IN THE MATTER	of the Resource Management Act 1991
	AND
IN THE MATTER	of an application to the **BAY OF PLENTY REGIONAL COUNCIL** by **NGATI TUWHARETOA GEOTHERMAL ASSETS LIMITED** for a change to the conditions of a resource consent (67151) that authorises the discharge of geothermal water from the eastbank of the Tarawera River

STATEMENT OF EVIDENCE OF JOHN GREGORY BURNELL

1. INTRODUCTION

1.1 My full name is John Gregory Burnell. I am employed by GNS Science as the Energy Research Leader and as a Senior Scientist with responsibility for modelling of geothermal reservoirs.

Qualifications and experience

1.2 I have the following degrees; all from Victoria University of Wellington:

(a) Bachelor of Science (Hons) in Mathematics (1979).

(b) Master of Science in Mathematics (1981).

(c) PhD in Applied Mathematics (1985).

1.3 In terms of professional experience, I note that:

(a) From 1981 to 1985, I lectured in mathematics at Victoria University of Wellington.

(b) In 1986, I joined the Applied Mathematics Division of the Department of Scientific and Industrial Research (DSIR) to undertake research and consulting in geothermal energy development.

(c) In 1992, DSIR was restructured and the Applied Mathematics Division became part of Industrial Research Limited (IRL). At IRL, my work involved modelling heat and mass flows in geophysical and industrial settings.

(d) Since 2013, I have worked for GNS leading geothermal reservoir modelling activities. In 2019 I became the GNS energy research leader.

1.4 I specialise in the mathematical modelling of geothermal systems. During the past 35 years, I have been involved in many research and development projects related to modelling geothermal systems. The research has included:

(a) work on the theory of two-phase flow in porous media;

(b) developing modelling software;

(c) incorporating chemistry into geothermal models;

(d) wellbore modelling; and

(e) pressure transient analysis.

1.5 I have undertaken consulting work in New Zealand, Japan, the Philippines and Papua New Guinea. Some of these projects include:

(a) Modelling the Ngawha geothermal system. I developed a reservoir model of Ngawha for Top Energy between 2014 and 2017. This work supported an assessment of the sustainability of future expansion of power generation at Ngawha. I presented this work as an expert witness at a consent hearing looking at the impact of increasing the level of extraction and reinjection of geothermal fluids.

(b) Modelling the Ngatamariki geothermal system. I developed a numerical reservoir model for Mighty River Power (MRP) between 2009 and 2011. This modelling work supported the assessment by MRP of the development size and was used during the resource consent application to predict the potential impact of the proposed development. I presented this work as an expert witness at the consent hearing. This model is still being used by MRP for field management.

(c) Modelling the Rotokawa geothermal system. I developed a numerical reservoir model for MRP in 2011 and continued to work on the model until 2014. This model has been used by MRP for on-going management of the Rotokawa field.

(d) Modelling the Tauhara geothermal system. I developed a numerical reservoir model for the Tauhara Middle 15 and Mountain Trusts in 2010.

This model was used to assess the impact of the proposed Tauhara II development by Contact Energy.

(e) Modelling the Wairakei geothermal system. I developed a numerical reservoir model for Geotherm Limited between 2001 and 2004. The model was used to support the resource consent application by Geotherm Limited for a new development at Wairakei and to assess the impact of the concurrent application of Contact Energy. I presented evidence on this work as an expert witness at the consent hearing.

(f) Modelling the Rotorua geothermal system. I have worked for the Bay of Plenty Regional Council since 1992 undertaking modelling activities related to the Rotorua system. This included appearing as an expert witness at an Environment Court hearing in 1998. The Rotorua model has been used to inform the regional council about sustainable levels of abstraction from the Rotorua system.

(g) Modelling the Lihir geothermal system in Papua New Guinea. I developed a numerical reservoir model for Lihir Gold between 2005 and 2010. This model was used to help Lihir Gold plan a geothermal development and mining operations.

(h) Modelling the Mt Apo geothermal system in the Philippines. I have been developing a numerical reservoir model for Energy Development Corporation since November 2013. The purpose of this model is to assist field management.

(i) I am the principal developer of the software suite GeoCad, which is a preprocessor for the TOUGH2 numerical geothermal simulator. This software suite is used throughout the world.

(j) Development of the wellbore simulator GFLOW software programme that is sold worldwide by the Japanese company GERD.

Involvement in the project

1.6 I was engaged by Ngati Tuwharetoa Geothermal Assets Limited (NTGA) to assess the effects on the Kawerau Geothermal Reservoir of delaying reinjection of the east bank discharge to the Tarawera River from 2021 to 2035. In that regard, I produced a technical report, "Assessing the Impact of Delaying Reinjection of NTGA River Discharge" (Burnell, 2020), that was included with the assessment of environmental effects in support of the application. I also provided additional information to Dr. Jonathon Clearwater who reviewed this report.

Purpose and scope of evidence

1.7 The purpose of my evidence is to address issues relevant to sustainability of the resource and to induced subsidence. I also address issues raised in submissions and in the officer's report that are relevant to my area of expertise.

1.8 My evidence is structured as follows:

(a) A summary of extraction from and reinjection into the Kawerau geothermal reservoir and use of the Kawerau Geothermal Reservoir Model for future forecasting (Section 3).

(b) A description of future forecasts developed to assess the impact of delaying reinjection of the current east bank river discharge, and results of those forecasts (Section 4).

(c) A discussion of the impacts on the Kawerau reservoir (Section 5);

(d) Predictions of future subsidence (Section 6).

(e) Comment on the reinjection issue raised in the submission by Te Runanga o Ngati Awa (Section 7).

(f) Comments on issues raised in the officer's report (Section 8).

1.9 A summary of my evidence is set out in Section 2 below.

Expert Witness Code of Conduct

1.10 I have read the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note (2014) and I agree to comply with it. I can confirm that the issues addressed in this statement are within my area of expertise and that in preparing my evidence I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. SUMMARY OF EVIDENCE

2.1 I have conducted an investigation into the impact on the Kawerau geothermal reservoir of delaying, from 2021 to 2035, the reinjection by NTGA of geothermal water that is currently discharged into the Tarawera River from the East Bank discharge point.

