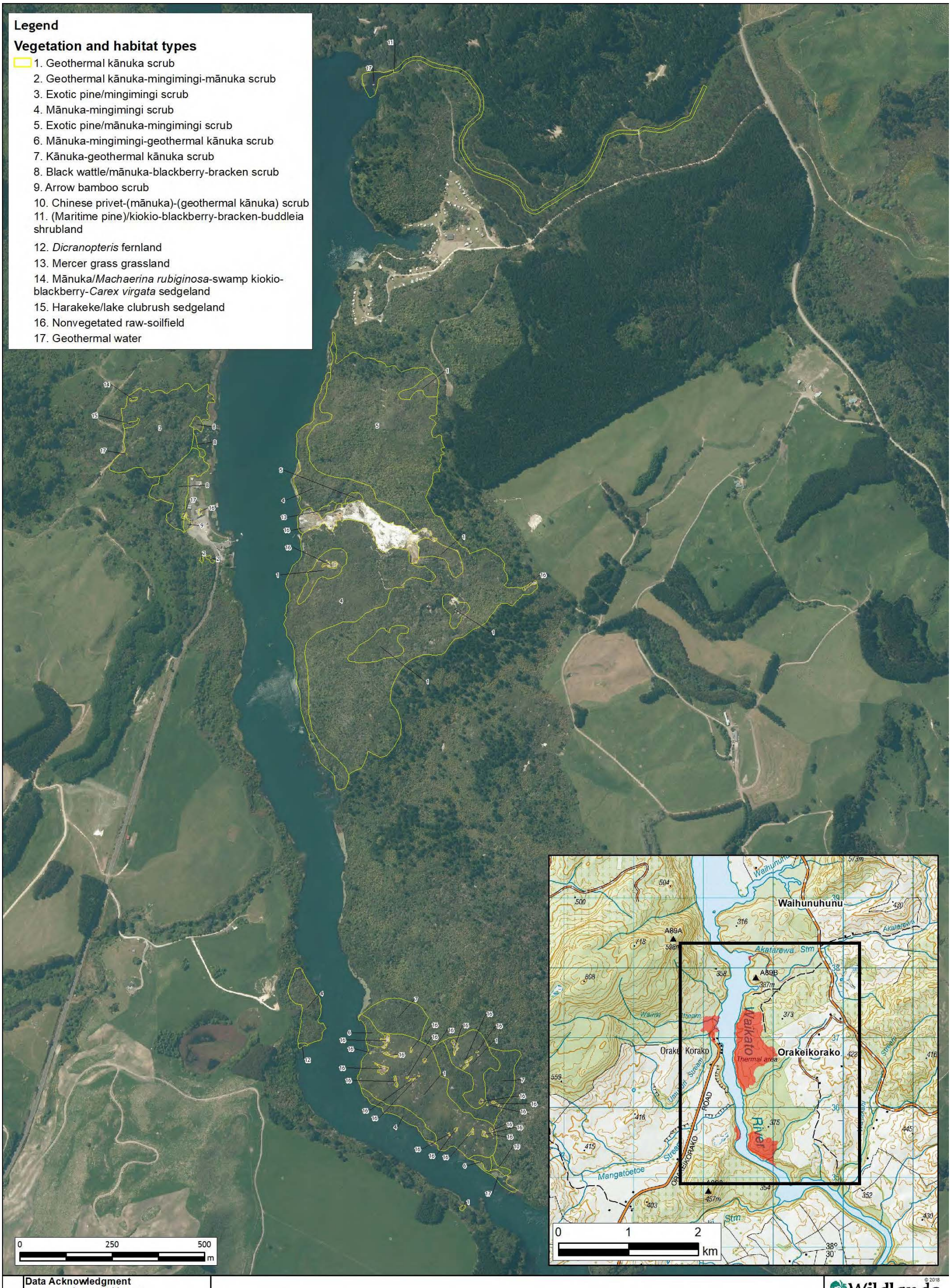

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Report: 4363
Client: WRC
Ref: 01 1769
Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017\
File: Orakeikorako.mxd

Orakeikorako

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Scale: 1:9,468
Date: 28/02/2018
Cartographer: JO
Format: A3

ORAKEIKORAKO

Area:	Geothermal Habitat: *c.*61.5 ha Geothermal Vegetation: *c.*61.3 ha
Geothermal Field:	Orakeikorako
Site Description:	Orakeikorako is an amalgamation of three sites assessed in Wildland Consultants (2014a): Akatarewa Stream, Orakeikorako, and Red Hills. Orakeikorako consists of unprotected private land, protected private land (Orakeikorako Conservation Covenant) and protected land (Whirinaki Stream Marginal Strip administered by DOC). It has a high diversity of geothermal features including streams, stream margins, steam vents, fumaroles, seepages, geysers, sinter deposits, mineral pools, craters, mud pools and an extensive sinter terrace. The Red Hills and Orakeikorako parts of the site are of national significance for their ecological values (Wildland Consultants 2014a). The site contains a good quality example of geothermal habitat, which includes nationally uncommon ecosystems (fumaroles, geothermally heated dry ground; Williams *et al*. 2007, Holdaway *et al*. 2012). Fifteen Threatened and At Risk species are known from the site: geothermal kānuka (At Risk-Naturally Uncommon), *Christella* aff. *dentata* ("thermal") (At Risk-Declining), *Dicranopteris linearis* (At Risk-Naturally Uncommon), *Cyclosorus interruptus* (At Risk-Declining), *Schizaea dichotoma* (At Risk-Naturally Uncommon), *Calochilus robertsonii* (At Risk-Naturally Uncommon), *Nephrolepis flexuosa* (At Risk-Declining), *Corunastylis pumila* (At Risk-Naturally Uncommon), North Island robin (At Risk-Declining), whitehead (At Risk-Declining), New Zealand falcon (At Risk-Recovering), black shag (At Risk-Naturally Uncommon), grey duck (Threatened-Nationally Critical), Australian coot (At Risk-Naturally Uncommon), long-tailed bat (At Risk-Nationally Vulnerable). It comprises one of the best examples of geothermal vegetation in the Waikato Region, although pest plant and animal species of ecological concern are common in some parts of the site. Some of the features can be visited for a fee through the Orakeikorako tourism venture, while bathing is regularly undertaken at Akatarewa Stream and to a lesser extent at other sites. In the wider Orakeikorako area (probably including Waihunuhunu) Cody (2007) lists 32 features and geothermal characteristics present, with fourteen features listed as being of national or international significance.
Ecosystem Services:	Provisioning services present include honey production, conservatively valued at $15,680 annually. The area may also provide nutritional services from hunting, but no data is available on these activities. A small area of raupō has potential for fibre production. Wilding pines have been removed or killed on site. The site provides regulation and maintenance services including mass stabilisation and control of erosion rates, and sequestration of carbon (estimated at 14,589 tC annually) and potentially other climate change gases. The site provides a number of cultural services, although the extent of many of these is not well known. The main Orakeikorako area is a major tourist attraction (with an entry fee of $36 per person) and Akatarewa has a camping facility (Sun Club) that uses the geothermal features for bathing. Some parts of the area are potentially used for hunting. The site is of considerable scientific interest with 725 scientific publications found

