Environment B·O·P's requirement for the effective protection of natural geothermal surface features and ecologies, and
 - (iii) Environment B·O·P's requirement for efficient resource use, fail to be met.

15 Protecting Authorised Users

15.1 Explanation

Existing resource consent holders and users on interconnected multiple user systems (community schemes) have invested both time and money to access and use geothermal resource. The cost of bores, bore headworks, pipework, insulation, heat exchangers and reinjection systems can all amount to a substantial investment. It is the intention of Environment B·O·P to give a measure of confidence for existing authorised users in their geothermal resource allocation and, providing compliance with this regional plan can be met, protection of their geothermal investments.

Environment B·O·P will be expecting existing users to abide by the policy requirements developed in this regional plan, and should note in particular the policy seeking more efficient use of resource and the requirements for the installation of reinjection systems or down hole heat exchangers within three years.

15.2 Issue

Environment B·O·P will need to establish some certainty and protection for authorised users, particularly from unreasonable costs and over allocation.

15.2.1 Preferred Option

That Environment B·O·P will seek to protect current authorised geothermal resource users, provided that the user complies with the policy requirements of the Rotorua Geothermal Regional Plan.

15.2.2 Principal Reasons

For resource users there are three principles that Environment B·O·P seeks to achieve, they are: cost equity and natural justice, protection of rights and certainty of availability.

Cost equity can only be achieved if Environment B·O·P is aware of and has registered authorisations for every bore that extracts geothermal fluid or energy or reinjects geothermal fluid. Cost equity relates to distributing costs levied on resource users fairly and relates to Environment B·O·P's ability to control wasteful or inefficient use thereby providing further available resource for use. Natural justice requires that all users are treated fairly with respect to their rights, but in turn must respect that they have statutory duties and obligations that must be fulfilled.

To protect the rights of users Environment B·O·P must also be aware of their location and requirements. Unauthorised users would have difficulty promoting claims of detrimental effect should resource consents be granted to adjacent property owners. Conversely, if an application is made for a resource use activity that may detrimentally affect an adjacent authorised resource user, then

the affected users concerns would need to be considered by Environment B·O·P in its decisions.

Certainty of availability of resource gives confidence to users that they have authorisation to take and use geothermal resource to the extent of their consent terms and conditions, and can feel confident to invest in more efficient equipment to better capture and use geothermal energy and reduced resource waste.

Environment B·O·P is also aware of a potential problem relating to the security of tenure of those geothermal resource users that have a current Category "B" licence issued prior to the Resource Management Act commencing in October 1991. Under section 387(1) of the Resource Management Act 1991, all licences have now become water permits.

Under the Geothermal Energy Act 1953, two categories of user licences were issued to people in multiple user systems. Category "A" licences permit those people who have a supply bore on their properties to both take and use resource. Category "B" licences were held by those people who are connected to the supply bore but, because they did not have their own bore, only used resource supplied from the Category "A" licence holders bore. To give protection to those with "B" licences, Environment B·O·P will only recognise a multiple user system if the group of users form themselves into a body of persons that have a documented association to represent their individual and collective right and interests in which each person has equal rights to an authorised allocation of geothermal resource. Any resource consent granted will be to a body of persons that have a documented association to represent their individual and collective right and interests not any one individual bore owner. As from the date on which this regional plan became operative, Environment B·O·P will only consider applications from group schemes that are formally composed of a body of persons that have a documented association to represent their individual and collective right and interests. Until this matter is clarified, both Category "A" and Category "B" licence holders would not qualify as having transferrable resource consents.

The main reason for this policy is to secure resource tenure for Category "B" licence holders. With no formal agreement, Category "B" users are vulnerable should the owner of the main abstraction bore make unilateral decisions without consultation with the remainder of the users on the system. There is also the issue of the Category "B" licence holder being an authorised user as provided for in the transitional provisions of the Resource Management Act. Each Category "B" licence holder could in theory lay claim to an allocation of resource representing their portion of the group scheme (probably for an amount that would be insufficient to do anything useful with) and this would also make each group scheme vulnerable to expensive consent variations.

15.3 Objective, Policies and Methods

15.3.1 Objective

The use of geothermal energy by authorised users remains secure and sustained.

15.3.2 **Policies**

- 15.3.2(a) To recognise the commitments and investments of existing current authorised resource users while ensuring that the geothermal resource is taken, used and discharged in accordance with the policies and rules of the Rotorua Geothermal Regional Plan.
- 15.3.2(b) To encourage all users supplied by an interconnected multiple user system to form into a documented association to represent their individual and collective rights and interests.

15.3.3 **Methods of Implementation**

15.3.3(a) Process

15.3.3(a)(i) To be considered under this section, the applicant is required to have a current authorisation, provided that Environment B·O·P may, at its discretion, consider an application under this section if the applicant has had a valid authorisation within one year from the date of application.

15.3.3(a)(ii) The applicant shall supply the following application information and evidence as appropriate when application is being sought for a replacement resource consent:

- (a) That the application is lodged with Environment B·O·P no later than 6 months before the expiry of the original resource consent expires (section 124 of the Resource Management Act 1991), and
- (b) That the application is for an amount of mass or energy not exceeding their existing authorisation, and
- (c) That the use of resource is efficient, and
- (d) That any fluid extracted is or will be reinjected, or a down hole heat exchanger is being used, and
- (e) That the bore installation has been maintained to standard, and
- (f) That the application complies with all other policies of this regional plan.

15.3.3(a)(iii) In accordance with Section 418(2) and (4) of the Resource Management Act 1991;

- (a) Any permission for the taking of geothermal energy from the Rotorua geothermal field for any purpose authorised (by licence or otherwise) under Section 9 (1)(b) of the Geothermal Energy Act 1951 is hereby revoked on the date six months following the date on which this regional plan becomes operative.
- (b) Any taking of heat or energy from geothermal water or from the material surrounding geothermal water in the Rotorua geothermal aquifer being lawfully taken or used, and such taking or use did not require any licence or other authorisation, shall cease to be permitted from the date six months following the date on which this regional plan becomes operative.

- (c) Any taking of heat or energy from geothermal water or from the material surrounding geothermal water in the Rotorua geothermal aquifer being taken pursuant to any general authorisation, including General Authorisation No 6 of the Environment B·O·P Transitional Regional Plan, shall cease to be so authorised from the date six months following the date on which this regional plan becomes operative.
- 15.3.3(a)(iv) Category B licence holders currently using geothermal water, heat or energy from interconnected multiple user systems are hereby recognised by Environment B·O·P as having part interest together with Category A licence holders in any new or replacement resource consent to take and use a resource allocation for that system.
- 15.3.3(a)(v) Any body of persons that have a documented association to represent their individual and collective rights and interests, and represent all users supplied by an interconnected multiple user system, will be recognised by Environment B·O·P.
- 15.3.3(a)(vi) When considering an application for the replacement of a licence or resource consent for an interconnected multiple user system, regard shall be had to:
- (a) any current licence, resource consent or other documented permission advised by any user of the system, and
 - (b) any claim of interest in the system, including the identity of individual users, the amount of resource they seek and their interest in the application, and
 - (c) whether the application has been lodged and documented in a manner that protects any rights and interests established by a) or b) above
- 15.3.3(b) Rules
- 15.3.3(b)(i) An application for a resource consent that is essentially similar to the original resource consent may, at the discretion of Environment B·O·P, be considered as a non-notified application for a discretionary activity.
- 15.3.3(b)(ii) A replacement resource consent for an immediate previous authorisation that complies with the requirements of section 15.3.3 of this regional plan, but is for a geothermal bore system that does not have effective reinjection to the geothermal aquifer, or a down hole heat exchanger, shall be subject to the following condition:

AQUIFER PROTECTION

The Grantee is required to install, or connect into, an effective reinjection or down hole heat exchanger system within three years from the date on which the Rotorua Geothermal Regional Plan becomes operative provided that in the case of financial hardship, or in the case of inadequate time to effectively comply, the grantee may, on written application to Environment B·O·P, seek an extension of up to two further years. The grantee shall, if required, supply information to evidence a claim of financial hardship. Any extension shall not exceed five years from the date on which the Rotorua Geothermal Regional Plan becomes operative.

15.4 Environmental Results Anticipated

- (a) Existing authorised users who have given effective effort to using resource efficiently and minimising environmental effects will gain certainty of access to resource.
- (b) All users on an interconnected multiple user system will have a measure of security of tenure, providing for the protection of rights and the enhancement of the “social environment”.

16 Managing Unauthorised Users

16.1 Explanation

The taking of geothermal resource, heated water or energy from geothermal source over 30°C requires an authorisation. There are many and various forms of licences, rights and permits that have been issued over time and in fairness to all users Environment B·O·P will be researching all such authorities to bring them within the management system of the regional plan.

There may be users who are confident that they have or did have authority to operate a bore, but now find that they have difficulty validating that authority. For these users Environment B·O·P will work together with the bore owner to research whether the use can be validated.

The only difficulty arises where bores have been constructed and used following the October 1991 commencement of the Resource Management Act, in this situation, the bore must have a current authorisation to be used.

In the context of this section; an unauthorised user is anyone whose authority to take and use geothermal resource has not yet been determined through the policies and methods of this plan

16.2 Issue

The effective management of the Rotorua geothermal resource can not be achieved while there are unauthorised users on the field.