Effects on the reservoir

2.2 This investigation has been undertaken by developing scenarios for the numerical reservoir model (KRMV5) to assess the effects on subsurface conditions (pressure, temperature, steam fraction) in the reservoir. I have developed Case A versions of the scenarios which represent the currently consented reinjection arrangement and Case B versions which represent the proposed application reinjection arrangements.

2.3 The results of this work predict that delaying reinjection of the East Bank river discharge until 2035 has a negligible effect (less than 0.1% for the extracted energy of all developers over 50 years) on conditions in the geothermal reservoir and, as a result:

(a) will not impact the activities of the other developers / users of the geothermal reservoir; and

(b) is fully consistent with the long-term sustainability of the Kawerau geothermal resource

Effects on subsidence

2.4 I have also investigated the impact of the application on any subsidence induced by geothermal operations at Kawerau. Due to version differences with the official reservoir model and subsidence model, a new subsidence model was developed and calibrated using broadscale historical changes in reservoir conditions.

2.5 This subsidence model was used to predict the impact of delaying reinjection. The result is that there is predicted to be a negligible amount of extra subsidence associated with the consent application scenarios over the production area and a minor decrease around the reinjection area.

Comment on reinjection issue raised by Te Runanga o Ngati Awa

2.6 The submission by Te Rūnanga o Ngāti Awa (TRONA) states:

> *"There is various research which suggests reinjection is very important for all types of geothermal reservoirs."*

2.7 As a general statement, this is valid. However, past analysis indicates that there is a substantial level of natural recharge occurring in the Kawerau reservoir, which is not a common occurrence. The reservoir model was calibrated to include the effects of this natural recharge, and predictions from the model demonstrate that delaying reinjection of the east bank river discharge has a negligible effect on the state of the reservoir. In my opinion, reinjection is less important for maintaining reservoir conditions at Kawerau than in other geothermal systems.

Comments on issues raised in the officer's report

2.8 The officer's report comments on uncertainty in the assessment of subsidence I made in my report (Burnell, 2020), but concludes the following:

> *"Therefore, I believe it is reasonable to assume that the potential adverse effects on the geothermal system and therefore other geothermal users associated with the continued discharge of geothermal fluid to the river are likely to be appropriate, despite the uncertainty resulting from the Subsidence Model not being calibrated to the most recent version of the Kawerau Reservoir Model."*

2.9 I agree with the reporting officer's comments, which are further supported by the updated calculation I have made which predicts a negligible amount of extra subsidence associated with the consent application scenarios.

3. SUMMARY OF EXTRACTION FROM AND REINJECTION TO THE KAWERAU GEOTHERMAL RESERVOIR AND USE OF THE KAWERAU GEOTHERMAL RESERVOIR MODEL FOR FUTURE FORECASTING

3.1 In my report, Burnell 2020, I summarise the current levels of extraction and reinjection in the Kawerau geothermal system. Four operators are currently extracting 5,569 tonnes/hour (t/h) of geothermal fluid from the system and reinjecting 3,776 t/h.

3.2 Around 400 t/hr of geothermal water flows through the Umupokapoka Lagoon, bathpools and flows to the Tarawera River from the West Bank outfall. A further 470 t/hr of geothermal water is cooled down and flows to the Tarawera River from the East Bank outfall. The impacts of delaying, from 2021 to 2035, the reinjection of this east bank discharge to the river back into the reservoir has been the focus of my investigations.

3.3 To assess these impacts, a numerical reservoir model was used. This provides a means to make quantitative predictions of the future behaviour of the system. A reservoir model can be used to estimate the system state (pressure, temperature, steam fraction) and how it changes as a result of future extraction from and reinjection into the reservoir.

3.4 The current Kawerau Reservoir Model has been under development by Mercury since 2012 (Mercury, 2019). The latest version is V5 (KRMV5), which was updated in late 2019. GNS did not have direct access to the reservoir model, but prepared scenarios to be run by Mercury and was provided with summaries of the model output.

4. MODEL FORECASTS

4.1 The forecast scenarios developed to assess the impact of delaying the reinjection of the East Bank river discharge are presented in Section 2 of my report (Burnell, 2020). The forecasts were run for 50 years. There were two groups of scenarios with two subcases shown in Tables 4.1 and 4.2.

Table 4.1 Forecast scenarios considered for this assessment.

	Description
Scenario 1	In this scenario, all operators at Kawerau (NTGA, KGL, GDL, TAOM) produce and inject at full consent conditions.
Scenario 2	This is a variant of Scenario 1 with NTGA production spread over a wider area.

Table 4.2 Summary of forecast scenarios sub-cases.

	Description
Sub-case A	For this sub-case, the East Bank Tarawera River discharge is transferred to deep reinjection in 2021. This is what is required by current consent conditions.
Sub-case B	For this sub-case, the East Bank Tarawera River discharge is transferred to deep reinjection in 2035. This is what is proposed by the application to change the conditions of consent.

4.2 The difference between Scenarios 1 and 2 is the locations of future NTGA production wells. Sub-case A represents the current consent conditions and Sub-case B represents the consent application.

4.3 The results of these forecasts are also presented in Section 2 of my report (Burnell, 2020). The results consider differences in reservoir pressures and in extracted energy. An example of the predicted enthalpy (analogous to extracted energy) is shown in Figure 4-1.