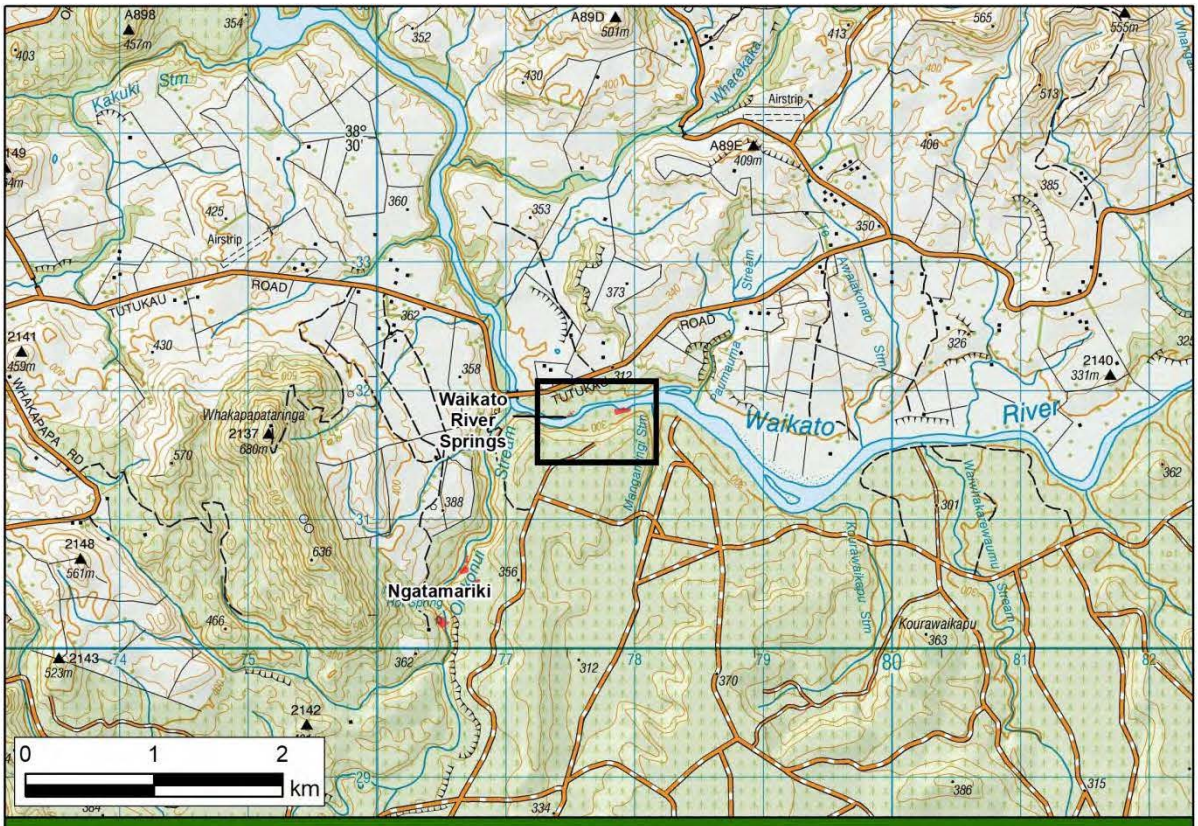
	through a Google Scholar search. Warning signs for public safety are present, and tracks have been constructed to protect people from hazardous areas, and to protect the features. There are also warning signs near the lake edge at Red Hills. There are abundant signs at the main tourist area at Orakeikorako explaining some of the natural and cultural history of the site.

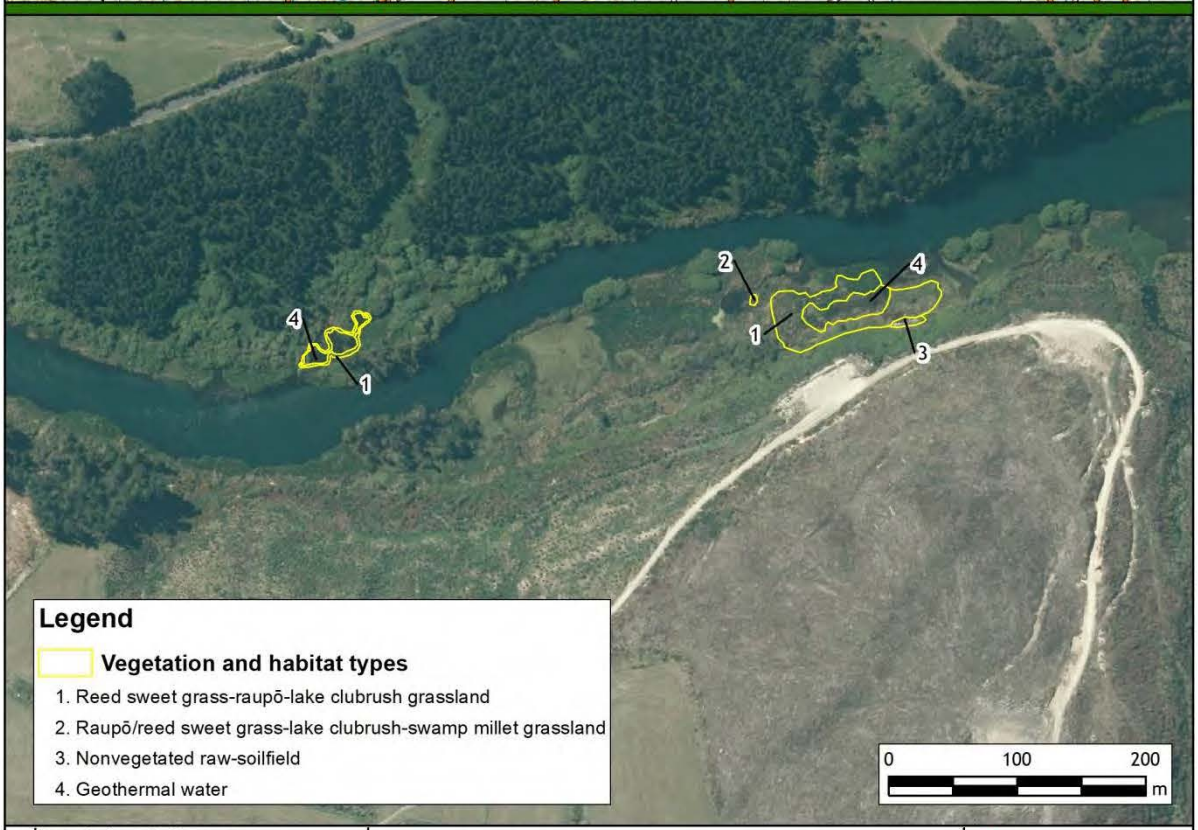
Orakeikorako tourist area. (August 2011)

Overview from northeast of the Orakeikorako site. Tourist buildings and facilities are on the other side of Lake Ohakuri. (February 2014)

A small geyser at Red Hills, part of the Orakeikorako site. (March 2007)

Red Hills, part of Orakeikorako, contains extensive areas of geothermal kānuka. (February 2014)





Legend

Vegetation and habitat types

1. Reed sweet grass-raupō-lake clubrush grassland
2. Raupō/reed sweet grass-lake clubrush-swamp millet grassland
3. Nonvegetated raw-soilfield
4. Geothermal water

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Report: 4363
Client: WRC
Ref: 01 1769
Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017\
File: Waikato_River_Springs.mxd

