

Geothermal features annual monitoring report – June 2021

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Abstract

Annual geothermal monitoring data from 2005 to 2021 are presented for long-term observations of geothermal feature conditions. A field survey was conducted in November – December 2020. Twelve geothermal fields were visited: Atiamuri, Mokai, Ngatamariki, Orakei Korako, Reporoa, Rotokawa, Tauhara, Te Kopia, Waikite, Waiotapu, and Whangairorohea. Water temperature and pH measurements were taken where possible, and general observations on the feature conditions were also recorded. Images captured from a relatively new infrared thermal imager device are included in this report to show the thermal profile of each surface feature. Many features have exhibited temperature and pH changes since 2005, while others remained relatively unchanged. The Hydrothermal Eruption Crater at Ngatamariki is observed to have a semi-permanent sediment apron composed of pumiceous materials from a landslide which occurred in 2019. A new feature that we named Orion’s Belt was discovered in late 2020 at Orakei Korako. The Champagne Pool at Waiotapu and Te Manaroa Pool at Waikite are two major alkali-chloride springs that did not show major changes since 2005.

Executive summary

Waikato Regional Council is required by RMA s36 to monitor the state of the regional environment, which includes 70% of the nation's geothermal resource. The existing geothermal resources provide many social, cultural, scientific, and economic benefits. Geothermal features are dynamic and have a natural range of behaviours and activities that need to be understood, so that anthropogenic changes can be identified and addressed in an appropriate manner if necessary. Uses of the regional geothermal resource can adversely affect the natural character of the resource and therefore it is important to undertake regular monitoring to identify changes.

Annual monitoring of geothermal surface is conducted at geothermal fields that are most sensitive to changes, as a way to continuously monitor and update the state of environment in these geothermal areas. Most of the features monitored are alkali chloride springs and geysers, which are typically characterised by their near-neutral pH, boiling conditions, chloride-rich chemistry, and in many places sinter deposition. Data of alkali chloride springs and geysers provide the best representation of the deep benign chloride reservoir conditions of a geothermal system. Included in the annual monitoring is Whangairoheia, a small geothermal system, while Horohoro, Ketetahi, Ohaaki, Tokaanu, and Wairakei are some of the large systems not monitored due to lack of access, a lack of significant surface features, or because large-scale geothermal resource users such as geothermal electricity producers are required to do monitoring.

Since 2005, many features have experienced temperature and pH changes, with some of the conditions returning to initial conditions from 2005. At Ngatamariki, a pumiceous sediment apron is forming at the Hydrothermal Eruption Crater due to natural causes. A group of newly formed features named the Orion's Belt was discovered in Orakei Korako. Wharepapa Rd Fumaroles in Reporoa has been buried by soil, and no longer show any thermal signature. The bathing structure at West Mokai Spring has now been removed.

It is valuable to continue undertaking annual monitoring of geothermal features to increase understanding of the region's geothermal resources, so that long-term feature conditions and changes can be observed, and any threats or damage to the features due to human causes can be mitigated appropriately.

1 Introduction

Monitoring of a selection of geothermal features in the Waikato Region was implemented in 1995. The aim of the monitoring is to observe the natural state of geothermal surface features. Assessments are made on changes that are occurring over time, as well as reporting on any threats or damage to the features. This will allow us to make more informed decisions to protect and enhance the geothermal resources and ecosystems.

1.1 Report Content

Annual geothermal monitoring is conducted once a year and includes quarterly sites and sites only visited once a year (Figure 1). This report covers data from January 2005 to May 2021. The specific geothermal fields recorded throughout this monitoring period are as follows:

- Atiamuri
- Mokai
- Ngatamariki
- Orakei Korako
- Reporoa
- Rotokawa
- Tauhara
- Te Kopia
- Waiotapu
- Waikite
- Whangairorohea

Waikite and Waiotapu are separate geothermal fields within the Waikite-Waiotapu-Waimangu geothermal system, while Tauhara is a part of the Wairakei-Tauhara geothermal system. Also recorded in this report is Mokai geothermal system and Kurapai Geyser in Orakeikorako, both visited after an absence of several years.

1.2 Methodology

Direct water temperature is measured using a *Fluke 566 IR Thermometer* with a 6 m submersible thermocouple attached. The infrared *FLUKE TiS60+ thermal imager* is used to as to collect secondary measurements to the submersible thermocouple, and is used to produce infrared spectra images shown for some sites.

GPS co-ordinates gathered during previous site visits have been converted from NZMG to NZTM, which is now the standard coordinate system for WRC. Where existing known co-ordinates have not been available, a *Garmin GPSmap 60CSx* has been used to record locations, with an accuracy of ± 5 m. Each GPS reading was taken in the same spot as the photograph was taken from.

pH measurements were taken using *Whatman® Universal pH 1-11* indicator papers. Samples were cooled before being tested, to comply with the paper's temperate range. Where possible, water flow was estimated. The liquid flow or discharge was estimated when assessed to be realistic, i.e., that the entire flow can be seen, and seepage or flow diversion is not occurring on a large scale.

The water level was recorded for some features; subject to choosing an easily identified and physically long-lived benchmark in the vicinity, or relative to the overflow level. 'Ebullition' and gas discharge are recorded, also water clarity and colour, and the general condition of the sinter is noted.

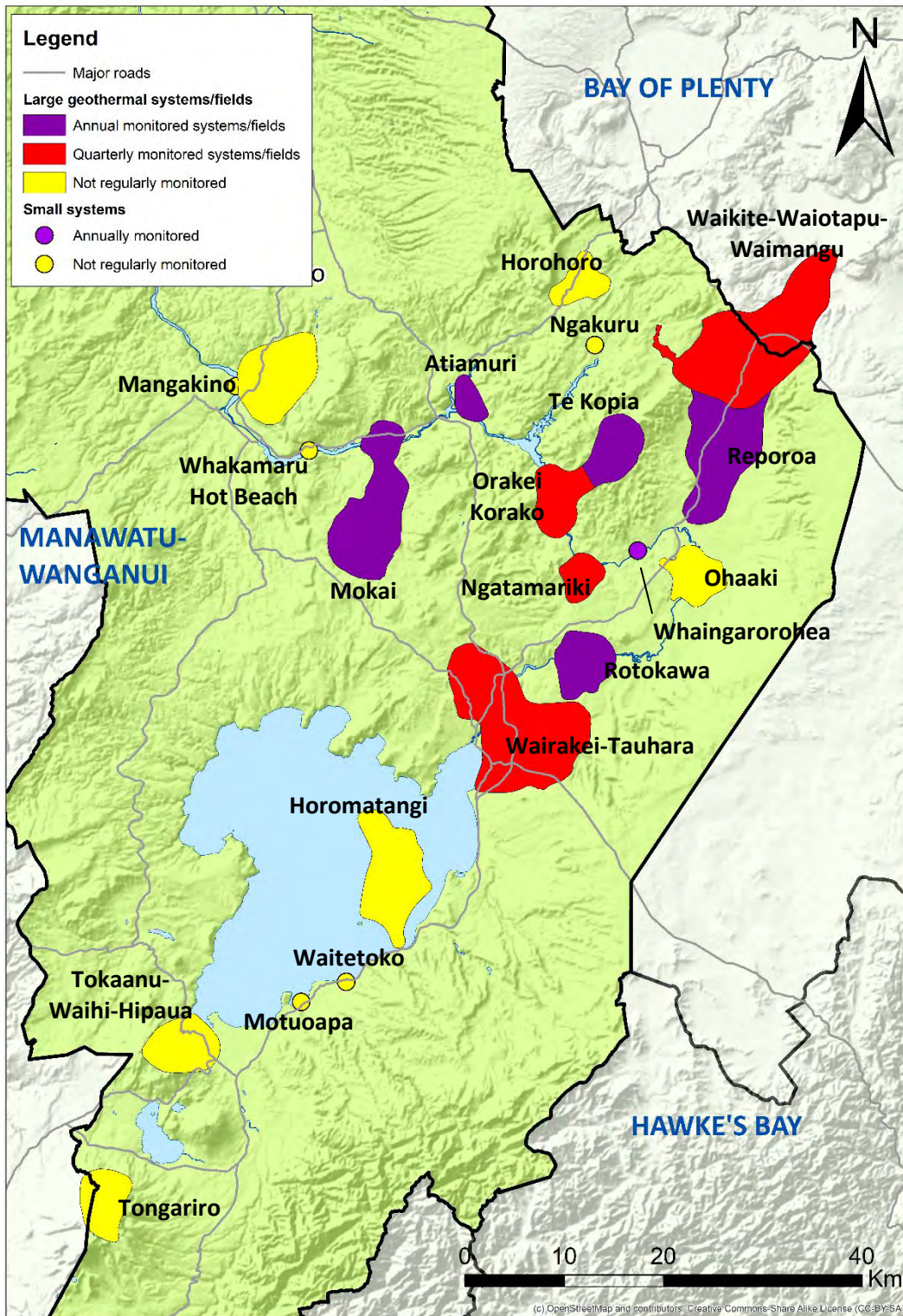


Figure 1 Map of the geothermal systems within the Taupo Volcanic Zone area of the Waikato Region. Systems and fields monitored annually are shown in purple, quarterly monitored fields in red, and unmonitored systems in yellow. All quarterly sites are monitored during annual monitoring periods. Small geothermal systems are shown as circles.

2 ATIAMURI

2.1 66_94: Upper Atiamuri School Spring

- A small feature appearing more similar to a culvert than a natural spring due to anthropogenic modifications to the feature. The feature is distinguishable from nearby water bodies by orange staining in the flow area.
- This feature has insufficient data continuity for long-term trend comparisons.

Location: -38.333298, 176.066017

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2018/02/08	7.6	22.1		<2.0	Clear	Colourless	nd
Comments	<i>Water temperature:</i> Transferred from Fulcrum <i>Water level:</i> Overflowing						



Fig.1 - taken on 2021-04-29 09:11:03"



Fig.2 - taken on 2021-04-29 09:11:10"

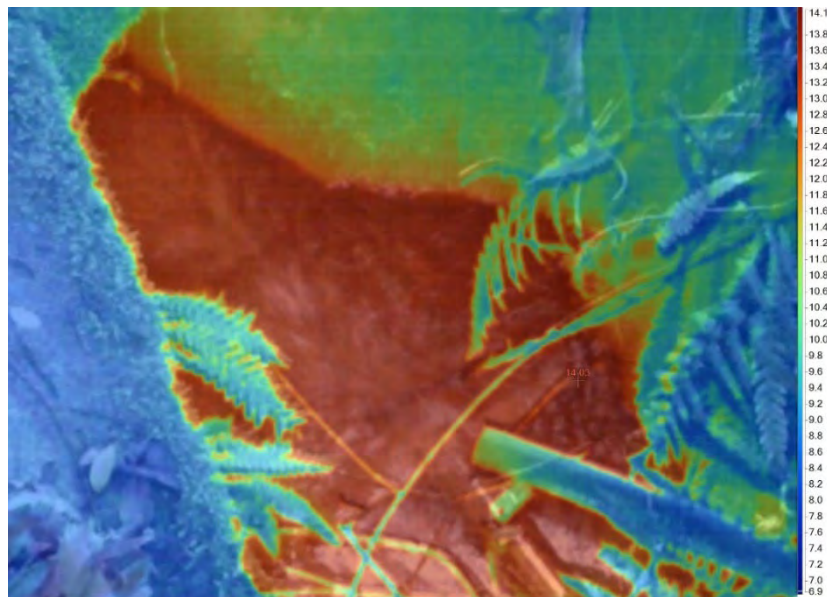


Fig. 3 Infrared image of the Atiamuri School spring. Taken on 2021-04-29.

2.2 3058_6: Bergs Crater

- An eruption crate that was a sinter-depositing spring in prehistoric times but is now inactive. Until the late 1990s it was a sinter-lined crater about 5 metres deep with a slightly warm pool at the bottom. When the land use changed from forestry to farming the farmer filled it in with tree stumps and other organic debris.
- The feature is currently dry and vegetated, making observation of crater surface difficult.

Location: -38.363132, 176.04621

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14		14.0					
2020/02/25		25.0					
Comments	No activity, ground collapsing at southeast side.						



Fig.1 - taken on 2020-02-25 10:48:05"



Fig.2 - taken on 2020-02-25 10:48:40"

2.3 3058_2: Whangapoa Pools Northwest Pool

- Large circular pool >10 m in diameter with fencing around. Due to fencing, measurements are taken at a man-made pool at the outflow.
- The pool has a dug channel about 1.5 m deep keeping the pool level artificially low. This is because the pool was previously used as the source water for a public swimming pool, which was demolished in the early 1990s.
- Despite slight increases and decreases since 2005, the temperature and pH measurements at this feature remain similar up to 2021.

Location: -38.362452, 176.049843

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/05/08	8.0	65.8		<0.5	Cloudy	Blue/green	Upwelling at outlet
Comments	Surging Water level: Overflowing						
2016/01/18	7.5	64.2		<0.5	Cloudy	Green/blue	Constant upwelling at outlet
Comments	Water level: Overflowing						
2017/01/20	7.5	50.5		<0.5	Clear	Blue	Audible bubbling
Comments	Ebullition: Too steamy to see the pool						
2018/02/08	7.0	60.4		<0.5	Cloudy	Green - Light	Upwelling at outlet
Comments	pH: Temp 49.4 Water level: Overflowing						
2019/01/14	7.0	52.0		<0.5	Cloudy	Blue - Green	Audible bubbles
Comments	Water level: Overflowing Ebullition: Raining difficult to see						
2020/02/25	7.9	60.4		<0.5	Clear	Green	Steaming, cannot see pool to see ebullition.
2021/04/29	7.0	50.8	0	<5.0	Clear	Colourless	Only audible
Comments	Sampled from outflow due to barbed wires, where algal communities are observed. Ebullition cannot be visually observed due lack of access and steam discharge blocking line of view.						

Whangapoa Pools Northwest Pool: Temperature and pH for 2005/1/1 - 2021/5/1

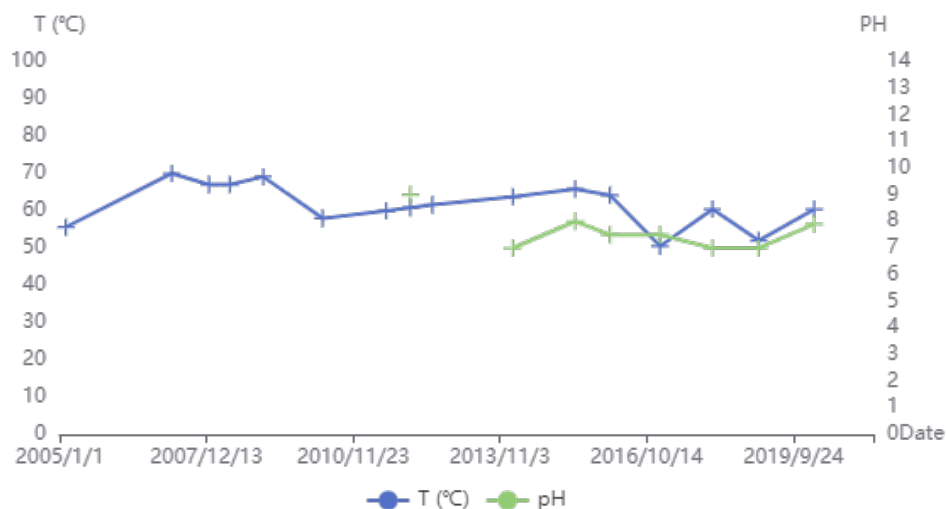




Fig.1 - taken on 2020-02-25 10:22:34"



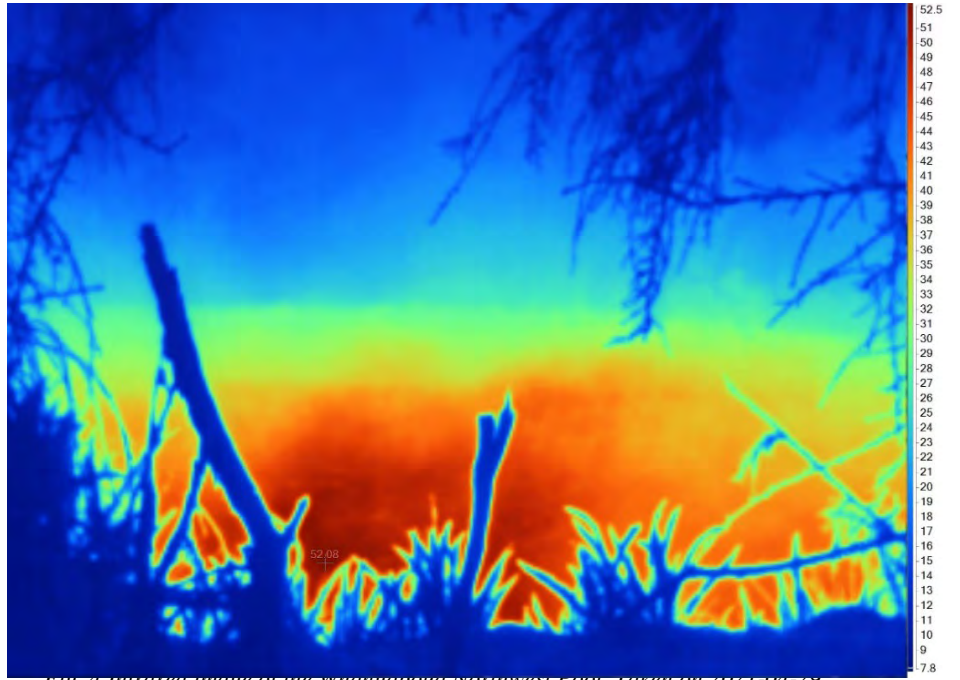
Fig.2 - taken on 2020-02-25 10:25:07"



Fig.3 - taken on 2021-04-29 10:06:07"



Fig.4 - taken on 2021-04-29 10:04:43"



2.4 3058_3: Whangapoa Pools: Southeast Pool

- Large circular pool ~15 m in diameter, also known as the Scalding Pool.
- This pool previously had a shallow discharge channel dug when it was on private forestry land. In the mid 1990s the land surrounding the two Whangapoa Pools was given to the NZ Government and designated Scientific Reserve under the management of the Department of Conservation. DOC restored the natural water level, removed pipes and pine trunks from the pool and sinter outflow terrace, and planted native vegetation on the surrounding land.
- Temperature and pH conditions remain stable between 2005 to 2021.

Location: -38.362914, 176.050069

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/05/08	8.0	61.3		<0.5	Clear	Blue	Upwelling in centre
Comments	<i>Water level: Overflowing</i>						
2016/01/18	8.0	65.3		<0.5	Clear	Blue/Aqua	Upwelling
Comments	<i>Water level: Overflowing</i>						
2017/01/20	7.0	64.8		<0.5	Clear	Turquoise	Upwelling in centre
2018/02/08	6.5	59.3		<0.5	Clear	Turquoise	Upwelling in centre
Comments	<i>Water level: Overflowing</i>						
2019/01/14	7.5	64.3		<0.5	Clear	Blue	Constant upwelling in centre
Comments	<i>Water level: Overflowing</i>						
2020/02/25	8.0	66.7		<0.5	Clear	Green - Blue	Constant upwelling
2021/04/29	7.0	57.0	0	<5.0	Clear	Colourless	Constant ebullition from a single point
Comments	Noodles of sinter near outflow. Suspended silica fragments in water, sinter layers are very weak. Some fresh silica deposited on pool rim, but very thin layers only.						

Whangapoa Pools: Southeast Pool: Temperature and pH for 2005/1/1 - 2021/5/1

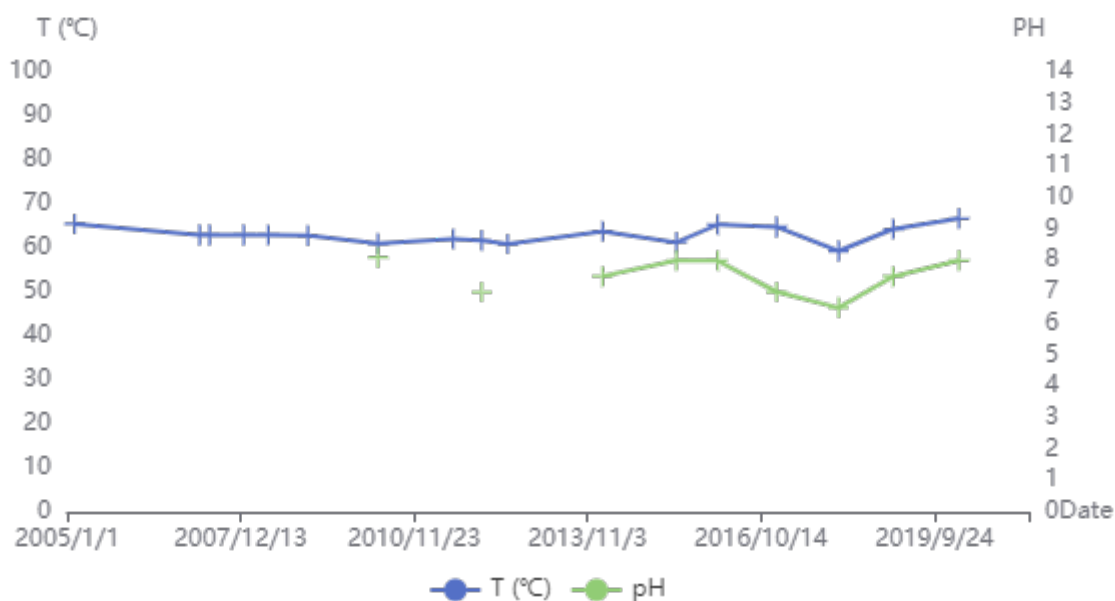




Fig.1 - taken on 2020-02-25 10:48:05"



Fig.2 - taken on 2021-04-29 09:40:00"

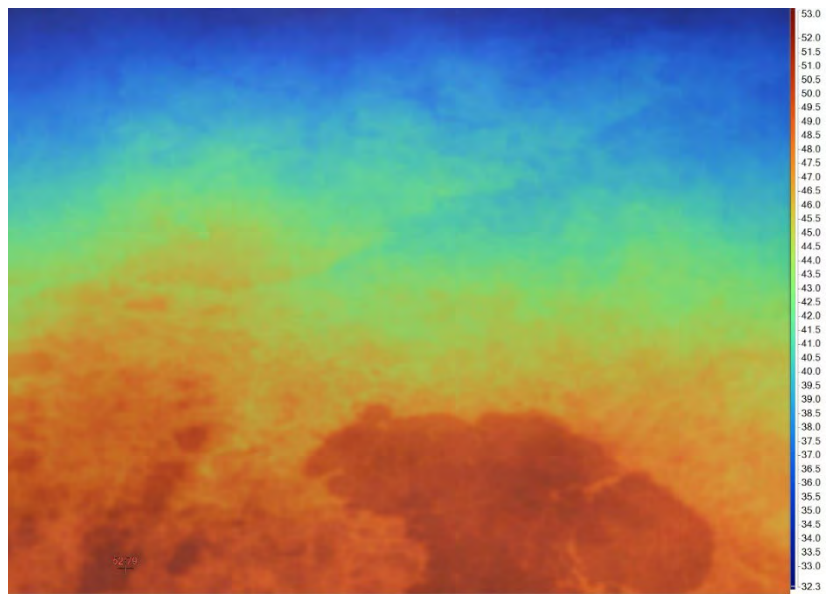


Fig. 3 Infrared image of the Whangapoa Southeast Pool. Taken on 2021-04-29.

2.5 3058_1: Matapan Rd

- A feature springing from a fracture in an ignimbrite block, cascading down as a small waterfall.
- Temperature decreased significantly between 2007 to 2016, accompanied with a minor pH decrease. By 2020, both properties recovered to 2005 levels.
- In recent years a landslide on the ignimbrite face substantially altered the spring and outflow characteristics.
- The landowner channels some of the flow to a private spa pool.

Location: -38.35349, 176.079352

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/05/08	6.5	52.4		<2.0	Clear	Clear	nd
Comments	<i>Water level: Overflowing</i>						
2016/01/18	7.0	58.0		<0.5	Clear	Clear	nd
Comments	<i>Water level: Overflowing</i>						
2017/01/20	6.0	40.0		<0.5	Clear	Clear	nd
2018/02/08	5.5	42.5		<0.5	Clear	Colourless	nd
Comments	Looks like there has been a flood or a slip, area has changed. <i>Water level: Overflowing</i>						
2019/01/14	6.5	60.1		<0.5	Clear	Colourless	nd
Comments	<i>Water level: Overflowing</i>						
2020/02/25	7.9	67.6		<0.5	Clear	Colourless	nd
2021/04/29	7.0	66.8	0	<5	Clear	Colourless	Nd, flowing like a stream
Comments	Algal growth observed.						

Matapan Rd: Temperature and pH for 2005/1/1 - 2021/5/1

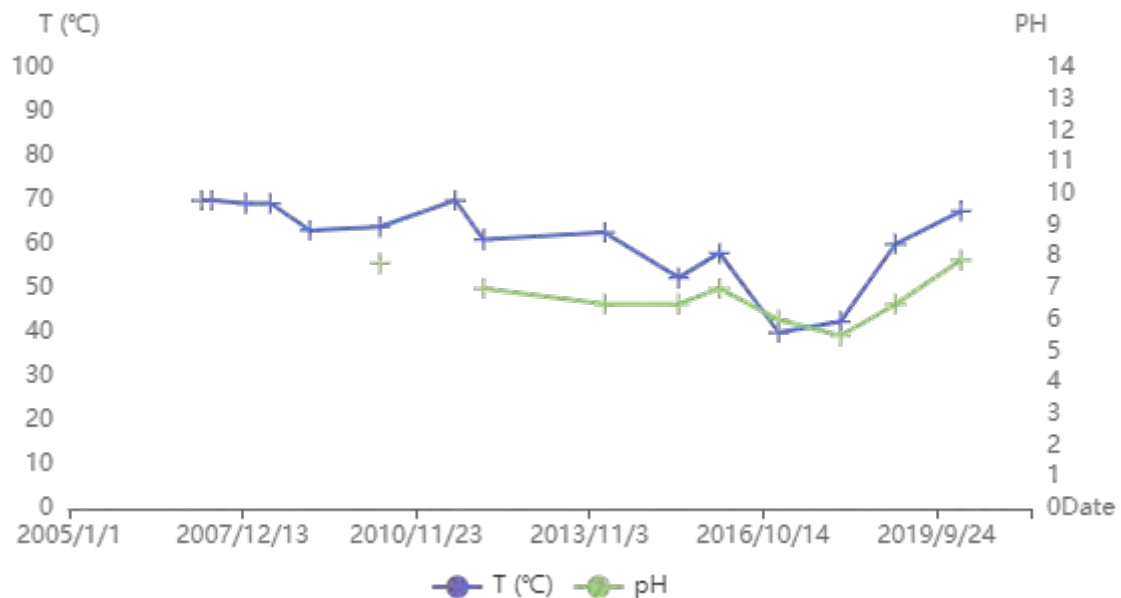




Fig.1 - taken on 2020-02-25 11:39:46"



Fig.2 - taken on 2020-02-25 11:40:36"



Fig.3 - taken on 2021-04-29 11:26:07"



Fig.4 - taken on 2021-04-29 11:30:58"

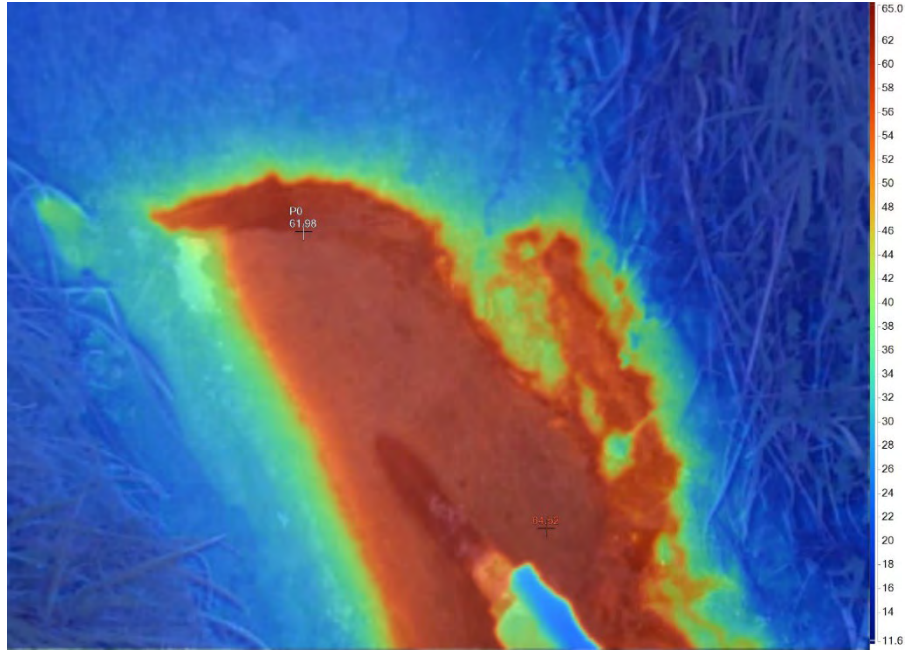


Fig. 5 Infrared image of the 152 Matapan Rd spring. Taken on 2021-04-29.

3 MOKAI

3.1 3062_12: P3 Paerata Rd (Mud Geyser / MKNF13)

- A large rectangular mud geyser, with dimensions being 10 m diameter E-W and 5 m N-S.
- Constantly upwelling or erupting up to 1.5 m high. Difficult to observe surface due to constant steam discharge, and as the vertical distance from ledge to the feature below is ~ 15 m.
- Direct temperature and pH measurements cannot be taken with current methodologies.

Location: -38.510253, 175.929819

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2007/04/01				None	nd	nd	nd
Comments	E2765575 N6295092.Feature located at Paerata Rd. Now called Mokai Mud Geyser. <i>Water level: nd</i>						
2008/01/01				None	nd	nd	Audible vigorous bubbling
Comments	Feature not visible due to intense clouds of steam. Pool heard bubbling vigorously. <i>Water level: nd</i>						
2009/02/01				None	nd	nd	Bubbling
Comments	Feature not visible due to steam. Steam and gases latered rock walls. Cliffs bright white colour. <i>Water level: nd</i>						
2010/06/14		88.0		None	nd	light grey	Violent upwelling
Comments	<i>Water level: nd</i>						
2011/07/24		82.0		None	nd	nd	Violent upwelling, the mud appeared to be boiling.
Comments	Infrared is affected by the steam.						
2021/04/29		56.8		Nd	Muddy	Grey	Constant, violent
Comments	Difficult to visually observe feature due to steam but when momentarily clear, constant violent rupturing of the mud was observed. The ebullition does not seem to be centred at one point, and the mud was observed to not be viscous (water-like consistency). <i>Temperature: Infrared thermometry measurement from ~20 m distance.</i>						

P3 Paerata Rd (Mud Geyser / MKNF13: Temperature and pH for 2005/1/1 - 2021/5/1

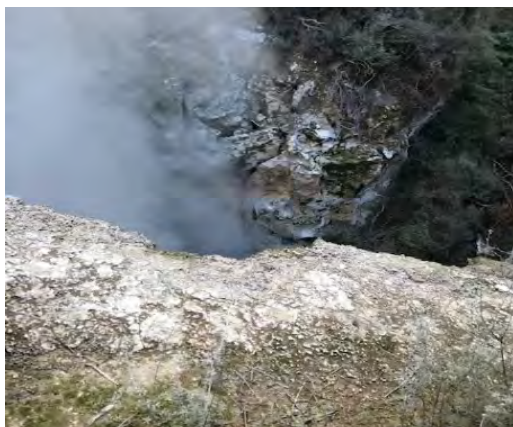


Fig.1- taken on 2021-04-29

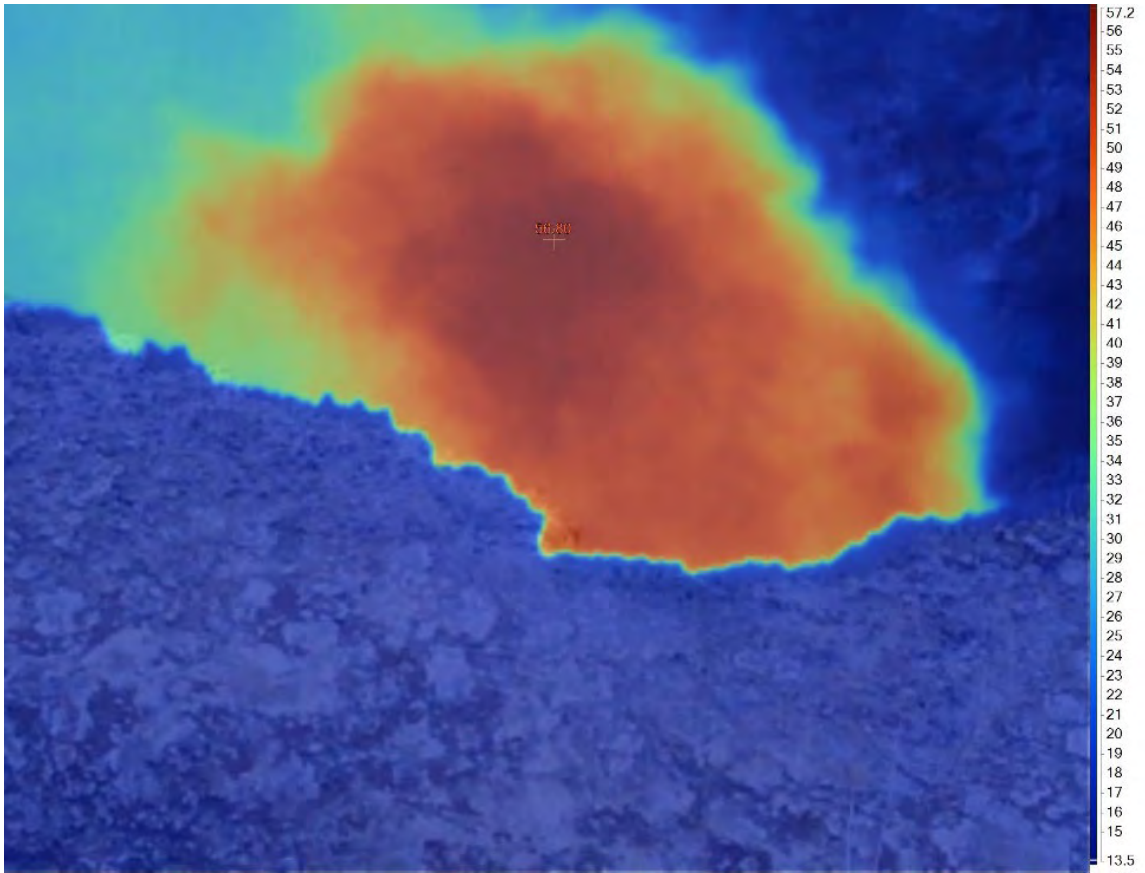


Fig. 2 Infrared image of the Mud Geysir. Taken on 2021-04-29.

3.2 3062_13: P4 Paerata Rd (Feature 1 / P1 a-g)

- An area with a group of mud pools and hot seeps. Gas discharge visible from multiple points.
- Direct temperature and pH measurements not taken as ground looks unstable.

Location: -38.510404, 175.930972

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2007/04/01				None	nd	nd	nd
Comments	Cluster of geothermal features located at Paerata Road in an area 100m long x 70m wide. <i>Area of feature:</i> 100m long x 70m wide						
2008/01/01		45.0		None	Muddy	Green/brown	nd
Comments	Features predominantly brown and muddy with low water levels. Colour varied from green to brown. <i>Water temperature:</i> Temperature range 29-45 degrees <i>Water level:</i> Water level low						
2009/02/01				None	Muddy	Brown	nd
Comments	Group of geothermal features 100m long x 70m wide <i>Water level:</i> nd <i>Area of feature:</i> 100m x 70m						
2010/06/14	2.3	14.0		None	Murky	Grey/brown	Calm
Comments	<i>Water level:</i> nd						
2011/07/24		16.0		None	Murky	Grey/brown	Calm
Comments	All features merged into one pool. <i>Water level:</i> nd						
2021/04/29		66.4			Muddy	Grey	Low in some pools
Comments	Site was driest ever observed by Richard Setters (Mercury). Area observed to be separate mud pools and steam vents due to the low water level.						



Fig.1- taken on 2021-04-29

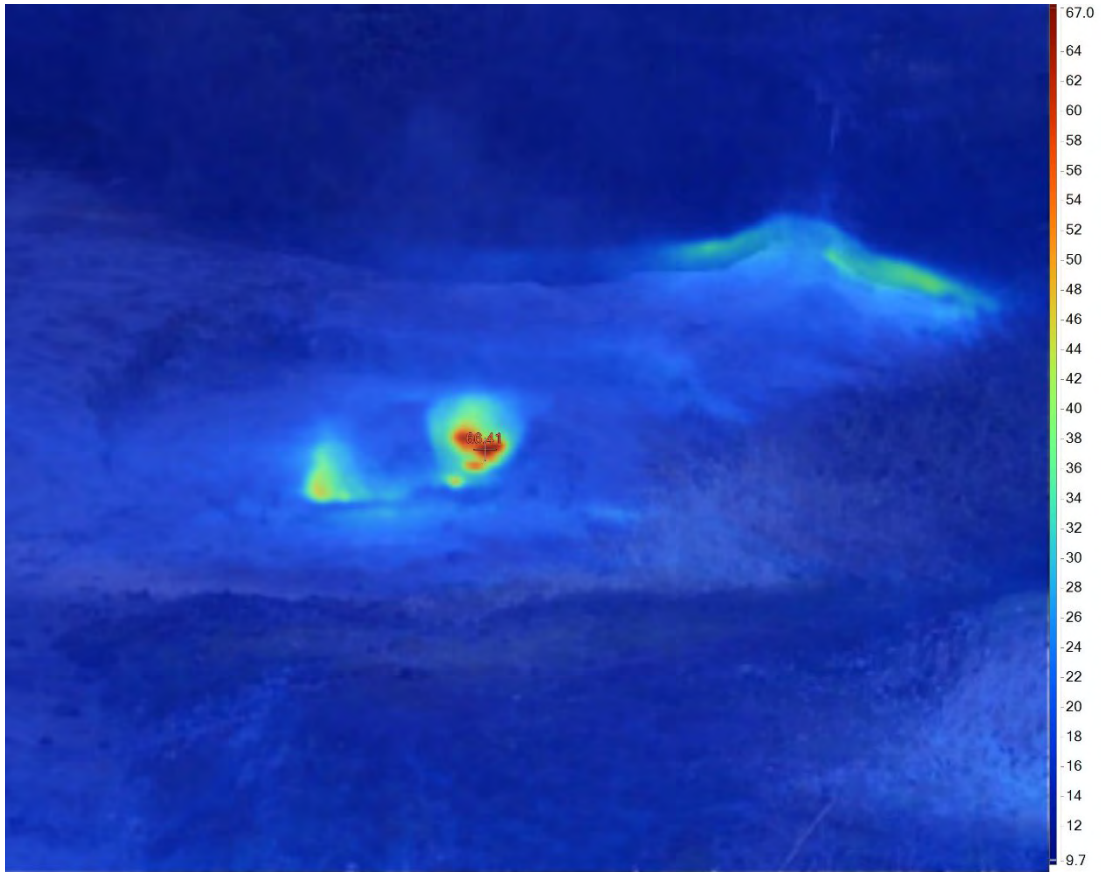


Fig. 2 Infrared image of ta mud pool at P4 Paerata Rd. Taken on 2021-04-29.

3.3 3062_14: T5 Tirohanga Rd - Crater 3

- Between 2007 to 2011, temperature of this feature fluctuated within 20 °C, but more data required for observing long-term trends.

Location: -38.503965, 175.905234

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2007/04/01				None	nd	nd	nd
Comments	Two mud pools located at site. E2763448 N6295832. <i>Water level: nd</i>						
2008/01/01		64.4	2.0	None	Muddy	Grey	nd
Comments	Surrounding weeds flattened and covered in mud. <i>Water level: Below surface</i>						
2009/02/01		47.5		None	nd	Grey	nd
Comments	Pool is overflowing. Area of steaming ground and burnt vegetation beside the pool. <i>Water level: nd</i>						
2010/06/14		7.0	66.0	None	Murky	Brown	Calm
Comments	Water level covering ground between the pools in a 0.6 m wide channel. <i>Water level: Overflowing</i>						
2010/06/14		6.1	41.0	<2.0	Murky	Brown	Calm
Comments	Water level covering ground between the pools in a 0.6 m wide channel. <i>Water level: Overflowing</i>						
2011/07/24		63.0	1.5	>0.5	Murky	Brown	Calm
Comments	<i>Water level: Below rim</i>						
2021/04/29		62.3	0.3	Nd	Muddy	Brown – Light	Constant on multiple spots.
Comments	Floating black raft structures similar to bacterial mats or sulphur globules observed. Small pool flows into the larger pool and has stronger ebullition. <i>Water Level: Has been decreasing, lowest ever observed by Richard Setters (Steam field coordinator, Mercury)</i>						

T5 Tirohanga Rd - Crater 3: Temperature and pH for 2005/1/1 - 2021/5/1





Fig.1 - taken on 2021-04-29



Fig.2 - taken on 2021-04-29



Fig.3 - taken on 2021-04-29

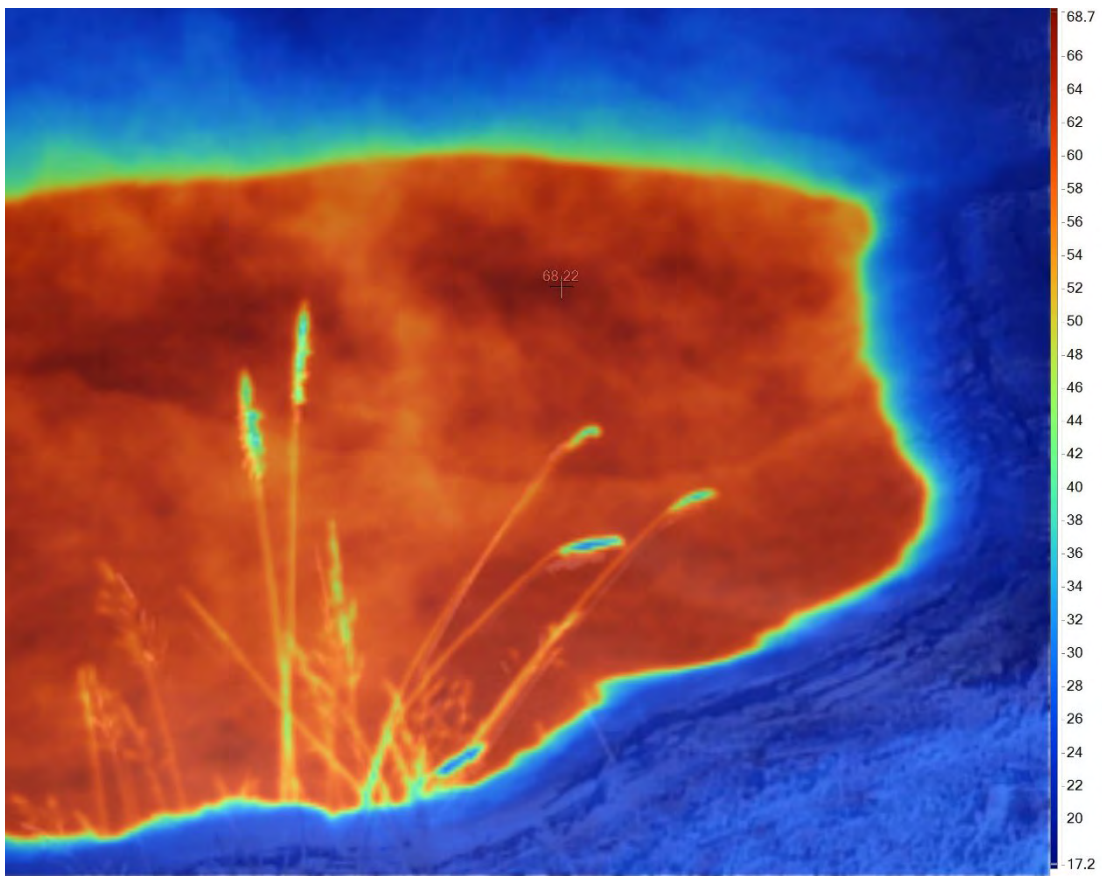


Fig. 4 Infrared image of the mud pool at P4 Paerata Rd. Taken on 2021-04-29

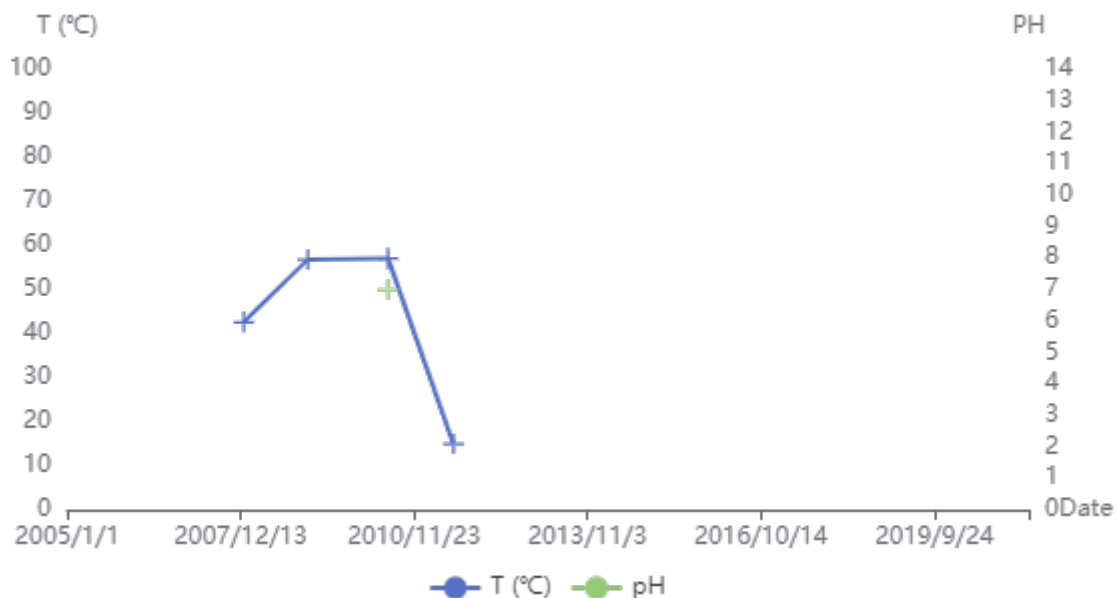
3.4 3062_37: T1 & T2 Tirohanga Rd Crater 8a

- The elevated grounds marginal to the crater are warmer even when the feature is dry.
- The temperature of this feature decreased significantly in 2011, but there has been poor data continuity since to observe any other changes.

Location: -38.505198, 175.905272

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2008/01/01		42.6		None	Muddy	Brown	Calm
Comments	Ascending gas bubbles covering entire pool. pH: nd Water level: nd						
2009/02/01		56.8		None	Muddy	Brown	Ascending gas bubbles within entire pool
Comments	Now merged with Feature 1. pH: nd Water level: nd						
2010/06/14	7.0	57.0	0.3	None	Milky	Khaki	Calm
Comments	Water level: Below rim						
2011/07/24		15.0		None	Milky	Pale brown	Calm
Comments	Site has two merged pools. E2763460 N6295714 pH: nd Water level: nd						
2021/04/29		52.0	0.4	Nd	Clear	Green – Blue	Nd

T1 & T2 Tirohanga Rd Crater 8a: Temperature and pH for 2005/1/1 - 2021/5/1



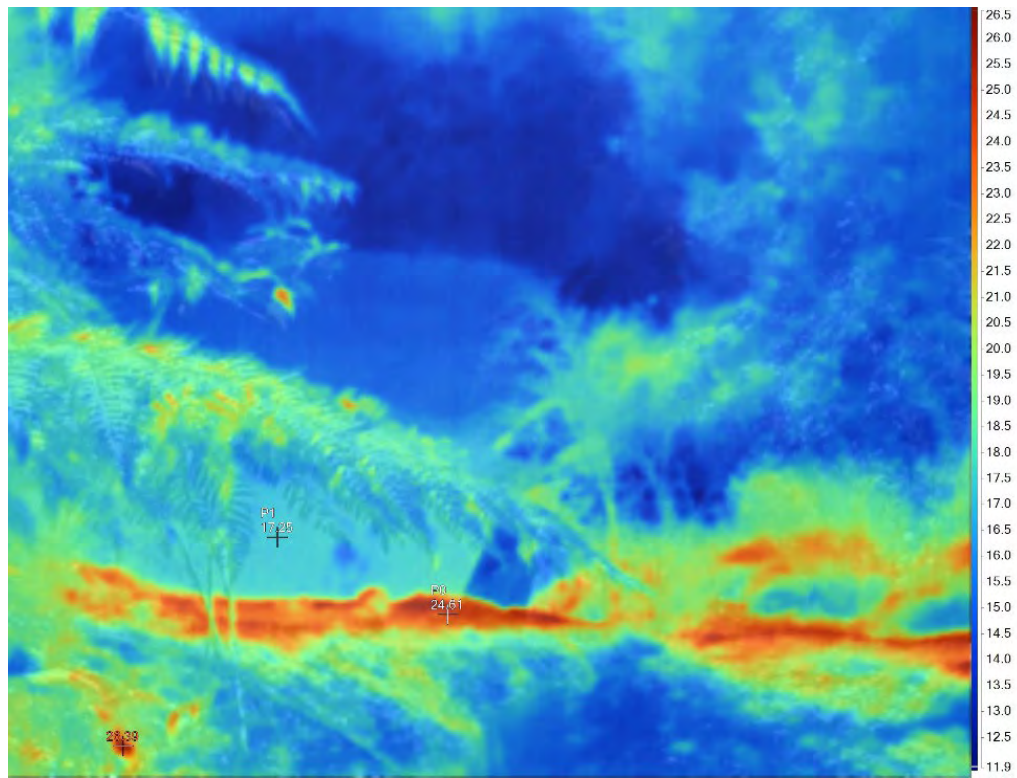


Fig. 1 Infrared image of Crater 8a. Taken on 2021-04-29.

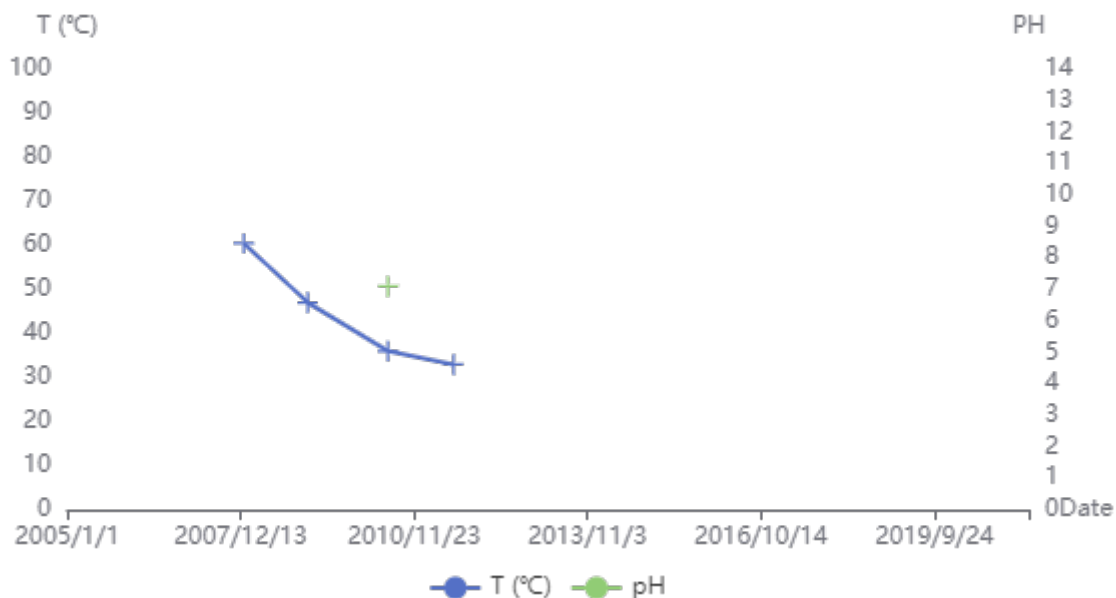
3.5 3062_38: T3 Tirohanga Rd Crater 8

- Feature could only be observed behind a vegetation cover for safety measures. As a result, direct temperature and pH measurements cannot be obtained.
- Temperature measurements decreased significantly between 2007 to 2011.

Location: -38.505045, 175.905278

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2007/04/01				None	nd	nd	nd
Comments	E2763455 N6295751 Water level: nd						
2008/01/01		60.5		None	Mud	Grey	Rare gas discharge evident in pool. Steaming.
Comments	Water level: nd						
2009/02/01		47.0		None	Murky	Green	Calm, steaming.
Comments	No signs of upwelling or discharge evident. Steaming. Water level: nd						
2010/06/14	7.1	36.0	0.3	None	Murky	Pale brown	Calm
Comments	Water level: Below stump.						
2011/07/24		33.0	0.2	None	Murky	Green	Calm
Comments	This pool is ~5m from Feature 1 and Feature 2, however the water level is ~1.5m above Feature 1 and Feature 2. Water level: Below stump.						

T3 Tirohanga Rd Crater 8: Temperature and pH for 2005/1/1 - 2021/5/1



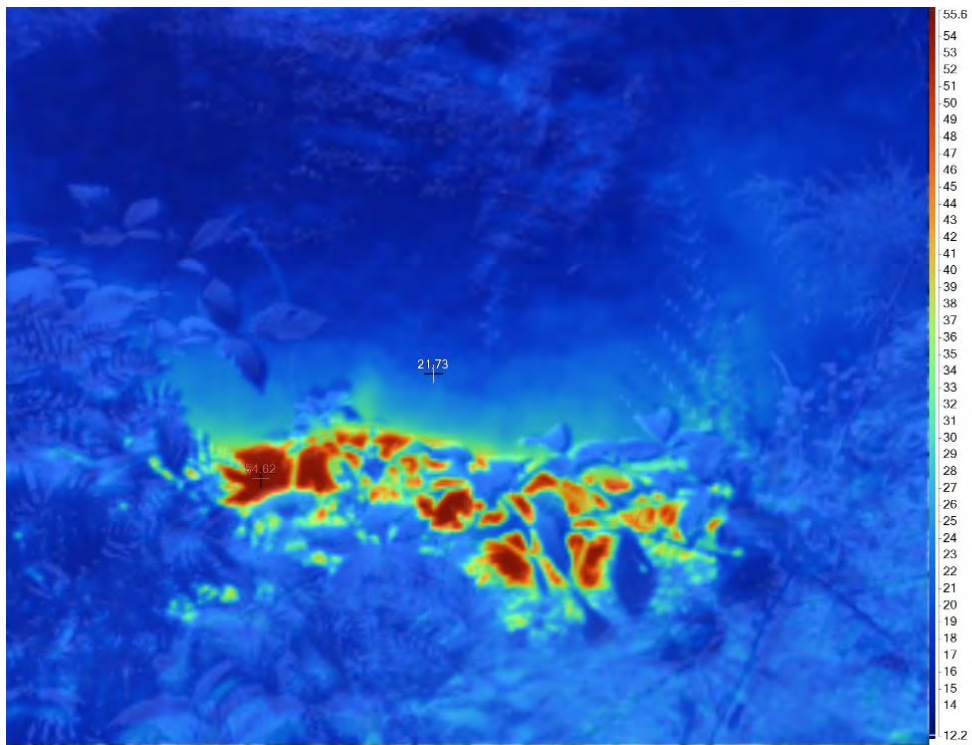


Fig. 1 Infrared image of Crater 8. Taken on 2021-04-29

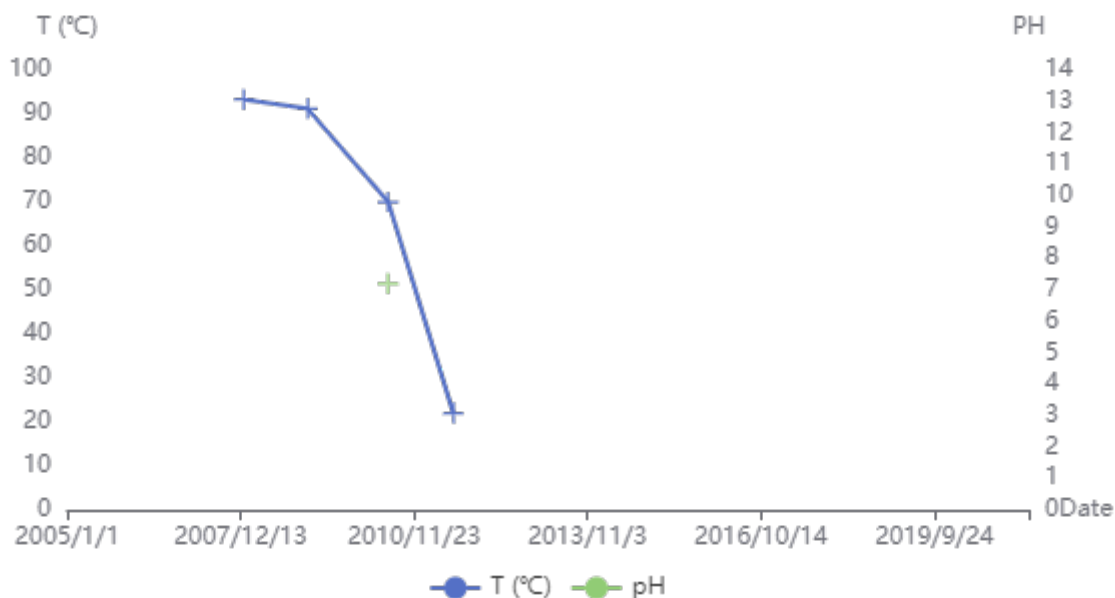
3.6 3062_39: T4 Tirohanga Rd - Crater 7

- Feature cannot be safely approached due to hazards. As a result, direct temperature and pH measurements cannot be obtained.
- Observations using an IR camera show that the rock wall next to the feature is much hotter than the mud surface.
- Temperature measurements decreased significantly between 2007 to 2011.