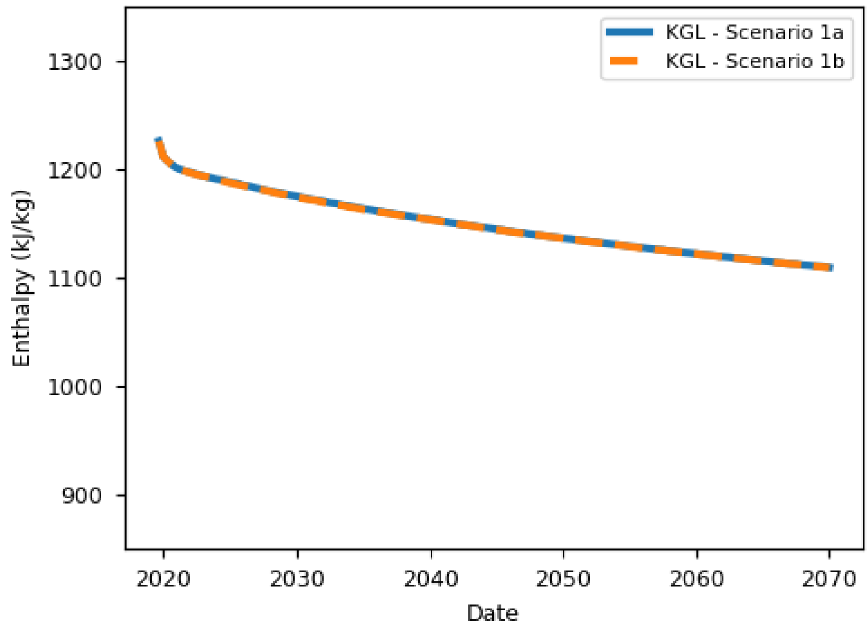

Figure 4-1 Simulated average production enthalpy for KGL comparing Scenarios 1A and 1B

5. **IMPACTS ON KAWERAU RESERVOIR**

5.1 Section 2 of my report (Burnell, 2020) presents the full results of the forecasts run using the numerical reservoir model. These show that delaying the reinjection of the East Bank river discharge (sub-case B) has an impact of less than 0.1% for the extracted energy of all developers over the 50 years.

5.2 Pressures within the reservoir are up to 0.5 bar lower for sub-case B for the period from 2021 to 2035 compared to sub-case A. After 2035, there is no discernible difference between the cases. This level of pressure change is small and unlikely to impact flow rates from any of the production wells. For comparison, wells at Wairakei and Rotokawa have seen pressures fall by more than 20 bar with minimal impact on flow rates.

5.3 The finding from these forecasts is that sub-case B has a negligible effect on the geothermal reservoir and is fully consistent with long-term sustainability of the Kawerau geothermal resource.

6. **SUBSIDENCE**

6.1 In my report (Burnell, 2020), an assessment of subsidence was made based on a subsidence model presented by Geomechanics Technologies (2019). The assessment in that report was based on the previous version V4 of the Kawerau Reservoir Model (KRMV4, (Mercury, 2018)). The scenarios used with the

Geomechanics Technologies subsidence model differ from those considered in this evidence, so were not suitable to directly assess the impacts on subsidence of the consent application. I therefore attempted to interpolate the results from the subsidence model based on differences in pressures between similar scenarios from KRMV4 and KRMV5.

6.2 It was difficult for me to accurately assess differences in potential subsidence between sub-cases A and B because:

(a) I did not have access to a subsidence model based on the current version of the reservoir model; and

(b) output supplied to me from the reservoir model scenarios run with KRMV5 was limited to contour plots of spatial changes (Figure 6-1) and tabulated pressure data at 5 monitor wells.

6.3 As detailed data on the predicted reservoir conditions was not available, the review undertaken by Dr. Jonathon Clearwater for the Officer's report found there is uncertainty in the approach taken to obtain subsidence predictions presented in my report.

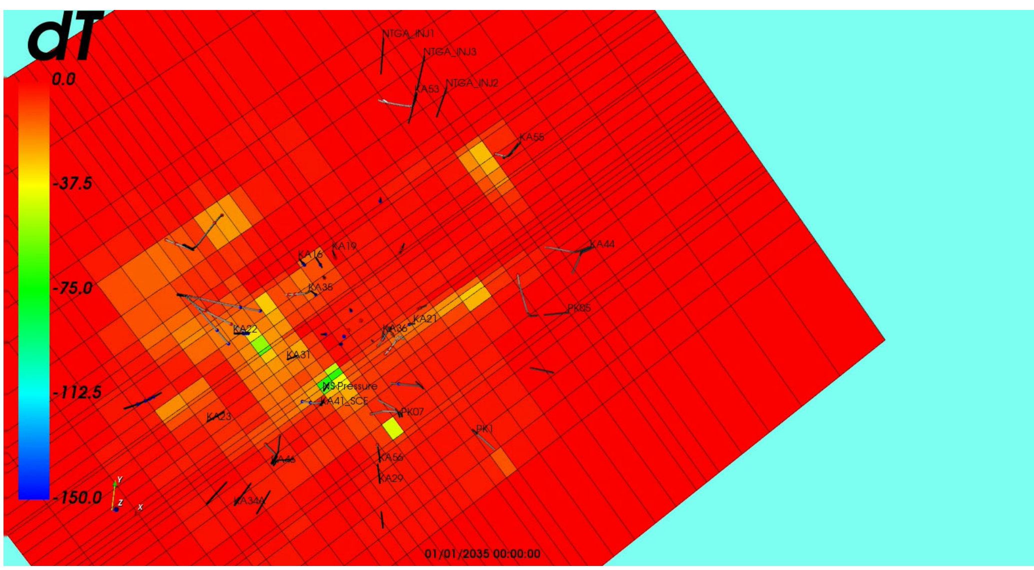

Figure 6-1: Simulated temperature change from KRMV5 between 2019 and 2035 at an elevation of -1375 for Scenario 1A.

6.4 To address this uncertainty, I have now obtained tabulated output data of reservoir conditions from KRMV5 and used this in a newly developed subsidence model. As the information available regarding the reservoir model was limited, a simplified subsidence model was used to avoid having large numbers of unconstrained model parameters.

Subsidence model

6.5 Subsidence from geothermal developments is caused by production or injection of fluid in a geothermal reservoir. Fluid production or injection will generally result in local changes in pressure and/or temperature. In turn, a pressure or temperature change in a given rock volume will cause that volume to contract or expand, and since the volume is connected to the wider reservoir, surface changes in elevation will result.

6.6 The mathematical technique I used to model subsidence has been applied to previous resource consent applications for Rotokawa (Terralog, 2007), Kawerau (Young and White, 2005), Ngatamariki (Burnell, 2010) and Ngawha (Burnell, 2015). Pressures and temperatures throughout the reservoir are used to calculate changes in stress, which, in turn, can be related to ground subsidence. To connect calculated pressure and temperature changes to ground subsidence, I have used the Geertsma disk model described in Young and White, 2005.