Waikato River Springs

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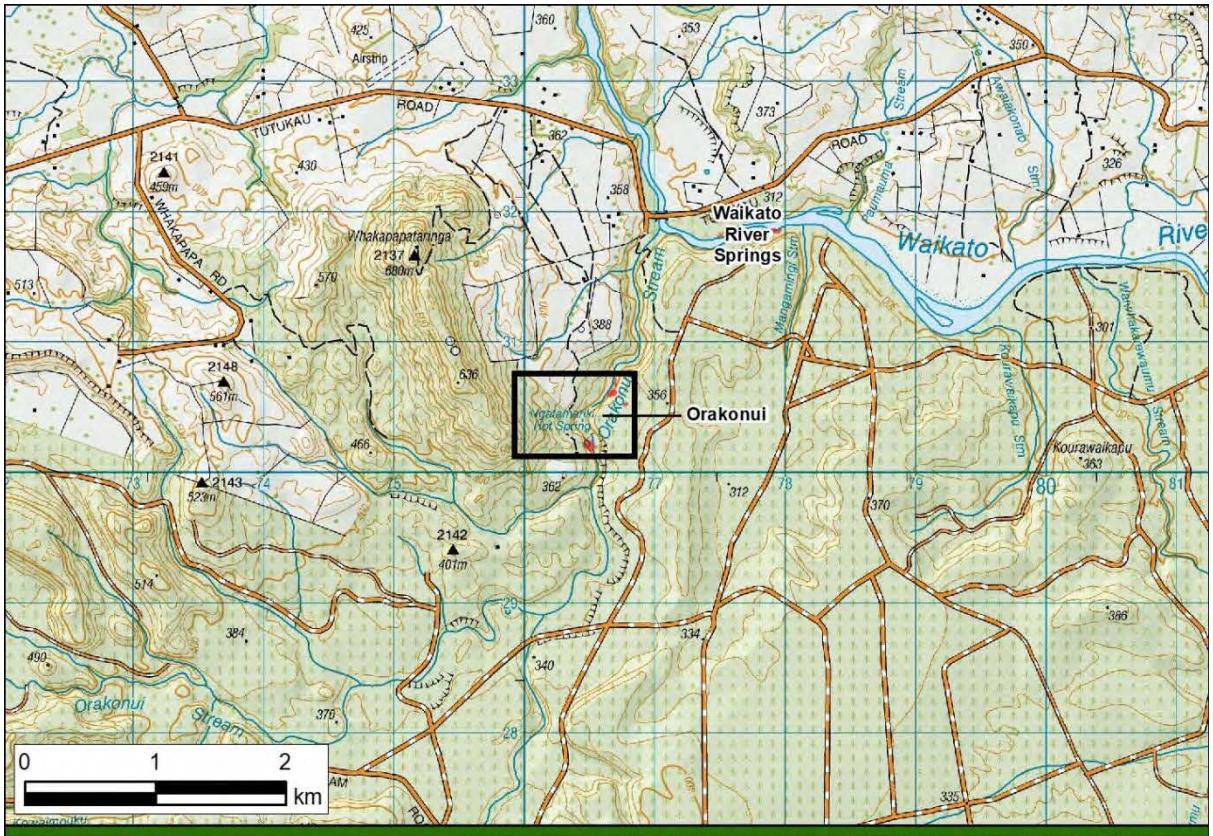
Scale: 1:5,000
Date: 19/06/2017
Cartographer: JO
Format: A4

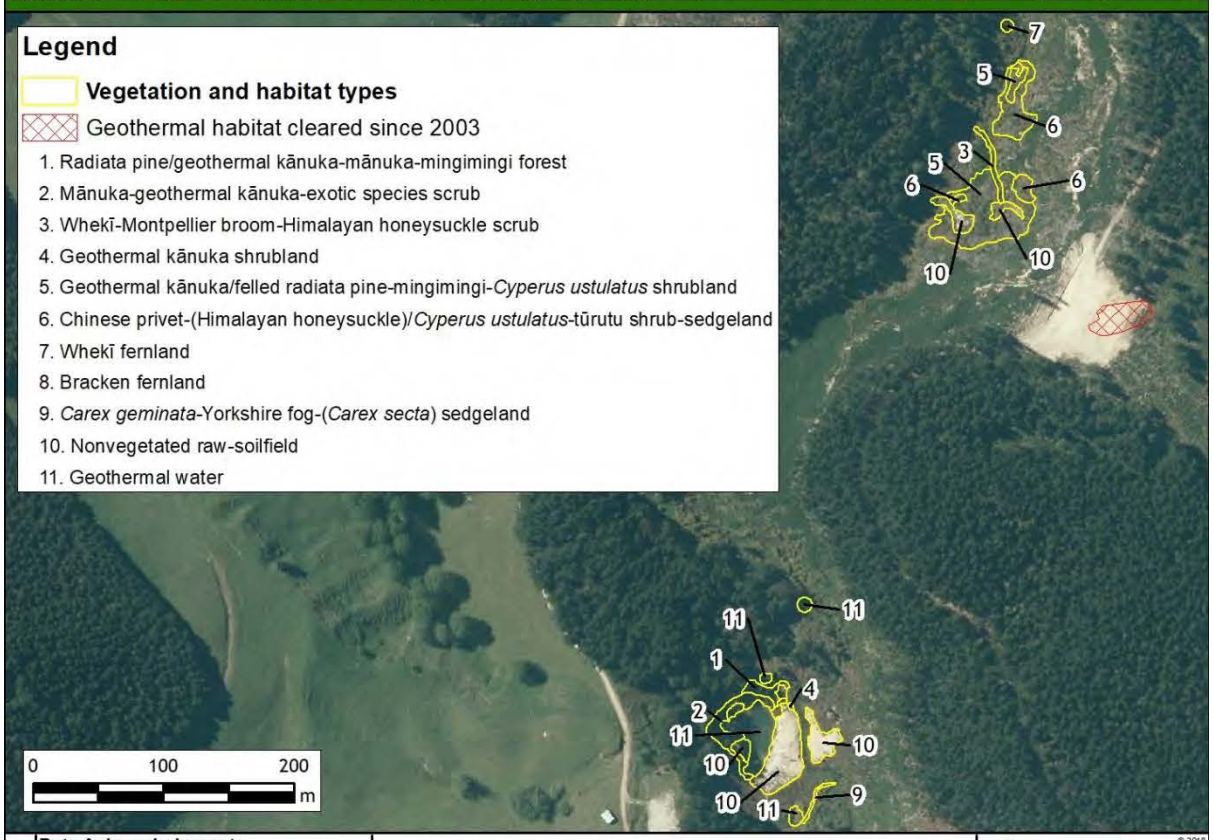
WAIKATO RIVER SPRINGS

Area:	Geothermal Habitat: *c.*0.6 ha Geothermal Vegetation: *c.*0.4 ha
Geothermal Field:	Ngatamariki
Site Description:	The Waikato River Springs site is located *c.*20 km north of Taupō, on the Waikato River margins on protected land (Ngatamariki Hot Springs Scenic Reserve, administered by the Department of Conservation). It comprises geothermally influenced pools, hot springs and heated soil. The site contains a small population of an At Risk plant species, *Christella* aff. *dentata* ("thermal") (At Risk-Naturally Uncommon), as well as the North Island fernbird (At Risk-Declining). Weed species such as reed sweetgrass (*Glyceria maxima*) dominate the wetland areas of this site. Adjoining habitats are the Waikato River, mixed indigenous and exotic scrub, and plantation forest. Two of the features (the author does not specify what site in the Ngatamariki field) have been listed as being of geodiversity importance in Cody (2007).
Ecosystem Services:	Due to the small size of the site ecosystem service values are limited. Many of the geothermal features at the site are related to the Waikato River and wetland vegetation in which they occur. The site is rarely visited, as it is difficult to access and probably not well known. The site provides some regulation and maintenance services of bioremediation in wetland habitat and riparian vegetation (unknown value). The vegetation provides sequestration of carbon and potentially other climate change gases although the volume of these was not able to be determined. Little is known about the cultural importance of the site.

