Taheke Geothermal Project – Further Application Information

This document sets out additional information, using the structure set out in the online portal.

PART I: APPLICANT

Applicant details

Person or entity making the request:

ROOPU Whakarite Mahi Limited Partnership – a NZ Limited Partnership (registration number 50027984) between The Proprietors of Taheke 8C and Adjoining Blocks Incorporation (**Taheke 8C**), and Eastland Generation Limited. Its general partner is Te Turapa Wai Ariki Limited, an NZ Limited Company (company number 7882517) with its ultimate holding company being ROOPU Whakarite Mahi Limited Partnership (shareholders being Taheke 8C and Eastland Generation Limited).

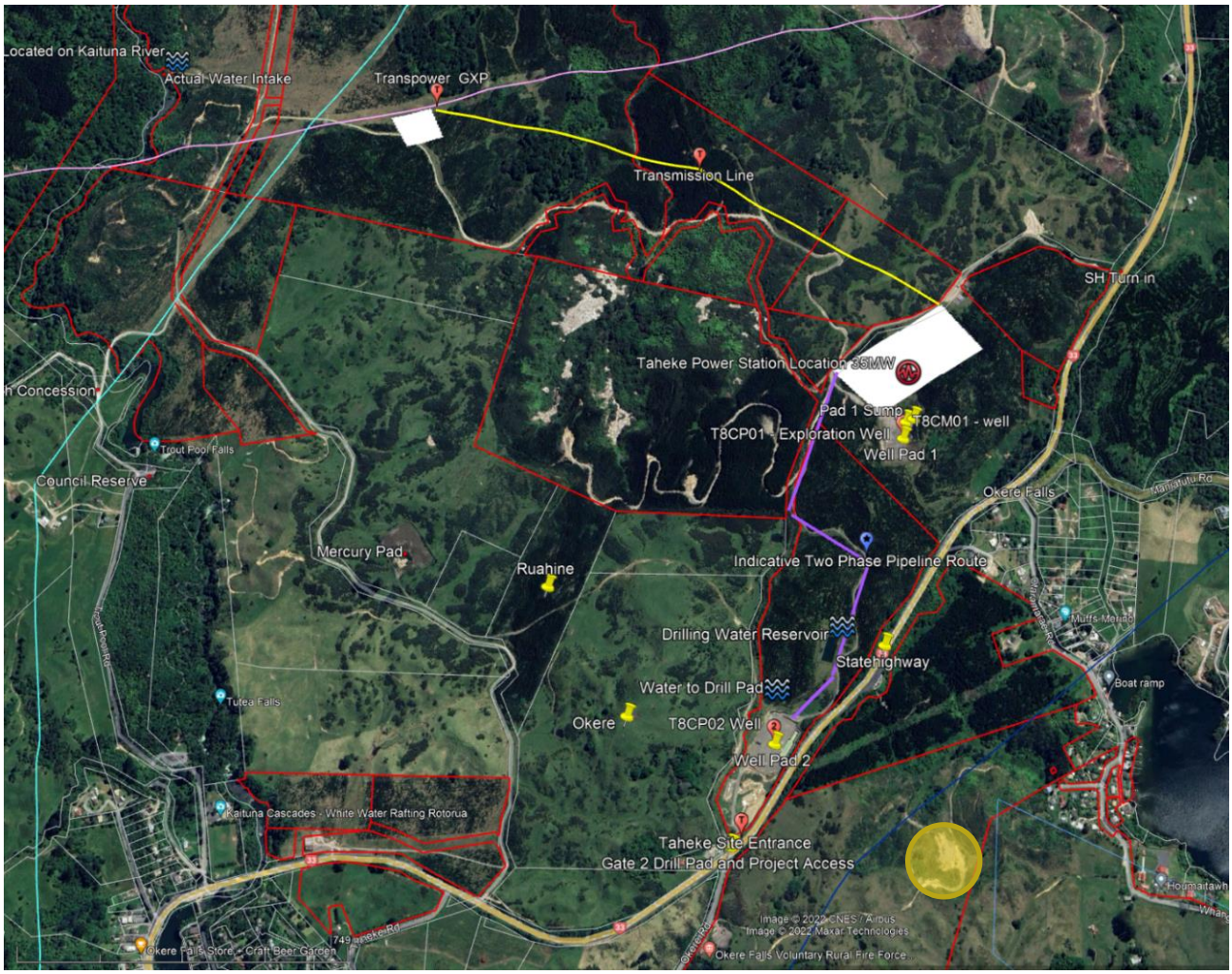
Taheke 8C is a Māori Incorporation (Structure ID 70963) and was incorporated on 22 January 1954 by Order of Incorporation issued by the Māori Land Court.

Eastland Generation Limited (company number 1960145) is an NZ Limited Company with its registered office in Gisborne. Its only shareholder is Eastland Group Limited (company number 2426052), also an NZ Listed Company with its registered office in Gisborne. Eastland Group Limited is owned by Trust Tairāwhiti, the regional development trust for Tairāwhiti.

PART II: PROJECT LOCATION

Site/Location

Please note that the legal descriptions are as described in the portal and in the shapefiles. It is anticipated that there will also be a well pad located approximately at the area marked by the yellow circle, along with underground drilling under the land described as Rotoiti 17 Block comprised in RT 505759 and the land described as Lot 2 DPS 40578 comprised in RT SA36C/174.



Registered legal land owner(s):

Records of Title SA69A/795, 509150, 646099, SA1289/79, SA18B/1385, SA18B/1383 and SA1289/78 are all owned by The Proprietors of Taheke No 8C and Adjoining Blocks Incorporated.

Records of Title 505759 and SA36C/174 are owned by Hulton Patchell Support Services Limited as Custodian Trustee of the Whangamoa Trust.