16.2.1 Preferred Option

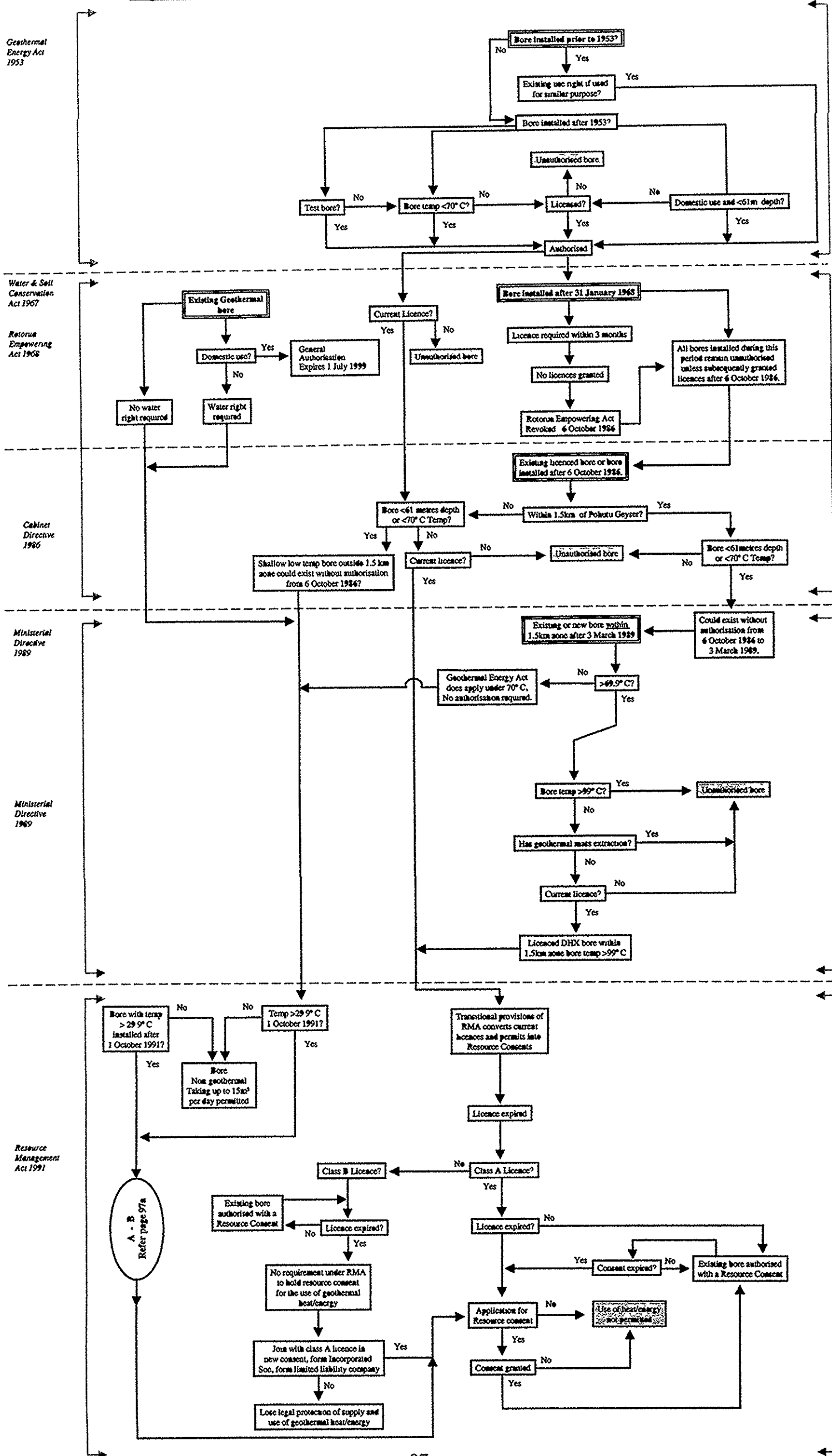
That Environment B·O·P work together with people who have no formal authorisation to take geothermal resource to determine the status of their resource use. If, as a result, people are found to have no valid authorisation, then they be given a period of three months in which to secure an allocation of geothermal resource and make a formal application for a resource consent. Any user subsequently discovered to be taking and/or using geothermal resource would, following due warning, be prosecuted. This process shall not apply to bores installed and used without resource consent on or after 1 October 1991.

16.2.2 Principal Reason

There is some confusion about who is authorised to take and use geothermal resource. The lack of previous management and multitude of agencies involved have not helped this confusion.

Parallel to this, is the issue as to where the burden of proof should lie and what tests should be applied to establish whether some prior actual or implied consent permit or licence exists.

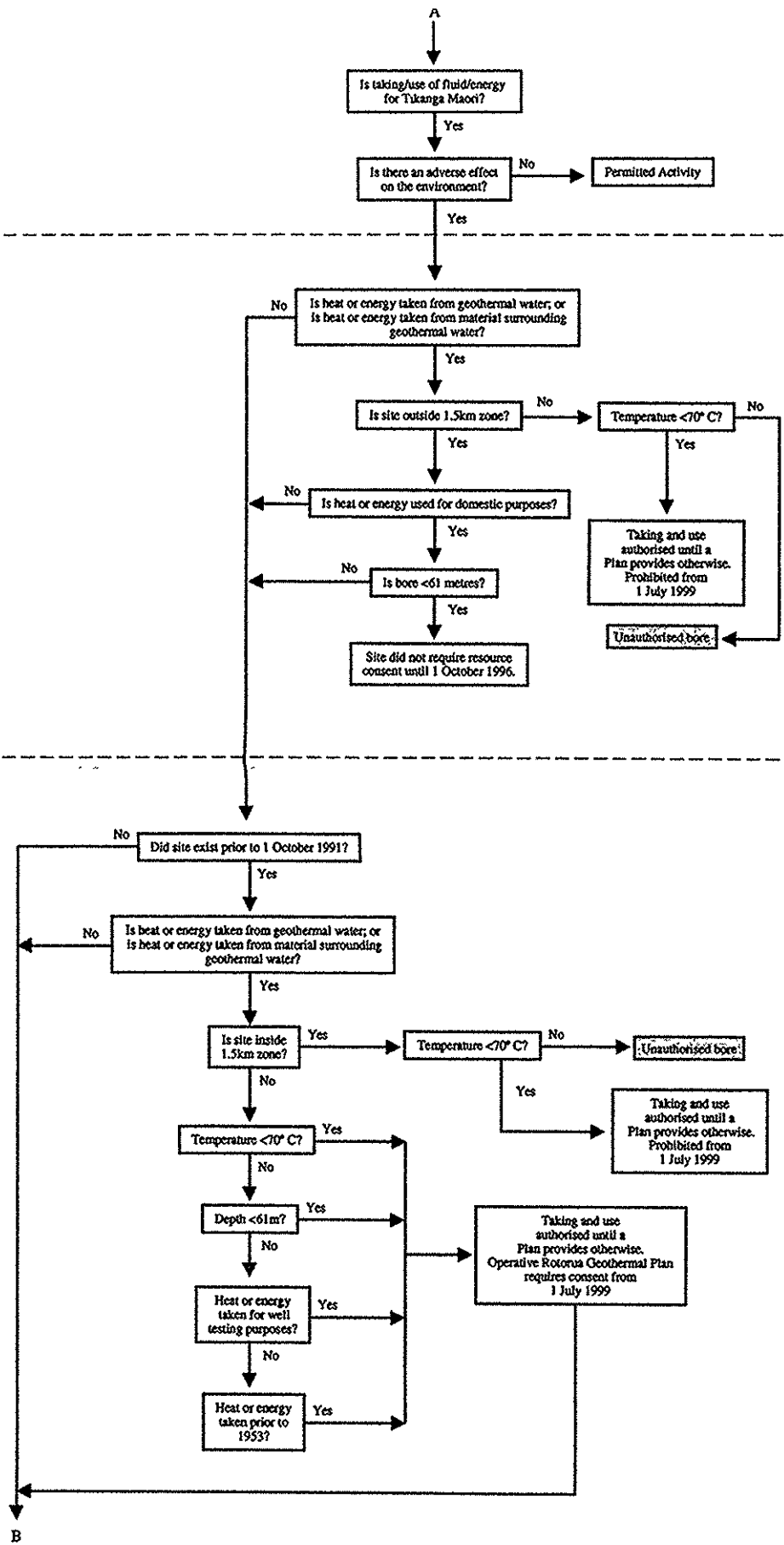
Figure 7 - Rotorua Geothermal Bore Authorisation Flow Chart



Tikanga Maori

RMA Section 418(2)

RMA Section 418(4)



The transitional provisions of the Resource Management Act set down clearly which forms of prior licences or permits become resource consents and these have been duly documented by Environment B·O·P. Following the establishment of the Resource Management Act, the taking, using or diversion of geothermal water or energy required a resource consent.

In terms of equity and the law, anyone who takes and uses geothermal resource without valid current authority, is removing resource that may otherwise be allocated, is not contributing to the costs of managing the field and is committing an offence against the Resource Management Act. Such a user also contradicts Environment B·O·P's management effort of the field by being outside control mechanisms, monitoring statistics and consent conditions. Environment B·O·P has requested in the media that unauthorised users come forward for registration of interest, there was no response.

In order to clearly define which of the currently operating bores are authorised and which are not, Figure 7 shows a flow-chart that outlines the various permit and licensing systems that have applied to the allocation of resource from the Rotorua field over time.

16.3 Objective, Policies and Methods

16.3.1 Objective

Unauthorised bore users are discouraged from committing offences under the Resource Management Act.

16.3.2 Policies

- 16.3.2(a) To identify and register authorised users of geothermal resource.
- 16.3.2(b) To actively pursue the decommissioning of any bore used without authorisation to take and use geothermal resource.
- 16.3.2(c) To revoke the right of existing users to take and use geothermal resource pursuant to Section 418(2) and (4) of the Resource Management Act 1991.
- 16.3.2(d) To encourage unauthorised users to determine the authority by which they claim a right to take and use geothermal resource.
- 16.3.2(e) To provide a moratorium for a period of three months, for unauthorised users to secure an allocation of geothermal resource and apply for appropriate resource consent.

16.3.3 Methods of Implementation

16.3.3(a) Detection of Unauthorised Users

Environment B·O·P will:

- 16.3.3(a)(i) Establish a monitoring system designed to detect and register the location, owner and authorisation status of all bores on the Rotorua geothermal field whether in use or not.

- 16.3.3(a)(ii) Register, monitor and map known current authorisations for the taking or use of geothermal resource.
- 16.3.3(a)(iii) Work together with bore owners to ascertain whether individual bores that have no known current authorisation are authorised or not.
- 16.3.3(b) Prevention of Unauthorised Abstraction
- Environment B·O·P will:
- 16.3.3(b)(i) When it has reasonable grounds to believe that a bore is being operated without authorisation, issue a written warning notice to the owner of the bore. The warning notice will include a summary of the grounds for Environment B·O·P's concerns.
- 16.3.3(b)(ii) Require that after receiving a warning notice a bore owner shall, within 20 working days, provide to Environment B·O·P information stating the authority under which the bore owner believes the bore to be operating.
- 16.3.3(b)(iii) Following assessment of any advice or information received, determine whether or not a bore is being used with or without authorisation and respond accordingly.
- 16.3.3(b)(iv) Ensure that any bore used to illegally access and take geothermal water, heat or energy from the Rotorua geothermal field is effectively decommissioned by any practical means.
- 16.3.3(b)(v) Following a moratorium period of 60 working days from the date on which an unauthorised taking and use of geothermal resource has been determined by Environment B·O·P to have no authorisation, pursue, as appropriate, enforcement action.
- 16.3.3(c) Rules
- 16.3.3(c)(i) The taking and use of geothermal heat or energy from geothermal water, or heat or energy from the material surrounding any geothermal water, pursuant to section 418(2) and (4) of the Resource Management Act 1991, is hereby revoked on the date one year from the date on which this regional plan becomes operative.