Waikato River Springs.
A small population of *Christella* aff. *dentata* ("thermal") is present at this site. (June 2006)

Waikato River Springs. (June 2006)





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Report: 4363
Client: WRC
Ref: 01 1769
Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017\
File: Orakonui.mxd

Orakonui

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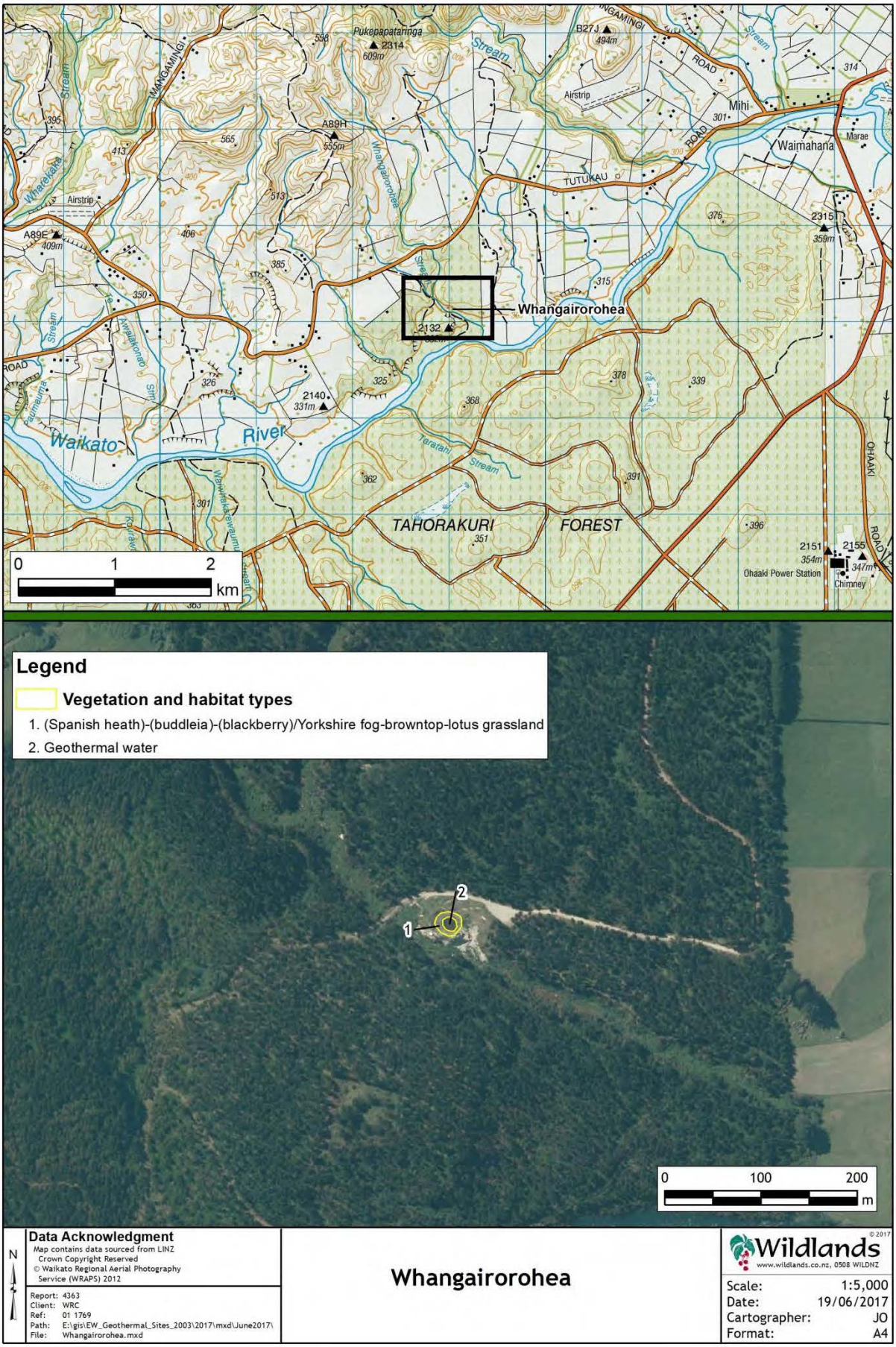
Scale:	1:5,000
Date:	28/02/2018
Cartographer:	JO
Format:	A4

ORAKONUI

Area:	Geothermal Habitat: *c.*1.1 ha Geothermal Vegetation: *c.*0.9 ha
Geothermal Field:	Ngatamariki
Site Description:	Orakonui is located *c.*15 km north of Taupō and is a mix of protected public land (Ngatamariki Hot Springs Scenic Reserve) and unprotected private land. Geothermal features include pools, hot pools, mud pools, streams, springs, sinter, and seepages. Orakonui is of regional significance for its ecological values (Wildland Consultants 2014a). It provides important habitat for seven At Risk species: geothermal kānuka (At Risk-Naturally Uncommon), *Dicranopteris linearis* (At Risk-Naturally Uncommon), *Cyclosorus interruptus* (At Risk-Declining), North Island robin (At Risk-Declining), North Island fernbird (At Risk-Declining), whitehead (At Risk-Declining), and long-tailed cuckoo (At Risk-Naturally Uncommon) It contains nationally uncommon habitat types: heated ground (dry); geothermal streamsides, and hydrothermally altered ground (now cool) (Williams *et al*. 2007, Holdaway *et al.* 2012). Orakonui is the best quality example of geothermal vegetation in the Ngatamariki Geothermal Field. Informal access tracks are present within the site and pose a threat to the ecological values of geothermal vegetation, along with pest plant and animal species of ecological concern. Herbicide spray drift has also damaged vegetation on occasion. The Ngatamariki Geothermal Field that this site is located in has been utilised for electricity generation. Current visitor numbers to Ngatamariki are low due to its isolation. Vegetation and geophysical monitoring of the features is undertaken - partly to assess if using the Ngatamariki Geothermal Field for energy production is having any effects on these values. Cody (2007) lists 15 features and geothermal characteristics present at or near this site, although none were ranked as being of national significance or higher.
Ecosystem Services:	Provisioning services present include limited honey production (valued conservatively at $40 annually) and possible nutritional services from hunting (no data available on actual use). The site provides regulation and maintenance services of bioremediation (unknown value). The vegetation provides mass stabilisation and control of erosion rates, and sequestration of carbon (142.8 tC annually) and potentially other climate change gases. The site provides a limited number of cultural services, although the extent of many of these is not well known. Visitor use of the site is low and it cannot be viewed from any public viewing points or roads. The site is of scientific interest with 365 research papers published on the geophysical characteristics of the site and its geothermal field (Google Scholar Search).

