

# **Priorities for pest plant control, pest animal control, and fencing at geothermal sites in the Waikato region - 2014 update**

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**PRIORITIES FOR PEST PLANT CONTROL,  
PEST ANIMAL CONTROL, AND FENCING  
AT GEOTHERMAL SITES IN THE  
WAIKATO REGION - 2014 UPDATE**

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environments





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AT GEOTHERMAL SITES IN THE  
WAIKATO REGION - 2014 UPDATE**

**Contract Report No. 2755a**

December 2014

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## 1. INTRODUCTION

The management priorities for all known sites containing geothermal vegetation in the Waikato Region have previously been assessed in 2006 (Wildland Consultants 2006b) and 2011 (Wildland Consultants 2011).

In 2006, Wildland Consultants identified priorities for management (pest plant and animal control, and fencing) in 40 geothermal sites in the Waikato Region based on ecological information presented on these sites in a 2004 report on the distribution, extent, and ecological values of geothermal vegetation at 40 sites in the Waikato Region (Wildland Consultants 2004). Information on ecological threats to and management requirements of the geothermal vegetation and features at these sites was collected as part of the 2004 study. In 2011/2012, the ecological inventory report and the assessment of management priorities report were updated (Wildland Consultants 2012a).

In 2014, the inventory of sites containing geothermal vegetation in the Waikato Region was updated based on field assessments at 28 sites, and, for the remaining sites, assessment of 2012 aerial photographs and the most recent field work undertaken at each site (Wildland Consultants 2014). The inventory now includes 64 sites. Three sites were merged into one site (Western Te Kopia), and two additional sites (Kathleen Springs and Mountain Road) were surveyed during the 2014 study.

This report updates the priorities for management of geothermal sites in the Waikato Region, based on the most up to date ecological information for each site (Wildland Consultant 2014).

## 2. OBJECTIVES

The objective of this project is to update the 2011 report (Wildland Consultants 2011) by identifying priorities for pest plant control, pest animal control, and fencing in 64 geothermal sites in the Waikato Region. Each site is to be ranked in order of priority for pest plant control, fencing requirements (i.e. exclusion of domestic stock), and pest animal control (if deemed relevant).

## 3. METHODS

### 3.1 Information sources

The information from Wildland Consultants (2014) that was collected during field work, and a desktop exercise was used as the basis to assess and rank the management requirements of sites for pest plant, pest animal, and domestic stock threats (i.e. fencing requirements). This report includes data from earlier published and unpublished assessments and reports, aerial photographs, and local knowledge of the sites. Information on each site was collated and presented in a table (Appendix 1). A description of each of the table fields and relevant methods used to populate each field is presented in Appendix 2. Fields include:

- Site Number;
- Site Name;
- Tenure;
- Size;
- Significance level;
- Key values of the site;
- Threats;
- Vulnerability;
- Description of threats;
- Action required;
- Ecological Benefit;
- Priority;
- Ecological Change and Management Since Previous Assessment (Wildland Consultants 2011);
- Comments.

Twenty-eight sites were inspected in 2014. Sites that have not been visited in the field in 2014 (36 sites and part of one site) are listed in Appendix 3.

### 3.2 Prioritisation of sites for management

Prioritisation of site requirements for pest plant control, pest animal control, and fencing considered the following factors:

- The overall value of the site (significance ranking).
- Specific ecological values (e.g. Threatened and At Risk species) threatened because of pest plants, domestic stock, or animal pests.
- Land tenure and ongoing restoration management activities.
- Potential effectiveness/cost effectiveness of the management effort.

## 4. FINDINGS

Key pest plant, pest animal, and domestic stock threats for each of the 64 sites are summarised in Appendix 1. The vulnerability of each site to those threats, the actions required to address them, and the benefits and priority of ecological management are presented. In the following sections, sites that are of a high, medium, or lower priority for pest plant control, pest animal management, and/or exclusion of domestic stock are identified.

### 4.1 Pest plants

Six geothermal sites require immediate weed control, and these are listed in Table 1. In particular, wilding pines (*Pinus* spp.) require immediate control at Waiotapu North (WTV03) and Waiotapu South (WTV05). Ornamental trees and plantings at Tokaanu Thermal Park (TOV08) should be removed, whilst at Hipaua (TOV02), surveillance

Table 1: **Pest plant control** priorities at geothermal sites in the Waikato Region. Descriptions of the threat to each site and the control actions that are required are summarised in Appendix 1.

Immediate		High		Medium		Lower		No Priority	
WAV01	Waikite Valley	WTV01	Maungaongaonga	MKV03	Tirohanga Road	HHV01	Horohoro	MKV01	Whakamaru
WTV03	Waioapu North	WTV04	Maungakakamea	ATV02	Whangapoa Springs	WAV02	Northern Paeroa Range	TGV01	Te Maari Craters
WTV05	Waioapu South		(Rainbow Mountain)	TKV02	Murphy's Springs	WTV02	Ngapouri	TGV02	Ketetahi
THV07	Waipahih Valley	MKV02	Waipapa Stream	TKV04	Western Te Kopia	MKV04	Paerata Road	TGV03	Emerald Lakes
TOV02	Hipaua	TKV01	Te Kopia	OKV02	Akatarewa Stream	ATV01	Upper Atiamuri West	TGV04	Red Crater
TOV08	Tokaanu Thermal Park	OKV01	Waihunuhunu	RPV01	Longview Road	ATV03	Matapan Road		
		OKV03	Orakeikorako	RPV02	Wharepapa Road	TKV06	Mangamingi Station		
		OKV04	Red Hills	RPV03	Golden Springs	OKV05	Akatarewa East		
		NMV02	Orakonui <sup>1</sup>	OHV02	Ohaaki Steamfield East	NMV01	Waikato River Springs		
		THV01	Otumuheke	THV04	Broadlands Road	WGV01	Whangairorohea		
		OHV01	Ohaaki Steamfield West	WKV01	Te Rautehuia	THV03	Spa Thermal Park		
		THV06	Crown Road	WKV06	Lower Wairakei Stream	THV05	Crown Park		
		WKV02	Te Rautehuia Stream			WKV04	Wairakei Borefield		
		WKV03	Upper Wairakei Stream (Geyser Valley)			WKV07	Karapiti Forest		
		WKV05	Te Kiri O Hine Kai Stream Catchment/ Wairoa Hill			WKV08	Hall of Fame Stream		
		WKV10	Craters of the Moon			WKV09	Waipouwerawera Stream/Tukairangi		
		RKV01	Rotokawa North			THV08	Mountain Road		
		RKV02	Lake Rotokawa			THV09	Kathleen Springs		
		TOV03/	Tokaanu Lakeshore			TOV07	Maunganamu West		
		TOV05/	Wetland			TOV09	Tokaanu Urupa Mud Pools		
		TOV06				TOV10	Maunganamu East		
						TOV11	Maunganamu North Wetland		
						TOV14	Tokaanu Tailrace Canal		

<sup>1</sup> Previously called Ngatamariki in earlier reports (e.g. Wildlands Consultants 2011 and 2012a).

for pest plants such as pampas (*Cortaderia selloana*) are the priority. At Waikite Valley (WAV01), *Cyperus involucratus*, ivy (*Hedera helix*), and Mexican daisy (*Erigeron karvinskianus*) are expanding in extent alongside geothermal stream margins, and have the potential to threaten other parts of this site if allowed to spread. At Waipahihi Valley, consideration should be given to eradicating buffalo grass (*Stenotaphrum secundatum*), or monitoring and controlling it to reduce the threat to the *Cyclosorus interruptus* population. The invasive *Cyperus involucratus* appears to have increased in extent at Waipahihi Valley since 2011 and should also be controlled. Other pest plant species at Waipahihi Valley include radiata pine (*Pinus radiata*), pampas, Khasia berry (*Cotoneaster simonsii*), wilding pines, agapanthus (*Agapanthus praecox* subsp. *orientalis*), periwinkle (*Vinca major*), and ivy.

Wilding conifers, particularly maritime pine (*Pinus pinaster*) and radiata pine, and also lodgepole pine (*Pinus contorta*), black pine (*Pinus nigra*), bishop pine (*Pinus muricata*), ponderosa pine (*Pinus ponderosa*), strobus pine (*Pinus strobus*), Douglas fir (*Pseudotsuga menziesii*), and European larch (*Larix decidua*), are a threat to many sites. Other pest trees present in geothermal vegetation in the Waikato Region include flowering cherry (*Prunus* sp.), Chinese privet (*Ligustrum sinense*), cotoneaster (*Cotoneaster simonsii*, *Cotoneaster glaucophyllus*), false acacia (*Robinia pseudoacacia*), eucalyptus (*Eucalyptus* sp.), Tasmanian blackwood (*Acacia melanoxylon*), silver birch (*Betula pendula*), crack willow (*Salix fragilis*), grey willow (*Salix cinerea*), and tree lucerne (*Chamaecytisus palmensis*).

Where herbicides are to be used for pest tree control, care needs to be taken to avoid accidentally killing indigenous plants and vegetation cover. Herbicide should only be applied to deciduous trees when the trees are in leaf (e.g. the best time of the year to control willow is January/February). This applies not only to foliar application but also to drilling and poisoning. When trees are felled, they should be felled away from geothermal vegetation, where possible.

Pampas is scattered through many geothermal sites and is generally a high priority for control. Undertaking control when pampas is flowering makes identification easier for weed control operators. Although *Cyperus involucratus* has only been recorded at two sites (Waikite Valley and Waipahihi Valley), it should be eradicated at these sites. This species has the potential to spread further along stream banks at Waikite Valley, threatening *Christella* aff. *dentata* “thermal” populations. Ivy and Mexican daisy are also invading stream banks and threatening *Nephrolepis flexuosa* populations at Waikite Valley, and should be controlled at the same time.

Blackberry (*Rubus fruticosus* agg.), broom (*Cytisus scoparius*), buddleia (*Buddleja davidii*), Himalayan honeysuckle (*Leycesteria formosa*), gorse (*Ulex europaeus*), Spanish heath (*Erica lusitanica*), and exotic grasses are common on cooler geothermal soils and on the margins of sites, but are difficult to manage in most situations. Where they are present in low abundance (e.g. buffalo grass (*Stenotaphrum secundatum*) at Waipahihi Valley) they should be eradicated where possible or controlled to prevent them from spreading.

When controlling pest plants in geothermal sites it is important to avoid damaging indigenous geothermal vegetation. It is advisable that an ecologist who is familiar with geothermal flora and vegetation be involved with planning weed control operations and, in some cases, be on site to advise contractors so that adverse effects

on threatened species and biodiversity values can be avoided or minimised. This is particularly important where there are ‘Threatened’ or ‘At Risk’ flora species growing in close proximity to infestations of pest plants. For example, control of pest plants may remove protective shelter from populations of ferns typical of geothermal habitat resulting in them being susceptible to foliage damage during frosts if the surrounding canopy is removed. Pest plant control can also result in stream banks becoming more vulnerable to erosion, which can affect populations of ‘At Risk’ ferns.

## 4.2 Pest animals

Pest animal management requirements were assessed during what was often a single site visit (refer to Table 2). Impacts of pest animals are not always able to be identified during a single site visit, although likely impacts can be assessed based on the vegetation and landforms present. Information is often based on knowledge of pest animals that are likely to be present in or near these sites.

Table 2: Priorities for **pest animal control** at geothermal sites in the Waikato Region<sup>1</sup>.

High		Medium		Lower	
WTV05	Waiotapu South	WAV01	Waikite Valley	WTV02	Ngapouri
		WTV01	Maungaongaonga	MKV02	Waipapa Stream
		WTV03	Waiotapu North	MKV03	Tirohanga Road
		WTV04	Maungakakaramea (Rainbow Mountain)	MKV04	Paerata Road
		TKV01	Te Kopia	ATV02	Whangapoa Springs
		OKV03	Orakeikorako	TKV03	Western Te Kopia
		OKV04	Red Hills	TKV02	Murphy's Springs
		NMV02	Orakonui <sup>2</sup>	OKV01	Waihunuhunu
		RKV02	Lake Rotokawa	OKV02	Akatarewa Stream
				RPV01	Longview Road
				RPV02	Wharepapa Road
				RPV02	Golden Springs
				OHV01	Ohaaki Steamfield West
				OHV02	Ohaaki Steamfield East
				THV01	Otumuheke
				THV03	Spa Thermal Park
				THV04	Broadlands Road
				THV05	Crown Park
				THV06	Crown Road
				THV07	Waipahihi Valley
				WKV01	Te Rautehuia
				WKV02	Te Rautehuia Stream
				WKV03	Upper Wairakei Stream (Geyser Valley)
				WKV05	Te Kiri O Hine Kai Stream Catchment/Wairoa Hill
				WKV08	Hall of Fame Stream
				WKV10	Craters of the Moon
				RKV01	Rotokawa North
				TOV02	Hipaua
				TOV07	Maunganamu West
				TOV03/04/05/06	Tokaanu Lakeshore Wetlands
				TOV08	Tokaanu Thermal Park
				TGV01	Te Maari Craters
				TGV02	Ketetahi
				TGV03	Emerald Lakes

<sup>1</sup> No sites require ‘immediate’ pest animal control. Sites where pest animal control is not currently required are not listed. Descriptions of the threat to each of these sites and the control that is required are provided in Appendix 1.