16.4 Environmental Results Anticipated

- (a) Unauthorised bores currently operating on the geothermal field will either become authorised or will be shut down and sealed, decreasing drawoff from the geothermal aquifer.
- (b) Field management costs will be more equitably distributed.
- (c) Field management effort to reduce adverse environmental effects will be more effective.
- (d) Authorised bore operators and owners will be better protected.
- (e) The preservation and protection of features and efficiency of resource use will be enhanced.

17 Equating Allocation to Use

17.1 Explanation

This section is designed to induce both users and decision makers to consider with care whether the amount of geothermal resource sought by an applicant is reasonable when related to the use proposed. It will challenge some current wasteful practices particularly with regards the control of heating temperatures.

Essentially the section will ensure that the amount allocated is, within reasonable tolerance, neither too much nor too little for the use proposed.

17.2 Issue

The amount of geothermal resource granted to a user should be related directly to their use requirement, and limited to prevent resource being wasted.

17.2.1 Preferred Option

That Environment B·O·P will require, as part of the information supporting any new application, an assessment relating to the amount of mass or energy sought to the use of the resource sought and evidence of the efficiencies anticipated by the applicant. Environment B·O·P will consider altering existing consents to meet the minimum geothermal aquifer water levels required by this regional plan.

17.2.2 Principal Reasons

The over allocation of geothermal resource is one symptom of previous relaxed management coupled to the misconception that the Rotorua geothermal resource was somehow limitless and free. This has also lead to use inefficiencies and waste of resource. If this situation is permitted to continue then the limited quantity of available resource is in fact unnecessarily restricted.

Over recent years Environment B·O·P has been requiring applicants to relate mass sought to the use they require. This formula should be continued if optimal resource utility potentials are to be achieved. For resource consents granted prior to this precaution, Environment B·O·P has the ability through this regional plan to establish a review of consent conditions (Resource Management Act section 128(b)).

Reviews of consent conditions can apply where rules in the regional plan establish ranges of temperature or pressure of geothermal water to be achieved and where Environment B·O·P is of the opinion that it is appropriate to review conditions in order that minimum aquifer water levels set by regional plan rules can be met.

17.3 Objective, Policies and Methods

17.3.1 Objective

Achieve efficient use practices and the prevention of the waste of available resource.

17.3.2 Policy

17.3.2(a) To ensure that the allocation of geothermal resource to an applicant is not excessive but equates to an amount that is reasonable, and will ensure the efficient use of resource for the activity proposed.

17.3.2(b) To discourage and prevent the waste of geothermal resource.

17.3.3 Methods of Implementation

17.3.3(a) Application Requirements

17.3.3(a)(i) Each new or replacement application for geothermal resource consent to provide, amongst other application details, evidence relating the amount of geothermal water, heat or energy sought to the particular resource use proposed.

17.3.3(a)(ii) Any assessment presented by the applicant to accord with the policies for efficient use required by this regional plan.

17.3.3(a)(iii) Will, in assessing and deciding on any application for a consent to take and/or use geothermal resource, give effect to the requirements for efficiency set by this regional plan.

17.3.3(a)(iv) May, at its discretion, grant a consent for the amount sought by the application, or for a lesser amount subject to agreement with the applicant, or may decline the application.

17.3.3(a)(v) All users of geothermal water, heat or energy from the Rotorua geothermal resource are required to avoid or remedy practices that result in the waste of geothermal resource.

17.3.3(a)(vi) Each resource consent granted to take or use geothermal resource for a new activity shall be subject to the requirements of section 125 of the Resource Management Act 1991 provided that any extension granted on application under section 125(1)(b) of the Resource Management Act 1991 shall not exceed six months.

17.3.3(a)(vii) Environment B·O·P will investigate methods and means of achieving greater efficiencies in the use of geothermal resource. Information gathered shall be collated and made available at cost.

17.3.3(a)(viii) All geothermal resource recovered as a result of the efficiency requirements of this regional plan shall be monitored and registered.

17.3.3(b)

Rule

17.3.3(b)(i)

An allocation of geothermal resource granted by a resource consent shall be limited to an amount sufficient for the efficient use of resource relative to the activity proposed. For the purposes of this rule, the efficient use of resource means that all practicable means have been or will be installed to ensure that wastage of geothermal resource, in particular heat and energy, is minimised.

17.4

Environmental Results Anticipated

- (a) Resource users will be restricted to amounts of resource that are relevant to the use they propose.
- (b) Resource users are restricted from installing inefficient or wasteful resource use systems.
- (c) Resource users are restricted from unnecessarily holding amounts of available resource that could be made available to other users.
- (d) Resource users are restricted from capturing resource for speculative purposes.
- (e) Resource users are restricted from holding resource on the off chance that they may need a bit more at some future time.
- (f) Resource users would only get enough resource to operate their proposed use efficiently, without waste.

18 Transfer of Allocations

18.1 Explanation

With the exception of the surface feature areas and the abstraction exclusion zone, the Rotorua geothermal resource is to a large extent able to be accessed almost anywhere over the field. Apart from restrictions as to location and the total net amount of extracted resource, there is no technical reason to inhibit users from transferring allocations of resource provided the objectives and policy criteria of the plan can be met. Establishing a mechanism to facilitate transfer would allow a greater flexibility for existing and potential users to make decisions that would otherwise be difficult to achieve. There is a potential that transferring allocated resource may have the effect that resource use would over time shift from domestic towards commercial activities, however it should be noted the choice to transfer would remain with the resource consent holder.

18.2 Issue

To achieve resource mobility, to provide for community resource use aspirations and to allow the holders of resource allocations a wider range of options, a mechanism for facilitating the transfer of geothermal resource should be provided.

18.2.1 Preferred Option

That Environment B·O·P provide for the transferring of geothermal resource between authorised users that have recognised transferrable consents, but subject to controls to ensure that the objectives and policies of the Rotorua Geothermal Regional Plan are not compromised.

18.2.2 Principal Reasons

The concept of transferrable resource consents has many theoretical advantages but also some serious restrictions. To provide for authorised consent holders to sell and transfer all or part of their rights to geothermal resource to another user would create a resource market that, in theory, should lead to movement of resource towards the highest economic benefit. In contrast however, movement in that market may compromise objectives in this regional plan and subvert social and amenity aspiration of the Rotorua community. In this context it is proposed that transferring will be provided for but not by way of an open market system. Only if a transfer can be arranged within specified policy parameters will it be authorised to take place. Any payment of monies resulting will remain outside the jurisdiction of Environment B·O·P. Environment B·O·P will be involved only to the extent of establishing a register of transferrable consents, testing a proposed transfer against policy parameters, enabling the issuing of new resource consents (subject to section 136(2) of the Resource Management Act 1991) and establishing appropriate resource use conditions.

18.3 Objective, Policies and Methods

18.3.1 Objective

Provision for the transferring of geothermal resource allocations.

18.3.2 Policies

- 18.3.2(a) To enable transferring to occur as efficiently as is practicable.
- 18.3.2(b) To facilitate transferring of resource provided that the objectives, policies and methods of this regional plan are not compromised.
- 18.3.2(c) To establish a register of transferrable consents.
- 18.3.2(d) To ensure that the transfer of any portion or allocation of geothermal resource related to an interconnected multiple user system recognises the interests of users that take or use geothermal water, heat or energy from the system.

18.3.3 Methods of Implementation

18.3.3(a) Transfer Register and Procedure

Environment B·O·P will:

- 18.3.3(a)(i) Establish and maintain a register of those resource consents and associated bore systems that qualify as transferrable consents.
- 18.3.3(a)(ii) Require that a transfer proposal be submitted to Environment B·O·P for assessment, under the signatures of all parties to the transfer.
- 18.3.3(a)(iii) Consider a transfer proposal with reference to an assessment on environmental effects.
- 18.3.3(a)(iv) Without limiting any other consideration that it may have regard to, Environment B·O·P may have regard to the following criteria when considering a transfer proposal:
- (a) Whether the transfer would result in the extracted resource being reinjected or heat resource being accessed by a downhole heat exchanger,
 - (b) Whether the transfer would result in the shifting of the resource abstraction point to a distance further away from Pohutu Geyser.
 - (c) Whether the transfer results in compliance with the objectives, policies and methods of this regional plan.
- 18.3.3(a)(v) Advise the parties of its assessment of the proposal.
- 18.3.3(a)(vi) Require, pursuant to section 136(2)(b)(ii) of the Resource Management Act 1991, the completion of an appropriate resource consent transfer application, as prescribed by section 136(4) of that Act.

- 18.3.3(a)(vii) Not accept liability or responsibility for compensation, commercial competition or subsequent availability of a transferred resource allocation.
- 18.3.3(b) Rules
- 18.3.3(b)(i) Transferring a geothermal resource is limited to originate from any resource consent that qualifies and is registered as a transferrable consent identified on Environment B·O·P's transferrable consents register.
- 18.3.3(b)(ii) A transfer of geothermal resource shall not result in a net additional demand on the resource.
- 18.3.3(b)(iii) A transfer has not occurred until all relevant application requirements, policy criteria and rules have been complied with, and new or replacement resource consents issued.
- 18.3.3(b)(iv) The transfer shall not result in any increased adverse effects on the surface features of the Rotorua geothermal resource.
- 18.3.3(b)(v) Any bore owner transferring the whole of their resource allocation shall have no further claim to that transferred allocation.
- 18.3.3(b)(vi) Any bore owner transferring part of their resource allocation shall adjust their bore and use systems accordingly.
- 18.3.3(b)(vii) Environment B·O·P shall not involve itself with any negotiation, transactions, or exchanges of money or goods between parties in relation to a transfer of geothermal resource.
- 18.3.3(b)(viii) The transfer of any portion or allocation of geothermal resource related to an interconnected multiple user system shall require the application for transfer to be made with the consent of all users connected into that system. Any application not complying with this provision shall be a notified discretionary activity.

18.4 Environmental Results Anticipated

- (a) Mobility of resource use about the field.
- (b) Net shift of extractive effects away from Whakarewarewa.
- (c) Enable allocated resource to shift to more efficient use.
- (d) Induce a shift to downhole heat exchangers and reinjection.
- (e) Enable users choices.

19 Controlling Environmental Effects

19.1 Explanation

This section considers four environmental effect issues; effects caused by the placement of geothermal bores, effects on the field from the withdrawal of geothermal water, effects caused by the discharge of fluid to the environment and effects resulting from the discharge of geothermal gases.

The abstraction of geothermal water or energy (heat) has the highest order of impact and effect on field aquifer water levels, pressure and geothermal surface features. Generally the effect of individual abstractions is a function of radial distance from the abstraction point (cones of influence). It is the cumulative effect of many such cones of influence that can cause water level and pressure to drop, thereby affecting geothermal surface features. The configuration of cones of influence also change due to the differences in geology around the abstraction point. In this context it is necessary that Environment B·O·P remains aware of the positioning of all new abstraction and reinjection bores.