6.7 The basis for this model is the following expression for the subsurface compaction $\Delta\alpha$ of a volume based on the local change in pressure and temperature:

$$\Delta\alpha = c_P{}^{*}.\Delta P + c_T{}^{*}.\Delta T$$

6.8 Using this approach, only two material parameters are required to be specified:

(a) the compaction coefficient c_P*; and

(b) the thermal compressibility c_T*.

6.9 These compaction parameters (compressibility and thermal expansivity) will vary in the reservoir depending on the rock type, and can be estimated by matching predicted historical subsidence to measurements from field levelling surveys.

6.10 As GNS does not have access to the full details of the KRMV5 reservoir model, a simplified version of the reservoir stratigraphy was used to estimate compaction parameters. This stratigraphy was based on the published geological model of Milicich et al, 2013.

6.11 In addition, a simplified estimate of the pressure changes between 2006 and 2018 was prepared based on observed pressure changes from the reservoir. A subsidence calculation was then performed based on these pressure changes. The compaction parameters were adjusted to match measured changes in ground level shown in the report by Geomechanics Technologies, 2019.

6.12 A comparison of the calibrated modelled subsidence with the measured subsidence is shown in Figures 6-2 and 6-3. In my opinion, this is an acceptable match for predicting future subsidence.

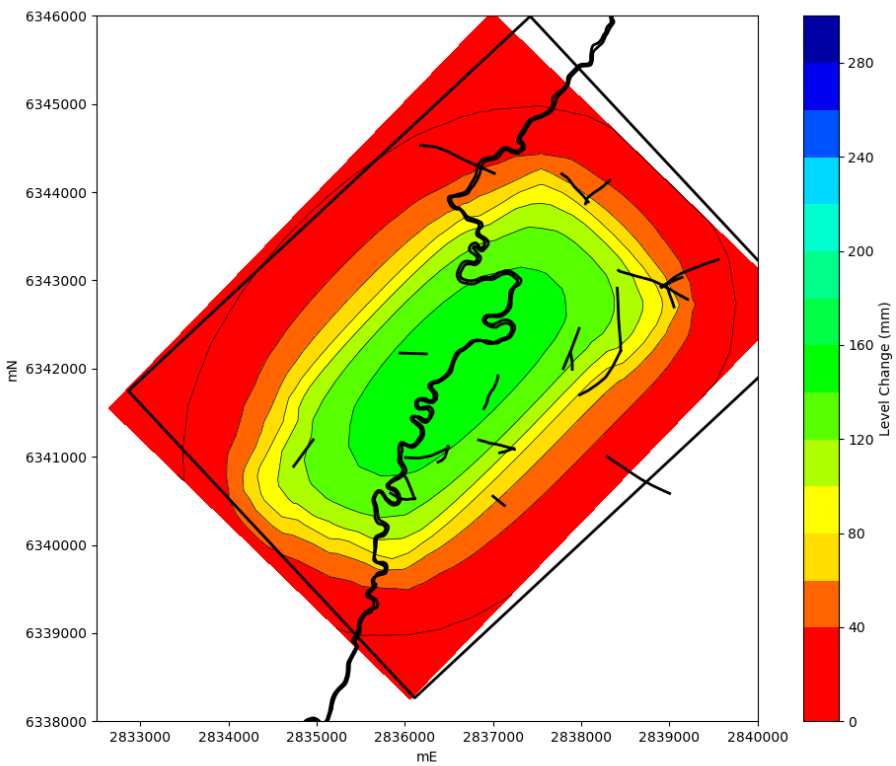

Figure 6-2: Modelled subsidence between 2006 and 2018.

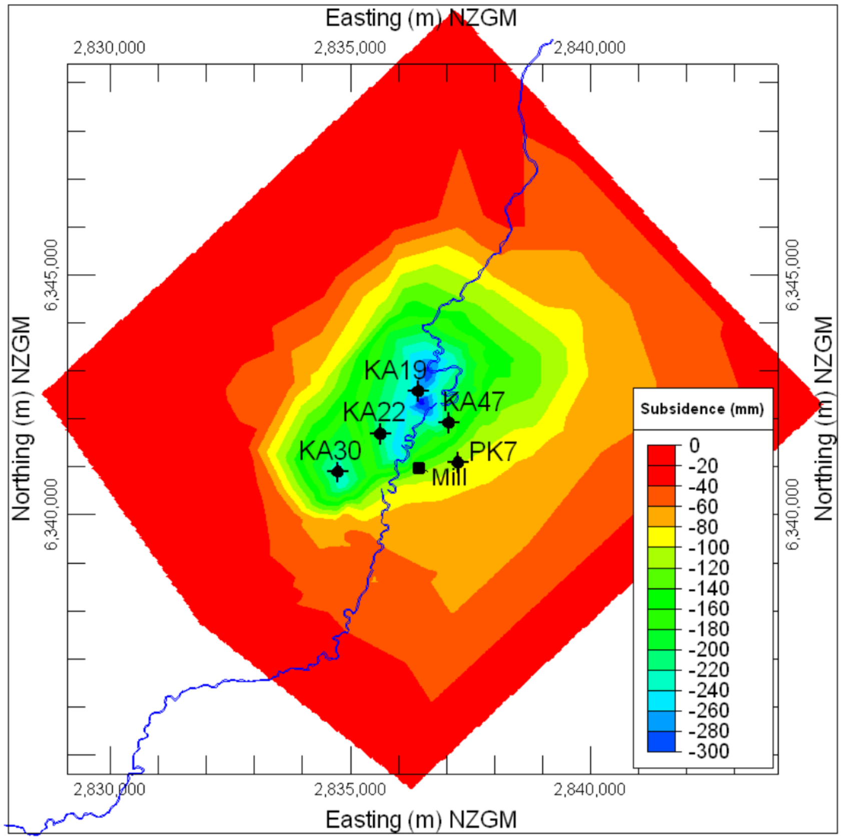

Figure 6-3: Measured subsidence between 2006 and 2018 taken from Geomechanics Technologies 2019.