<sup>2</sup> This site was previously known as Ngatamariki in earlier reports (e.g. Wildlands Consultants 2011 and 2012a).

One site, Waiotapu South (WTV05), has been identified as a high priority for pest animal control because pigs are having significant adverse effects on the geothermal wetlands. Pig trampling damage was evident throughout the wetlands in this site. Feral pigs are also a medium priority for control at Waiotapu North (WTV03), and pigs, deer, and possums require monitoring and management at Te Kopia (TKV01), Maungaongaonga (WTV01), Maungakakamea (WTV04), Red Hills (OKV04), Orakonui<sup>1</sup> (NMV02), and Waikite Valley (WAV01). Wallabies are a threat to geothermal features at Waikite Valley and may be a threat at other sites. The sites listed above all have very high ecological values that are threatened by pest animal impacts. More details on each of the sites listed in Table 2 and their requirements for pest animal control are presented in Appendix 1.

Six sites that are currently grazed by stock are not considered a priority for pest animal management until fencing of geothermal habitat to exclude stock has been undertaken: Horohoro, Northern Paeroa Range, Matapan Road, Mangamingi Station, Akatarewa East, and Mountain Road. An additional 14 sites were either considered too small for pest animal control to be practicable, or management of pests was considered unlikely to greatly enhance ecological values. These sites are: Whakamaru, Upper Atiamuri West, Waikato River Springs, Whangairorohea, Wairakei Borefield, Lower Wairakei Stream, Karapiti Forest, Waipouwerawera Stream/Tukairangi, Kathleen Springs, Tokaanu Urupā Mud Pools, Maunganamu East, Maunganamu North Wetland, Tokaanu Tailrace Canal, and Red Crater.

#### 4.3 Exclusion of domestic stock

The ecological values of 26 sites would be enhanced by excluding domestic stock from geothermal vegetation within these sites (Table 3). Domestic stock adversely impact geothermal vegetation within sites by grazing of vegetation and trampling of vegetation and fragile geothermal soils. Stock exclusion is an immediate priority at one site, Te Rautehuia Stream (WKV02), where stock had access to the site in 2011. At the remaining 38 sites fencing is not currently required to protect values, given the current surrounding land use (e.g. forestry and conservation land). At some sites, fencing was in a good condition when inspected in 2014, but all sites should be inspected on a regular basis to ensure fences are maintained to a good condition and stock are excluded from geothermal vegetation and habitats. More detailed information about each of the sites is presented in Appendix 1.

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<sup>1</sup> This site was previously known as Ngatamariki in earlier reports (e.g. Wildlands Consultants 2011 and 2012a).

Table 3: Priority for fencing (or maintenance of fences) to exclude domestic stock at geothermal sites in the Waikato Region<sup>1</sup>.

Immediate		High		Medium		Lower	
WKV02	Te Rautehuia Stream	TKV02	Murphy's Springs	WAV01	Waikite Valley	HHV01	HoroHoro
		THV06	Crown Road	WTV02	Ngapouri	WAV02	Northern Paeroa Range
		WKV01	Te Rautehuia	WTV05	Waiotapu South	MKV03	Tirohanga Road
				MKV04	Paerata Road	ATV03	Matapan Road
				TKV01	Te Kopia	TKV03	Western Te Kopia
				OKV03	Orakeikorako	OKV05	Akatarewa East
				TKV06	Mangamingi Station	RPV03	Golden Springs
				RPV01	Longview Road	OHV02	Ohaaki Steamfield East
				RPV02	Wharepapa Road	THV04	Broadlands Road
				THV06	Crown Road	THV08	Mountain Road
						RKV01	Rotokawa North
						TOV11	Maunganamu North Wetland

#### 4.4 Other threats to geothermal areas

Threats other than those listed above and in Appendix 1 also occur at geothermal sites. A full description of known threats to geothermal sites in the Waikato Region are summarised in Section 8 of Wildland Consultants 2014 (Wildland Consultants Ltd Contract Report No. 3330). These include:

- Exploitation of geothermal fields for energy production;
- Tourism and recreation where it is not managed well;
- Dumping of rubbish;
- Management of neighbouring plantation forests and shelterbelts;
- Fire;
- Genetic pollution;
- Wetland infilling and drainage;
- Industrial/residential/roading development.

## 5. SUMMARY

Information about each of the 64 geothermal sites assessed in this study is summarised in Appendix 1. The threat mechanisms operating at each site, their vulnerability to those threats, the actions required to address them, and the benefits and priority of ecological management are identified. The numbers of sites which were identified as having immediate, high, medium, or lower priority for management for each factor are presented in Table 4. Pest plant control was identified as an immediate priority at six sites and a high priority at 18 sites. Pest animal management is a high priority at one site, whilst exclusion of domestic stock is of immediate priority at one site and a high priority at three sites. At the single site with a high priority for pest animal control (WTV05 Waiotapu South), pest plant control is also ranked as an immediate priority.

<sup>1</sup> Sites where fencing is not currently required are not listed. Descriptions of each of these sites and the fencing that is required are provided in Appendix 1.

Table 4: Number of geothermal sites in the Waikato Region where pest animal control, pest plant control, or exclusion of domestic stock is of immediate, high, medium, or lower priority.

	Immediate	High	Medium	Lower	No Priority
Pest plant management	6	18	12	23	5
Pest animal management	0	1	9	34	20
Exclusion of grazing domestic stock	1	3	10	12	38

Implementation of management at sites where priorities are immediate or high should be instigated as soon as is practicable. Holistic management of sites should also be considered. For example, if management of one factor, e.g. pest plants, pest animals, or fencing, is to be undertaken at a particular site because it has been identified as of immediate or high priority, then it may be cost-effective to undertake other management actions at that site at the same time.

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## REFERENCES

- de Lange P.J., Norton D.A., Courtney S.P., Heenan P.B., Barkla J.W., Cameron E.K., Hitchmough R., and Townsend A.J. 2009: Threatened and uncommon plants of New Zealand (2008 revision). *New Zealand Journal of Botany* 47: 61-96.
- Miskelly C.M., Dowding J.E., Elliott G.P., Hitchmough R.A., Powlesland R.G., Robertson H.G., Sagar P.M., Scofield R.P., Taylor G.A. 2008: Conservation status of New Zealand birds, 2008. *Notornis*, 55: 117-135.
- Wildland Consultants Ltd 2004: Geothermal Vegetation of the Waikato Region - Revised 2004. *Wildland Consultants Contract Report No. 896*. Prepared for Environment Waikato. 238 pp.
- Wildland Consultants Ltd 2005a: Wilding pine and exotic tree control in Waiotapu Geothermal Areas March/April 2005. *Wildland Consultants Contract Report No. 855*. Prepared for Kaingaroa Timberlands. 3 pp.
- Wildland Consultants Ltd 2005b: Ecological assessment of a proposal for the discharge of geothermal fluid from Tokaanu Thermal pools. *Wildland Consultants Ltd Contract Report No. 1108*. Prepared for Department of Conservation. 22 pp.

- Wildland Consultants Ltd 2005c: Effects of plantation harvesting and wilding pines and wilding pine removal at the Waipapa Stream Geothermal Area. Second inspection. *Wildland Consultants Ltd Contract Report No. 1229*. Prepared for Carter Holt Harvey Forests. 2 pp.
- Wildland Consultants 2006a: Field evaluations of five geothermal sites, Waikato Region, June 2006. *Wildland Consultants Ltd Contract Report No. 1403*. Prepared for Environment Waikato. 26 pp.
- Wildland Consultants 2006b: Priorities for pest plant and animal control, and fencing at geothermal sites in the Waikato Region. *Wildland Consultants Ltd Contract Report No. 1291a*. Prepared for Environment Waikato. 23 pp.
- Wildland Consultants 2007a: Requirements for the protection and enhancement of ‘Craters of the Moon’ - a geothermal natural area and tourist attraction near Taupo. *Wildland Consultants Ltd Contract Report No. 1785*. Prepared for Department of Conservation. 40 pp.
- Wildland Consultants 2007b: Evaluation and mapping of selected geothermal sites for minor variation to Waikato Regional Plan - geothermal vegetation and geophysical properties: February 2007. *Wildland Consultants Ltd Contract Report No. 1588*. Prepared for Environment Waikato. 55 pp.
- Wildland Consultants 2007c: Distribution and density of *Christella* sp. ‘thermal’, *Cyclosorus interruptus*, and *Hypolepis dicksonioides* at geothermal sites in the Waikato Region. *Wildland Consultants Ltd Contract Report No. 1611*. Prepared for New Zealand Plant Conservation Network. 59 pp.
- Wildland Consultants 2007d: Field evaluations of nine geothermal sites, Waikato Region, June 2007. *Wildland Consultants Ltd Contract Report No. 1619*. Prepared for Environment Waikato. 27 pp.
- Wildland Consultants 2011: Priorities for pest plant control, pest animal control, and fencing at geothermal sites in the Waikato Region in 2011. *Wildland Consultants Ltd Contract Report No. 2755*. Prepared for Environment Waikato. 27 pp.
- Wildland Consultants 2012a: Geothermal vegetation of the Waikato Region - An update based on 2007 aerial photographs. *Wildland Consultants Ltd Contract Report No. 2348*. Prepared for Waikato Regional Council.
- Wildland Consultants 2012b: Ecological assessment and ecological restoration advice, Otumuheke Stream, Taupo. *Wildland Consultants Ltd Contract Report No. 3082*. Prepared for Waikato Regional Council. 73 pp.
- Wildland Consultants 2014: Field inventory and assessment of geothermal vegetation in the Waikato Region based on 2012 aerial photographs. *Wildland Consultants Ltd Contract Report No. 3330*. Prepared for Waikato Regional Council.

**THREATS TO GEOTHERMAL SITES IN  
WAIKATO REGION - PEST PLANTS, PEST  
ANIMALS, AND GRAZING (STOCK)**

A description of each field in the table  
is provided in Appendix 2 of this report.

Table 5: Threats to geothermal sites in Waikato Region - pest plants, pest animals, and grazing (stock). A description of each field in the table is provided in Appendix 2.

Site Number	Site Name	Tenure	Extent of Geothermal Habitat (ha)	Significance Level	Key Values of the Site	Threats/ Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment Undertaken in 2011 (Wildland Consultants 2011)	Comments
<b>Horohoro Geothermal Field</b>													
HHV01	Horohoro	Unprotected private land	c.0.1	Local	This site contains a small example of geothermal habitat - a nationally rare habitat type.	Pest plants	Lower	One pool is mostly surrounded by pasture species, the other pool is mostly surrounded by exotic species.	No action required.	Lower	Lower	Not assessed. Changes unlikely to be significant. Site appears unchanged in aerial photographs.	The site is surrounded by pasture with few indigenous geothermal species present. Indigenous ecological values could be restored by fencing the pools to exclude grazing animals, and undertaking restoration planting around the pools. If the largest pool is fenced to exclude stock, <i>Nephrolepis flexuosa</i> (which was recorded at this site in 1995 (Given 1995)), could be reintroduced to pool margins at this site.
						Pest animals	No threat	The site is highly modified and is currently more vulnerable to grazing by domestic stock than pest animals.	No action required.	N/A	N/A		
						Domestic stock	Medium	The site is not fenced and stock have access to the site.	Fencing both pools to a standard to exclude domestic stock.	Lower	Lower		
<b>Waikite Geothermal Field</b>													
WAV01	Waikite Valley	Protected (Waikite Valley Scenic Reserve; Otamakokore Stream Marginal Strip; Waikite Wildlife Management Reserve) and unprotected private land	c.19.9	National	This site contains a very large population of <i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species. It also contains populations of prostrate kānuka <sup>1</sup> , <i>Nephrolepis flexuosa</i> , <i>Dicranopteris linearis</i> , <i>Hypolepis dicksonioides</i> , <i>Cyclosorus interruptus</i> , and <i>Thelypteris confluens</i> (all of which are 'At Risk'). Three 'At Risk' bird species are also present: spotless crane, North Island fernbird, and pied stilt.	Pest plants	High	The discontinuous geothermal features and vegetation are located within a matrix of pasture, other exotic vegetation, and small patches of indigenous vegetation. Invasive pest plants present include blackberry, grey willow, barberry, pampas, <i>Cyperus involucratus</i> , pasture grasses, and Mexican daisy. Pest plants threaten populations of 'At Risk' fern species and geothermal vegetation quality. <i>Cyperus involucratus</i> is expanding in extent and ivy is smothering <i>Nephrolepis flexuosa</i> .	Control grey willow, pampas, blackberry, Mexican daisy, ivy, and <i>Cyperus involucratus</i> as a priority. A management plan to address pest plant threats is urgently needed for the entire site, followed by implementation. A long-term action plan to control blackberry along sections of the Otamakokore Stream should be developed and implemented. This stream habitat is important for threatened ferns.	Immediate	Immediate	Work has been undertaken since 2007 to raise the water table within the wetland area in the centre of this site, which has increased the area of geothermal wetland at this site. This area has also been fenced to exclude stock (funded by DOC and WEMCTI), which has resulted in a significant improvement in vegetation condition at the site. Weed control is ongoing at DOC administered sites adjoining the Landcorp farm. Wallabies are now known to be present at this site. <i>Cyperus involucratus</i> threatens habitat for <i>Christella</i> aff. <i>dentata</i> ("thermal") and <i>Nephrolepis flexuosa</i> , and has noticeably expanded in extent on the true left of the stream downstream of Te Manaroa Spring. A significant stretch of geothermal stream margins has been fenced since 2007. The priority for fencing at this site has therefore reduced to medium since 2011; most of the geothermal vegetation at the site is now fenced to exclude stock. The remaining	Wallabies threaten vegetation condition. Pigs may threaten wetland vegetation.
						Pest animals	Medium	Pigs, deer, and wallabies are present.	Pest animal control will enhance the ecological values of the site. Wallaby control will need to be undertaken in surrounding areas to benefit the site.	High	Medium		
						Domestic stock	Medium	Most of the geothermal features are fenced to exclude stock.	Fence the remaining areas that are accessible to stock.	Medium	Medium		

<sup>1</sup> Recent revision to the taxonomy of the *Kunzea ericoides* complex (see de Lange 2014) was not adopted in the 2014 iteration of the extent and composition of geothermal vegetation in the Waikato Region (Wildland Consultants 2104) because field work for the study was completed prior to the publication of the revision. Additional field work would be required in order to accurately determine which of the new kānuka taxa occur at each of the geothermal sites in the Waikato Region. This is discussed in more detail in the Methods section of the Wildlands 2014 report.