Both mass and energy abstractions cause the field to experience a localised pressure drop around the abstraction point. Mass abstraction without reinjection has the highest net effect, whereas mass abstraction with reinjection, and energy abstraction through down hole heat exchangers have a lesser net effect. Currently the abstraction of mass from the Rotorua geothermal resource has been equated directly with the abstraction of heat via downhole heat exchanges. Environment B·O·P will need to develop guidelines to provide further definitive information on the mass energy relationship. Abstraction of heat energy downstream from a natural thermal spring outflow is probably the abstraction process that has least direct impact, but again this depends on location. The policies of this section are designed to induce, over time, a shift towards resource access methods that have the least net environmental effect.

The field model will enable better prediction of the cumulative and net effects of abstraction so that if required, the management of available quota taken from a particular location can be adjusted.

Reinjection will be encouraged as a discretionary activity, requiring a non-notified consent with conditions to establish depth and location etc. There are some circumstances however where reinjection is either impracticable or potentially dangerous. There are areas of "boiling ground", for example in Ohinemutu, where reinjection is not technically feasible and may be potentially dangerous. The plan will need to provide a discretion to Environment B·O·P to make exceptions from reinjection requirements in special circumstances. Where a down hole heat exchanger or trade-out option is available that alternative must also be considered.

The reinjection of cold fluid may also have a local effect on the field and under those circumstances where this effect may be detrimental, Environment B·O·P will reserve the right to set temperature limits on reinjected fluid to protect the field.

The discharge of geothermal fluid into surface drainage systems can have high environmental effects that Environment B·O·P is obliged to control and monitor.

Hot, corrosive and sometimes toxic, geothermal fluid can completely alter surface ecologies and can cause hot water hazards. It is proposed that the discharge of geothermal fluid into surface watercourses or shallow bores will be a discretionary activity requiring a resource consent.

The discharge of gases from the Rotorua geothermal resource has some insidious side effects on the Rotorua community. Corrosion of metals, smell and acidic alteration of surface moisture can result.

In summary, apart from supplying thermal baths, taking geothermal water is now old technology. While reinjection can form satisfactory solution to remedy effects on the field, the best practicable option for the future is not to remove geothermal water at all, but to access heat directly via downhole exchangers. This will help maintain good field aquifer water levels and pressure and avoid the need to dispose of fluid and the extra expenses that would cause to users.

19.2 **Issue: effects caused by the placement of geothermal bores**

The inappropriate placement of geothermal bores could result in adverse environmental effects and hazards, and raises the possibility of a user being refused a resource consent.

19.2.1 **Preferred Option**

To require the construction or installation of any new or replacement bore to be a discretionary activity, subject to conditions as to location and the return of construction and testing information.

19.2.2 **Principal Reasons**

In the past a major constraint to the effective management of the Rotorua field, and a potential source of geothermal hazard has been the relatively random installation of geothermal bores. There has been no required standard of construction although professional engineers and bore drillers are aware of the standards required for safe geothermal bore drilling practices and construction.

A bore installed too close to another abstraction or reinjection bore can compromise the performance efficiency of both bores. Bores constructed too close to geothermal features such as hot springs can destroy outflow from the feature. Bores drilled into boiling ground need to be constructed under precautionary conditions to prevent risk of hydrothermal eruptions and other hazards to drillers and the neighbourhood.

For these reasons, and to prevent a constructed bore with installed headworks costing many thousands of dollars from being refused a resource consent because it is in the wrong place, proposes a no cost registration and permitting system for geothermal bore construction and installation. Any person that wishes to have a bore constructed will be required to apply to Environment B·O·P at no cost for a land use resource consent for a discretionary activity to authorise the installation. The resource consent will be non-notified and issued within 10 working days if the installation complies with the schedule of

conditions, standards and terms. The conditions will require the consent holder to provide information both before and after construction.

The application information required would be: location, bore dimensions, construction technique and materials. Following construction, the information to be returned to Environment B·O·P would be: geologic information, resource parameter information (e.g. temperature profile, mass flow rates, borehead pressure ratings and mass production information).

19.3 Issue: effects caused by the withdrawal of geothermal water

The withdrawal of geothermal water lowers field aquifer water levels and causes environmental effects.

19.3.1 Preferred Option

To require all users that extract geothermal fluid to install a reinjection or down hole heat exchanger system within three years, and to require that resource consents for any new bore system, or renewal of existing system, are limited to a term of 10 years with reinjection or a downhole heat exchanger, provided that:

- (a) The taking of limited amounts of geothermal fluid for medicinal and therapeutic facilities may be granted if waste fluid is subsequently reinjected, and**
- (b) Under special circumstances, particularly where reinjection is not practicable, Environment B·O·P may waive or defer the reinjection requirement. In such circumstances Environment B·O·P may consider other options to limit mass abstraction effects.**

19.3.2 Principal Reasons

Environmental effects include effects on the geothermal field itself. If the net mass abstraction from the Rotorua geothermal resource was decreased to near zero, energy able to be extracted could, in theory, be increased. A reduction in abstracted geothermal water will provide effective protection for surface flows from geothermal features.

It is to the advantage of the field, geothermal surface features and all users that the move towards reinjection proceeds as quickly as is practicable. To this end the policies proposed set a three year transition time, with discretion for Environment B·O·P to extend this to five years under circumstances where there is proven hardship. The policy will not prevent the taking of mass (fluid) for medical or therapeutic purposes however reinjection of used geothermal fluid will be required.

The use of downhole heat exchangers will require a singular consent for a discretionary activity to divert heat and energy, and may also be non-notified.

The whole concept of best practical use of Rotorua geothermal resource hinges on minimising abstraction effects on the geothermal field itself.

19.4 Issue: effects caused by the discharge of fluid to the environment

Surface and soakage discharges of bore abstracted geothermal fluid are destructive, hazardous and have unnecessary effects on the environment.

19.4.1 Preferred Option

That following a three year transition period, and apart from defined special circumstances, Environment B·O·P would prohibit the discharge of geothermal fluid into any environment other than the source from which it came and will only grant consent to withdraw geothermal water on the condition that all fluid would be returned to the source from which it came.

19.4.2 Principal Reasons

Discharging geothermal fluid into the surface environment is no longer an acceptable way to manage waste geothermal fluid. Apart from compromising field pressure, surface discharge has the potential to contaminate water tables with chemical salts and precipitates. Geothermal fluid is usually toxic and corrosive and can also destroy plant and instream life when discharged at temperatures above 30°C. At temperatures above 50°C surface discharges can kill vegetation, alter soil structure and is generally a hazard to people, domestic animals and wildlife.

Discharges into watercourses that already contain geothermal fluid from natural outflows, such as the Puarenga Stream, require special consideration. While such streams are already in a natural state due to natural discharges, an increase in geothermal fluid discharged into them will cause an alteration of their hydrology, chemistry and thermal characteristics. Additional discharges of fluid would have local and cumulative effects that would need to be controlled and monitored. The same would apply to discharges directly into lake Rotorua.

There are only three special situations where discharge into the environment should be encouraged:

- (a) Reinjection of fluid (including condensates and gases) back into the geothermal aquifer from which it was taken, and
- (b) Discharge of fluid withdrawn from a surface source (stream or pool) back into that source, and
- (c) The discharge of fluid into surface drainage where reinjection is either impracticable or potentially dangerous.

The singular processing of multiple consents to take from and discharge to the same geothermal source will further encourage a return of resource back to its natural source.

19.5 Issue: effects resulting from the discharge of geothermal gases.

The venting of gas, particularly from unused bores, poses an avoidable threat to the environment, and an unnecessary hazard risk to the community.

19.5.1 Preferred Option

That Environment B·O·P requires the sealing of all unused geothermal bores and ensures that any operational bore, including production, reinjection and soak bores are made safe from gas discharge.

19.5.2 Principal Reasons

Discharge of gases from geothermal bores has been in the past considered a "passive side effect" of the use of the resource. This perspective is no longer appropriate. Cumulatively the gas emissions from the field have the potential to cause health risk and interfere with community wellbeing. The uncontrolled venting of gas from either operating production bores or abandoned bores is not a desirable environmental outcome. The technology and installation of means to control gas emissions, such as suitable pumps, vents and casings, are expensive.

The escape of gases particularly hydrogen sulphide (H₂S) and carbon dioxide (CO₂) to the atmosphere can pose a serious risk to health if not detected and avoided. This matter is particularly concerning where bores are installed within buildings that have inadequate ventilation. Both H₂S and CO₂ are "heavier" than air and sink to displace air in basements and foundations where they can concentrate to toxic levels.

Geothermal gases also combine with atmospheric moisture to form an acid solution on condensing surfaces that can corrode metals. Electronic equipment is particularly vulnerable as are iron construction materials.

Environment B·O·P realises that there is a large natural discharge of gases from the Rotorua geothermal field. The whole matter of how and whether the natural discharge of gas should or can be controlled is an issue that may need to be carefully assessed in the future, however where unnecessary effects from geothermal gas discharges due to resource use exist, those effects should be avoided or remedied.

Discharge of gases from the Rotorua geothermal resource can be considered in three main categories:

Category A venting from controlled systems, such as production and reinjection bores and soakholes. These discharges should be avoided and where practicable remedied with gas discharges limited and controlled.

Category B, venting from rogue bores, especially unused production bores and soakholes and bores that have not been adequately sealed. There is no real reason for Category B discharges to take place, they should be prevented through a requirement for property owners to seal any such rogue bores.

Category C natural venting through ground or geothermal surface features. Usually can not be realistically prevented. Known sources of natural geothermal gas venting and residential or commercial areas should be identified, monitored and assessed to find out if there is any remedial action that can be taken such as ground venting into ducting systems, ducting gas above building heights etc. Any remedial action that would destroy any significant surface feature would not be permitted unless a serious imminent hazard to life existed.

19.6 Objectives, Policies and Methods

19.6.1 Objectives

19.6.1(a) Protected and enhanced geothermal field aquifer water levels and pressures.

19.6.1(b) Unnatural surface discharges of geothermal fluid are avoided or remedied.

19.6.1(c) Surface ecologies and water quality are protected from surface discharges of geothermal fluid.

19.6.1(d) The effects and hazards from the uncontrolled discharge of gases from bores are avoided or remedied.

19.6.2 Policies

19.6.2(a) To control the location and means of constructing and installing a geothermal bore.

19.6.2(b) To encourage and eventually require existing resource users to shift away from net mass abstraction and install effective reinjection systems or down hole heat exchangers over a three year period, or up to five years in special circumstances

19.6.2(c) To encourage and eventually require existing resource users to shift away from the discharge of geothermal fluid into surface drainage systems and shallow soakage systems over a five year period, except in special circumstances

19.6.2(d) To prohibit the hazardous uncontrolled discharge of geothermal gases from any bore.