Record of Title 438880 is owned by:

- Ani Miria Stokes, Beverley Anne Stokes and Daniel Lennard Stanley Stokes as trustees, as to a 0.0500 share
- Denise Rangikatiria Purdie as to a 0.0500 share
- Julie Leanne Te Arai Morton, Julie Moana Morton and Rex Mawae Morton as trustees, as to a 0.0500 share
- Kingi Marshall Grace as to a 0.0625 share
- Proprietors of Taheke 8C and Adjoining Blocks Incorporated as trustees, as to a 2.5000 share
- Eric Stanley Tama-O-Te-Rangi Grace, Hiro Menamena Grace (also known as Hiro Menamena Te Moana), Jared Edward Te Pokiha
- Grace, Juliet Kararaina Porter (also known as Juliet Kararaina Grace), Lillian Beryl Hutita Grace and Robert Rangitukehu Grace as trustees, as to a 0.0625 share
- Kelly Elizabeth Te Reo, Victor Maniapoto Ball and Zelda Wikitoria McClure as trustees as to a 0.0500 share

- Bruce Temaaha Campbell, Eddie John Kingi Shepherd and Charmayne Marea Brennan as responsible trustees, jointly, no survivorship as to a 0.05 share
- Lancaster Raymond Burns as to a 0.0312000000 share
- Karin Grace Assink as to a 0.0313000000 share
- Benjamin James Grace, Cody Temuera Grace and Kurtis Tongariro Grace as to a 0.0625 share as Responsible Trustees jointly, no survivorship

PART III: PROJECT DETAILS

Project details

Figure 1. Geothermal power plant flash steam in New Zealand.

Figure 2. One of 22 dry steam plants at The Geysers in California.

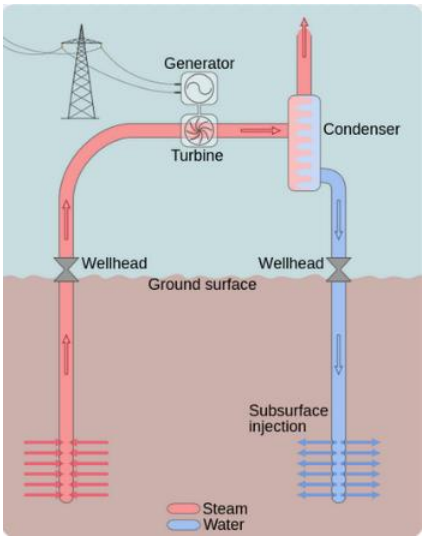


Figure 3. Dry steam cycle.

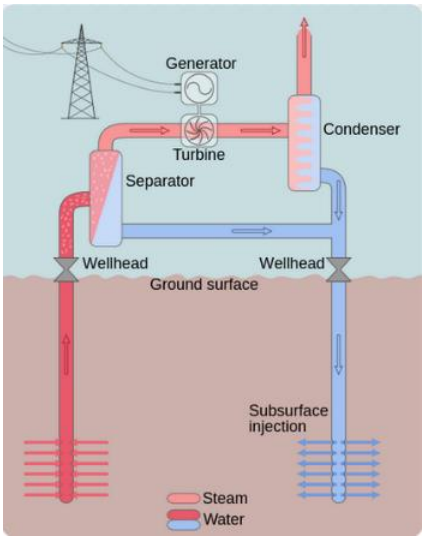


Figure 4. Flash steam cycle.

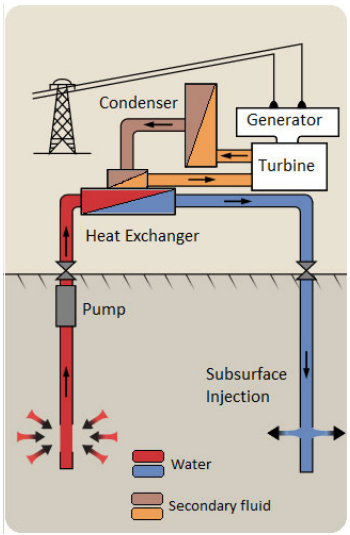


Figure 5. Binary cycle. The lighter brown is vaporized nPentane, while darker brown is liquid nPentane.

Previous resource consent or notice of requirement applications

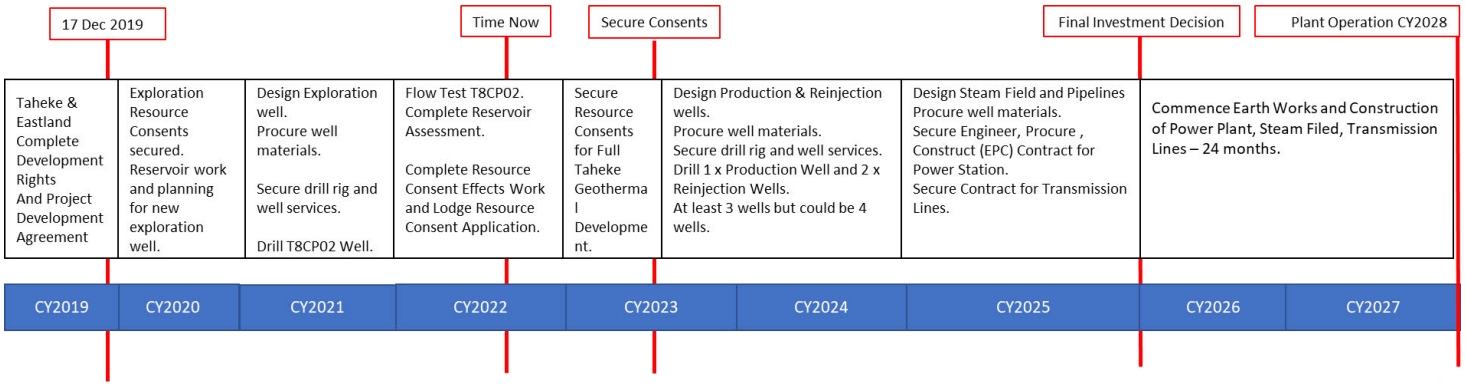
Previous applications made:

There have been previous resource consents granted by both the Bay of Plenty Regional Council and Rotorua District Council in relation to the land which is the subject of the application. The following consents are consents which are still 'live' and which also relate to the activity of geothermal electricity generation.