Site Number	Site Name	Tenure	Extent of Geothermal Habitat (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment Undertaken in 2011 (Wildland Consultants 2011)	Comments
												unfenced geothermal vegetation should also be fenced to exclude stock.	
WAV02	Northern Paeroa Range	Unprotected private land	c.0.3	Local	This site contains seven small areas of geothermal vegetation and habitat (a nationally rare habitat type). Prostrate kānuka, an 'At Risk' species, is present as occasional scattered plants.	Pest plants	Lower	Most areas of geothermally-altered soils are largely devoid of vegetation. Blackberry and grey willow are locally common on the margins.	Crack willow control would improve site values.	Medium	Lower	This site was not field surveyed in 2014. However, the site is unlikely to have undergone any significant change over this time period.	
					Pest animals	Lower	Rabbits are present.	No action required.	N/A	N/A			
					Domestic stock	Medium	This site is fenced, but most of the features have been altered through stock trampling and grazing.	The site should be fenced more securely to exclude stock.	Lower	Lower			
<b>Waiotapu Geothermal Field</b>													
WTV01	Maungaongaonga	Protected (Maungaongaonga Scenic Reserve)	c.8.7	National	This site is one of the best quality remaining examples of geothermal vegetation in New Zealand. It is part of an ecological sequence from geothermal vegetation (prostrate kānuka scrub and nonvegetated raw-soilfield) through to non-geothermally influenced forest. The vegetation is of good quality and pest plants are relatively uncommon. The site also provides habitat for four 'At Risk' plant species: <i>Nephrolepis flexuosa</i> , <i>Korthalsella salicornioides</i> , prostrate kānuka, and <i>Dicranopteris linearis</i> .	Pest plants	Medium	If pest plants are not controlled and spread into this site, this will diminish the indigenous character of the site. The main pest plant species present are blackberry, radiata pine, Douglas fir, Spanish heath, gorse, and narrow-leaved carpet grass. This site needs to be checked regularly for pest plants and control undertaken as required.	Pest plants (which are currently uncommon at the site) should be controlled including wilding pines, gorse, and blackberry. Control of narrow-leaved carpet grass should also be considered at this site.	High	High	Management priorities have not changed since 2004.	
					Pest animals	Medium	Pigs and deer are present within the site and are likely to damage existing geothermal vegetation and have negative effects on plant regeneration. Wallabies may also be a threat to parts of this site in the future, as they are present in the Tumunui Bush which is near this site.	This site should be monitored for pest animals and control of these species should be undertaken when necessary. The site should be inspected regularly for wallabies, which should be controlled if present.	Medium	Medium			
					Domestic stock	No threat		No action required.	N/A	N/A			
WTV02	Ngapouri	Unprotected private land	c.6.5	Local	Although large parts of this site are dominated by exotic pest plants, it is a moderate-sized area of geothermal habitat - a nationally rare habitat type.	Pest plants	Lower	Much of this site is already dominated by pest plants so its vulnerability to further degradation and modification is relatively low.	Control invasive exotic plants including crack willow, Tasmanian blackwood, blackberry, and wilding pines. Develop and implement a management plan to control blackberry and establish indigenous species alongside riparian margins to enhance site values.	Medium	Lower	The extent of geothermal vegetation that is fenced to exclude domestic stock has increased considerably since the site was previously surveyed in 2004. Other parts of the site still require fencing. Additional areas of geothermal vegetation were found in the 2014 survey. No change was noted in a study of recent aerial photographs.	Some parts of the geothermal vegetation and habitats are subject to grazing, and extensive areas are dominated by pest plants. These areas are important linkages between the better quality areas of geothermal habitat, including adjacent sites to Ngapouri, which include Waiotapu South, Waiotapu North, and Maungaongaonga. Regular management of pest plants, particularly wilding trees should be undertaken. These areas should be monitored regularly for management issues. Formal protection and a restoration plan with subsequent implementation would enhance and protect the highly significant ecological values of greater Waiotapu Geothermal Field.
					Pest animals	Lower	Parts of the site are grazed and/or dominated by exotic plant species, and are not highly vulnerable to further modification by pest animals.	Pest animal control may enhance the ecological values of the site, but fencing to exclude stock is a higher priority.	Lower	Lower			
					Domestic stock	Lower	Sheep have access to parts of the site, but it is already highly modified so its level of vulnerability to degradation is relatively low.	Construct fences around unfenced areas and maintain existing fences.	Medium	Medium			
WTV03	Waiotapu North	Unprotected private land and protected (Waiotapu Scenic Reserve).	c.42.8	Regional	This site contains a relatively large area of a nationally uncommon vegetation/habitat type - geothermal. It also contains populations of two 'At	Pest plants	High	Pest plants dominate some areas, particularly on cooler ground. Species present include wilding pines, broom, blackberry, Spanish heath, grey willow, and cotoneaster.	Pest plant species need to be controlled, particularly wilding pines, grey willow, and cotoneaster. All wilding conifers have now been	High	Immediate	This site was not field surveyed in 2014.	Kaingaroa Timberlands initiated control work of some pest plant species in the areas of highest significance in autumn

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					Risk' species - prostrate kānuka and <i>Dicranopteris linearis</i> .				removed from DOC administered mud pools site on Loop Road.			in the 2011 survey that were not found in the 2004 survey. These were mostly areas that were more visible during field survey due to recent clearance of pine plantation and better quality 2007 aerial photographs.	2005 (Wildland Consultants 2005). This work has continued since then. The legally unprotected geothermal vegetation at this site forms an important linkage between the protected areas of geothermal habitat at Maungakakamea (Rainbow Mountain) and Waiotapu South. Regular management of pest plants, particularly wilding trees should be undertaken. These areas should be monitored regularly for management issues, and a restoration plan with subsequent implementation for these areas would enhance and protect the highly significant ecological values of this field. Formal protection should be considered for the best quality geothermal vegetation at this site.
						Pest animals	Medium	Pigs and deer are present within the site and are likely to damage and have negative effects on the regeneration of the geothermal vegetation within the site. Wallabies may also be present.	Control pigs. Wallabies should be controlled if present.	Medium	Medium		
						Domestic stock	No threat	None of the surrounding vegetation is farmland. If the surrounding land use changes to farming in the future, then the fencing of these geothermal features to exclude stock will be a priority.	No action required.	N/A	N/A	Some minor loss of geothermal vegetation has occurred in places following pine tree harvesting, but in most instances it appears that the land manager has taken reasonable care to avoid damage to geothermal habitats.  A small infestation of African feather grass ( <i>Cenchrus macrourus</i> ) has been controlled by Waikato Regional Council. This is an invasive species and follow-up inspections should be undertaken.	
WTV04	Maungakakamea (Rainbow Mountain)	Protected (Rainbow Mountain Scenic Reserve) and unprotected private land	c.51.6	National	This site is a good quality example of an ecological sequence grading from geothermal vegetation (prostrate kānuka shrubland and geothermal wetland) to indigenous forest. It is contiguous with Waiotapu North and Waiotapu South, forming part of the largest area of geothermal vegetation in New Zealand. It contains populations of eight 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate kānuka, <i>Dicranopteris linearis</i> , <i>Schizaea dichotoma</i> , <i>Calochilus paludosus</i> , <i>C. robertsonii</i> , <i>Petalochilus alatus</i> , and <i>Stegostyla atradenia</i> .	Pest plants	Medium	Considerable wilding conifer control has been undertaken at the site, but re-establishment remains a threat to some areas of prostrate kānuka scrub and other geothermal vegetation and habitats.	Control wilding pines.	High	High	This site was not field surveyed in 2014.  The most notable change since the early 2000s is the continued control of pines by Department of Conservation. The site is in a markedly improved condition as a result.  Minimal ecological change is visible in aerial photographs since the 2011 field survey.	
						Pest animals	Medium	Pigs, deer, and possums are likely to be having adverse effects on the geothermal vegetation. Wallabies may also be present.	Wild pest animals should be monitored, and controlled where necessary.	Medium	Medium		
						Domestic stock	No threat		No action required.	N/A	N/A		
WTV05	Waiotapu South	Protected (Waiotapu Scenic Reserve and Waiotapu Stewardship Area) and unprotected private land	c.111.5	Part International/ part Regional/ part Local	This site contains one of the best representative examples of geothermal wetland and terrestrial vegetation remaining in New Zealand. However, pest plants are dominant surrounding many areas of geothermal vegetation. The wetland to the south contains the largest population of <i>Cyclosorus interruptus</i> (an 'At Risk' species) at any geothermal site in New Zealand.	Pest plants	High	The areas around key geothermal features are well-maintained for public viewing, but the vegetation is modified by the presence of maritime pine. Few other pest plants are present.	Pest plants at the site should be controlled, particularly the extensive parts covered with exotic pines (maritime pine, radiata pine, black pine, and strobus pine). Other pest plants that should be controlled include blackberry, black wattle, broom, gorse, and Spanish heath.	High	Immediate	This site was not field surveyed in 2014. Some pine control was noted during the 2014 surveys of nearby sites on the eastern side of State Highway 5 near the Waiotapu Tavern. A small fire also occurred in a small part of site in 2013.	
						Pest animals	High	Pigs are having a significant negative impact on geothermal wetland vegetation.	This site should be monitored for pest animals and control of these species should be undertaken when necessary.	High	High	2011 assessment: wilding pines have been controlled in the northeastern part of the site, as a result the quality of the habitat present has greatly improved. Pest pines continue to degrade parts of the site where control	
						Domestic stock	No threat	Fences between the geothermal vegetation of Waiotapu South and Ngapouri Station should be inspected regularly to ensure that farm stock do	Fences should be inspected regularly, and maintained as necessary.	Medium	Medium		

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								not have access to geothermal vegetation and features.				has not taken place. Overall, the extent of geothermal habitat at Waiotapu South is considered to be similar to 2004. The additional area mapped in Wildland Consultants (2011) is based on new areas of geothermal vegetation and habitat identified by field survey.	
<b>Mokai Geothermal Field</b>													
MKV01	Whakamaru	Unprotected private land	<0.1	Local	Whakamaru comprises a very small example of geothermal habitat.	Pest plants	No threat	The site is largely unvegetated. No pest plants were noted in 2008.	No action required.	N/A	N/A	Unknown, this site has only been surveyed in 2008.	
						Pest animals	Unknown		No action required.	N/A	N/A		
						Domestic stock	No threat	The site is not grazed by domestic stock.	No action required.	N/A	N/A		
MKV02	Waipapa Stream	Unprotected private land	c.1.2	Part National/ part Local	Waipapa Stream contains the third largest population of <i>Christella aff. dentata</i> ("thermal") in New Zealand. It is an 'At Risk' species.	Pest plants	High	Invasive plant species include blackberry, radiata pine, Himalayan honeysuckle, and Japanese honeysuckle. The site is vulnerable to reinvasion of wilding pines from the surrounding pine plantations, and to disturbance associated with management of the surrounding pine plantations.	Continue controlling wilding pines, and other pest plants present.	Medium	High	This site was not field surveyed in 2014.  Some wilding pine control has been undertaken by Carter Holt Harvey and subsequently by Waikato Regional Council in the northern and western parts of the site in 2010/2011.  Careful management of surrounding pine plantation is required to ensure the ecological values of the site are maintained or enhanced. Logging on steep slopes surrounding the site could increase sedimentation into geothermal areas. Wildland Consultants have been involved with management of this area with Carter Holt Harvey Forests (Wildland Consultants 2005c).  Other pest plant control (e.g. buddleia, broom, and blackberry) was undertaken by Waikato Regional Council around the hot springs in 2011. Waikato Regional Council has also constructed rails around the hot springs after an adjoining landowner constructed tracks through the area.	A large proportion of land in the wider area has recently been converted from forestry to dairy farming. An inspection should be undertaken to determine whether the change in management has affected the ecological condition of the site.
					Pest animals	Unknown	Pest animals may be present, but effects were not observed.	Monitor, and control as necessary.	Lower	Lower			
						Domestic stock	No threat	The site is surrounded by plantation forestry. Fences should be maintained to exclude stock if the surrounding land use changes.	No action necessary, although fencing should be inspected if adjacent land is converted to farmland.	N/A	N/A		
MKV03	Tirohanga Road	Unprotected private land	c.0.2	Local	Tirohanga Road contains a very small area of geothermal habitat, a nationally uncommon habitat type. It provides habitat for a small population of prostrate kānuka, an 'At Risk' species.	Pest plants	Medium	Vegetation at the site is dominated by exotic pasture grasses and blackberry. The grassland is vulnerable to invasion by woody weeds e.g. blackberry, wilding pines.	Changes to geothermal vegetation that are likely to be associated with draw-off from the geothermal field should be monitored. A management plan for restoration of this site should be developed by ecologists with an understanding of the ecological values of this site.	Medium	Medium	This site was not field surveyed in 2014.  2011 Assessment: It appears that new fencing to exclude stock has been relocated further away from the geothermal features (parts of the old fence remain). Recent spraying has killed large areas of	Indigenous geothermal vegetation should not be sprayed with herbicide.
						Pest animals	Unknown	Pest animals may be present but no effects were observed.	No action required.	Lower	Lower		