19.6.2(e) To promote the controlled discharge of geothermal gases.

19.6.2(f) To limit the term of resource consents and establish eventual prohibitions to achieve the above policies.

19.6.2(g) To encourage the use of surface geothermal resource outflow as an alternative to bore abstraction, subject to the protection of surface ecologies.

19.6.3 **Methods of Implementation**

Environment B·O·P will:

- 19.6.3(a) Promote an education campaign to explain the new requirements, especially the need to obtain resource consents for the discharge of geothermal fluid and geothermal gases.
- 19.6.3(b) Make available information on the location and extent of surface geothermal outflows and encourage the use of outflow resource provided the use does not cause damage to sensitive ecosystems.
- 19.6.3(c) Rules
- 19.6.3(c)(i) From the date three years following the date on which the Rotorua Geothermal Regional Plan becomes an operative plan, the taking and using of geothermal water from a bore installed into the Rotorua geothermal field aquifer shall be a prohibited activity, unless all geothermal water abstracted through that bore is effectively reinjected at an appropriate temperature into the source from which it was taken, in which case the taking and using of geothermal water shall be a discretionary activity provided that:
- a) If an applicant demonstrates to the satisfaction of Environment B·O·P that for a particular bore system reinjection is not technically feasible or may be potentially dangerous, abstraction from that bore shall be a discretionary activity.
 - b) For an existing bore, an authorised user or consent holder may, within one year following the date on which the Rotorua Geothermal Regional Plan becomes an operative plan, make written application, including appropriate evidence, to Environment B·O·P, requesting, on the grounds that the requirement will cause unreasonable financial hardship, an extension to the requirement that all geothermal water abstracted through their bore is effectively reinjected into the source from which it was taken within three years following the date on which the Rotorua Geothermal Regional Plan becomes an operative plan. On receiving such an application, Environment B·O·P may, at its discretion, extend the reinjection compliance period for that authorised user or consent holder, to a date greater than three years but not exceeding five years following the date on which the Rotorua Geothermal Regional Plan becomes an operative plan. Any such extension given by Environment B·O·P shall have the effect of causing the taking and using of geothermal water from that bore to be a discretionary activity until the date on which the extended period expires, and from then on shall be a prohibited activity unless all geothermal water abstracted through that bore is effectively reinjected into the source from which it was taken.
 - c) Notwithstanding the above requirements and provisions, rule 13.5.3(b)(ii) prohibiting the taking and using of bore abstracted geothermal water within the 1.5 kilometre mass abstraction exclusion zone shall take precedence.
- 19.6.3(c)(ii) The taking of geothermal water, heat or energy for the purpose of testing the production of a bore shall be a Permitted Activity provided:

- (a) The discharge of geothermal water taken does not contaminate the environment, and
 - (b) The taking of geothermal resource does not continue for longer than 48 hours, unless by prior arrangement with Environment B·O·P, and
 - (c) The taking and discharge of geothermal water remains controlled by appropriate headworks.
- 19.6.3(d) Discretionary Activities (Restricted)
- 19.6.3(d)(i) The construction or installation of any new bore, replacement bore or reinjection bore that will access geothermal resource shall be a discretionary activity requiring a land use consent.
- 19.6.3(d)(ii) Application details for the construction or installation of any new bore, replacement bore or reinjection bore shall be in the prescribed form and shall include the following information relating to the proposed bore:
- (a) Bore Location diagram, including the location of all adjacent bores, and
 - (b) Name of the drilling company and Certified Bore Manager, and
 - (c) Whether the installation is for a new or replacement bore, and
 - (d) Purpose for the bore (production, reinjection or DHX), and
 - (e) Intended method of fluid disposal (non-DHX), and
 - (f) Diameter of the bore, and
 - (g) Proposed depth of the bore, and
 - (h) Borehead construction and design, and
 - (i) Bore construction and installation technique, and
 - (j) Construction materials to be used.
- 19.6.3(d)(iii) When considering an application for the construction or installation of any new bore, replacement bore or reinjection bore, Environment B·O·P shall restrict the exercise of its discretion to the following matters:
- (a) The location, depth and diameter of the bore, and
 - (b) information and monitoring requirements, and
 - (c) any administrative charges payable, and
 - (d) the period of the consent, and
 - (e) whether the application shall be notified, and
 - (f) whether the consent holder shall be required to supply calorimeter test results, and

- (g) whether the consent holder shall be required to supply a chemical analysis, and
 - (h) whether the installation of the bore is to be under the direct control of a Certified Bore Manager and whether the Grade of that Certified Bore Manager is correct relative to the depth of bore proposed and the requirements of the Geothermal Energy Regulations 1961.
- 19.6.3(d)(iv) Each resource consent granted for the construction or installation of any new bore, replacement bore or reinjection bore shall comply with the following conditions, standards and terms:

BORE TEST INFORMATION

Within 10 working days following the date of installation, the consent holder shall return the following bore test information to Environment B·O·P:

- (a) *Actual bore depth, and*
- (b) *A bore log showing the depths of geological strata intercepted by the bore, and*
- (c) *The temperature profile of the bore, and*
- (d) *Borehead (mass) temperature, and*
- (e) *Borehead pressure, and*
- (f) *Depth to water level, and*

If specifically required by Environment B·O·P return, within 60 working days following the date of installation, the following bore test information:

- (g) *Calorimeter test results, and*
- (h) *Chemical analysis (to standard method 852) of production fluid, including pH, conductivity, and concentrations of Na, Mg, K, Ca, HCO₃, SO₄, NO₃, Cl and B.*

PROVISION FOR CONTROL AND MEASURING DEVICES

The borehead design and construction shall include a manual bore control valve and provide for the installation of an orifice plate and water meter after the bore control valve.

19.6.3(e) **Discretionary Activities**

- 19.6.3(e)(i) Subject to the provisions of rule 19.6.3(c)(i), the taking, using or diverting of geothermal water with or without reinjection, and the taking, using or diversion of energy, including heat from a down hole heat abstraction system are deemed to be activities that have an adverse effect on the environment and shall be discretionary activities requiring a water permit, provided that rule 13.5.3(b)(ii) prohibiting the taking and using of geothermal water within the 1.5 kilometre mass abstraction exclusion zone shall take precedence.

- 19.6.3(e)(ii) An application for a water permit to take and use geothermal resource without reinjection shall not be granted unless accompanied by an application for a discharge permit to cover the discharge of fluid following use.
- 19.6.3(e)(iii) The discharge by reinjection of geothermal fluid or gas back into the geothermal surface source or aquifer from which the fluid or gas was extracted shall be a discretionary activity.
- 19.6.3(e)(iv) The discharging of geothermal fluid into any part of the environment **other** than by direct return or reinjection back into the geothermal surface source or aquifer from which the fluid or gas was extracted shall be a discretionary activity requiring a discharge permit.
- 19.6.3(e)(v) The continuous, controlled and safe discharge of geothermal gases from any bore or soakage hole into the air or surface environment outside the fluid source reservoir shall be a discretionary activity requiring a discharge permit.
- 19.6.3(e)(vi) The taking and discharging of geothermal water or geothermal energy, including heat from or into any surface geothermal resource, flowing naturally from the Rotorua geothermal field shall be a discretionary activity.
- 19.6.3(f) Prohibited Activities
- 19.6.3(f)(i) Commencing the physical construction or installation of a bore to access geothermal resource without a current land use resource consent granted under this regional plan is a prohibited activity.
- 19.6.3(f)(ii) The discharge of **bore extracted** geothermal fluid outside the geothermal aquifer from which the fluid was extracted shall be a prohibited activity from the date five years following the date on which the Rotorua Geothermal Regional Plan became an operative regional plan, **provided** that where the applicant demonstrates to the satisfaction of Environment B·O·P that for a particular bore reinjection is not technically feasible or may be potentially dangerous, the discharge shall remain a discretionary activity.
- 19.6.3(f)(iii) The discharge of **bore extracted** geothermal fluid into the surface environment or to soakage shall become a prohibited activity from the date five years following the date on which the Rotorua Geothermal Regional Plan became an operative regional plan, **provided** that where the applicant demonstrates to the satisfaction of Environment B·O·P that for a particular bore reinjection is not technically feasible or may be potentially dangerous, the discharge shall remain a discretionary activity.
- 19.6.3(f)(iv) The uncontrolled discharge of geothermal gases from any bore or soakage hole shall become a prohibited activity from the date one year following the day on which the Proposed Rotorua Geothermal Regional Plan became an operative regional plan.
- 19.6.3(g) Resource Consent Terms and Conditions
- 19.6.3(g)(i) A resource consent granted for a water permit to take geothermal water **without** reinjection shall be limited to a period not exceeding the date three years following the date on which the Rotorua Geothermal Regional Plan became operative, **provided** that where the applicant demonstrates to the satisfaction of Environment B·O·P that for a particular reason fluid reinjection is

- not technically feasible or may be potentially dangerous, the term of consent shall be limited to a period not exceeding ten years.
- 19.6.3(g)(ii) Resource consents granted for a combined water and discharge permits to abstract geothermal water with effective reinjection discharge shall be limited to a period not exceeding ten years, on condition that the reinjection system returns all abstracted geothermal fluid into the geothermal aquifer from which it was sourced.
- 19.6.3(g)(iii) A resource consent granted for a water permit to extract geothermal energy, including heat, from a down hole heat exchanger system shall be limited to a period not exceeding ten years, on condition that the exchanger system is maintained to ensure that no discharges of geothermal fluid or geothermal gases occur to the surface environment.
- 19.6.3(g)(iv) Resource consents granted for a combined water and discharge permit for the taking and discharging of geothermal water, heat or energy from and into the same surface geothermal resource flowing naturally from the Rotorua geothermal field shall be limited to a period not exceeding ten years, on condition that the fluid is returned substantially unaltered into the source from which it was drawn.
- 19.6.3(g)(v) A resource consent granted for a discharge permit to discharge geothermal fluid to surface or soakage drainage systems shall be limited to a period not exceeding the date five years following the date on which the Rotorua Geothermal Regional Plan became an operative regional plan, provided that where the applicant demonstrates to the satisfaction of Environment B·O·P that for a particular bore reinjection is not technically feasible or may be potentially dangerous, the term of consent shall be limited to a period not exceeding ten years.
- 19.6.3(g)(vi) A resource consent granted for a discharge permit to discharge geothermal gases shall be limited to a period not exceeding the date five years following the date on which the Rotorua Geothermal Regional Plan became an operative regional plan.

19.7 Environmental Results Anticipated

- (a) A shift towards minimal abstraction or the substantial reinjection of all extracted geothermal fluid within three years.
- (b) A shift to the use of down hole heat exchangers and fluid reinjection will be encouraged for five years and required after that.
- (c) There will be control over unnatural discharges of geothermal fluid into surface drainage and shallow groundwater systems, culminating in a substantial prohibition on the surface and soakage discharge of bore extracted fluid after five years.
- (d) The unnatural emission of geothermal gases into the air will be remedied.
- (e) The hazard of uncontrolled gas emissions from bores and soak holes will be remedied.