Bay of Plenty Regional Council	
Consent suite RM20-0847 granted to the Proprietors of Taheke 8C and Adjoining Blocks	This suite of consents covers: Discharge To Air Expiry 30 April 2031 Discharge to Land Expiry 30 April 2031 OSET Discharge Expiry 12 April 2026 Install a Bore Expiry 30 April 2031 Earthworks or Excavation Expiry 30 April 2031

Consent 68062 granted to the Proprietors of Taheke 8C and Adjoining Blocks	This consent covers: Place and Use a Temporary Surface Water Intake Structure on and over the Bed of the Kaituna River Take and Use Water From the Kaituna River for Geothermal Bore Drilling and Geothermal Power Generation Expiry 31 May 2025
Rotorua District Council	
Consent RC14179 granted to the Proprietors of Taheke 8C and Adjoining Blocks/Contact Energy Ltd on 24 November 2011	Land use – to undertake activities associated with drilling five geothermal wells upon drill pads exceeding 200 square metres in size and well drilling using a drilling rig exceeding 10 metres in height
Consent 14818 granted to Transpower NZ on 18 December 2013	To replace poles on the ARI-EDG and OKE-TMI A Transmission Line

Construction readiness



PART VII: ADVERSE EFFECTS

Adverse effects on the environment:

The ROOPU Whakarite Mahi Limited Partnership has engaged a number of experts as part of the Taheke Geothermal Project. Experts have been engaged to address civil works, planning, reservoir geology, reservoir engineering, geochemistry, geophysics, reservoir modelling, ecology, landscape, visual and natural character, noise, air quality, traffic, economics, cultural and archaeological matters.

In undertaking their assessments (which are currently being finalised), the experts have provided a preliminary description of what they consider to be the anticipated and known adverse effects on the environment, including measures for how these might be avoided or mitigated. The potential effects are summarised as follows:

Ecology

Dr Vaughan Kessing (Boffa Miskell) has been commissioned to address ecological effects associated with the Taheke Geothermal Project. He notes that, overall, there are no likely adverse terrestrial ecological effects associated with the Proposal, as all terrestrial features are outside of the likely infrastructure areas, including roading. Dr Keesing notes that of the six wetland features on the Proposal Site, two are debatably natural wetlands, two are natural wetlands that are under active restorative activity, and two are more certain features. He goes on to state that of the six wetlands only one has indigenous cover to any extent. Dr Keesing considers that all the potential effects to the wetlands can be avoided by the appropriate location of activities and infrastructure. The Partnership has confirmed that there will be no infrastructure or earthworks undertaken within 100m of any natural wetland. Dr Keesing states that the surface geothermal features present on the Proposal Site are robust without very specialised vegetation and instream fauna and appropriate management and monitoring will ensure these areas do not shrink or degrade because of the geothermal resource use. Dr Keesing goes on to record that the proposed abstraction of water from the Okere River is small and therefore will not result in any aquatic adverse effects. Further, he states that discharges of stormwater, daily operations water and brine water will be able to be managed on site through treatment and appropriate ground discharge, such that no aquatic system or wetland will be adversely affected. In addition, Dr Keesing records that long term soil and air temperature and vegetation monitoring of the Taheke geothermal feature will ensure any changes are recognised and managed appropriately.

Air Quality

Mr Peter Stacey (Air Quality Consulting New Zealand) has been commissioned to address the air quality effects associated with the Taheke Geothermal Project. Mr Stacey records that the Proposal will result in both construction and operational air emissions. He notes that those activities likely to bring about the greatest potential to generate particulate emissions during construction include the development of the power station platform, operation of earth-moving equipment; construction of wells, pipelines and transmission lines, construction of new roads, movement of vehicles on unsealed access roads and the rehabilitation of construction areas. Mr Stacey considers that, based on the assessment he has undertaken thus far, with appropriate mitigation in place, the potential for dust effects will be confined to the immediate construction area. Mr Stacey notes that the nearest sensitive receptor is approximately 300 m from construction activities and, therefore, at a sufficient distance to not be affected by dust discharges.

In terms of operational emissions to air, Mr Stacey records that the geothermal fluid to be abstracted from the wells contains a small percentage of NCG (less than one percent), primarily CO_2 (carbon dioxide 95% of total), CH_4 (methane), N_2, (nitrogen), H_2S and various other minor air contaminants. He notes that most of these gases separate from the geothermal steam as it condenses, and that this gas stream is to be evacuated from the condenser and vented to the atmosphere above the air-cooled condenser or cooling tower. Mr Stacey states that H_2S is the primary air discharge that requires consideration as it has the potential to cause health effects and odour nuisance. He goes on to note that minor contaminants such as mercury and ammonia are also discharged but at much lower levels. Mr Stacey notes that based on his assessment so far, predicted concentrations of air pollutants are expected to be well below health-based assessment criteria. Consequently, he considers there to be limited potential for adverse health effects from the operation of the plant at nearby receptor locations.

Finally, Mr Stacey records that H_2S emissions from the plant have the potential to exceed the odour assessment criteria at nearby locations, however, based on the prevailing winds, the frequency of odours above the criteria is expected to be low, thereby reducing the likelihood of odour nuisance effects. He goes on to note that atmospheric dispersion modelling will be undertaken as part of the resource consent application to better understand the potential for odour to be experienced within the local community and confirm that nuisance effects will not occur.

Noise

Mr Malcolm Hunt (Malcolm Hunt Associates – Noise and Environmental Engineers) has been commissioned to address the noise effects associated with the Taheke Geothermal Project. Mr Hunt's assessment covers potential emissions associated with station construction, on-going station operation, intermittent sound from steam venting or bypass operation, in addition to noise emitted during occasional geothermal well drilling, well testing, and associated works in the steamfield. His assessment involves quantifying expected noise emissions using computer-based modelling methods to calculate noise levels expected in the area. For each of the two power station options, Mr Hunt has assessed noise levels predicted for the relevant receiver sites and compared these to the relevant noise performance standards. Mr Hunt's assessment is informed by recent results of measurements of existing ambient sound levels taken at three locations in the local area (including adjacent to sensitive receiver locations). The assessment of potential noise considers existing sound levels and quantifies how these will be relatively unaffected by noise from the operation of the proposed power station. While the assessment is informed by a comparison with ambient sound levels, the primary focus of the assessment is on compliance with the noise standards of the Rotorua District Plan and the New Zealand construction noise standard NZS6803:1999 Acoustics – Construction Noise.