Location: -38.504837, 175.905292

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2007/04/01				None	nd	nd	nd
Comments	3 mud pools located E2763460 N6295777 <i>Water level:</i> nd						
2008/01/01		93.3		<10.0	nd	Pale grey	Several zones of upwelling
Comments	Consists of 3 mud pools each 2.5m deep. <i>Water level:</i> Overflowing						
2009/02/01		91.2	2.5	<None	Clear	Clear	Minor gas discharge
Comments	No water visible. Pool depth 2.5m in all 3 pools. No gas or visible upwelling. <i>Water level:</i> Below surface						
2010/06/14	7.2	70.0		None	Slightly milky	Brownish blue	Calm
Comments	<i>Water level:</i> Ground level						
2011/07/24		22.0	1.3	None	Slightly milky	Pale brown	Calm
Comments	Features have cooled considerably since February 2009. E2763460 N6295777 <i>Water level:</i> Below rim						

T4 Tirohanga Rd - Crater 7: Temperature and pH for 2005/1/1 - 2021/5/1



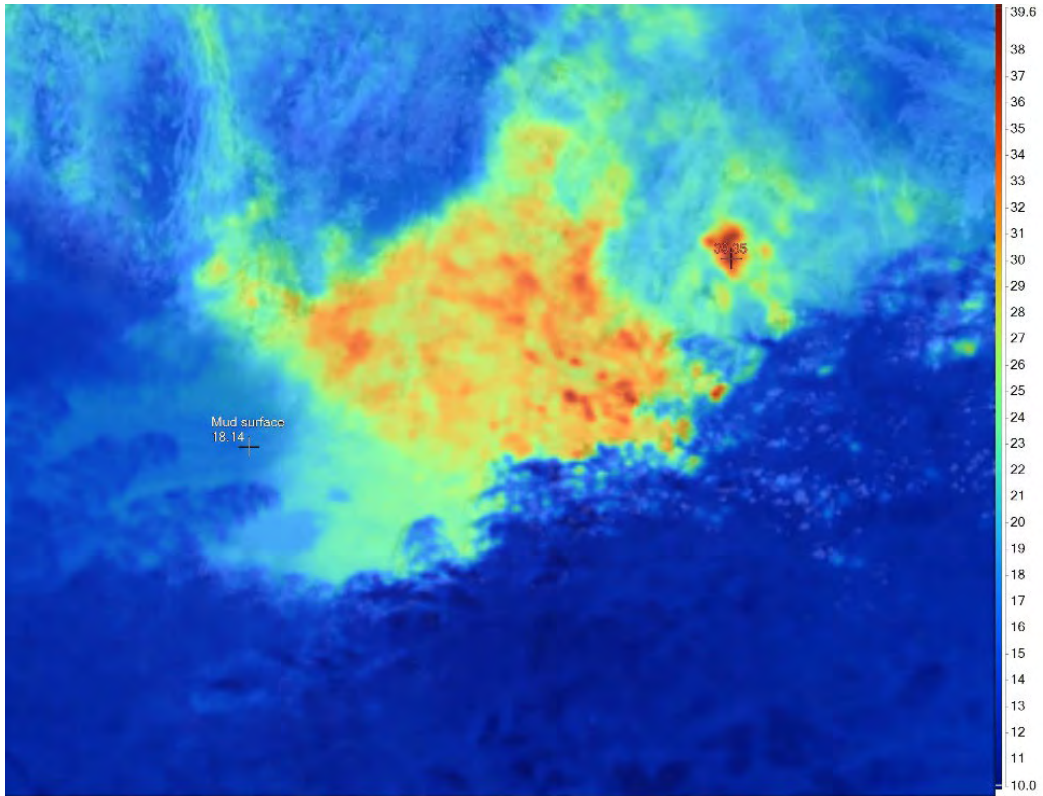


Fig. 1 Infrared image of Crater 7. Taken on 2021-04-29.

3.7 3062_17: West Mokai Spring MKF17

- Often incorrectly called “Parekiri Pool”, which is a different feature.
- Not enough continuous data has been collected for long-term trend observations.

Location: -38.501748, 175.903414

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2018/02/08	3.1	51.6		<1.0	Clear	Colourless	nd
Comments	Bath house torn down. Now just a pool. Water level: Overflowing						
2021/04/29	6.0	47.9			Clear	Colourless	Nd, bubbly surface
Comments	Water surface is covered by numerous gas bubbles.						

West Mokai Spring MKF17: Temperature and pH for 2005/1/1 - 2021/5/1



Fig.1 - taken on 2021-04-29 20:37:06"

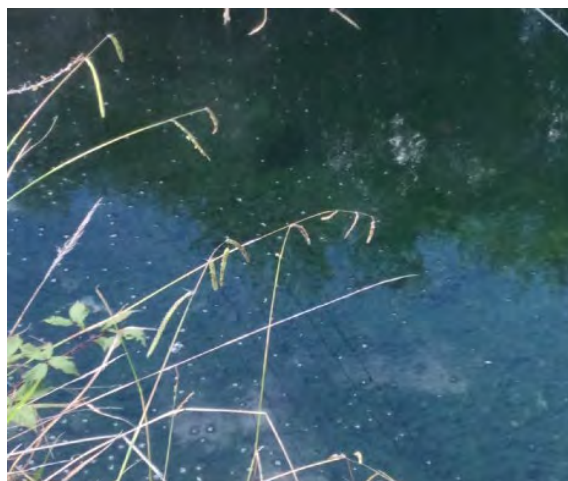


Fig.2 - taken on 2021-04-29 20:37:11"

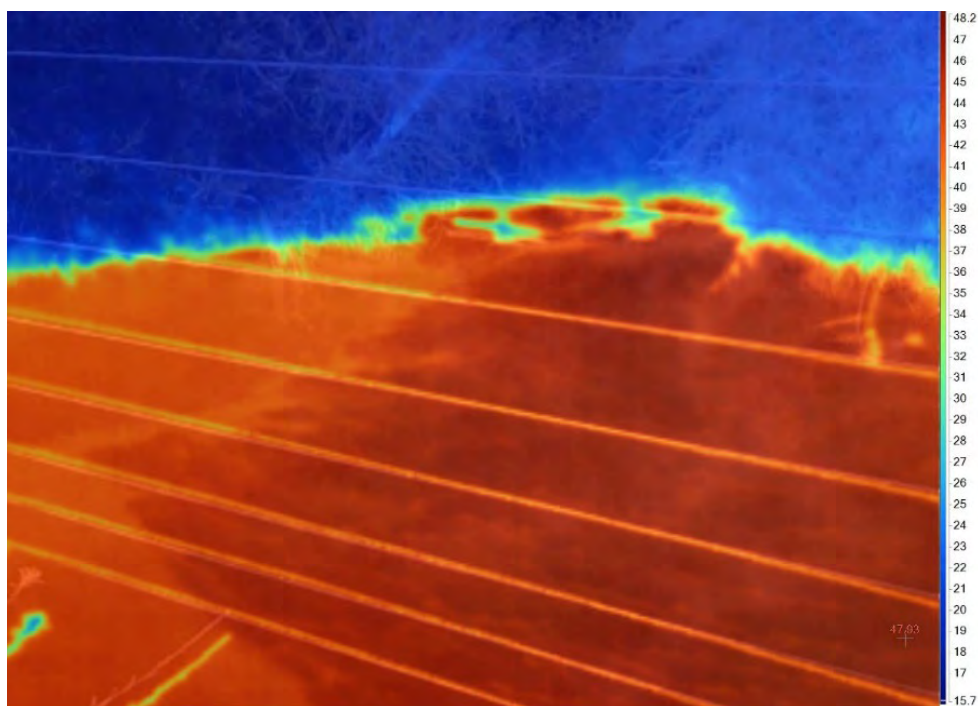


Fig. 3 Infrared image of MKF17. Taken on 2021-04-29.

3.8 3062_42 : Waipapa Stream Springs

- Multiple alkali chloride streams discharging into the Waipapa Stream, mixing and consequentially turning the stream chemistry into a geothermal stream.

Location: -38.456718, 175.953866

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2018/02/08	5.5	56.2		None	Clear	Colourless	nd
Comments	Thick blackberry all the way to site. Cannot see wooden fence from road. <i>Water level: nd</i>						
2021/04/29	7.3	60.8		<10.0	Clear	Colourless	
Comments	Minor sinter deposition on stream margins						

Waipapa Feature (Spring): Temperature and pH for 2005/1/1 - 2021/5/1

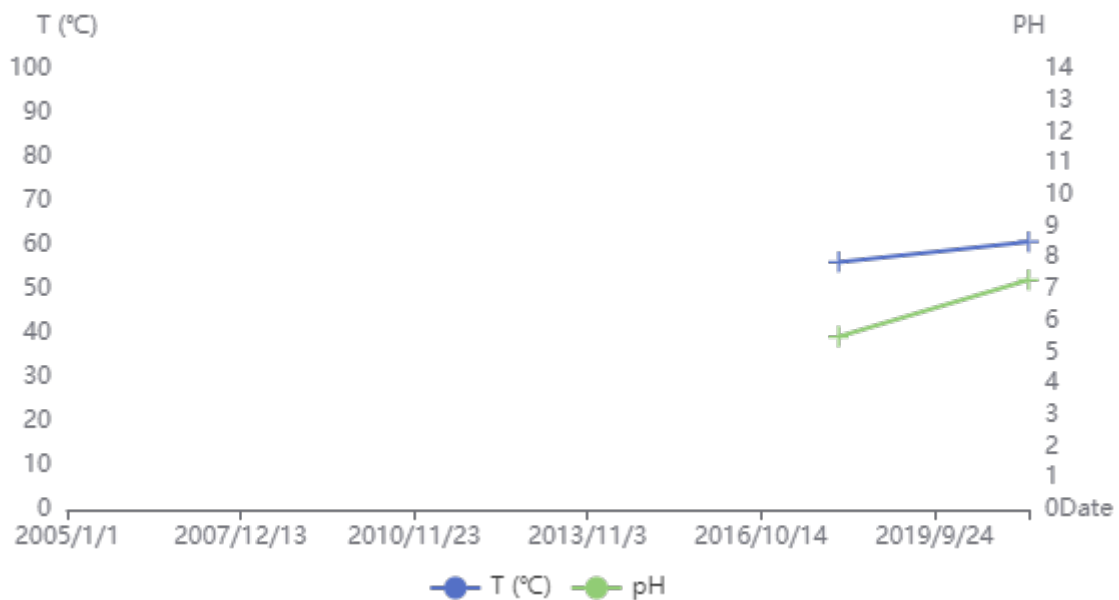


Fig.1- taken on 2021-04-29

4 NGATAMARIKI

4.1 3063_1: Hydrothermal Eruption Crater

- Since the hydrothermal eruption that formed this feature in 2005, temperature measurements experienced constant but minor decrease between 2005 to 2017, since which the temperature has fluctuated within a 20 °C range.
- pH measurements fluctuated from 2011 to 2016, but slowly increased since 2016 towards neutral conditions.
- In November 2019, a large weather event caused large amounts of pumiceous sediments from the nearby slope to become transported and deposited into the feature. In February 2020, much of the pumiceous debris could be seen accumulating into a sediment apron on the north-western side of the feature, while those that were floating were bounded by microbial communities, forming numerous raft-like structures. In November 2020, raft structures were no longer present, while the sediment apron appeared to be permanent. The permanent nature of the apron was later confirmed in April 2021, when it was observed that the sediments have settled.

Location: -38.533395, 176.172105

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	6.0	45.9	0.105	<2.0	Murky	Green - Dark	Relatively constant ebullition in places
Comments	Whole pool is steaming. Lots of yellow algal mats <i>Water level:</i> ESG						
2019/04/16	6.0	40.4	0.8	<3.0	Murky	Green - Dark	Small bubbles in several areas
2019/11/08	6.0	43.3	0.07	<3.0	Murky	Green - Murky	Small bubbles all over pool
Comments	Algal mats are right side of pool. Scum on surface on far right and left of pool.						
2020/02/11	6.0	48.4	0.095	<6.0	Murky	Brown - Dark	Small bubbles all over pool.
Comments	The area has changed considerably. There has been a landslip on the far side. This may be what has caused the change to the pool. There is a large mound of dirt on the far side, the HER crater is brown. Freshly broken silica blocks on top of mound on access side.						
2020/08/04	7.0	38.0	0.215	<5.0	Murky	Brown	Small bubbles
Comments	Foggy <i>Ebullition:</i> Small bubbles around the edge						
2020/12/03	4.0	46.5	0.2		Murky	Green - Dark	Low to high
Comments	Sediment apron 2-3 m thick on W side, looks more permanent compared to last visit. W side more effervescent. Ebullient spring observed on SW side, grey waters, flowing into main pool (possibly previously submerged but exposed due to water level drop). No rafting Cyanobacteria formations observed. <i>Ebullition:</i> Generally low ebullition. Moderate ebullition in NE side with individual bubbling centres. New spring observed in the far SW with high ebullition. <i>Eruption</i> Constant on SE side						
	6.0	51.0	0.3	>10.0	Cloudy	Green – Murky	Constant low ebullition
Comments	The sediment apron has become permanent. Increased pH since last monitoring trip.						

Hydrothermal Eruption Crater: Temperature and pH for 2005/1/1 - 2021/5/1

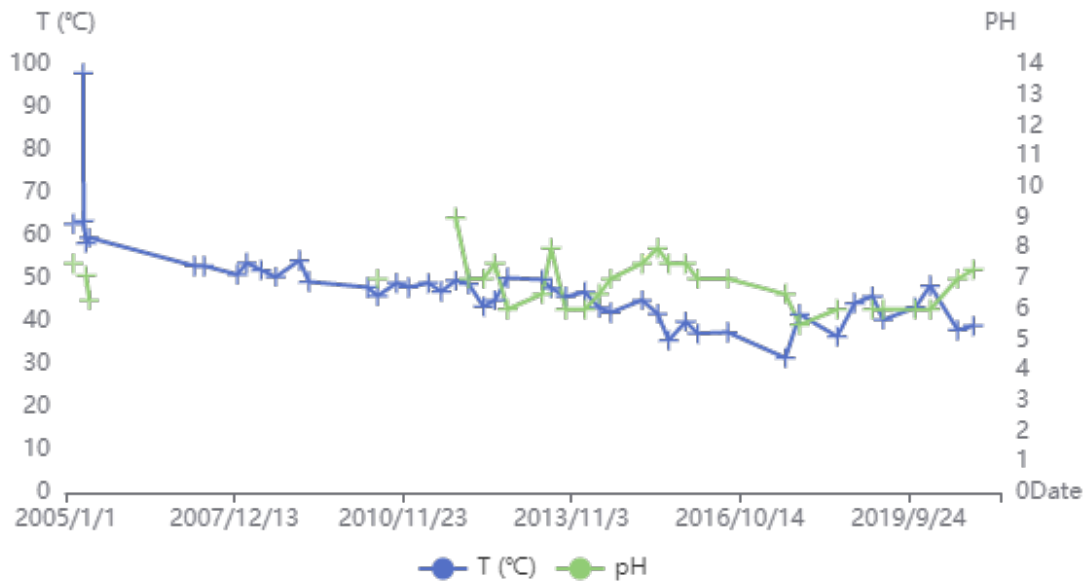


Fig.1 - taken on 2018-10-16 12:26:05"



Fig.2 - taken on 2019-04-16 11:01:55"



Fig.3 - taken on 2019-11-08 09:04:50"



Fig.4 - taken on 2020-02-11 10:06:30"



Fig.5 - taken on 2020-08-04 10:37:16"



Fig.6 - taken on 2020-11-13 13:03:20"



Fig.7 - taken on 2021-04-30 12:43:42"

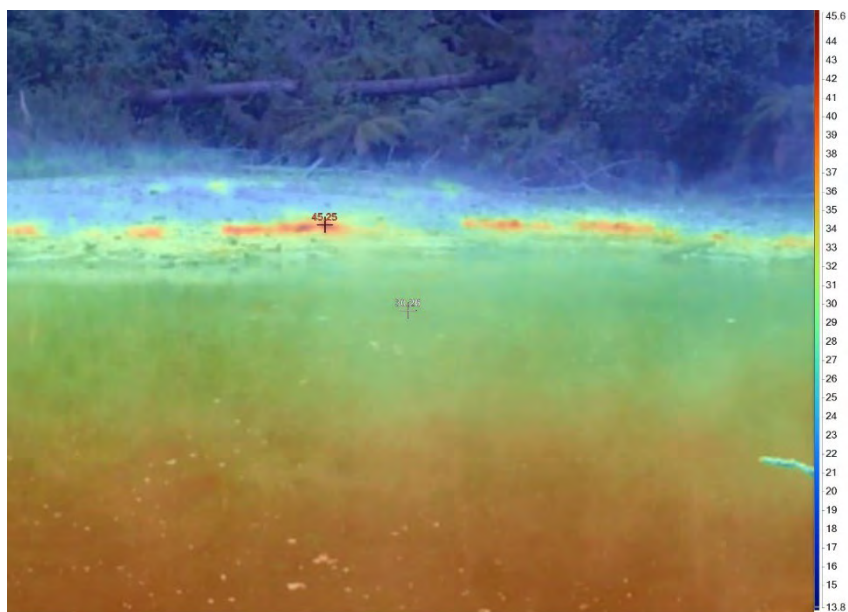


Fig. 8 Infrared image of the distal part of the hydrothermal eruption crater. Taken on 2021-04-30.

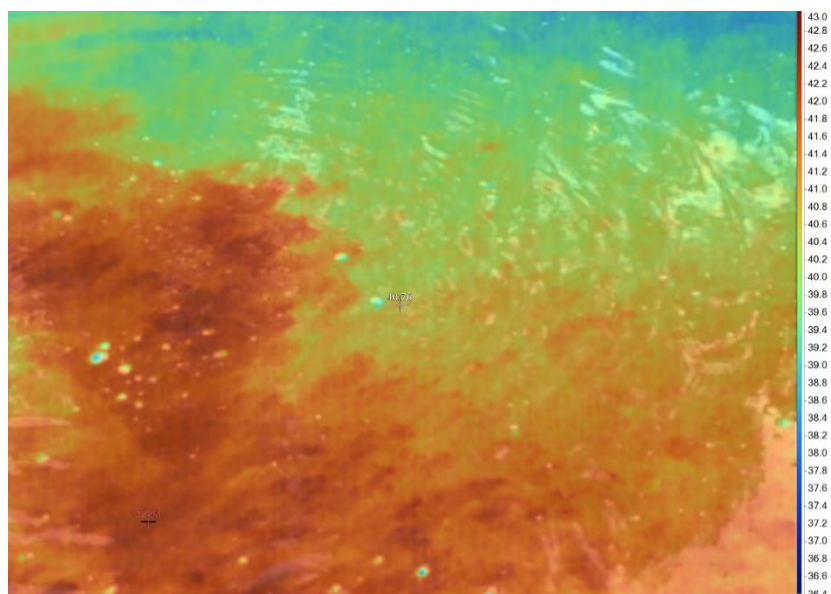


Fig. 9 Infrared image of the proximal part of the hydrothermal eruption crater. Taken on 2021-04-30.

4.2 3063_4: Southern Spring aka Biodiversity Pool

- On the aftermath of the Ngatamariki hydrothermal eruption in 2005, temperature conditions of the Biodiversity Pool decreased by over 60 °C, before rebounding back to above 70 °C later in the year. Since then, the pool's temperature underwent a minor steady decline until 2010. Temperatures conditions changed more dramatically between 2010 to 2016, when temperatures fluctuated and decreased from ~70 °C to 20 °C, but later increased to pre-2010 conditions in 2019.
- pH conditions generally have a positive correlation to temperature conditions, however, no pH measurements were taken in the relatively stable temperature period between 2005 – 2010, and in the period of greatest temperature decrease between 2014 and 2016 due to the pool track being heavily overgrown.

Location: -38.534198, 176.172393

Date	pH	Temp °C	LevelFlow (m) (l/s)	Clarity	Colour	Ebullition
2019/02/08	7.0	70.0	None	Clear	Colourless	Constant in patches
Comments	Measurements taken on far side of pool					
2019/04/16	6.0	58.2	None	Clear	Grey - Light	Constant bubbles
Comments	<i>Water level: Nd</i>					
2019/11/08	7.0	68.4		Clear	Colourless	Constant ebullition in centre
2020/02/11				Murky	Brown - Light	nd -appears calm from a distance
Comments	Canâ€™t access as tree has fallen across path. Pool appears brown and murky.					
2020/11/13	7.4	71.0		Clear	Green - Dark	Ebullition
Comments	Log on northern side, algae on surface. Plant material fallen into spring. Bubbles everywhere on surface. <i>Ebullition: Mainly on north side. Spring is bubbly/effervescent all around</i>					
2021/04/30	7.0	65.0		Clear	Green – Light	Constant low ebullition from main pool. Other pools are more ebullient.
Comments	White mineral precipitates forming on subaqueous objects and subaerial branches. <i>Thermocouple Temp: Not possible to take measurement at hottest point.</i>					

Southern Spring aka Biodiversity Pool: Temperature and pH for 2005/1/1 - 2021/5/1

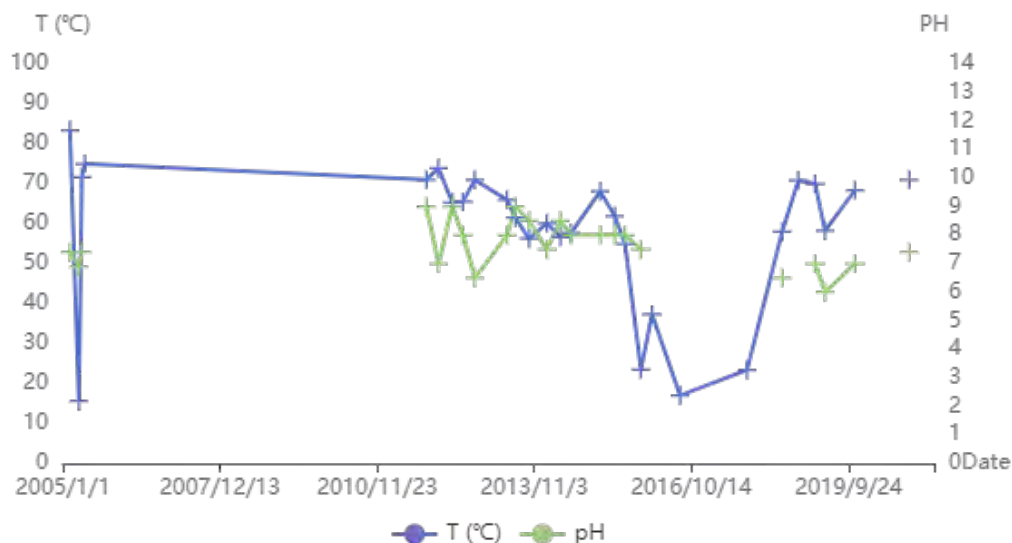




Fig.1 - taken on 2018-10-16 12:57:44"



Fig.2 - taken on 2019-04-16 11:26:50"



Fig.3 - taken on 2019-11-08 09:24:20"



Fig.4 - taken on 2020-11-13 13:40:22"



Fig.5 - taken on 2021-04-30 13:24:56"



Fig.6 - taken on 2021-04-30 13:25:01"



Fig.7 - taken on 2021-04-30 13:27:55"

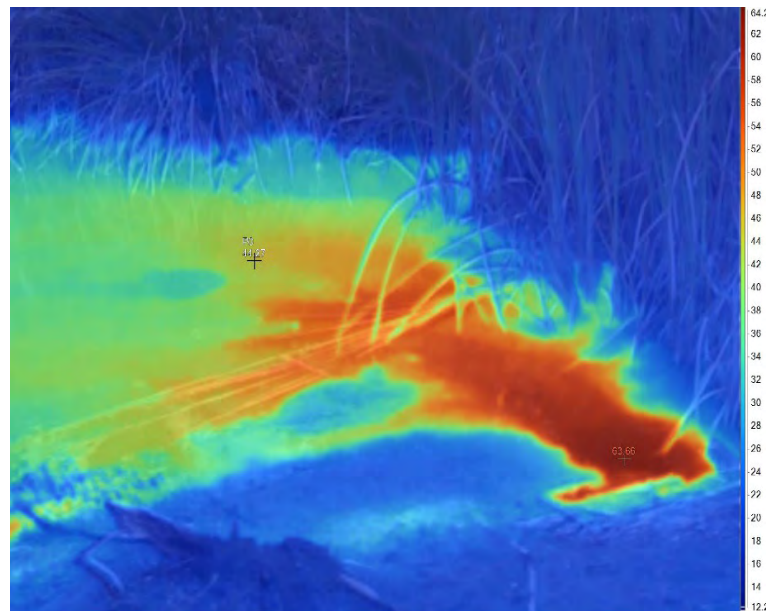


Fig. 8 Infrared image of the Biodiversity Pool. Taken on 2021-04-30.

5 ORAKEI KORAKO

5.1 3065_1: Map of Australia

- The temperature at this pool regularly cycles between 80 °C and approximately 70 °C since early measurements were taken in 2008.
- pH measurement is observed to be inversely correlated to temperature, and ranges between pH 6 and 8, remaining near-neutral.
- In December 2020, the pool overflowed significantly and microbial mat communities formed in overflows above soil level. Silicification was ongoing, with some mats becoming partially silicified. In March 2021 the silicified mats are has become absent, but it is unknown if the process is natural or anthropogenic.

Location: -38.473425, 176.1426

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	6.5	80.0	0.22	<0.5	Clear	Blue	Constant upwelling
Comments	<i>Water level:</i> Ruler						
2019/04/16	6.0	75.4	0.22	<0.5	Clear	Blue - Light	---
2019/07/26	7.0	78.1	0.21	<1.0	Clear	Blue	Constant bubbling on right side
Comments	<i>Water level:</i> Water overflowed onto grass area.						
2019/08/19	7.0	73.0	0.21	<1.0	Clear	Blue	Constant bubbling on right side
Comments	<i>Water level:</i> Water overflowed onto grass area.						
2019/11/08	7.0	77.4	0.225		Clear	Blue - Light	Constant on right side
Comments	Tree fallen into pool on right						
2020/02/11	6.0	77.3	0.225	<1.0	Clear	Blue	Constant upwelling on right side.
2020/08/06	8.0	79.2		<0.5	Clear	Blue - Green	Small bubbles
Comments	<i>Ebullition:</i> Not constant						
2020/12/04	7.0	70.0	0.2		Clear	Blue – Light	Low
Comments	Overflowing and sinter depositing. Microbial communities growing in overflow areas of soil and grass. Spring and thermal gradient seems to be extending. <i>Infrared Temp:</i> Some grassy areas observed to have T >50 C. <i>Water Level:</i> Risen above previous levels, increasing water content in soil <i>Clarity:</i> 5 m <i>Ebullition:</i> Infrequent gas bubbles rising from a focus point at the deepest part of spring.						
2021/04/30	7.0	77.8	0		Clear	Colourless	Constant weak ebullition from single part of the pool.
Comments	Pool no longer overflowing as observed on Dec 2020. Recent sinter deposits are damaged and algal communities are gone. Areas of increased temperatures around pool now cool.						

Map of Australia: Temperature and pH for 2005/1/1 - 2021/5/1

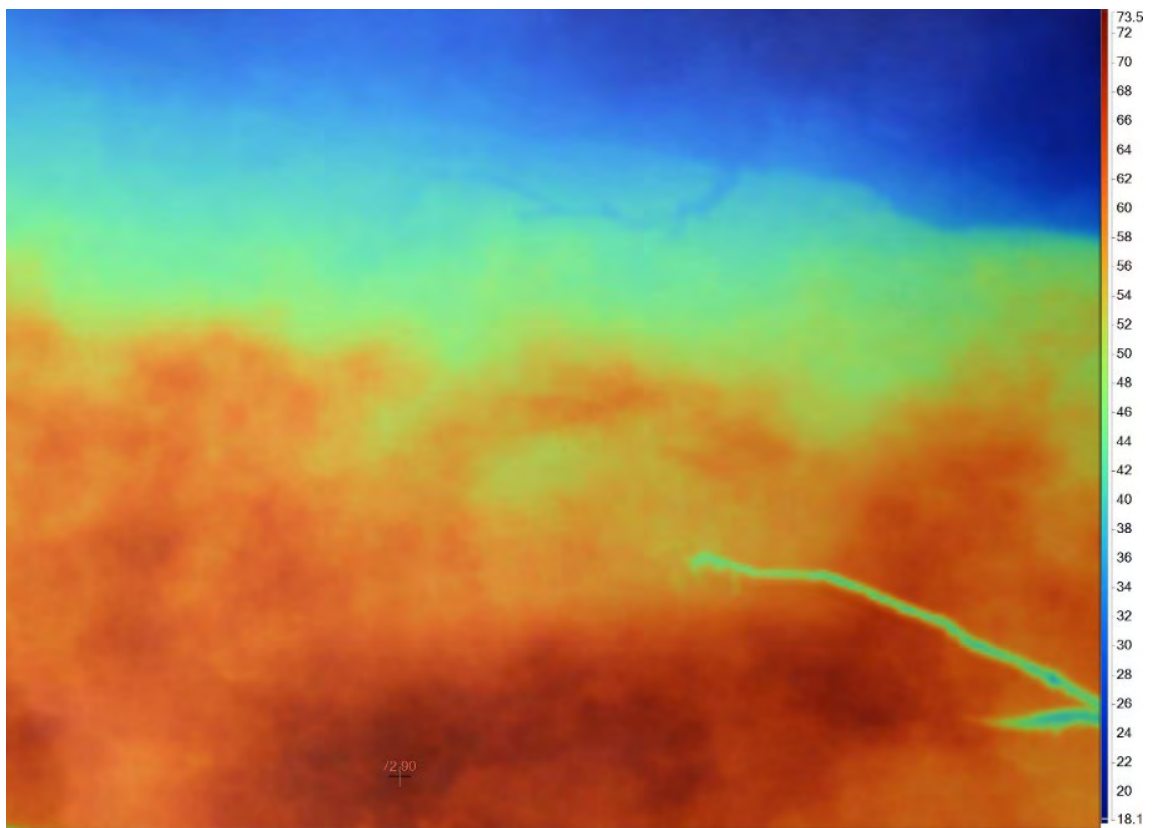
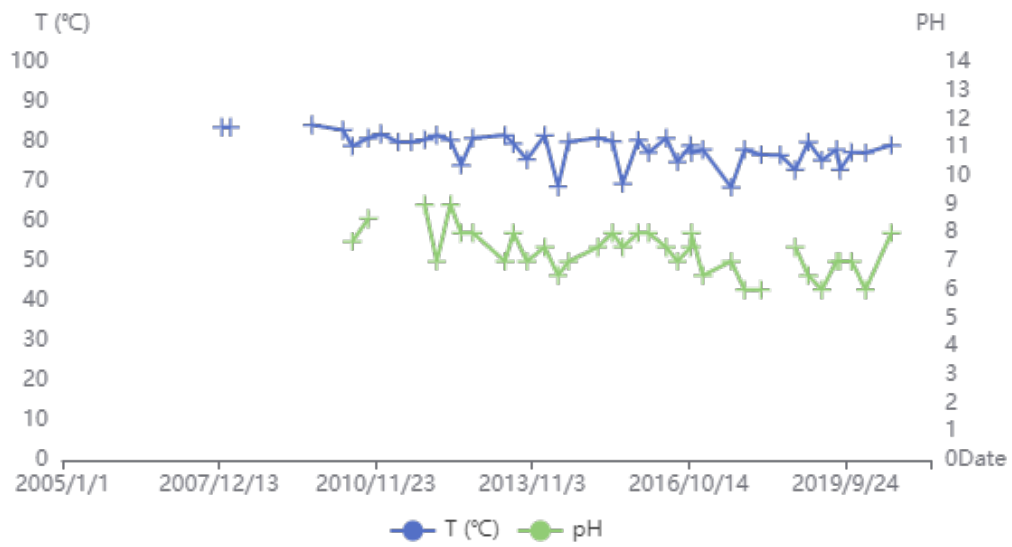


Fig. 1 Infrared image of Map of Australia. Taken on 2021-03-26.



Fig.2 - taken on 2018-10-16 08:40:30"



Fig.3 - taken on 2019-07-26 10:32:56"



Fig.4 - taken on 2019-07-26 10:33:42"



Fig.5 - taken on 2019-07-26 10:36:02"



Fig.6 - taken on 2019-11-08 10:07:10"



Fig.7 - taken on 2020-02-11 11:38:22"



Fig.8 - taken on 2020-08-06 09:32:59"



Fig.9 - taken on 2020-12-04 11:36:26"

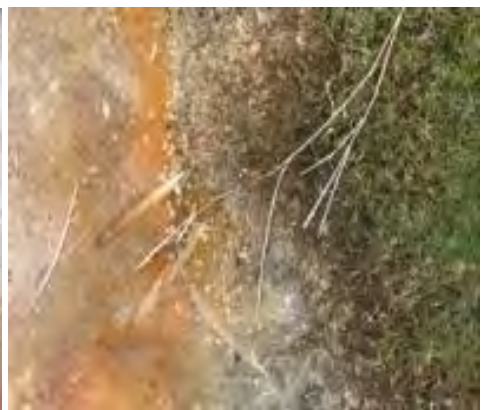


Fig.10 - taken on 2020-12-04 11:40:36"



Fig.11 - taken on 2020-12-04 11:40:41"



Fig.12 - taken on 2020-12-04 11:40:50"



Fig.13 - taken on 2021-03-26 11:22:20"

5.2 3065_2: OKF26 Mercury Monitoring Pool

- This pool has water temperatures between 74 and 83.2 °C, and is monitored by Mercury as one of the features used for understanding the relationship between Orakei Korako and Ngatamariki.

Location: -38.473195, 176.142452

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	5.5	74.1		<0.5	Clear	Brown	Constant upwelling
Comments	<i>Water level:</i> Overflowing						
2019/04/16	6.0	82.2	0.45	<0.5	Clear	Colourless	Constant bubbles
Comments	Installed data logger S0083094 <i>Water level:</i> Used tape measure ESG broken						
2019/07/26	7.0	80.5	0.21	<0.5	Clear	Brown	Constant bubbling in centre
Comments	Datalogger retrieved.						
2019/08/19	7.0	83.2	0.21	<0.5	Clear	Brown	Constant bubbling in centre
Comments	Datalogger retrieved.						
2020/08/06	6.0	79.1			Clear	Brown - Dark	Constant bubbles
Comments	<i>Ebullition:</i> In middle of pool						
04/12/2020	7.0	80.6		<1	Clear	Brown	Constant, moderate
Comments	Thin sinter observed forming the margin of pool, underlying organic topsoil. <i>Clarity:</i> Clear to 0.5 m, obscure beyond 0.5 m <i>Ebullition:</i> Erupting for 90 seconds						
2021/03/26	6.0	82.8	0		Clear	Brown – Light	
Comments	Old sinter deposits at pool margins. <i>Ebullition:</i> Constant moderate ebullition from centre of pool. Minor bubbles springing sporadically elsewhere. <i>Flow:</i> Weak flow						

OKF26: Temperature and pH for 2005/1/1 - 2021/5/1

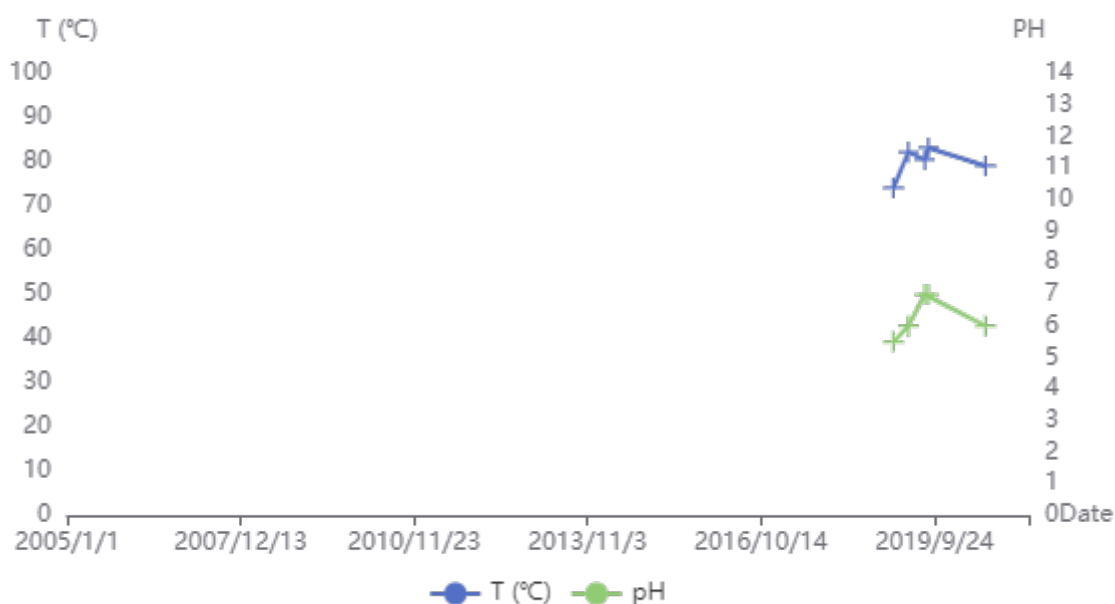




Fig.1 - taken on 2019-04-16 12:40:03"



Fig.2 - taken on 2019-07-26
10:43:09"



Fig.3 -taken on 2020-08-06
09:42:01"



Fig.4 - taken on 2020-12-04

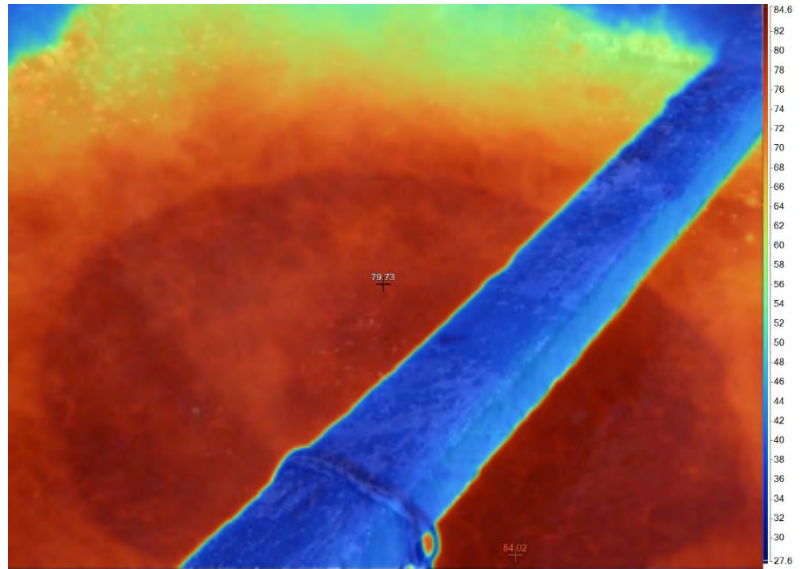


Fig 5. Infrared image of OKF26. Taken on 04-12-2020.

5.3 3065_6: Diamond Geyser

- Temperature conditions at Diamond Geyser have been constantly ranging between 70 and 90 °C.
- pH measurements have a great variation between pH 3 and 9. This could be affected by water accumulating at the surface of geyser vent being affected by the subaerial environment when the feature is not overflowing, with dissolved H₂S oxidising to H₂SO₄.
- This feature regularly erupts and overflow to the distal apron. Microbial mats with bubblemat textures grow in the outflow along the intermediate and distal vent slope.

Location: -38.473622, 176.146676

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	6.5	80.7		None	Clear	Grey - Dark	Constant upwelling near outlet
Comments	Water level: Overflowing						
2019/04/16	5.0	76.2		None	Clear	Grey - Dark	Constant at outlet
Comments	Logger installed S0083095 Water level: Overflowing						
2019/07/24				None	---	---	---
2019/07/26	7.0	81.0		<0.05	Clear	Grey - Dark	Constant at outlet
Comments	Feature to the right of geyser has been active						
2019/08/19	7.0	85.7		<0.05	Clear	Grey - Dark	Constant at outlet
Comments	Feature to the right of geyser has been active						
2019/11/08	7.0	88.3		<0.05	Clear	Blue - Grey	Constant bubbles at outlet
Comments	Path up to diamond geyser is wet. Looks like the new vent beside it has increased its flow path. Do not go up the path if the vent is noisy.						
2020/02/11	5.0	87.8		<0.5	Clear	Blue - Grey	Constant upwelling at outlet
2020/08/06	6.0	76.0		<1.0	Clear	Grey - Dark	Small bubbles
2020/12/04	6.0	81.0	0	>3.0	Clear	Blue – Grey	Constant low ebullition, focused at one point
Comments	Clarity: 3 m						
2021/03/26	6.0	88.9	0	Nd	Cloudy	Grey	Constant ebullition at 2 points
Comments	New but minor nodular sinter deposits observed.						

Diamond Geyser: Temperature and pH for 2005/1/1 - 2021/5/1

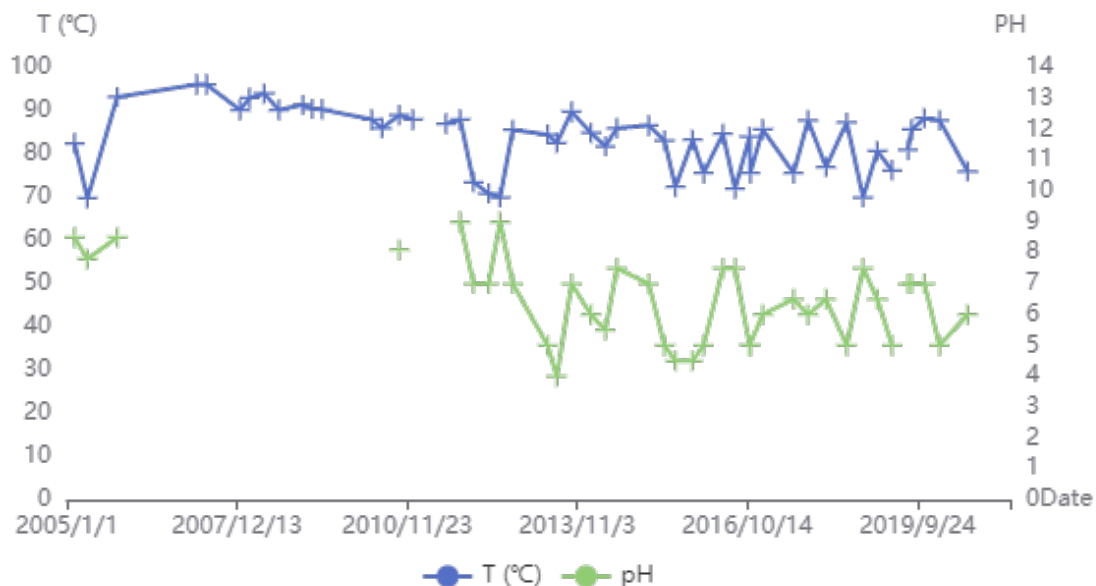




Fig.1 - taken on 2018-10-16 09:08:48"



Fig.2 - taken on 2019-04-16 13:07:25"



Fig.3 - taken on 2019-07-26 11:00:38"



Fig.4 - taken on 2019-11-08 10:28:41"



Fig.5 - taken on 2020-02-11 12:03:51"



Fig.6 - taken on 2020-08-06 09:56:27"



Fig.7 - taken on 2020-12-04 12:51:34"



Fig.8 - taken on 2021-03-26 10:41:16"

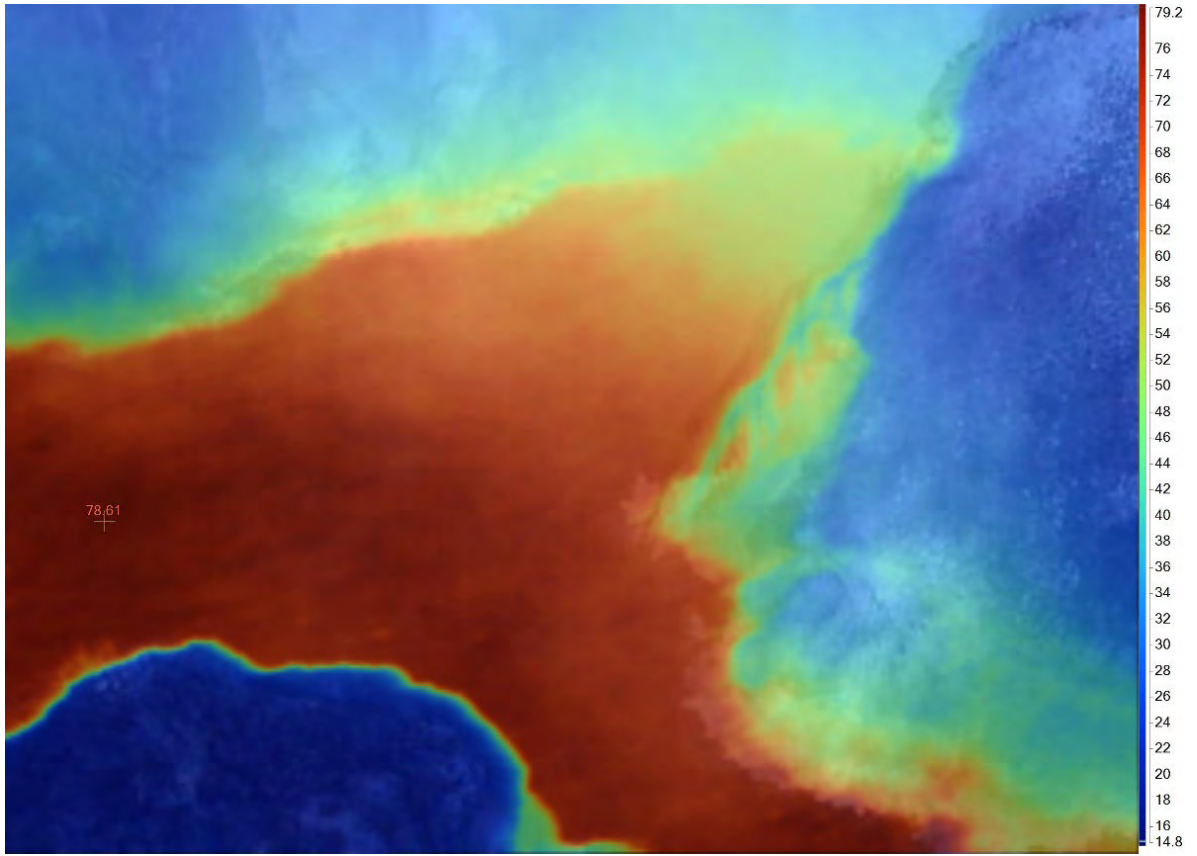


Fig. 9 Infrared image of Diamond Geyser. Taken on 2021-03-26.

5.4 3065_7: Bush Geyser

- The recorded temperature at Bush Geyser have greatly varied between 60 and 100 °C. As the best measurements are taken when the geyser is erupting, and given that the geyser does not always erupt during the visits, it is likely that low temperature measurements correspond to monitoring trips when the feature does not erupt, instead of reflecting true thermal cyclicity of the feature.
- The average pH measurements are between pH 6 and 8, remaining near-neutral.
- Organic debris deposited from nearby trees are become silicified by the erupted fluids if they fall into the geyser's splash zone.

Location: -38.47351, 176.146821

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	8.0	50.0	1.0	None	Clear	Colourless	nd
Comments	<i>Water level:</i> Below ground level <i>Ebullition:</i> No eruption						
2019/04/16	8.0	90.6	0.97	0.0	Clear	Colourless	Steam, no audible ebullition
Comments	Dataloggers installed: S0056396 and 98944						
2019/07/26	8.0		1.2	0.0	Clear	Colourless	Erupted
Comments	<i>pH:</i> nd						
2019/08/19	8.0	90.0	1.2	0.0	Clear	Colourless	Erupted
Comments	<i>pH:</i> nd						
2019/11/08	8.0	78.3	0.9		Clear	Colourless	Calm steaming
Comments	Erupted while we were at Cascade Geyser. <i>Ebullition:</i> Recent eruption heard it while at Diamond Geyser. Erupted again while we were at Cascade Geyser for over 2 minutes.						
2020/02/11	6.0	98.9			Clear	Colourless	Vigorous eruption for 5 minutes
2020/08/06		87.0			Clear	Colourless	Bubbling
Comments	<i>Ebullition:</i> Could only hear it						
2020/12/04	8.0	32.0	0	Nd	Clear	Colourless	Nd
Comments	Feature currently dry. Fresh nodular geysers observed proximal to vent. <i>pH:</i> from ex-situ sample in the slash zone <i>Infrared Temp:</i> Measured on the surface, water level not high enough <i>Water Level:</i> Not high enough to be observable						
2021/03/26		91.3	0	Nd			
Comments	Features around this geyser have expanded. Not currently erupting. <i>Ebullition:</i> Could only hear it						

Bush Geyser: Temperature and pH for 2005/1/1 - 2021/5/1

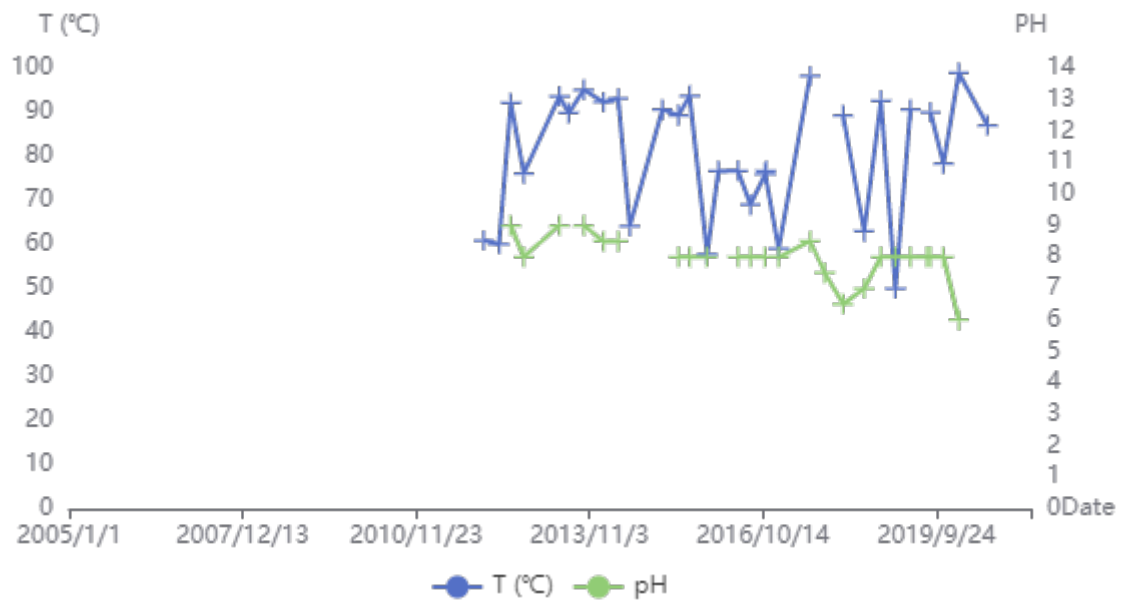


Fig.1 - taken on 2018-10-16 09:22:42"



Fig.2 - taken on 2019-04-16 13:23:18"



Fig.3 - taken on 2019-07-26 11:10:45"



Fig.4 - taken on 2019-11-08 10:39:11"



Fig.5 - taken on 2020-02-11 12:18:48"



Fig.6 - taken on 2020-08-06 10:03:16"



Fig.7 - taken on 2020-12-04 12:41:44"



Fig.8 - taken on 2021-03-26 10:53:30"

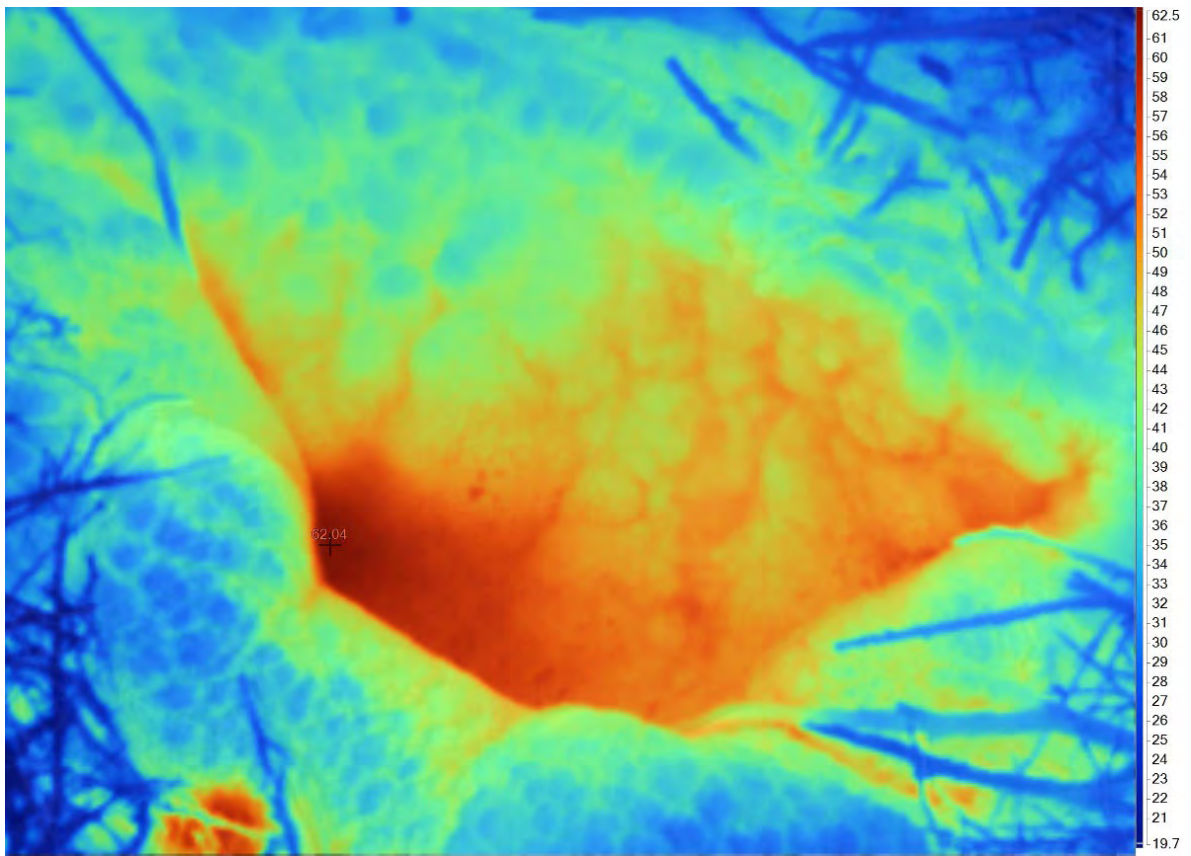


Fig. 9 Infrared image of Bush Geyser. Taken on 2021-03-26

5.5 3065_18: Sapphire Geyser

- This geyser is usually only observed from the tourist path but is actually relatively safe to approach through the sinter platform.
- Water eruptions and steam eruptions have been observed at this geyser, playing up to 0.5 m and lasting more than 5 minutes.
- Microbial mats forming proximal to Sapphire Geyser (black to orange cover on Fig.1 to Fig.3) are actually discharge of Cascade Geyser overflowing to its distal slope, where Sapphire Geyser is. Sapphire Geyser is observed to have geyserite sinter texture and lacks lower temperature microbial mat communities.
- Not enough continuous data has been collected for long-term trend observations.