6.13 The calibrated compaction parameters for this model are shown in Table 6.1.

Table 6.1 Compaction parameters used in the simplified subsidence model.

Elevation	$c_M \times 10^{-5}$ (bar $^{-1}$)	$\alpha \times 10^{-6}$ ($^oC^{-1}$)
Surface to -300 mRL	6.0	20
-300 to -600 mRL	6.0	20
-600 to -750 mRL	6.5	20
-750 to -1050 mRL	4.0	20
-1050 to -1350 mRL	4.0	15
-1350 to -1800 mRL	0.1	15
-1800 to -3800 mRL	0.1	15

6.14 The values in my model are consistent with the compaction parameters used in the Mercury subsidence model (Geomechanics Technologies, 2019), which has shallow compressibilities (CM) in the range 0.9 to 3.3 x 10-5 (bar-1) and deeper compressibility's in the range 0.06 to 0.5 x 10-5 (bar-1).

6.15 The thermal expansivities were based directly off those reported in the Geomechanics Technologies report in the range of 15 to 50 x 10-6 $^{o}C^{-1}$. As there is little available data on temperature changes in the reservoir, the calibration did not include such changes and so does not constrain the thermal expansivities. As a consequence, the values used in the Mercury subsidence model were taken directly.

Predicted subsidence

6.16 The subsidence model and data from the numerical reservoir model were used to calculate estimates of future subsidence. Figures 6-4 to 6-11 show the changes in reservoir pressures and temperatures from the reservoir model between the periods 2020 and 2035 and 2020 and 2070 for Scenario 1B.

6.17 2035 is the year when an increase in reinjection will occur for Scenario 1B; so it will be the time when the largest change in pressure (compared to Scenario 1A) will occur. From these figures it is seen that pressures reduce by less than 3 bar between 2020 and 2070. In the northern reinjection area pressures increase by up to 15 bar and temperatures decease by up to 80 °C.

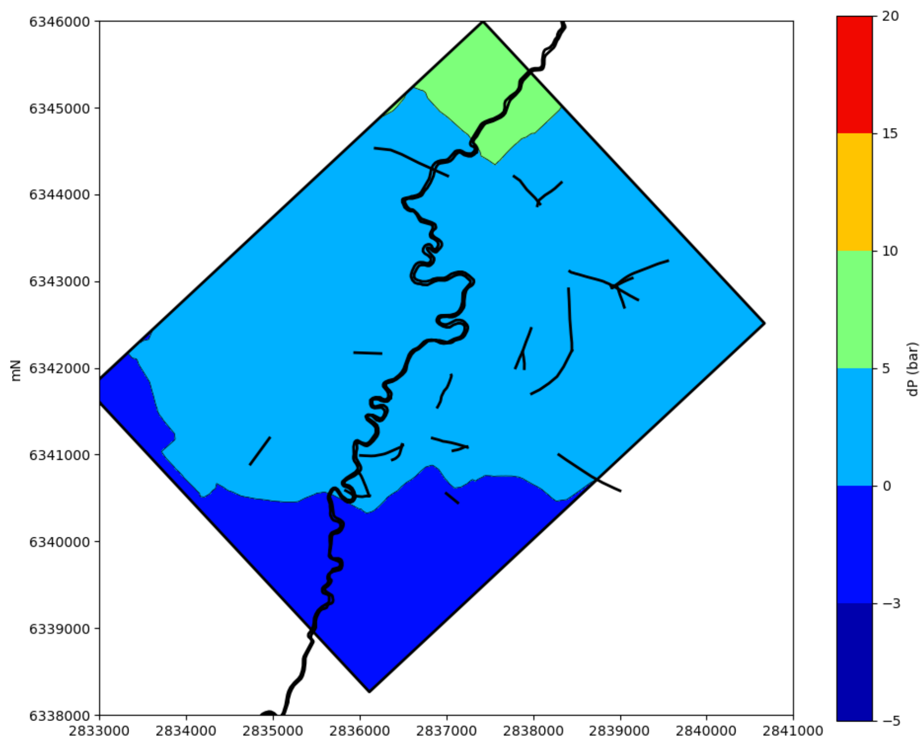

Figure 6-4: Calculated difference of pressure in 2035 and 2020 at -1612.5 mRL for Scenario 1B. Negative values are when the 2035 pressures are lower than 2020.

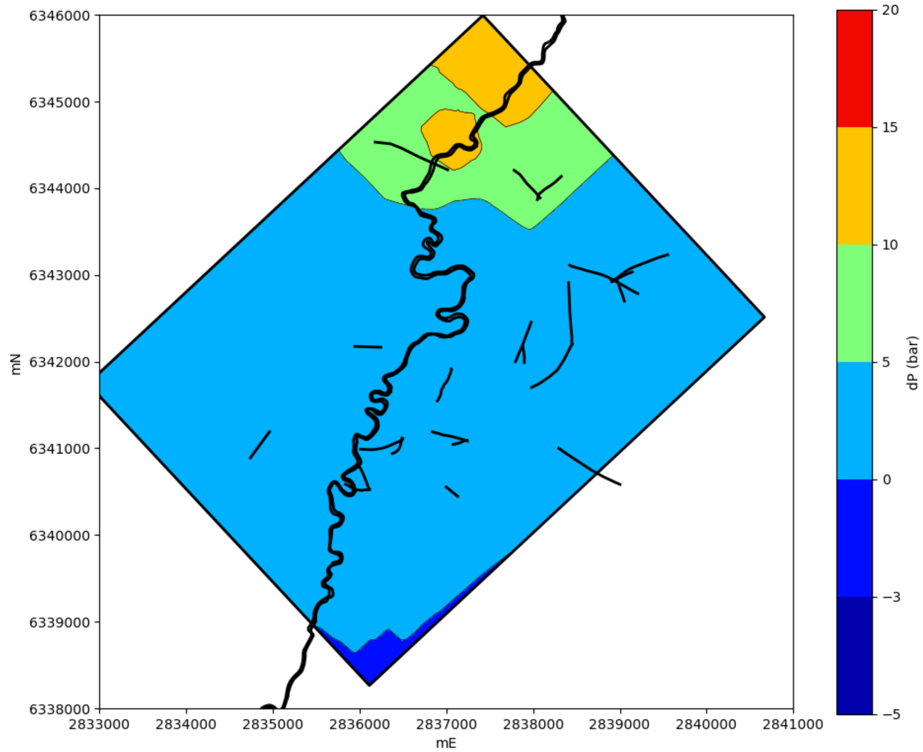

Figure 6-5: Calculated difference of pressure in 2070 and 2020 at -1612.5 mRL for Scenario 1B. Negative values are when the 2070 pressures are lower than 2020.