Mr Hunt's assessment of noise effects has found that levels of noise emitted during normal operation for both power station generation options will be capable of individually fully complying with the applicable noise standards. Mr Hunt has conducted a separate assessment of noise to be emitted by each of the two power station options during intermittent steam venting (due to unforeseen circumstances) or operation under 'Bypass mode'. This has found that each of the two options will be able to comply with the applicable noise standards at the relevant noise assessment locations in the area. Further, Mr Hunt notes that noise emitted during the construction of the power station and ancillary facilities (both options) and steam field development will be able to be controlled and managed to achieve compliance with the New Zealand Construction Noise Standards. Mr Hunt notes that an assessment of noise levels emitted during infrequent well drilling associated with the Taheke geothermal development has found that the activity will be able to comply with the noise standards for well drilling. In summary, Mr Hunt considers that it is likely that noise emissions associated with various aspects of the proposed Taheke 8C geothermal project will have a 'less than minor' overall noise effect on the environment. Finally, Mr Hunt concludes that the low level of noise effect on the environment anticipated is due to precautions taken in siting the station and the low-noise type of activities proposed to be established as part of the Taheke Geothermal Project.

Traffic

Mr Ian Carlisle (Stantec New Zealand) has been engaged to address the traffic effects associated with the Taheke Geothermal Project. Mr Carlisle records that all site access is proposed to utilise the existing (but upgraded) site access on SH33 north of Maniatutu Road. In order to manage traffic and safety effects associated with this access, it is proposed to construct a fully formed intersection on SH33 to serve this access, including channelised turning facilities for right-turning traffic. Mr Carlisle notes that there is currently a 2.5 m shoulder which has been recently installed by Waka Kotahi for left turn in movements. The management of construction movements is proposed through the development of a Construction Traffic Management Plan ('**CTMP**') for the duration of the construction period associated with the Project. Waka Kotahi will be consulted as part of the preparation of the traffic assessment for the project to discuss the potential mitigation options.

Permits will be required from the Road Controlling Authority for any overweight and over dimension components. These permits are usually applied for at the detailed design stage and require the applicant to demonstrate safe and efficient movement of the vehicles. Mr Carlisle has not identified any impediment to the granting of such permits.

Mr Carlisle states that it is expected that the additional traffic generated by the proposed activity will have minimal effect on the operation of SH33, which is expected to continue to provide a high level of service to users. Following completion of the construction works, the operational traffic volumes are expected to be minimal and can be readily accommodated on the surrounding road network.

Landscape

Mr John Goodwin (Boffa Miskell) has been commissioned to address the landscape, visual and natural character effects associated with the Taheke Geothermal Project. Mr Goodwin notes that it is expected that a relatively large volume of earthworks will be required to create the access from SH33 to accommodate construction and maintenance traffic and to construct the flat platform for the proposed geothermal plant. He records that the power station platform will require the removal of a localised hillock which is approximately up to 20-30m high, with more localised earthworks required to construct the stormwater ponds, well platforms, pipeline supports and transmission line poles. Mr Goodwin considers that the required earthworks have the potential to result in adverse landscape effects due to the change and modification to the natural attributes of the Site, particularly the existing landform and existing land cover. However, he records that, given the location and relatively low elevation of the earthworks, coupled with the surrounding rolling topography which provides a high degree of screening of the Site area, it is anticipated that the visibility of the main earthworks (i.e. power

station platform) and their influence across the wider landscape will generally be contained, limiting the adverse effects on the wider character and visual amenity of the area surrounding the Site.

In terms of wells and pipelines, Mr Goodwin records that connections will be made from the existing and proposed production wells to the power station site via above ground steel pipes, with aluminium cladding. He notes that these are a characteristic feature of geothermal power projects and are often a visible feature viewed from roads in and around the Wairakei area near Taupō. Mr Goodwin records that some of the southern-most well heads and part of the pipe distribution network are likely to be visible from SH33 as low structural elements and are likely to somewhat contrast with the existing landscape character. He goes on to note that once completed, the wells and visible pipelines, with appropriate mitigation (e.g. landform rehabilitation, revegetation and use of recessive colours on the most visible infrastructure) should enable these elements to be integrated into the existing landscape setting.

Mr Goodwin records that the height of the power station and associated structures are expected to be in the order of 14m - 25m above the platform (depending on design solution selected). The power station and associated structures will be located within a valley area away from SH33 and once constructed, both options are not expected to be visible from the road or adjacent properties to the south, ensuring that any adverse effects on the landscape character and visual amenity of the area are contained and minimised. In terms of the transmission line, Mr Goodwin states that the transmission line will be installed on 22m tall monopoles over a distance of approximately 1.8km. He notes that some earthworks will be required for the poles in order to construct its foundation, as well as the creation of an access track to provide construction access to each structure. Works required to provide construction access to the new transmission line would be partially restored upon completion of construction, leaving behind a 'farm style' track to provide maintenance access. Due to the location of the transmission line on hill tops and high points within the landscape, Mr Goodwin records that the extent of visibility is wider than that of the power station, however generally limited to the surrounding hills and areas of commercial forestry. He notes that no views from residential properties or SH33 are available.

Overall, Mr Goodwin states that based on the information currently available it is considered that the construction and operation of the development is unlikely to result in any significant effects on the landscape of the site and surrounding area. He records that mitigation measures, once implemented, would assist in reducing adverse effects resulting from the Proposal and that such mitigation measures should include siting of all proposed components to minimise adverse effects on the existing landform and indigenous vegetative characteristics of the site; rehabilitation of disturbed land through shaping and integrating landform to reflect the character of the surrounding topography; planting of appropriate indigenous plant species to screen and integrate structures, stormwater ponds and other elements of the Proposal.

Cultural Effects

Mr Buddy Mikaere (Buddy Mikaere and Associates) has been engaged to update his previous Cultural Impact Assessment ('**CIA**') for the Site in terms of the Taheke Geothermal Project. Mr Mikaere had prepared the Taheke 8C Geothermal Project CIA (dated July 2010) and undertaken further work regarding the same (an addendum) in 2014. In updating his previous assessment Mr Mikaere records that further to his September 2022 Site visit, that the potential impact on cultural values brought about by the Taheke Geothermal Project, are, as a result of the co-operative nature of the Proposal, with the Proprietors of Taheke 8C and Adjoining Blocks Incorporated ('**Taheke 8C'**), being a partner in the Project, considered to be less than minor and should not be an impediment to the granting of any required resource consents.