20 Efficiency in Resource Use

20.1 Explanation

Alongside minimising abstraction effects on field pressure, establishing firm yet practicable means of achieving efficient use of resource will enhance availability and perhaps lead to extra resource becoming available for consumers.

Wasteful practices reduce resource availability for other activities and will be actively discouraged. Efficient practices that free up extra resource for new ventures will be encouraged.

The added drawoff needed to sustain inefficient uses and abstraction methods result in lower local field pressures. Conversely, better efficiencies in use and abstraction can help increase local field pressure gradients. Exceptions aside, down hole heat exchangers have the least net impact on local field pressures (relative to energy equivalents) followed by bore abstraction with reinjection of waste fluids to the same depth. Abstraction with discharge of waste into shallow soak pits or a drainage system is the least efficient method with highest environmental effects.

Currently there is no incentive to either use geothermal resource efficiently or invest in current heat exchange and insulation technologies. On the other hand, to change technologies is expensive and the regional plan will need to allow time to encourage and enable alterations to be made to existing systems, either as they are replaced, or over an agreed time.

The practice of leaving heated pools uncovered, controlling heat by opening windows rather than turning down the valve etc. will be discouraged, and will eventually become an expensive option. An assessment of efficiency will be one of the requirements for each new use consent application. Careful analysis will be required to match the amount of resource allocated to the need proposed. Resource allocated will simply not be sufficient to provide for wasteful practices or enable them to continue.

Efficiencies can also be achieved by using cascade techniques to better capture available thermal energy, encouraging the idea of multiple users off single systems, and using waste heat from natural surface discharges. Theoretically, the use of insulation and control of heat discharge alone could easily save considerable amount of unnecessary drawoff from the field.

Users must now recognise and accept that the Rotorua geothermal resource is a limited resource and it is only through their efforts to achieve efficiencies that there will be sufficient resource available to realise some of the aspirations that the Rotorua community has for future geothermal development.

This may mean the upgrading of current systems, ideally toward down hole heat exchanger systems that are sealed against gas venting.

The expense this will set users may raise the option to consider alternative energy sources. In the future, the wasteful use of geothermal energy will become an increasingly inappropriate and expensive option.

The efficient use and development of the Rotorua geothermal resource is a matter that Environment B·O·P is required to have particular regard to in management of the resource.

The issues regarding efficient use of the Rotorua geothermal resource result from a need to change current practices in a way that minimises stress on users, yet achieves the sustainability, protection and effect avoidance principles of the regional plan.

20.2 Issue

Some users are wasting geothermal resource by taking more than they need or failing to insulate or control heat flows.

20.2.1 Preferred Option

That when assessing renewed and new resource consents, Environment B·O·P will, amongst other considerations, evaluate whether the applicant proposes an efficient use of geothermal resource and whether the amount sought relates to the use proposed without waste. Environment B·O·P may grant an application that does not meet efficiency standards, however the period of grant will be limited on the expectation that efficient resource use would be implemented prior to reapplication. The period of grant is proposed to be limited to two years in this situation.

20.2.2 Principal Reason

Any geothermal heat capture system will have some heat leakage. The cost of making a system completely efficient would be prohibitive. However, between wasteful practices and extreme efficiency at high cost lies a point where with better management and perhaps some expenditure the true value of geothermal energy will be realised and waste significantly reduced.

20.3 Objective, Policies and Methods

20.3.1 Objective

Protection of available resource from inefficient and wasteful use practices.

20.3.2 Policies

20.3.2(a) To require resource consent holders to control their taking and using of geothermal water or energy to minimise heat loss.

20.3.2(b) To require resource consent holders to maintain their mass and heat abstraction and exchanger systems to minimise heat loss.

- 20.3.2(c) To require resource consent holders to insulate their mass and heat abstraction and exchanger systems and associated pipework to minimise heat loss.

20.3.3 **Methods of Implementation**

20.3.3(a) Information

- 20.3.3(a)(i) As practicable, Environment B·O·P will investigate establishing geothermal resource efficiency standards on means and methods to protect available resource from inefficient and wasteful use practices.

- 20.3.3(a)(ii) Environment B·O·P will compile and make available any information it has on means, methods and resource efficiency standards.

20.3.3(b) Application Criteria

- 20.3.3(b)(i) As appropriate, Environment B·O·P may require the installation of control devices for bores that are over productive relative to the amount sought.

- 20.3.3(b)(ii) All resource applications to take or use geothermal resource are accompanied by an analysis of measures that the applicant has or will undertake to prevent waste of geothermal resource, in particular heat and energy.

20.3.3(c) Consent Terms and Conditions

- 20.3.3(c)(i) Any consent granted to take or use geothermal resource, including energy and heat, shall be made subject to a condition requiring that adequate control of heat transfer equipment has been installed, including any variable control or sealed orifice devices that Environment B·O·P considers necessary to achieve minimum heat loss from the system proposed.

- 20.3.3(c)(ii) The amount of resource granted to an applicant shall, in terms of energy or heat (thermal) equivalents, not exceed an amount adequate to service the use sought.

- 20.3.3(c)(iii) On any subsequent application for a resource consent, an assessment of the applicants efficiency performance shall be made, relative to any consent conditions of the applicants previous consent, and to the policy requirements of this regional plan.

20.4 **Environmental Results Anticipated**

- (a) Wastage of geothermal resource will stop.
- (b) By requiring an assessment of efficiency of use to be considered by Environment B·O·P when a resource consent is sought, wasteful abstraction will be limited and the environment better protected.
- (c) Resource consent holders will need to consider means and methods that they can use to remedy any adverse effects their resource use may have on the field. This will enhance resource conservation and protect the environment.

21 Administration of Resource

21.1 Explanation

The operational success of this plan depends greatly on the continued participation of all involved in the resource to give effective encouragement and direction to this regional plan. The regional plan itself should be seen as a dynamic management tool that will likely from time to time need amendments and reviews. Although to large extent Environment B·O·P has a duty to monitor the effectiveness of the plan and initiate change processes, other agencies and the community will be asked to provide key information on whether the regional plan is achieving desired and anticipated results. To achieve this Environment B·O·P will seek to set up workshop style discussion sessions on a regular basis.

21.2 Administration Responsibilities

The primary responsibility to administer and monitor this regional plan lies with Environment B·O·P, however Environment B·O·P does recognise that the plan will probably need adjustment when it becomes operational. Environment B·O·P will need to consult with and involve local authority and community interest groups in any operational review process. To achieve this it is proposed to establish a Rotorua Geothermal Liaison Group that will convene regularly to oversee the operation of the regional plan.

Although statutory duty for the management of the Rotorua geothermal resource rests on Environment B·O·P, Environment B·O·P recognises that iwi of the Te Arawa people have rangatiratanga over them and act as kaitiaki of them. In this respect Environment B·O·P will take particular note of the requirements and aspirations that Te Arawa people have and will form a system of administration that has regard to Te Arawa kaitiaki principles.

Environment B·O·P is required by the Resource Management Act and the Proposed Bay of Plenty Regional Policy Statement to take into account the principles of the Treaty of Waitangi. The Proposed Regional Policy Statement (PRPS) has as a policy the requirement to ensure the participation of kaitiaki of tangata whenua in the management of those geothermal resources within their rohe (PRPS Section 5.3.2(b)(vii) page 117). The PRPS further requires that Environment B·O·P recognises that;

- (a) The principles of the Treaty are based on partnership, active protection and rangatiratanga, and
- (b) The principles of the Treaty affords iwi authorities and hapu a status distinct from that of interest groups or members of the public, and
- (c) Each iwi has the right to define there own preferences for the sustainable management of natural and physical resources, where this is not inconsistent with the Resource Management Act, and Environment B·O·P policy statements and plans (PRPS Section 12.3.1 page 176).

There is an opportunity to activate these requirements in the plan by establishing with iwi a partnership management relationship to oversee and co-ordinate the interaction between the Rotorua Geothermal Regional Plan and the management requirements of the kaitiaki of tangata whenua.

Environment B·O·P is aware that the users of Rotorua geothermal resource are not impressed with the disparate system of inspections and charges put on them by the Rotorua District Council, Environment B·O·P and the Ministry of Commerce. It is Environment B·O·P's intention to actively advocate and seek the integration of agency effort on these matters, establish a regime of actual and reasonable costing and avert the duplication of administration and inspection effort.

There exists transitional Environment B·O·P policy and guideline provisions that also seek to control, permit and administer the Rotorua geothermal resource. With the advent of this proposed regional plan it is no longer necessary that these various other directives of Environment B·O·P exist. Policy is set out in this section to remove these anomalous instruments.

21.3 Objective, Policies and Methods

21.3.1 Objective

The achievement of efficient and effective administration of this regional plan, while minimising costs.

21.3.2 Policies

21.3.2(a) To establish and convene regular meetings of a Rotorua Geothermal Liaison Group to discuss the operation of the Rotorua Geothermal Regional Plan.

21.3.2(b) To encourage a partnership management relationship with tangata whenua of the Whakarewarewa and Ohinemutu rohe.

21.3.2(c) To actively advocate that an integrated inspectorate and charging system be established for the Rotorua geothermal resource.

21.3.2(d) To remove redundant policy and to promote more effective policy.

21.3.3 Methods of Implementation

21.3.3(a) Rotorua Geothermal Regional Plan Workshops

Environment B·O·P will:

21.3.3(a)(i) Ensure that the Rotorua Geothermal Liaison Group is an informal group facilitated by Council to provide an open forum for interested parties including (without limitation) geothermal users, Tangata Whenua, the District Council, and representatives of the tourism industry and the Minister of Conservation to meet and discuss matters related to the regional plan, and arrange that a Liaison Group meeting be held not less than every twelve months from the date on which the proposed regional plan became operative. The Liaison Group is a consultative group.

21.3.3(a)(ii) Keep a register of matters including any issues, problems and concerns raised about the regional plan, its operation or the Rotorua geothermal field.

21.3.3(a)(iii) Act to remedy any urgent matter that arises, and bring other matters to the attention of the Rotorua Geothermal Liaison Group for discussion and solution.

21.3.3(b) Responsibilities of Tangata Whenua

21.3.3(b)(i) Environment B·O·P will seek to establish a partnership of management relationship with tangata whenua. This will be primarily for the geothermal resource and the hot pools and springs and other geothermal surface manifestations within the Whakarewarewa and Ohinemutu areas of the field. The purpose of this partnership will be to oversee any partnership matters that the tangata whenua or Environment B·O·P consider require attention including:

- (a) The registration and protection of geothermal taonga, and
- (b) The determination of who has the right to claim geothermal use rights under Section 14 (3)(c) of the Resource Management Act, and
- (c) Resolution of the concerns and matters of importance to tangata whenua noted at the Geothermal Meeting with Te Arawa Representatives on 15 July 1993, and
- (d) Any other partnership matters that the tangata whenua or Environment B·O·P consider require attention.