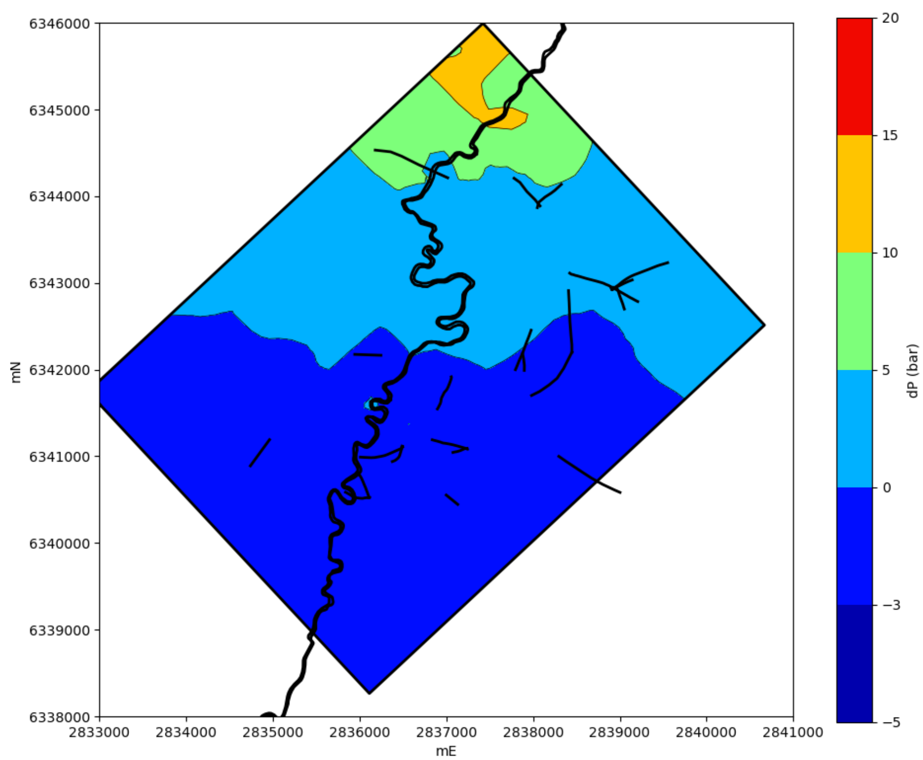

Figure 6-6: Calculated difference of pressure in 2035 and 2020 at -1112.5 mRL for Scenario 1B. Negative values are when the 2035 pressures are lower than 2020.

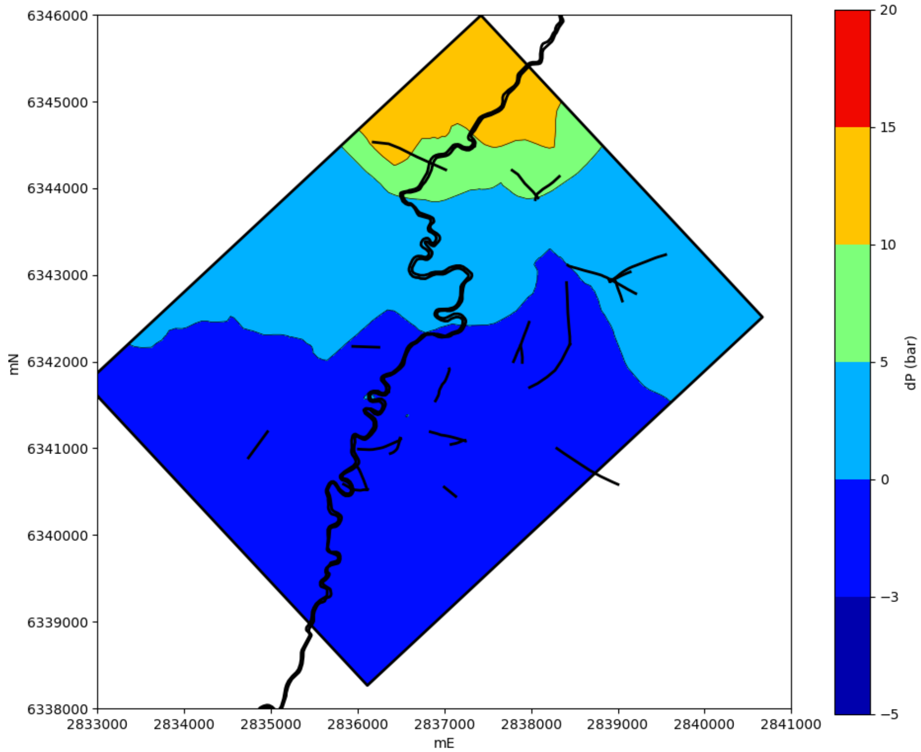

Figure 6-7: Calculated difference of pressure in 2070 and 2020 at -1112.5 mRL for Scenario 1B. Negative values are when the 2070 pressures are lower than 2020.