Location: -38.473503, 176.147084

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14							Erupted with steam for 30 seconds no water
2019/04/16				None	---	---	---
2019/07/26				None	---	---	---
2019/08/19				None	---	---	---
2020/02/11	8.9	97.6			Clear	Colourless	Erupting up to 0.5m for over 5 minutes
2020/12/04		43.0			Clear	White	Erupting
Comments	Geyser observed to erratically play up to 2 m. <i>Infrared Temp:</i> Taken 15 m away <i>Eruption:</i> Constant eruption playing 0.2 m high. Erratic eruptions up to 2 m high for ~15 seconds.						
2021/03/26	7.0	99.4	0.4		Clear	Colourless	Constant ebullition below geyser vent
Comments	<i>Eruption:</i> Splashes just > 0.2 m high constantly. Erupted up to 4-5 m high for 76 seconds, followed by an intense steam discharge for ~30 seconds.						



Fig.1 - taken on 2018-10-16 09:30:27"



Fig.2 - taken on 2019-04-16 13:36:25"



Fig.3 - taken on 2019-11-08 10:44:04"



Fig.4 - taken on 2020-02-11 12:23:32"



Fig.5 - taken on 2020-12-04 13:12:44"

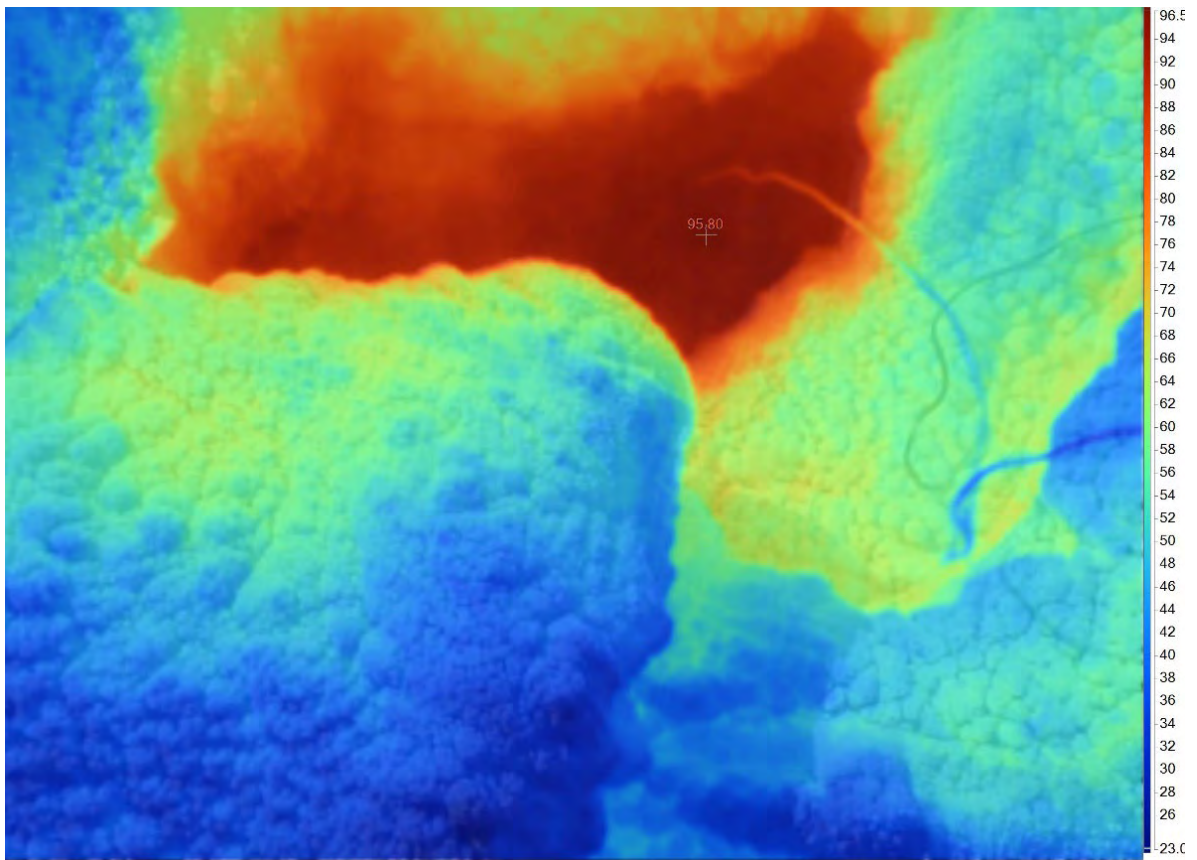


Fig.6 Infrared image of Sapphire Geysers. Taken on 2021-03-26.

5.6 3065_8: Cascade Geyser

- Due to the sub-horizontal vent opening of the Cascade Geyser, its eruptions often are observable but do not reach outside of the vent “cave”. Small eruptions that do not exit the cave are infrequently observed, playing up to 0.5 m and lasting up to 30 seconds. At rare occasions, the geyser may erupt a high steam column of water outside of the cave opening.
- The overflow of the geyser flows to the distal apron and to areas surrounding Sapphire Geyser, and even reaching the geothermal marsh facies. Some overflowed areas are populated by microbial mat communities.
- There are not enough continuous measurements to make long-term trend observations.

Location: -38.473594, 176.147031

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14					Clear	Colourless	Erupted for 30 secs
Comments	<i>Ebullition:</i> Erupted twice for 30 seconds						
2019/04/16				None	---	---	---
2019/07/26				None	---	---	---
2019/08/19				None	---	---	---
2020/12/04		65.5			Clear	Colourless	Infrequent
Comments	Infrequent eruptions. Remaining algal community dying. <i>Ebullition:</i> Fluid observed but does not eject out of cave opening (geyser vent). ~0.5 m column observed for 30 seconds.						
2021/03/26		53.4					Infrequent
Comments	<i>Eruption:</i> Short periods of <1 min of increased splashing and ebullition, but no eruption or rupturing out of geyser mouth.						



Fig.1 - taken on 2018-10-16 09:28:53"



Fig.2 - taken on 2019-04-16 13:35:32"



Fig.3 - taken on 2019-07-26 11:22:31"



Fig.4 - taken on 2019-11-08 10:40:50"



Fig.5 - taken on 2020-02-11 12:27:53"



Fig.6 - taken on 2020-08-06 10:13:15"



Fig.7 - taken on 2020-12-04 13:00:40"



Fig.8 - taken on 2020-12-04 13:08:28"



Fig.9 - taken on 2021-03-26 11:10:52"

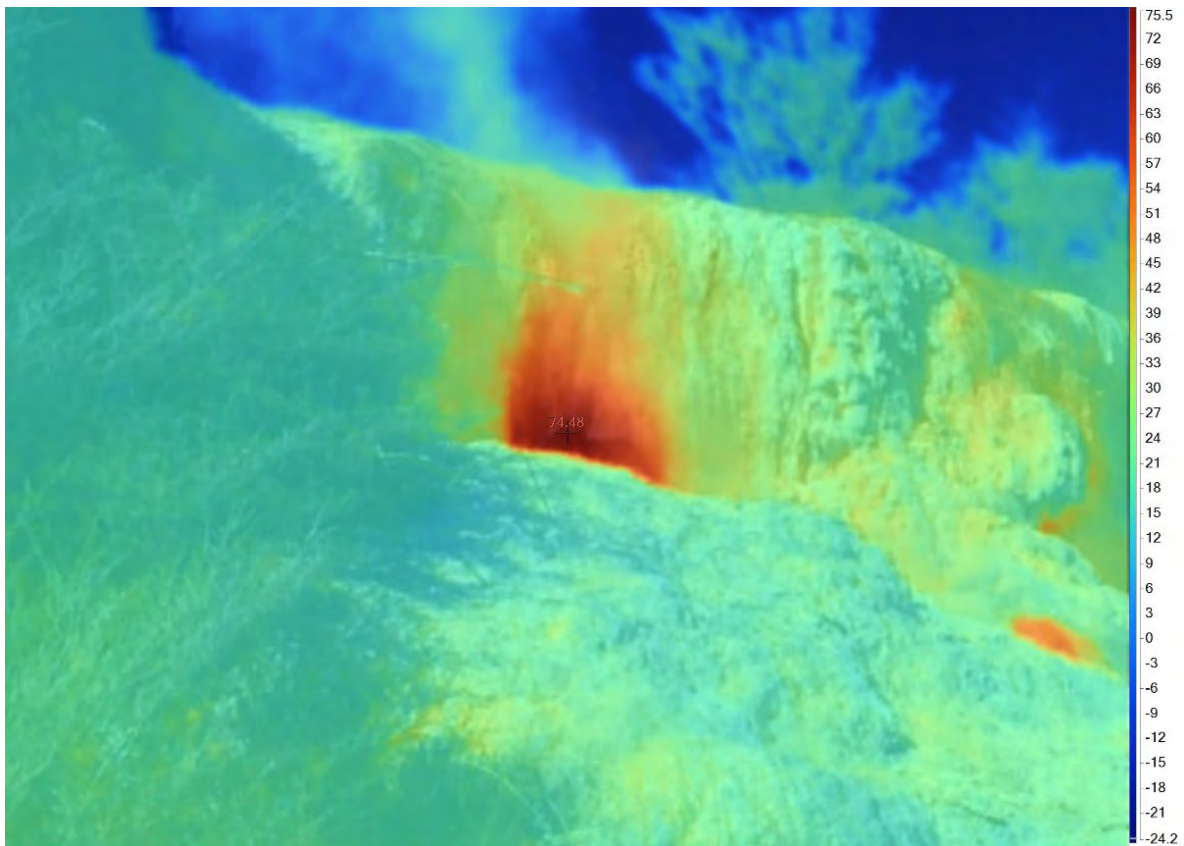


Fig. 10 Infrared image of Cascade Geyser. Taken on 2021-03-26.

5.7 3065_29: Devil's Throat

- The temperature of this feature has remained in constant near-boiling conditions, except in February 2019 when measurements dropped to 63 °C and again to 75 in August 2020 (75 °C).

Location: -38.473101, 176.147616

Date	pH	Temp °C	LevelFlow (m) (l/s)	Clarity	Colour	Ebullition	
2019/01/14	7.5		<1.0	Clear	Colourless	Vigorous	
Comments	<i>Water temperature:</i> Thermocouple not working <i>Water level:</i> Overflowing						
2019/02/23	7.0	63.0	<0.5	Clear	Colourless	Boiling	
Comments	<i>Water level:</i> Overflowing						
2019/04/16	6.0	99.1	<1.0	Clear	Colourless	Erupting	
Comments	<i>Water level:</i> Overflowing <i>Ebullition:</i> Was calm then started erupting at 13:52 causing flow to increase						
2019/07/26	7.0	89.0	<1.0	Clear	Colourless	Constant, vigorous ebullition. Surging.	
2019/08/19	7.0	98.0	<1.0	Clear	Colourless	Constant, vigorous ebullition. Surging.	
2019/11/08	6.0	94.5	<1.0	Clear	Colourless	Constant vigorous ebullition up to 0.2 m high.	
Comments	There is a lot of water flowing down from the terrace and the vent behind the feature.						
2020/02/11	7.0	93.5	<1.0	Clear	Colourless	Cyclical ebullition quiet for 5 minutes then erupted vigorously up to 0.2m high.	
2020/08/06	7.0	75.0	<1.0	Clear	Grey - Dark	Boiling	
2021/03/26	7.0	81.3	0	>8.0	Clear	Colourless	Not visible, sporadically audible
Comments	Not extrusive eruptions. Water flowing out as 2 "streams".						

Devil's Throat: Temperature and pH for 2005/1/1 - 2021/5/1

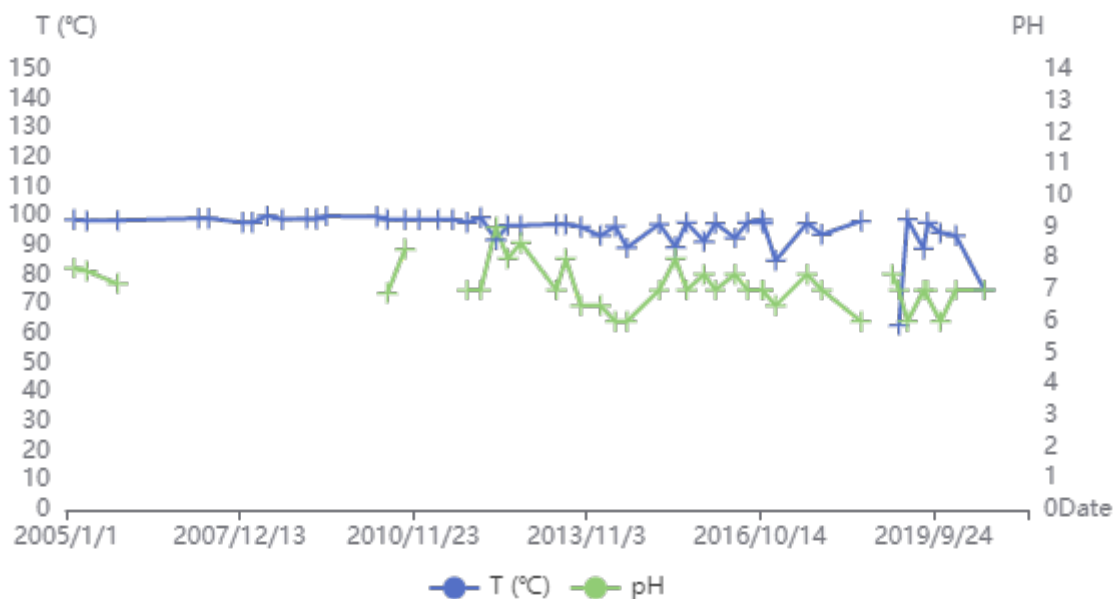




Fig.1 - taken on 2018-10-



Fig.2 - taken on 2019-04-16



Fig.3 - taken on 2019-07-26



Fig.4 - taken on 2019-11-08



Fig.5 - taken on 2020-02-11



Fig.6 - taken on 2020-08-06



Fig.7 - taken on 2020-12-04

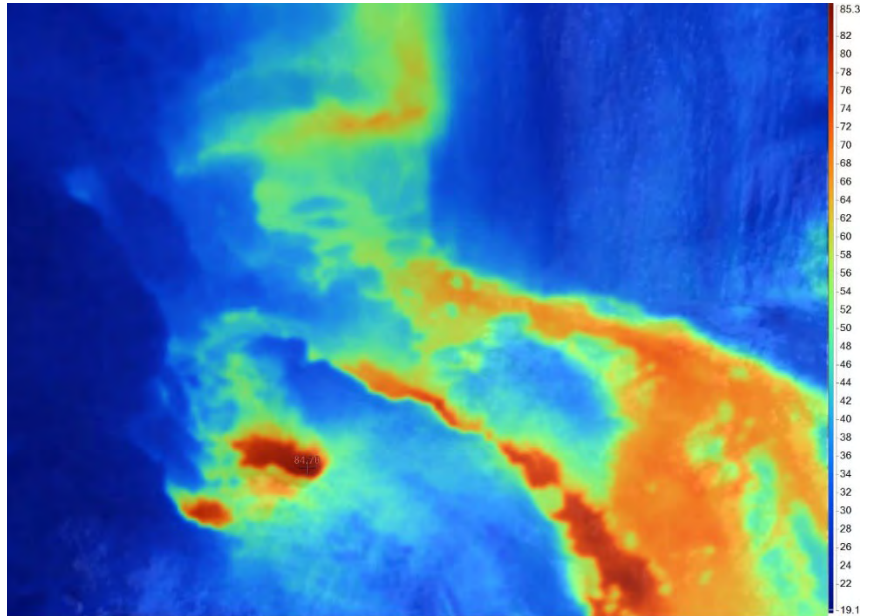


Fig. 8 Infrared image of Devil's Throat. Taken on 2021-03-26.

5.8 3065_11: Map of Africa

- Pool difficult to access due to overflows and algal mat growth, so only infrared temperature measurements could be taken.
- Feature became completely covered by microbial mats in August 2020 (Fig.7), but was no longer covered by mats in December 2020.

Location: -38.473485, 176.147393

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14		39.3		None	Clear	Green - Dark	nd
Comments	Too dangerous to take some measurements. Couldn't access pool. <i>Water level:</i> Overflowing <i>Ebullition:</i> Was raining so couldn't tell.						
2019/04/16	5.0	50.0		None	Clear	Grey - Dark	Calm
Comments	Orange algal mat.						
2019/07/26		46.0		None	Clear	Grey - Dark	Calm
Comments	Algae mats growing over pool. Can't get close to get pH.						
2019/08/19		53.0		None	Clear	Grey - Dark	Calm
Comments	Algae mats growing over pool. Can't get close to get pH.						
2019/11/08		33.0			Clear	Grey - Dark	Calm
Comments	Thick algae mats surrounding pool and over it. 0.1m deep near path. Unsafe to walk out to get pH.						
2020/02/11		41.3		<0.05	Clear	Black	Calm
2020/08/06		38.0		<0.5	Clear	Black	No ebullition
2021/12/04	Nd	55.0	0		Murky	Black	No ebullition
Comments	Feature relatively calm, but could possibly have lateral seeps through its margins, under algal colonies or on sinter. <i>Water Level:</i> Possibly seeping out through the margins <i>Clarity:</i> Poor clarity						
2021/03/26	Nd	57.9	0.2		Nd	Nd	Nd
Comments	No algal communities over surface. <i>Water Level:</i> Low water level						



Fig.1 - taken on 2018-10-16 09:43:41"



Fig.2 - taken on 2019-04-16 13:45:50"



Fig.3 - taken on 2019-07-26 11:31:56"



Fig.4 - taken on 2019-11-08 10:52:25"



Fig.5 - taken on 2019-11-08 10:53:02"



Fig.6 - taken on 2020-02-11 12:35:14"



Fig.7 - taken on 2020-08-06 10:17:25"



Fig.8 - taken on 2020-12-04 13:26:49"

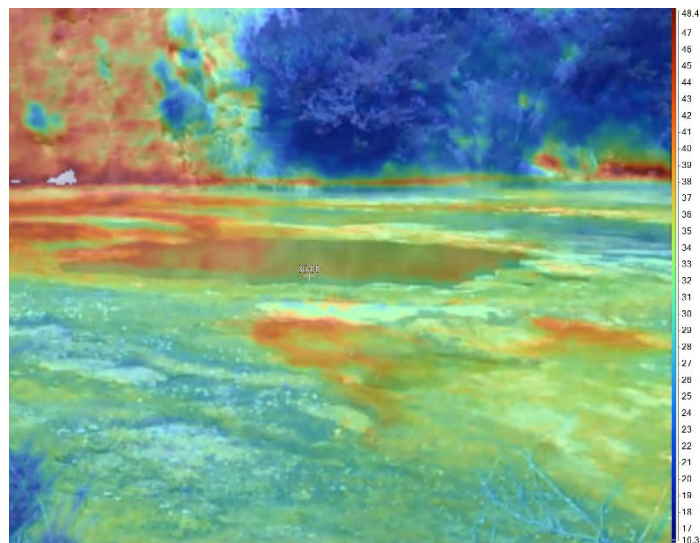


Fig.9 Infrared image of Map of Africa. Taken on 2020-12-04.

5.9 3065_31: Manganese Pool

- This is one of the most thermally and physically dynamic pools monitored throughout the region. The overall temperature gradient of this pool has been constantly decreasing since 2005, when the pool was recorded in near-boiling conditions. Major temperature decreases occurred in 2007, 2010, 2013, 2015, and 2019, but temperatures generally rebound to the 50 – 70 °C range.
- pH conditions have been more stable than temperature measurements, generally ranging between pH 6 and 8.
- This pool often receives the overflow from features below the Golden Fleece Terrace, primarily the Wairiri Geyser.
- Prominent conophyton structures were observed in the middle of the pool in February 2020 (Fig.4). Previous visit of the author to the pool in March 2019 did not record observations of the conophyton structures. By December 2020, the pool is almost 50% populated by silicified conophyton structures (Fig.5 and Fig.6). It is important to note that this period when the conophyton structures were observed coincides with a period with no overflow from higher elevation features. By March 2021 (Fig.7), Wairiri Geyser was erupting and overflowing over Manganese Pool, and no conophyton structures were present any longer.

Location: -38.473464, 176.148171

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	6.5	55.2		None	Clear	Green - Light	Occasional bubbles
Comments	<i>Water level: Overflowing</i>						
2019/07/26	7.0	22.6	0.9	0.0	Clear	Colourless	Calm
Comments	Inflow from terrace, artists pallet flowing over scarp						
2019/08/19	7.0	22.8	0.9	0.0	Clear	Colourless	Calm
Comments	Inflow from terrace, artists pallet flowing over scarp						
2019/11/08	7.0	27.5		<0.05	Clear	Green - Light	Calm
Comments	Overflow from pools below Golden Fleece as well as from Golden Fleece Terrace flowing into Manganese Pool.						
2020/02/11	7.5	69.7			Clear	Colourless	Constant small bubbles
Comments	Thick algal mats surrounding pool. Flow from Artists Palette. Flow is diffuse.						
2020/12/04	6.0	61.2	0	<1.0	Clear	Colourless	Low constant ebullition
Comments	Overflowing feature. Coniform structures now fully silicified. <i>Water Level: Multiple outflows</i>						
2021/03/26		57.0	0		Cloudy	Colourless	Nd
Comments	Spring reduced in size by ~1/3. All conophyton structures now silicified and inactive. Overflow from Wairiri Geyser enters this feature, diluting the waters.						

Manganese Pool: Temperature and pH for 2005/1/1 - 2021/5/1

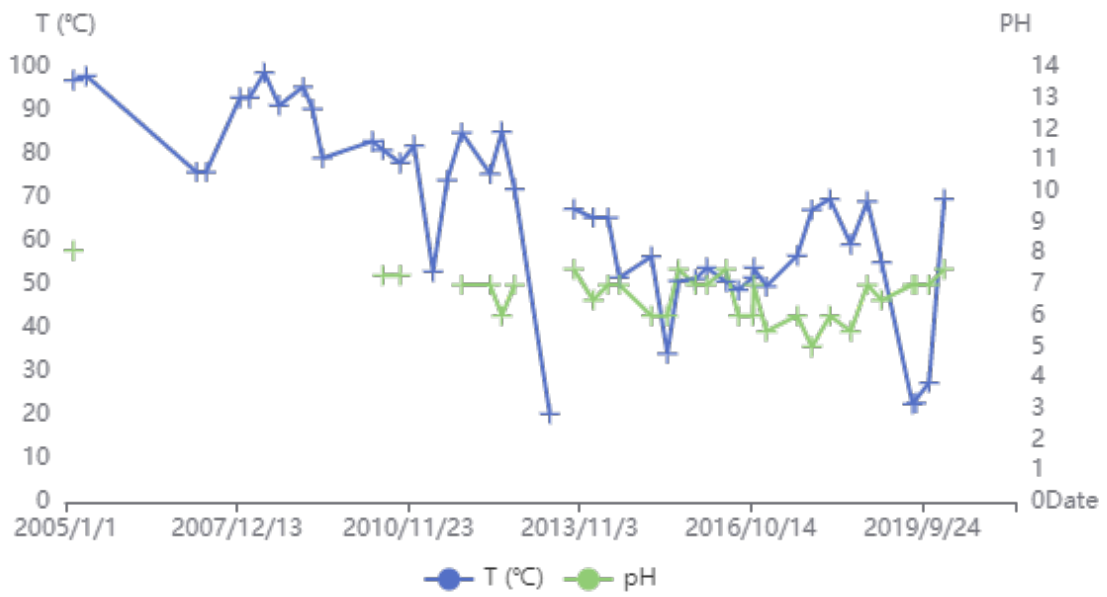


Fig.1 - taken on 2019-07-26 11:59:01"



Fig.2 - taken on 2019-11-08 11:18:02"



Fig.3 - taken on 2019-11-08 11:18:55"



Fig.4 - taken on 2020-02-11 13:02:02"



Fig.5 - taken on 2020-12-04 13:52:09"



Fig.6 - taken on 2020-12-04 13:59:14"



Fig.7 - taken on 2021-03-26 11:58:03"

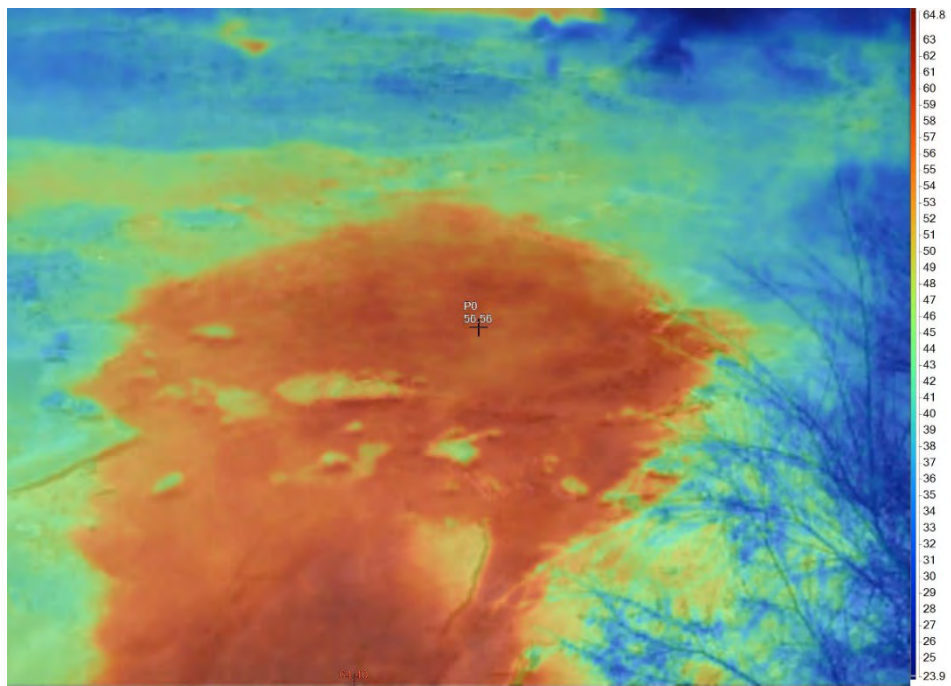


Fig. 8 Infrared image of Soda Fountain. Taken on 2021-03-26.

5.10 3065_30: Fred & Maggie Pool

- Temperature conditions remain relatively stable between 90 and 100 °C from 2005 to 2018. In early 2019, a temperature decrease was recorded, reaching a low of 47.3 °C, before recovering to historical levels in April 2019, and then decreasing again to today.
- pH measurements have constantly fluctuated between pH 5 and 8.
- The two pool basins have been observed to have no hydrological communication during low water levels.
- Spicular geyserrite textures were present above the pool rim in March 2019 (observed by author before working for WRC), but disappeared as of December 2020.

Location: -38.473221, 176.148183

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	6.5	47.3		<0.5	Clear	Colourless	Constant upwelling
Comments	Increased flow from Artist's Palette, flowing into this pool and cooling it down <i>Water temperature:</i> Temp taken with IR Camera as IR gun not working. <i>Water level:</i> Overflowing						
2019/04/16	5.0	93.3		<0.5	Clear	Colourless	Constant boiling at outlet
Comments	Inflow from Golden Fleece terrace <i>Water level:</i> Nd						
2019/07/26	6.0	84.9		<0.5	Clear	Grey	Constant bubbles near outlet
Comments	Other flow from terrace and Golden Fleece scarp is overflowing from artists pallet						
2019/08/19	6.0	86.3		<0.5	Clear	Grey	Constant bubbles near outlet
Comments	Other flow from terrace and Golden Fleece scarp is overflowing from artists pallet						
2019/11/08	5.0	71.1		<0.5	Clear	Green tinge	Constant ebullition at outlet
Comments	Water flowing into pool from Golden Fleece Terrace.						
2020/02/11	6.0	75.6		<0.5	Clear	Colourless	Constant upwelling
Comments	Algae from the edge is ending up in the pool and floating within it.						
2020/08/06	6.0	74.0		<1.0	Clear	Colourless	Constant bubbles
Comments	<i>Ebullition:</i> Middle of pool						
2020/12/04	7.0	91.0	0	>3.0	Clear	Blue	High constant ebullition
Comments	Previously observed geyserrite rim now nonexistent. <i>Clarity:</i> 1.5 m						
2021/03/26	7.0	91.2	0	Nd	Clear	Colourless	Constant ebullition
Comments	Overflow of Wairere geyser now flows into this feature.						

Fred & Maggie Pool: Temperature and pH for 2005/1/1 - 2021/5/1

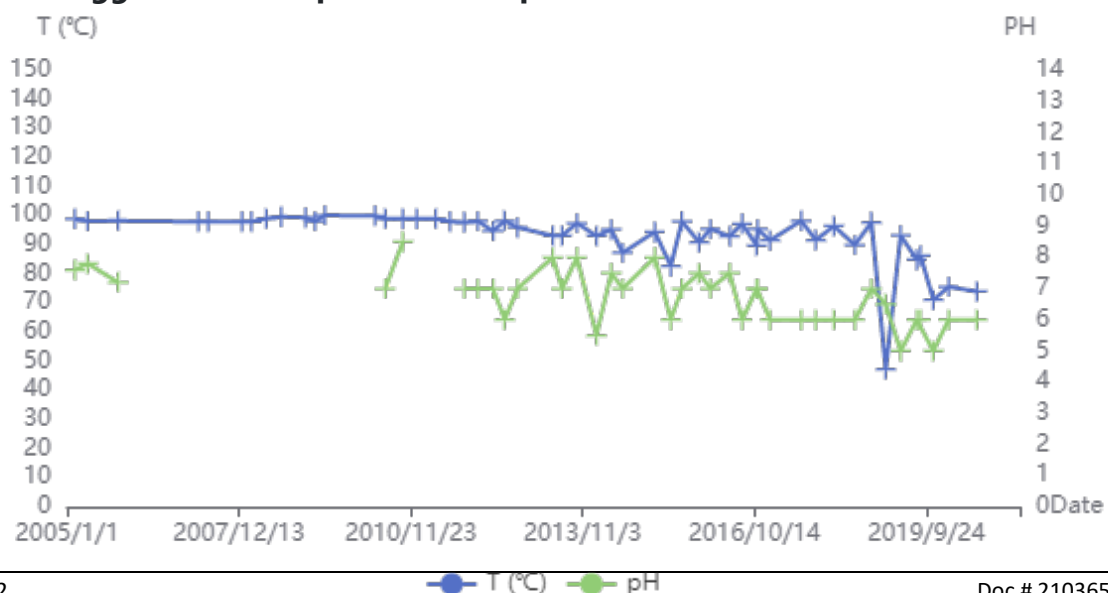




Fig.1 - taken on 2018-10-16 10:02:39"



Fig.2 - taken on 2019-04-16 14:01:44"



Fig.3 - taken on 2019-07-26 11:50:46"



Fig.4 - taken on 2019-11-08 11:10:21"



Fig.5 - taken on 2020-03-11 12:53:26"



Fig.6 - taken on 2020-08-06 10:34:40"



Fig.7 - taken on 2020-12-04 13:48:41"

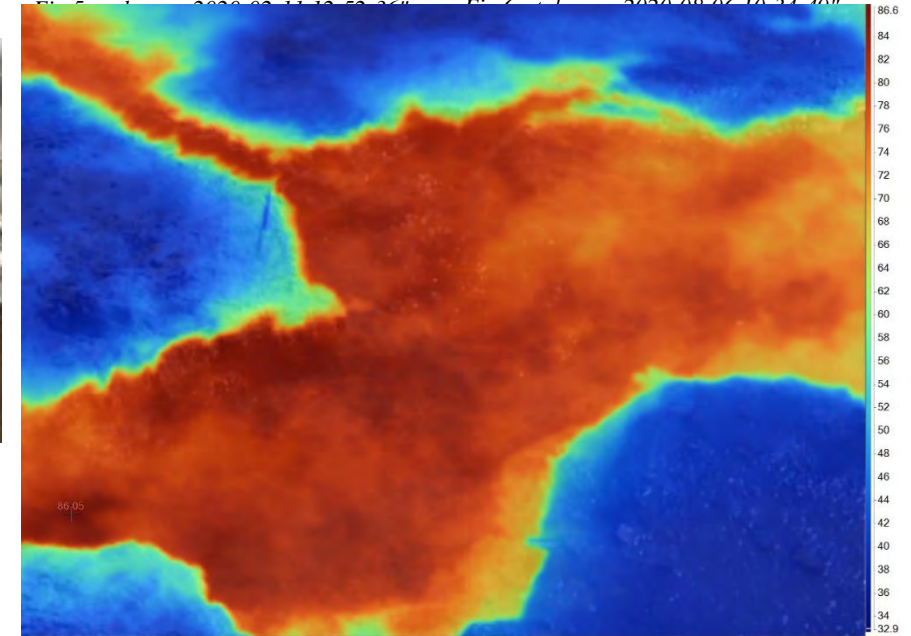


Fig. 8 Infrared image of Fred and Maggie Pool. Taken on 2021-03-26.

5.11 3065_22: Soda Fountain

- The temperature measured at Soda Fountain regularly fluctuates from near-boiling conditions (95 – 100 °C) to 70 °C. In 2014, the temperature was at its coldest, declining to ~50 °C before returning to the regular trend.
- This feature typically has an outflow, but may irregularly become fully dry (Fig.5).

Location: -38.473762, 176.147141

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	7.5	75.9		<0.5	Clear	Blue - Light	Vigorous
Comments	Water level: Overflowing						
2019/04/16	7.0			<0.5	Clear	Blue - Light	Constant boiling
Comments	pH: 6.5 Water temperature: Thermocouple not working Water level: Overflowing						
2019/07/26	8.0	93.9		<0.5	Clear	Blue	Constant bubbles
Comments	Ebullition: Near the back						
2019/08/19	8.0	96.1		<0.5	Clear	Blue	Constant bubbles
Comments	Ebullition: Near the back						
2019/11/08	7.0	90.1		<0.5	Clear	Blue - Light	Constant upwelling on far side 0.2m high
2020/02/11		63.7	1.5				
Comments	Pool is empty. There is inflow from the right side of the pool that is 63 degrees. Water temperature: May be from inflow Water level: Cant see water estimate as pool is empty						
2020/08/06	8.4	97.3		<1.0	Clear	Blue - Light	Boiling
Comments	Ebullition: Back of pool						
2020/12/04	6.0	88.0	0	>5.0	Clear	Blue – Light	Constant high ebullition
Comments	Very ebullient, overflowing. Sinter at pool margin, geyserite at opposite end of the pool, with nodular and globular textures.						
2021/03/26	Nd	Nd	Nd	Nd	Nd	Nd	Nd
Comments	Currently empty. Steam up to 56 °C.						

Soda Fountain: Temperature and pH for 2005/1/1 - 2021/5/1

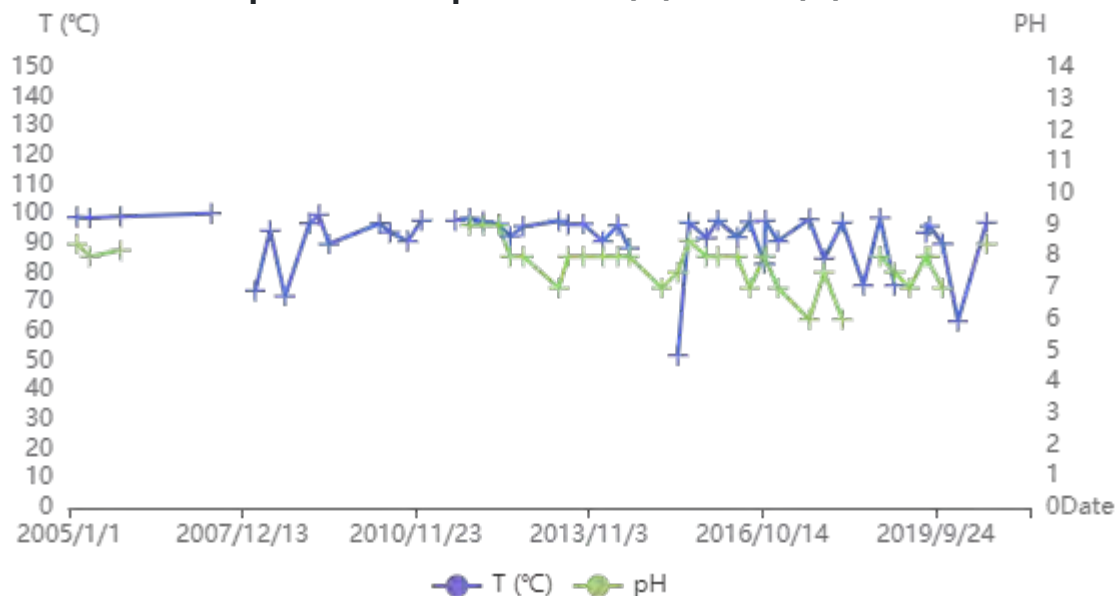




Fig.1 - taken on 2018-10-16 11:10:14"



Fig.2 - taken on 2019-04-16 14:59:38"



Fig.3 - taken on 2019-07-26 12:49:43"

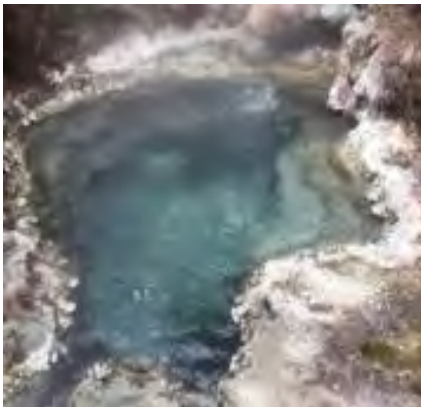


Fig.4 - taken on 2019-11-08 12:03:07"



Fig.5 - taken on 2020-02-11 13:51:27"



Fig.6 - taken on 2020-08-06 11:36:12"



Fig.7 - taken on 2020-12-04 15:14:22"



Fig.8 - taken on 2020-12-04 15:14:10"



Fig.9 - taken on 2021-03-26 12:32:59"

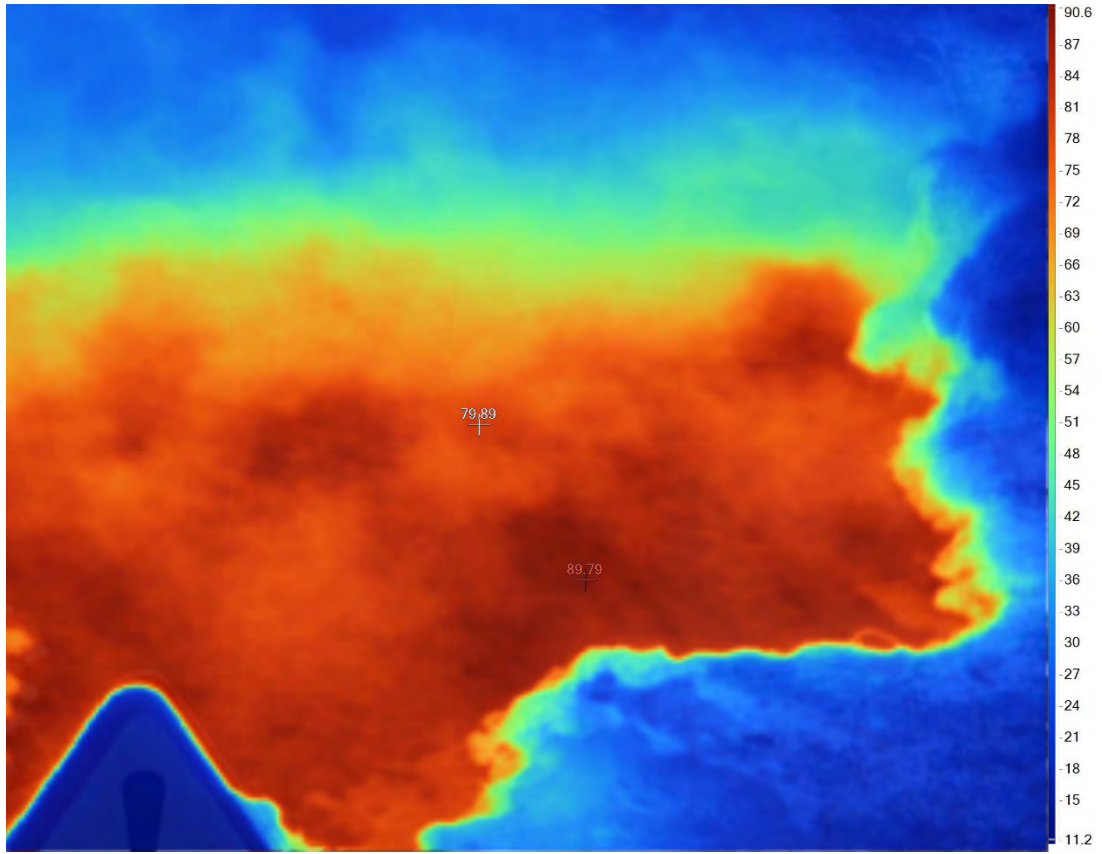


Fig. 10 Infrared image of Soda Fountain. Taken on 2021-03-26.

5.12 3065_177: North Pool by Boardwalk

- The temperature of this pool fluctuates from near-boiling conditions to as low as 40 °C. General temperature conditions have decreased since 2013, and from 2018 the feature has had relatively low water level or gone completely dry.
- pH conditions have ranged from 5 to 8 but have experienced more changes since 2015.

Location: -38.474339, 176.148461

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	8.0	39.1	0.4	None	Murky	Grey	Constant bubbles
Comments	<i>Water temperature:</i> Used infrared camera for temp <i>Water level:</i> Below lower rim						
2019/04/16	5.0		0.93	0.0	Murky	Grey	Constant bubbles
Comments	<i>Water temperature:</i> Not working						
2019/07/26	6.0	56.3	0.7		Murky	Grey - Light	Constant bubbles
Comments	Inflow from artists pallet						
2019/07/26	6.0	60.4	0.7	0.0	Murky	Grey - Light	Constant bubbles
Comments	Inflow from artists pallet						
2019/08/19	6.0	56.3	0.7	0.0	Murky	Grey - Light	Constant bubbles
Comments	Inflow from artists pallet						
2019/11/08	6.0	47.5	1.0		Clear	Colourless	Calm occasional bubbles
Comments	Inflow from terrace, increased while we were there. Heard more activity on artists palette.						
2020/02/11	6.0	63.6	0.5		Clear	Colourless	Constant bubbles
2020/08/06	6.0	62.9	0.5		Murky	Grey - Light	Constant bubbles
Comments	<i>Ebullition:</i> Middle of pool						
2020/12/94	6.0	73.0	2.2	0	Muddy	Colourless	Nd
Comments	Low water level, surrounding environment dry. Sinter exposed. <i>Clarity:</i> Mixing with surrounding mud and sediments						

North Pool by Boardwalk: Temperature and pH for 2005/1/1 - 2021/5/1

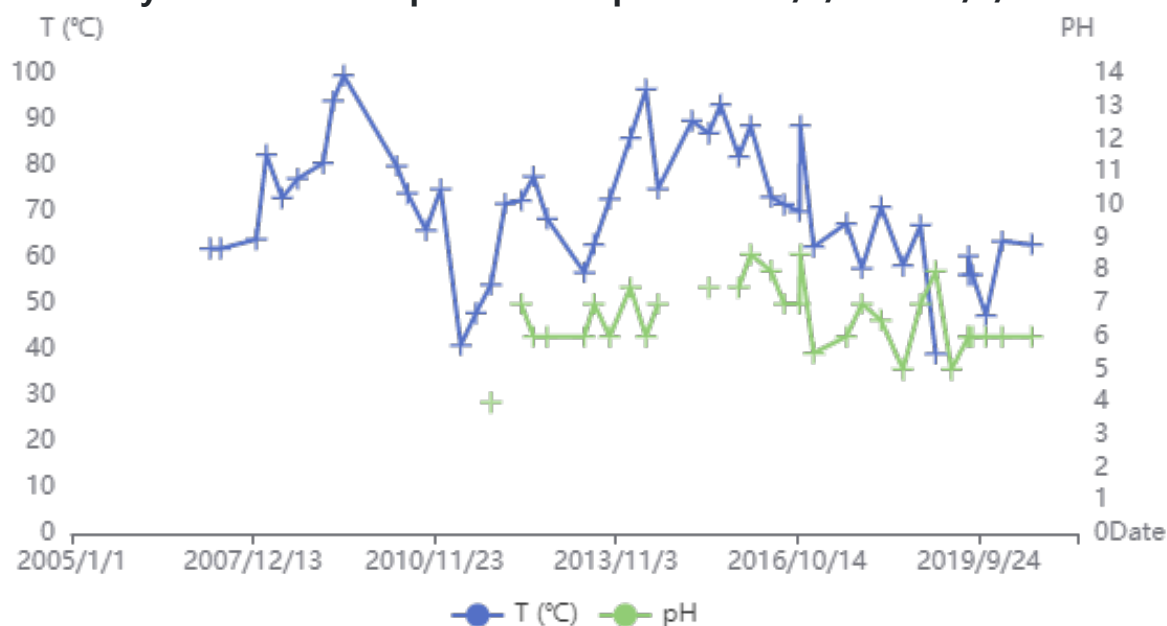




Fig.1 - taken on 2018-10-16 10:44:13"



Fig.2 - taken on 2019-07-26 12:23:00"



Fig.3 - taken on 2019-11-08 11:35:58"



Fig.4 - taken on 2020-02-11 13:19:26"



Fig.5 - taken on 2020-08-06 11:05:17"



Fig.6 - taken on 2020-12-04 14:30:03"

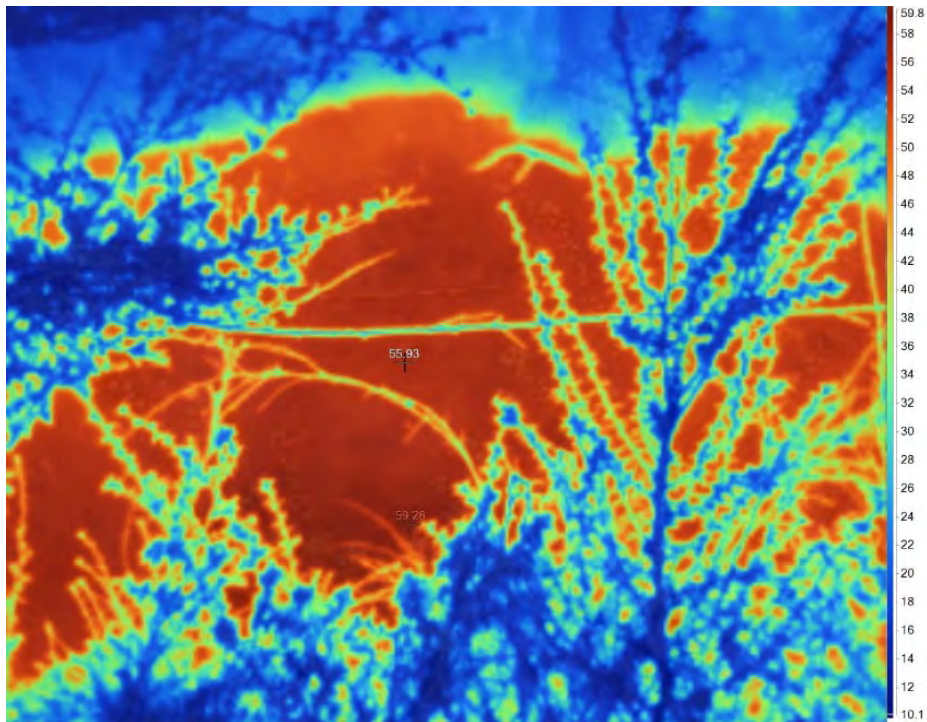


Fig.7 Infrared image of North Pool by Boardwalk. Taken on 2020-12-14.

5.13 3065_178: South Pool by Boardwalk

- From 2006 to 2017, water temperature has always fluctuated between 50 and 80 °C. In 2017, a decreasing temperature trend was observed, and until 2021, the temperature has remained below 50 °C.
- pH conditions are regularly between pH 5 and 8, except in 2013 (pH 2, possibly anomalous) and 2019 (pH 3).
- Water colour may vary between murky grey and cloudy brown.

Location: -38.474375, 176.148474

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	4.0		1.0	None	Murky	Brown - Light	Occasional upwelling
Comments	<i>Water temperature:</i> Thermocouple stopped		<i>Water level:</i> Below ground level		working		
2019/04/16	5.0	48.6	1.48	0.0	Clear	Brown	Occasional bubbles
2019/07/26	5.0	46.8	1.3	0.0	Clear	Brown	Calm
Comments	Brown algae mats covering everything						
2019/08/19	5.0	46.3	1.3	0.0	Clear	Brown	Calm
Comments	Brown algae mats covering everything						
2019/11/08	6.0	44.7	1.3		Clear	Colourless	Calm
Comments	Pool is cooler than usual. Green algae growing in pool.						
2020/02/11	6.0	45.4	1.6		Clear	Colourless	Occasional bubbles
Comments	Leaves floating on surface. Branch in pool.						
2020/08/06	6.0	43.8	0.5		Clear	Brown - Light	Constant small bubbles
2020/12/04	6.0	67.6	1.6	0	Clear	Grey – Light	Moderate
Comments	Relatively low water level <i>Ebullition:</i> Foci at margin and centre of pool						

South Pool by Boardwalk: Temperature and pH for 2005/1/1 - 2021/5/1

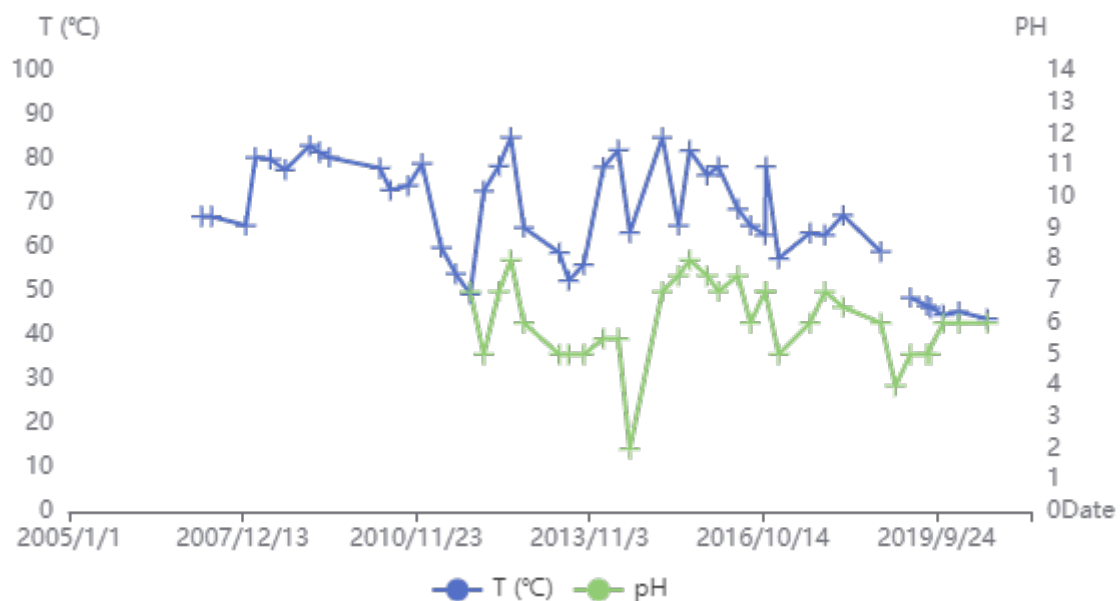




Fig.1 - taken on 2018-10-16 10:40:05"



Fig.2 - taken on 2019-07-26 12:14:10"



Fig.3 - taken on 2019-11-08 11:30:04"



Fig.4 - taken on 2020-02-11 13:15:09"



Fig.5 - taken on 2020-08-06 10:56:49"



Fig.6 - taken on 2020-12-04 14:36:14"



Fig.7 - taken on 2020-12-04 14:36:23"

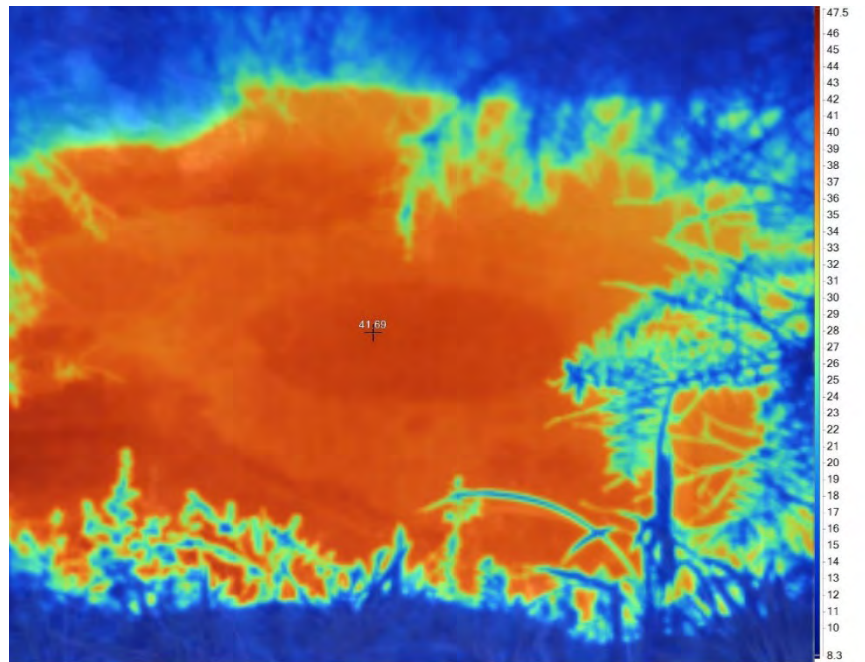


Fig.8 Infrared image of South Pool by Boardwalk. Taken on 2020-12-14.

5.14 3065_180: Fumarole to the left of the boardwalk

- The temperature of this fumarole has been fluctuating since the start of recording in 2005. However, the temperature has never reached measurements from 2010, when the discharge was measured to have reached ~90 °C.
- There are no pH measurements as this fumarole is discharging gases only.

Location: -38.474027, 176.148367

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14		35.6					nd
Comments	Water level: Dry						
2019/04/16		31.7		0.0	---	---	Steaming on front
Comments	Water level: Nd						
2019/07/26		27.0		None	---	---	Steaming
Comments	Ebullition: At front						
2019/08/19				None	---	---	Steaming
Comments	Ebullition: At front						
2020/12/04		62.0					
Comments	Deposition of red minerals around vent possibly As-rich.						

Fumarole to the left of the boardwalk: Temperature and pH for 2005/1/1 - 2021/5/1





Fig.1 - taken on 2018-10-16 10:32:56"



Fig.2 - taken on 2019-04-16 14:14:48"



Fig.3 - taken on 2019-07-26 12:10:14"



Fig.4 - taken on 2019-07-26 12:10:21"



Fig.5 - taken on 2020-12-04 14:19:27"

5.15 3065_185: Ruatapu Cave main pool

- The period from 2005 to 2016 had relatively stable temperature conditions, with only minor fluctuations. In 2017, the temperature increased to ~45°C, before dropping to ~30 °C in 2018 and 2018.