21.3.3(c) Integrated Inspectorate

21.3.3(c)(i) Environment B·O·P and the Rotorua District Council will actively advocate to Government that an integrated inspectorial and charging system be established for the Rotorua geothermal resource.

21.3.3(d) Rescinding Previous Policy

21.3.3(d)(i) Authorisation to abstract geothermal water pursuant to General Authorisation No.6 of the Bay of Plenty Regional Council Transitional Regional Plan dated October 1991 is hereby cancelled.

21.4 Environmental Result Anticipated

Best practicable operation of the Rotorua Geothermal Regional Plan, with continued active community liaison and participation.

22 Monitoring and Review

22.1 Introduction

The monitoring requirements of this regional plan consists of two inextricably interlinked parts;

- (a) Monitoring the geothermal field, and
- (b) Monitoring the regional plan.

22.1.1 Monitoring the Geothermal Field

Prior to the initiation of this regional plan, the monitoring of the Rotorua field was oriented towards the effects of the bore closure programme. As the plan began to take form, the emphasis shifted to the production of a field model to bring together the theoretical and data information so that cause and effect relationships could be made. These relationships in turn have led to suggested policy structuring in the management sections of the plan. In the future it is envisaged that the plan, and feedback from the implementation of plan policy will modify the emphasis of the Rotorua geothermal monitoring programme. This will require flexibility, and policy has been established to provide for an annual review of the monitoring programme (11.5.3(b)(ii)). In summary:

- (a) Previous monitoring focused on the effects of the bore closure programme.
- (b) The current monitoring programme is designed to supply information to assist the development of management strategies in the plan and to develop the field model.
- (c) Future monitoring will be focused to evolve with the regional plan, to fill any information deficiencies detected and to provide for the continuing precision of the field model.

22.1.2 Monitoring the Geothermal Plan

Both good planning practice and the Resource Management Act (section 67(1)(i)) requires that this regional plan be subjected to continuous and formal reviews. As the Rotorua Geothermal Regional Plan begins to function careful note will be taken of any undesirable situations that occur, any deficiencies and any other means that could be used to achieve results in an easier or more cost effective way. Although the instigation of a full review would be expensive, Environment B·O·P would be bound to initiate a review if the situation required resolution and could not be resolved in any other way. To achieve the effective review of this regional plan the following objective, policies and methods are established.

22.2 Objective, Policies and Methods

22.2.1 Objective

Continual monitoring and review of the effectiveness of the plan as a means of achieving its objectives and policies.

22.2.2 Policies

22.2.2(a) To ensure the Rotorua geothermal field monitoring programme is oriented to provide information that supports the objectives and policies of this regional plan.

22.2.2(b) To compile a register of matters that may require reconsideration in any subsequent review of the regional plan.

22.2.2(c) To initiate action to resolve any matter that may confuse or subvert the objectives or policies of this regional plan.

22.2.3 Methods of Implementation

Environment B·O·P will:

22.2.3(a) Align the Rotorua geothermal field monitoring programme to the requirements of this regional plan.

22.2.3(b) Monitor the regional plan for structural and operational faults.

22.2.3(c) Initiate a review of the regional plan at any time that an unacceptable fault arises.

22.2.3(d) Initiate a full review of the regional plan after five years from the date on which this regional plan became operative.

22.3 Environmental Results Anticipated

(a) The effectiveness of the environmental objectives and outcomes of the plan will be continuously monitored, and reviewed as appropriate.

PART IV
APPENDICES

23 Appendix One: Glossary and Definitions

Where italics are used in the glossary, the definition is from section 2 of the Resource Management Act 1991.

Acidity : A measurement related to the concentration of hydrogen ions, having a pH between 0 and 7.

Alkalinity : A measurement related to the concentration of hydroxide ions. Having a pH between 7 and 14.

Ambient temperature : The temperature of any part of the atmosphere which immediately surrounds an entity.

Amenity values : *Those natural or physical qualities and characteristics of an area that contribute to people's appreciation of it's pleasantness, aesthetic coherence, and cultural and recreational attributes.*

Anthropocentric : Regarding man as the central factor of the universe.

Aquifer : A geological formation capable of supplying an economic quantity of fluid or energy.

Atua : A God.

Bay of Plenty Regional Council : Environment B·O·P.

Bedrock : Country rock.

Bore : A hole drilled into the ground to access a wanted commodity.

Borehead : The top of a bore; usually above ground level. The headworks of a bore, including any valves, flanges, measurement and control devices. Also referred to as a wellhead.

Breccia : A rock type made up of angular pieces imbedded in a finer matrix.

Caldera : A large, often circular basin shaped volcanic depression created by either the destruction of the upper part of the volcanic cone by an eruption of great force or the collapse of the volcanic cone inwards.

Chemical reagent : Chemicals that when combined together they produce a change in the chemicals to give a product. eg. acid and iron produces rust. Acid and iron are reagents.

Chloride : A chloride atom which has received an electron, e.g. the negative ion in common salt.

Chloride flux : The rate at which chloride ions migrate through a medium.

Contaminant : *Includes any substance (including gases, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat-*

- (a) *when discharged into water, changes or is likely to change the physical, chemical or biological condition of water; or*
- (b) *when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged.*

Continental Plate : The earth's surface is comprised of a number of huge segments. These segments move in relation to each other. Where they collide, mountain ranges can form and where they subduct, areas of volcanism can occur.

Country rock : The solid older rock lying below the younger, usually less consolidated rocks or soils.

Crustal : Of the earth's crust.

Diatomaceous sediments : Friable organic deposits composed largely of the siliceous remains of diatoms.

Discharge : *Includes emit, deposit and allow to escape.*

Discharge flume : An artificial outflow channel.

Down hole heat exchanger : A device installed down a bore to remove heat from a geothermal field without removing geothermal fluid, using fresh water circulated through a heat exchanger at depth.

DHX : Down hole heat exchanger.

Ecocentric : Regarding the environment as the central factor of the universe.

Effect : ... *unless the context (of the Act) otherwise requires, the term 'effect' includes -*

- (a) *any positive or adverse effect;*
- (b) *any temporary or permanent effect;*
- (c) *any part, present, or future effect;*
- (d) *any cumulative effect which arises over time or in combination with other effects - regardless of the scale, intensity, duration, or frequency of the effect, and also includes -*
- (e) *any potential effect of high probability; and*
- (f) *any potential effect of low probability which has a high potential impact.*

Enthalpy : The heat content of a fluid. The heat content of a geothermal steam and water mixture can be described by enthalpy.

Environment : *Includes*

- (a) *ecosystems and their constituent parts, including people and communities*
- (b) *all natural and physical resources*
- (c) *amenity values and*
- (d) *the social, economic, aesthetic, and cultural conditions which affect the matters stated in (a) to (c) of this definition or which are affected by those matters.*

Environment B·O·P : The Bay of Plenty Regional Council.

Equilibrium : A stable state of a system. Once equilibrium has been reached, no further net change in the physical or chemical state of materials in the system, or in their proportions, will occur without some external interference.

Feedwater : Geothermal fluid flowing into surficial features such as geysers.

Flashing : the rapid conversion of pressurised superheated water into steam.

Fumarole : A small vent in a volcanic area from which steam, gases and various acids are ejected.

Gas : Geothermal fluid contains gases, mainly carbon dioxide. There are also varying amounts of hydrogen sulphide which gives Rotorua its characteristic smell.

Geothermal energy : *Energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water.*

Geothermal field : Identified by extensive scientific investigations that have been conducted, in particular, detailed resistivity surveys and by the drilling and testing of deep boreholes. The energy content and productive potential of the locality have been reasonably assessed.

Geothermal field equilibrium : The balance between the inflow of geothermal water (natural + reinjected) and the outflow of geothermal water (natural + user extracted) at a field pressure fluctuating around an annually constant level.

Geothermal fluid : Refers to all geothermal water, liquid, steam, gas and condensate ejected from a geothermal bore or any geothermal feature.

Geothermal mass : A measure of geothermal fluid. The volume of a fluid changes with temperature and pressure. Therefore it is more accurate to refer to a mass of fluid rather than a volume. This is especially relevant to geothermal fluid which can be subjected to rapid and extreme changes in both temperature and pressure.

Geothermal surface (surficial) feature(s) : Includes structures formed by deposition from geothermal water, phenomena and manifestations caused by the release of geothermal water, steam and gases from geothermal fields and any resulting earthforms, any geothermally activated geysers, fumaroles, sinter cones, tomos, mud pools, hot and cold water pools, springs, steam and gas vents, pressure domes, fissures and also includes inactive structures formed by extinct or intermittent geothermal activity.

Geothermal water : *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.*

Geyser : A violent ejection of steam and super heated water from an underground source through a hole in the ground.

Gravel : A mixture of coarse sand and small rounded stones.

Groundwater : Water that occupies pores, cavities, cracks and other spaces in crustal rocks and soil.

Grout : A sand and cement mixture used to seal bores into the surrounding material.

Hydrostatic head : A pressure equivalent to the height of a vertical column.

Ignimbrite : A pyroclastic flow deposit of rhyolite composition. They are volcanic rocks which form thick sheets covering many square kilometres of ground.

Intrinsic values : *In relation to ecosystems, means those aspects of ecosystems and their constituent parts which have value in their own right, including (a) their biological and genetic diversity; and (b) the essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience.*

Iwi : Tribe or grouping of people, usually with a common ancestor.

Kaitiakitanga : *The exercise of guardianship; and in relation to a resource, includes the ethic of stewardship based on the nature of the resource itself.*

Lateral transmissivity : A measure of the rate at which a fluid can move laterally within a medium.

Magma : Molten rock material that forms igneous rocks upon cooling. Magma that reaches the surface is lava.

Mana : Effective customary authority or prestige.

Mana whenua : Customary authority and title exercised by an iwi or hapu over land and other taonga within the tribal rohe.

Mass extraction exclusion zone : A specified area where the extraction of geothermal water is prohibited. The 1.5km zone surrounding Pohutu is an example of this.

Minimum geothermal aquifer water level : The water level set by the Regional Council below which the 20 day limit is activated.

Moturiki datum : Sea level, as defined at Moturiki Island, Mt Maunganui, from which heights are measured.

Natural and physical resources : *Includes land, water, air, soil, minerals, and energy, all forms of plants and animals (whether native to New Zealand or introduced), and all structures.*

Net mass abstraction: means the calculated difference between the total daily mass tonnage abstracted, and the total daily mass tonnage reinjected.