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						Domestic stock	Lower	The site is fenced but stock may still access this site.	Fences should be inspected regularly and maintained as necessary.	Lower	Lower	blackberry, and there has been some loss of mānuka (and possibly <i>Histiopteris incisa</i> ). Between the geothermal expressions and the fence, browntop-Yorkshire fog-paspalum grassland dominates. Waste material that had been dumped into geothermal features (noted in 2007 report) appears to have been removed from site.	
MKV04	Paerata Road	Unprotected private land	c.1.7	Local	A small population of prostrate kānuka, an 'At Risk' species, is present. It is the largest population of this species in the Mokai Geothermal Field.	Pest plants	Medium	Blackberry has been controlled and pine seedlings have been planted surrounding some geothermal features. These features are vulnerable to pine invasion and/or shading. Other features are already dominated by exotic species (e.g. pasture grasses) and are grazed so are not currently vulnerable to pest plant invasion.	Monitor spread of wilding pines and blackberry. Control if it is invading into geothermal vegetation.	Medium	Lower	This site was not field surveyed in 2014.  2011 assessment: Blackberry has been sprayed and radiata pine has been planted adjacent to and within the site. Vegetation clearance and herbicide application on some geothermal vegetation has occurred.	2011 Assessment: Areas mapped as 'B' in Wildland Consultants (2014) are grazed by cattle.
						Pest animals	Rabbits	Rabbit are present in geothermal areas with some burrows present.	Rabbit control should be undertaken in geothermal sites and adjacent pasture.	Medium	Lower		
						Domestic stock	Medium	Stock have access to many of the geothermal features at this site.	Fencing of all areas of geothermal vegetation and geothermal features not currently fenced to exclude stock will allow geothermal vegetation to re-establish around these features.	Medium	Medium		
<b>Atiamuri Geothermal Field</b>													
ATV01	Upper Atiamuri West	Unprotected private land	<0.1	Local	Upper Atiamuri West is a small area of geothermal habitat, a nationally uncommon habitat type. However the geothermal features are very small and highly modified, with few indigenous species present.	Pest plants	Lower	The site is already dominated by exotic plant species, notably blackberry, so is not very vulnerable to further modification by pest plants.	Pest plant control and restoration of the adjacent gully margins with geothermal habitat and features could be considered, however this site is not a priority for management.	Lower	Lower	This site has only been assessed once (in 2007), but any significant recent change is unlikely.	
						Pest animals	No threat	Few indigenous plant species are present, and the vegetation is dominated by exotic species, so grazing pest animals are not currently a threat.	No action required.	N/A	N/A		
						Domestic stock	No threat	The site is fenced and stock are excluded.	No action required. Ensure fences are maintained.	N/A	N/A		
ATV02	Whangapoa Springs	Protected (Whangapoa Springs Scientific Reserve) and unprotected private land	c.0.1	Regional	The site comprises geothermal pools with prostrate kānuka and one small population of the <i>Nephrolepis flexuosa</i> on their margins. Both species are classified 'At Risk' species.	Pest plants	Medium	Scattered blackberry is present around the northern pool. If monitoring and control of blackberry is not continued it may re-establish at this site, and impact recent restoration plantings.	Continue to control blackberry.	Medium	Medium	This site was not field surveyed in 2014.  2011 assessment: the condition of the vegetation surrounding these pools has improved greatly since 2003. The blackberry and broom has been controlled and planting of indigenous tree species has taken place.	
						Pest animals	Medium	Recent plantings of indigenous species may be vulnerable to grazing by pest animals.	Monitor the site and, if necessary, conduct pest animal control.	Lower	Lower		
						Domestic stock	No threat	The site is securely fenced and stock are excluded.	Ensure fences are maintained.	N/A	N/A		
ATV03	Matapan Road	Unprotected private land	<0.1	Local	This site is a very small area of geothermal habitat, a nationally uncommon habitat type.	Pest plants	Medium	Creeping bent and Yorkshire fog may encroach on the spring and thermal stream margins.	Pasture species could be controlled and the site restored using appropriate indigenous species. However, this site is not a priority for management.	Lower	Lower	This site was not field surveyed in 2014.  2011 assessment: the site had not been assessed prior to 2011, but it is	

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						Pest animals	Unknown	Pest animals may be present, but no effects were observed.	No action required.	N/A	N/A	unlikely to have undergone significant recent change within the last ten years.	
						Domestic stock	Medium	The site is not fenced and is located within grazed pasture.	If the site is fenced it will need to be regularly inspected to detect and control pest plants, if necessary. However, this site is not a priority for management.	Lower	Lower		
<b>Te Kopia Geothermal Field</b>													
TKV01	Te Kopia	Protected (Te Kopia Scenic Reserve) and unprotected private land	c.64.3	International	This site has the best remaining, good quality, relatively large area of geothermal vegetation that forms part of an indigenous ecological sequence including geothermal vegetation (prostrate kānuka, geothermal wetland and nonvegetated raw-soilfield) through to indigenous forest. It also has one of the largest populations of <i>Dicranopteris linearis</i> and prostrate kānuka in New Zealand (both species are 'At Risk'). It also contains populations of five other 'At Risk' species: <i>Nephrolepis flexuosa</i> , <i>Calochilus paludosus</i> , <i>C. robertsonii</i> , <i>Korthasella salicornioides</i> and <i>Schizaea dichotoma</i> .	Pest plants	High	The invasion of wilding pines is a continuing threat to this area, and there is potential for pest plant invasion along the walking tracks. Blackberry and gorse are also present on margins.	Continue ongoing control of wilding pines. Blackberry and gorse should be monitored and controlled if spreading into geothermal areas.	High	High	The Department of Conservation has undertaken pest plant control (particularly control of wilding pines) in the best examples of geothermal habitat.	Extensive control of wilding pines has been undertaken by the Department of Conservation. Requires ongoing monitoring and follow-up control of regenerating wilding pines for the foreseeable future.
					Pest animals	Medium	Pigs and deer are known to be present and are likely to damage and have negative effects on the regeneration of the geothermal vegetation. If wallabies spread into this area, they are likely to cause considerable damage to the geothermal vegetation and habitats present.	Pigs and deer populations should be monitored regularly and controlled when necessary. Monitor wallabies and control if they are present.	Medium	Medium			
					Domestic stock	No threat	The reserve is fenced to exclude stock.	Fences should be inspected regularly and, if necessary, repaired. Fencing is vulnerable to damage by treefall and expansion of blackberry on site margins.	Medium	Medium			
TKV02	Murphy's Springs	Unprotected private land	c.0.2	Regional	Murphy's Springs is in poor ecological condition but contains a relatively large population of <i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species.	Pest plants	Medium	Plantation pines occur over indigenous shrubland. The site may be vulnerable to a further harvesting and planting of pines at this site.	Pines should be controlled. Pines should be felled away from geothermal features to avoid damaging indigenous vegetation and <i>Christella</i> aff. <i>dentata</i> ("thermal"), where possible.	Medium	Medium	This site was field surveyed for the first time in 2011. Some recent felling of pine trees into geothermal areas was evident.	
					Pest animals	Lower	Possum sign has been observed at the site. Deer and pigs are also likely to be present. If wallabies spread into this area, they are likely to cause considerable damage to the geothermal vegetation and habitats present.	Pest animal control may reduce threats to the ecological values of the site, particularly the population of <i>Christella</i> aff. <i>dentata</i> ("thermal") present.	Lower	Lower			
					Domestic stock	Medium	The site is not fenced and cattle have access.	The site should be fenced to exclude stock.	High	High			
TKV03	Western Te Kopia	Unprotected private land	c.0.3	Local	Several gullies containing geothermal vegetation, isolated mud pools, and geothermally heated ground and small areas of sinter. It supports small populations of two 'At Risk' species: prostrate kānuka and <i>Nephrolepis flexuosa</i> .	Pest plants	Medium	Exotic pest plants are common, including blackberry, alder, cotoneaster, macrocarpa, Tasmanian blackwood, Mercer grass, and creeping bent.	The site would benefit from pest plant control (particularly of alder and cotoneaster).	Medium	Medium	This site has only been field surveyed as part of this study in 2010.  2011 assessment: The landowner has observed that the southern mud pool has become more vigorous in recent years.  This site comprises sites Te Kopia Northwest, Te Kopia West Mud Pools, and Te Kopia Red Stream from 2011.	
					Pest animals	Lower	Possum sign has been observed at the site.	Pest animal control may enhance the ecological values of the site.	Lower	Lower			
					Domestic stock	No threat	Most of this site is fenced to exclude stock, but some small features are unfenced.	Fences should be regularly inspected and maintained.	Lower	Lower			
TKV06	Mangamingi Station	Unprotected private land	c.0.5	Local	Mangamingi Station supports small populations of two 'At Risk' species, prostrate kānuka and <i>Dicranopteris linearis</i> .	Pest plants	Medium	While the site is grazed, it is not highly vulnerable to pest plants.	Blackberry should be controlled. If the site is fenced it will be important to monitor the site for pest plants (particularly	Lower	Lower	The site has only been field surveyed as part of this study in 2010. This site is unlikely to have undergone significant recent change.	

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									blackberry, wilding pines, and Spanish heath).				
						Pest animals	Lower	The site is already grazed by sheep which requires management before pest animals would be an issue.	No action required.	N/A	N/A		
						Domestic stock	High	The site is grazed by sheep which are causing trampling damage and impacting on natural regeneration of indigenous geothermal vegetation.	The ecological condition of this site will improve markedly and populations of 'At Risk' species would be likely to expand if it is fenced to exclude stock.	Medium	Medium		
<b>Orakeikorako Geothermal Field</b>													
OKV01	Waihunuhunu	Unprotected private land	2.8	National	This site contains good populations of four 'At Risk' species: <i>Christella</i> aff. <i>dentata</i> ("thermal"), <i>Cyclosorus interruptus</i> , <i>Dicranopteris linearis</i> , and <i>Nephrolepis flexuosa</i> . It also contains a good quality example of geothermal wetland habitat.	Pest plants	Medium	Grey willow and crack willow are common in the wetland and around the geothermal stream. Plantation pine forest bounds part of the site, so it may be vulnerable to wilding pine invasion.	Control grey willow and crack willow.	High	High	There has been little change to the site since it was previously visited in 2007. The density of blackberry has increased around the margins of the stream, making access to the upper reaches and hot springs difficult in 2014.	
						Pest animals	Unknown	Feral pig sign was noted. Deer, and possums may be having adverse impacts on the site.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV02	Akatere Stream	Unprotected private land	1.4	Regional	<i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species is scattered alongside stream margins throughout this site. <i>Cyclosorus interruptus</i> and <i>Dicranopteris linearis</i> , also 'At Risk' species, have been recorded in the past.	Pest plants	Medium	The site is already highly modified by pest plants such as blackberry, pampas, grey willow, buddleia, Himalayan honeysuckle, cotoneaster, black wattle, and wild kiwifruit.	Implement pest plant management.	Medium	Medium	Apart from a decline in the abundance of <i>Christella</i> aff. <i>dentata</i> ("thermal"), there has been little change.	
						Pest animals	Unknown	Signs of pest animals were not apparent when the site was inspected.	Pest animal control may enhance the ecological values of the site if they are present.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV03	Orakeikorako	Unprotected private land and Protected (Whirinaki Stream Marginal Strip)	c.46.8	National	This site is one of the best examples of geothermal vegetation and features in the Waikato Region. It supports populations of four 'At Risk' species: prostrate kākūka, <i>Schizaea dichotoma</i> , <i>Christella</i> aff. <i>dentata</i> ("thermal") and one of the largest populations of the <i>Dicranopteris linearis</i> in New Zealand. It also supports a number of other notable geothermal plant species and a high diversity of geothermal features.	Pest plants	Medium	Wilding pines have been controlled and have reduced in abundance and extent since previous survey in 2004. However, pampas has become established in places following pine control. The site remains vulnerable to expansion of existing pest plant infestations. Vegetation on the western side of the river has localised patches of pest plants including maritime pine, black wattle, blackberry, Japanese honeysuckle, and bamboo.	Exotic pines and pampas should be removed from all geothermal areas. If pines are not removed then many of the ecological values present at this site will be markedly reduced. On the west side of the river, maritime pine, black wattle, blackberry, Japanese honeysuckle, and bamboo should be controlled.	High	High	Part of this site was field surveyed in 2014 and other parts were viewed from Lake Ohakuri.  The boundaries of the site have been updated following pine control using better quality 2012 aerial photographs. Since pine removal, the boundaries of geothermal vegetation are much easier to identify on aerial photographs. The most significant real change to the site is the management of pine trees on the eastern side of the river/lake, which has greatly improved the ecological character of the site.	Total control of wilding pines and pampas should be implemented within the geothermal area at Orakeikorako.
						Pest animals	Medium	Pigs and deer are known to be present and are likely to have negative effects on the regeneration of the geothermal vegetation.	Pest animal control, particularly of pigs, may enhance the ecological values of the site.	Medium	Medium		
						Domestic stock	No threat	Stock have access to the parts of this site on the western side of Lake Ohakuri. These areas should be a high priority for fencing.	The ecological condition of this site will improve markedly and populations of 'At Risk' species would be likely to expand if it is fenced to exclude stock.	Medium	Medium	Pine control has been undertaken at this site as recently as winter 2013. Recent (2014) control of pampas has been carried out by Waikato Regional Council but was not completed due to time and weather constraints. Otherwise, change in pest plant cover and extent is	