Mr Mikaere records that the outcomes of his 2010 and 2014 assessments remain unchanged. In this regard, while he acknowledges that the project has advanced since his previous work, he confirms that none of these changes are of a magnitude that would impact the cultural aspects of the Project and his earlier assessment of "less than minor" still stands. In terms of his previous work, Mr Mikaere records that the use of the land should be of a nature that enhances Taheke 8C's kaitiaki role, and that the historic site, Te Pakira, and land known as Waikite (that has important spiritual values) should be avoided. Further, Mr Mikaere notes that, as far as possible, native bush stands should be protected. Mr Mikaere further records that it will be important to maintain the sustainability of the geothermal taonga resource and also to minimise and carefully manage earthworks required as part of the Proposal. He recommends that landscaping and planting in respect of earthworks and other development work will ensure that the Taheke Geothermal Project's impact is minimised. Mr Mikaere highlights that his previous assessment found no impact on traditional sites within the Project footprint, or indeed, on known occupation sites of more recent origin. Neither were there any ecological concerns. Similarly, with regard to indigenous flora and fauna, Mr Mikaere states that the Project impact was determined to be less than minor. Mr Mikaere goes on to note that the water take for the project from the Okere/Kaituna River was also found to have less than minor effects with no discernible impacts on river morphology or ecology, and importantly, was culturally acceptable thereby meeting Part 2 sections 6(e), 7(a) and 8 of the RMA (1991). Mr Mikaere notes that his 2014 CIA addendum dealt with an application to increase the water take from the Okere/Kaituna River at the project abstraction point. Mr Mikaere states that the water drawn from the Kaituna River is not in sufficient quantities to have a negative impact on river flows, ecology or customary fisheries.

Overall, as highlighted above, Mr Mikaere suggests that in complying with the relevant provisions of the local and national government policy and with the appropriate mitigation measures in place, there are no cultural issues that should prevent the Proposal from proceeding.

Archaeology

Sarah Phear and Richard Shakles (Clough and Associates Limited ('**Clough**')) have been retained to update an archaeological assessment that Clough had previously completed for the Site and to provide any archaeology assistance required. Within their October 2022 Archaeological Assessment *'Taheke 8C Geothermal Project, Bay of Plenty – Fast Track Archaeological Assessment',* Clough notes that Taheke has been occupied by Ngati Pikiao for many generations. Clough goes on to state that the geothermal area located within the Taheke Block is based around the Onepu Stream which drains into the Kaituna River. Clough records that although the thermal areas were treated with respect, they were not considered tapu, with the only tapu areas identified around the block being the urupa, of which one was located north-west of the Taheke Block around a settlement called Te Pakira. Clough states that a number of archaeological sites have been recorded in the general vicinity of the project area, the majority of sites recorded are pā, most of which were recorded in the 1960s along the banks of Lake Rotoiti. Only one archaeological site identified (U15/772) is located within an area of potential development – however it is not within the footprint of works. Clough note that a very small amount of shell midden was identified and recorded during forestry operations at Ruahine Forest Harvest Area 1541 in 2020 (U15/823). However, the site has been destroyed, with the remnant shell the only remaining element. Further, the site is outside of the proposal area. In addition, Old Coach Road (NZTM E1895127 N5722159) is located on the eastern side of Taheke Papakainga 28, the thermal area. Clough records that the road from the old coach road to the thermal area would have been heavily modified during sulphur mining for much of the 20th century. The alignment of the old coach road and the road to the thermal area have not been recorded under the NZAA site recording scheme as they have been extensively modified over the last century, with the only valuable level of recording being the original alignment of the roads which is clearly visible on both historic and modern plans.

Overall, Clough records that the Proposal will have no adverse effects on archaeological values as no recorded archaeological sites are located within the proposed project footprint. However, Clough states that the Proposal will require significant earthworks, with the full detail of earthworks and design not yet known. Given this, it is possible that unrecorded subsurface remains may be exposed during any proposed development. This is not considered to be a high probability, however, to address potential effects, Clough recommends further survey work and measures such as an Accidental Discovery Protocol and an Archaeological Management Plan, with an Archaeological Authority applied for if effects on the site cannot be avoided, or if any further archaeological remains were exposed during development.

Reservoir Engineering

Mr Alan Clotworthy (Senior Reservoir Engineer, Private Consultant) has been retained to address the Reservoir Engineering associated with the Taheke Geothermal Project. In providing background to the Taheke Geothermal Project, Mr Clotworthy notes that to date, three slimhole wells and two deep wells have been drilled. The wells drilled by Contact Energy were: T8C-M01 slimhole to 1106 m, T8C-M02 slimhole to 635 m, T8C-M03 slimhole to 1045 m, T8C-P01 deep deviated exploration/production well to 2062 m, and T8C-P02, a deep deviated production well, was drilled by Eastland, to 1519 m (1370 m vertical). These wells have been / are being used, together with other geoscience information and modelling to understand the reservoir characteristics and resource sustainability'

With regard to the potential adverse effects from production at Taheke, Mr Clotworthy records that the positive aspects of the Taheke geothermal system include the high temperature and high permeability encountered by T8C-M03 and T8C-P02, which will result in an efficient use of the resource and limited requirement for injection of separated brine and condensate.

Mr Clotworthy records that the thick clay cap overlying the high temperature geothermal resource means that there should be minimal interaction with the overlying groundwater system. This will also result in more sustainable production from the reservoir. He notes that the flow of heat and fluid from the geothermal reservoir to the surface features at Taheke is relatively small compared to most fields. Monitoring of the thermal features to date has shown substantial seasonal variation. The monitoring conducted during the T8C-P02 discharge test did not show any significant response, although the test period was limited. Mr Clotworthy considers that ongoing monitoring will provide evidence of adverse effects, if any occur.

Mr Clotworthy notes that the connection, if any, between Taheke and Tikitere is uncertain and is best estimated by numerical modelling (as addressed further in Dr Clearwater's Reservoir Modelling commentary below). He states that, should there be a connection, then injection may potentially be used to mitigate the impact.