Large geothermal pool in the southern
part of the Orakonui site. (October 2016)

Northern part of the Orakonui site with areas of geothermal
sinter and geothermal kānuka. (October 2016)


Legend
Vegetation and habitat types
1. (Spanish heath)-(buddleia)-(blackberry)/Yorkshire fog-browntop-lotus grassland
2. Geothermal water
Whangairorohea
TAHORAKURI FOREST
Waikato River
Waimahana
Mihi
Ohaaki Power Station
Chimney
0 1 2 km
0 100 200 m
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Report: 4363
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Whangairorohea
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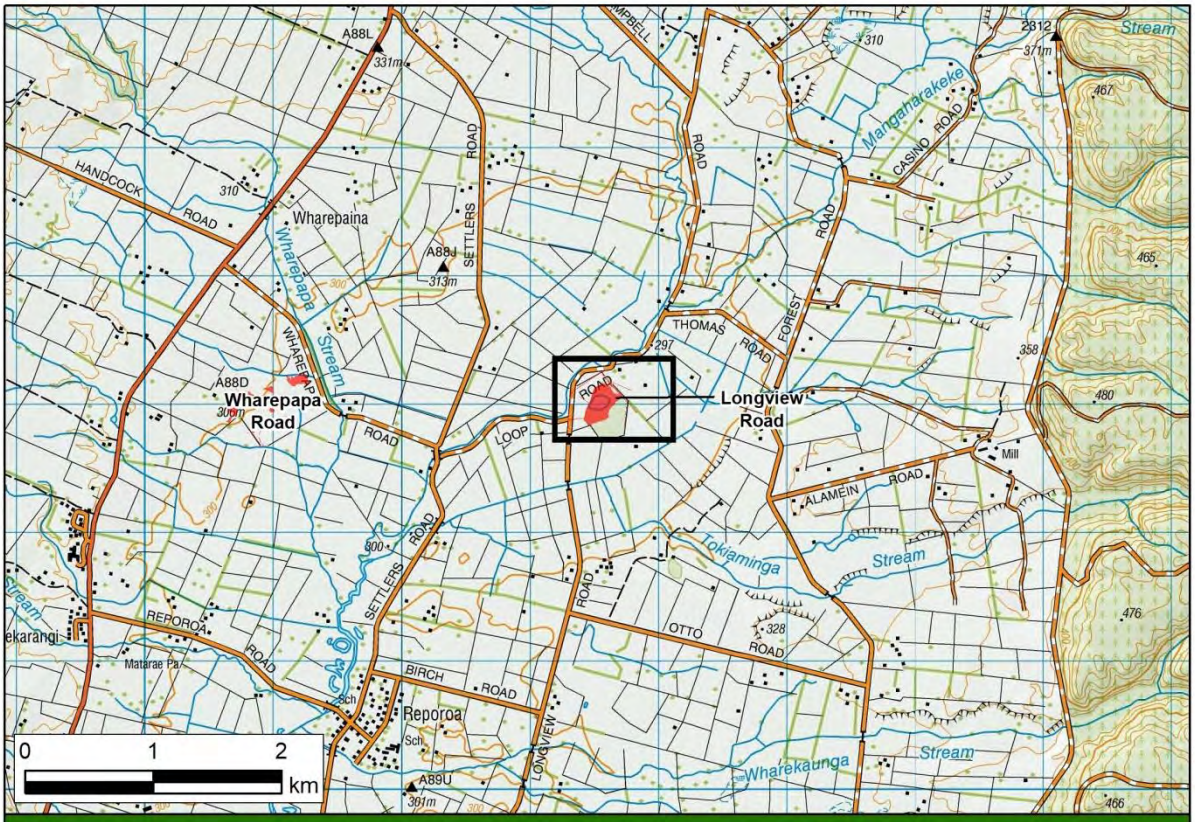
Scale: 1:5,000
Date: 19/06/2017
Cartographer: JO
Format: A4

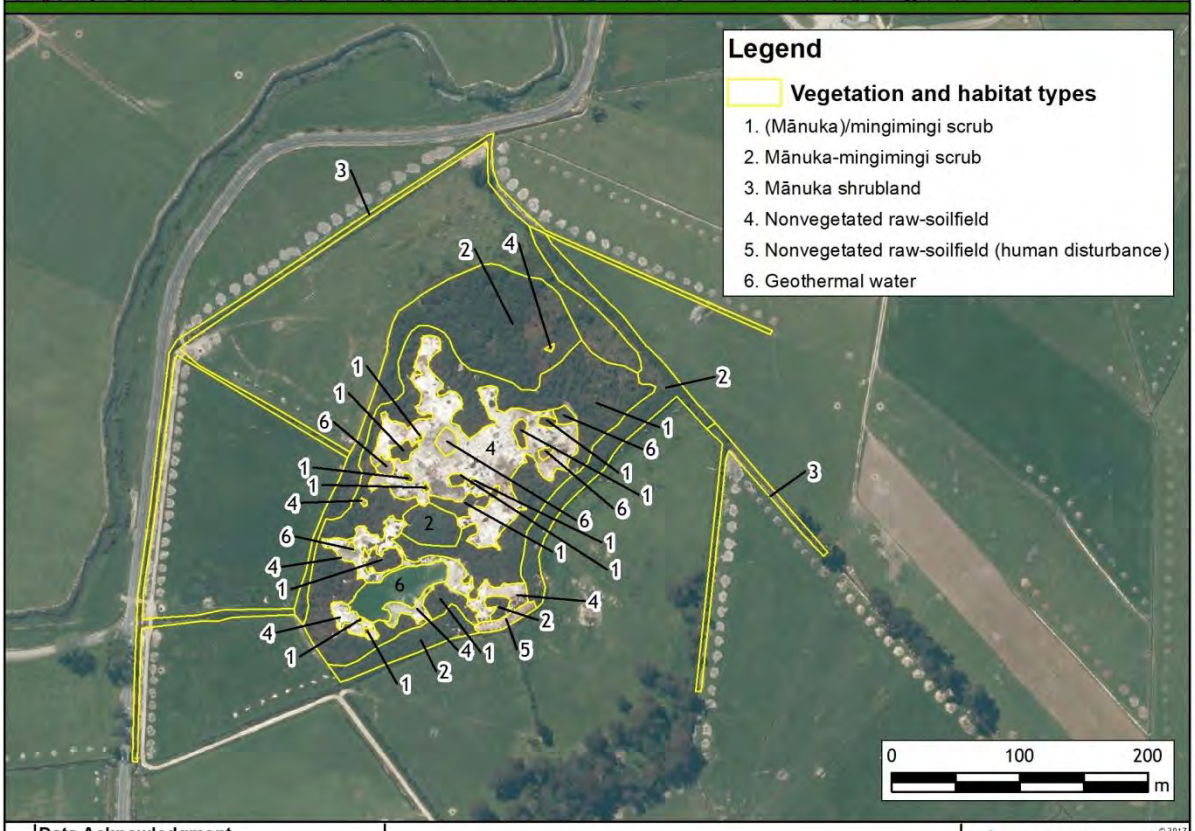
WHANGAIROROHEA

Area:	Geothermal Habitat: <0.1 ha Geothermal Vegetation: <0.1 ha
Geothermal Field:	Whangairorohea
Site Description:	Whangairorohea is located *c.*23 km north of Taupō on unprotected private land and comprises a geothermal pool (*c.*10 × 15 metres). The pool is surrounded by radiata pine plantation, with a 20-50 metre buffer zone in which the vegetation comprises exotic grassland, with a small gully dominated by blackberry and Himalayan honeysuckle. The pool is used by locals for bathing (but has no public access), and a small jetty has been built for easy access. It is a small example of a nationally uncommon, geothermal habitat. No At Risk or Threatened species have been recorded at the site.
Ecosystem Services:	This site is a very small geothermal site on private land and has been highly modified as a result of clearance of vegetation surrounding the pool, and at times earthworks. As a result, ecosystem services are few. It is mainly used by a limited number of people for bathing and as a landscape feature on a Māori owned forestry block.