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												considered to be minimal since the 2007 survey.  An additional area of geothermal vegetation was identified and added to the site, north of the existing area on the western side of Lake Ohakuri. This area was unknown to the authors when undertaking previous work (Wildland Consultants 2012).	
OKV04	Red Hills	Protected private land (Orakei Korako Conservation Covenant)	c.13.1	National	This site together with Orakeikorako comprises one of the best areas of geothermal vegetation in Waikato Region. Much of Red Hills is dominated by extensive areas of prostrate kānuka, an 'At Risk' species. There are good populations of <i>Christella</i> aff. <i>dentata</i> ("thermal"), and <i>Dicranopteris linearis</i> is present (both species are classified 'At Risk').	Pest plants	Medium	Wilding pines have been controlled within this site and have been significantly reduced in extent since 2011. However, this site is vulnerable to reinvasion of wilding pines and pampas. Wilding pines threaten the indigenous character of the site and are likely to adversely affect indigenous geothermal vegetation through shading and tree fall.	Control populations of exotic pines (maritime pine and radiata pine) and Chinese privet.	High	High	Land that includes this site has been returned to Ngati Tahu-Ngati Whaoa as part of their Treaty of Waitangi settlement. No real changes to the extent of geothermal manifestations at this site are known. Any changes made to site boundaries are based on higher quality aerial photographs, rather than any real change to geothermal extent.  Control of exotic pines has been undertaken by DOC and Ngati Tahu-Ngati Whaoa since 2011. Pine control has improved the ecological condition of the site since it was previously surveyed.  Pampas control was undertaken by Waikato Regional Council in 2013.	Follow-up pine control by Ngati Tahu-Ngati Whaoa is planned for 2015 for pines missed during the 2013 (and previous years) operations.  Regular monitoring should be undertaken with follow-up control as required.
						Pest animals	Medium	Pig sign was observed (rooting, rubbing, and scat) and deer are known to be present. Both species are likely to have negative effects on the regeneration of the geothermal vegetation. Possum runs were also noted.	Pest animal control, particularly of pigs, deer, and possums, may enhance the ecological values of the site.	Medium	Medium		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV05	Akatarewa East	Unprotected private land	0.1	Local	Akatarewa East comprises a small example of geothermal vegetation, which is a nationally uncommon habitat type. It also provides habitat for two 'At Risk' flora species: prostrate kānuka and <i>Dicranopteris linearis</i> .	Pest plants	Medium	Radiata pine is present on less geothermal-active areas of the site, and Spanish heath is scattered throughout. Buddleia and blackberry are also present. Radiata pines have the potential to spread further and to shade the geothermal vegetation.	The radiata pine should be removed.	Lower	Lower	This site was not field surveyed in 2014.  There is no known ecological information for this site prior to the 2011 study. This site is unlikely to have undergone significant recent change.	
						Pest animals	Lower	The site is grazed by domestic stock, so management of pest animals is not a priority unless the site is fenced to exclude stock.	No action required.	N/A	N/A		
						Domestic stock	Medium	This site is unfenced and grazed, although parts of the site are too steep for stock to access.	The site requires fencing and should be retired from grazing.	Medium	Lower		
<b>Ngatamariki Geothermal Field</b>													
NMV01	Waikato River Springs	Unprotected private land	c.0.4	Regional	Waikato River Springs includes a small population of an 'At Risk' species, <i>Christella</i> aff. <i>dentata</i> ("thermal"). North Island fernbird, which is also classified as 'At Risk', has been recorded at the site.	Pest plants	Lower	Pest plant species such as reed sweetgrass and grey willow dominate much of the site.	Chinese privet, grey willow, and wilding pine could be controlled, but it is probably a major undertaking to control reed sweetgrass.	Lower	Lower	This site was not field surveyed in 2014.  This site is unlikely to have undergone significant recent change.	
						Pest animals	Unknown	This site is unlikely to be vulnerable to pest animals.	No action required.	N/A	N/A		
						Grazing by domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		

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NMV02	Orakonui <sup>2</sup>	Protected (Ngatamariki Hot Springs Scenic Reserve) and unprotected private land	c.0.9	Regional	The site supports populations of three 'At Risk' species: <i>Cyclosorus interruptus</i> , <i>Dicranopteris linearis</i> , and prostrate kānuka. It is also the best quality area of geothermal vegetation in the Ngatamariki Geothermal Field.	Pest plants	Medium	The site is surrounded by pine plantation and is vulnerable to wilding pine invasions.	Control all wilding pines.	High	High	Geothermal activity has changed the landforms and species composition of the southern part of this site (prior to 2011). A hydrothermal eruption has reformed a geothermal lake and mud pools, and deposited hydrothermal eruption debris.	The Department of Conservation has initiated some pine control at this site.
						Pest animals	Lower	Possum and deer sign have been recorded at the site.	Pest animal control may enhance the ecological values of the site	Medium	Medium		
						Domestic stock	No threat	Stock do not currently have access to this site. Fencing on nearby farmland should be checked to ensure stock do not have access to this site.	No action required.	N/A	N/A		
<b>Whangairorohea Geothermal Field</b>													
WGV01	Whangairorohea	Unprotected private land	<0.1	Local	Whangairorohea is a small site that comprises a geothermal pool within plantation radiata pine forest. The site is a small example of geothermal habitat, a nationally uncommon habitat type.	Pest plants	Lower	Spanish heath, buddleia, and blackberry are present on the margins of the pool.	Pest plant control would improve site values.	Lower	Lower	Vegetation has been cleared from part of the site since 2010.	
						Pest animals	Lower	Much of the vegetation surrounding the pool is exotic and impacts are likely to be minor.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
<b>Reporoa Geothermal Field</b>													
RPV01	Longview Road	Protected (Molloy Conservation Covenant)	c.5.9	Regional	This is the largest continuous example of geothermal vegetation associated with the Reporoa Geothermal Field. Prostrate kānuka, an 'At Risk' species has been recorded from this site in the past.	Pest plants	Medium	Blackberry, if left uncontrolled, is likely to spread further at the site. Alteration of water tables (e.g. farm drains) may be a key issue for management of blackberry at this site.	Monitor spread of blackberry and control if it invades geothermal vegetation.	Medium	Medium	Based on an assessment of aerial photographs, and 2014 field work, this site does not appear to have changed since 2004. Fencing surrounding the largest geothermal features requires maintenance.	Some grazing occurs around streams and constructed drains that contain geothermal water outside of the main geothermal site.
						Pest animals	Unknown	Possums are present. Deer and pigs may also be occasionally present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Medium	The fences surrounding the site require maintenance, although no stock impacts were found in the covenanted area.	The margins of the heated creeks/channels need to remain fenced to exclude grazing animals. Fences should be monitored and maintained.	Medium	Medium		
RPV02	Wharepapa Road	Unprotected private land	c.3.4	Part Regional/ part Local	This site contains a small population of the 'At Risk' species, prostrate kānuka, and an area of nationally uncommon habitat type - geothermal habitat.	Pest plants	Medium	Exotic species including rank pasture grasses, blackberry, and wilding pines are present. The site is highly degraded so is only moderately vulnerable to further modification by pest plants.	Wilding trees should be controlled. Blackberry should be monitored and controlled if it is spreading into geothermal areas.	Medium	Medium	This site was not field surveyed in 2014.  2011 assessment: Additional features were identified during the 2010 survey. These are not new features and would have been present in earlier surveys.	Rubbish disposal and drainage have adverse effects at this site. Harvesting of pine trees has caused considerable damage to geothermal features at one location.
						Pest animals	Lower	Pest animals are likely to be present, but grazing by stock is currently having a greater impact.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Medium	Most of the features are fenced but the fences are in poor condition so stock have access to geothermal features.	Fences should be repaired and maintained to exclude stock. Parts of the site currently grazed should be fenced.	Medium	Medium		
RPV03	Golden Springs	Unprotected private land	c.0.7	Part Regional/ part Local	Golden Springs supports a population of <i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species.	Pest plants	High	The populations of <i>Christella</i> aff. <i>dentata</i> ("thermal"), east of SH5 are vulnerable to pest plant invasion, but other parts of the site are already highly degraded by pest plants such as blackberry, Chinese privet, grey willow, Japanese honeysuckle, and ivy.	The site is small and highly degraded but would benefit from pest plant control.	Medium	Medium	Most of the vegetation that was previously unfenced on the western side of State Highway 5 has now been fenced.	
						Pest animals	Lower	The site is unlikely to be significantly vulnerable to pest animals, compared with impacts of farming.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Medium	Almost all the geothermal vegetation and habitats at this site are now	Fencing should be inspected regularly and maintained as	Lower	Lower		

<sup>2</sup> Previously called Ngatamariki in earlier reports (e.g. Wildlands Consultants 2011 and 2012a).

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<b>Ohaaki Geothermal Field</b>													
OHV01	Ohaaki Steamfield West	Unprotected private land	c.11.6	Regional	This site contains a relatively large population of prostrate kānuka, and a small population of <i>Dicranopteris linearis</i> (both 'At Risk' species). The site comprises a relatively large example of a nationally uncommon vegetation type - geothermal habitat.	Pest plants	High	The site is vulnerable to the continued spread and reinvasion of pest plants, particularly wilding pines and pampas.	Maintain ongoing control of wilding pines and pampas. Monitor other pest plants and control if necessary.	High	High	This site was not field surveyed in 2014, however changes due to land subsidence were evident in an assessment of 2012 aerial photographs.  Ongoing pampas and wilding pine control is being undertaken by Contact Energy. The area next to Ohaaki Marae has been maintained free from pines since pine control was undertaken by Waikato Regional Council in 2011. Inspection of 2012 aerial photographs indicates that an area of prostrate kānuka has recently been cleared for access tracks and laying of pipe. A prostrate kānuka population has established on bare ground near the marae, where it had been previously mapped as nonvegetated raw-soilfield.  A small, previously unknown area of geothermal vegetation has been added to the site in 2014 based on inspection of 2012 aerial photographs. It is located to the south of other areas previously mapped as part of this site.	
						Pest animals	Lower	Pest animals are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OHV02	Ohaaki Steamfield East	Part unprotected private land, part protected (QEII)	c.6.4	Regional	This site is a relatively large example of geothermal habitat that contains a good population of prostrate kānuka, an 'At Risk' species.	Pest plants	High	Parts of the site are dominated by pest plants, particularly blackberry and wilding pines, but there are areas of prostrate kānuka scrub and shrubland and nonvegetated raw-soilfield that remain vulnerable to pest plant invasion. The recently bulldozed tracks that have been pushed into the site also provide sites for pest plant establishment.	Maintain ongoing control of wilding pines and pampas. Monitor spread of blackberry, broom, and gorse and control invasions within prostrate kānuka scrub and shrubland and nonvegetated raw-soilfield. Monitor and control pest plants establishing on tracks.	Medium	Medium	This site was not field surveyed in 2014. Some blackberry control and earthworks were evident on 2012 aerial photographs (WRAPS 2012).  Ongoing pampas and wilding pine control is being undertaken by Contact Energy. The area next to Ohaaki Marae has been maintained free from pines since pine control was undertaken by Waikato Regional Council in 2011.  2011 assessment: With no geothermal wastewater dumping at the site, 'artificial' geothermal water is no longer present. Vegetation change has occurred since the site was last mapped in 2004. Prostrate kānuka has become established on part	
						Pest animals	Lower	Pest animals are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Lower	Most of the site is fenced to exclude stock. If the part of the site to the south (which is currently grazed by cattle) was fenced, then indigenous geothermal vegetation could expand in this area.	Fence the parts of the site that are grazed. However, this is not a priority management action.	Lower	Lower		