Location: -38.475027, 176.149694

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14		26.9		None	Clear	Green	Calm, steam coming from back
Comments	Steam coming from back of pool Water temperature: Taken from platform using IR camera as IR gun not working Water level: nd						
2019/04/16				None	Clear	Green - Light	Calm
Comments	Steam at back of pool Water level: nd						
2019/07/26		45.1		0.0	Clear	Green - Blue	Calm
Comments	Ebullition: Steaming at the back						
2019/08/19				0.0	Clear	Green - Blue	Calm
Comments	Ebullition: Steaming at the back						
2019/11/08		44.9			Clear	Green - Light	Calm
2020/02/11		46.7			Clear	Blue	Calm
2020/08/06		31.0			Clear	Green - Dark	No ebullition
2020/12/04		36.0					
Comments	Team observed at far end of cave						

Ruatapu Cave main pool: Temperature and pH for 2005/1/1 - 2021/5/1

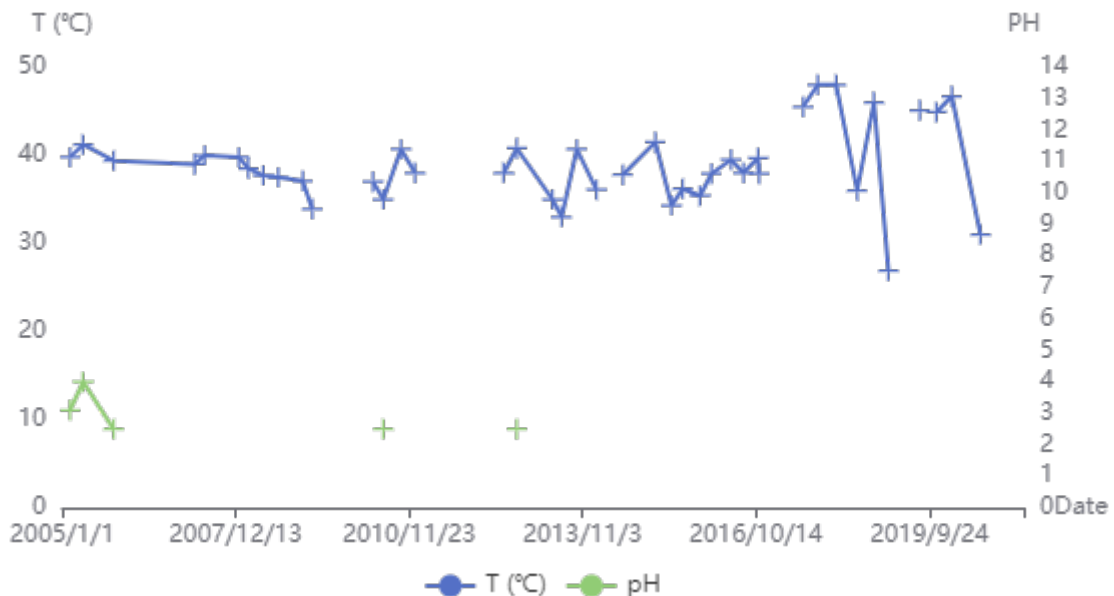




Fig.1 - taken on 2018-10-16 10:59:39"



Fig.2 - taken on 2019-04-16 14:48:37"



Fig.3 - taken on 2019-07-26 12:36:14"



Fig.4 - taken on 2019-11-08 11:52:04"



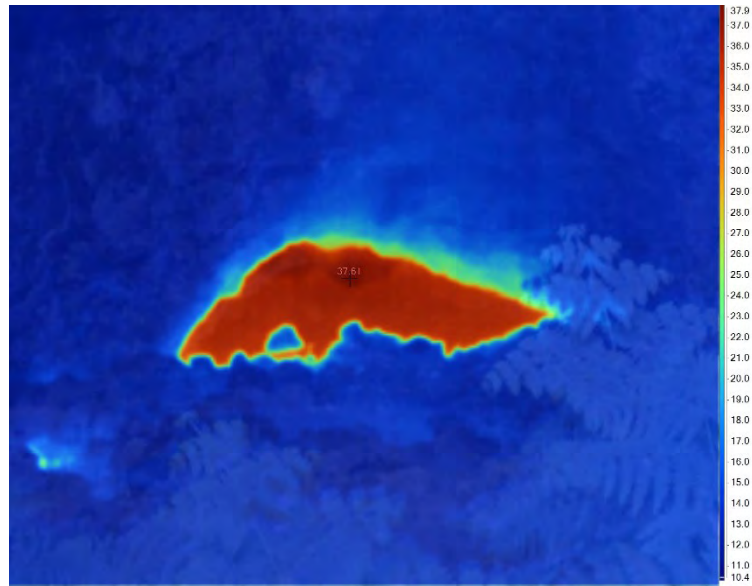
Fig.5 - taken on 2020-02-11 13:36:05"



Fig.6 - taken on 2020-08-06 11:16:43"



Fig.7 - taken on 2021-03-26 12:19:51"



5.16 3065_183: Kurapai

- From the tourist centre, the tourism site operators see frequent eruptions of this geyser.
- The geothermal ground surrounding the geyser (above the sinter terrace) is still active.

Location: -38.474553, 176.147221

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/07/26				None	---	---	Deep audible bubbling
Comments	Looks like it has erupted recently- water around the edge. Got confirmation that it has erupted 3 times recently <i>Ebullition: Steaming</i>						
2019/08/19	43.5			None	---	---	Deep audible bubbling
Comments	Looks like it has erupted recently- water around the edge. Got confirmation that it has erupted 3 times recently <i>Ebullition: Steaming</i>						
2020/12/04						White	Erupting
Comments	<i>Eruption: Erupting for 90 seconds, playing up between 7 and 10 m high. Microbial mats observed inside the wall of the geyser vent. Geyser vent is ca 3 m long, 1.5 m deep, and 3 m deep, with a flat gravel floor. Rising about 50 cm from the floor is a pipe encrusted with sinter. The pipe was once much longer but has been broken, with the longer part lying fallen on the gravel bed. The geyser vent is quite dry after an eruption due to rapid evaporation of the hot water. The site manager Greg Gibson says it fills very quickly, in less than a minute once the water starts rising following the previous eruption and erupts up to 8-13 times a day.</i>						



Fig.1 - taken on 2020-12-04



Fig.2 - taken on 2020-12-04



Fig.3 - taken on 2020-12-04"

5.17 3065_500: Orion's Belt

- A set of 3 new non-flowing neutral chloride springs discovered due to audible eruption and visible steam column >5 m high. Vegetation surrounding the features is still green while dead vegetation is observed proximal to margins of features, indicating new and localised thermal features. The three pools are the west pool, middle pool, and east pool. Age of features unknown but appears very recent because the vegetation is freshly dead.
- Infrequent periods of increased ebullition for about 1-2 minutes, with water column rising to ~1 m and splash zone extending 2 m away from middle pool.
- Location near old overgrown path, approximately 25 m NE of old sinter terrace leading up to Kurapai (3065_183).
- Measurements are from the middle pool.

Location: 2784624 E, 6298450 N. Location measured from GPS (+/- 5 m).

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
04/12/2020	7.0	82			Muddy	Brown	Constant, episodic high

Comments

Clarity: Clear to 0.5 m, obscure beyond 0.5 m

Ebullition: Constant, with periods of increased ebullition



Fig.1 - taken on 2020-12-04



Fig.2 - taken on 2020-12-04



Fig.3 - taken on 2020-12-04

5.18 3065_451: Waihunuhunu Inlet 1

- The water temperature at Waihunuhunu Inlet is relatively consistent, apart from two decreases that occurred in 2011 and 2019.
- The source spring that feeds this stream is several kilometres away, and at the point of discharge into Lak Ohakuri, where the measurement is taken, has been culverted under Te Kopia Rd. Accordingly, the measurement point is from a perched pipe discharging into the Waihunuhunu arm of the lake. It is very likely that the feature provenance has higher temperature conditions than at the sampling point.

Location: -38.452977, 176.156227

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	7.0	50.0		<30.0	Clear	Colourless	nd
Comments	<i>Water</i>		<i>level: Overflowing</i>			from	pipe
	<i>Bathers: And 1 observer in boat</i>						
2019/11/08	6.0	36.0		<30.0	Clear	Colourless	nd
2020/02/11	6.0	40.6		<40.0	Clear	Colourless	nd
Comments	Flaxes have been planted. <i>pH: pH5.5</i>						
2020/08/05	7.2	53.1		<10.0	Clear	Colourless	No ebullition
2020/12/04	5.0	51.9	0	>25.0	Clear	Colourless	N/a
2021/03/26	5.0	51.9	0	>2.0	Clear	Colourless	N/a

Waihunuhunu Inlet 1: Temperature and pH for 2005/1/1 - 2021/5/1

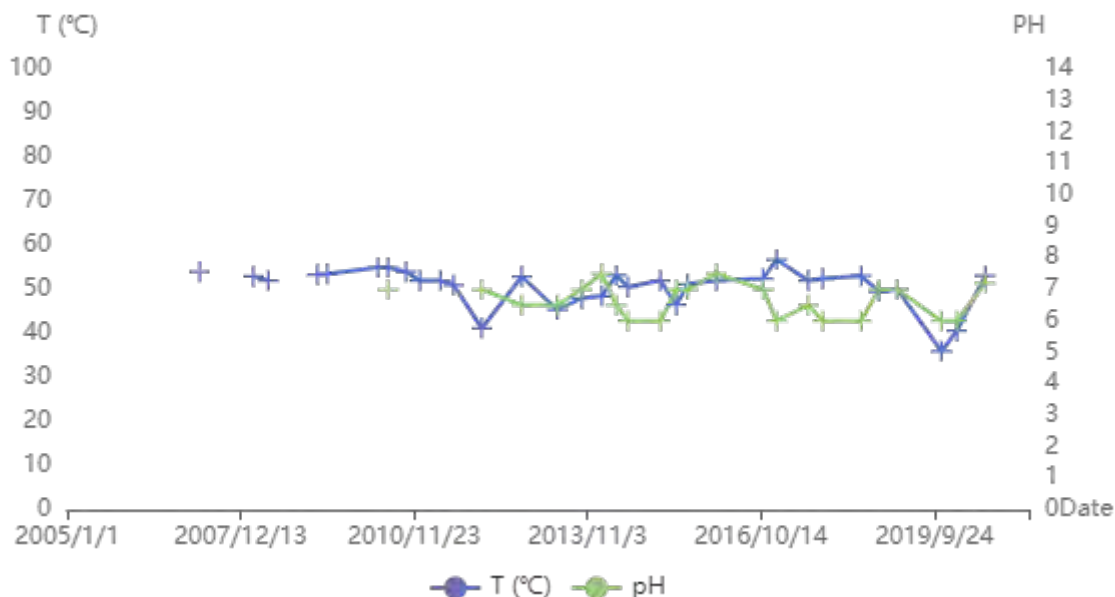




Fig.1 - taken on 2018-10-15 14:19:12"



Fig.2 - taken on 2019-11-08 12:51:11"



Fig.3 - taken on 2019-11-08 12:52:03"



Fig.4 - taken on 2020-02-11 08:41:13"



Fig.5 - taken on 2020-08-05 08:56:22"



Fig.6 - taken on 2021-03-26 14:11:39"

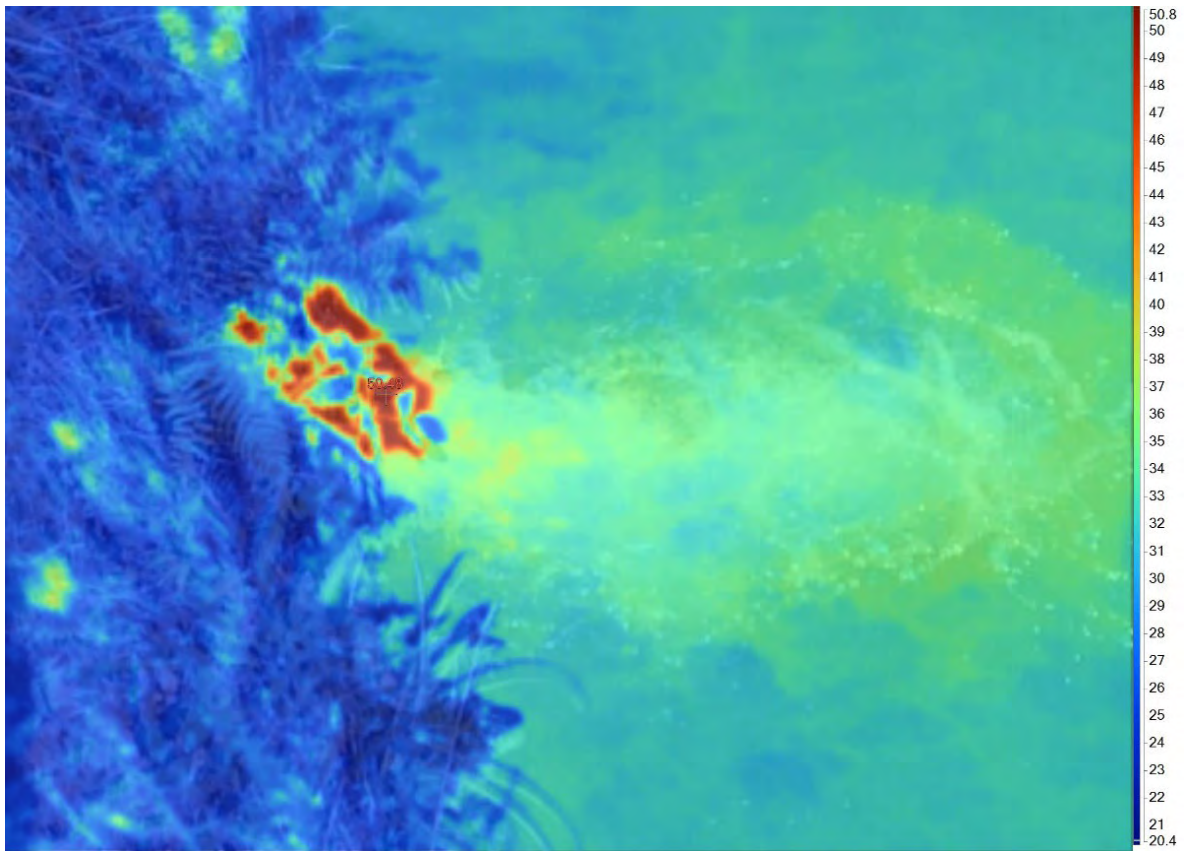


Fig. 7 Infrared image of Waihunuhunu Inlet. Taken on 2021-03-26.

6 REPOROA

6.1 3066_1: Butcher's Pool

- Butcher's Pool is a natural hot pool that Rotorua District Council has built wooden swimming pool infrastructure around. Both the temperature and pH conditions at Butcher's Pool have been relatively stable since 2010. Based on infrared imagery (Fig.3), the hottest water seem to accumulate around the margins of the pool, and not in the centre.

Location: -38.453451, 176.34291

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2016/12/01	7.0	38.8	1.2	None	Clear	Blue	small bubbles
Comments	Some scum on surface <i>Water level:</i> below pool surround <i>Bathers:</i> 4 bystanders, 2 foreign						
2017/01/27	7.0	39.6	0.85	None	Clear	Blue/green	Effervescent
Comments	Orange scum around edges of pool <i>Water level:</i> Below pool rim						
2018/02/09	5.0	37.6	0.8	None	Clear	Blue - Light	Small bubbles in centre
Comments	Oil slick over two areas of pool. Some scum near outlet <i>Water level:</i> From top of pool edge						
2019/01/15	7.5	40.2	0.8	None	Clear	Blue - Light	Effervescing in centre. Constant upwelling in spots
Comments	Oily slick on surface and scum on surface near outflow <i>Water level:</i> From top of pool edge						
2020/02/26	6.7	37.2	0.77		Clear	Green - Blue	Effervescent
Comments	Orange, foamy algae near outflow.						
2021/03/25	7.0	41.9	0.5		Clear	Colourless	Constant small bubbles. Effervescent.
Comments	Water surface has scum and an oily sheen.						

Butcher's Pool: Temperature and pH for 2005/1/1 - 2021/5/1

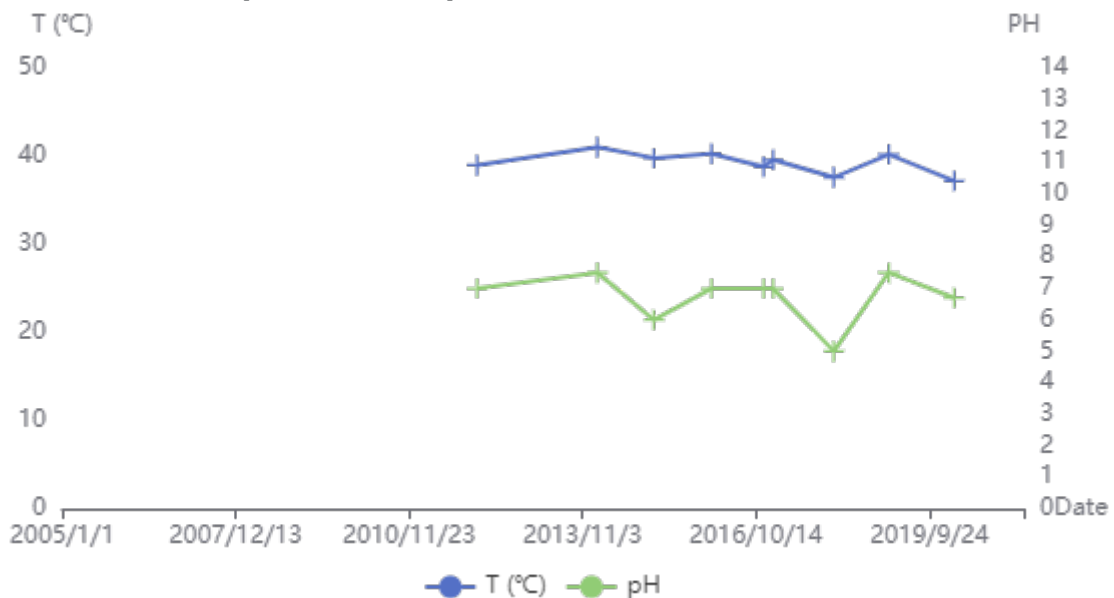




Fig.1 - taken on 2020-03-17 11:15:04"



Fig.2 - taken on 2021-03-25 17:07:00"

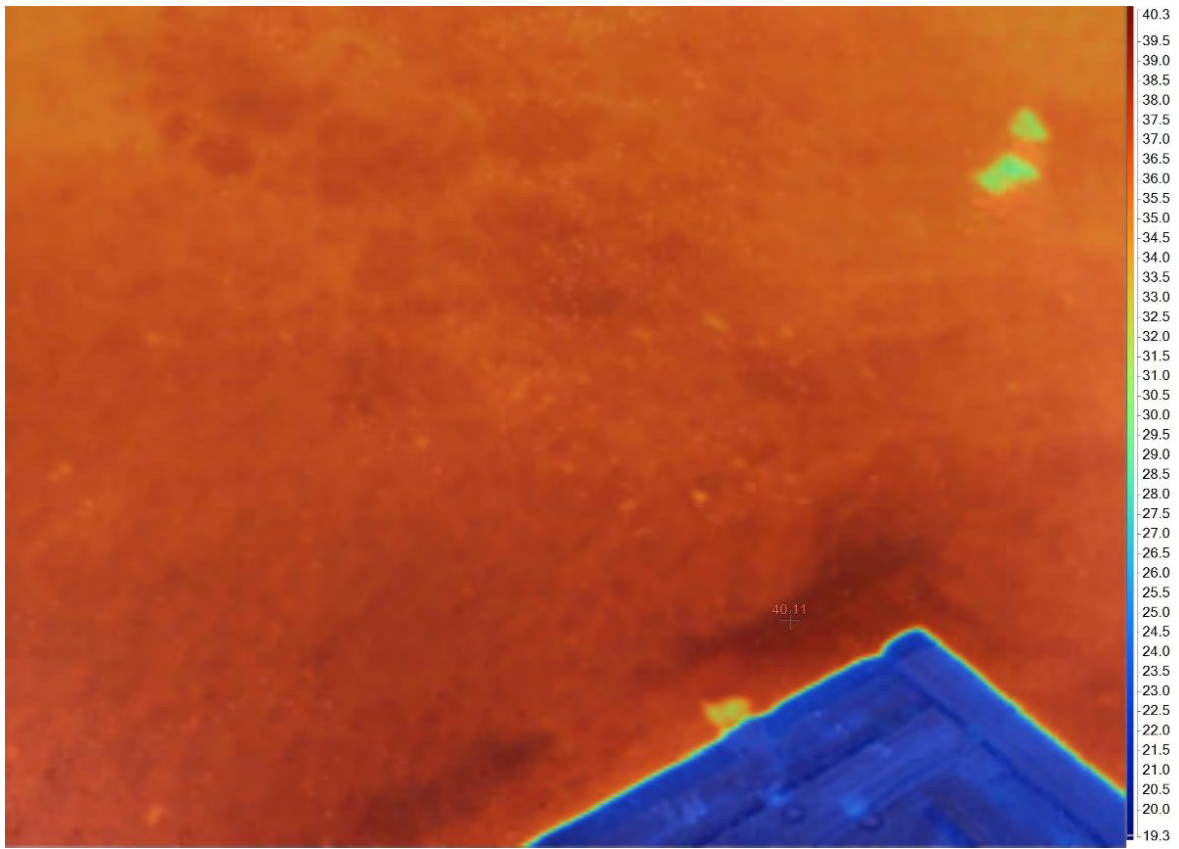


Fig. 3 Infrared image of Butcher's Pool. Taken on 2021-03-25.

6.2 3066_24: Wharepapa Rd: Fumaroles

- The fumaroles are in a flat paddock on a dairy farm, adjacent to a very hot chloride spring. The fumarole area heat output fluctuates greatly over the course of years, expanding and contracting the area and number of fumaroles and mud pools. The fumaroles experienced cooling periods from 2008 to 2011 and from 2016 to 2017.
- During a visit in March 2021, the fumaroles have been buried by soil, and no thermal signature was observed through an infrared camera.

Location: -38.416027, 176.330671

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28		75.8	0.9				Audible bubbling
Comments	Ground collapsing <i>Water level:</i> Below ground level <i>Area of feature:</i> 0.5x0.7						
2016/01/12		78.4					Audible bubbling
Comments	Small collapse on side						
2017/01/27		47.1	0.4	None	nd	nd	Audible bubbling
Comments	Collapsing, covered in grass <i>pH:</i> nd <i>Water level:</i> depth <i>Area of feature:</i> 0.24 x 0.27						
2018/02/09		30.6		None	Muddy	nd	nd
Comments	Ground collapsed into vent, depth 0.1 m below ground level <i>Water level:</i> nd						
2019/01/15		49.1	0.9	None	Muddy	Brown - Dark	Constant bubbling
Comments	Fumarole 1 & 2 now one larger fumarole <i>Water level:</i> Below ground level - angled						
2020/02/26		75.0					Steaming
Comments	Ground collapsing in vent.						

Wharepapa Rd: Fumaroles: Temperature and pH for 2005/1/1 - 2021/5/1

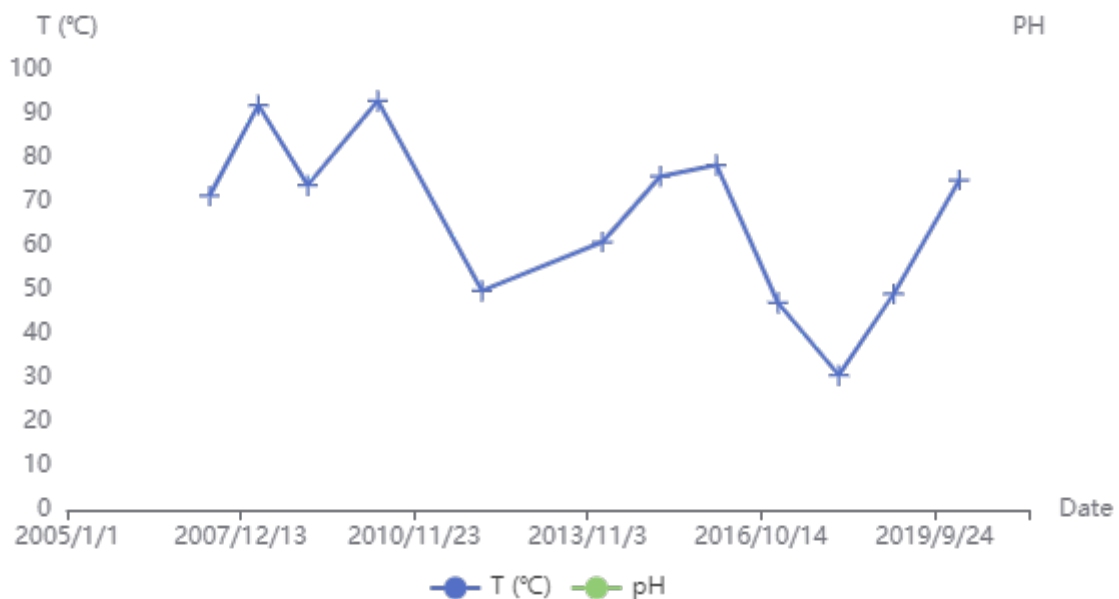




Fig.1 - taken on 2020-03-17 11:15:04"



Fig.2 - taken on 2021-03-25

6.3 3066_25: Longview Road Lake

- Water temperature increased by approximately 10 °C from 2011 to 2013 without accompanying pH change. Measurements slightly reduced to approximately 28°C and have remained so until 2021.

Location: -38.413805, 176.36113

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28	3.0	33.7		None	Murky	Green	Effervescing
Comments	<i>Water level: nd</i>						
2018/02/09	3.5	28.7		None	Murky	Green - Light	Several areas of discharge
Comments	Scum on top of pool <i>Water level: nd</i>						
2019/01/15	2.8	28.5		None	Green - Light	Cloudy	nd
Comments	Unsafe to get close due to increase size of mud pool. Scum on surface of lake <i>Water level: nd</i>						
2021/03/25	4.0	28.9	0	Not observed	Cloudy	Gren – Murky	Multiple foci, constant vigorous ebullition
Comments	Water surface areas near the lake margins are covered with bubbles.						

Longview Road Lake: Temperature and pH for 2005/1/1 - 2021/5/1

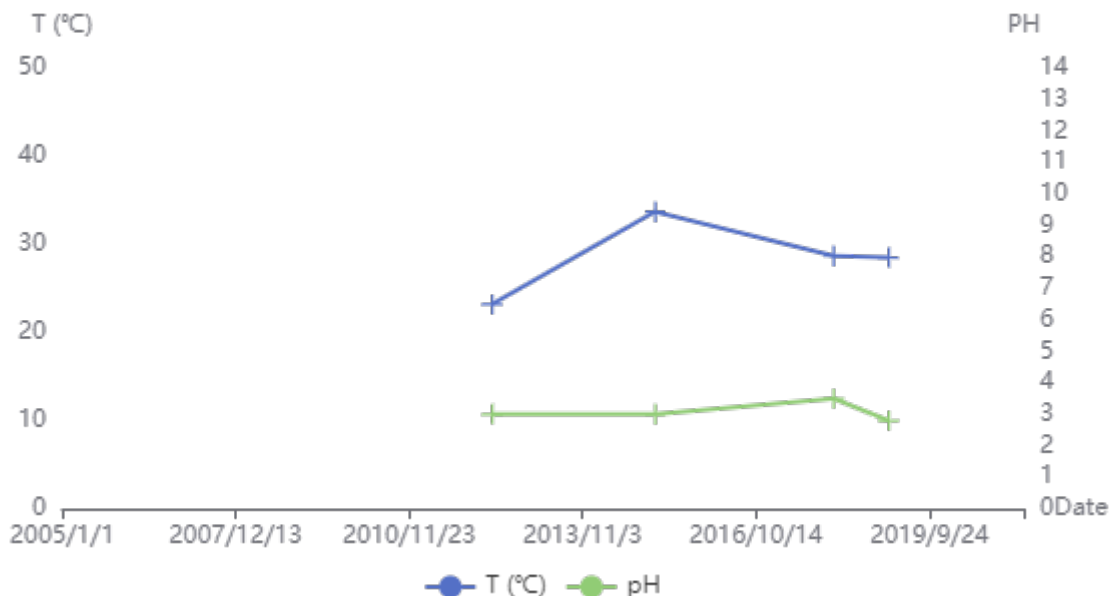




Fig.1 - taken on 2021-03-25 17:41:14"



Fig.2 - taken on 2021-03-25 17:41:24"

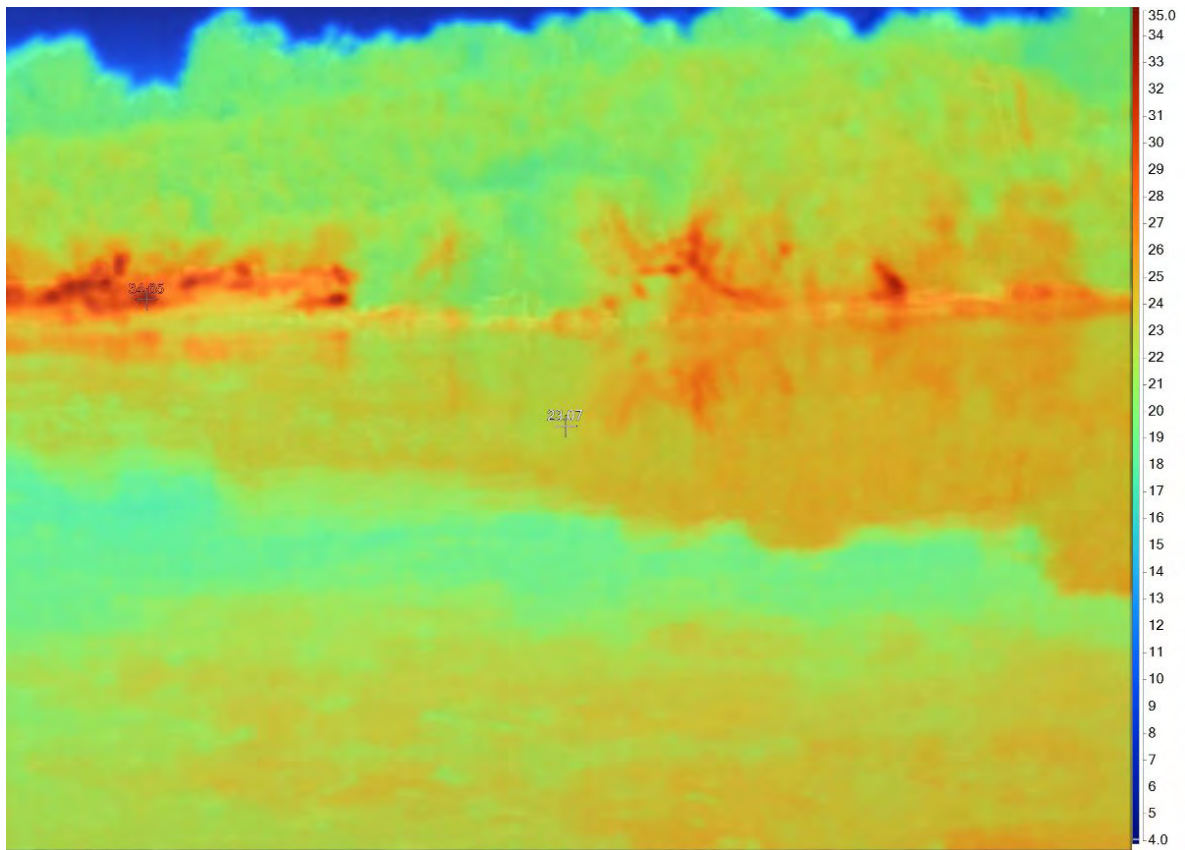


Fig. 3 Infrared image of Longview Road Lake. Taken on 2021-03-25.

6.4 3066_26: Longview Road Mud Pools

- The average temperature of the mud pools appears to be approximately 23 – 25°C. Two temperature increases were observed in 2011 and 2017. In 2011, the temperature increased from <20 °C to the average levels. In 2017, the measurement shortly increased to 30.2°C, before again returning to the mean level, and then increasing again in 2019.

Location: -38.413257, 176.361379

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28		25.0			Murky	Brown	Constant discharge
Comments	Ground cracked, too hazardous to get close						
2016/01/12	2.0	23.6	0.15	None	Murky	Brown	Constant all over pool
Comments	Ground around mud pools too unstable to access lake <i>Water level: Below ground level</i>						
2016/12/01	2.0	23.6	0.15	None	Murky	Brown	Constant all over pool
Comments	Ground around mud pools too unstable to access lake <i>Water level: Below ground level</i>						
2017/01/27	2.5	30.2	0.3	None	Murky	Brown	Constant discharge
Comments	<i>Water level: below rim</i>						
2018/02/09	2.0	22.3	0.1	None	Turbid	Brown - Light	Bubbles all over
Comments	<i>Water level: Below rim</i>						
2019/01/15	3.0	22.9	0.05	None	Muddy	Brown - Light	Constant in multiple spots
Comments	Pool larger than last time <i>Water level: Below rim</i>						
2020/02/26		28.0	0.5		Muddy	Brown	Constant discharge all over.
Comments	Lots of new holes opened up, sulphur deposits around some vents. Ground too soft to walk around to get to pool. Could not get close to take pH measurement.						

Longview Road Mud Pools: Temperature and pH for 2005/1/1 - 2021/5/1

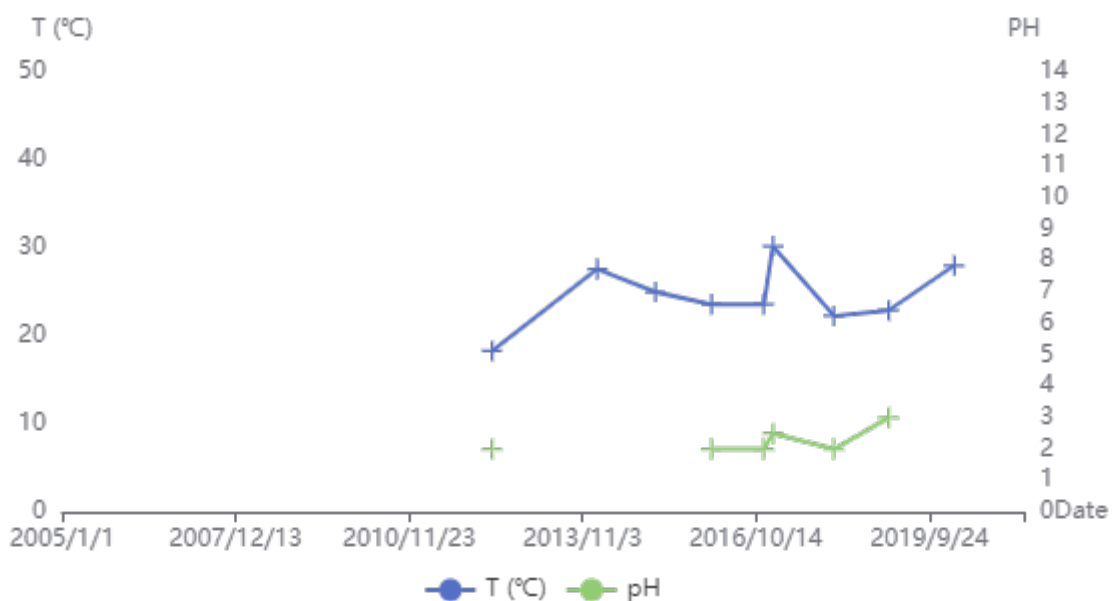




Fig.1 - taken on 2020-02-26 14:51:31"



Fig.2 - taken on 2020-02-26 14:51:21"

6.5 3066_8: Figure 8 Shaped Hot Pool

- Between 2005 to 2021, the water temperature at Figure 8 Shaped Hot Pool remained between 80 and 100 °C, and with pH constantly remaining at near-neutral conditions.

Location: -38.415366, 176.330458

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28	8.0	96.6	0.2	None	Murky	Brown	Constant upwelling, discharge
Comments	Large pool surging, flowing into small pool <i>Water level:</i> Below rim						
2016/01/12	7.5	90.6		None	Clear	Clear	Calm
Comments	Flowing into small pool <i>Water level:</i> nd, inflow from large pool						
2017/01/27	7.5	88.1	0.15	None	Clear	Clear	Upwelling
Comments	Pools joined <i>Water level:</i> below outflow						
2018/02/09	7.0	90.5		None	Clear	Colourless	Constant bubbles
Comments	Fence collapsing around feature <i>Water level:</i> Overflowing into small pool, level higher than normal						
2019/01/15	7.0	84.6	0.05	None	Clear	Grey - Light	Constant bubbling in center
Comments	<i>Water level:</i> Below outflow						
2020/02/26	7.7	90.5	0.2	<0.5	Clear	Colourless	Vigorous intermittent periods of high ebullience. Constant bubbling when calmer.
Comments	Water level and ebullition changing throughout visit. <i>Water level:</i> Water level changes dropped with high ebullience.						
2021/03/25	7	92.4	0	None	Clear	Colourless	Constant low ebullience
Comments	All nearby terrain and fumaroles covered with soil. Pool not separated into two small sub-pools (not separating with 3066_27).						

Figure 8 shaped hot pool: Temperature and pH for 2005/1/1 - 2021/5/1

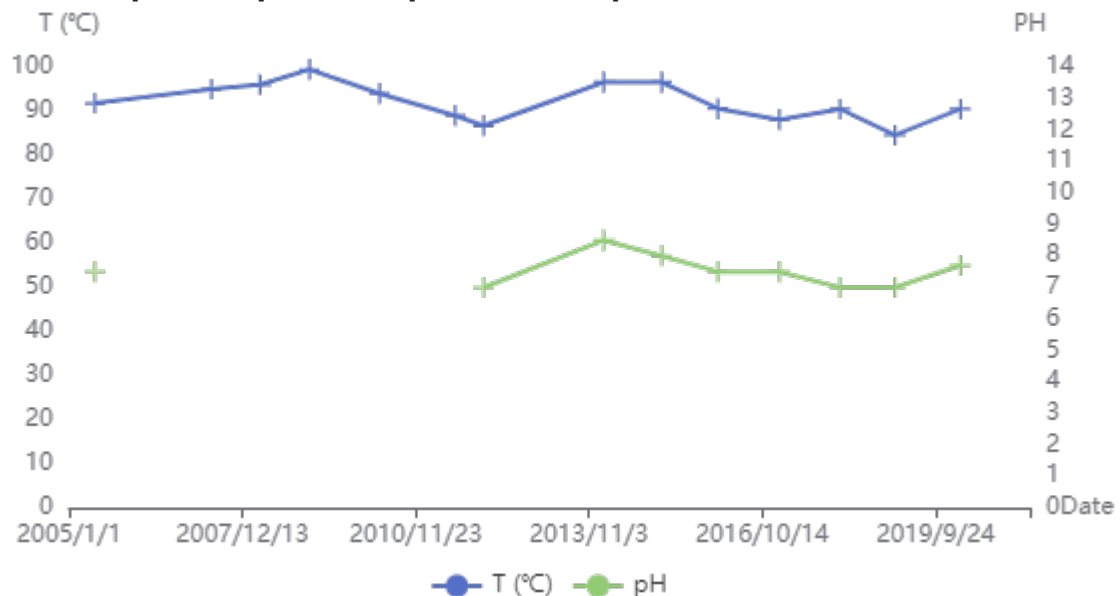




Fig.1 - taken on 2020-02-26 13:52:26"



Fig.2 - taken on 2021-03-25 13:19:40"

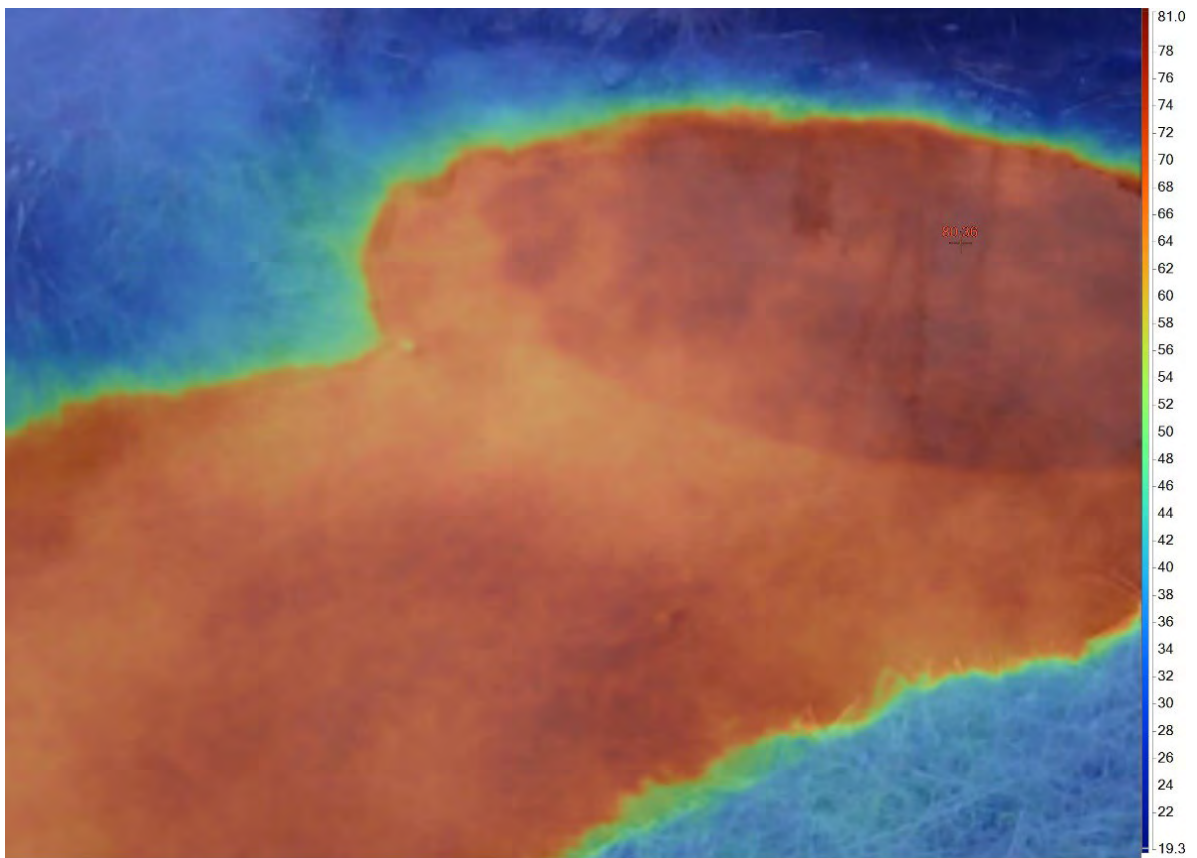


Fig. 3 Infrared image of Figure 8 Pool. Taken on 2021-03-25.

6.6 3066_27: Figure 8 shaped hot pool -small pool

- The temperature of this pool remains below 90 °C and below conditions at feature 3066_8, with which this feature could sometimes be merged with (as observed in March 2021). In 2018, the temperature dropped to 74 °C, but immediately returned to previous conditions.
- The pH at this site has been declining from pH 9 in 2012 to pH 5 in 2020.

Location: -38.415341, 176.330388

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2017/01/27	7.0	89.5	0.15	None	Clear	Clear	Calm
Comments	<i>Water level: below outflow</i>						
2018/02/09	6.0	74.0		None	Clear	Colourless	Calm
Comments	Large pool overflowing into small pool. Fence collapsing around feature. <i>Water level: nd</i>						
2019/01/15	6.5	87.0	0.2	None	Clear	Green - Light	Infrequent bubbling
Comments	<i>Water level: Below rim</i>						
2020/02/26	5.0	89.0	0.5		Clear	Colourless	Occasional bubbles

Figure 8 shaped hot pool -small pool: Temperature and pH for 2005/1/1 - 2021/5/1

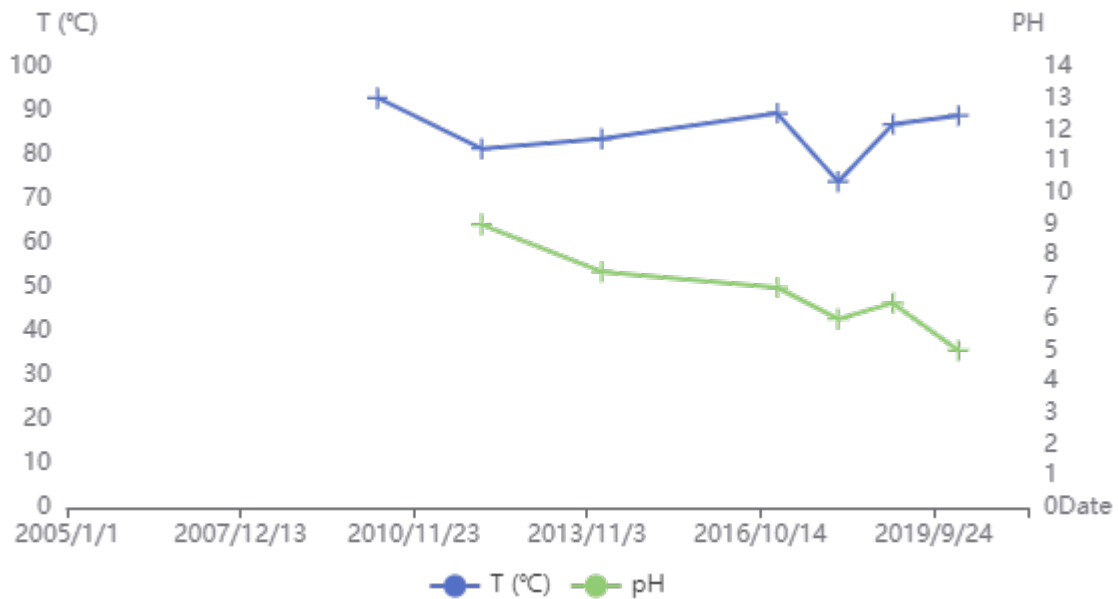




Fig.1 - taken on 2020-02-26 13:45:43"



Fig.2 - taken on 2020-02-26 13:46:35"

6.7 3066_9: Hot Pool 3 at Reporoa

- Temperature conditions at Hot Pool 3 between 2005 to 2010 remained relatively constant at near-boiling conditions. Since 2012, there has been a decreasing trend in the average temperature; however, the feature underwent cycles of short-term increase and decrease, with temperatures ranging between 75 and 94 °C.
- pH measurements have generally decreased from pH 9 to 7.
- There are multiple anthropogenic debris including coils inside the feature.

Location: -38.415908, 176.331342

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28	7.0	94.0	<2.0		Clear	Blue	Constant upwelling
Comments	Very steamy, fence broken <i>Water level: Overflowing</i>						
2016/01/12	8.0	80.2	<2.0		Clear	Blue	Upwelling
Comments	<i>Water level: Overflowing</i>						
2016/12/01	8.0	91.2	<2.0		Clear	Blue	Upwelling
Comments	<i>Water level: Overflowing</i>						
2017/01/27	7.0	86.3	<2.0		Clear	Blue	Upwelling
Comments	<i>Water level: Overflowing</i>						
2018/02/09	8.0	92.5	<5.0		Clear	Blue - Dark	Constant all over
Comments	New fence around feature <i>Water level: Overflowing</i>						
2019/01/15	7.5	75.6	<3.0		Clear	Blue	Constant upwelling in centre
Comments	Small pool has opened up behind main pool. <i>Water level: Overflowing</i>						
2020/02/26	7.7	92.5	<2.0		Clear	Blue	Occasional bubbles
Comments	Fence repaired around pool. Pool calmer than usual. Oil on surface.						
2021/03/25	7	93.2	0.5	<2.0	Clear	Blue	Constant ebullition near outflow point
Comments	Oily sheen observed on water surface around pool margins, provenance unknown.						

Hot Pool 3 at Reporoa: Temperature and pH for 2005/1/1 - 2021/5/1

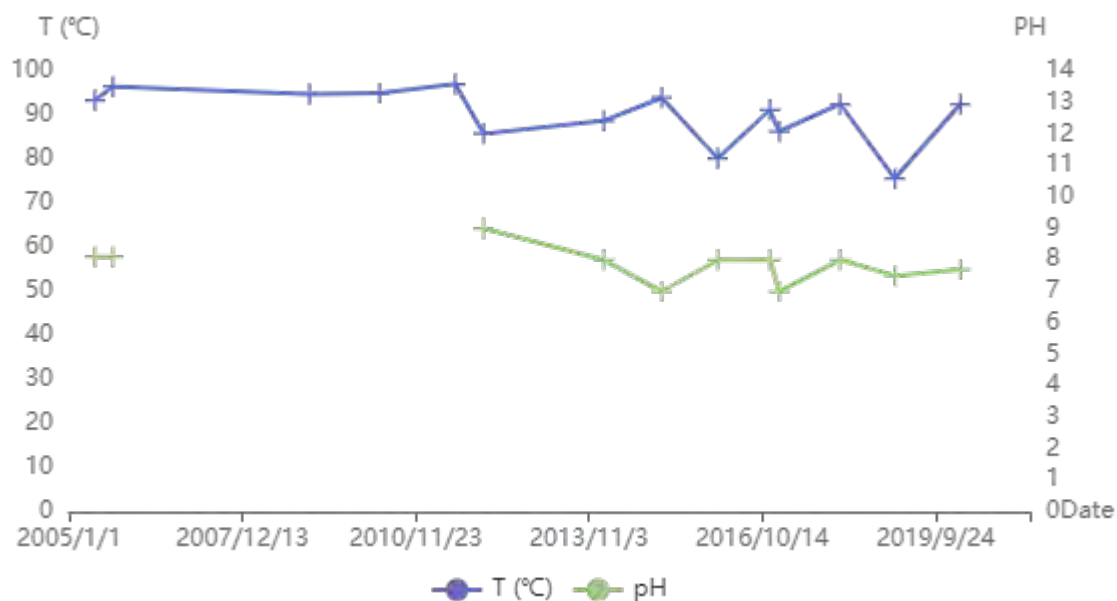




Fig.1 - taken on 2020-02-26 14:00:09"



Fig.2 - taken on 2020-02-26 14:01:03"



Fig.3 - taken on 2021-03-25 13:30:34"



Fig.4 - taken on 2021-03-25 13:30:42"

6.8 3066_10: Hot Pool 4 at Reporoa

- Temperature measurements decreased from 63°C to 49.6°C between 2017 to 2018 but have increased to 62°C in 2020.

Location: -38.413609, 176.334591

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28		71.3	1.5	None	Murky	Brown	Constant discharge
Comments	<i>Water level:</i> Below Overflow						
2016/01/12		67.5	1.5	None	Murky	Grey/brown	Constant discharge
Comments	<i>Water level:</i> Below ground level						
2016/12/01		67.5	1.5	None	Murky	Grey/brown	Constant discharge
Comments	<i>Water level:</i> Below ground level						
2017/01/27	nd	63.1	2.0	None	Murky	Grey	Constant discharge
Comments	<i>Water temperature:</i> Temp taken from race <i>Water level:</i> below rim						
2018/02/09		49.6	0.4	None	Murky	Grey	Constant bubbling
Comments	Measurements taken from the race. <i>Water temperature:</i> Taken from race <i>Water level:</i> Below ground level						
2019/01/15		53.7	0.2	None	Clear	Grey	Constant bubbles in centre
Comments	Measurements taken from the race. <i>Water temperature:</i> Taken from race with steam interference <i>Water level:</i> Below ground level						
2020/02/26		62.0	1.5		Murky	Brown	Constant vigorous discharge.
Comments	Sulphur deposition up to 1m above water level. <i>Water temperature:</i> Taken from race.						

Hot Pool 4 at Reporoa: Temperature and pH for 2005/1/1 - 2021/5/1

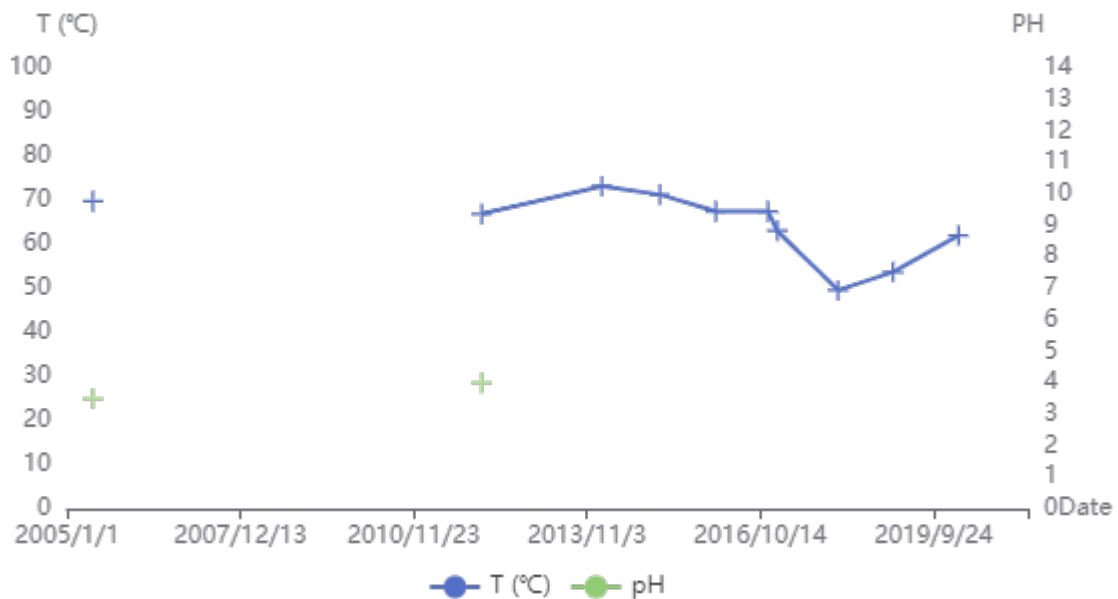




Fig.1 - taken on 2020-02-26 14:15:19"

6.9 3066_11: Golden Springs Motel; North Pool

- Temperature decreased to below 30 °C from 2007 to 2011 but recovered to 39.4 °C in 2015, before constantly experiencing a minor decrease to 2019.
- pH generally remained at pH 7, in exception to 2018 when pH was measured to be 5. However, this change was not reflected by abnormal temperature changes during the same period.