Mr Clotworthy states that T8C-P02 steam contained a relatively high level of green-house gases (CO2 and CH4). However, the partial pressure of CO2 declined from 3 bar in January to 2.2 bar in June. The presence of condensate in the steam zone indicates cooling and hence accumulation of gases. He consider that it is likely that the historically accumulated gas level will decline to a lower level during the first few months of production.

Mr Clotworthy records that the evidence from the discharge test of T8C-P02 is that there appears to be limited natural recharge and therefore the nature and location of injection is expected to be important for maintaining pressure and production over the period of the resource consent.

Experience in other geothermal fields, according to Mr Clotworthy, shows that it is not possible to have sufficient information regarding the flow paths within the reservoir to accurately predict the rate of return of injected fluids back to the production wells. Given the nature of the Taheke resource, with separate steam and liquid zones, Mr Clotworthy considers that the injection strategy will be more complicated than for other, liquid-dominated fields, in the region. He states that adaptive management will be required to initially locate and possibly re-locate injection wells both in terms of horizontal and vertical separation. Flexibility for injection locations is important.

Finally, Mr Clotworthy notes that If the discharge enthalpy remains high, it is possible that supplementary injection of groundwater or wastewater would be beneficial for sustainability of the resource.

Reservoir Geology

Dr Phil White (Panda Geoscience Limited) has been retained to address the Reservoir Geology associated with the Taheke Geothermal Project. Dr White records that the Taheke geothermal field lies near the northern end of the Taupo Volcanic Zone **('TVZ'**), a zone extending from Ruapehu to White Island where volcanic activity has been focused over the last 2 million years. He goes on to state that at Taheke, the greywacke basement has been downfaulted to a depth of about 900m below sea level, and is overlain by a sub-horizontal sequence of lavas, pyroclastic deposits and volcanic-rich sediments. Dr White notes that the geothermal system is hosted in both the greywacke basement and the overlying volcanic and sedimentary units, and that on the Proposal Site, surface thermal features comprise steaming ground and fumaroles. He goes on to state that the heat source for the geothermal system is expected to be a buried magma, and that while the location of that heat source is unclear, well data suggests that it is not beneath the thermal area, but to the south of the wells that have been drilled on site to date. The Mourea Fault cuts through the Taheke area from southeast to northwest, close to the location of SH35, along with many other minor faults.

Dr White considers that based on a regional analysis, the most extensional (*i.e.* most permeable) faults at Taheke will be oriented ~070° (ENE), which is different from most of the TVZ (025 to 040°). Given this, drilling has been oriented towards the southeast as this would be across the most permeable structures and towards the heat source. Previous drilling has identified high temperatures in the area. However, high permeability is also required for a good production well. Dr White notes that the intersection of the fault and the well have coincided with excellent permeability.

Dr White is of the opinion that ground subsidence associated with the Taheke Geothermal Project is expected to be minimal. This is because reservoir pressure decline will be managed through reinjection that, overtime, will need to be adapted to ensure targeted and sustainable reservoir management for the long term. Further, injection wells will be located to the north of the production area. It is proposed that the injection wells will return fluids to a part of the reservoir that is sufficiently close to the production area so as to maintain reservoir pressure, but far enough away that they will not cause rapid cooling. Monitoring for subsidence associated with the Taheke Geothermal Project will include regular field surveys. Subsidence rates are not expected to be an issue of concern, as a result of the Proposal.

Reservoir Chemistry

Dr Kevin Brown (GEOKEM Geothermal and Environmental Geochemistry) has been engaged to address the Reservoir Chemistry associated with the Taheke Geothermal Project. Dr Brown notes that chemical samples were obtained from well T8C-P02 during a limited discharge of the well on 14 – 18 June 2022. In addition, Dr Brown states that a further downhole sample was obtained at 1175m CHF on 19th June after the well had been shut in and was not flowing to the surface. Dr Brown records that the chemical components of this suite of samples are the basis for defining possible adverse discharges to the environment.

Dr Brown considers that the chemistry of the downhole samples is consistent with a model of a deep brine flow from the bottom of the well and a mainly steam flow plus small weak brine/ condensate into the well above that. He states that during discharge of the well, brine from the deep inflow mixes with steam and brine/condensate liquid from the steam inflow and both rise in the well. When the well is shut in, the liquid/condensate from the upper inflow flows down the well and into the deep brine. Dr Brown notes that comparison of the flowing downhole samples and the static downhole sample showed that the total of the liquid discharge into the well consisted mainly from the deep flow and only a little from the upper mainly steam inflow. Dr Brown considers that the chemical components of the brine from the deep inflow are typical of geothermal fields throughout the TVZ.

With regard to surface samples, Dr Brown notes that 70% of the mass flow is vapour (steam and non- condensable gases -NCGs), and 30% is brine. With continuing discharge, slightly more brine was being produced, and this trend is expected to continue. The proportion of NCGs in the vapour phase also increased slightly as the discharge continued. Dr Brown records that the principal component of the NCGs is carbon dioxide (CO_2), with lesser amounts of hydrogen sulfide (H_2S), methane (CH_4) and hydrogen (H_2). He notes that there are also very small amounts of mercury (Hg) in the vapour phase, together with other gases of no environmental concern. Dr Brown goes on to note that the liquid phase is a dilute sodium/potassium chloride brine typical of the fluids discharged from geothermal developments in the TVZ. He states that the brine does contain low levels of elements of environmental concern such as arsenic and antimony. In addition, he notes that at the temperature and pressure of the proposed power plant, about 75% of the mass produced will be steam and gas and about 25% will be liquid brine.

In terms of discharges to the environment, Dr Brown records that the liquid brine has a number of components of environmental interest, and these will all normally be reinjected back into the deep formation in the brine during production. During plant outages or other special circumstances, the brine may be diverted to lined ponds at the surface and later injected back into the ground. As identified, Dr Brown further records that the well T8C-P02 has considerable concentrations of NCGs. Calculations show that the likely 'equivalent CO_2 concentration' that could be discharged for ETS purposes would be around 50,000 ppm. However, it is planned that these NCGs will also all be injected back into the formation. Rarely, during plant trips or at plant start up, some NCGs may temporarily be discharged to the atmosphere (with discharges to the atmosphere being addressed by Mr Stacey, above). Consequently Mr Brown states that during normal operation of the Taheke Geothermal plant, there will be no adverse discharge of any geothermal liquids or gases to the environment.