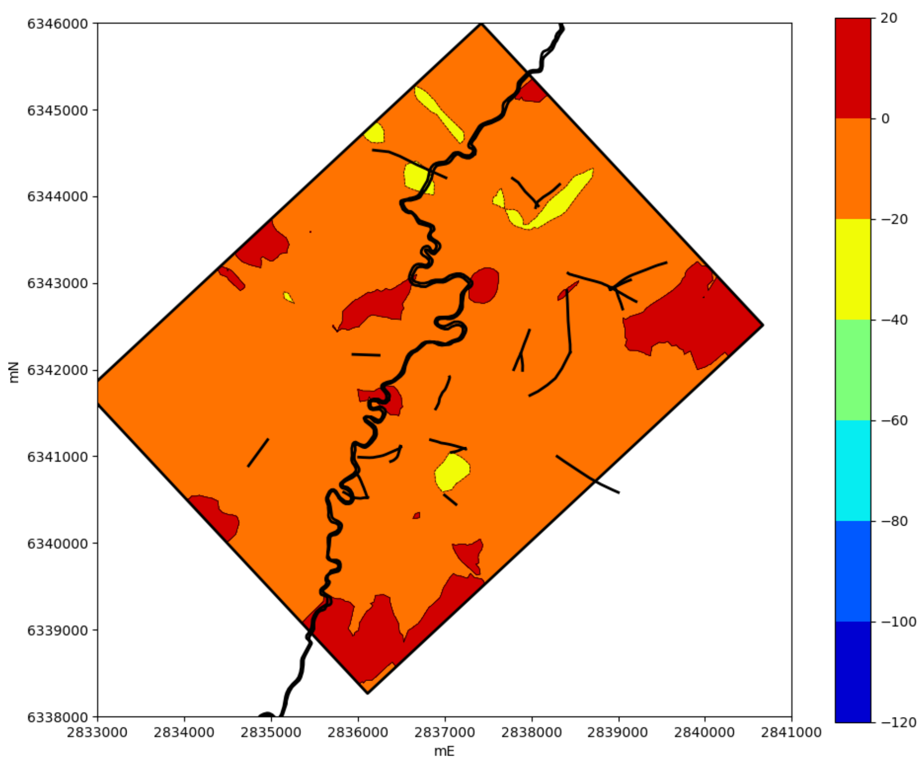

Figure 6-8: Calculated difference of temperature in 2035 and 2020 at -1612.5 mRL for Scenario 1B. Negative values are when the 2035 temperatures are lower than 2020.

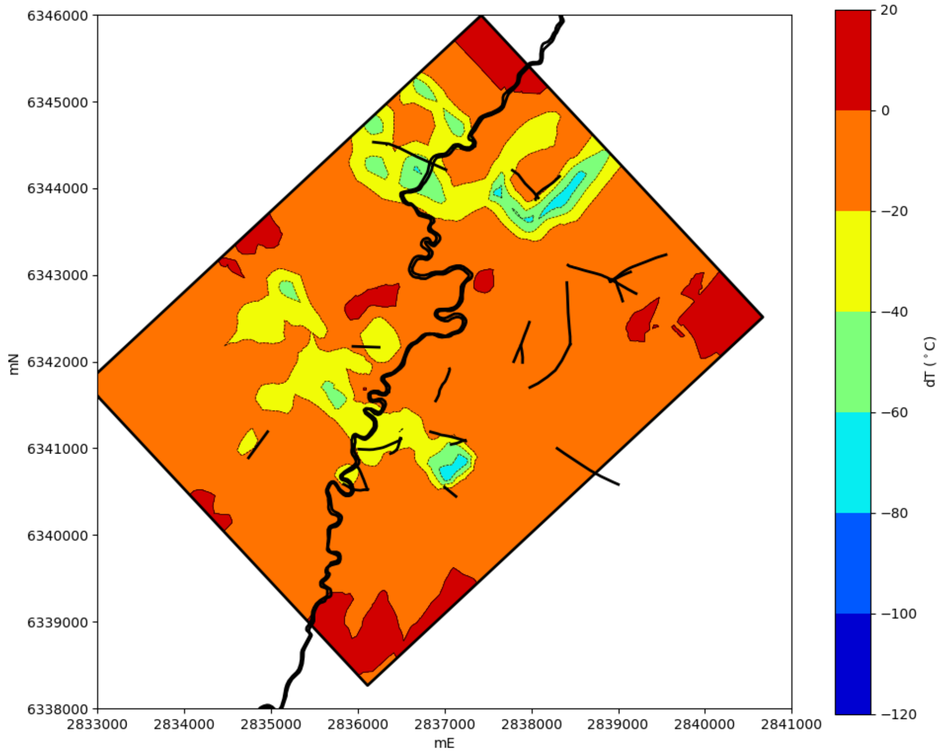

Figure 6-9: Calculated difference of temperature in 2070 and 2020 at -1612.5 mRL for Scenario 1B. Negative values are when the 2070 temperatures are lower than 2020.

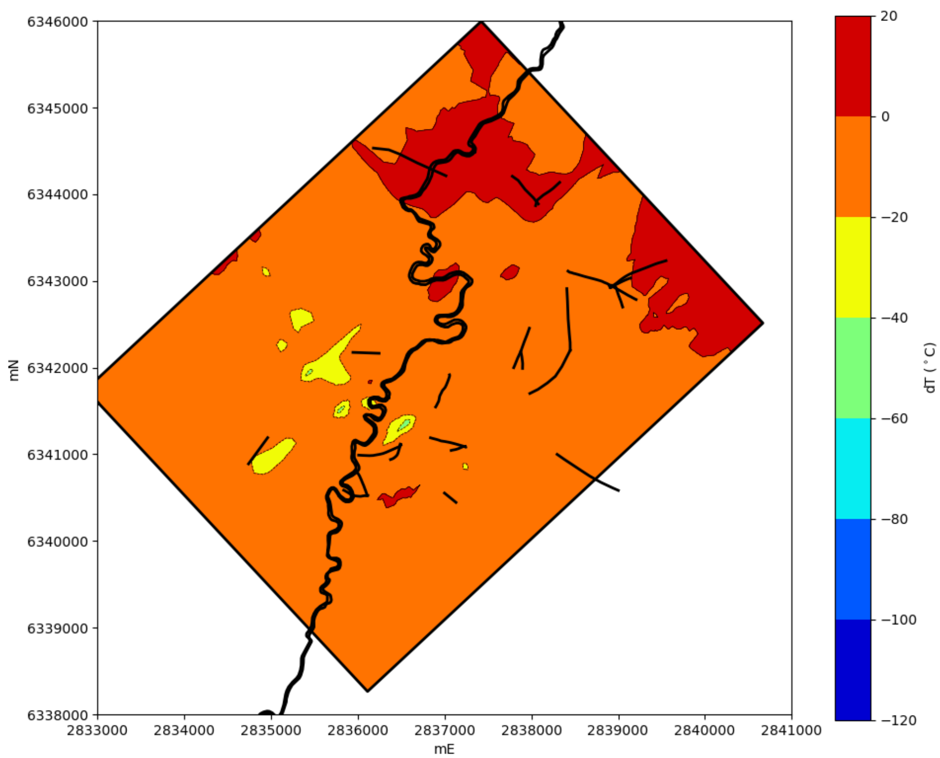

Figure 6-10: Calculated difference of temperature in 2035 and 2020 at -1112.5 mRL for Scenario 1B. Negative values are when the 2035 temperatures are lower than 2020.