Location: -38.46875, 176.30955

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/21	7.5	39.4		<30.0	Murky	Green	Calm
Comments	Green algae on steps around pool. Couldn't access south pool due to access being blocked by a tree falling down. <i>Water level: Overflowing</i>						
2016/01/12	7.0	37.8		<30.0	Cloudy	Cloudy	Calm
Comments	<i>Water level: Overflowing</i>						
2016/12/01	7.0	37.4		<30.0	Cloudy	Cloudy	Calm
Comments	<i>Water level: Overflowing</i>						
2017/01/27	7.0	37.8		40.0	Murky	Pale green	nd
Comments	<i>Water level: Overflowing</i>						
2018/02/09	5.0	35.6		<20.0	Murky	Green-grey	nd
Comments	<i>Water level: Overflowing</i>						
2019/01/15	7.0	33.4		<20.0	Murky	Grey	Calm
Comments	<i>Water level: Overflowing</i>						
2020/02/26	7.1	35.6	0.41	<20.0	Cloudy	Blue - Grey	nd
2021/03/25	7.0	39.4	0	<20.0	Cloudy	Grey – Light	n/a

Golden Springs Motel; North Pool: Temperature and pH for 2005/1/1 - 2021/5/1

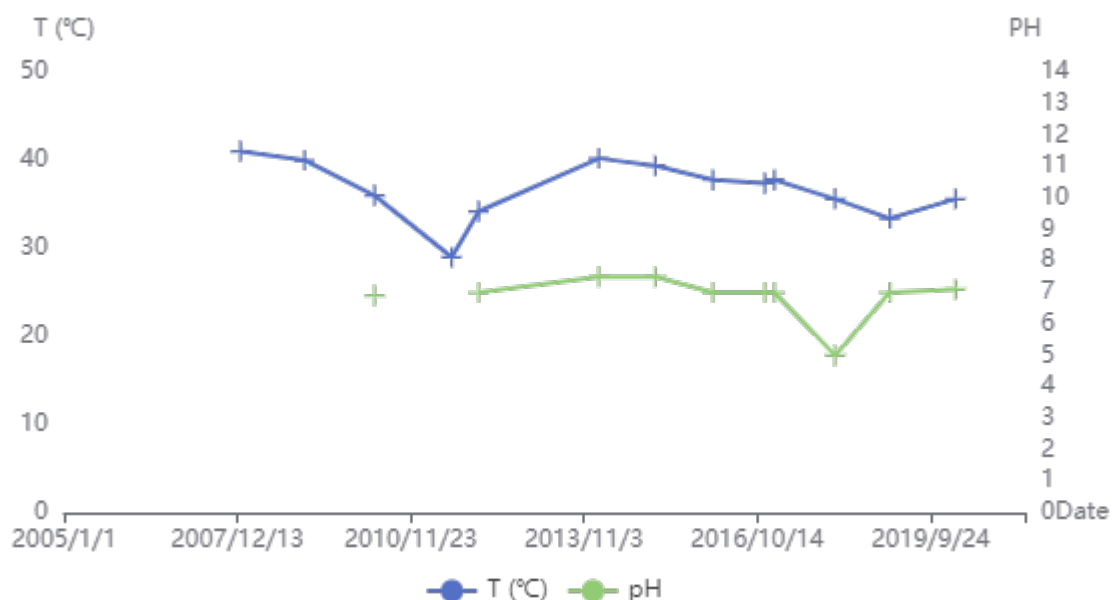




Fig.1 - taken on 2020-03-17 11:15:12"



Fig.2 - taken on 2021-03-25 21:33:20"

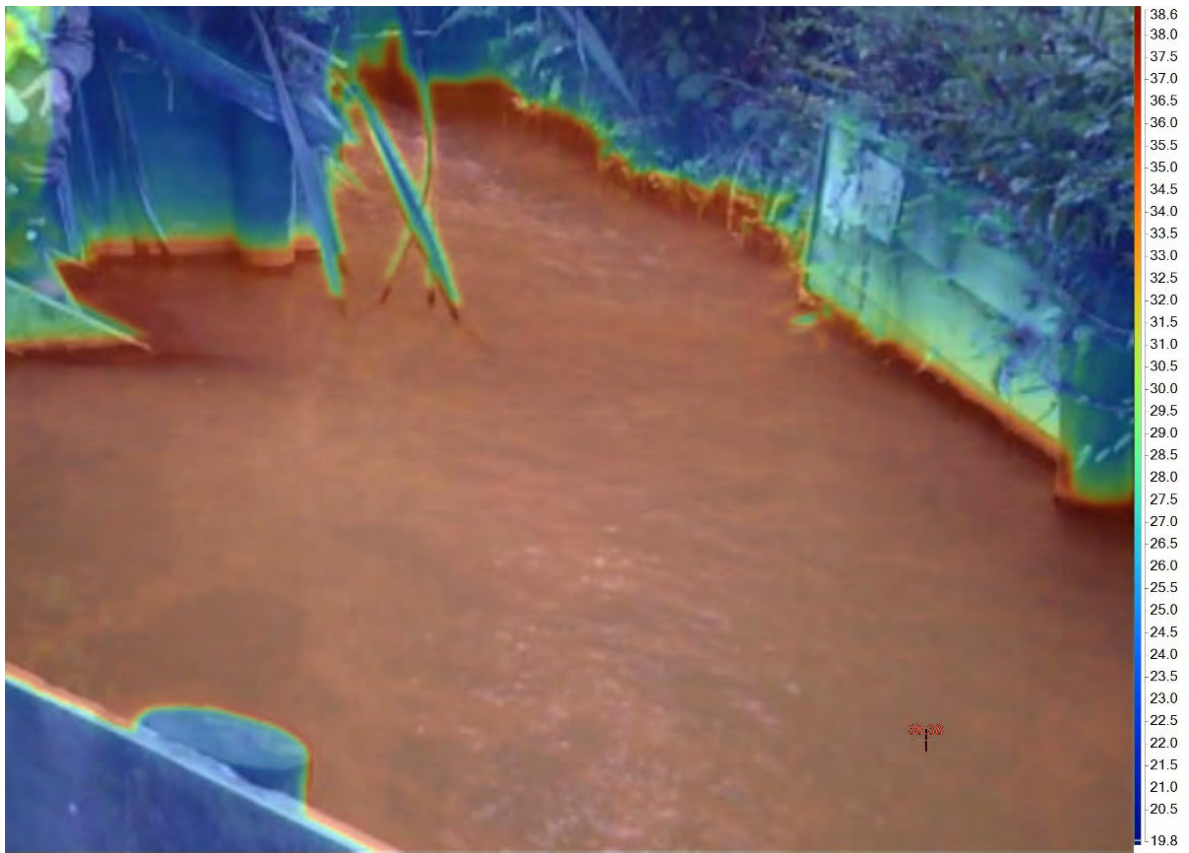


Fig. 3 Infrared image of North Pool. Taken on 2021-03-25.

6.10 3066_12: Golden Springs Motel; South Pool

- The temperature of this feature experiences periods of minor decline since 2007 but has always remained between 30 and 40 °C.
- pH measurements appear to be inversely correlated to temperature, with measurements since late 2017 showing that pH decreases when temperature increases. However, all of the changes are relatively minor.

Location: -38.470031, 176.308852

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2016/01/12	7.0	34.6		40.0	Cloudy	Green/grey	Calm
Comments	<i>Water level: Overflowing</i>						
2016/12/01	7.0	33.6		40.0	Cloudy	Green/grey	Calm
Comments	<i>Water level: Overflowing</i>						
2017/01/27	6.5	35.5		<40.0	Murky	Pale green	nd
Comments	<i>Water level: Overflowing</i>						
2018/02/09	6.0	33.4		<30.0	Murky	Green-grey	nd
Comments	<i>Water level: Overflowing</i>						
2019/01/15	7.5	32.0		<30.0	Murky	Grey	nd
Comments	<i>Water level: Overflowing</i>						
2020/02/26	6.0	35.6	0.7	<20.0	Cloudy	Grey - Light	nd
Comments	<i>Water level: Water level has dropped considerably.</i>						
2021/03/25	7.0	37.5	0	<5.0	Cloudy	Grey	N/a
Comments	<i>Relatively weak flow compared to previous records.</i>						

Golden Springs Motel; South Pool: Temperature and pH for 2005/1/1 - 2021/5/1

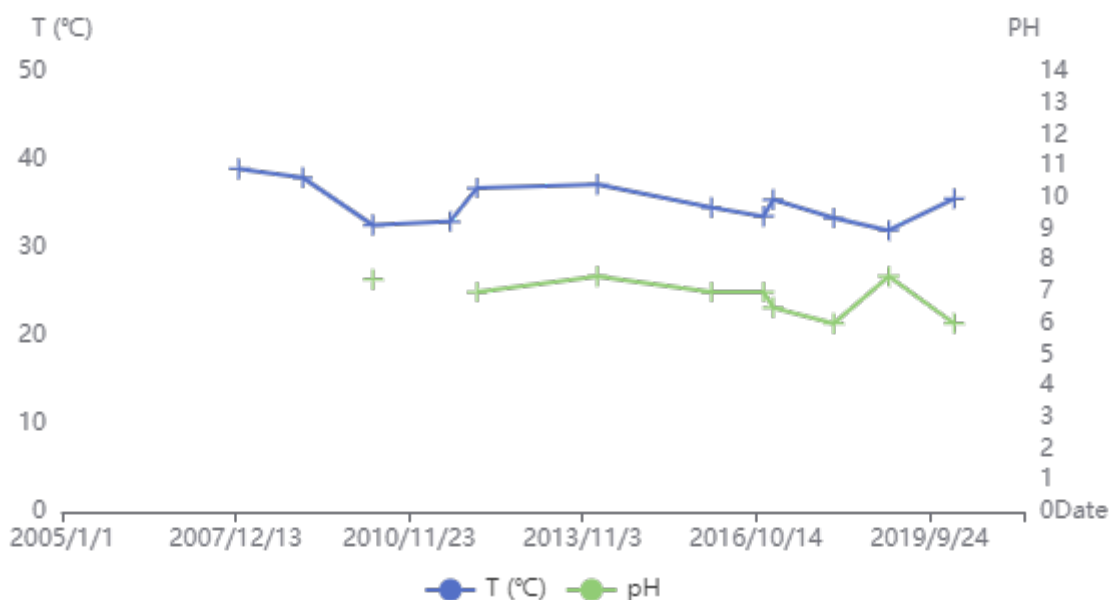




Fig.1 - taken on 2020-03-17 11:15:14"



Fig.2 - taken on 2021-03-25 21:33:40""

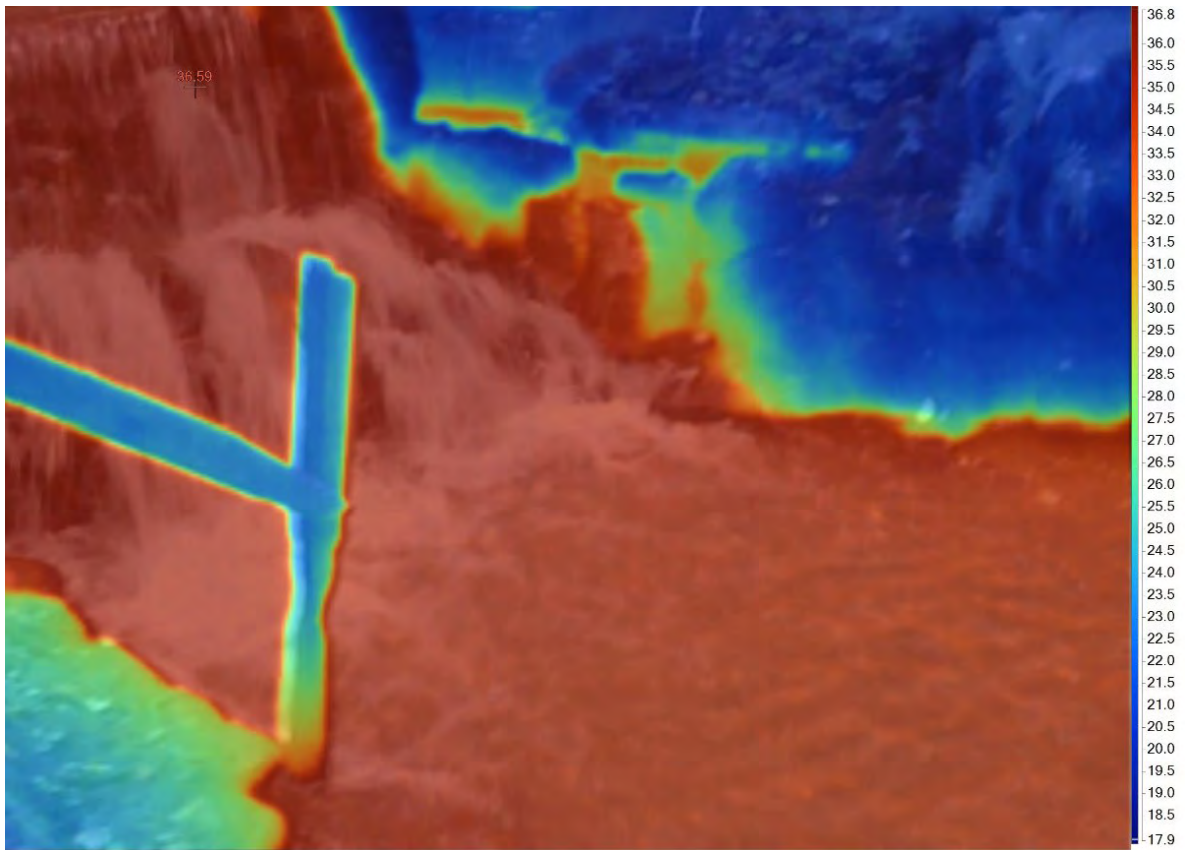


Fig. 1 Infrared image of South Pool. Taken on 2021-03-25.

6.11 3066_13: No 3 across Golden Spring Hotel

- The water temperature of this feature has remained relatively constant since 2006.
- pH has remained in near-neutral conditions except for observations in 2018, where the pH was measured to be 5.
- Pool is often covered in organic debris and/or subaerial microbial mat communities, making it difficult to observe the water conditions.
- In 2021 a very large tree has fallen across the pool, with its trunk and branches acting as a partial roof.

Location: -38.465192, 176.310522

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/21	6.5	42.0			Murky	Green	Effervescing
Comments	Algal mats						
2016/01/12	7.0	41.3		None	Murky	Green-yellow	Effervescing
Comments	Water level: nd						
2016/12/01	7.0	38.8		None	Murky	Green-yellow	Effervescing
Comments	Water level: nd						
2017/01/27	7.0	41.0		None	Murky	Pale Green	Effervescing in centre
Comments	Algal mats covering most of the pool Water level: Overflowing						
2018/02/09	5.0	40.3		None	Cloudy	Green - Light	Effervescing
Comments	Less algal mats than usual Water level: nd						
2019/01/15	6.5	40.5		None	Cloudy	Green - Light	Effervescing in centre
Comments	Water level: nd						
2020/02/26	6.8	41.3	0.2		Murky	Green - Light	Effervescing in centre
Comments	Algae mats covering most of the feature.						
2021/03/25	7	42.9	0	N/a	Cloudy	Green - Murky	Constant ebullition
Comments	Surface covered in organic debris.						

No 3 across Golden Spring Hotel: Temperature and pH for 2005/1/1 - 2021/5/1

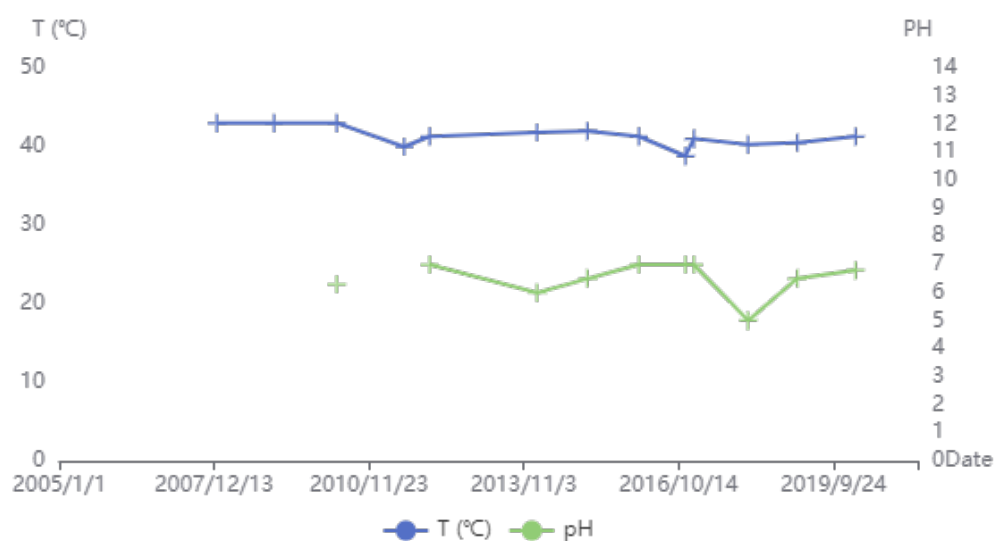




Fig.1 - taken on 2020-02-26 12:04:25"



Fig.2 - taken on 2021-03-25 16:41:12"

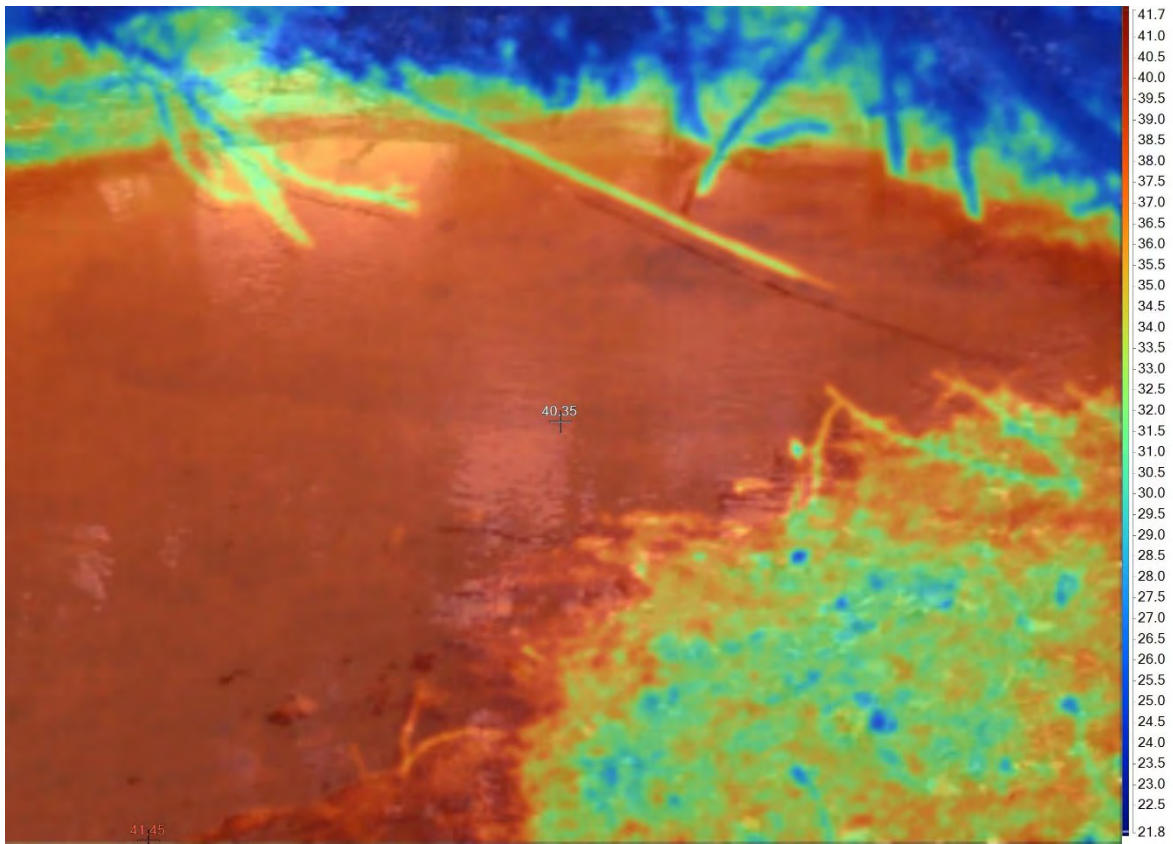


Fig. 3 Infrared image of No3 pool. Taken on 2021-03-25.

6.12 3066_14: No 4 across the Golden Springs Hotel

- This site has experienced temperature decreases at the same time as 3066_13, in 2010 and 2016. This is expected as both sites are only different points of a stream, and so have the same water source.

Location: -38.464388, 176.310267

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2016/01/12	7.5	38.1		None	Cloudy	Green/blue	Small bubbles
Comments	Algal mats on pool Water level: nd						
2016/12/01	7.5	37.1		None	Cloudy	Green/blue	Small bubbles
Comments	Algal mats on pool Water level: nd						
2017/01/27	7.0	39.4		None	Murky	Grey/green	Calm
Comments	Algal mats covering most of the pool Water level: Overflowing						
2018/02/09	5.0	38.9		None	Cloudy	Green-grey	nd
Comments	Algal mats covering feature Water level: Overflowing						
2020/02/26	5.0	45.9			Clear	Colourless	Constant upwelling in centre.
Comments	Algal mats covering most of the pool.						
2021/03/25	7.0	46.7	0	N/a	Cloudy	Grey	nd
Comments	Algae covered on the surface.						

No 4 across the Golden Springs Hotel: Temperature and pH for 2005/1/1 - 2021/5/1

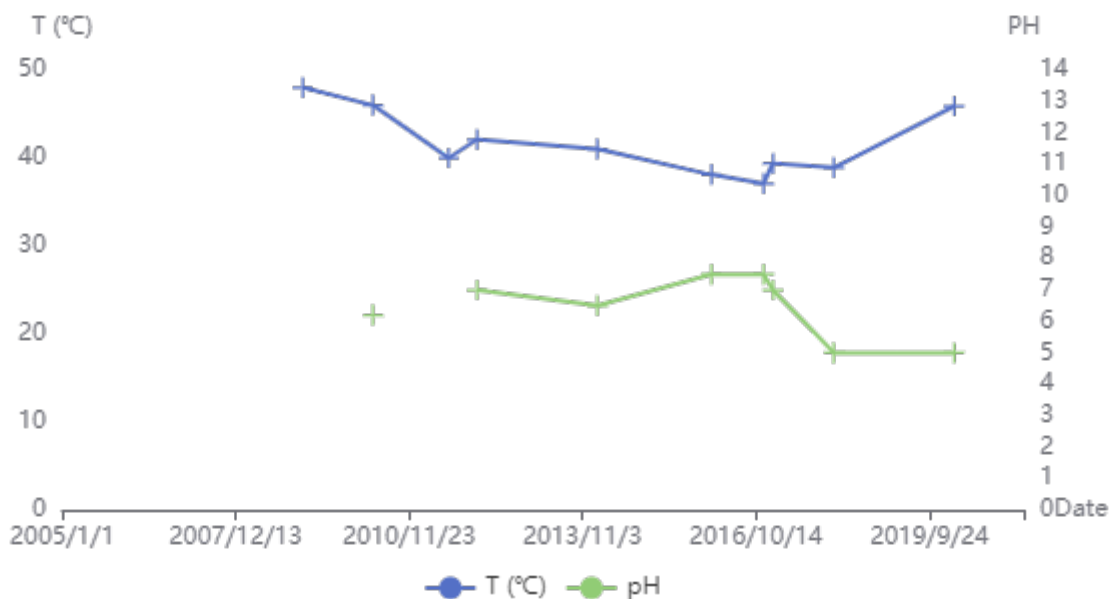




Fig.1 - taken on 2020-02-26 12:15:01"

Fig.2 - taken on 2020-02-26 12:17:48"

Fig.3 - taken on 2021-03-25 16:49:29"

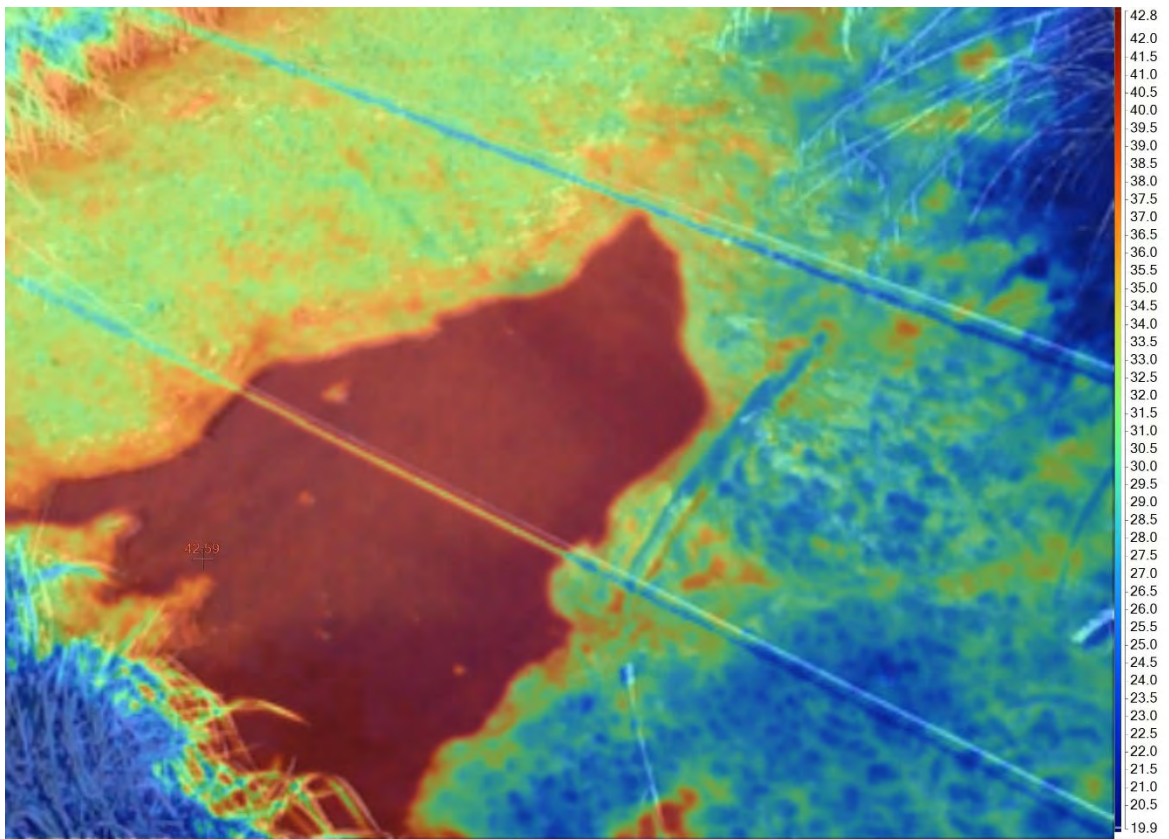


Fig. 4 Infrared image of No 4 pool. Taken on 2021-03-25.

7 ROTOKAWA

7.1 3067_3: RKF3

- Water temperature conditions decreased between 2014 to 2017.
- pH measured at this site has always shown acidic pH, between pH 3 and 4.

Location: -38.62713, 176.190395

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2014/01/29	3.0	48.4		None	Cloudy	Pale green	Constant discharge
Comments	<i>Water level:</i> Not overflowing						
2015/01/21	3.0	51.7		<0.5	Clear	Green grey	Small discharge around pool
Comments	<i>Water level:</i> nd						
2016/01/12	2.5	47.4		None	Cloudy	Pale green	Constant discharge
Comments	<i>Water level:</i> not overflowing						
2018/02/09	3.0	32.3	0.4		Cloudy	Green - Light	Areas of small bubbles
Comments	H2S, gas alarms read up to 20ppm. Water level lower than usual. <i>Water level:</i> Below inflow.						
2019/01/15			0.5		Murky	Green - Murky	Constant bubbling all over
Comments	Couldn't get close to the pool due to gas clouds blowing across the pools. <i>pH:</i> nd, unsafe to get sample <i>Water temperature:</i> nd - unsafe <i>Water level:</i> Below ground level - estimated from a distance						
2020/02/26		36.0	0.5		Cloudy	Green - Blue	Constant gas discharge on left less ebullient in centre. Slightly effervescent.
Comments	Ebullition on left, producing sulphur. Thick sulphur on ground next to pool. New outflow formed, currently dry. Soft ground. Two dead animals (wild pigs?) in pool. Couldn't access RKF4.						
2021/04/30	4.0	39.6	0.3		Milky	Blue - Light	None

RKF3: Temperature and pH for 2005/1/1 - 2022/1/1

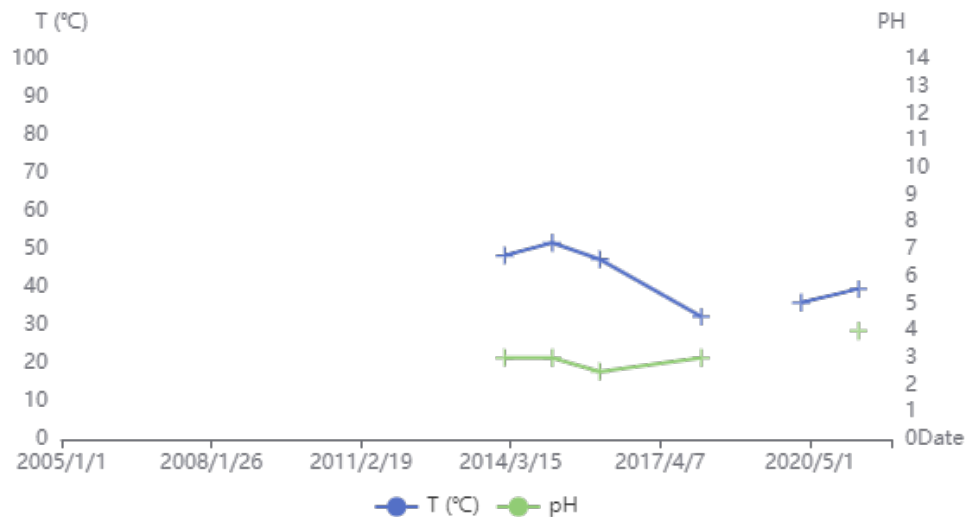




Fig.1 - taken on 2020-02-26 10:16:18"



Fig.2 - taken on 2020-02-26 10:16:25"



Fig.3 - taken on 2021-04-30 10:03:44"



Fig.4 - taken on 2021-04-30 10:03:48"

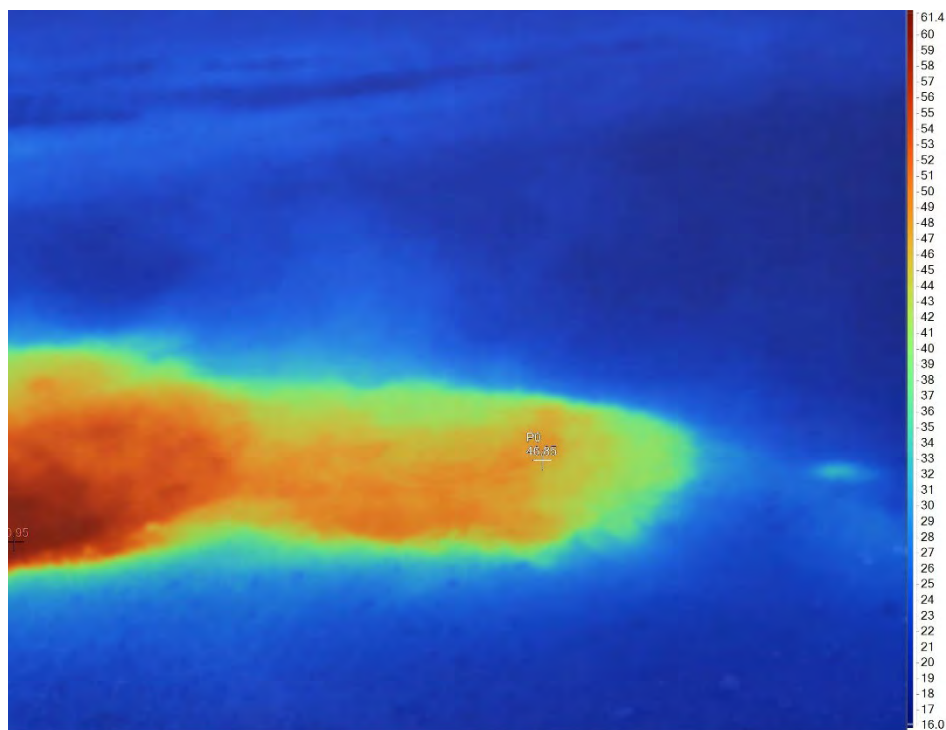


Fig. 4 Infrared image of RKF3. Taken on 2021-04-30.

7.2 3067_4: RKF4

- Temperature experienced an increase between 2016 and 2018, but no measurements were taken in 2017. From 2018 to 2021, the temperature condition has been relatively stable.
- pH measured at this site has remained relatively unchanged since 2014.

Location: -38.62713, 176.190395

Date	pH	Temp °C	LevelFlow (m) (l/s)	Clarity	Colour	Ebullition
2014/01/29	2.5	73.1	None	Murky	Grey/green	Constant
Comments	<i>Water level: Overflowing Area of feature: 3 x 3 m</i>					
2015/01/21	3.0		None	Clear	Clear	Constant discharge
Comments	<i>Water temperature: nd - couldn't get temp as wind changed, too dangerous with high H2S gas. Water level: nd</i>					
2016/01/12	3.0	70.7	None	Clear	Blue	Constant, vigorous
Comments	<i>Water level: Overflowing</i>					
2018/02/09	3.0	82.5	<1.0	Murky	Grey - Light	Constant all over
Comments	<i>Water level: Overflowing</i>					
2021/04/30	2.4	82.5		Cloudy	Yellow	Constant audible ebullition not visible due to steam
Comments	<i>Suspended yellow sediments (possibly sulphurous) on water surface, and 0.3-0.8 diameter sediment rim around pool.</i>					

RKF4: Temperature and pH for 2005/1/1 - 2022/1/1

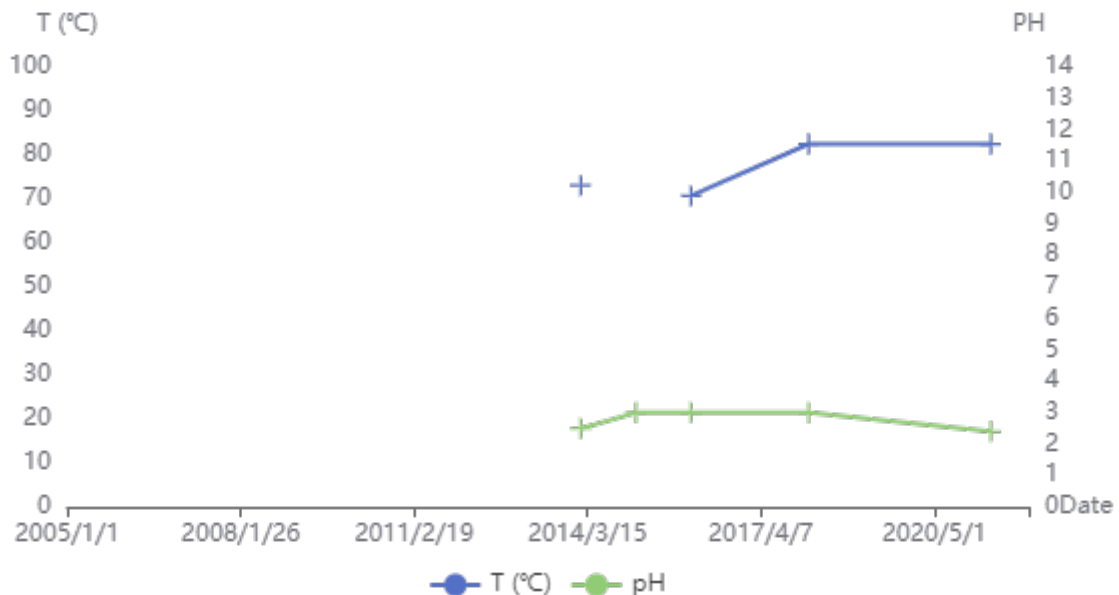




Fig.1 - taken on 2021-04-30 10:12:55"



Fig.2 - taken on 2021-04-30 10:13:01"

8 TAUHARA

8.1 3068_119: Kathleen Stream u/s confluence Otumuheke

- Despite temperature fluctuations occurring until 2021, this feature has a decreasing temperature trend since at least 2009.
- Discharge rates of Otumuheke Stream has been decreasing according to measurements on WRC weirs, which could potentially influence the temperature changes occurring.
- pH measurements fluctuate without observed direct correlation to temperature.

Location: -38.671534, 176.091551

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.5	46.7		<5.0	Clear	Colourless	nd
Comments	Green algae and iron floc on stream bed <i>Water level: Overflowing</i>						
2019/04/29	6.0	31.0		<5.0	Clear	Colourless	nd
Comments	<i>Water level: Overflowing</i>						
2019/07/26	6.0	37.3		<5.0	Clear	Colourless	nd
Comments	Fence post across part of stream. Orange algae.						
2019/08/19	6.0	36.0		<5.0	Clear	Colourless	nd
Comments	Fence post across part of stream. Orange algae.						
2019/11/08	6.0	36.1		<10.0	Clear	Colourless	nd
Comments	Green and orange algae on stream bed. Algae mats floating on stream.						
2019/12/12	6.0	42.5		<5.0	Clear	Colourless	nd
Comments	Orange algae on stream bed. Oily substance on surface.						
2020/02/26	5.0	35.4		<5.0	Clear	Colourless	nd
Comments	Orange algae on stream bed. Oily substance on surface.						
2020/08/05	7.0	33.0		<5.0	Clear	Colourless	No ebullition
2020/12/10	7.0	50.0	0.2	<3.0	Clear	Colourless	N/a
2021/03/25	7.0	51.2	0	Not measured	Clear	Colourless	N/a

Kathleen Stream u/s confluence Otumuheke: Temperature and pH for 2005/1/1 - 2021/5/1

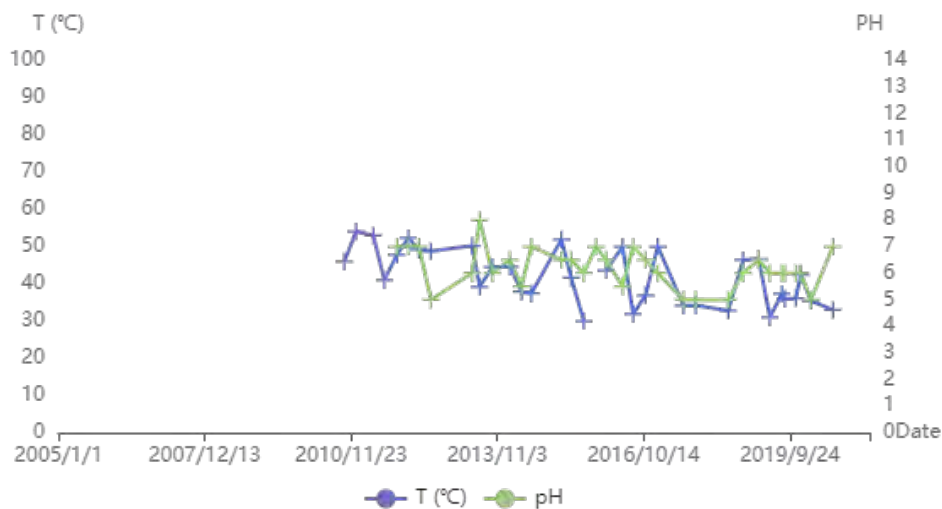




Fig.1 - taken on 2020-03-17 11:15:16"



Fig.2 - taken on 2021-03-25 18:41:00"

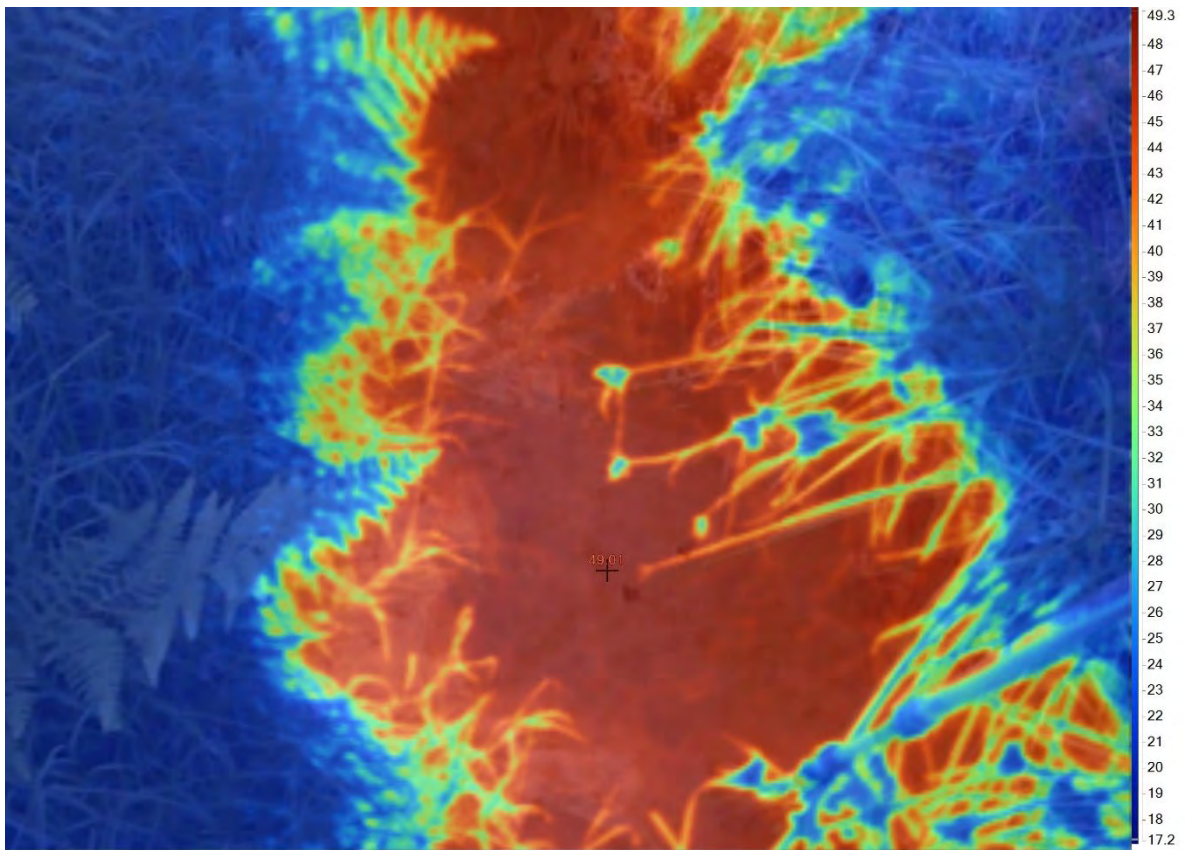


Fig. 3 Infrared image of Otumuheke Stream. Taken on 2020-03-25.

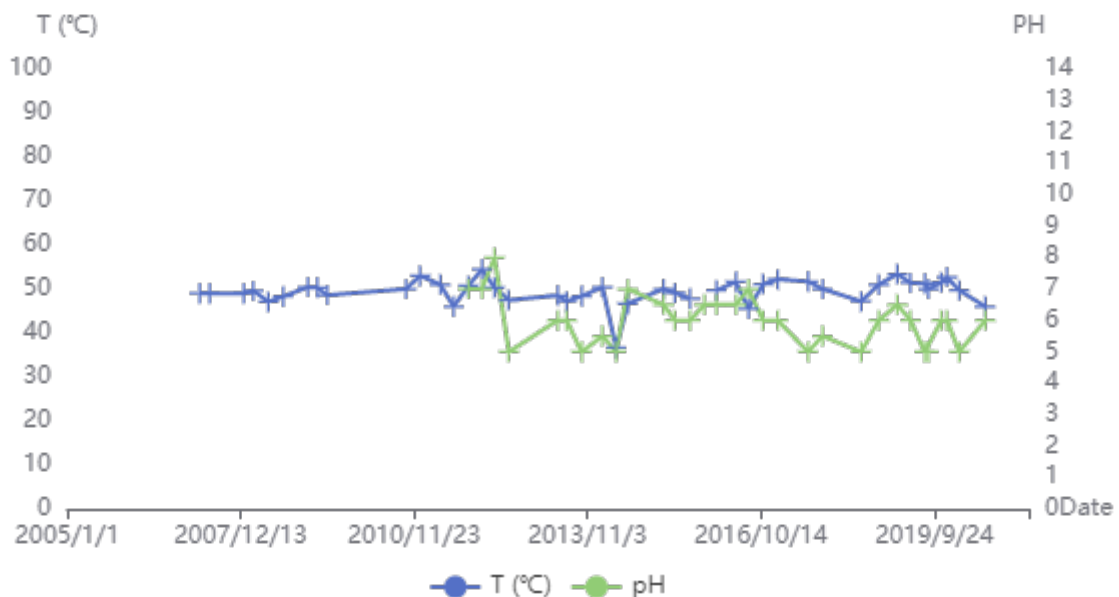
8.2 3068_101: Otumuheke u/s confluence Kathleen Stream

- The temperature conditions at this sampling point have been relatively stable, with the only major decrease being observed in early 2014.
- Fluctuations in pH measurements appear to somewhat reflect the changes in temperature.

Location: -38.671515, 176.091562

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.5	53.4		<40.0	Clear	Colourless	nd
Comments	Water level: Overflowing						
2019/04/29	6.0	51.4		<20.0	Clear	Colourless	nd
Comments	Water level: Overflowing						
2019/07/26	5.0	51.2		<40.0	Clear	Colourless	nd
Comments	Orange algae						
2019/08/19	5.0	50.0		<40.0	Clear	Colourless	nd
Comments	Orange algae						
2019/11/08	6.0	51.5		<40.0	Clear	Colourless	nd
2019/12/12	6.0	52.7		<20.0	Clear	Colourless	Nd
Comments	Water level is lower than usual.						
2020/02/26	5.0	49.7		<30.0	Clear	Colourless	nd
2020/08/05	6.0	46.0		<5.0	Clear	Colourless	No ebullition
2021/03/25	7.0	46.9	0	<5.0	Clear	Colourless	N/a

Otumuheke u/s confluence Kathleen Stream: Temperature and pH for 2005/1/1 - 2021/5/1



8.3 3068_112: Waipahihi New Spring

- Temperature has been stable between 2010 and 2015, when fluctuations occurred, but stayed within a range between 50 and 70 °C.
- pH shows a strong positive correlation to changes in temperature measurement.

Location: -38.70258, 176.102028

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	5.5	54.0		<0.5	Clear	Colourless	nd
Comments	<i>Water temperature:</i> Used infrared camera as IR gun not working						
2019/07/26	7.0	65.2		<0.5	Clear	Colourless	nd
Comments	Looks like more flow than there used to be. Path way getting swampy, stream will block path soon. Also appears to be higher water level downstream.						
2019/08/19	7.2	67.3		<0.5	Clear	Colourless	nd
Comments	Looks like more flow than there used to be. Pathway getting swampy, stream will block path soon. Also appears to be higher water level downstream.						
2020/12/10	7.0	67.0	0	>2.0	Clear	Colourless	N/a
2021/03/26	6.0	66.9	0	>7.0	Clear	Colourless	N/a

Waipahihi New Spring: Temperature and pH for 2005/1/1 - 2021/5/1

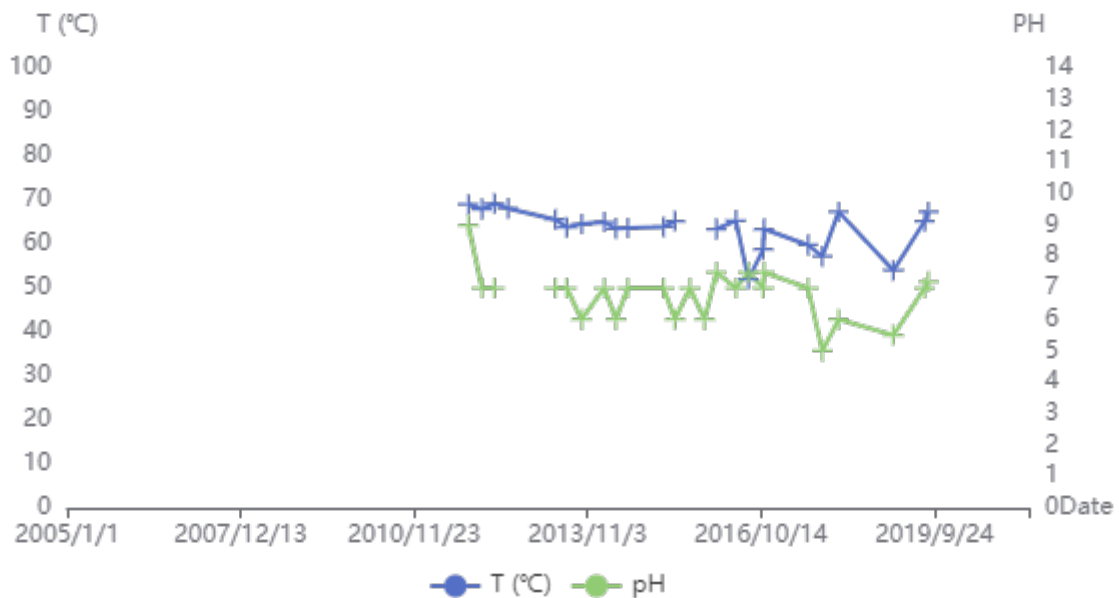




Fig.1 - taken on 2019-07-26 09:34:30"



Fig.2 - taken on 2020-12-03 16:45:08"



Fig.3 - taken on 2020-12-03 16:45:20"



Fig.4 - taken on 2021-03-26 08:21:08"

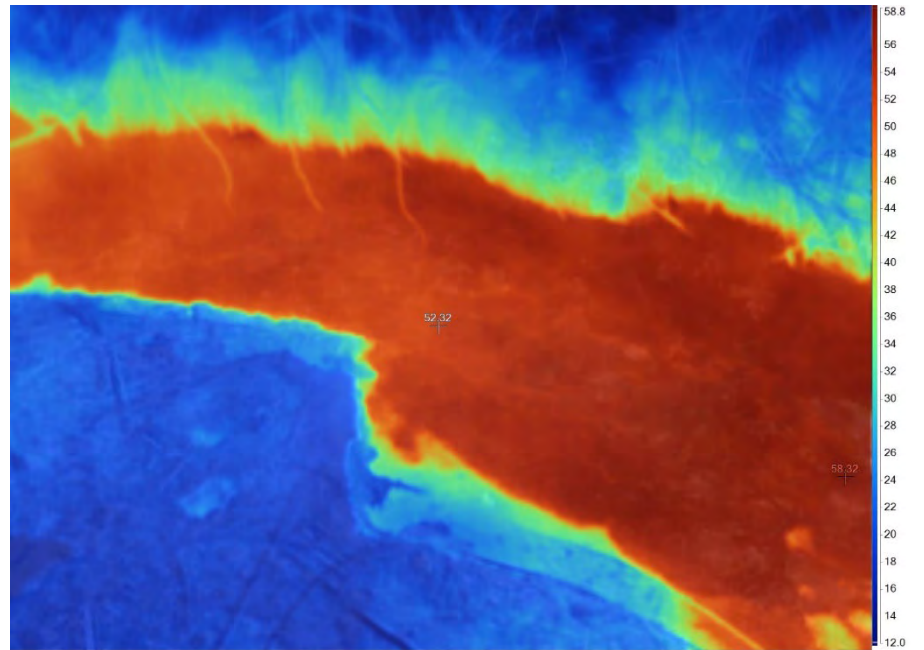


Fig. 5 Infrared image of Waipahihi New Spring. Taken on 2020-03-17.

8.4 3068_6: Waipahihi Source Spring

- Between 2008 to 2016, the temperature of this springs has a negative trend, before experiencing increasing temperature between 2016 and 2021.
- pH conditions vary but remain in near-neutral conditions.

Location: -38.702477, 176.10253

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/01/14	5.5			<0.5	Clear	Colourless	nd
Comments	Water temperature: Thermocouple not working Water level: Overflowing						
2019/04/29	6.0	57.0		<0.5	Clear	Colourless	Constant bubbles
Comments	Water level: Overflowing						
2019/07/26	7.0	62.4		<0.5	Clear	Colourless	Calm
2019/08/19	7.0	61.0		<0.5	Clear	Colourless	Calm
2019/11/07	6.0	66.2		<0.5	Clear	Colourless	Calm
Comments	Lots of bees						
2019/12/12	6.0	58.9		<0.5	Clear	Colourless	Nd
Comments	Cutty grass growing in TR bank. Logger S0056396 installed						
2020/02/25	6.0	65.0		<0.5	Clear	Colourless	Calm
Comments	Lots of vegetation around pool now. Many bees on TR bank. Data logger removed.						
2020/08/05	6.8	72.4			Clear	Grey	No ebullition
2020/12/03	7.0	66.7	0	<4.0	Clear	Colourless	Low, constant
Comments	Metal coil is observed inside the pool.						
2021/03/26	6.0	67.5	0		Clear	Colourless	Nd

Waipahihi Source Spring: Temperature and pH for 2005/1/1 - 2021/5/1

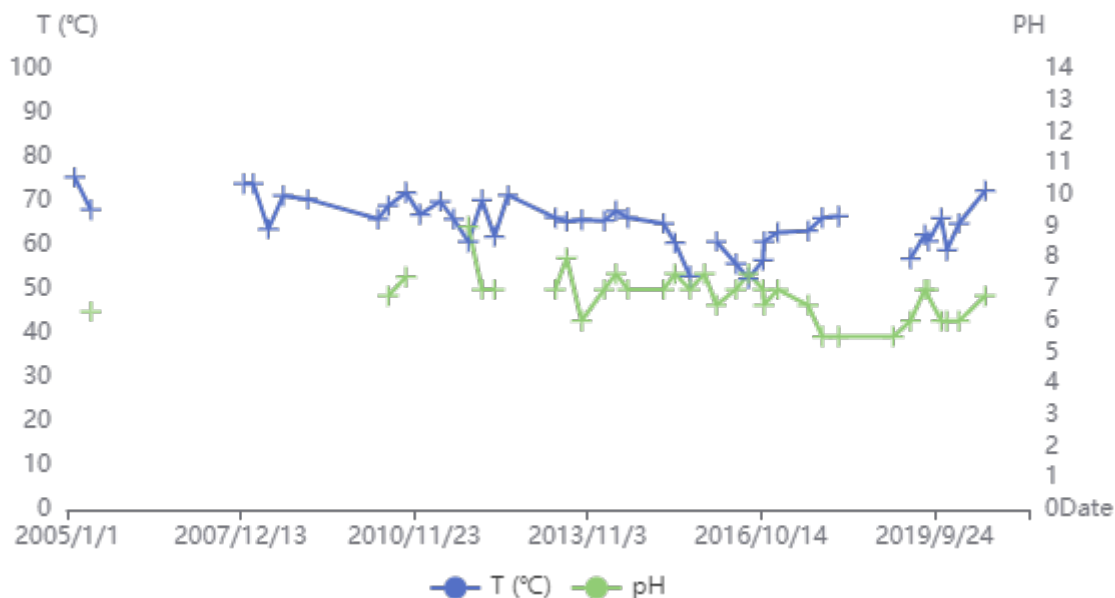




Fig.1 - taken on 2019-04-29 14:59:19"



Fig.2 - taken on 2019-07-26 09:22:43"



Fig.3 - taken on 2019-07-26 09:23:45"



Fig.4 - taken on 2019-11-07 17:34:39"



Fig.5 - taken on 2019-12-12 15:11:14"



Fig.6 - taken on 2020-02-25 17:06:21"



Fig.7 - taken on 2020-12-03 17:13:01"

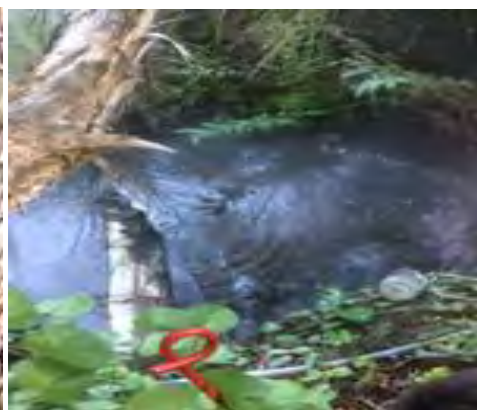


Fig.8 - taken on 2021-03-26 08:00:07"

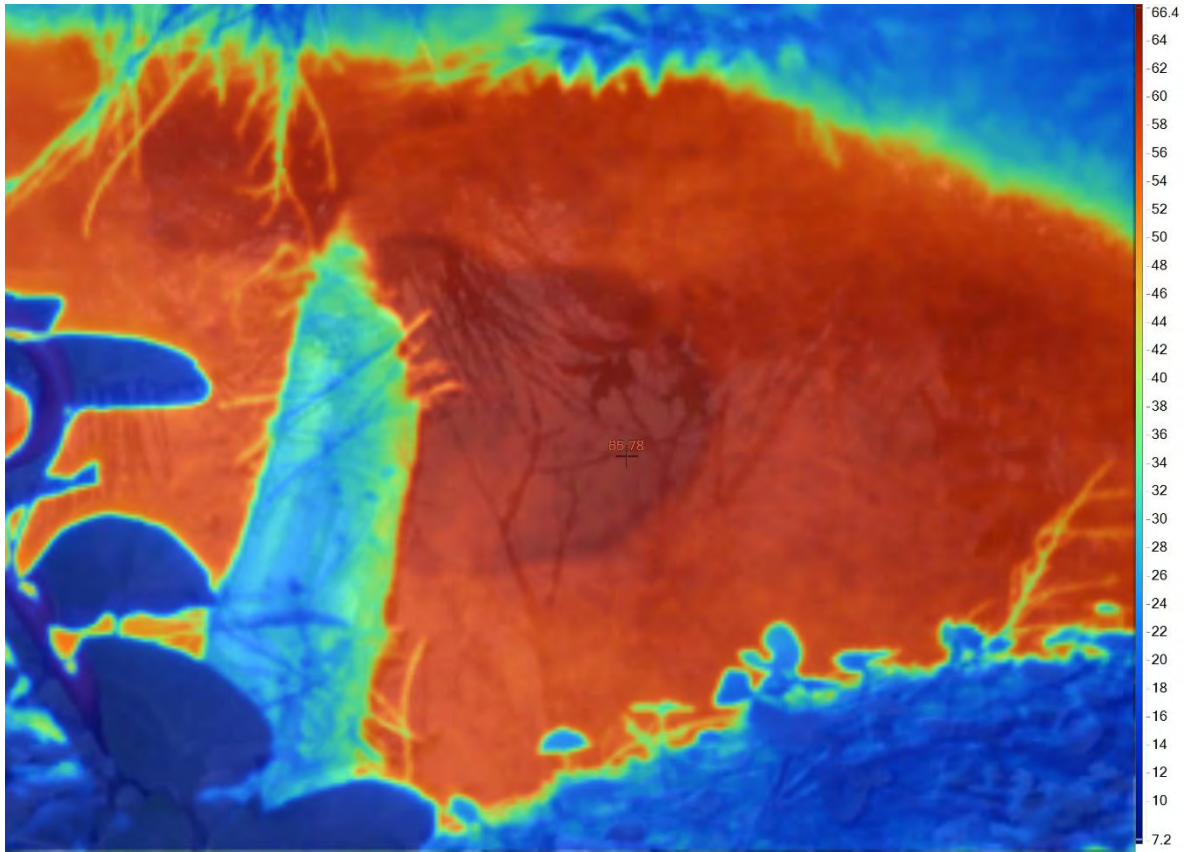


Fig. 9 Infrared image of Waipahihi Source Spring. Taken on 2021-03-25.