Geophysics

Dr William Cumming (Cumming Geoscience) has been engaged to address the Geophysics associated with the Taheke Geothermal Project. Dr Cumming records that the Taheke resource conceptual model used to support well targeting and the numerical simulation of the Taheke geothermal reservoir has been constrained by the subsurface results from the five deep wells and the extrapolation of these results using Magnetotellurics[1] ('**MT**') resistivity images derived from 41 MT stations acquired by Contact Energy in 2010-2011 and 101 MT stations from Mercury in 2005-2010, the location and chemistry of surface manifestations, surface geology and related geoscience and hydrologic data.

Dr Cumming notes that the main elements of the Taheke conceptual model illustrate a >300°C upflow located south of the wells, consistent with the existence of a larger scale heat source below the lake that might be shared with Tikitere to the south, without necessarily implying a hydrologic connection to Tikitere. He states that the smectite clay confirms the usual correlation of smectite clay with low MT, while the isotherms are constrained by measured temperatures where wells are available and have been extrapolated using the correlation of low MT resistivity with the impermeable smectite clay cap that controls the buoyant flow path of hot water. However, because the smectite-rich zone at Taheke is, in part, correlated with sediments and weathered volcanic tuffs rather than hydrothermal alteration, Dr Cumming states that the low resistivity zone is likely to extend beyond the geothermal system.

Dr Cumming records that deep permeability appears to be strongly localised on the Mourea Fault. He states that, in the conceptual model, the Mourea Fault constrains the > 300°C upflow so that it forms a relatively thin boiling outflow extending to the north of the very productive well T8C P02. The 300°C outflow extends northward from well T8C P02, declining to 240°C to the northwest below the fumarolic area and further declines in temperature and significance to the northeast into the plane of the cross-section. Dr Cumming records that because only one well constrains the geometry of the 300°C zone, and because the MT stations near well T8C-P01 are ambiguous (due to interference from power line noise), alternative models for the > 300°C upflow and 300°C outflow are feasible. For example, the structural geology suggests that the > 300°C upflow might be more closely aligned with the Mourea Fault. Dr Cumming goes on to note that the model has been emphasized in the reservoir modelling and simulation because it seems more consistent with the

[1] **Magnetotellurics** (**MT**) is an electromagnetic geophysical method for inferring the Earth's subsurface electrical conductivity from measurements of natural geomagnetic and geoelectric field variation at the Earth's surface.

geochemistry of the boiling 300°C zone, the permeability associated with 270°C zone closer to the bottom of the well, and the general expectations for a more extensive heat source deep below the lake.

Reservoir Modelling

Dr Jonathon Clearwater (Flow State Solutions) has been retained to undertake the Reservoir Modelling for the Taheke Geothermal Project. Dr Clearwater records that a full field numerical model of the Taheke geothermal system has been developed and calibrated to available data. He states that the Taheke Reservoir Model grid covers a vertical extent from ground surface to -3100 masl and a lateral extent of 12km by 16km and is based on the 2022 conceptual model developed by the Taheke Reservoir Team. Dr Clearwater notes that key resource features of the conceptual model are an upflow to the south of the existing wells, the existence of a thin steamzone at -650 masl near T8C-M03 and T8C-P02 and an outflow to the north and to the Taheke Thermal Area. He notes that a connection between the Taheke and Tikitere geothermal systems is considered unlikely, but since such a connection is possible, the numerical model grid extends to cover the assumed boundaries of both the Taheke and Tikitere geothermal systems so that the model can be used to assess the potential impacts at Tikitere from the development of the Taheke Geothermal Project.

Dr Clearwater considers that the model obtains a reasonable match to measured pressure and temperature data from wells T8C-M01, T8C-M02, T8C-M03, T8C-P01 and T8C-P02. Further, he states that the model also reproduces the high enthalpy discharge from the flow tests at T8C-M03 and T8C-P02 and the pressure recovery observed during the T8C-P02 flow test.

Dr Clearwater records that the numerical model is adequately calibrated to be used in running forecast scenarios to broadly assess the sustainable level of production from the reservoir. Forecasts run with the model indicate that the Taheke Geothermal Resource can support a production rate of 10,000t/day over a 30-year forecast period. Dr Clearwater highlights that further work will continue to refine and improve the model as new data is available.

With regard to effects, Dr Clearwater notes that subsidence at Taheke is expected to be minimal due to the forecasted modest change in reservoir pressure and favourable geologic setting (as discussed by Dr White). The numerical model will be used to make quantitative subsidence forecasts to be considered during the consenting process.

Further, and as highlighted above, Dr Clearwater states that a connection between the Taheke and Tikitere geothermal systems is unlikely, but possible. In the numerical model, the two systems are fed by separate upflows and separated by low permeability above -1500 masl. Between -1500 and -1750 masl a zone of moderate permeability is assumed to connect the two systems at depth. He states that this is a conservative assumption that enables pressure changes at Taheke to be transmitted to Tikitere. If a permeable connection does not exist, then there will be no effect at Tikitere. If a connection exists, as is assumed in the modelling, then the pressure change at Tikitere will be dependent on the production and injection strategy used to develop the Taheke Geothermal Project. He records that in numerical model forecasts with 98% of produced fluid reinjected into the reservoir, there was less than 1 bar pressure change at Tikitere.

Dr Clearwater states that measurements of heat and mass flow from the Taheke Thermal Area show substantial natural variation. He notes that it is possible that development of the Taheke geothermal resource may cause additional changes, however these may be hard to determine given the natural variation. Dr Clearwater records that modelling suggests that the change in heat and mass flow from the Taheke Thermal Area will be dependent on the pressure change local to the Taheke Thermal Area, and that this pressure change will be influenced by the production and injection strategy used to develop the resource.

Dr Clearwater concludes that the forecast changes in reservoir pressure and temperature are comparable to changes observed in other developed New Zealand geothermal fields . Numerical model investigations suggest that adverse pressure impacts at Tikitere and/or effects on surface feature flow can be mitigated by an appropriate production and injection strategy during field development.