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												of what was previously nonvegetated raw-soilfield. Blackberry appears to have increased in dominance, particularly in the southern half of the fenced portion of the site.	
<b>Wairakei-Tauhara Geothermal Field</b>													
THV01	Otumuheke	Protected (Patuwi Marginal Strip) and unprotected private land	c.2.3	Part National/ part Local	This site contains sizeable populations of two 'At Risk' species: <i>Cyclosorus interruptus</i> , and <i>Christella</i> aff. <i>dentata</i> ("thermal"). Other species present include <i>Nephrolepis flexuosa</i> and <i>Hypolepis dicksonioides</i> , which are also classified 'At Risk'. This site is the best quality example of geothermal wetland surrounding Taupō township and restoration of ecological values at the site would be valuable for educational purposes.	Pest plants	Medium	The site has already been degraded by surrounding urban land development and pest plants. However, remaining areas of indigenous vegetation are vulnerable to expansion of pest plant infestations.	Pampas and wilding pines should be controlled. Blackberry should be monitored and controlled if it spreads into geothermal areas.	High	High	Pest plant control has been undertaken at the site since 2011. A restoration plan has been prepared which provides guidance on how to manage the key threats to this site (Wildland Consultants 2012b). This plan is being implemented as a joint project between landowners, Waikato Regional Council, and volunteer groups.	Care should be taken during pest plant control to protect populations of threatened species in this area including <i>Nephrolepis flexuosa</i> , <i>Christella</i> aff. <i>dentata</i> ("thermal"), <i>Hypolepis dicksonioides</i> , and <i>Cyclosorus interruptus</i> .
						Pest animals	Unknown	No evidence of adverse effects caused by pest animals were observed at the site.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A	The most noticeable change at this site comprises the removal of pines from gully walls, particularly in the upper stream gully and pampas control.	
THV03	Spa Thermal Park	Unprotected private land	c.1.4	Local	Spa Thermal Park comprises a small area of degraded geothermal vegetation but it includes a small population of prostrate kānuka, an 'At Risk' species.	Pest plants	High	As this site appears to have cooled, exotic pest plants have spread into the site.	Control wilding pines, silver birch, broom, blackberry, ivy, German ivy, buddleia, Himalayan honeysuckle, and gorse. Not a priority for management.	Lower	Lower	Additional areas of historically active geothermal soils not previously known to the authors have been added to the site. Overall the site has not undergone any real change since 2011.	
						Pest animals	Lower	Pest animals may be present, but site is not a priority for management.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
THV04	Broadlands Road	Protected (Broadlands Road Geothermal Scenic Reserve) and unprotected private land	c.30.1	Regional	This site contains a large area of good quality prostrate kānuka (an 'At Risk' species) scrub and shrubland. It also comprises a relatively large area of geothermal habitat - a nationally uncommon vegetation type.	Pest plants	High	Invasive exotic species include blackberry, wilding pines (radiata pine and maritime pine), strawberry tree, grey willow (seedlings), and occasional broom. The continued spread of pest plants has the potential to alter the indigenous character of the site.	Wilding pines should be controlled. Blackberry, gorse, and broom should be monitored and controlled if they spread into geothermal areas.	Medium	Medium	This site was not field surveyed in 2014. It is unlikely that any significant ecological or management changes have occurred at this site. A small area of vegetation clearance was evident on 2012 aerial photographs (WRAPS 2012).	
						Pest animals	Low	Pest animals may be present at the site, but the type of vegetation present is not a high priority for active management.	No action required.	Lower	Lower		
						Domestic stock	Low	A very small proportion of the site is grazed.	Most of the site has been fenced to exclude stock. However small areas to the east of the reserve are accessible to stock. Existing fences should be checked and maintained.	Lower	Lower		
THV05	Crown Park	Protected (Taupo District Council Reserve)	c.0.9	Local	This small site includes a small area of prostrate kānuka shrubland. Prostrate kānuka is an 'At Risk' species.	Pest plants	High	The site is threatened by the continued spread of exotic pest plants into the site e.g. blackberry, wilding pines.	Control of pest plants has greatly enhanced the viability of this site. Ongoing control of pest plants, including blackberry, banksia, wilding pines, flowering cherry, eucalyptus, Chinese privet,	Lower	Lower	Waikato Regional Council has undertaken pest plant control at this site, particularly the removal of large exotic pines surrounding the site. Follow-up control of broom	

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									silver birch, Khasia berry, Himalayan honeysuckle, and pampas is recommended.			and pine seedlings has also been undertaken. Rubbish has also been removed from the site by the Waikato Regional Council.	
						Pest animals	Unknown	No pest animals were noted, but may be present in low numbers.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A	One small area of prostrate kānuka has been cleared for a BMX track.	
THV06	Crown Road	Unprotected private land	c.20.4	Regional	This site contains a relatively large example of shrublands of the 'At Risk' prostrate kānuka. It also contains a small population of the 'At Risk' <i>Dicranopteris linearis</i> . Although degraded in habitat by the spread of pest plants and ongoing grazing by stock, the site comprises a relatively large area of vegetation influenced by geothermal activity - a nationally uncommon habitat.	Pest plants	High	The most abundant pest plants at the site are broom and blackberry. Chinese privet, wilding pines, and buddleia are also present. This site is vulnerable to further pest plant invasion because of continual disturbance, particularly in the south-western area (motocross track and neighbouring industrial area).	If control measures are undertaken to reduce pest plants the ecological values of the site are likely to improve markedly. If areas are fenced to exclude stock they will need to be regularly monitored to detect and control pest plant invasions.	High	High	This site was not field surveyed in 2014.	Activities that have caused clearance of geothermal vegetation include a motorcross track, development of an industrial area, and construction of a highway that bisects the site. Parts have also been affected by fire.
						Pest animals	Lower	Pest animals are present at the site: rabbits were observed.	Pest animal control may enhance the ecological values of the site.	Lower	Lower	2011 assessment: Approximately 1.5 ha of geothermal vegetation has been cleared since 2004. The loss was due, in part, to road construction and development of an industrial subdivision.	
						Domestic stock	Medium	Domestic stock have previously had access to parts of the site, where they have damaged indigenous geothermal vegetation by trampling and grazing. It appears that most of the site is not currently grazed.	Fencing to exclude domestic stock from parts of the site still grazed by stock would greatly improve the ecological values of the site.	Medium	Medium	Prostrate kānuka shrubland is still recovering after a fire in 2002. Parts of the site on the western side of the new highway are now fenced to exclude stock.	
												Waikato Regional Council has recently commenced work to control wilding pines and broom on land adjoining the new highway.	
												The boundaries of geothermal vegetation have been revised based on 2012 aerial photographs (WRAPS 2012). The boundary of prostrate kānuka scrub is much clearer on 2012 photographs than photographs available for earlier surveys.	
THV07	Waipahihi Valley	Protected (Waipahihi Stream Conservation Area) and unprotected private land.	c.0.3	Regional	This site contains small populations of three 'At Risk' species: prostrate kānuka, <i>Cyclosorus interruptus</i> , and <i>Hypolepis dicksonioides</i> .	Pest plants	High	<i>Cyclosorus interruptus</i> is potentially vulnerable to invasion of pest plants, particularly the recent spread of buffalo grass at the site. The geothermal spring is fenced but the surrounding area has been planted with exotic trees including olive, wilding pines, and ornamental cherry. The invasive <i>Cyperus involucratus</i> appears to be increasing in extent at this site. There has been some work to control blackberry. Other pest plant species include radiata pine, pampas, Khasia berry, agapanthus, periwinkle, and ivy.	Control pest plants at the site.  A conservative approach should be taken to controlling pest plants around <i>Cyclosorus interruptus</i> populations, to minimize the risks associated with sudden exposure of <i>Cyclosorus interruptus</i> to summer heat or winter frosts.	High	Immediate	Pest plant control has reduced the blackberry infestation located west of the spring area. Other pest plants have increased in cover, most notably <i>Cyperus involucratus</i> and buffalo grass.	Control of pest plants should be carried out in a manner that does not threaten the small populations of the threatened fern species present.
						Pest animals	Lower	Pest animals are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Grazing is not currently a threat at this site. Areas of the site that adjoin farmland are fenced to exclude stock.	No action required.	N/A	N/A		
WKV01	Te Rautehuia	Unprotected private land	c.7.8	Regional	This site is a relatively large example of geothermal vegetation and contains	Pest plants	Medium	The spread of pest plants, particularly wilding pines, threatens to alter the indigenous character of the site.	Remove wilding pines which are a key threat to the site.	High	Medium	This site was not field surveyed in 2014.	Consult landowner regarding management of geothermal features at

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					populations of three 'At Risk' species: <i>Nephrolepis flexuosa</i> , <i>Dicranopteris linearis</i> , and prostrate kānuka.	Pest animals	Lower	The site is not highly vulnerable to pest animals compared to impacts of domestic stock.	Pest animal control may enhance the ecological values of the site if/when stock have been excluded.	Lower	Lower	2011 assessment: Radiata pine and maritime pine continue to invade naturally occurring geothermal vegetation, particularly prostrate kānuka scrub and shrubland. Deer tracks and signs of trampling were seen throughout the fenced prostrate kānuka shrubland. Blackberry is scattered through parts of the prostrate kānuka shrubland.	this site, in conjunction with site WKV02 (Te Rautehuia Stream).
						Domestic stock	Medium	2011 assessment: Stock (e.g. deer) have access to parts of the site, including parts that are fenced, and have caused significant damage to geothermal vegetation. The effects of stock access has also prevented geothermal vegetation from establishing around geothermal features.	Discuss with the landowner the desirability of excluding stock from fenced geothermal vegetation. Fence the remaining unfenced areas of geothermal vegetation.	High	High		
WKV02	Te Rautehuia Stream	Unprotected private land, Wairakei Tourist Park, Riparian Marginal Strip	c.1.9	Regional	This site comprises several geothermal areas surrounded by riparian margins, farmland, and plantation forest. It contains a population of <i>Nephrolepis flexuosa</i> and a moderate-sized population of prostrate kānuka. Both species are classified as 'At Risk'.	Pest plants	Medium	Wilding pines and blackberry are occasionally present but have the potential to spread further into geothermal vegetation and features and reduce the indigenous character of the site.	Control wilding pines and blackberry. Monitoring will be required if/when stock are excluded.	High	High	This site was not field surveyed in 2014.  2011 assessment: mixed fernland on the walls of the geothermal crater (NZTM E1867136 N5721902) appears to have been removed by natural geothermal activity (recorded in Wildland Consultants 2004). This area is now predominantly covered in nonvegetated raw soilfield with prostrate kānuka, mānuka, mingimingi, blackberry, broom, <i>Lycopodiella cernua</i> , and bracken scattered around the margins.	Consult the landowner regarding management issues at this site in conjunction with site WKV01 (Te Rautehuia).
						Pest animals	Lower	The site is not highly vulnerable to pest animals because it is being trampled and grazed by domestic stock.	Pest animal control may enhance the ecological values of the site if/when stock have been excluded.	Lower	Lower		
						Domestic stock	High	2011 assessment: the western part of this site is grazed and stock (e.g. deer) are causing significant vegetation disturbance and trampling and reducing the ability of geothermal vegetation to establish around geothermal features.	Construct fences to exclude domestic stock.	High	Immediate		
WKV03	Upper Wairakei Stream (Geyser Valley)	Protected (Wairakei Thermal Park)	c.4.9	Regional	This site contains populations of three 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate kānuka, and <i>Dicranopteris linearis</i> .	Pest plants	High	The site is already highly degraded by pest plants, but remaining areas of indigenous geothermal vegetation are vulnerable to invasion.	Pest plant control is required, including Tasmanian blackwood, wilding pines (radiata pine and lodgepole pine), brush wattle, false acacia, grape vine, purple pampas, tradescantia, heather, cotoneaster, blackberry, buddleia, and Spanish heath.	High	High	It appears that some minor weed control has occurred on the track margins, but the grape infestation has spread further into the site and the cover of Chinese privet has increased since 2011. False acacia is present in the prostrate kānuka-mingimingi scrub on the south side of the geothermal stream.	
						Pest animals	Lower	The indigenous vegetation and geothermal features are less vulnerable to the pest animals than pest plant threats to the site.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		The site is vulnerable to fire. A recent fire in 2012 has damaged prostrate kānuka scrub at this site.
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV04	Wairakei Borefield	Unprotected private land	<0.1	Local	Wairakei Borefield comprises two small patches of prostrate kānuka surrounded by an industrial site. Prostrate kānuka is an 'At Risk' species.	Pest plants	Medium	Broom and gorse are present but the regular disturbance associated with operation of the surrounding industry may provide further sites for weed establishment.	Control gorse and broom and minimise site disturbance. This site is a low priority compared with other geothermal sites.	Lower	Lower	Little change is evident.	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV05	Te Kiri O Hine Kai Stream Catchment/ Wairoa Hill	Unprotected private land	c.35.6	Regional	Although somewhat degraded in quality, this site comprises a relatively large area of geothermal vegetation - a nationally uncommon vegetation type. It contains populations of the following 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate	Pest plants	Medium - High	As a whole the site is moderately vulnerable to pest plants. However, the cooler margins are more vulnerable to pest plant invasions than areas where soil temperature is higher. Pest plants include wilding pines, blackberry, pampas, and Spanish heath.	Control wilding pines (radiata pine and maritime pine) which are currently at relatively low densities in warmer parts of the site, is a high priority. Monitoring and control of pines and blackberry on the margins is	High	High	Radiata pine growth since 2007 within mingimingi scrub at the southern end of the site has resulted in changing this vegetation type to (exotic pine)/ mingimingi-kānuka scrub. In the middle of this site, an	