Oxidised : A state in which an atom loses electrons or hydrogen ions, or gains oxygen ions; i.e. rust is oxidised iron.

Permeable : A quality which allows for the transmission of fluid through a medium.

Pressure gradient : The amount of change in atmospheric pressure between two points.

Rainfall deficit : A period of lower than average rainfall.

Regional Policy Statement : *An operative regional policy statement approved by a regional council under the First Schedule {to the Act}, and includes all operative changes to such a policy statement (whether arising from a review or otherwise).*

Regional Plan : *An operative plan approved by a regional council under the First Schedule and includes all operative changes to such a plan (whether arising from a review or otherwise).*

Reinjection : The return of geothermal fluid into the geothermal aquifer from which the fluid was sourced.

Resistivity boundary : Geothermal fields are often characterised by low resistivity. The boundary between the low resistivity of the geothermal area and the higher resistivities of the surrounding area.

Rhyolite : A fine grained volcanic rock of granitic composition.

Rhyolite dome : Dome shaped structures formed of rhyolite. The hospital hill is an example of a rhyolite dome.

Rohe : A territory or boundary which defines the area within which a tangata whenua group claims traditional association and mana whenua.

Sand : Fine particle of rock.

Saturation : The state where the maximum quantity of gas is dissolved in a fluid for a given pressure and temperature.

Sedimentary : A type of rock formed by the accumulation and cementation of mineral grains transported by water, wind, or ice to the site of deposition or by chemical precipitation at the depositional site.

Sedimentary layers : These are layers of sedimentary rocks. Rocks are formed by build up of sand, gravel and mud. Sometimes the particles are cemented together to form solid rock.

Seepage : The slow movement of a fluid through a porous medium.

Shallow well : In Rotorua, this is defined as a well less than 61 metres in depth.

Silica : Chemically, it is silicon dioxide, but the properties of the silica group are closely allied to the silicates.

Siltstone : A fine grained consolidated rock, composed largely of silt.

Sinter cone : A cone comprised of siliceous or calcareous material around the orifice of a geyser or hot spring, as a result of deposition from the hot fluid.

Spa : A mineral spring or place where such a spring is found.

Spring : A natural flow of water from the ground at a point where the watertable intersects the surface.

Strata : The layers of sediment deposited through geologic processes.

Strategic equilibrium : The state of field balance where water levels in the geothermal aquifer oscillate above a defined minimum geothermal aquifer water level.

Subduction : The process of a continental plate being overridden by another plate with it being forced down into the underlying mantle along an oblique plane.

Supersaturated : The state where a fluid has been cooled below its saturation temperature without crystallisation taking place.

Sustainable management : *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.*

Tangata whenua : *In relation to a particular area, means the iwi, or hapu, that holds mana whenua over the area.*

Taonga : Highly prized property; a treasure.

Tikanga Maori : *Maori customary values and practices.*

Treaty of Waitangi (Te Tiriti o Waitangi) : *Has the same meaning as the word "Treaty" as defined in section 2 of the Treaty of Waitangi Act 1975.*

Two phase : Where the geothermal fluid contains both steam and water.

Waahi tapu : Sacred site. These are defined locally by the hapu and iwi, which are the kaitiaki for the waahi tapu.

Waiariki : Hot springs.

Waiariki : Water of Gods.

Wairua : Spirit.

Water : *Means-*

- (a) *Water in all its physical forms whether flowing or not and whether over or under the ground;*
- (b) *includes fresh water, coastal water, and geothermal water; and*
- (c) *does not include water in any form while in any pipe, tank, or cistern.*

Water body : *Fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area.*

Well : A geothermal bore drilled vertically down into the geothermal aquifer or zone. It is cased with steel pipe which is grouted into the ground.

Well casing : A lining of a well, usually of steel.

Wellhead : See borehead.

24 Appendix Two: Consultation Details

24.1 Consultation

24.1.1 Public Meeting: 17 February 1993

The first round of public consultation on the plan commenced with a public meeting on 17 February 1993. That meeting was designed as a seminar to present the findings of the bore closure report and outline some of the management options available to Environment B·O·P. The meeting debated wide and various issues including:

- (a) The management roles of the various agencies involved, particularly Environment B·O·P, the Rotorua District Council, the Ministry of Commerce, and tangata whenua;
- (b) The lack of co-ordination and the high expense of bore inspections;
- (c) How much geothermal resource was actually available and where;
- (d) The quality of the data being used;
- (e) The management of unauthorised bores.

A call was made to those attending the meeting to further consider matters raised and make written comments.

24.1.2 "Think-Tank" Workshop: 18 February 1993

Following from the February public meeting Environment B·O·P convened a "think-tank" workshop of planning and technical experts on 18 February 1993 to assess issues raised at the meeting and set out the issues that the regional plan would need to address. That workshop established some of the fundamental principles of plan development including that the regional plan should contain policy to address a need to:

- (a) Establish a more precise model of the field to assess natural and manmade effects;
- (b) Define the relationship between mass and heat withdrawal;
- (c) Ensure that any serious effort to sustain the qualities and potentials of the field would included a progressive move towards the complete reinjection of extracted geothermal water, and a shift to down hole heat exchangers and the further use of surface flows;
- (d) Include within the regional plan a protection for the traditional use of geothermal resource by Maori;
- (e) Require precise and effective protection policies with regards to geothermal surface activities, features and ecologies, with particular emphasis on the protection of Whakarewarewa;

- (f) Bring a certainty to those resource users that are existing consent holders and are using their allocation of available geothermal resource efficiently with minimal environmental effects.

24.1.3 **Registration of Unregistered Geothermal Users: 27 March 1993**

The question of unauthorised and unregistered geothermal users became a matter that Environment B·O·P sought to resolve prior to the regional plan becoming operational. Environment B·O·P noted that once the regional plan became provisional, an unauthorised user would become vulnerable to committing a wider range of offences against the Resource Management Act 1991. To provide an opportunity, Environment B·O·P advertised on three occasions in late March and early April 1993, requesting that currently unauthorised users register with Environment B·O·P by 30 April 1993 so that the status of their bores could be assessed and any required remedial action taken. There was no response.

24.1.4 **Interest Group Workshop: 29 June 1993**

This workshop was held in Rotorua. Those in attendance represented sector groups of geothermal resource users, Maori (Te Arawa) interests, Department of Conservation, Ministry of Commerce, Rotorua District Council and Environment B·O·P. An issues paper was provided as the basis for discussion and some detailed concepts on issue resolution possibilities began to take form. These became the basis for the development of working documents that lead to a pre-draft plan.

24.1.5 **Geothermal Meeting with Te Arawa Representatives: 15 July 1993**

At this meeting staff of Environment B·O·P met with representatives of those Te Arawa iwi that have mana whenua, and exercise Rangitiratanga, over areas of Rotorua geothermal resource. From that meeting, the following concerns and matters of importance to Te Arawa were noted:

- (a) Te Arawa supports the concept of sustaining the mauri of the Rotorua Geothermal Resource (RGR) and requires that the Rotorua Geothermal Regional Plan follows the sustainable management principles of the Resource Management Act, as those principles are in general accord with the geothermal kaitiakitanga principles of Te Arawa;
- (b) Te Arawa require that the Waiariki of the geothermal field be respected. The field is to be sustained at a level that ensures the good health and protection of the mauri of the field and its features for present and future generations;
- (c) Te Arawa will define what geothermal taonga are;
- (d) Te Arawa will identify the respective iwi or hapu of Te Arawa that are kaitiaki to specific areas of the Rotorua geothermal field;
- (e) The respective Rotorua iwi or hapu of Te Arawa that are the kaitiaki of geothermal taonga will identify and name their taonga, or not, as they

- wish. Te Arawa will provide Environment B·O·P with the location and name of taonga they wish identified;
- (f) Te Arawa require that named taonga are to be respected, protected and referred to by their given Maori names throughout all planning documents;
 - (g) Te Arawa understands that Environment B·O·P has no jurisdiction to determine ownership of the field. Te Arawa acknowledge that Environment B·O·P is obligated by the Resource Management Act to allocate geothermal resource available for use;
 - (h) Te Arawa require to be involved in the administration and management of the Rotorua geothermal resource as management partners in accord with the principles of the Treaty of Waitangi;
 - (i) Te Arawa require that the Rotorua Geothermal Regional Plan provides for the self-regulation and self-management of geothermal surface manifestations on land owned by Te Arawa iwi as they have rangatiratanga over them and are kaitiaki of them. Te Arawa are to give guidance as to whether the concerns and matters of importance noted are complete with respect to the plan.

24.1.6

Peer Review Workshop: 30 September 1993

This was a specialist resource management and planning workshop designed to test the practicability of the draft policy and method elements of the plan against actual scenarios. Each suggested section, objective, policy and method was rigorously scrutinised as to:

- (a) Whether the sections proposed would achieve the management aim and principal objectives of the regional plan;
- (b) Whether the policy and method structure of each section would work to achieve the objectives proposed;
- (c) Whether proposed policy and methods were legally possible with respect to the requirements of the Resource Management Act 1991;
- (d) Whether there were other more effective options available to achieve the policy effects required;
- (e) The merits or otherwise of alternative means of achieving the policy effects required;
- (f) Structural, semantic and syntax changes necessary to amend the regional plan.

From this workshop an amended draft regional plan was produced for analysis by the specialist workshop in October.

24.1.7 **Interest Group Workshop: 20 October 1993**

The workshop was held in Rotorua and in attendance were representatives of sector groups of geothermal resource users, Maori (Te Arawa) interests, Department of Conservation, Ministry of Commerce, Rotorua District Council and Environment B·O·P. A draft plan was provided as the basis for discussion and a section by section analysis made, with Environment B·O·P staff explaining what each section sought to achieve and the workshop debating the practicability of the policy, means, methods and principles proposed. A wide range of principles and matters were covered and the determinations of the workshop included:

- (a) That the first term of the regional plan be limited to five years and in that term, management policy criteria and method parameters be conservative, particularly while the actual effects criteria and parameters remain uncertain;
- (b) That the concept of not protecting the geothermal surface features of Kuirau Park be abandoned, but that the surface outflow from the Kuirau Park upflow zone be identified as a resource that can be utilised subject to regional plan provisions;
- (c) That the features and scenario tests of the Rotorua geothermal field model be made known and available to the public;
- (d) That the requirement for the installation of reinjection systems be decreased from five years to three years;

Following on from that workshop written submissions were received from the Rotorua District Council, the Department of Conservation and the Rotorua Bore Users Association.

24.1.8 **Environment B·O·P Workshop: 16 November 1993**

The matters covered at this workshop have been incorporated into the plan as per the directives of the Resource Planning Committee.