8.5 3068_16: Taharepa Springs

- The temperature conditions at Taharepa Springs are relatively stable since 2006.
- pH conditions consistently measure between pH 5 and 7.
- Orange staining affecting the water and surrounding rocks was observed in 2020 and 2021. It is possible that the orange colour is caused by mineral leaching.

Location: -38.70023, 176.084303

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.0	64.4		<0.5	Clear	Colourless	nd
Comments	<i>Water level: Overflowing</i> <i>Bathers: Has been dammed up in places</i>						
2019/04/29	7.0	58.0		<0.5	Clear	Colourless	nd
Comments	<i>Water level: Overflowing</i>						
2019/07/26	6.0	67.8		<0.5	Cloudy	Colourless	nd
Comments	Rocks across outflow						
2019/08/19	6.0	59.0		<0.5	Cloudy	Colourless	nd
Comments	Rocks across outflow						
2019/11/07	6.0	63.4		<0.5	Clear	Colourless	nd
Comments	Some blockages to outlet						
2020/02/26	5.0	64.0		<0.05	Clear	Colourless	nd
Comments	Sand has infilled most of the pool area.						
2020/08/05	6.7	64.3		<1.0	Clear	Colourless	No ebullition
2020/12/10	7.0	61.5	0	<1.0	Clear	Orange	No ebullition
Comments	Orange staining observed in water and surrounding rocks, non-algal. Oily substance observed at one section of the spring.						
2021/03/26	7.0	57.0	0		Clear	Orange in some areas	No ebullition
Comments	Orange staining in some areas from mineral/soil.						

Taharepa Springs: Temperature and pH for 2005/1/1 - 2021/5/1

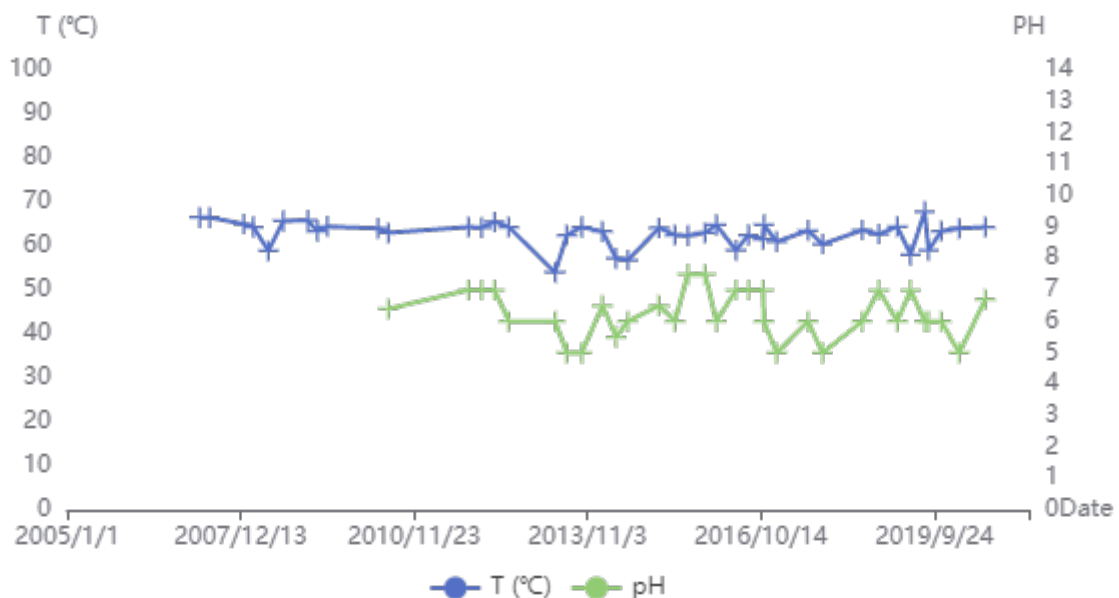




Fig.1 - taken on 2018-10-15 17:31:59"



Fig.2 - taken on 2019-04-29 14:35:56"



Fig.3 - taken on 2019-07-26 08:25:59"



Fig.4 - taken on 2019-11-07 18:05:25"



Fig.5 - taken on 2020-02-26 08:41:08"



Fig.6 - taken on 2020-02-26 08:43:18"



Fig.7 - taken on 2020-12-04 08:29:00"



Fig.8 - taken on 2021-03-26 07:14:03"

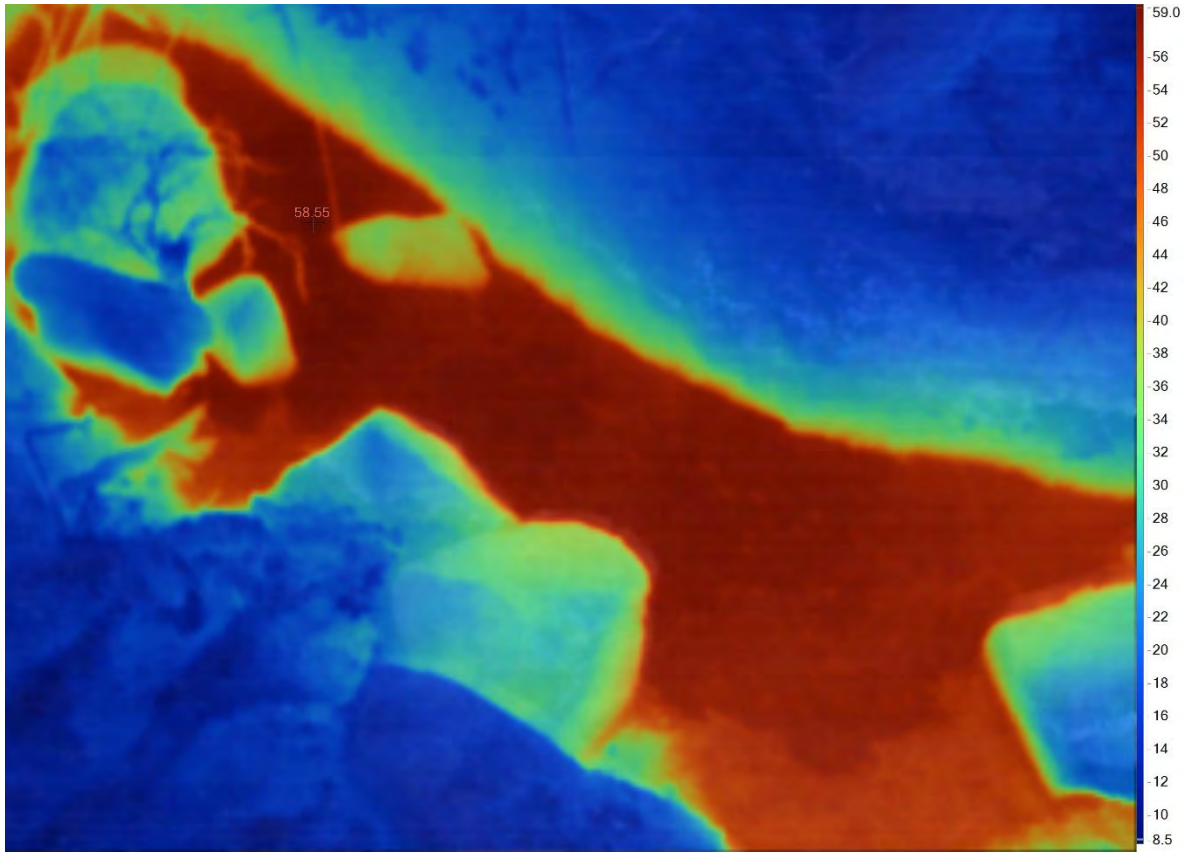


Fig. 9 Infrared image of Taharepa Spring. Taken on 2021-03-26.

8.6 3068_17: Rocky Point Spring

- This feature has an average water temperature between 60 and 70 °C, however experiences fluctuations due to lake water incursions during high lake level.
- During high lake level, the spring is underwater and cannot be monitored.

Location: -38.701805, 176.085049

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	7.0	64.1		<0.5	Clear	Colourless	nd
Comments	Water level: Overflowing						
2019/04/29	6.0	63.0		<1.0	Clear	Colourless	nd
Comments	Water level: Overflowing						
2019/07/26	7.0	65.6		<0.5	Clear	Colourless	nd
2019/08/19	7.0	64.2		<0.5	Clear	Colourless	nd
2019/11/07		23.4			Clear	Colourless	Calm
Comments	Lake level high, feature flooded.						
2020/02/26	6.0	63.0		<0.5	Clear	Colourless	nd
2020/08/05	6.8	62.0		<0.5	Clear	Colourless	No ebullition
2021/03/26	7.0	67.0	0	<1	Clear	Colourless	None, only small ripples on the surface

Rocky Point Spring: Temperature and pH for 2005/1/1 - 2021/5/1

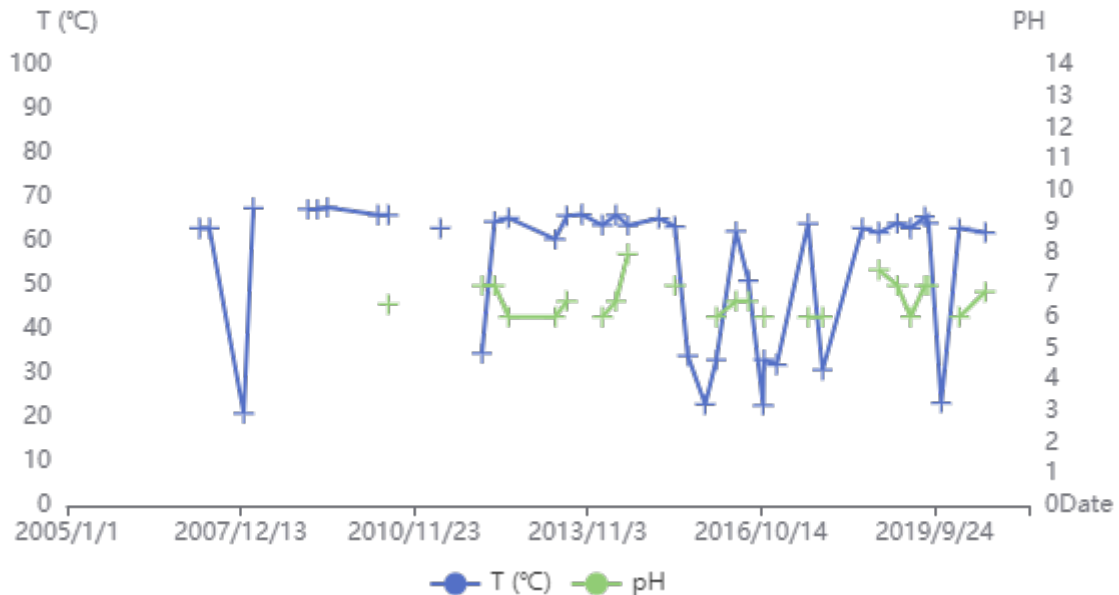




Fig.1 - taken on 2018-10-15 17:23:23"



Fig.2 - taken on 2019-04-29 14:26:53"



Fig.3 - taken on 2019-04-29 14:28:06"



Fig.4 - taken on 2019-07-26 08:17:41"



Fig.5 - taken on 2019-07-26 08:18:07"



Fig.6 - taken on 2019-11-07 17:58:20"



Fig.7 - taken on 2020-02-26 08:27:53"



Fig.8 - taken on 2021-03-26 07:29:04"

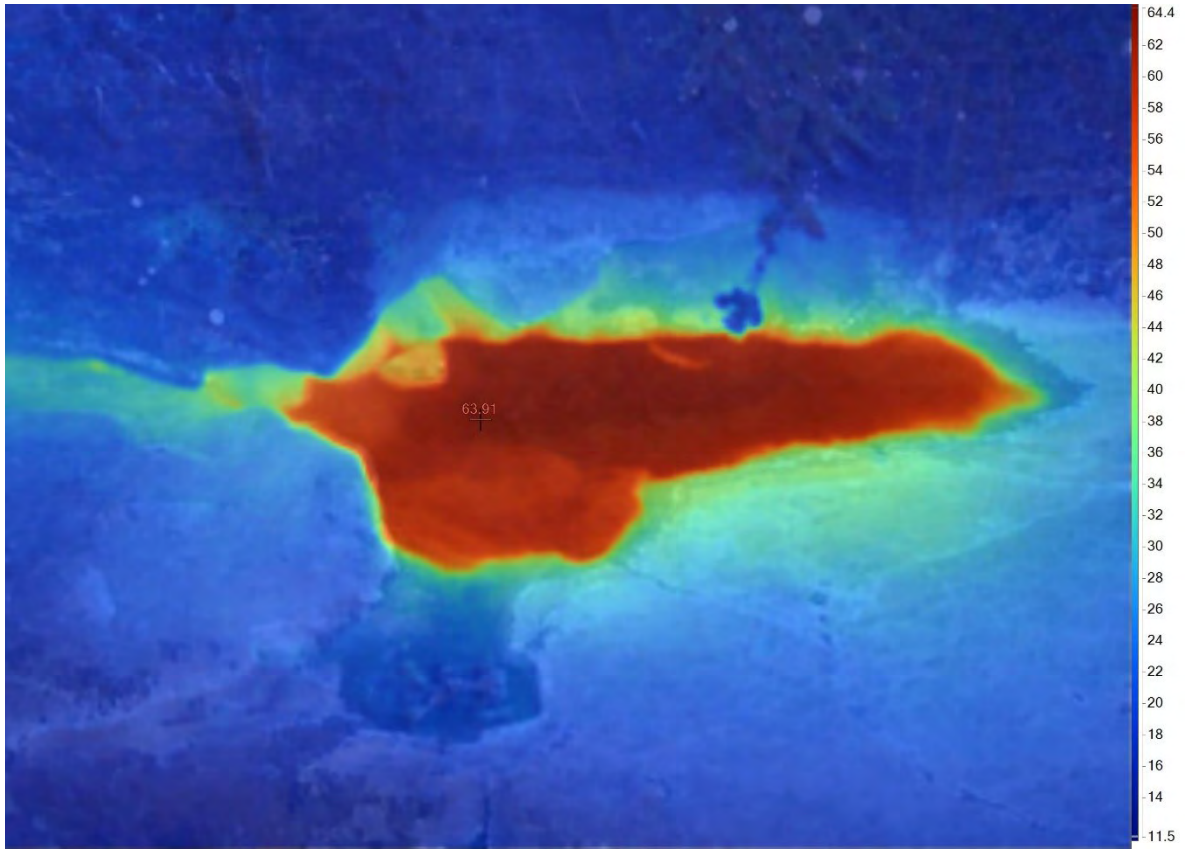


Fig. 9 Infrared image of Rocky Point Spring. Taken on 2021-03-26.

9 TE KOPIA

9.1 3069_1: Large pool and mud volcano

- Surface temperature of the mud at the main pool area decreased between 2011 and 2018, before increasing from 2018 to 2020.

Location: -38.401345, 176.215514

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07		37.0		None	Milky	Blue - Light	Bubbles at far end
Comments Water level: Close to top of pool							
2020/02/25		45.0			Muddy	Grey - Light	Bubbling all over pool.
2021/03/26			4.0		Muddy	Brown – Light	Constant at multiple points at the pool

Large pool and mud volcano: Temperature and pH for 2005/1/1 - 2021/5/1

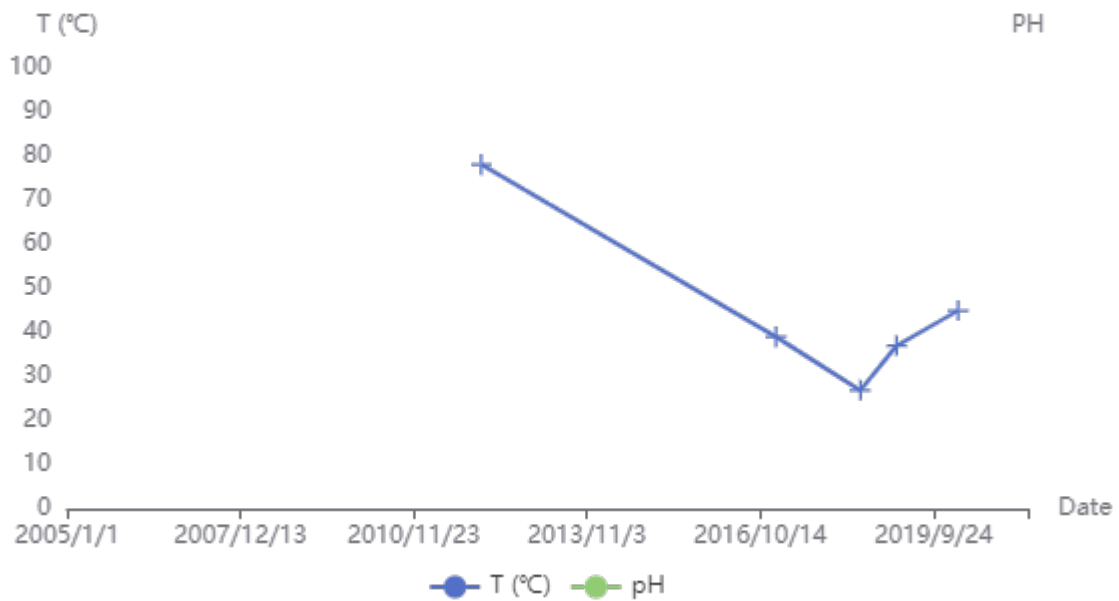


Fig.1 - taken on 2020-02-25 15:49:03"



Fig.2 - taken on 2021-03-26 14:35:11"

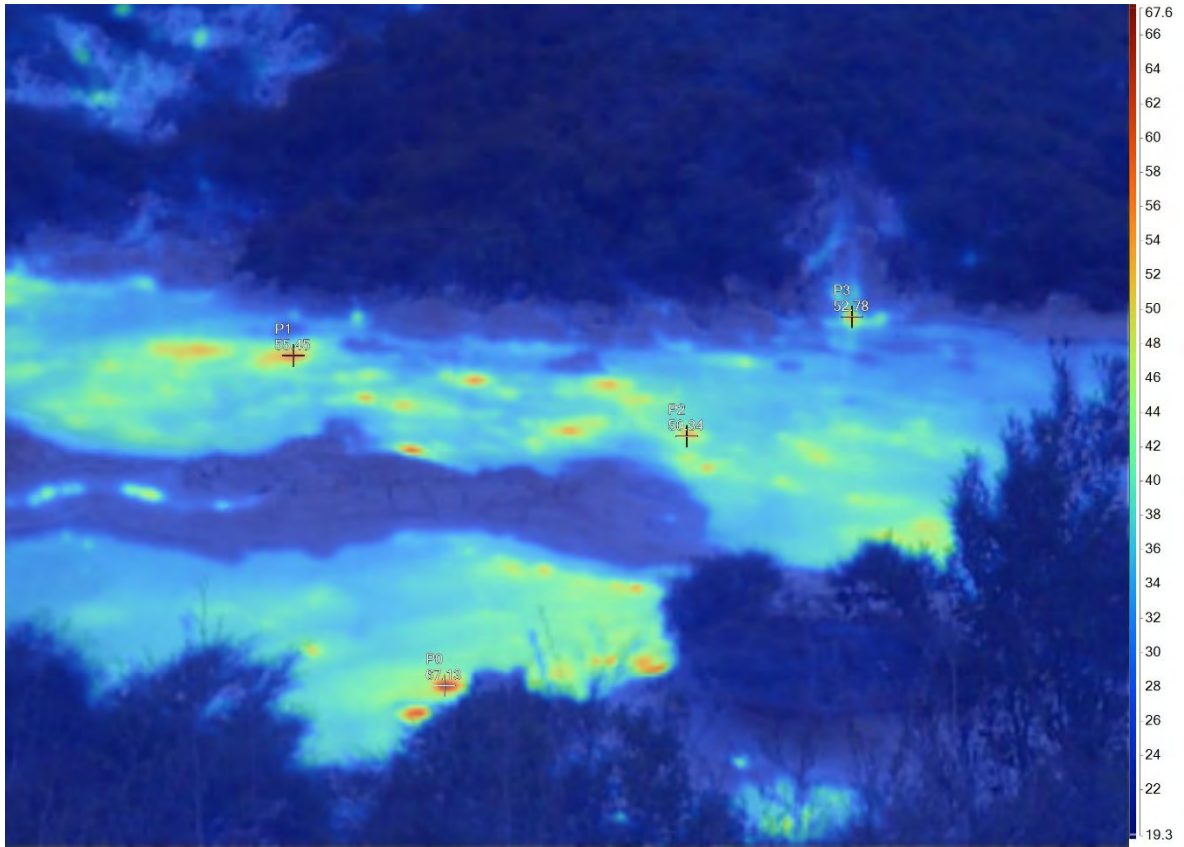


Fig. 3 Infrared image of Te Kopia mud pools. Taken on 2021-03-26.

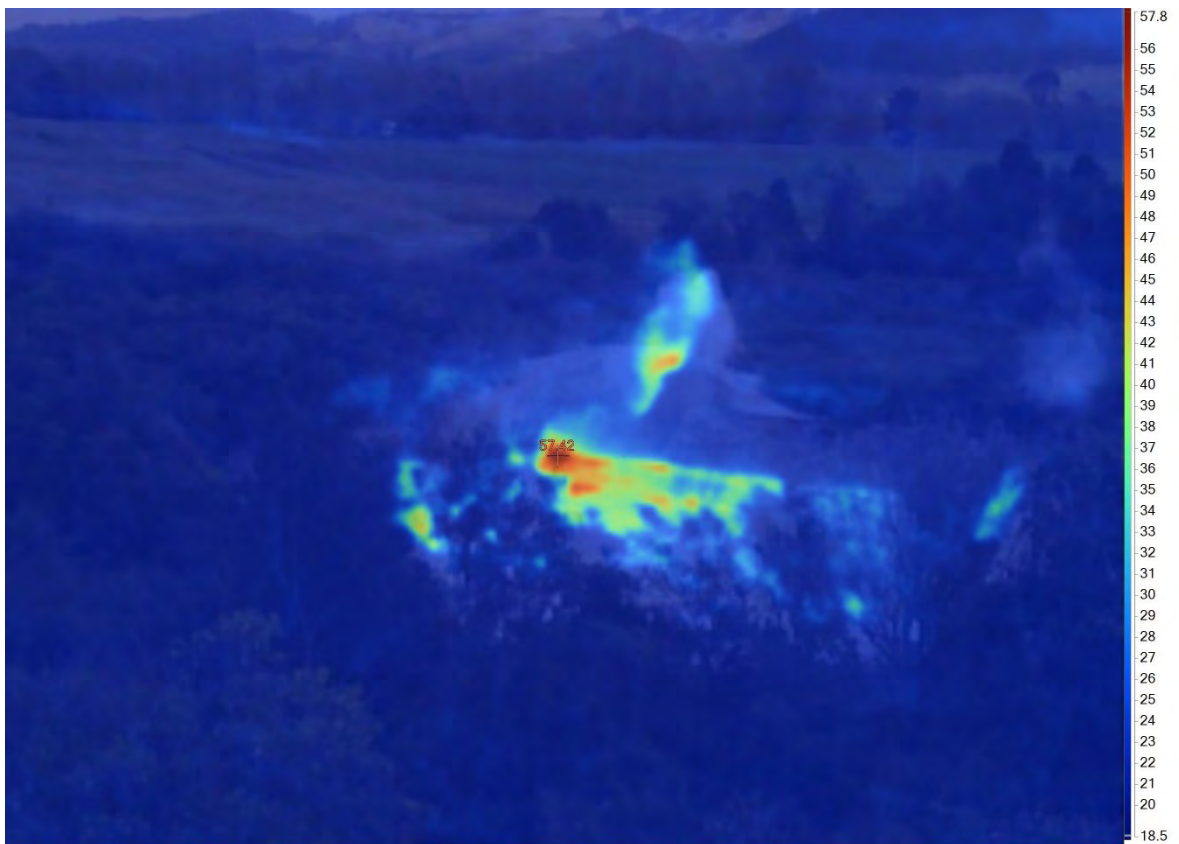


Fig. 4 Infrared image of Te Kopia mud volcano. Taken on 2021-03-26.

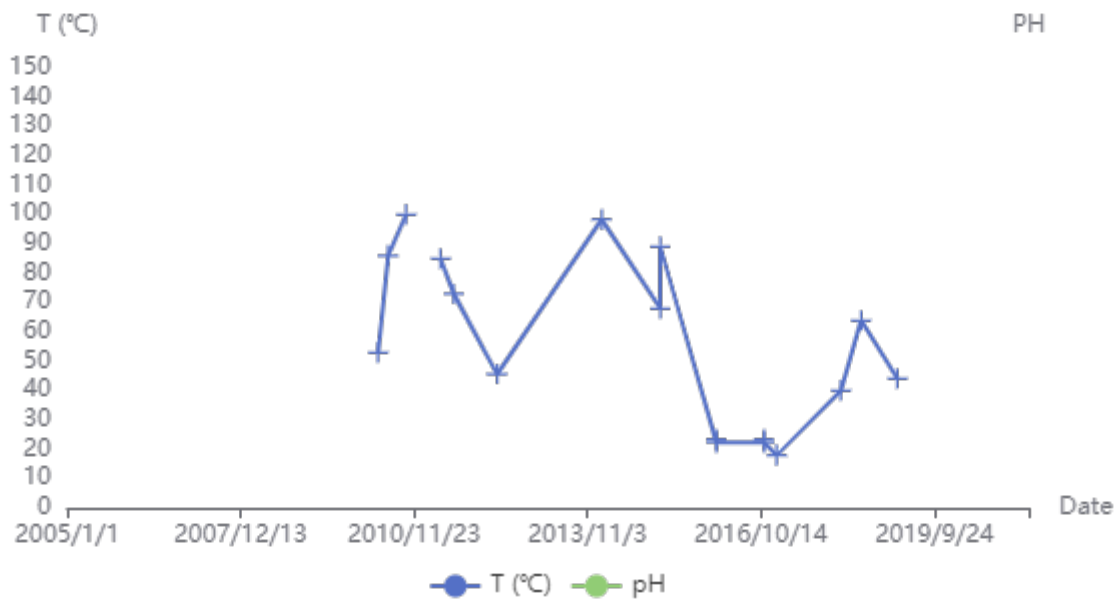
9.2 3069_4: Mud pools west of Te Kopia Rd

- The mud temperature at this site significantly fluctuates between <20 and 100 °C, with evidence of mud eruptions observable at times such as in 2019.

Location: -38.397907, 176.216724

Date	pHTemp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2018/02/22	40.0	8.0	None	Muddy	Light brown mud	Bubbling mud, hissing steam
Comments	<i>Water level:</i> Below downhill side of vent					
2018/06/26	63.9	1.5	None	Muddy	Brown - Light	Constant discharge
Comments	<i>Water level:</i> Below downhill side of vent					
2019/02/07	44.1	6.0	None	Murky	Brown - Light	Vigorous gas discharge on right, calm in main vent
Comments	Recent eruption evident on trees. Hole appears larger. Doom vent appears to have blown out and is very steamy. <i>Water level:</i> Below downhill side of vent					

Mud pools west of Te Kopia Rd: Temperature and pH for 2005/1/1 - 2021/5/1



9.3 3069_43: TKF100

- This site is not regularly monitored and is an area of multiple geothermal cascades. Images of the sampling trip on 26 March 2021 are presented on Fig.1 – Fig.3.
- There is a difference between the temperature and pH measurements taken in 2005 and 2021. However, as measurements were not collected at the water provenance, natural changes to temperature and pH may occur as the water was moving downstream.

Location: -38.392088, 176.214394

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2005/09/30	7.5	60.3					
2021/03/26	5.0	47.3	n/a	>10.0	Clear	Cyan	N/a
Comments	Measurements were taken at the bottom of one of the cascades, not at the water source.						



Fig.1 - taken on 2021-03-26 15:39:30"



Fig.2 - taken on 2021-03-26 15:42:20"



Fig.3 - taken on 2021-03-26 15:42:25"

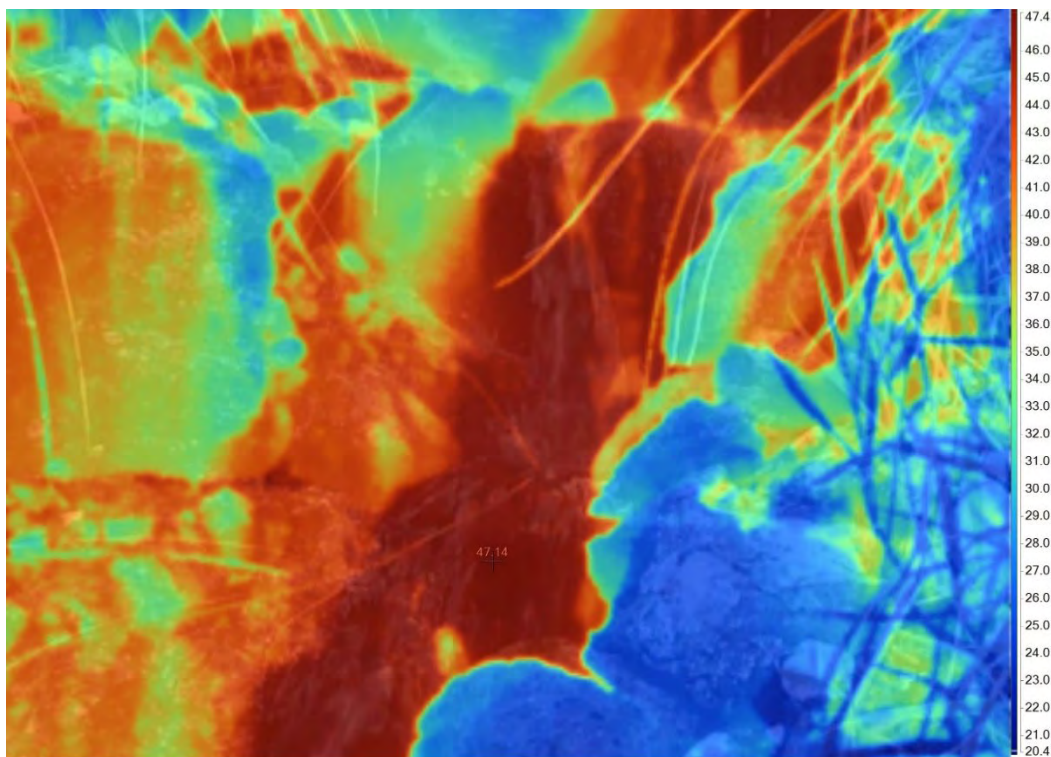


Fig. 4 Infrared image of the TKF100 falls. Taken on 2021-03-26.

9.4 3069_45: Murphy's twin tomos, eastern vent (Doom)

- The temperature at this mud pool has significantly fluctuated since 2010, however measurements were collected using near infrared thermometry at a distance of >10 m, so the margin of error for temperature measurements may be significant.

Location: -38.397897, 176.216758

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2017/01/19		20.2		None			Calm, no steam
Comments <i>Water level: dry</i>							
2020/02/25		83.0	3.5		Muddy	Grey - Light	Constant vigorous discharge in main pool hissing on side vent
Comments Mud is runny. Sulphur depositions on side of vent. TK8 blown out, hissing. Orange moss on trees above pool. Some branches have fallen into pool.							
2021/03/26		82.0	1	N/a	Muddy	Brown	Constant ebullition, with large bubbles ~20 – 30 cm in diameter

Murphy's twin tomos, eastern vent (Doom): Temperature and pH for 2005/1/1 - 2021/5/1

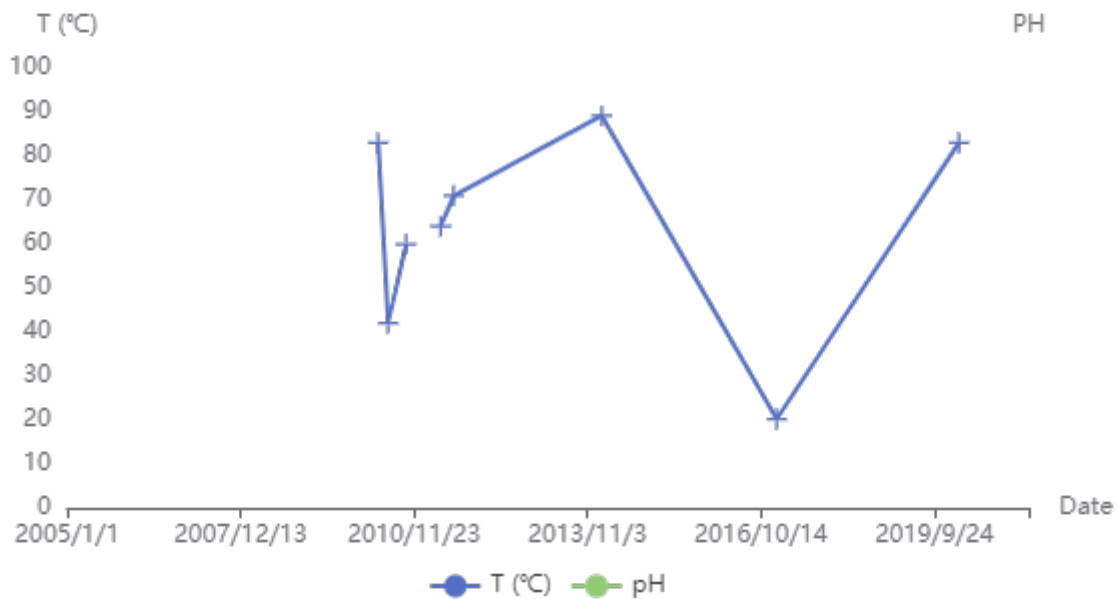




Fig.1 - taken on 2020-02-25



Fig.2 - taken on 2021-03-26

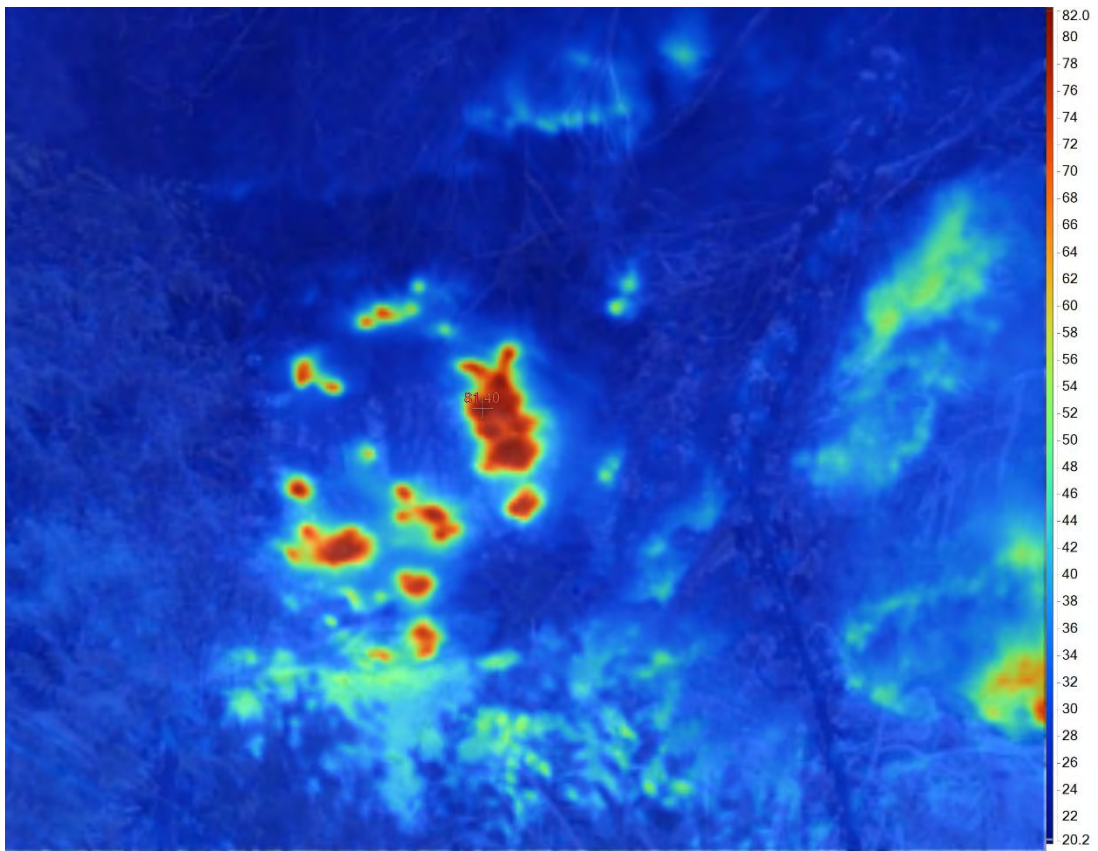


Fig. 3 Infrared image of Doom vent. Taken on 2021-03-26.

10 WAIKITE

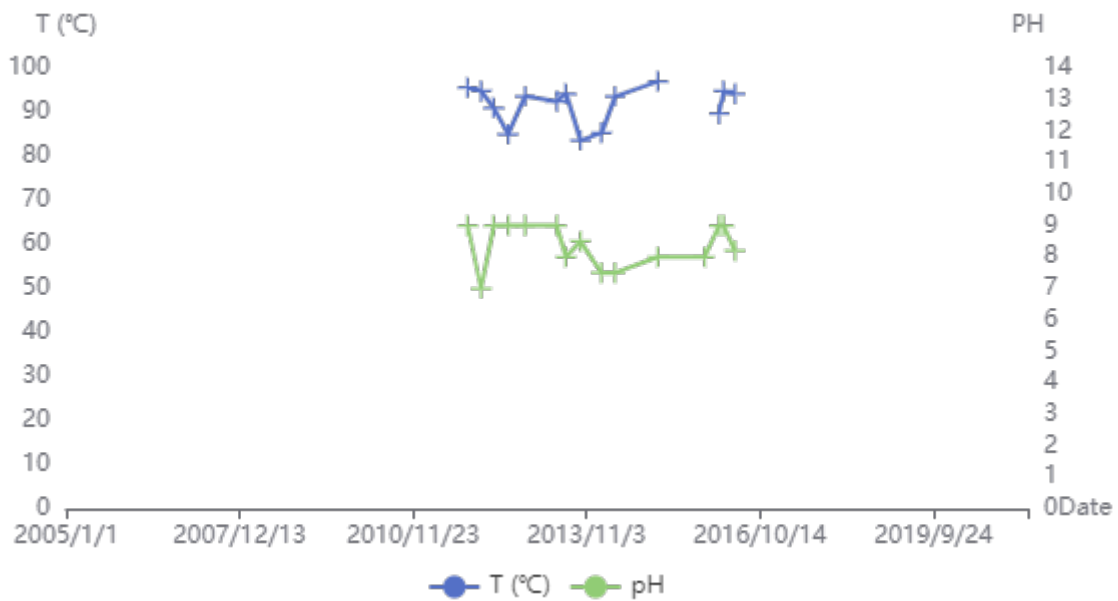
10.1 3073_106: Top Inlet Spring

- The water temperature of this feature has constantly remained between 80 and 100 °C between 2010 to 2016.
- pH conditions have ranged between pH 7 to 9.

Location: -38.326999, 176.303727

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2016/02/03	9.0	89.7		None	Clear	Clear	Vigorous
Comments	<i>Water level: Overflowing</i>						
2016/03/02	9.0	94.8		None	Clear	Clear	Vigorous
Comments	<i>Water level: Overflowing</i>						
2016/05/10	8.2	94.2		None	Clear	Clear	Vigorous discharge
Comments	<i>Water level: Overflowing</i>						

Top Inlet Spring: Temperature and pH for 2005/1/1 - 2021/5/1



10.2 3073_107: Hot Pools Supply Spring

- The overall temperature trend since 2005 is minor but visible temperature decrease over time and stays above 90 °C.
- pH conditions often fluctuate but remain within near-neutral conditions.
- Fresh geysers form around the pool within the splash zone (Fig.8).

Location: -38.327257, 176.304471

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.0	90.0		None	Clear	Colourless	Vigorous ebullition
Comments	<i>Water level: Overflowing</i>						
2019/04/29	7.0	93.4		None	Clear	Colourless	Vigorous
Comments	<i>Water level: Overflowing Ebullition: Vigorous on right, smaller spring in left</i>						
2019/07/25	7.0	89.0		None	Clear	Colourless	Vigorous ebullition
Comments	Centre vent vigorous discharge, constant smaller discharge from vent on left						
2019/08/19	7.0	92.8		None	Clear	Colourless	Vigorous ebullition
Comments	Centre vent vigorous discharge, constant smaller discharge from vent on left						
2019/12/05	7.0	90.5			Clear	Colourless	Vigorous discharge splashing up to 2.5m away
2020/02/10	6.0	93.8			Clear	Colourless	Vigorous ebullition spraying over path
2020/08/05	7.0	92.0		<1.0	Clear	Colourless	Vigorous
Comments	<i>Ebullition: Constant boiling</i>						
2020/11/13	8.1	93.3			Clear	Grey - Dark	High
Comments	Geyserite deposition surrounding spring. Red minerals on right side, similar to As rich minerals observed in other sites. Algae in splash zone, ~40 C area. <i>Ebullition: Splashes 1 m outside of spring</i>						
2021/03/26	7.0	94.4	0		Clear	Colourless	Erupting, with water column reaching up to 0.3 m high
Comments	Red algal communities growing in the splash zone within 2 m of pool margins. Now water from an upper spring is channelled into this feature (from 3073_106).						

Hot Pools Supply Spring: Temperature and pH for 2005/1/1 - 2021/5/1

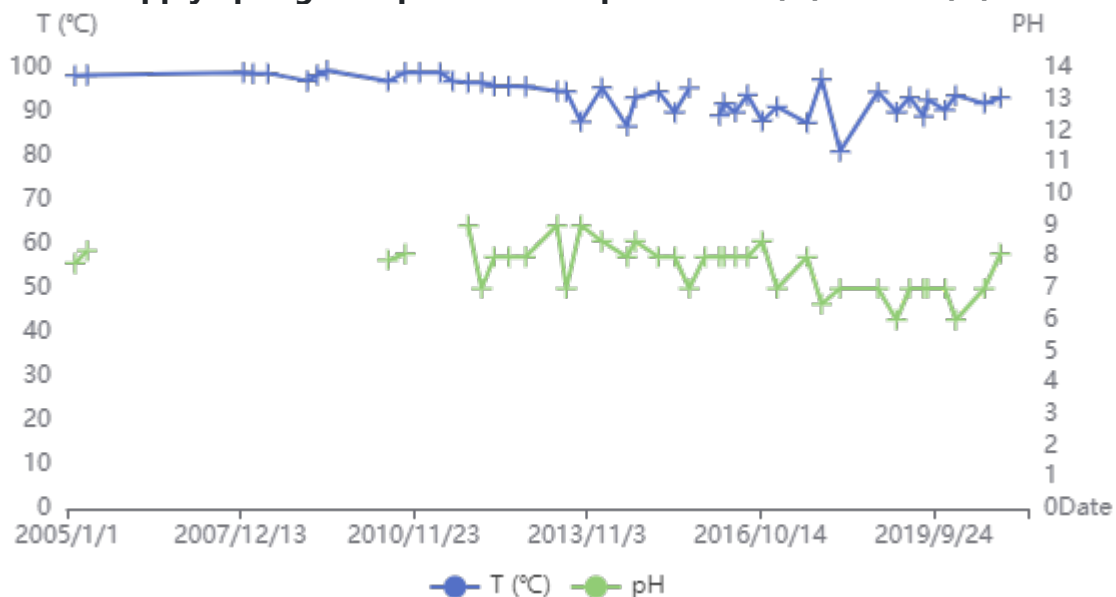




Fig.1 - taken on 2019-04-29 12:07:39"



Fig.2 - taken on 2019-07-25 16:03:08"



Fig.3 - taken on 2019-12-05 16:35:17"



Fig.4 - taken on 2020-02-10 15:56:15"



Fig.5 - taken on 2020-08-05 10:49:54"



Fig.6 - taken on 2020-11-13 11:26:26"



Fig.7 - taken on 2021-03-26 16:28:08"



Fig.8 - taken on 2021-03-26 16:28:26"

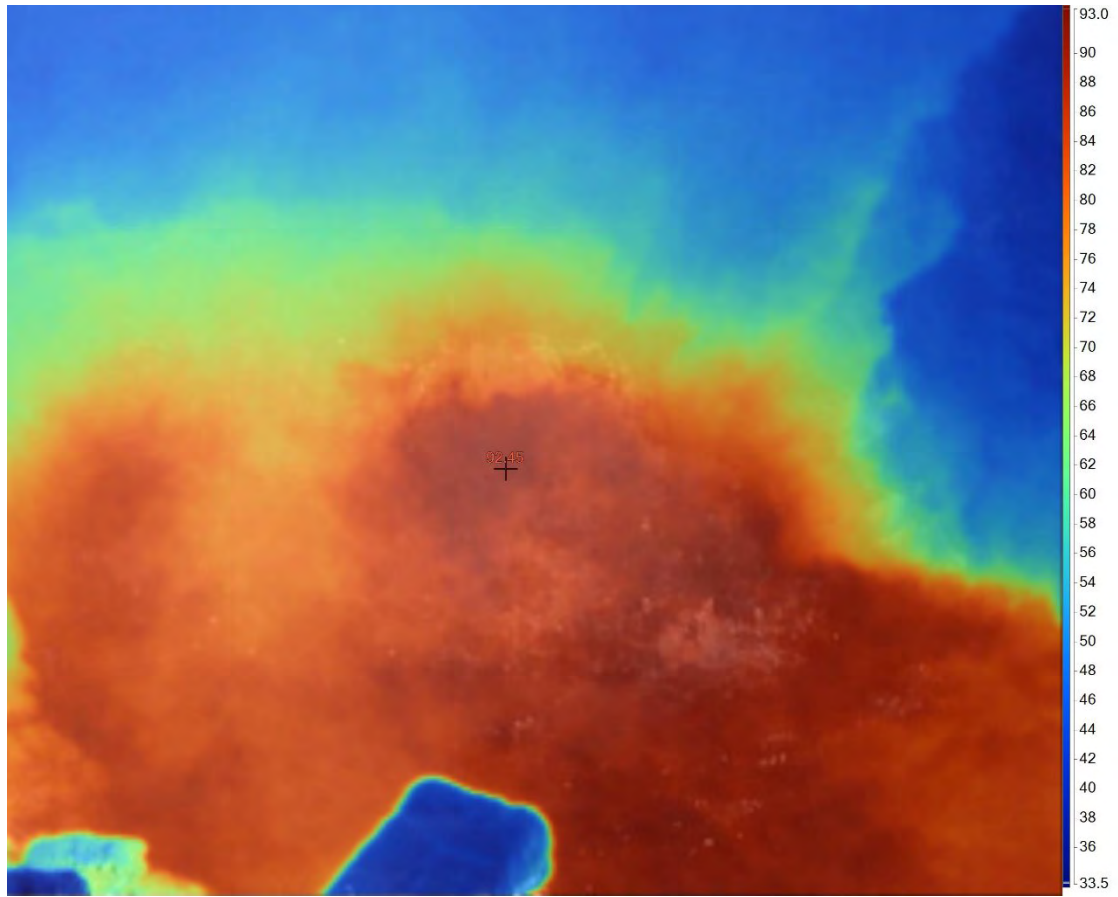


Fig. 9 Infrared image of Hot Pools Supply Spring Taken on 2021-03-25

10.3 3073_108: Pool adjacent to Supply Spring

- From 2010 to 2021, the water temperature of this feature has regularly varied between 60 and 90 °C. This is likely caused by relatively cooled waters from the outlet of Hot Pools Supply Spring (3073_107) entering into and cooling this feature.

Location: -38.32703, 176.303568

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.0	82.5	<0.5		Clear	Blue - Light	Constant upwelling
Comments	Area has been cleared Water level: Overflowing						
2019/04/29	7.0	81.8	None		Clear	Blue - Light	Constant upwelling
2019/07/25	7.0	75.0	<0.5		Clear	Colourless	Constant upwelling
2019/08/19	7.0	81.8	<0.5		Clear	Colourless	Constant upwelling
2019/12/05	7.0	81.1	<0.5		Clear	Blue - Light	Constant bubbling in centre 10 mm high
2020/02/10	7.0	83.3	<1.0		Clear	Blue - Light	Constant upwelling in centre
2020/08/05	6.0	72.0			Clear	Colourless	Constant bubbles
Comments	Ebullition: Towards the middle of pool						
2020/11/13	6.0	84.9	>3.0		Clear	Blue - Grey	Moderate
Comments	Clarity: No suspended materials Ebullition: Ebullition from deepest section non-effervescent						
2021/03/26	7.0	82.5	0	Nd	Clear	Colourless	Constant ebullition at multiple points
Comments	Not flowing out as water from Supply Spring (3073_107) is now entering into this feature.						

Pool adjacent to Supply Spring: Temperature and pH for 2005/1/1 - 2021/5/1

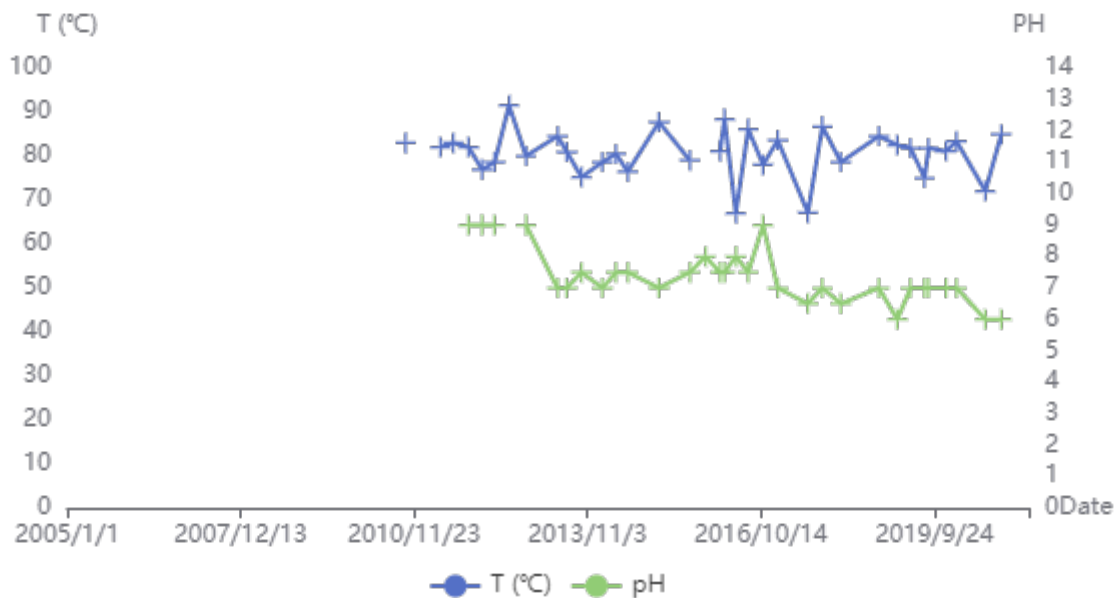




Fig.1 - taken on 2018-10-15 13:00:21"



Fig.2 - taken on 2019-04-29 12:11:16"



Fig.3 - taken on 2019-07-25 16:06:00"



Fig.4 - taken on 2019-07-25 16:07:33"



Fig.5 - taken on 2019-12-05 16:40:33"



Fig.6 - taken on 2020-02-10 15:58:38"



Fig.7 - taken on 2020-02-10 16:01:36"

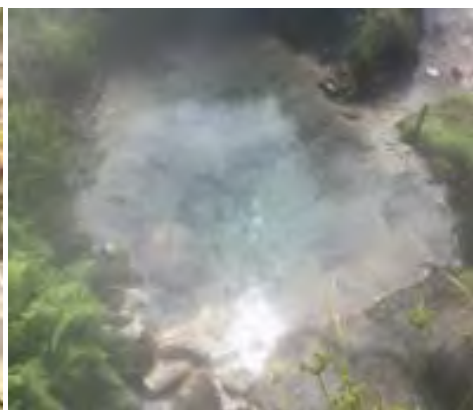


Fig.8 - taken on 2020-11-13 11:17:11"

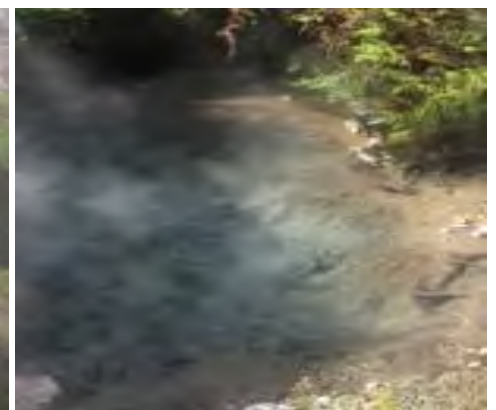


Fig.9 - taken on 2021-03-26 16:33:32"

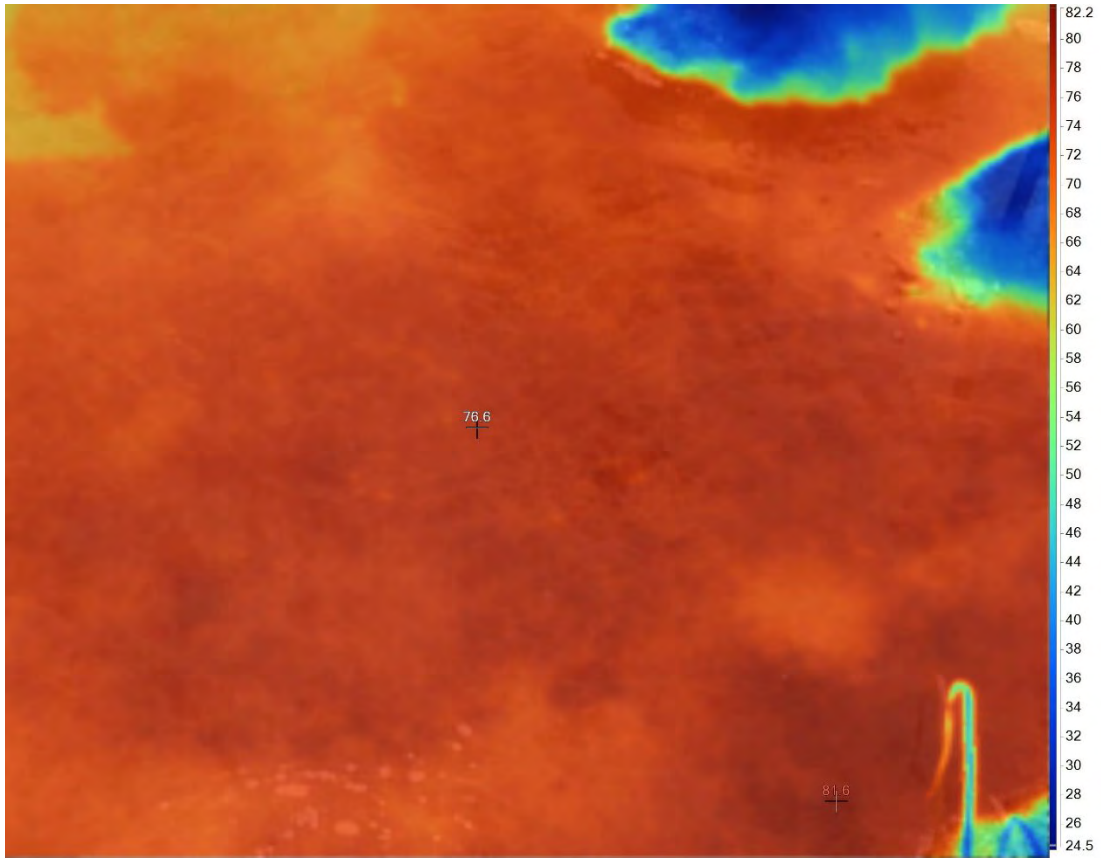


Fig.10 Infrared image of pool adjacent to Supply Spring. Taken on 2020-11-13.

10.4 3073_32: WAF5586 Te Manaroa Pool

- Besides short-term temperature decreases in 2013, 2016, and 2017, the general temperature trend at Te Manaroa Pool is consistent, remaining in near-boiling conditions.
- Average pH measurements have been decreasing since 2011, but measurements vary.