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					kānuka, and <i>Dicranopteris linearis</i> . Some areas of prostrate kānuka contain few pest plants compared with some other geothermal sites.	Pest animals	Lower	Pest animals, particularly possums are likely to be present.	a medium priority. Pest animal control may enhance the ecological values of the site.	Lower	Lower	area recorded as prostrate kānuka-mingimingi scrub in 2007 is now classified as radiata pine/mingimingi forest.	
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV06	Lower Wairakei Stream	Unprotected private land	<0.1	Regional	This site provides small degraded areas of habitat for an 'At Risk' species, <i>Christella</i> aff. <i>dentata</i> ("thermal"). <i>Hypolepis dicksonioides</i> (also 'At Risk') has been recorded previously at the site.	Pest plants	Medium	This site is already in a poor ecological condition and pest plants are common, including blackberry, Himalayan honeysuckle, montbretia, Montpellier broom, lupin, tree lucerne, Japanese honeysuckle, gorse, buddleia, and pampas. The population of <i>Christella</i> aff. <i>dentata</i> ("thermal") remains moderately vulnerable to any expansion of these infestations.	Monitor the population of <i>Christella</i> aff. <i>dentata</i> ("thermal") and control any pest plant infestations that may threaten it. A conservative approach should be taken to controlling pest plants around <i>Christella</i> aff. <i>dentata</i> ("thermal") populations to minimise the risks associated with sudden exposure of <i>Christella</i> to summer heat or winter frosts.	Medium	Medium	There has been minor change to this site since earlier surveys.	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV07	Karapiti Forest	Unprotected private land	c.0.4	Local	This small site contains populations of two 'At Risk' species: prostrate kānuka and <i>Dicranopteris linearis</i> . No <i>D. linearis</i> was found in 2014 and it may no longer be present at this site.	Pest plants	Medium	The site is surrounded by pine forest, with a small infestation of wilding pines. Himalayan honeysuckle, broom, and blackberry are also present, but are mainly confined to the margins of the geothermal area. Management is a lower priority than other larger geothermal sites.	Control wilding pines in geothermal vegetation.	Lower	Lower	The site appears to be declining in ecological condition.	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV08	Hall of Fame Stream	Protected (Huka Falls Scenic Reserve)	c.0.4	Regional	This small geothermal site contains a very small population of the 'At Risk' fern <i>Christella</i> aff. <i>dentata</i> ("thermal").	Pest plants	Medium	The blackberry and Himalayan honeysuckle around stream margins have probably reduced the extent of habitat available to <i>Christella</i> aff. <i>dentata</i> ("thermal"). Chinese privet is emergent over <i>Christella</i> populations adjacent to the Waikato River.	Control blackberry downstream from the hot springs. Control of Chinese privet should be considered adjacent to the Waikato River.	Medium	Lower	Little change is evident to the site. An additional population of <i>Christella</i> aff. <i>dentata</i> ("thermal") was found adjacent to the Waikato River in 2014.	
						Pest animals	Lower	The site is modified and is not very vulnerable to further modification by pest animals.	Pest animal control may enhance the ecological values of the site, but this is a low priority compared with other geothermal sites.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV09	Waipouwerawera Stream/Tukairangi	Protected (Waipouwerawera Stream Conservation Area)	c.0.1	Local	Waipouwerawera Stream/Tukairangi is a small area of geothermal vegetation in a degraded state - however geothermal vegetation is a rare vegetation type nationally. It contains a small population of an 'At Risk' species: prostrate kānuka. <i>Dicranopteris linearis</i> has been recorded from the site in the past.	Pest plants	Medium	Pest plants have spread at the site, possibly as a response to a decline in geothermal activity. This has the potential to continue, however this site is a low priority for management compared with other larger geothermal sites.	Wilding pines, blackberry, and broom should be controlled, but this site is a lower priority than for other geothermal sites.	Lower	Lower	This site was not field surveyed in 2014.	
						Pest animals	Lower	The site is highly modified and is not very vulnerable to further modification by pest animals.	No action required.	N/A	N/A	2011 assessment: The expansion of vegetation cover in the crater and a reduction in nonvegetated raw-soilfield suggests that the site has experienced reduced geothermal activity and that soil temperatures have decreased.	
						Domestic stock	Lower	The area is fully fenced and stock do not have access to this site.	No action required.	N/A	N/A		
WKV10	Craters of the Moon	Protected (Ministry of Tourism Reserve)	c.38.1	National	This site is a relatively large, good quality example of geothermal habitat and contains one of the best examples of thermotolerant vegetation	Pest plants	High	Pest plants occur at the site in low abundance (following recent management of pest plants), but have the potential to spread and to alter the indigenous character of the	Control small infestations of wilding pines (mostly radiata pines and maritime pines) and pampas. Control eucalypts, Chinese privet,	High	High	Some management of pest plants has been undertaken by site managers, and is ongoing. Techniques to discourage	Some control of pest plants has been undertaken.

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					zonation in response to soil temperature. Four 'At Risk' species are present: <i>Nephrolepis flexuosa</i> , prostrate kānuka, <i>Dicranopteris linearis</i> , and <i>Hypolepis dicksonioides</i> .			site.	tree lucerne, lupin, cotoneaster, Khasia berry, black wattle, grey willow, Himalayan honeysuckle, ornamental cherry, buddleia, blackberry, broom, and Spanish heath if/when they spread into additional geothermal areas. Control should be undertaken in a manner that minimises damage to populations of 'At Risk' plant species at the site.			use of informal tracks have been implemented by the Craters of the Moon Trust. In March 2011, Waikato Regional Council funded the control of pampas by aerial application of herbicide at this site.	
						Pest animals	Lower	Pigs, deer, and possums are likely to damage and have negative effects on the regeneration of the geothermal vegetation present. Rabbits and hares are also present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
THV08	Mountain Road	Road Reserve, Unprotected private land	c.0.1	Local	Several small areas of nonvegetated raw-soilfield, prostrate kānuka (an 'At Risk' species) shrubland, and geothermal mossfield.	Pest plants	Lower	Blackberry and broom are present, but are not significantly affecting geothermal vegetation and habitats.	No action required.	Lower	Lower	Not assessed prior to 2014.	
						Pest animals	No threat	No threat	This site is highly modified and is currently more vulnerable to grazing by domestic stock than by pest animals.	No action required.	N/A		
						Domestic stock	Medium	The site is not fenced and stock have access to the site.	Fencing is likely to enable indigenous vegetation to establish around geothermal features.	Lower	Lower		
THV09	Kathleen Springs	Protected (Taupo District Council Reserve)	c.0.1 ha	Local	Vegetation surrounding a small, historically active geothermal spring. A small population of prostrate kānuka is present (an At Risk species).	Pest plants	Medium	Pest plants are abundant at the site and are probably increasing in cover. Pest plants present include blackberry, radiata pine, maritime pine, Chinese privet, Khasia berry, Himalayan honeysuckle, silver birch, ornamental cherry, pampas, and strawberry tree.	Control pest plants. This site is a low priority for management compared with other geothermal sites in the Tauhara Geothermal Field.	Medium	Lower	Not assessed prior to 2014.	
						Pest animals	Lower	Pest animals such as possums are likely to be present.	No action required.	No action required	N/A		
						Domestic stock	No threat	The site is not farmed, or located near farmland.	No action required.	No action required	N/A		
<b>Rotokawa Geothermal Field</b>													
RKV01	Rotokawa North	Protected (Lake Rotokawa Conservation Area) and unprotected private land	c.40.1	Regional	An 'At Risk' species (prostrate kānuka) covers extensive parts of this site. A few plants of <i>Nephrolepis flexuosa</i> and <i>Dicranopteris linearis</i> (also 'At Risk' species) were recorded from the site in 2004.	Pest plants	High	Wilding pines are visually dominant, and are a serious threat to plant communities on cooler geothermal ground by shading prostrate kānuka scrub and shrubland. Grey willows are a threat to stream margins in northern parts of the site. Other invasive exotic plants present include pampas, broom, Himalayan honeysuckle, buddleia, pasture grasses, and blackberry.	Wilding pines and grey willow should be controlled.	High	High	Additional areas were added to the site in 2014 based on new information. The new areas are not the result of new geothermal manifestations but rather represent existing areas that have not previously been mapped. Other changes to site boundaries are based on better quality aerial photographs rather than real changes in the total extent of geothermal vegetation at the site.	
						Pest animals	Unknown	Pest animals were not observed at this site in 2014, but some species (e.g. pigs and deer) are likely to be present and adversely affecting the vegetation and habitats. Possum sign, pig sign, and rabbits were seen in the neighbouring site (Lake Rotokawa) in 2014.	Monitor and implement control as required.	Lower	Lower		
						Domestic stock	Lower	Stock have access to small parts of the site. Trampling can damage the geothermal vegetation.	Areas where stock have access should be fenced.	Medium	Lower		

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RKV02	Lake Rotokawa	Protected (Lake Rotokawa Conservation Area) and unprotected private land	c.74.7	National	An 'At Risk' species (prostrate kānuka), covers extensive parts of this site. The site also supports a relatively large population of <i>Calochilus robertsonii</i> , an 'At Risk' orchid species. While the vegetation is degraded in quality it comprises one of the largest areas of geothermal habitat - a nationally uncommon habitat type. North Island fernbird and pied stilt (both classed as 'At Risk') and banded dotterel (classed as 'Threatened') are present.	Pest plants	Medium	The site is already highly modified by pest plants but wilding pines are a serious threat to indigenous plant communities present, particularly on cooler geothermal ground or where prostrate kānuka scrub may be subjected to shading.	Exotic pines are visually dominant in places and should be controlled.	High	High	The quality of vegetation has improved over time as it re-establishes after a history of mining and road construction. Pine and other pest plant control has improved the indigenous character of this site in recent years.	Extensive control of wilding pines and other pest plants has been undertaken by DOC, but remains at high density in some places.
						Pest animals	Unknown	Possum sign, pig sign, and rabbits were seen in 2014. Deer are also likely to be present.	Monitor, and control as required.	Medium	Medium		
						Domestic stock	No threat	The site is fenced and neither stock nor stock damage was observed.	Ensure fences are maintained.	N/A	N/A		
<b>Tokaanu-Waihi-Hipaua Geothermal Field</b>													
TOV02	Hipaua	Unprotected private land	c.12.1	Regional	Hipaua is a relatively large area of geothermal habitat. It is an important habitat for an 'At Risk' species (prostrate kānuka). It is the only substantial example of prostrate kānuka in the Tongariro Ecological District. The vegetation is highly intact and displays good zonation. It is part of an extensive natural area extending from the shores of Lake Taupō to the summits of Kakaramea, Tihia and Pihanga.	Pest plants	Lower	The site is largely undisturbed by human activity and is surrounded by indigenous vegetation. There appears to be some pampas on photographs provided by Environment Waikato.	Pest plant surveillance and follow-up control as required.	High	Immediate	This site has not been field surveyed as part of this study.  Changes in site boundaries are primarily based on improved 2012 aerial photographs.	Access to this site was not granted, so the assessment has been compiled from existing literature, aerial photographs (2012 WRAPS), and a visual inspection from SH 41. A field survey would identify management requirements for this site, which should be considered a high priority for this site if access is granted by the landowners.
						Pest animals	Unknown	Unknown. Not field surveyed recently. Pigs and deer are likely to be present.	Survey site to assess impacts.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		
TOV03/ TOV04/ TOV05/ TOV06	Tokaanu Lakeshore Wetland	Unprotected private land and Protected (Tokaanu Recreation Reserve)	c.37.7	National	Tokaanu Lakeshore Wetland is an extensive area of raupō reedland on the shore of Lake Taupo. One 'Threatened' and two 'At Risk' bird species have been recorded in this wetland: New Zealand dabchick, spotless crane, and North Island fernbird. Australasian bittern (Threatened-Nationally Critical) is also present in the area. No threatened or at risk plant species are known from the site.	Pest plants	Lower	Pest plants are relatively rare in most of this site, with willow species (crack willow and grey willow) noted.	Grey willow and crack willow should be controlled.	Medium	High	This site was not field surveyed in 2014.  2011 assessment: No significant change is known to have taken place in this wetland in the last ten years.	
						Pest animals	Lower	Pest animals are unlikely to be a significant threat to this wetland.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		
TOV07	Maunganamu West	Protected (Tokaanu Public Garden Reserve) and unprotected private land	c.0.6	Regional	Maunganamu West is a small part of an extensive ecological sequence that extends from the shores of Lake Taupō to the summits of Kakaramea, Tihia, and Pihanga. The wetland vegetation is likely to provide habitat for fernbird and spotless crane (both classed as 'At Risk'). No threatened or at risk plant species are known from the site.	Pest plants	Medium	The main wetland is generally free of pest plants, although pest plants are present on margins and occasional crack willow is present in the wetland. Crack willow has the potential to spread further at this site. Other species present include blackberry and Japanese honeysuckle.	Crack willow should be controlled and the site should be monitored for other pest plants.	Lower	Lower	Unknown. This site was field surveyed in 2007. It is unlikely that this site has undergone any significant ecological change since then.	
						Pest animals	Lower	Pest animals are unlikely to be a threat to this wetland.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	This site is not grazed by stock.	No action required.	N/A	N/A		
TOV08	Tokaanu Thermal Park	Protected (Tokaanu Thermal Park Recreation Reserve administered by DOC) unprotected private land	c.7.2	Part Regional/ part Local	The site contains populations of three species ranked as 'At Risk' ( <i>Korthalsella salicornioides</i> , prostrate kānuka, and <i>Schizaea dichotoma</i> ). One other 'At Risk' species ( <i>Christella</i> aff. <i>dentata</i> ("thermal")) has been recorded in the past, but is now probably extinct at this site. This site is also part of an extensive natural area extending from the shores	Pest plants	High	Pest plants such as Japanese honeysuckle, ivy, exotic grasses, grey willow, and bamboo threaten the indigenous character of this high profile geothermal site. The tracks are a potential invasion site.	Control the pest plant species at the site and exotic ornamental trees. Avoid planting inappropriate species at the site.	High	Immediate	This site was not surveyed in 2014. Change at this site without field assessment is difficult to assess.  2011 assessment: Any changes to the boundary of geothermal vegetation are likely to be minor. Additional areas were	
						Pest animals	Lower	Pest animals are likely to be present, e.g. pigs and deer.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		