There is a structure built in the pool for bathing and a tyre tube probably used during play at Whangairorohea. (February 2014)

Whangairorohea. (February 2014)





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Report: 4363
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File: Longview_Road.mxd

Longview Road

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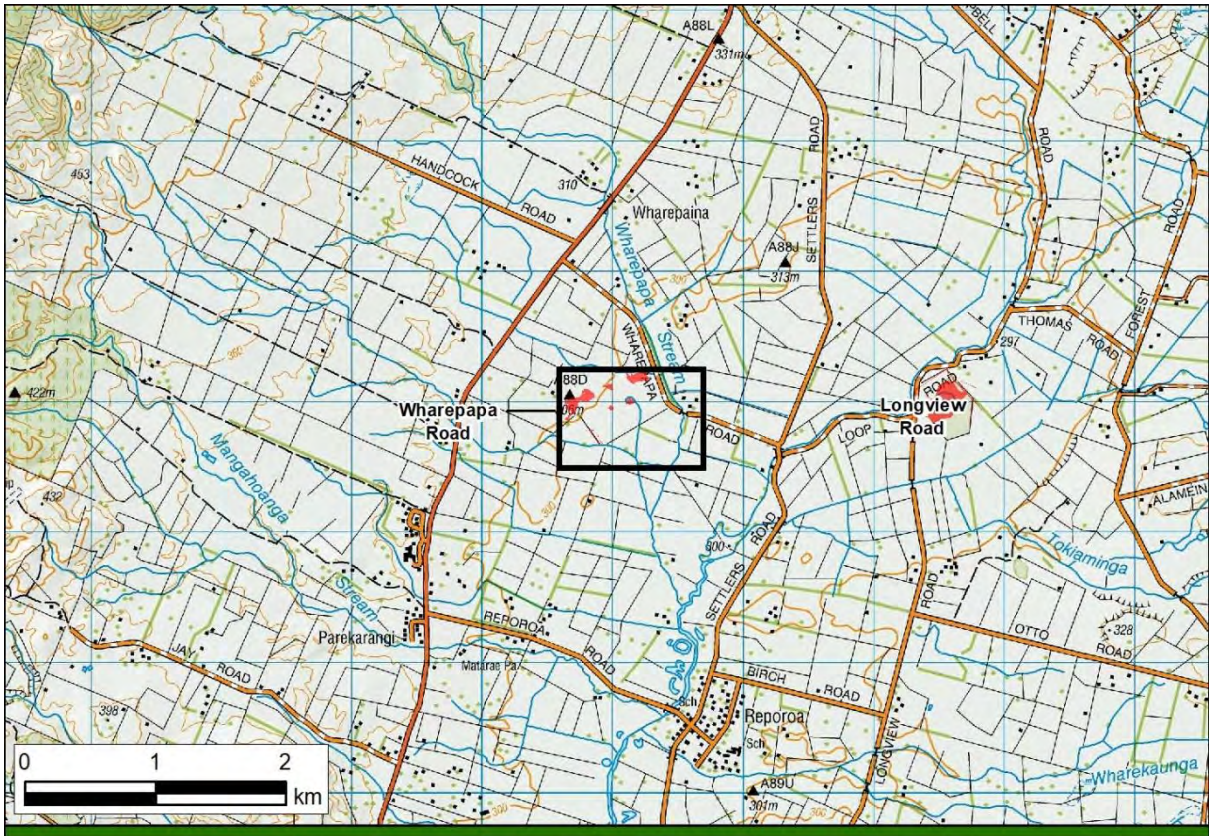
Scale:	1:5,000
Date:	19/06/2017
Cartographer:	JO
Format:	A4