Location: -38.326956, 176.304926

Date	pH	Temp °C	LevelFlow (m) (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.0	96.5	<50.0	Clear	Blue - Dark	Constant, boiling
Comments	<i>Water level: Overflowing</i>					
2019/04/29	7.0	88.0	<50.0	Clear	Blue - Dark	Constant vigorous upwelling up to 0.5 m
Comments	<i>Water level: Overflowing</i>					
2019/07/25	7.0	96.8	<60.0	Clear	Blue - Dark	Vigorous upwelling 0.5m high
Comments	Lots of steam by roadside. Manaroa very steamy.					
2019/08/19	7.0	92.0	<60.0	Clear	Blue - Dark	Vigorous upwelling 0.5m high
Comments	Lots of steam by roadside. Manaroa very steamy.					
2020/02/10	6.0	98.0	<50.0	Clear	Blue - Dark	Vigorous boiling in centre 0.5m high
2020/08/05	7.8	98.1	>5.0	Clear	Blue - Dark	Vigorous bubbling
Comments	Very steamy, couldn't see much <i>Ebullition: In middle of pool</i>					
2020/11/13	6.0	98.0	0	Clear	Grey	Very high ebullience, also effervescent
Comments	<i>Eruption Description: Constant eruption up to ~0.6 m high</i> Always boiling and erupting Nodular travertine is brown, interpreted to not be fresh					
2021/03/26	7.0	93.2	0	Clear	Colourless	Constant eruptive ebullition
Comments	Bigger radius of rupturing centre than usual					

WAF5586 Te Manaroa Pool: Temperature and pH for 2005/1/1 - 2021/5/1

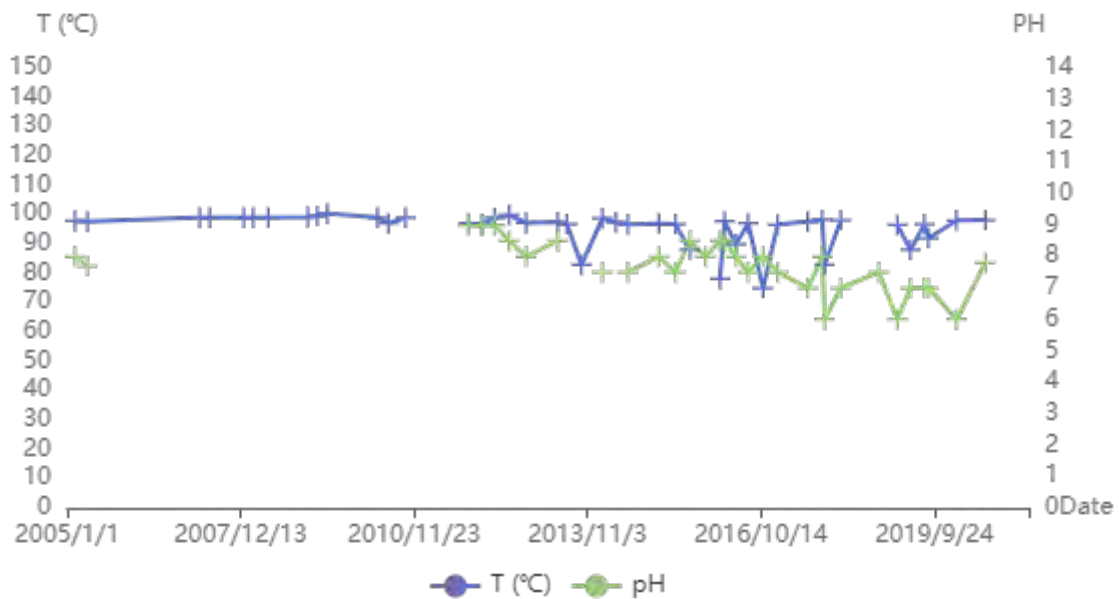




Fig.1 - taken on 2019-04-29 12:23:12"



Fig.2 - taken on 2019-07-25 16:21:43"



Fig.3 - taken on 2020-02-10 16:11:27"



Fig.4 - taken on 2020-08-05 11:02:48"



Fig.5 - taken on 2020-11-13 11:41:34"



Fig.6 - taken on 2020-11-13 11:42:00"



Fig.7 - taken on 2020-11-13 11:42:06"



Fig.8 - taken on 2020-11-13 11:45:51"



Fig.9 - taken on 2021-03-26 16:56:49"

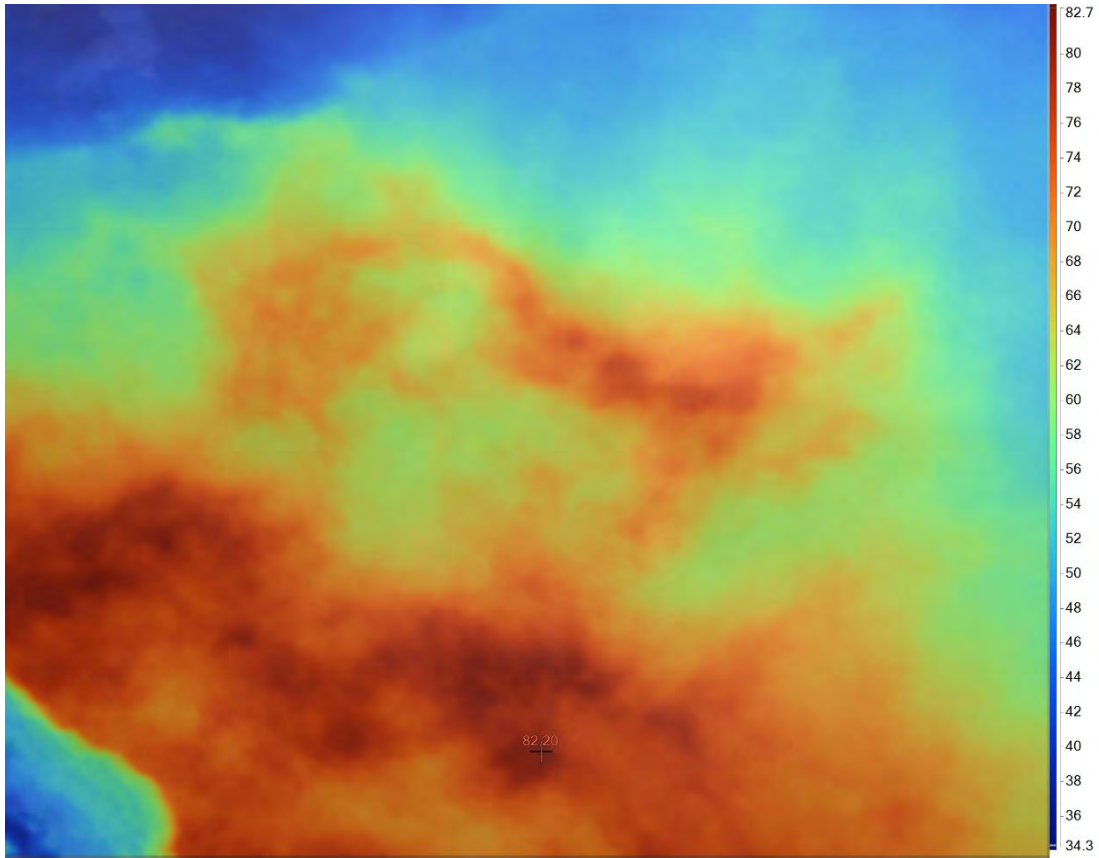


Fig.10 Infrared image of Te Manaroa Pool. Taken on 2021-03-26.

10.5 3073_109: Scalding Spring

- The water temperature at Scalding Springs regularly varies between 70 and 100 °C. A major temperature decrease occurred in October 2016, with the temperature falling to <30 °C, however this change was ephemeral.
- pH measurements range between pH 6 to 9.

Location: -38.316698, 176.314705

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	6.5	97.4		<0.5	Cloudy	Blue - Light	Constant, boiling
Comments	Has been used to cook meat. Oily, fatty substance on surface. Bits of plastic floating on surface. Smells like meat. Clarity is cloudy <i>Water level: Overflowing</i>						
2019/04/29	8.0	74.0		<0.5	Murky	Blue - Light	Constant bubbling at outlet
Comments	<i>Water level: Overflowing</i> <i>Clarity: Still a bit murky</i>						
2019/07/25	7.0	94.6		<0.5	Clear	Blue	Constant bubbling at outlet
2019/08/19	7.0	83.0		<0.5	Clear	Blue	Constant bubbling at outlet
2019/12/05	7.0	92.2		<0.5	Clear	Blue	Constant bubbles at outlet 30mm high
2020/02/10	7.0	87.2		<0.5	Clear	Blue	Constant bubbling at outlet
2020/08/05	7.0	94.4		<1.0	Clear	Blue	Constant bubbling
Comments	<i>Ebullition: Towards outlet/inlet</i>						
2020/11/13	7.6	95.4	0.05		Clear	Blue - Grey	Moderate
Comments	<i>Water level: Measurement below spring level up to 0.1 m</i> <i>Clarity: No suspended materials</i> <i>Ebullition: Intermittent pulses of high ebullition</i> <i>Area of feature: Estimated by sight</i>						
2021/04/30	7.0	94.3	0	>5.0	Clear	Colourless	Constant ebullition
Comments	Constant ebullition near outlet, which is the hottest part of the pool.						

Scalding Spring: Temperature and pH for 2005/1/1 - 2021/5/1

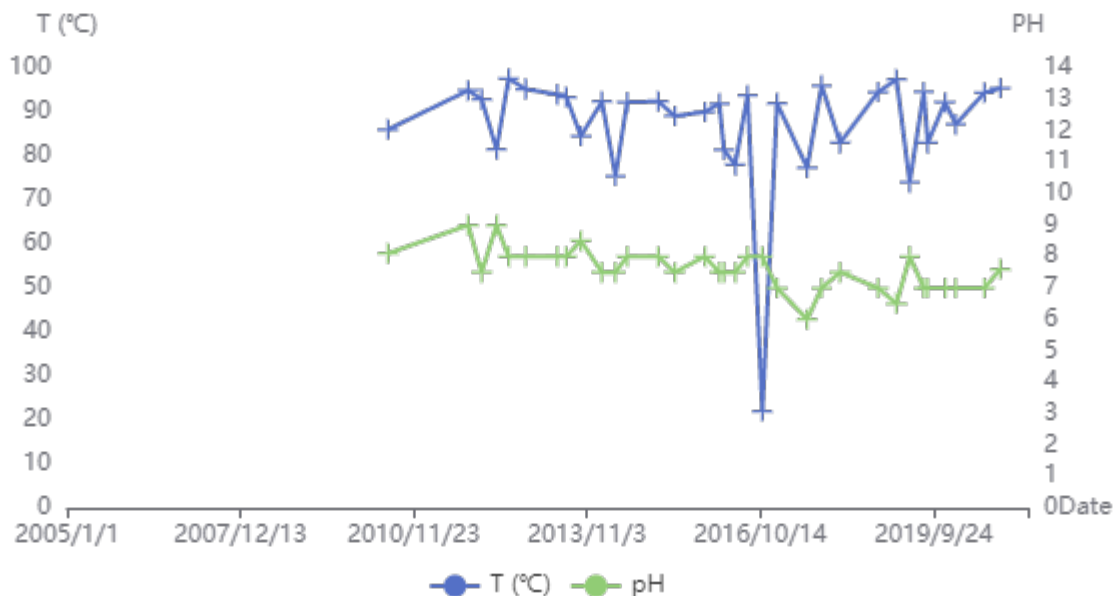




Fig.1 - taken on 2018-10-15 12:04:33"



Fig.2 - taken on 2019-04-29 11:37:40"



Fig.3 - taken on 2019-07-25 15:19:52"



Fig.4 - taken on 2019-12-05 16:04:15"



Fig.5 - taken on 2020-02-10 15:15:14"



Fig.6 - taken on 2020-08-05 10:13:24"



Fig.7 - taken on 2021-04-30 16:31:39"

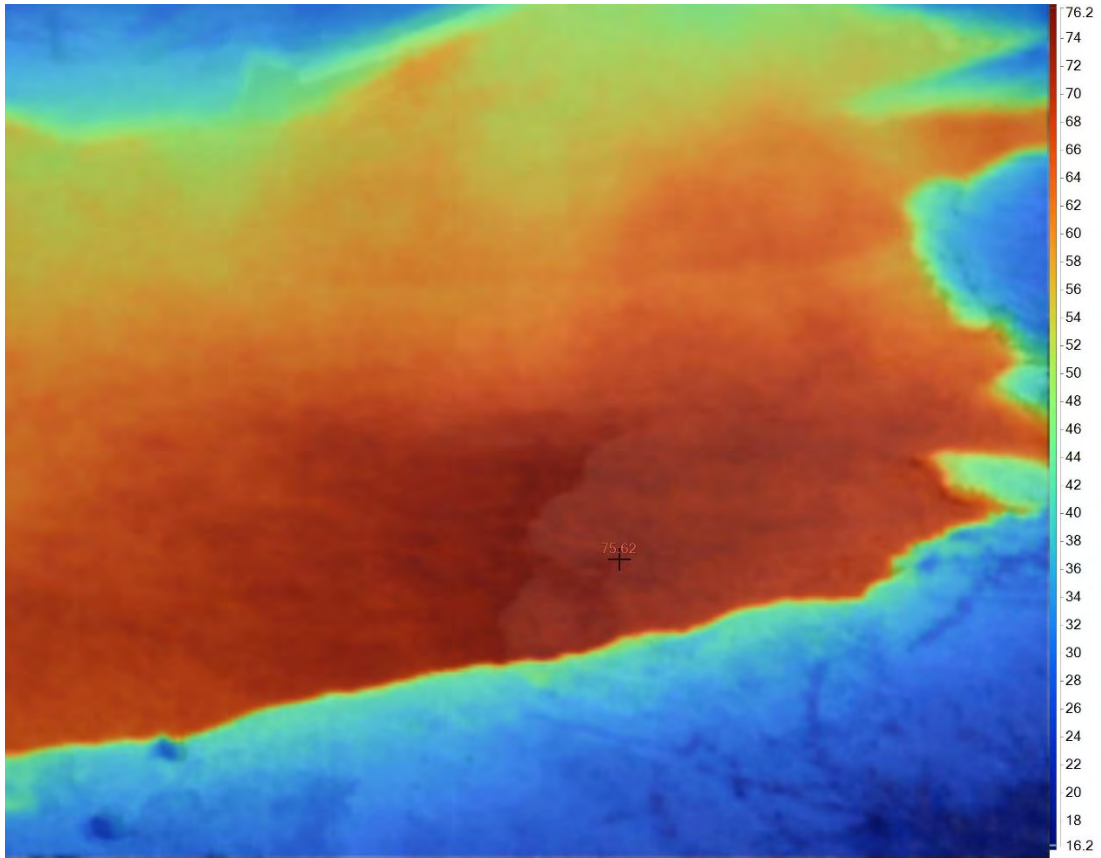


Fig.8 Infrared image of Scalding Spring. Taken on 2021-04-30.

10.6 3073_110: Waikite Scarp and Spring

- Significant short-term temperature increases occurred in 2013 and 2014, reaching near-boiling temperatures.
- pH measurements for this site range between pH 7 to 9.
- There is prominent sinter precipitation and silicification of organic debris at this feature (Fig.7).

Location: -38.32045, 176.312635

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/07	7.0	74.4		<0.5	Clear	Colourless	nd
Comments	Couldn't access spring due to blackberry <i>Water level: Overflowing</i>						
2019/04/29	9.0	67.0		<0.5	Clear	Colourless	nd
Comments	<i>Water level: Overflowing</i>						
2019/07/25	8.0			<0.5	Clear	Colourless	nd
2019/08/19	8.0	68.0		<0.5	Clear	Colourless	nd
2019/12/05	8.0	74.3		<0.5	Clear	Colourless	Nd
2020/02/10	8.0	75.5		<0.5	Clear	Colourless	nd
2020/08/05	9.3	65.7		<1.0	Clear	Colourless	No ebullition
2020/11/13	7.0	76.3		<1.0	Clear	Colourless	No ebullition
Comments	Full of silica deposition						
2021/04/30	8.0	79.1			Clear	Colourless	Nd
Comments	Microbial mats on stream margins and on vegetation. Animal remains observed in stream (frog, cricket and bird). Plants fall into stream and do not get directly calcified/silicified, but becomes opaque and lose organic matters.						

Waikite Scarp and Spring: Temperature and pH for 2005/1/1 - 2021/5/1

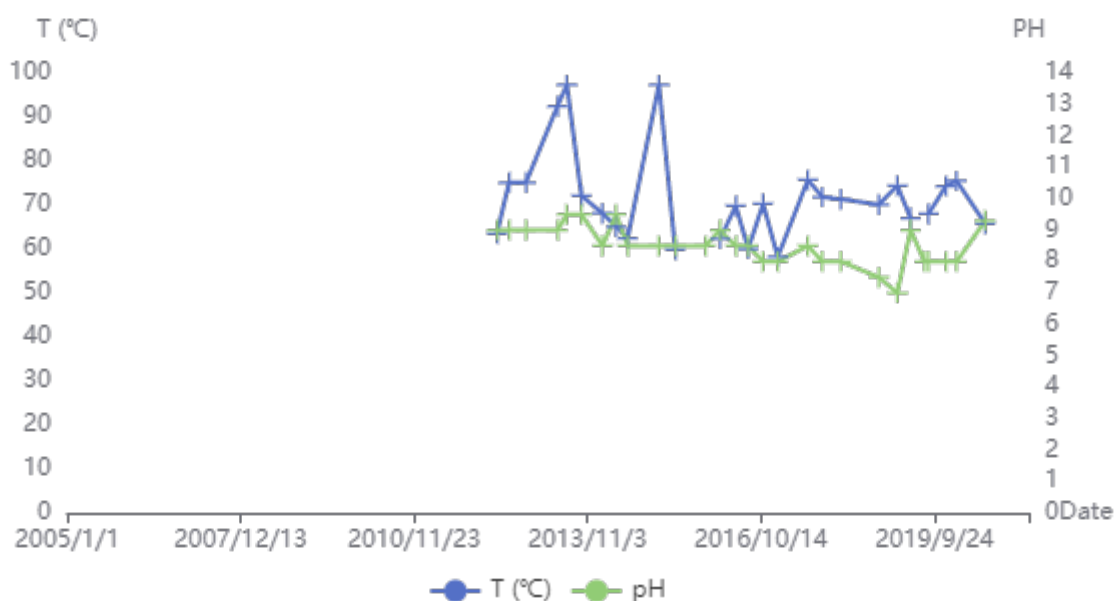




Fig.1 - taken on 2019-04-29 11:10:29"



Fig.2 - taken on 2019-04-29 11:16:46"



Fig.3 - taken on 2019-04-29 11:19:29"



Fig.4 - taken on 2019-07-25 14:54:31"



Fig.5 - taken on 2019-07-25 15:02:55"



Fig.6 - taken on 2019-12-05 15:28:51"



Fig.7 - taken on 2020-08-05 09:41:21"

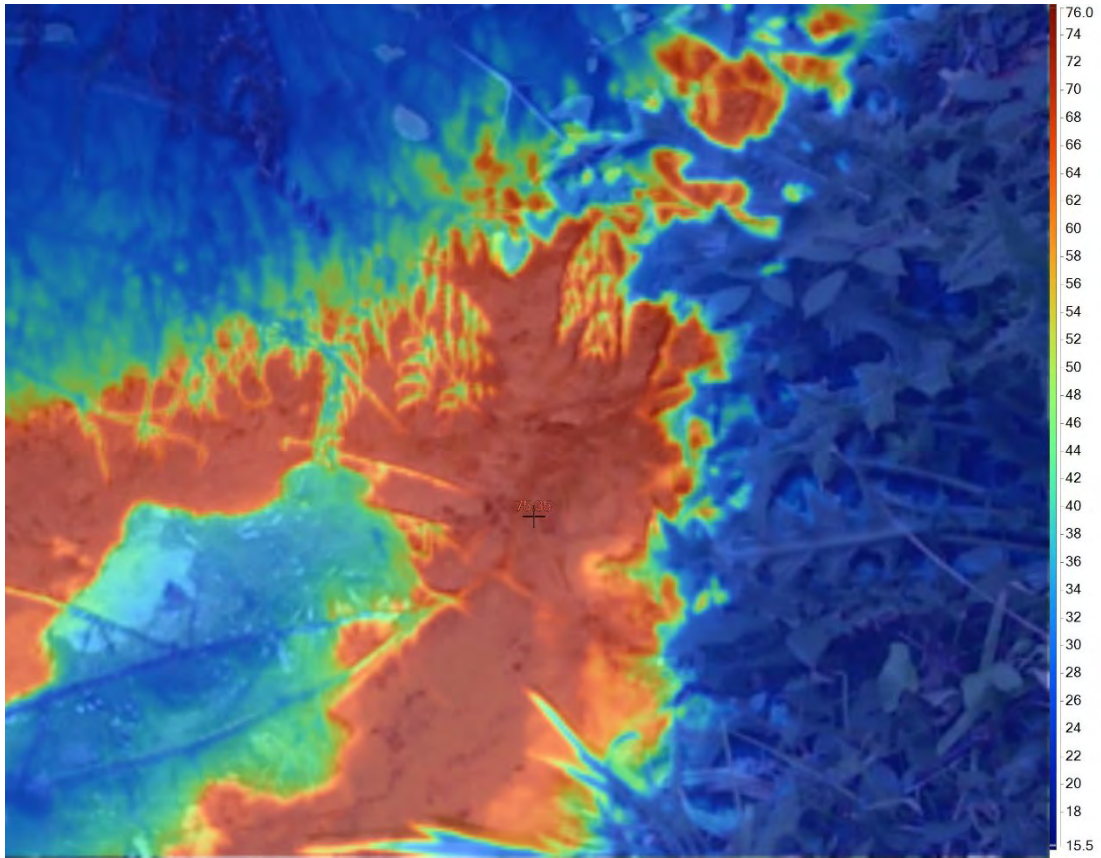


Fig.8 Infrared image of Waikite Scarp feature. Taken on 2020-08-05.

11 WAIOTAPU

11.1 3074_124: Kerosene Creek

- The water temperature at Kerosene Creek fluctuates seasonally, with slightly lower temperatures observed during winter, which reflect mixing with meteoric waters in periods of higher precipitation.
- pH conditions are regularly at pH 3 – 4.

Location: -38.335113, 176.386481

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	4.0			<170.0	Murky	Brown	nd
Comments	<i>Water temperature: nd</i> <i>Water level: Overflowing</i>						
2019/04/30	4.0	32.7		<190.0	Murky	Brown	nd
Comments	Foamy scum on true right bank of stream <i>Water level: Overflowing</i>						
2019/07/25	4.0	33.1	0.4	<200.0	Murky	Brown	nd
Comments	Trees fallen across stream upstream and downstream. More flow on TR bank <i>Water level: Overflowing</i>						
2019/08/19	4.0	32.0	0.4	<200.0	Murky	Brown	nd
Comments	Trees fallen across stream upstream and downstream. More flow on TR bank <i>Water level: Overflowing</i>						
2019/12/05	4.0	37.2		<180.0	Murky	Brown	Nd
2020/02/10	4.0	39.0	0.52	<160.0	Murky	Brown - Light	nd
Comments	<i>Water level: Overflowing</i>						
2020/08/04	4.0	34.2		>10.0	Murky	Green - Dark	No bubbles
2020/12/03	4.0	37.4	0	>10.0	Turbid	Brown	N/a
Comments	Foam observed as clusters on water surface.						
2021/03/25	4.0	38.7	0	>10.0	Clear	Brown – Light	N/a

Kerosene Creek: Temperature and pH for 2005/1/1 - 2021/5/1

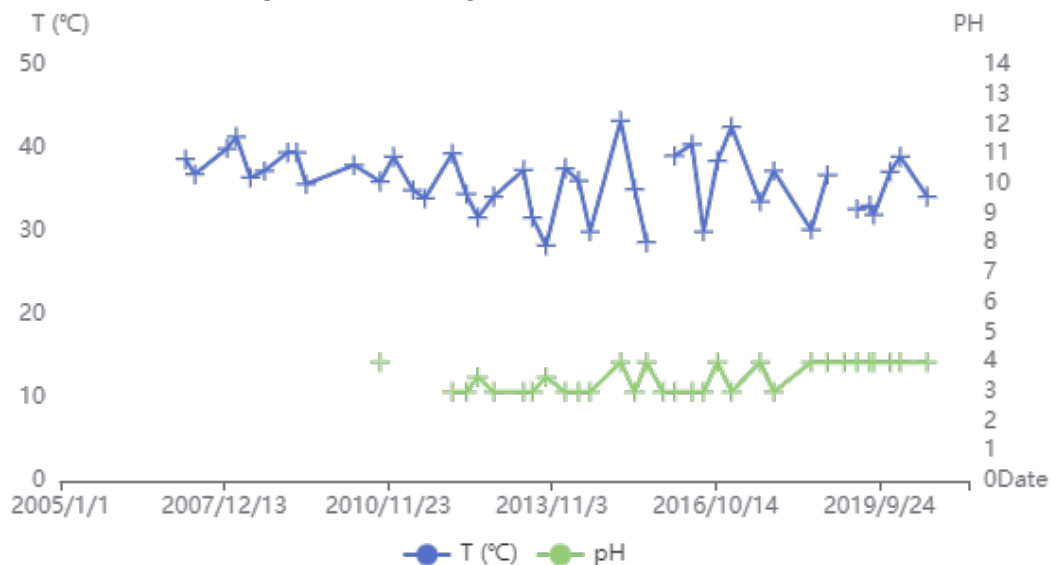




Fig.1 - taken on 2019-04-30 09:16:40"



Fig.2 - taken on 2019-07-25 14:06:51"



Fig.3 - taken on 2019-12-05 10:26:17"



Fig.4 - taken on 2020-02-10 09:39:59"

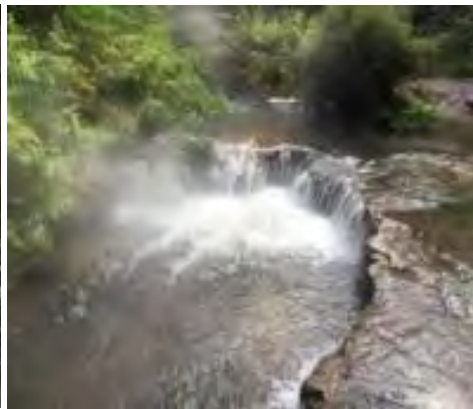


Fig.5 - taken on 2021-03-25 09:34:18"

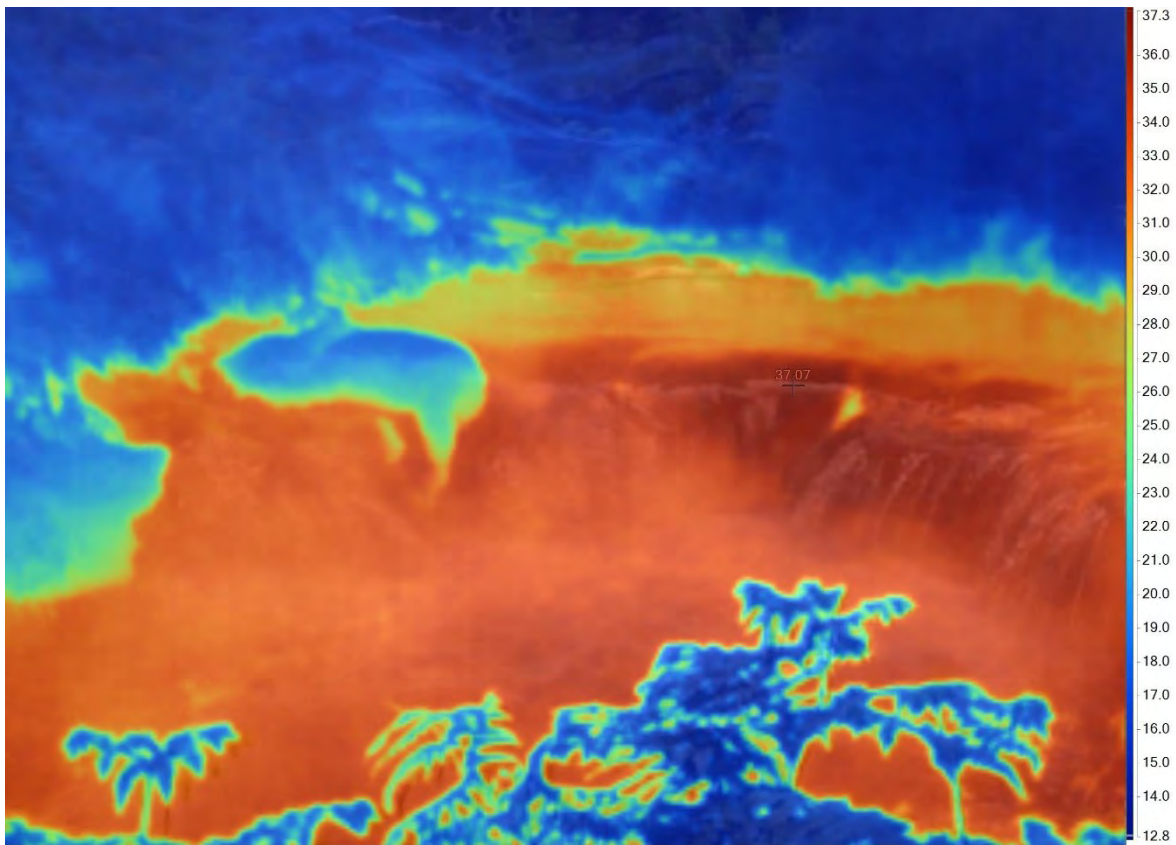


Fig. 1 Infrared image of Kerosene Creek sampling point. Taken on 2021-03-25.

11.2 3074_292: Kerosene Creek Large Pool

- This feature is often visited by bathers. In late 2020 and 2021, multiple branches have fallen into the pool.

Location: -38.335577, 176.386308

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08							
2019/04/30				None	---	---	---
2019/07/25				None	---	---	---
Comments	<i>Bathers: 4 observers</i>						
2019/08/19				None	---	---	---
Comments	<i>Bathers: 4 observers</i>						
2019/12/05							
2020/02/10							
2020/08/04							
2021/03/25	4.0	37.3	0		Clear	Brown – Light	N/a



Fig.1 - taken on 2019-04-30 09:21:23"



Fig.2 - taken on 2020-02-10 09:46:24"

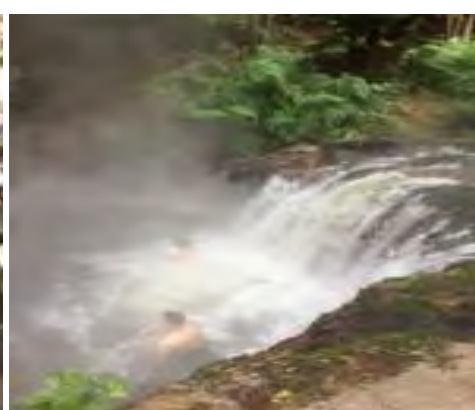


Fig.3 - taken on 2021-03-25 09:49:51"

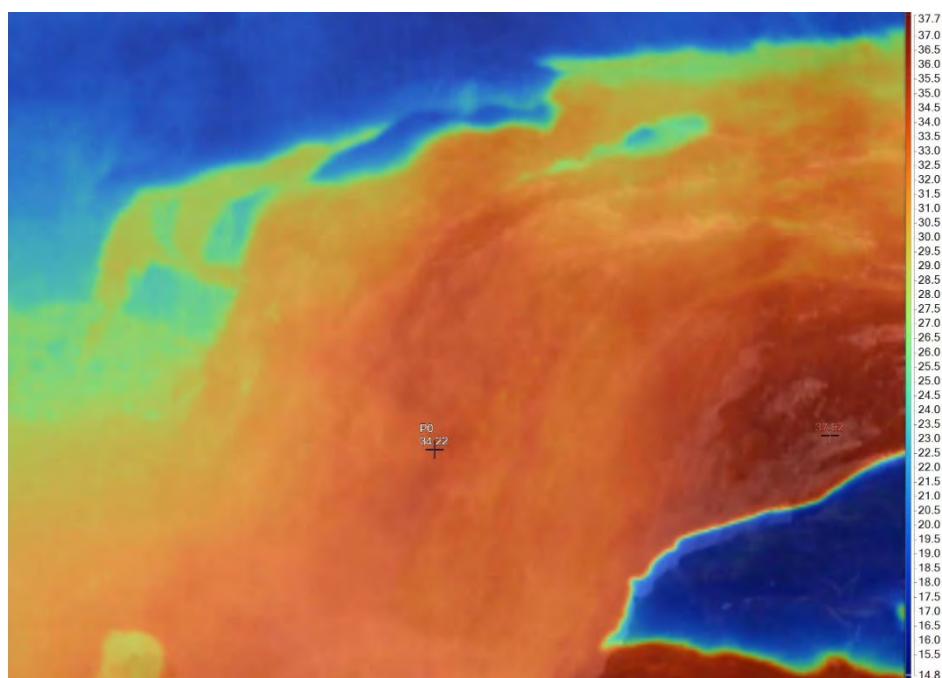


Fig. 4 Infrared image of Kerosene Creek Large Pool. Taken on 2021-03-25.

11.3 3074_174: WTF1049 The Hidden Pool

- Water temperature measurements at this pool consistently remain between 30 and 50 °C.
- pH conditions are typically between pH 2 and 3, indicating the water has travelled from its provenance. The only exception is a sample measuring pH 6 in 2012.

Location: -38.34984, 176.372193

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	3.0	39.3		<25.0	Murky	Grey - Dark	nd
Comments	<i>Water level: Overflowing</i>						
2019/04/30	3.0	37.0		<30.0	Murky	Brown	nd
Comments	<i>Water level: Overflowing</i>						
2019/07/25	3.0	37.0		<30.0	Murky	Brown - Dark	nd
2019/08/19	3.0	37.7		<30.0	Murky	Brown - Dark	nd
2019/12/05	3.0	40.4		<30.0	Murky	Brown	nd
2020/02/10	3.0	39.5		<40.0	Cloudy	Grey - Dark	nd

WTF1049 The Hidden Pool: Temperature and pH for 2005/1/1 - 2021/5/1

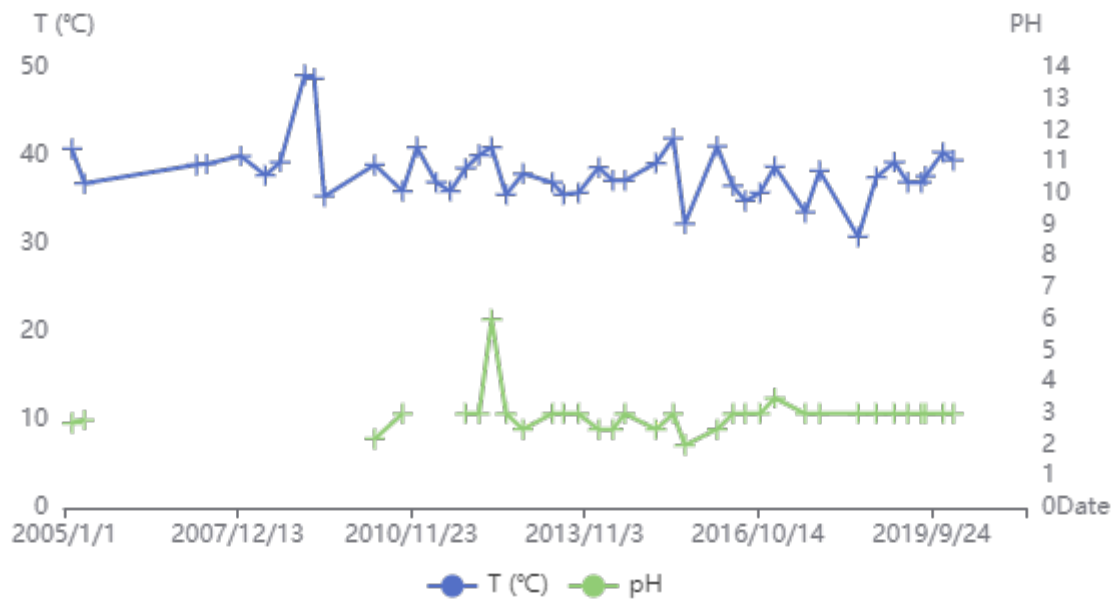




Fig.1 - taken on 2018-10-19 11:12:18"



Fig.2 - taken on 2019-04-30 11:13:21"



Fig.3 - taken on 2019-07-25 11:16:41"



Fig.4 - taken on 2019-12-05 11:54:41"



Fig.5 - taken on 2020-02-10 11:22:47"

11.4 3074_177: WTF1052 Lady Knox Geyser

- Freshly erupted waters from Lady Knox Geyser have near-boiling temperatures. Lower temperatures were measured when sampling was not undertaken on freshly erupted fluids.
- The sinter vent is much colder than the liquid and gas discharged by the geyser.

Location: -38.350748, 176.37696

Date	pHTemp °C	Level Flow (m) (l/s)	Clarity	Colour	Ebullition
2019/02/08	60.0		Clear	Colourless	Erupting
Comments	<i>Ebullition:</i> Erupted up to 10 meters. Still erupting when we left after 40 minutes				
2019/04/30	97.6	None	Clear	Colourless	Erupted
2019/07/25		None	---	---	Audible bubbling. No longer geysering.
2019/08/19	96.4	None	---	---	Audible bubbling. No longer geysering.
Comments	<i>Water temperature:</i> In the vent				
2019/12/05					Audible bubbling
2020/02/10					Erupted up to 4 m for 30 seconds.
2021/03/25					Only audible
Comments	Constant audible rumbling from within the vent, with constant steam discharge.				

WTF1052 Lady Knox Geyser: Temperature and pH for 2005/1/1 - 2021/5/1

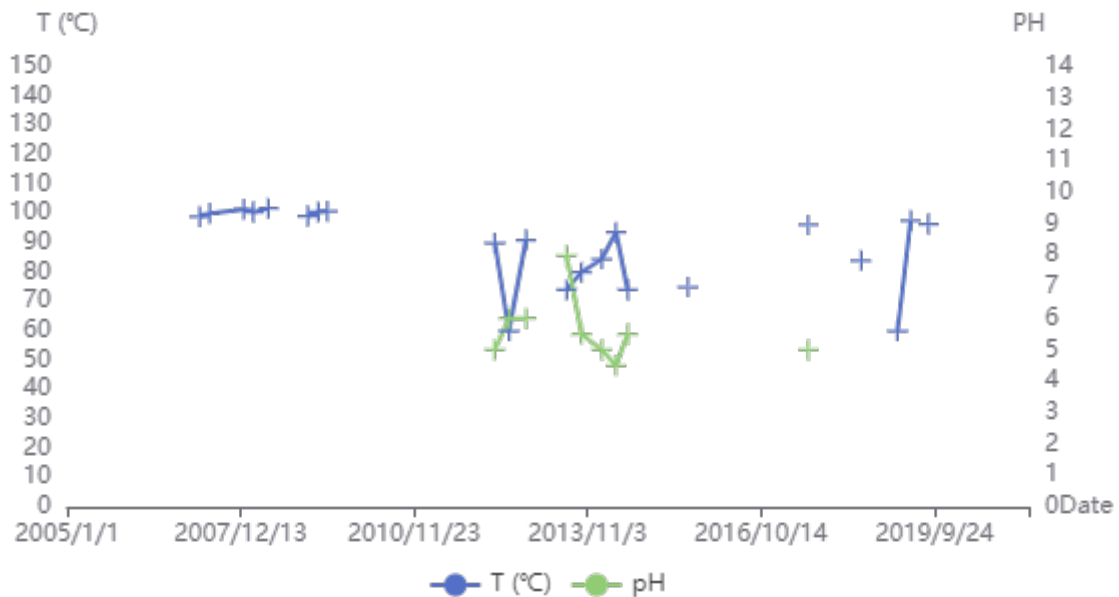




Fig.1 - taken on 2018-10-19 10:53:58"



Fig.2 - taken on 2019-04-30 10:40:27"



Fig.3 - taken on 2019-07-25 10:50:34"



Fig.4 - taken on 2020-02-10 10:36:11"

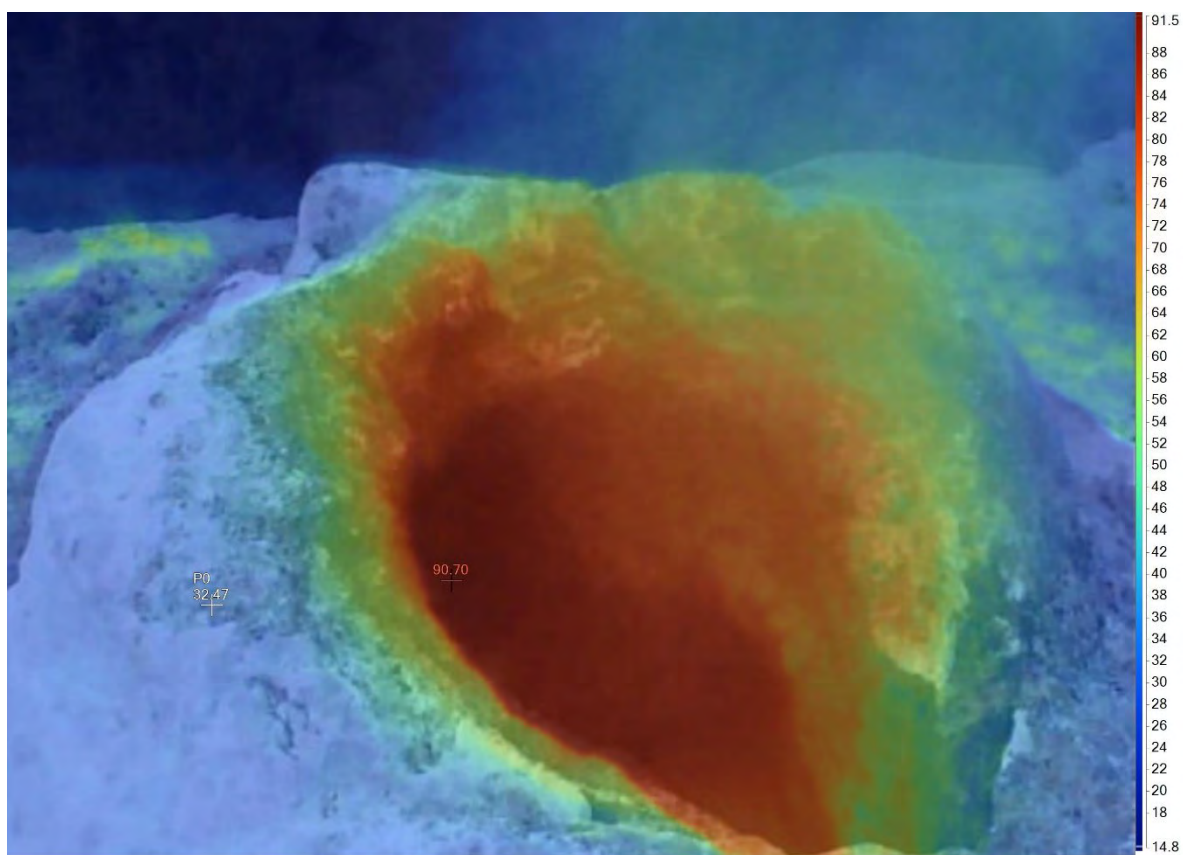


Fig. 5 Infrared image of Lady Knox Geyser. Taken on 2021-03-25.

11.5 3074_178: WTF1053 Knox hole spring and channel

- The overall temperature trend as Knox Hole Spring is decreasing over time, although there are major fluctuations (40 – 60 °C temperature change) occurring.
- pH conditions remain relatively stable since 2010.

Location: -38.350748, 176.37696

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	3.0	73.5	0.3	None	Clear	Colourless	Constant bubbling
Comments	<i>Water level:</i> Below ground level						
2019/04/30	3.0	80.1	0.4	0.0	Clear	Colourless	Constant bubbling
2019/07/25	3.0	65.0	0.2	0.0	Clear	Colourless	Constant bubbling
2019/08/19	3.0	67.7	0.2	0.0	Clear	Colourless	Constant bubbling
2019/12/05	3.0	64.0	0.35		Clear	Colourless	Constant bubbling 10mm high
2020/02/10	2.6	60.9	0.3		Clear	Colourless	Slightly Effervescent
2021/03/25	3.0	78.9	0.5	Very weak flow	Clear	Colourless	Constant moderate ebullition
Comments	Discharge downstream is very sulphurous.						

WTF1053 Knox hole spring and channel: Temperature and pH for 2005/1/1 - 2021/5/1

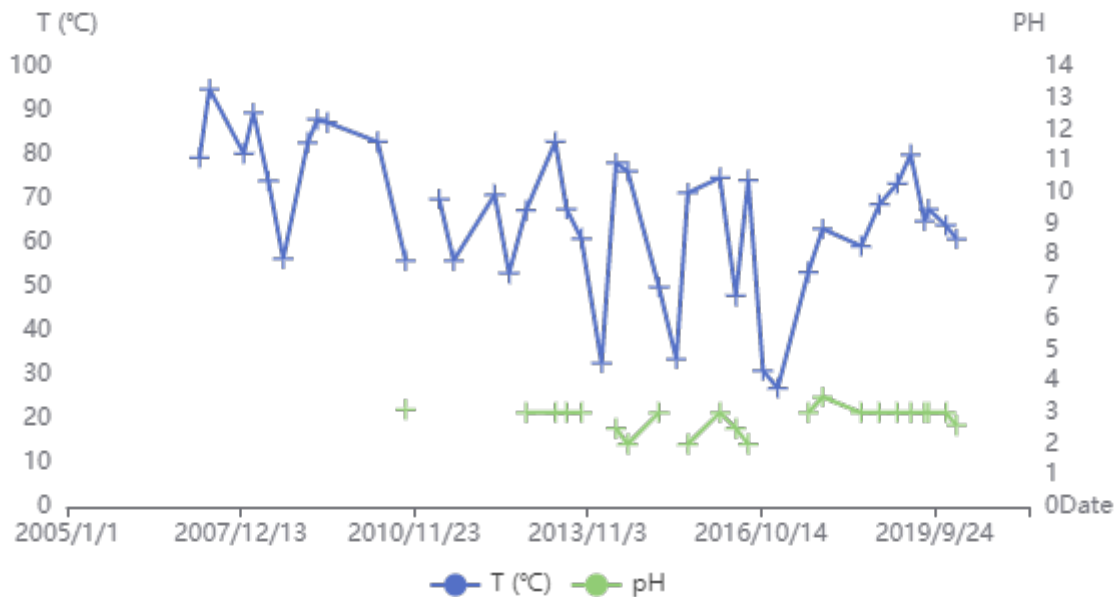




Fig.1 - taken on 2019-04-30 10:54:14"



Fig.2 - taken on 2019-07-25 11:00:20"



Fig.3 - taken on 2019-12-05 11:25:00"



Fig.4 - taken on 2020-02-10 10:43:01"



Fig.5 - taken on 2020-02-10 10:43:08"



Fig.6 - taken on 2021-03-25 10:37:24"

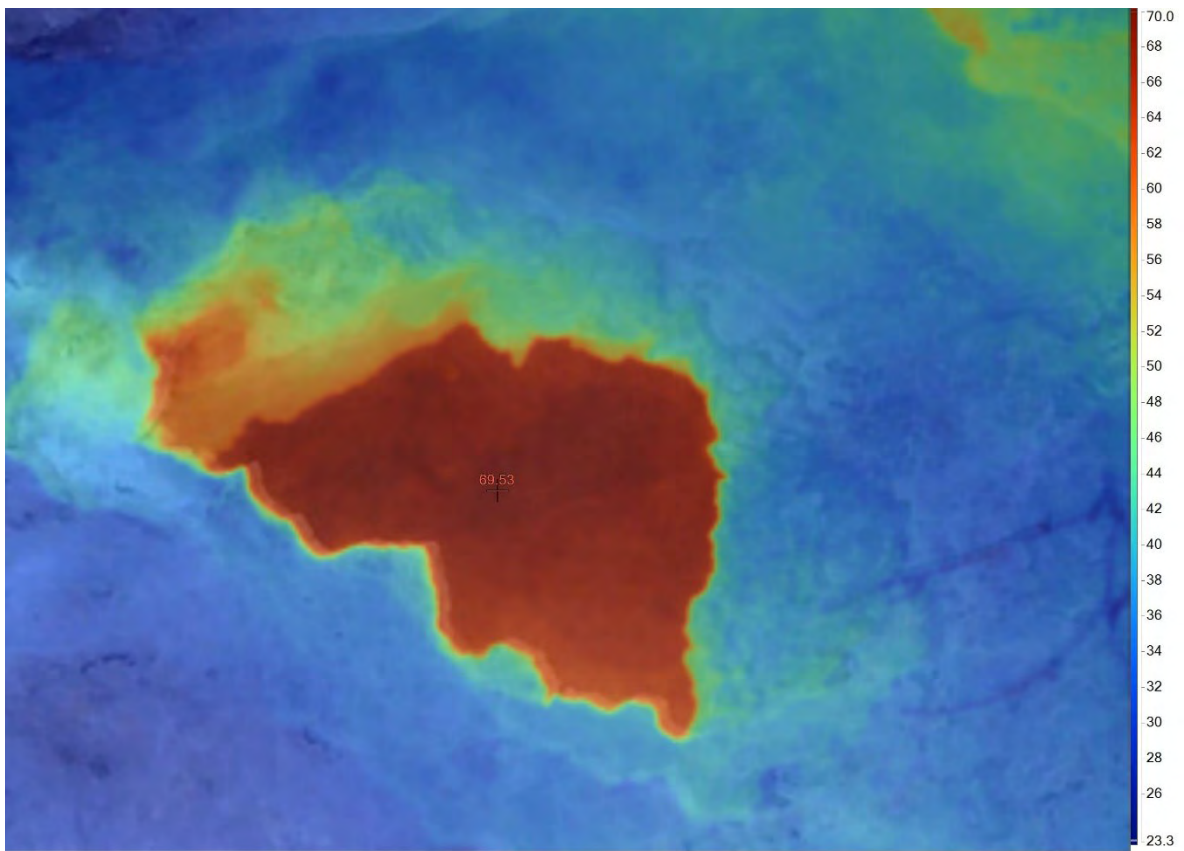


Fig. 2 Infrared image of Knox Hole spring. Taken on 2021-03-25.

11.6 3074_184: WTF1059 Weather Pool

- Water temperature conditions at Weather Pool decreased significantly in 2013 and 2019. The average temperature range is between 40 – 60 °C.
- This feature cannot be visited and sampled directly due to its location.
- Based on infrared imagery (Figure 8), the pool closest to Weather Pool is observed to have a greater temperature condition than Weather Pool.

Location: -38.356614, 176.36816

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08		64.0		None	Cloudy	Blue - Light	Occasional bubbles
Comments	<i>Water temperature: Temp</i>					taken	from board walk
	<i>Water level: Overflowing</i>						
2019/04/30				None	Cloudy	Green - Light	Calm
Comments	<i>Water level: Overflowing</i>						
2019/07/26		56.0		<0.05	Cloudy	Green - Blue	Calm
2019/08/19				<0.05	Cloudy	Green - Blue	Calm
2019/12/05		27.0		<0.5	Cloudy	Blue - Light	Small bubbles around edges
Comments	<i>Clarity: Slightly cloudy</i>						
2020/02/10		62.3		<0.5	Cloudy	Green - Light	Occasional bubbles
2020/08/04		53.0			Cloudy	Blue - Grey	Random bubbles
Comments	<i>Ebullition: In the middle of pool</i>						
2021/12/10		57.2		0.5	Milky	Blue – Grey	Nd
Comments	Feature was very calm.						
2021/03/25		50.3				Blue – Grey	Nd

WTF1059 Weather Pool: Temperature and pH for 2005/1/1 - 2021/5/1

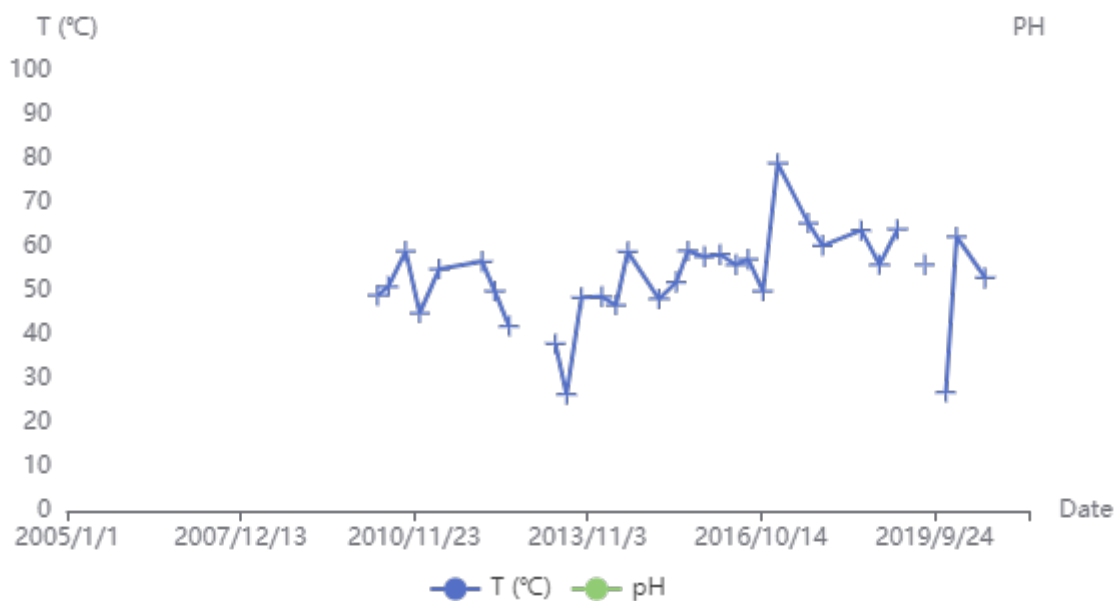




Fig.1 - taken on 2018-10-19 11:37:21"



Fig.2 - taken on 2019-04-30 11:44:51"



Fig.3 - taken on 2019-07-25 11:49:49"



Fig.4 - taken on 2019-12-05 12:41:55"



Fig.5 - taken on 2020-02-10 12:05:59"



Fig.6 - taken on 2020-12-03 11:55:08"



Fig.7 - taken on 2021-03-25 11:04:15"

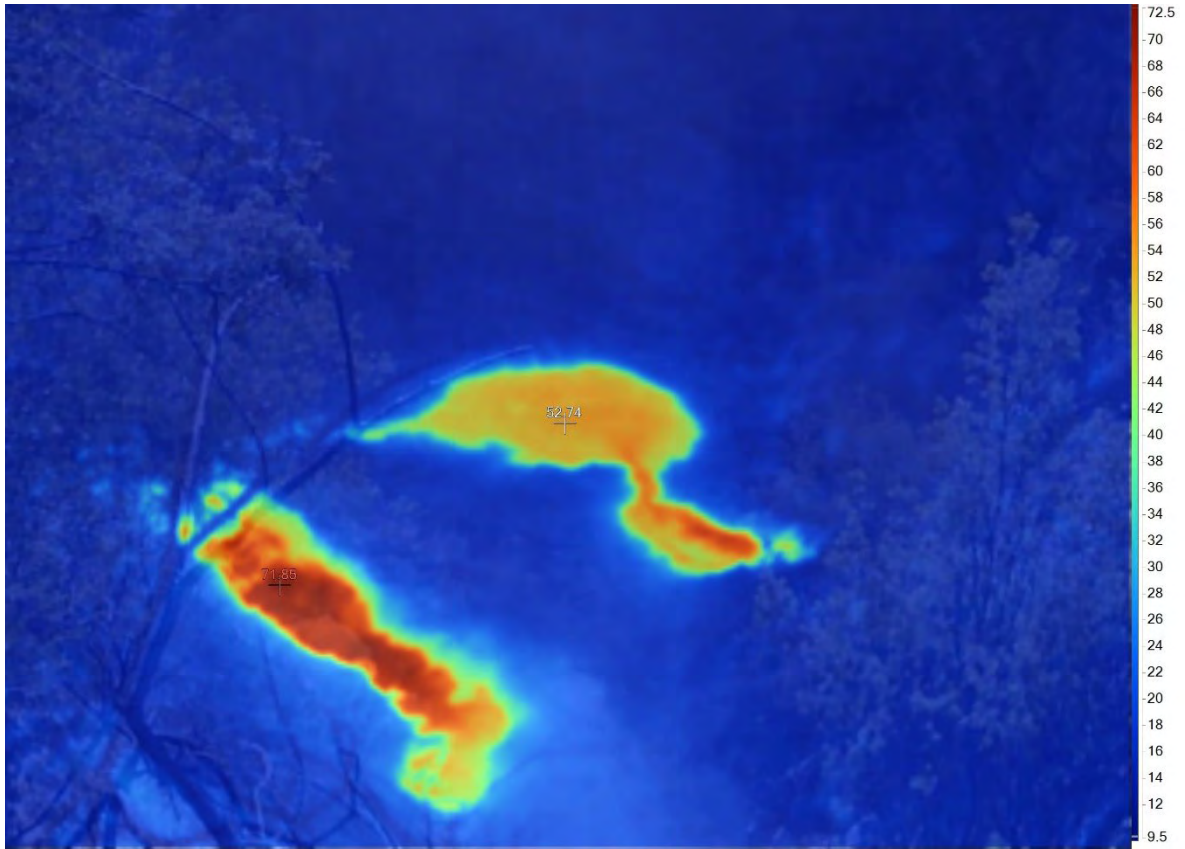


Fig. 3 Infrared image of Weather Pool. Taken on 2020-12-03.