PART IX: PURPOSE OF THE ACT

Economic benefits and costs:

Peter Clough (NZIER) has been engaged to provide an economic assessment of the Taheke Geothermal Project in accordance with the COVID-19 Recovery (Fast-Track Consenting) Act 2020. This assessment is enclosed, and is summarised in this section. Please also see enclosed "Cover Letter" for an overview of the Taheke Geothermal Project's application.

If consented, the ROOPU Whakarite Mahi Limited Partnership (the 'Partnership') will bear the costs of constructing the power station in expectation of earning return on its investment from the revenues from sale of its electricity, either from contracted customers or from participation in the wholesale electricity market. The Māori owners of The Proprietors of Taheke 8C and Adjoining Blocks Incorporated will, in turn, receive rent from the lease of the land and dividends from the profits of the operation after its debt is reduced. Those can be used to fund longer term economic development for their people through investment in training and job creating ventures.

Rotorua's share of national GDP is proportionately smaller than its share of the population, and its GDP per capita is smaller than the average for the Bay of Plenty Region and New Zealand. Nevertheless, Rotorua achieved a positive annual average growth rate for the 10 years up to 2021, built around primary production and the growth in tourism over that period. The Rotorua District has seen its economic activity contract through the COVID-19 pandemic, largely due to the border shut-downs and loss of tourism revenue to the District. Tourism spending in Rotorua almost halved between 2019 and 2021 and its contribution to Rotorua District's GDP fell from about 11% to 6% over the same period. With the impact of COVID-19 and the precautionary restrictions such as border closures, its economy shrank between 2020 and 2021 by more than the national average, while that of the Bay of Plenty region as a whole continued to experience positive growth.

Tourism accounted for 11% of Rotorua District's GDP in 2019, compared to about 4.6% of GDP nationwide. In 2021, with COVID-related border restrictions excluding almost all foreign tourists, tourism's share of GDP had shrunk (by 46%) to 6.2% in Rotorua District and (by 42%) to 2.8% in all New Zealand. While there was some rise in domestic tourism by New Zealanders precluded from overseas travel in this period, many tourism businesses had a lean time and could not support as many employees as in previous years. This contributed to Rotorua's employment shrinking by 2.9% between 2020 and 2021 after seven previous years of continuous growth.

A report by the Ministry of Business Innovation and Employment to a Bay of Plenty Regional Leadership Group identified a range of factors that would make recovery from COVID-19 disruptions challenging for the region, exacerbated by sub-regional variation in job losses. These included:

- Bay of Plenty has higher unemployment and lower household incomes than the national average.
- Tourism-dependent areas like Rotorua faced greater job loss than more diverse areas.
- Māori, youth and women were particularly hard hit by their greater presence in tourism-reliant hospitality and retail sectors.
- Business uncertainty had caused a shift towards greater reliance on casual and fixed-term workers with fewer opportunities for permanent employment.
- Existing skills shortages were exacerbated by border closures and the inability to access permanent or temporary workers from abroad.
- Forestry and wood processing increased mechanisation of their operations to counter worker scarcity, creating fewer opportunities for long-term post-COVID employment.
- Shovel-ready construction projects have absorbed some locals facing 'redeployment' by COVID-related lay-offs.

New projects like the Taheke geothermal development aid economic recovery from COVID-19 disruption by creating new demand for labour in the locality, payment of wages in the District, and new spending on goods and services from local suppliers, all of which help to increase incomes and well-being in the locality. Labour requirements may not be a perfect match for the skills of people who have lost their jobs from COVID disruption, but there will be opportunities for people to adapt to new jobs and acquire new skills and experience that will increase their resilience against future changes.

The Taheke Geothermal Project is a 'shovel-ready' project that can be swiftly brought on stream to provide spending and employment to help the District's recovery from COVID-19. It is expected to cost around s 9(2)(b)(ii) over several years, with construction concentrated over a three-year period. Excluding around s 9(2)(b)(ii) spent on generation and other electrical equipment that will be mostly imported, it will inject around s 9(2)(b)(ii) of capital investment into the local economy, much of it going to local suppliers of materials, services and labour, supporting business and wellbeing in the local economy.

It contributes to various objectives identified in section 19 of the COVID-19 Recovery (Fast-track Consenting) Act 2020 and warrants consideration under the Act for providing:

- Economic benefits for people and industries in the region affected by COVID-19, through employment generation and flow on effects, mostly in the construction phase;
- A source of power and local employment to support social and cultural wellbeing for current and future generations for decades to come;
- Ability to progress the project faster than would otherwise be the case, bringing those benefits forward into the near-term post-COVID recovery period.

The Taheke Geothermal Project will require a range of jobs in its construction stage, including relatively unskilled labourers who could be sourced from people in other industries who lost their jobs due to COVID-19. Staff specialised in geothermal development are more likely to come from Kawerau, which is still part of the broader Bay of Plenty Region and with employment challenges of its own.

The primary economic benefit of the Taheke geothermal power station will be harnessing geothermal energy to produce electricity. The combined effects on electricity consumers of building a geothermal power station at the Taheke site would be:

- Suppression of power price increases that could arise with 'alternative futures' without the Taheke development
- Avoidance of transmission losses that translate into lower transmission charges across the electricity system
- Reduced probability of supply disruption because the addition of new geothermal capacity near North Island markets increases the diversity of the portfolio of generation plant and reduces reliance on transmission of power from mainly South Island hydro plant
- The cost of the new power station's grid connection and transmission to market will ultimately be borne by consumers, but Taheke's North Island location will make that less than from some other potential generation sites that are more distant from main market demands.

Overall, Mr Clough states that the Taheke Power Station would add 3% to New Zealand's geothermal generation capacity and 4% to its annual geothermal generation, contributing to reducing greenhouse gas emissions and helping New Zealand's efforts to mitigate climate change and transition more quickly to a low emissions economy. By locating in an area where electricity demand exceeds generation capacity, the Project improves electricity supply by reducing transmission losses. Further, Mr Clough states that it also improves resilience by providing a source of renewable power that is less affected by meteorological hazards of climate change than other forms of renewable generation.