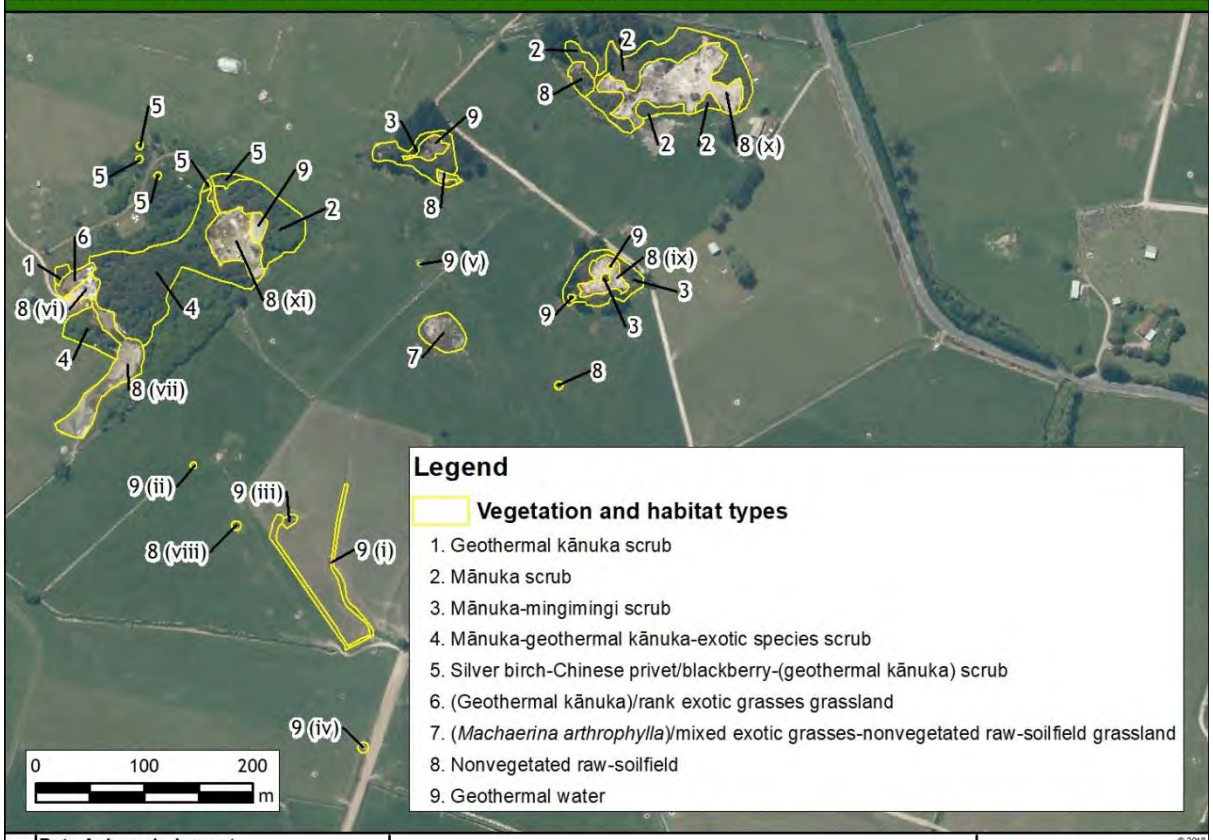
LONGVIEW ROAD

Area:	Geothermal Habitat: *c.*6.2 ha Geothermal Vegetation: *c.*5.9 ha
Geothermal Field:	Reporoa
Site Description:	The Longview Road site is located *c.*2.5 km north of Reporoa township on private protected land (Molloy Conservation Covenant). It comprises small geothermal pools, hot springs, and heated soils. The most significant geothermal features are well buffered with indigenous vegetation, and few weeds are present. This site is of regional significance for its ecological values (Wildland Consultants 2014a). It contains nationally uncommon habitat types: geothermally heated dry ground and hydrothermally altered ground (now cool) (Williams *et al*. 2007, Holdaway *et al.* 2012). It is also the best example of geothermal vegetation associated with the Reporoa Geothermal Field. The site interior has a relatively low cover of pest plants compared with most mānuka and mingimingi-dominant geothermal sites in the Waikato Region. Cody (2007) lists five features and geothermal characteristics present at or near this site, although none were ranked as being of national significance or higher.
Ecosystem Services:	Potential provisioning services present include honey production, which is conservatively valued at $1,840 annually. The site is likely to provide nutritional services from hunting (mostly duck shooting) as maimais are present near the pools (no data is available on use). The vegetation provides mass stabilisation and control of erosion rates, and sequestration of carbon (1,404 tC annually) and potentially other climate change gases. The site provides a number of cultural services, although the extent of many of these is not well known. Visitor use of the site is low, but it can be viewed from neighbouring country roads. The site is probably not used for bathing, but is used by hunters for duck shooting. The site is of scientific interest, with 162 research papers published on the geophysical characteristics of the site and its geothermal field (Google Scholar search).

Extensive area of geothermal pools surrounded by geothermally influenced bare ground at the Longview Road site. Mānuka is the most dominant plant species at the site. (January 2014)

Some drainage ditches outside the main part of the Longview Road site contain geothermal springs and seepages. (January 2014)





Legend

Vegetation and habitat types

1. Geothermal kānuka scrub
2. Mānuka scrub
3. Mānuka-mingimingi scrub
4. Mānuka-geothermal kānuka-exotic species scrub
5. Silver birch-Chinese privet/blackberry-(geothermal kānuka) scrub
6. (Geothermal kānuka)/rank exotic grasses grassland
7. (*Machaerina arthrophylla*)/mixed exotic grasses-nonvegetated raw-soilfield grassland
8. Nonvegetated raw-soilfield
9. Geothermal water

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Report: 4363
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Path: E:\gis\EW_Geothermal_Sites_2003\2013-2014\mxd\Figures\
File: Wharepapa Road.mxd

Wharepapa Road

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Scale: 1:6,000
Date: 28/02/2018
Cartographer: JO
Format: A4

WHAREPAPA ROAD

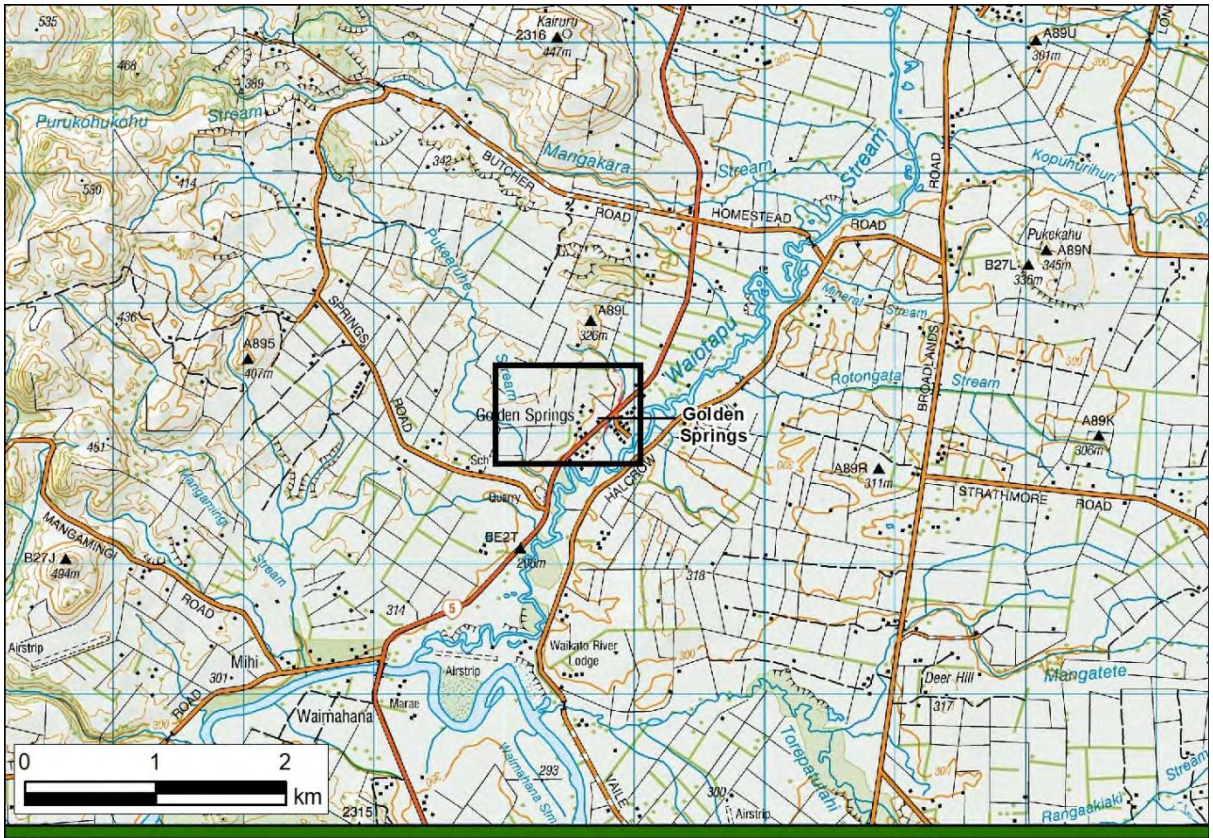
Area:	Geothermal Habitat: *c.*3.6 ha Geothermal Vegetation: *c.*3.4 ha
Geothermal Field:	Reporoa
Site Description:	The Wharepapa Road site is located *c.*2 km north of Reporoa township on unprotected private land. Most of the site comprises small and isolated geothermal areas surrounded by farmland, including fumaroles, mud pools, heated bare soils, geothermal springs, sinter terraces, and hot pools. This site has been divided into two parts, A and B. Area A is of regional significance for ecological values (Wildland Consultants 2014a) as it forms a moderate-sized area of geothermal habitat that includes nationally uncommon ecosystems: geothermally heated dry ground, fumaroles (Williams *et al*. 2007, Holdaway *et al*. 2012). It also contains small populations of an At Risk plant species (geothermal kānuka). Area B is of local significance (Wildland Consultants 2104a) because it contains small, disjointed, degraded examples of nationally uncommon habitat types: geothermally heated dry ground, fumaroles (Williams *et al.* 2007, Holdaway *et al.* 2012). The geothermal areas have been highly modified by dairy farming and the dumping of rubbish and are in poor condition. The values of the site are likely to improve if geothermal features are fenced to exclude stock. Cody (2007) lists 15 features and geothermal characteristics present at or near this site, with two features ranked as being of national significance or higher.
Ecosystem Services:	Potential provisioning services present include honey production, conservatively valued at $800 annually. Some of the pools have been used for cooking. Wood may be harvested for commercial gain or private firewood use, particularly silver birch and oaks. The site provides regulation and maintenance services through mass stabilization, control of erosion rates, and sequestration of carbon (547.4 tC annually) and potentially other climate change gases. The site provides a number of cultural services, although the extent of many of these is not well known. Visitor use of the site is low, but it can be viewed from neighbouring roads, including steam rising near State Highway 5. A small part of the site is probably used for bathing. The site is of scientific interest, with 21 research papers published on the geophysical characteristics of the site and its geothermal field and ecological features (Google Scholar search). Some warning signs for public safety are present at the site, and formed walking tracks and fences have been constructed near some features.