11.7 3074_185: WTF1060 Devil's Bath

- Water temperature at Devil's Bath undergoes significant fluctuations, however these measurements were taken using infrared thermometry at a distance of ~10 m, so are not highly accurate.

Location: -38.357366, 176.367382

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08		24.8		None	Milky	Green - Lime	Calm
Comments Water level: Above high watermark							
2019/04/30				None	Murky	Green - Lime	Calm
Comments Water level is higher than usual Water level: Above high water mark							
2019/07/25		17.0	1.0	None	Clear	Green - Lime	Calm
Comments Yellow precipitate above water line. Water level was 2m higher. Clarity: Visibility 0.5m. Clearer than usual.							
2019/08/19			1.0	None	Clear	Green - Lime	Calm
Comments Yellow precipitate above water line. Water level was 2m higher. Clarity: Visibility 0.5m. Clearer than usual.							
2019/12/05		25.3	0.2		Murky	Green - Lime	Calm
2020/02/10		30.2			Cloudy	Green - Lime	Calm
2020/08/04		17.0	5.0		Cloudy	Green - Lime	No bubbles
2020/12/03		27.1	-1.5		Murky	Green - Lime	Nd
2021/03/25		19.7	0		Milky	Green - Lime	Nd

WTF1060 Devil's Bath: Temperature and pH for 2005/1/1 - 2021/5/1

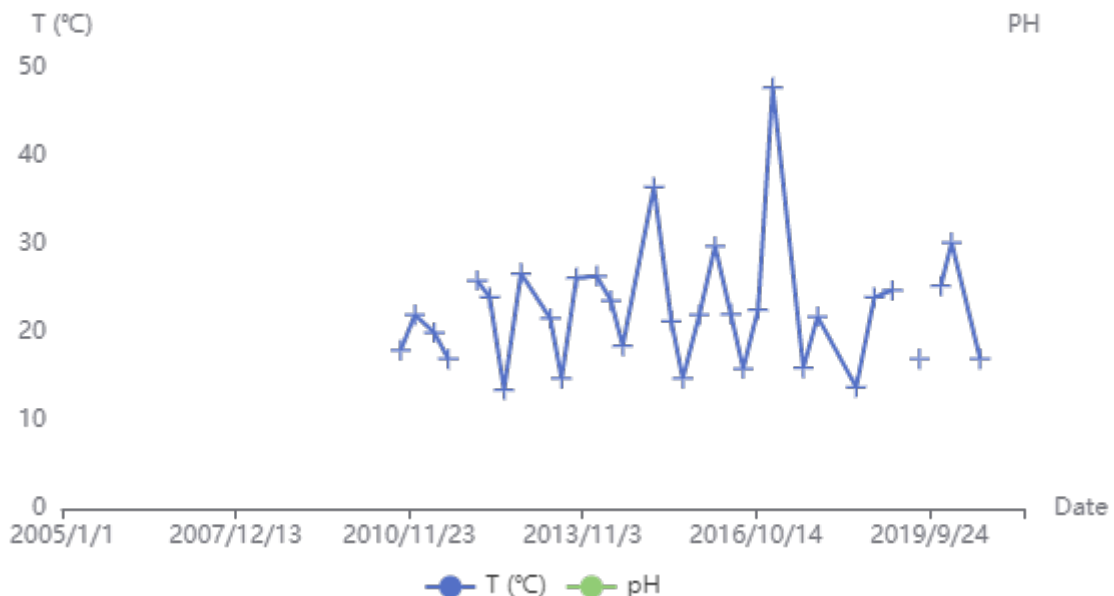




Fig.1 - taken on 2020-12-03 13:26:00"



Fig.2 - taken on 2020-12-03 13:26:00"

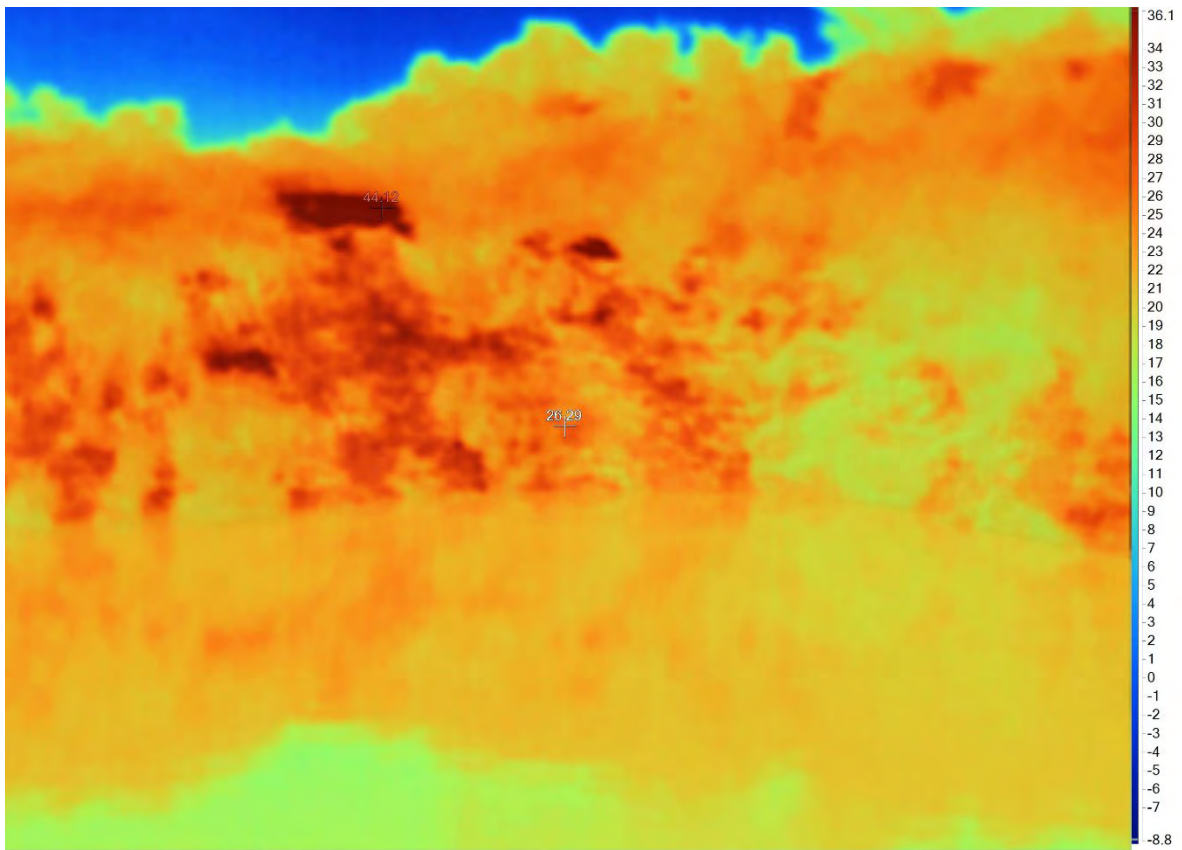


Fig. 3 Infrared image of Devil's Bath. Taken on 2020-12-03.

11.8 3074_191: WTF1066 NW Boardwalk geyser

- No temperature and pH measurements were taken at this feature.

Location: -38.358854, 176.369808

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/07/17					Cloudy	Green	
2015/10/29					Clear	Green	
2016/02/03					Cloudy	blue/green	Calm
2016/05/10					Clear	Green	nd
Comments	Yellow precipitate pH: nd Water level: nd						
2016/07/26					Cloudy	Pale green	Calm
2016/10/27				None	Clear	Pale green	Calm
Comments	Water level: Overflowing						
2017/01/26				None	Cloudy	Green	Calm
Comments	Water level: Not overflowing						
2017/08/03				None	Cloudy	One bluepool, one green pool	Calm
Comments	Water level: Full						
2017/10/31				None	Clear	Clear	Calm
Comments	Water level: Overflowing						

11.9 3074_192: WTF1067 Sinter Terraces-Foreground Pool

- The average temperature conditions at this pool fluctuates between 40 and 70 °C.
- Two prominent black streaks were observed SE of the pool from late 2020 (Fig.5 – 7), but their nature and provenance are unknown.

Location: -38.358495, 176.369471

Date	pHTemp °C	Level Flow (m) (l/s)	Clarity	Colour	Ebullition
2019/02/08	67.9	None	Murky	Green - Light	Constant bubbles
Comments	<i>Water level: Top of pool</i>				
2019/04/30	63.0	None	Cloudy	Green	Constant bubbles
Comments	<i>Water level: Overflowing</i>				
2019/07/25		<0.05	Clear	Yellow - Green	Constant bubbling
Comments	Very steamy				
2019/08/19	61.0	<0.05	Clear	Yellow - Green	Constant bubbling
Comments	Very steamy				
2019/12/05	70.4		Murky	Green - Light	Constant bubbling 10mm high
Comments	Colour and clarity have changed.				
2020/02/10	68.7		Murky	Green	Constant bubbling in centre
2020/08/04	55.0		Cloudy	Green - Blue	No bubbles
2020/12/03		Not flowing	Milky	Green – Yellow	Low ebullition
Comments	<i>Clarity: 0.5 m</i> 2 black elongate zones observed 7 – 8 m away from pool, possibly chemical fronts or algae.				

WTF1067 Sinter Terraces-Foreground Pool: Temperature and pH for 2005/1/1 - 2021/5/1





Fig.1 - taken on 2019-04-30 11:59:45"



Fig.2 - taken on 2019-07-25 12:00:53"



Fig.3 - taken on 2019-12-05 12:55:38"



Fig.4 - taken on 2020-02-10 12:19:36"



Fig.5 - taken on 2020-08-04 12:56:27"



Fig.6 - taken on 2020-12-03 12:14:28"



Fig.7 - taken on 2020-12-03 12:14:38"

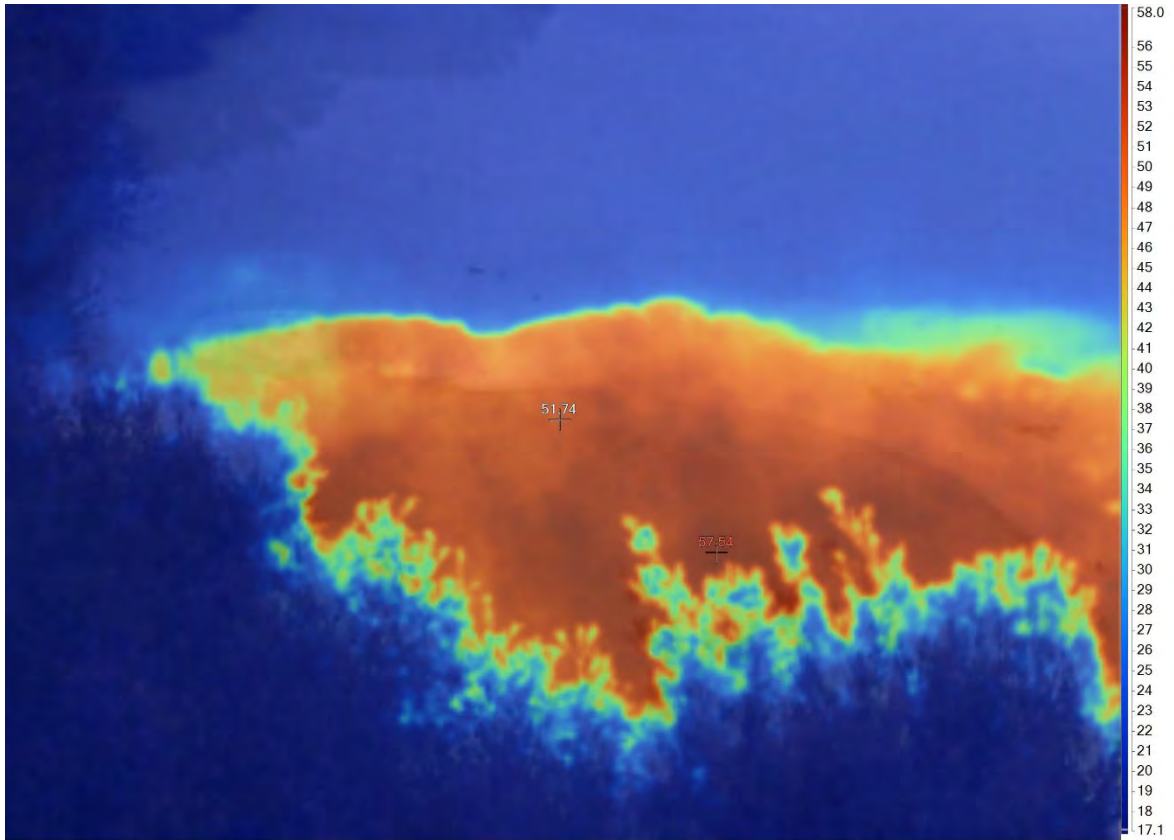


Fig. 8 Infrared image of Foreground Pool. Taken on 2020-12-03.

11.10 3074_194: WTF1069 Jean Batten Geyser

- The geyser had anomalous temperature fluctuations between 2011 to 2017, but is now inactive.

Location: -38.359252, 176.369758

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2016/02/03				None	nd	nd	Steam, no audible discharge
2016/05/10		30.0					nd
Comments	New hole has opened up beside the boardwalk, it is too dangerous to get close to the geyser, gas alarm going off. <i>Water temperature:</i> Temperature taken from boardwalk						
2016/07/26				None			Calm
Comments	Boardwalk has been moved, can't access the geyser <i>Water level:</i> No visible water						
2016/10/27			0.1	None	Clear	Clear	nd
Comments	<i>Water temperature:</i> Can't get close to geyser to put thermocouple in <i>Water level:</i> Below ground level						
2017/01/26		20.0		None			No steam
Comments	Geyser appears inactive - dry and no steam <i>Water temperature:</i> No visible water and appears inactive <i>Water level:</i> Dry, no visible water						
2017/08/03		25.6					
Comments	Can't get close enough to Geyser to sample or get temp reading. Temp taken with IR from about 10m away. <i>Water temperature:</i> Taken from 10m away <i>Water level:</i> No visible water						
2020/12/03		24	0		Clear	Blue – Grey	Nd
Comments	Area surrounding feature very dry.						
2021/03/25		27.1		None	nd	nd	nd
Comments	Could not get close to geyser as the ground appeared active and unstable. <i>Water level:</i> Below surface						

WTF1069 Jean Batten Geyser: Temperature and pH for 2005/1/1 - 2021/5/1

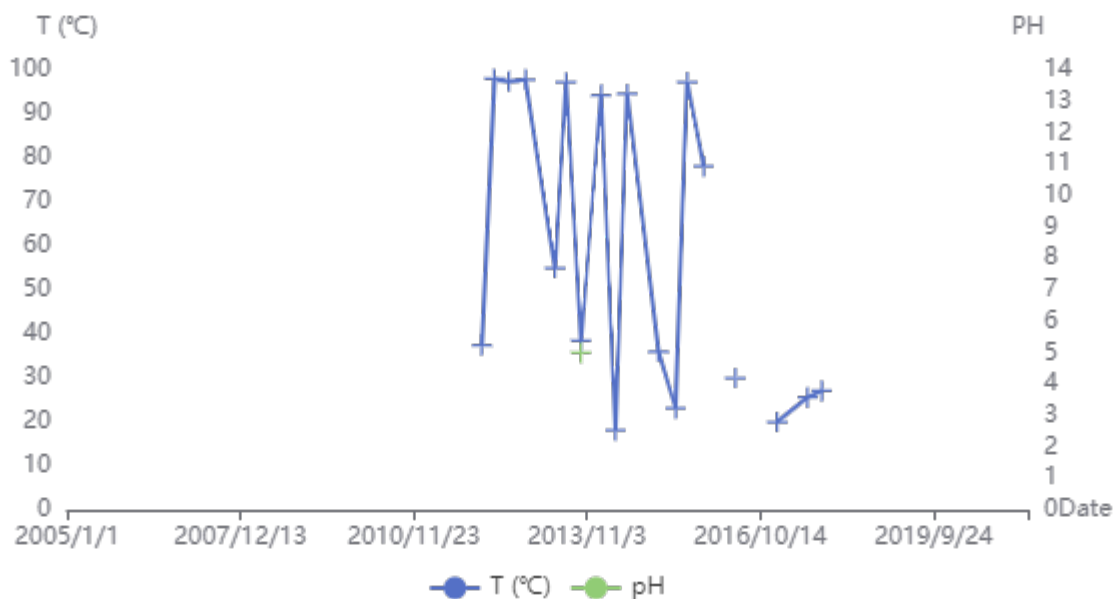




Fig.1 - taken on 2020-12-03 12:27:32"



Fig.2 - taken on 2021-03-25 11:24:12"

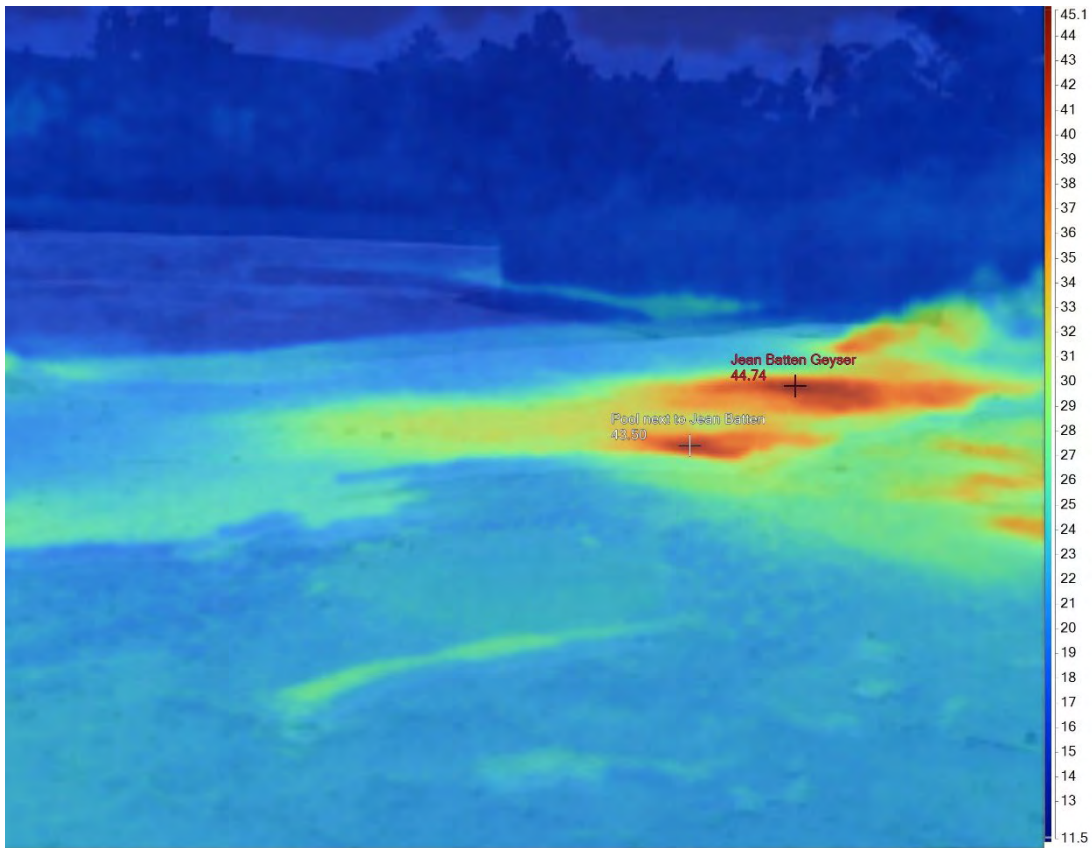


Fig. 3 Infrared image of Jean Batten Geyser and pool next to it. Taken on 2021-03-25.

11.11 3074_199: WTF1075 Oyster Pool

- Water temperature conditions at Oyster Pool average between 50 and 70 °C.
- pH conditions average at pH 5, with the greatest change occurring in 2011, when pH conditions decreased from pH 6 to 2.

Location: -38.361701, 176.369506

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	5.0	56.3		None	Cloudy	Green - Light	Constant from centre and edge
Comments	<i>Water level: Top of pool</i>						
2019/04/30	5.0	60.5		None	Cloudy	Green - Light	Constant bubbling in centre
Comments	<i>Water level: Overflowing</i>						
2019/07/25	5.0	59.0	<0.05		Cloudy	Green - Light	Constant bubbling
2019/08/19	5.0	62.9	<0.05		Cloudy	Green - Light	Constant bubbling
2019/12/05	6.0	58.9	<0.05		Cloudy	Green - Light	Constant bubbling in centre 10mm high
2020/02/10	5.0	62.1	<0.05		Milky	Green - Light	Constant bubbling in centre
2020/08/04	5.4	61.2			Cloudy	Green - Blue	Constant bubbling
Comments	<i>Ebullition: In the middle of pool</i>						
2020/12/03		48.0	0.1		Milky	Grey – Light	Moderate ebullition from multiple centres; no effervescence
Comments	Surrounding area is relatively dry						
2021/03/25	5.0	64.2	0	Nd	Milky	Blue – Grey	Constant ebullition

WTF1075 Oyster Pool: Temperature and pH for 2005/1/1 - 2021/5/1

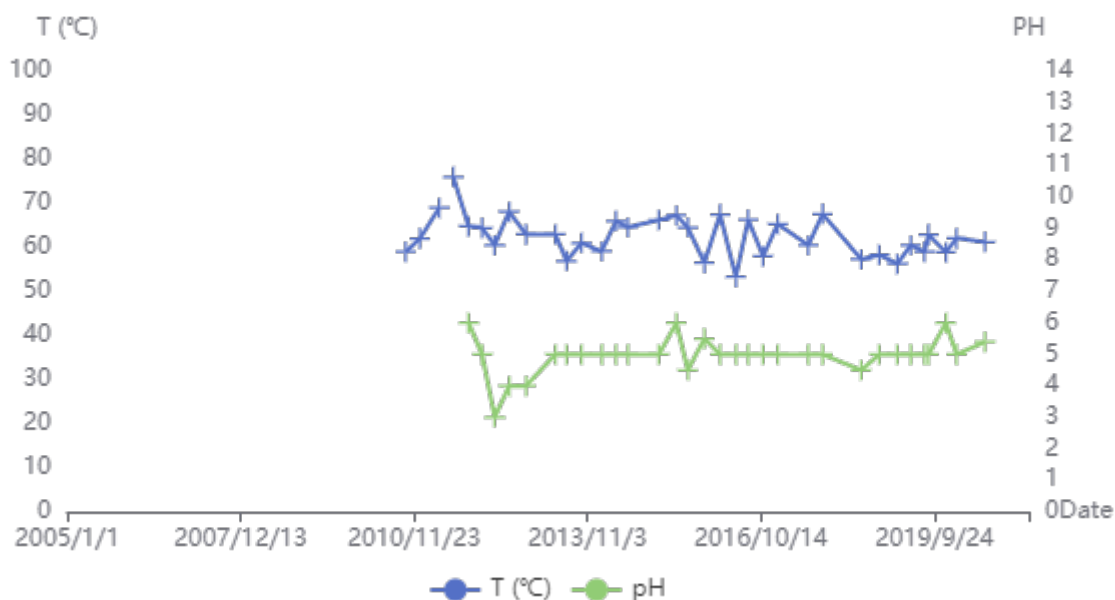




Fig.1 - taken on 2018-10-19 12:22:48"



Fig.2 - taken on 2019-04-30 12:37:30"



Fig.3 - taken on 2019-07-25 12:44:21"



Fig.4 - taken on 2019-12-05 13:39:04"



Fig.5 - taken on 2020-02-10 13:10:14"



Fig.6 - taken on 2020-12-03 12:52:57"



Fig.7 - taken on 2021-03-25 11:49:40"



Fig.8 - taken on 2021-03-25 11:49:59"

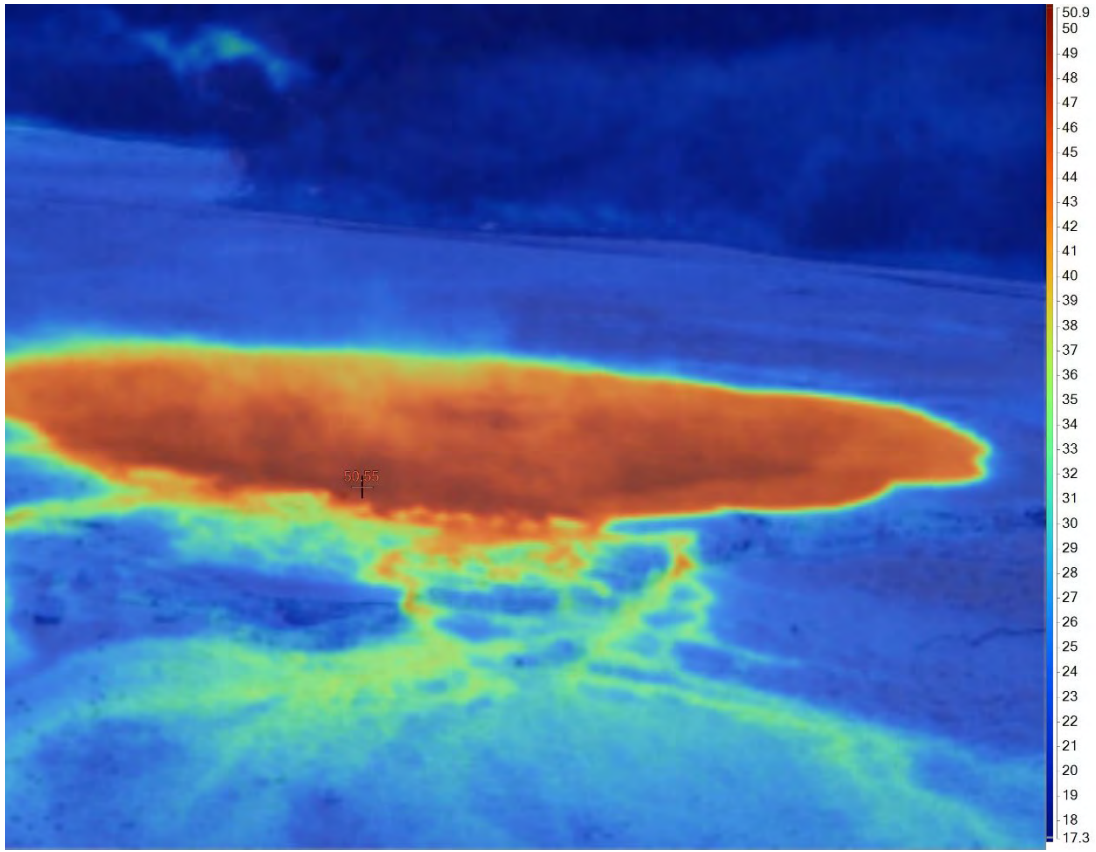


Fig. 9 Infrared image of Oyster Pool. Taken on 2021-03-25

11.12 3074_195: Waiotapu Geyser

- Waiotapu Geyser had lower average temperatures and fluctuated more since 2011, before experiencing a major temperature decrease in 2019.
- pH measurements of this feature is positively correlated to temperature measurements, with pH decreasing when temperature decreases.

Location: -38.361322, 176.369202

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	7.0	76.0	0.1	None	Clear	Colourless	Calm
Comments	<i>Water level: Below outflow</i>						
2019/04/30	5.0	82.3	0.2	None	Clear	Colourless	Calm
Comments	Oily slick on surface						
2019/07/25	5.0	77.0	0.35	0.0	Clear	Colourless	Calm and steaming
2019/08/19	6.5	34.2	0.35	0.0	Clear	Colourless	Calm and steaming

Waiotapu Geyser: Temperature and pH for 2005/1/1 - 2021/5/1

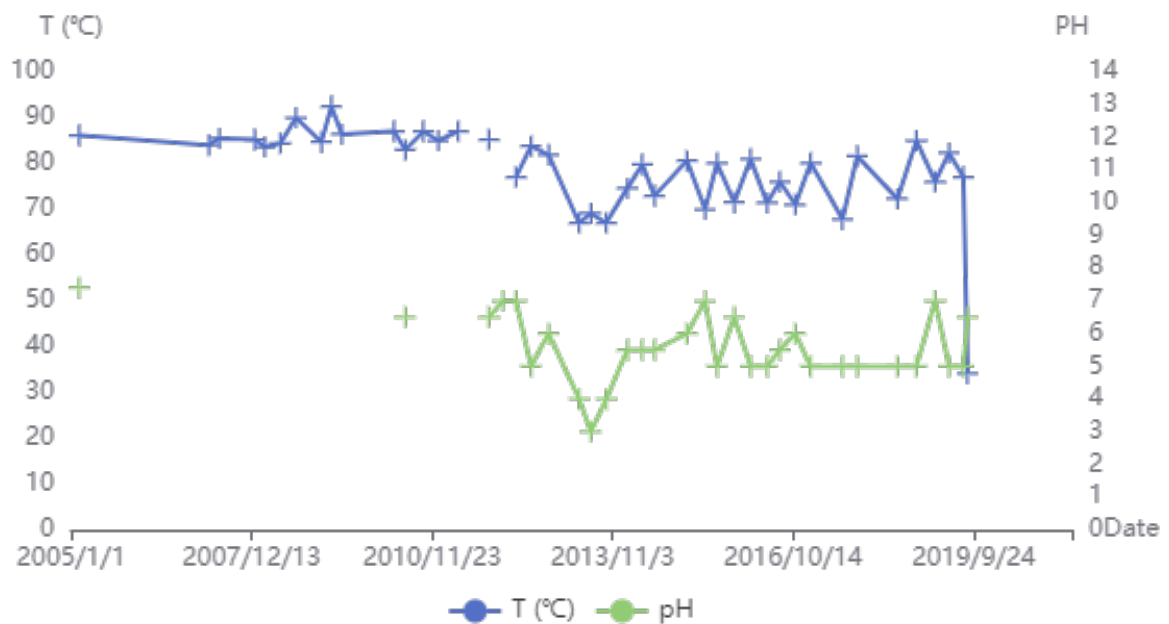




Fig.1 - taken on 2018-10-19 12:08:36"



Fig.2 - taken on 2019-04-30 12:20:16"



Fig.3 - taken on 2019-07-25 12:17:58"



Fig.4 - taken on 2020-12-03 12:59:46"



Fig.5 - taken on 2021-03-25 11:34:27"

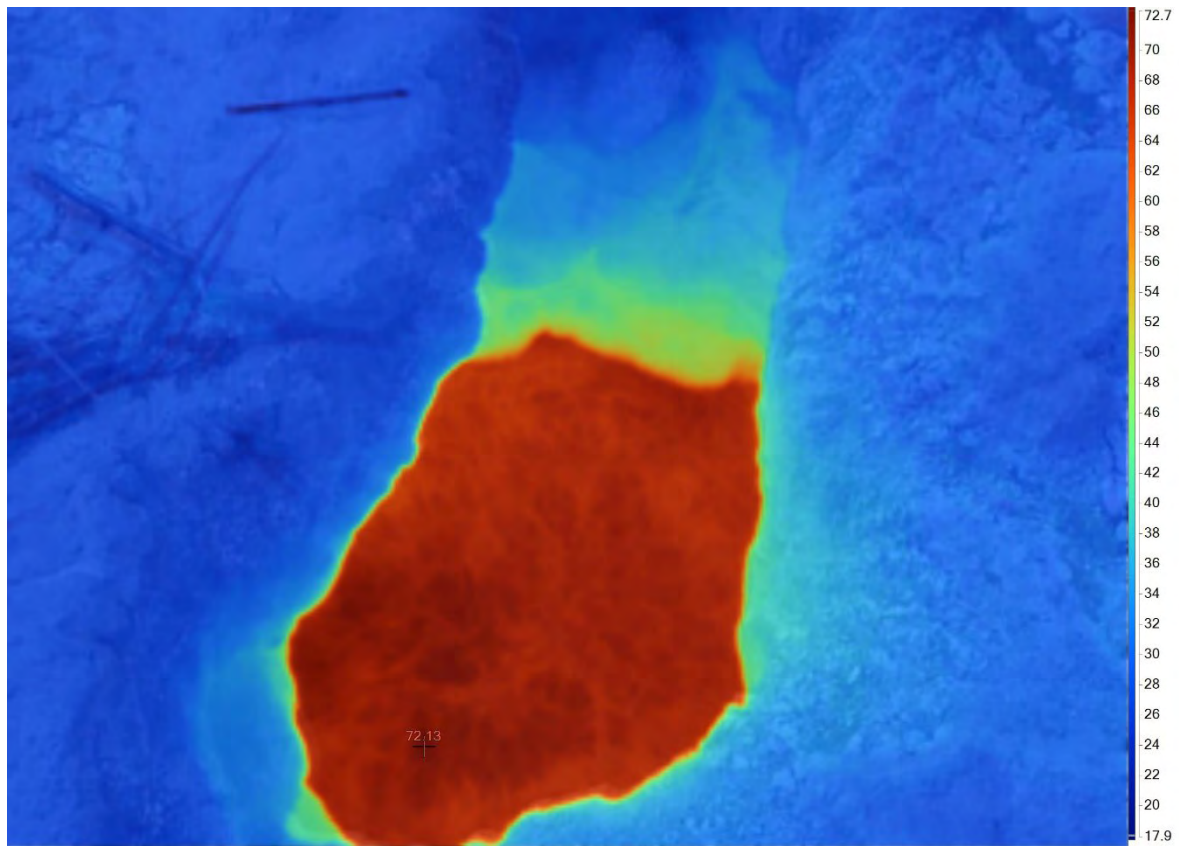


Fig. 6 Infrared image of Waiotapu Geyser. Taken on 2020-12-03.

11.13 3074_294: Waiotapu Geyser outlet 1

- Temperature at this outlet point increased between March to July 2019.
- Insufficient temperature and pH data for long-term trend observations.

Location: -38.361296, 176.369166

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	3.0	37.0		None	Clear	Colourless	Constant bubbling
Comments	<i>Water level: Overflowing</i>						
2019/04/30	3.0	45.0		None	Clear	Colourless	Bubbling
Comments	<i>Water level: Overflowing</i>						
2019/07/25	3.0	51.0		<0.5	Clear	Colourless	nd
Comments	Yellow precipitate. Inflow from stream.						
2019/08/19	3.0	53.2		<0.5	Clear	Colourless	nd
Comments	Yellow precipitate. Inflow from stream.						



Fig.1 - taken on 2019-04-30 12:25:09"



Fig.2 - taken on 2019-07-25 12:25:28"

11.14 3074_295: Waiotapu Geyser outlet 2

- There was a temperature decrease between February and April 2019. Temperature has since then remained in the lower measurement range.
- Insufficient temperature and pH data for long-term trend observations.

Location: -38.361334, 176.369111

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/02/08	3.0	46.4		None	Clear	Colourless	Constant bubbling
Comments	<i>Water level: Overflowing</i>						
2019/04/30	3.0	36.0		None	Clear	Colourless	bubbling
Comments	<i>Water level: Overflowing</i>						
2019/07/25	3.0	39.4		<0.5	Clear	Colourless	nd
Comments	Yellow precipitate. Gas monitor went off multiple times.						
2019/08/19	3.0	38.2		<0.5	Clear	Colourless	nd
Comments	Yellow precipitate. Gas monitor went off multiple times.						



Fig.1 - taken on 2019-04-30 12:31:08"



Fig.2 - taken on 2019-07-25 12:31:42"

11.15 3074_286: WTF3064 Champagne Pool Sampling Pt 3

- The water temperature measurements at this Champagne Pool sampling site remained relatively stable since 2006, without any major changes or fluctuations.
- pH measurements are not continuous, but show measurements between pH 5 to 6.

Location: -38.359253, 176.369403

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/07/25	5.0	75.1		<0.5	Murky	Green	Effervescent
Comments	Clarity is murkier than usual						
2019/08/19	5.0	69.0		<0.5	Murky	Green	Effervescent
Comments	Clarity is murkier than usual						
2019/12/05	6.0	74.3		<0.5	Murky	Green - Dark	Effervescent
2020/08/04	5.9	76.0			Clear	Green - Dark	Fizzing
Comments	<i>Ebullition:</i> Around the edges						
2020/12/03	6.0	64.0	0.5		Clear	Green-Blue	Low ebullition, effervescent
Comments	<i>Clarity:</i> 4 m Temperature only measured using infrared.						
2021/03/25	6.0	78.5	0		Clear	Colourless	Constant low ebullition, effervescent

WTF3064 Champagne Pool Sampling Pt 3: Temperature and pH for 2005/1/1 - 2021/5/1

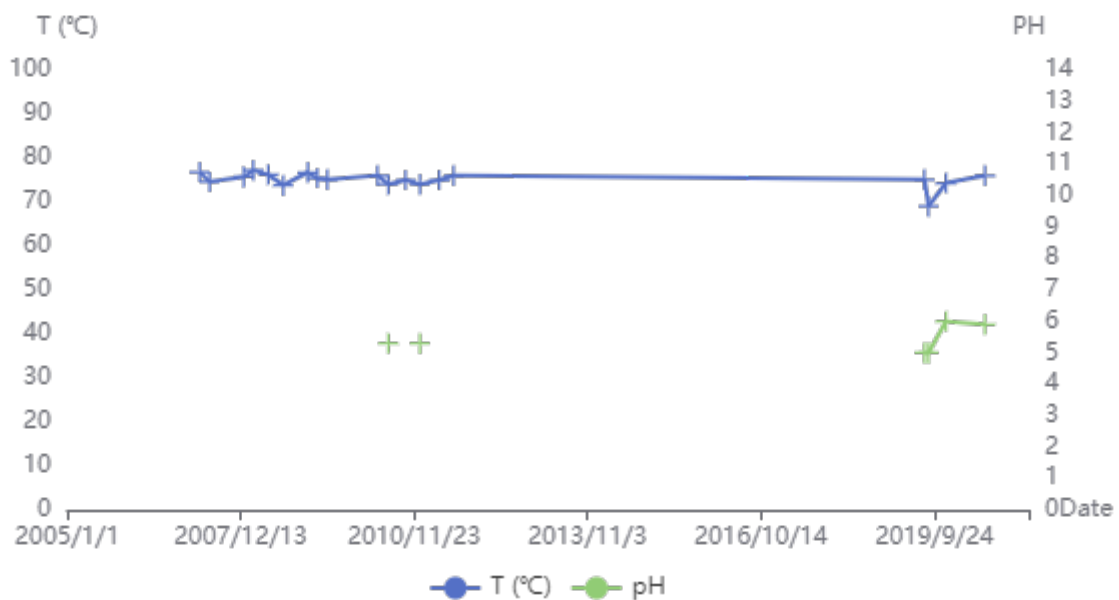




Fig.1 - taken on 2019-07-25



Fig.2 - taken on 2019-12-05



Fig.3 - taken on 2020-08-04

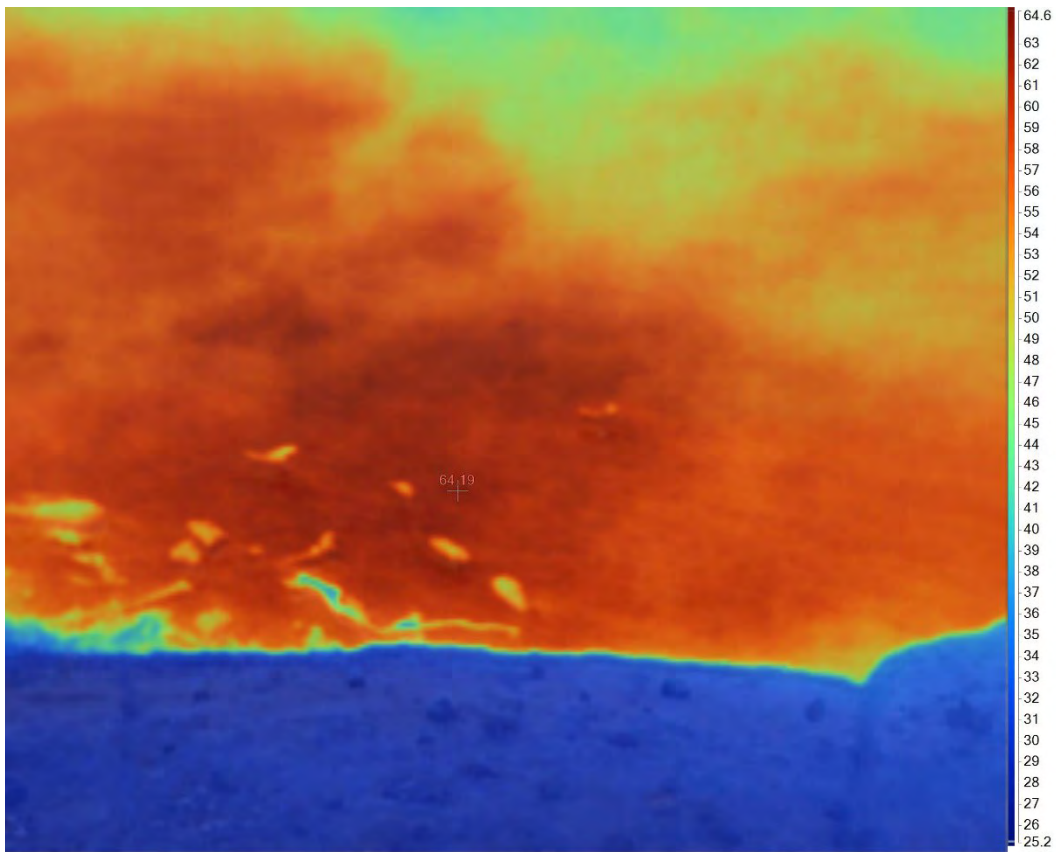


Fig. 4 Infrared image of Champagne Pool margins. Taken on 2021-03-25

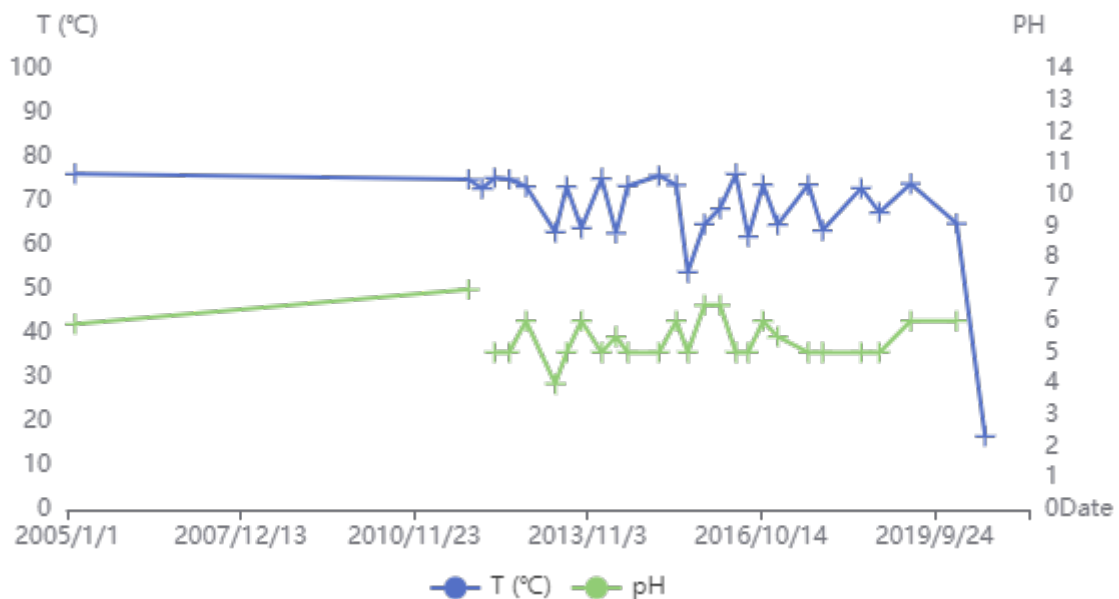
11.16 3074_291: WTF4064 Champagne Pool Sampling Pt 4

- Different sampling point to the same feature (Champagne Pool) as 3074_286. Point further west, closer to outflow.
- Temperature at this point is more fluctuating than at sampling point 3 (previous entry), but higher temperature readings are similar. Very low measurement in August 2020 could be anomalous, as measurements from sampling point 3 show regular water temperatures.
- As this sampling point is further away from the major upwelling area, it is possible that the measurements taken here are more influenced by subaerial processes, and therefore is less representative of the deep reservoir conditions.

Location: -38.359318, 176.36872

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2019/04/30	6.0	74.0		None	Clear	Green - Dark	Effervescent
Comments	<i>Water level: Overflowing</i>						
2020/02/10	6.0	65.0		<1.0	Murky	Green	Effervescent
2020/08/04		16.7		<1.0	Clear	Green - Blue	No ebullition

WTF4064 Champagne Pool Sampling Pt 4: Temperature and pH for 2005/1/1 - 2021/5/1



11.17 3074_212: WTF1088 Lake Ngakoro

- Water temperature conditions at Lake Ngakoro experienced an increasing trend between 2010 to 2013, before experiencing significant fluctuations to today.
- pH conditions remain relatively acidic, between pH 2 and 3.

Location: -38.363109, 176.36877

Date	pH	Temp °C	Level Flow (m) (l/s)	Clarity	Colour	Ebullition
2019/02/08		25.0		Cloudy	Green - Murky	Effervescent just out from edges
Comments	<i>Water temperature: By outflow</i>					
2019/04/30			None	Cloudy	Green	nd
2019/07/25		19.0	None	Murky	Blue - Light	Calm
Comments	Small island that was forming has disappeared. <i>Water temperature: Temp 26 by waterfall</i>					
2019/08/19			None	Murky	Blue - Light	Calm
Comments	Small island that was forming has disappeared.					
2019/12/05		24.6		Murky	Green	Calm
Comments	Small Island has reappeared <i>Water temperature: 34 near outlet</i>					
2020/02/10		18.7		Murky	Green	Effervescent around edges
Comments	Water level is low, island visible.					
2020/08/04		13.0		Cloudy	Green	Constant bubbles
Comments	<i>Ebullition: Around the edge</i>					

WTF1088 Lake Ngakoro: Temperature and pH for 2005/1/1 - 2021/5/1

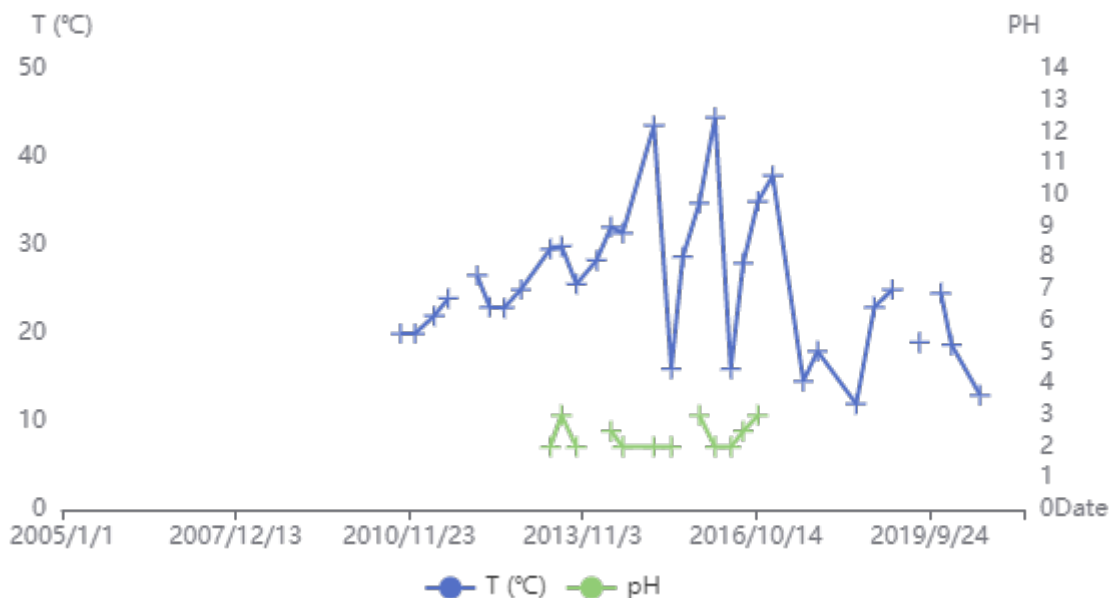




Fig.1 - taken on 2018-10-19 12:35:18"



Fig.2 - taken on 2019-04-30 12:47:21"



Fig.3 - taken on 2019-04-30 12:47:26"



Fig.4 - taken on 2019-07-25 12:57:03"



Fig.5 - taken on 2019-12-05 14:05:01"



Fig.6 - taken on 2020-02-10 12:59:39"

11.18 3074_172: WTF1047 Venus Bath Spring

- There are not enough temperature and pH measurements to observe long term trends.

Location: -38.349378, 176.37041

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2005/02/18	3.3	54.4		<0.5	Clear, visibility <2m	Clear	Calm
Comments	No changes. Fawn-grey sediments.						
2005/05/05	3.4	52.7		<0.3	Clear, visibility >2m	Green	Calm
Comments	No apparent changes.						

11.19 3074_281: Waitapu Loop Rd Pools

- This site is regularly visited, but no measurements are taken. Only number of bathers are recorded for this site.

Location: -38.35606, 176.364233



Fig.1 - taken on 2018-10-19 13:20:37"



Fig.2 - taken on 2018-10-19 13:20:43"



Fig.3 - taken on 2021-03-25 12:34:54"

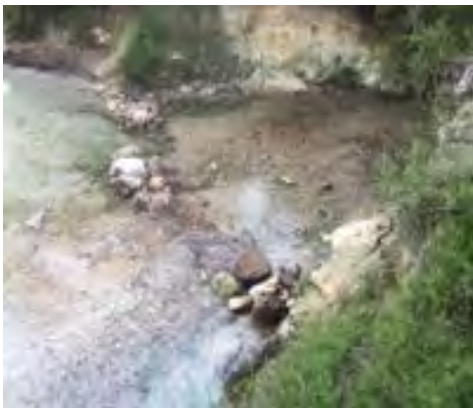


Fig.4 - taken on 2021-03-25 12:34:59"

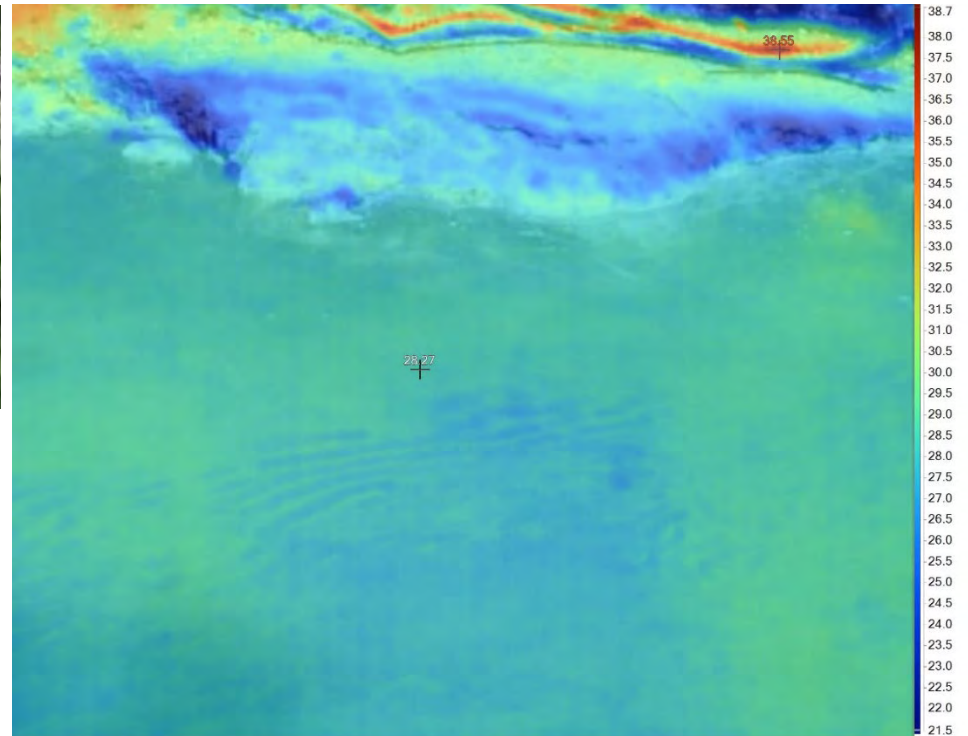


Fig.5 Infrared image of Loop Rd Pools. Taken on 2021-03-26.

12 WHANGAIROROHEA

12.1 3076_1: Tahunaatapu Pool

- The water temperature at Tahunaatapu Pool increased between 2005 and 2013, before significantly decreasing between 2013 to 2014, and has remained lower ever since.
- The pH measurements range between pH 5 and 9. Initial measurements from 2005 – 2014 show pH fluctuating between 7 and 9, but decreased to pH 5 in 2018, before reaching pH 8 in 2021.

Location: -38.335113, 176.386481

Date	pH	Temp °C	Level (m)	Flow (l/s)	Clarity	Colour	Ebullition
2015/01/28	7.0	39.8	0.8	None	Clear	Blue green	Occasional upwelling
Comments	Orange algal mats around edges <i>Water level:</i> Below top of jetty						
2017/01/20	6.0	35.1	0.5	None	Clear	Blue/green	Upwelling in centre
Comments	<i>Water level:</i> Below top of jetty						
2018/06/27	5.0	33.8	0.45	None	Clear	Colourless	Occasional bubbles in centre.
Comments	<i>Water level:</i> From top of jetty						
2019/02/07	7.0	35.0	0.41	None	Clear	Green - Blue	Occasional bubbles
Comments	Lots of orange algal mats on left of pool <i>Water level:</i> From top of jetty						
2020/02/25	7.0	37.8	0.39		Clear	Green - Blue	Constant bubbles in centre.
Comments	Lots of orange algae floating on left side of pool.						
2021/03/25	7.9	33.8			Clear	Colourless	Low but persistent in the centre of pool
Comments	Algal communities floating on surface						

Tahunaatapu Pool: Temperature and pH for 2005/1/1 - 2022/1/1

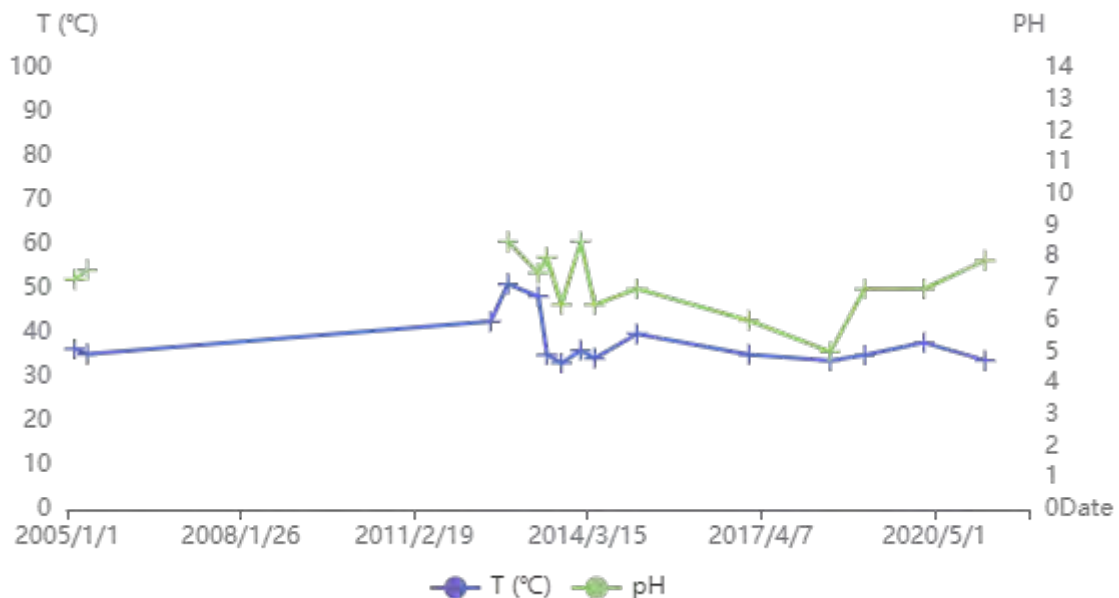




Fig.1 - taken on 2020-02-25 14:07:21"



Fig.2 - taken on 2021-03-25 14:56:34"