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					of Lake Taupō to the summits of Kakaramea, Tihia, and Pihanga and including Lake Rotopounamu and Lake Rotoaira.							added to this site in 2007, based on additional information on geothermal vegetation. However, this does not represent real change. The site was not reassessed in the field in 2010-2011, or in 2014.	
TOV09	Tokaanu Urupā Mud Pools	Protected (Tokaanu Hot-Springs Reserve)	<0.1	Regional	Tokaanu Urupā Mud Pools is a small part of an extensive ecological sequence that extends from the shores of Lake Taupō to the summits of Kakaramea, Tihia, and Pihanga. The ecological sequence includes extensive areas of geothermal habitat. Vegetation at the site comprises kānuka-dominated forest and no 'Threatened' or 'At Risk' species have been recorded.	Pest plants	Lower	The site is surrounded by indigenous vegetation and is in excellent condition. There is only scattered blackberry but it has the potential to spread further.	The site should be monitored, and pest plants should be controlled if they establish or if the blackberry spreads.	Lower	Lower	This site was field surveyed in 2007. It is unlikely that this site has undergone any significant ecological change since then.	
						Pest animals	Lower	No pest animal impacts noted in 2007.	No action required.	N/A	N/A		
						Domestic stock	Lower	Horses have been taken to the site, but there were no signs of horse grazing in the area when surveyed in 2007.	No action required.	N/A	N/A		
TOV10	Maunganamu East	Unprotected private land	<0.1	Local	Maunganamu East is a very small example of geothermal habitat, a nationally uncommon habitat type. The site comprises a small area of geothermal wetland.	Pest plants	Medium	Creeping bent is abundant. Blackberry, Japanese honeysuckle, and crack willow are also present.	Pest plant control may enhance the ecological values of the site.	Lower	Lower	This site was last field surveyed in 2007. It is unlikely that this site has undergone any significant ecological change since then.	
						Pest animals	Unknown	No pest impacts were noted.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		
TOV11	Maunganamu North Wetland	Protected (Tokaanu Thermal Park Recreation Reserve) and unprotected private land	1.4	Local	Maunganamu North Wetland is a small example of a nationally uncommon habitat type. No 'Threatened' or 'At Risk' species were noted during the 2007 but it is likely to provide habitat for wetland bird species, including spotless crane (an 'At Risk' species).	Pest plants	Medium	Crack willow was common in wetland.	The ecological value of the site would be improved if crack willow was controlled.	Lower	Lower	This site was last field surveyed in 2007. It is unlikely that this site has undergone any significant ecological change since then.	
						Pest animals	Unknown	A full site inspection has not been undertaken but pest animals are unlikely to be a notable threat to this site.	No action required.	N/A	N/A		
						Domestic stock	Medium	The site is not fenced and stock graze to its edges in 2007.	Fence the site to exclude stock.	Lower	Lower		
TOV14	Tokaanu Tailrace Canal	Unprotected private land	<0.1	Local	Tokaanu Tailrace Canal is a small geothermal site that occurs alongside an artificial tailrace canal.	Pest plants	Lower	Crack willow is common and has the potential to spread further.	Crack willow control would improve site values, but other geothermal sites are a higher priority for ecological restoration.	Lower	Lower	This site was last field surveyed in 2007. It is unlikely that this site has undergone any significant ecological change since then.	
						Pest animals	Unknown	No pest animal impacts were noted.	No action required.	N/A	N/A		
						Domestic stock	No threat	The site is not grazed by stock.	No action required.	N/A	N/A		
<b>Tongariro Geothermal Field</b>													
TGV01	Te Maari Craters	Protected (Tongariro National Park)	c.8.4	International	Te Maari Crater is within Tongariro National Park. It has remained largely undisturbed since a series of eruptions in the 1800s. It is a good quality example of geothermal habitat - a nationally uncommon habitat type.	Pest plants	Lower	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	This site was not surveyed in 2014. However, it appears additional geothermal habitat is present following the volcanic eruptions in 2012.	
						Pest animals	Lower	Hares and deer may graze the site.	Introduced mammals should be managed as part of the ongoing management of Tongariro National Park.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV02	Ketetahi	Unprotected private land	c.8.2	National	Ketetahi Hot Springs is a good quality example of a nationally uncommon habitat type - geothermal habitat. It is also one of series of geothermal features that extend into the surrounding Tongariro National Park.	Pest plants	Unknown	The site is largely unvegetated and pest plants are not likely to invade.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	This site has not been field surveyed as part of this project.	
						Pest animals	Lower	Hares and deer may graze the site.	Introduced mammals should be monitored and controlled.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV03	Emerald Lakes	Protected (Tongariro National Park)	c.11.2	International	Emerald Lakes comprises three crater lakes on Mount Tongariro and are surrounded by a good quality example of geothermal habitat - a nationally uncommon	Pest plants	No threat	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park. A small population of <i>Juncus bulbosus</i> was	Monitor for pest plants at five-yearly intervals.	N/A	N/A	This site was not field surveyed in 2014. It is unlikely that this site has undergone any significant ecological change since it	

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					habitat type.	Pest animals	Lower	present in the northernmost lake. Hares and deer may graze the site.	Introduced mammals should be managed as part of the ongoing management of Tongariro National Park.	Lower	Lower	was last field surveyed in 2011.	
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV04	Red Crater	Protected (Tongariro National Park)	c.0.8	International	This site contains geothermal habitat - a naturally rare habitat type.	Pest plants	No threat	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park	Monitor for pest plants at five-yearly intervals.	N/A	N/A	This site was not field surveyed in 2014. It is unlikely that this site has undergone any significant ecological change since it was last field surveyed in 2011.	
						Pest animals	Lower		No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		

## DESCRIPTION OF FIELDS USED TO ASSESS THE THREATS TO SITES WITH GEOTHERMAL VEGETATION IN THE WAIKATO REGION (APPENDIX 1)

Field	Description
Site Number	The number given to each geothermal site in Wildland Consultants (2014).
Site Name	The name given to each geothermal site in Wildland Consultants (2014).
Tenure	Tenure is shown as either protected or unprotected land, or both if applicable. If an area is protected, the type of protection (e.g. reserve, covenant) is shown.
Size	Extent of geothermal vegetation at each site is given in hectares.
Significance level	The significance level assigned to each site in Wildland Consultants (2014) based on the evaluation criteria defined in the Waikato Regional Policy Statement.
Key values of the site	An indication of why the site is significant including the presence of 'Threatened' and 'At Risk' species (as per de Lange <i>et al.</i> 2013 for plants and Robertson <i>et al.</i> 2013 for birds) that have been recorded from the site in Wildland Consultants 2014 and other surveys.
Threats	The threats to the ecological values of each geothermal site and geothermal features are listed under three headings: pest plants (weeds), pest animals, and domestic stock.
Vulnerability	The vulnerability of each site to each of the threat mechanisms is evaluated as follows: <ul style="list-style-type: none"> <li>- <i>High</i>: The indigenous plant community or geothermal feature is likely to undergo a significant decline in quality within the next five years if no measures are undertaken to control the threat.</li> <li>- <i>Medium</i>: The indigenous plant community or geothermal feature is likely to undergo a significant decline in quality in the next five to ten years if no measures are undertaken to control the threat.</li> <li>- <i>Lower</i>: The indigenous plant community is likely to undergo minor degradation due to the threat in the next ten years or so, or significant decline in quality over a longer period.</li> </ul>
Description of threats	A brief description of what impact each threat may have to the site if the threat is not effectively managed.
Action required	A brief description on what measures may be undertaken to reduce or remove the presence of a threat to the ecological feature or geothermal features at the site, if any. For each site, the management actions required to address the threats are described and the level of ecological benefit and the priority (urgency) of the actions are evaluated.
Ecological Benefit	The ecological benefit of controlling the threat(s) at each site is assessed as follows: <ul style="list-style-type: none"> <li>- <i>High</i>: The site has a high conservation value (Regional Significance Level or greater) and management of the threat is likely to significantly improve the viability of the indigenous geothermal vegetation and geothermal features at the site within the next five years.</li> <li>- <i>Medium</i>: The site has a high conservation value and management of the threat is likely to significantly improve the viability of the site in the next five to ten years, or</li> </ul>

	<p>The site has a moderate or lower conservation value and management of the threat is likely to significantly improve the viability and quality of the site within the next five years.</p> <ul style="list-style-type: none"> <li>- <i>Lower</i>: Management of the threat in any site category is likely to improve or maintain the viability of the site over a timeframe beyond the next ten years.</li> <li>- <i>Not applicable</i>: There is no perceived threat and/or no management action is required or recommended.</li> </ul>
Priority	<p>The priority for managing each threat at each site is assessed as follows:</p> <ul style="list-style-type: none"> <li>- <i>Immediate</i>: The highest priority sites for active management. These are generally of international or national significance, or large regionally significant sites. Includes sites where a relatively small investment in the short term may deal cost-effectively with a management problem or threat and avoid potentially more significant problems.</li> <li>- <i>High</i>: Generally sites of high ecological value (e.g. large regionally significant sites, nationally significant sites or better) where threats do not immediately threaten the site, but management will significantly improve the viability of key ecological features.</li> <li>- <i>Medium</i>: Sites of regional significance or better where management will significantly improve the long-term viability of ecological features at the site, or sites of local significance where the management action has the potential to improve the site so that it may, in future, meet the criteria for regional significance.</li> <li>- <i>Lower</i>: Either sites of local significance where management will improve the viability of ecological values or geothermal features, or sites ranked higher where management will improve ecological viability but will require the allocation of significant resources.</li> <li>- <i>Not applicable</i>: No obvious threats or no action required.</li> </ul>
Ecological Change and Management Since Previous Assessment (Wildland Consultants 2011):	Any change to ecological features of the site since the previous assessment, taking into consideration whether changes to site descriptions are real or based on better information for the site (e.g. better quality aerial photographs or identification of previously unmapped areas of geothermal vegetation). In addition, any management of ecological threats that has been undertaken since the previous surveys is noted.
Comments	Any further comments.

**LIST OF SITES WHERE NO FIELD WORK WAS UNDERTAKEN  
IN 2014, WITH YEAR OF MOST RECENT SURVEY**

2011-12 Study		2003-2007 Study		Not Surveyed Since 2003	
WAV02	Northern Paeroa Range	MKV01	Whakamaru	TOV02	Hipaua
WTV03	Waiotapu North	ATV01	Upper Atiamuri West	TGV02	Ketetahi
WTV04	Maungakakamea (Rainbow Mountain)	TOV03/	Tokannu Lakeshore Wetland		
WTV05	Waiotapu South	TOV04/			
MKV02	Waipapa Stream	TOV05/			
		TOV06			
MKV03	Tirohanga Road	TOV07	Maunganamu West		
MKV04	Paerata Road	TOV08	Tokaanu Thermal Park		
ATV02	Whangapoa Springs	TOV09	Tokaanu Urupā Mud Pools		
ATV03	Matapan Road	TOV10	Maunganamu East		
TKV02	Murphy's Springs	TOV11	Maunganamu North Wetland		
TKV03	Western Te Kopia	TOV14	Tokaanu Tailrace Canal		
TKV06	Mangamingi Station				
OKV03	Orakeikorako (western part surveyed in 2014)				
OKV05	Akatarewa East				
NMV01	Waikato River Springs				
RPV02	Wharepapa Road				
OHV01	Ohaaki Steamfield West				
OHV02	Ohaaki Steamfield East				
THV04	Broadlands Road				
THV06	Crown Road				
WKV01	Te Rautehuia				
WKV02	Te Rautehuia Stream				
WKV09	Waipouwerawera Stream/ Tukairangi				
TGV01	Te Maari Craters				
TGV03	Emerald Lakes				
TGV04	Red Crater				