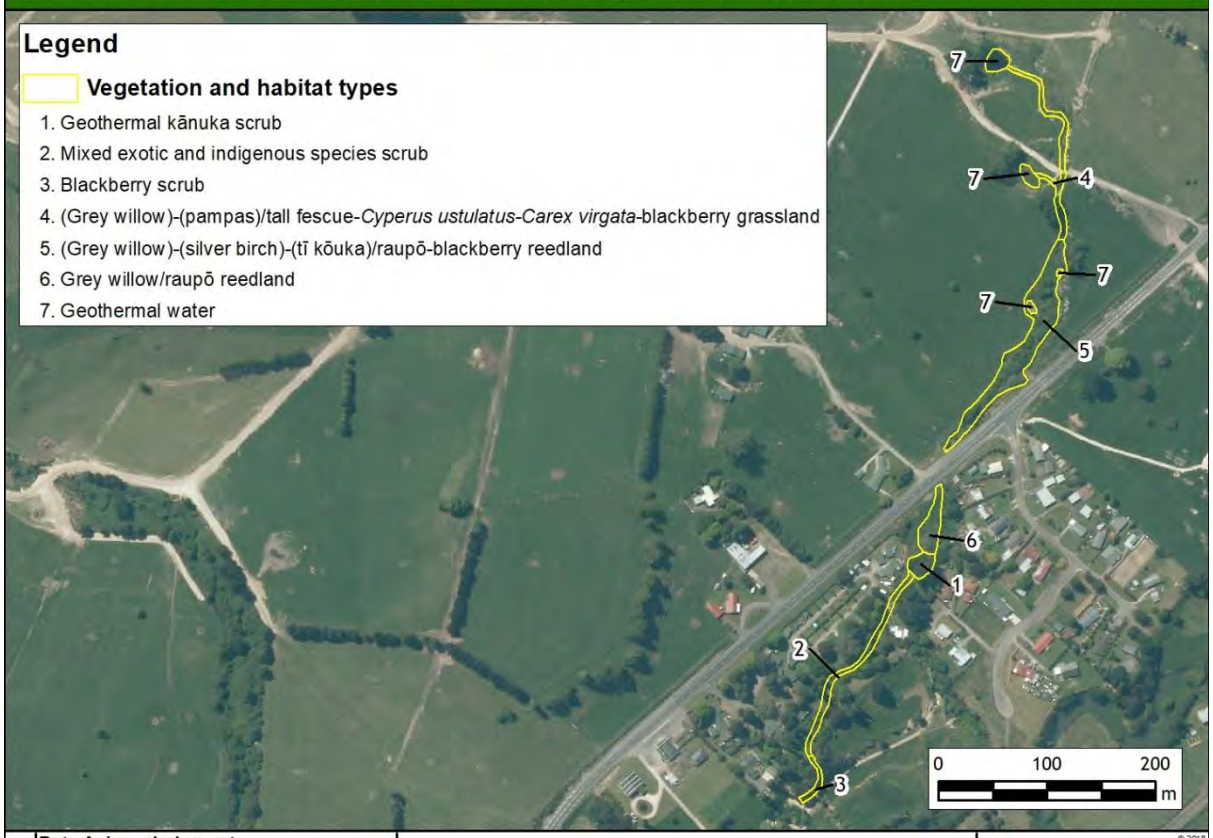
A large population of arrow grass (*Triglochin striata*) occurs at the Wharepapa Road site. (January 2017)

Many of the features present at Wharepapa Road occur amongst farmland. (January 2017)

Wharepapa Road. (July 2010)

Structures near one of the pools indicate that the pool at Wharepapa Road has probably been used for cooking food. (July 2010)





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Report: 4363
Client: WRC
Ref: 01 1769
Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017\
File: Golden_Springs.mxd

Golden Springs

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Date:	28/02/2018
Cartographer:	JO
Format:	A4

GOLDEN SPRINGS

Area:	Geothermal Habitat: *c.*0.8 ha Geothermal Vegetation: *c.*0.7 ha
Geothermal Field:	Reporoa
Site Description:	Golden Springs geothermal area is located on both sides of State Highway 5 at the Golden Springs settlement. All geothermal areas are on unprotected private land. The site comprises geothermal hot springs, open water and a small geothermal wetland, all nationally uncommon habitat (Williams *et al*. 2007, Holdaway *et al.* 2012). The heated streams and ditches provide habitat for *Christella* aff. *dentata* ("thermal") (At Risk-Naturally Uncommon). A small population of geothermal kānuka (At Risk-Naturally Uncommon) is also present. This site is generally in a poor ecological condition, and pest plants are common; however the current holiday park landowners are very keen to undergo restoration of the site. The stream has been extensively altered in places with a diversion for water wheels, several dams, and excavations for swimming holes; channels have also been dug. The stream near the campground and some of the pools on the western side of the highway are used for bathing. A subtropical snail with potential to host parasites that cause human disease is found in water at this site (Duggan 2002).
Ecosystem Services:	Provisioning services include the historic extraction of the warm geothermal stream for bathing purposes. An area of raupō has potential for fibre production. Planted woody species at the site could be utilised for firewood - although the extent of use is unknown. The site provides regulation and maintenance services of bioremediation in wetland habitat and riparian margins (unknown value). The vegetation present provides mass stabilisation and control of erosion rates, and sequestration of carbon (166.6tC annually) and potentially other climate change gases. The site provides a number of cultural services. The geothermal stream is a significant feature of the camping ground, has pools constructed within it, and is regularly used for bathing. A rope swing is present on the western side of the highway above a fenced geothermal pond amongst farmland. Considerable works to fence riparian margins of geothermal streams and wetland habitat have been undertaken on the western side of the highway in recent years to keep stock out of riparian margins (including geothermal). The site is of scientific interest, with 2,410 research papers published on the geophysical characteristics of the site, its geothermal field, and ecological features (Google Scholar search). Some warning signs for public safety are present at the site, and formed walking tracks, bridges and hand rails have been constructed near some features.

The geothermal springs are a key attraction at the Golden Springs Campground. (July 2017)

Golden Springs Campground bathing site. (January 2014)

Geothermal springs in a wetland at Golden Springs, surrounded by farmland. Many of these features are now fenced. (January 2014)