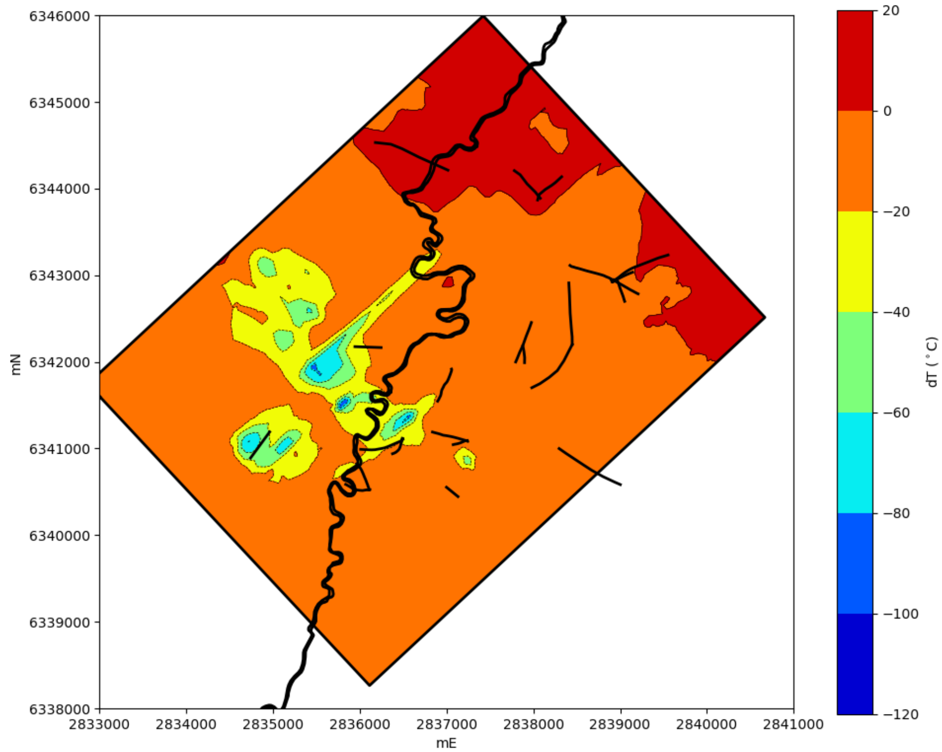

Figure 6-11: Calculated difference of temperature in 2070 and 2020 at -1112.5 mRL for Scenario 1B. Negative values are when the 2070 temperatures are lower than 2020.

6.18 Based on the changes in pressure and temperature, the change in ground surface between 2020 and 2070 was then calculated. These are shown for Scenarios 1A and 1B in Figures 6-12 and 6-13. These predictions show future subsidence over the production area of less than 500 mm, with an area of higher subsidence around the reinjection wells KA49, KA51, KA53 and KA55. This area of higher subsidence is due to enhanced thermal contraction from cooling of the reservoir rocks by the colder reinjection fluids.

6.19 The subsidence changes predicted here are smaller than those given in the Geomechanics Technologies report. For example, over the production area the Geomechanics Technologies calculations predict approximately 1000 mm of subsidence between 2018 and 2068 (Figure 6-16), whereas the model here predicts approximately 400 mm of subsidence. I consider that the main reason for the difference in predicted subsidence is likely to be that KRMV5 predicts a lower amount of pressure decline than KRMV4. I cannot be more certain about that without access to the Mercury and Geomechanics Technologies models. Having said that, it is not the absolute amount of predicted subsidence that is relevant but the predicted change in subsidence that would occur from the case

B scenarios. I do not consider that the difference between 400 mm and 1000 mm of subsidence over a period of 50 years is material to these estimates.

6.20 The model presented here also predicts that the area of greatest subsidence is around the reinjection wells KA49, KA51, KA53 and KA55 whereas it is focussed on the production area in the Geomechanics Technologies model. This difference may be attributable to the difference in the reservoir models KRMV4 and KRMV5.

6.21 Another possible reason for the difference is the Geertsma disk model can overestimate the subsidence due to temperature declines that occur over a small volume. As a result, the predictions of subsidence around the reinjection area could be considered an extreme case.

6.22 To assess the difference in predicted subsidence from delaying reinjection of the East Bank river discharge, the difference in subsidence between Scenarios 1A and 1B is shown in Figure 6-14. Negative values mean that there is less subsidence for Scenario 1B and positive values means there is more subsidence.

6.23 In the south-west of the reservoir there is up to 10 mm more subsidence for Scenario 1B, with up to 26 mm less subsidence in the north around the reinjection area. Thus, the impact of delaying reinjection of the East Bank river discharge is:

(a) a negligible increase in subsidence over the production area; and

(b) a minor decrease around the reinjection area.

6.24 The same calculations were undertaken for Scenario 2. As the results are very similar to those of Scenario 1, I only present the difference in subsidence between Scenario 2A and 2B in Figure 6-15. These predict that the difference between Cases A and B – with 10 mm more subsidence for Scenario 2B around the production wells and 26 mm less subsidence around the reinjection area.

6.25 The results of this modelling of subsidence predicts that delaying reinjection of the east bank river discharge contributes less than 10 mm of extra subsidence out of a total of 400 mm. In my opinion, the predicted extra subsidence caused by the current proposal will be negligible.

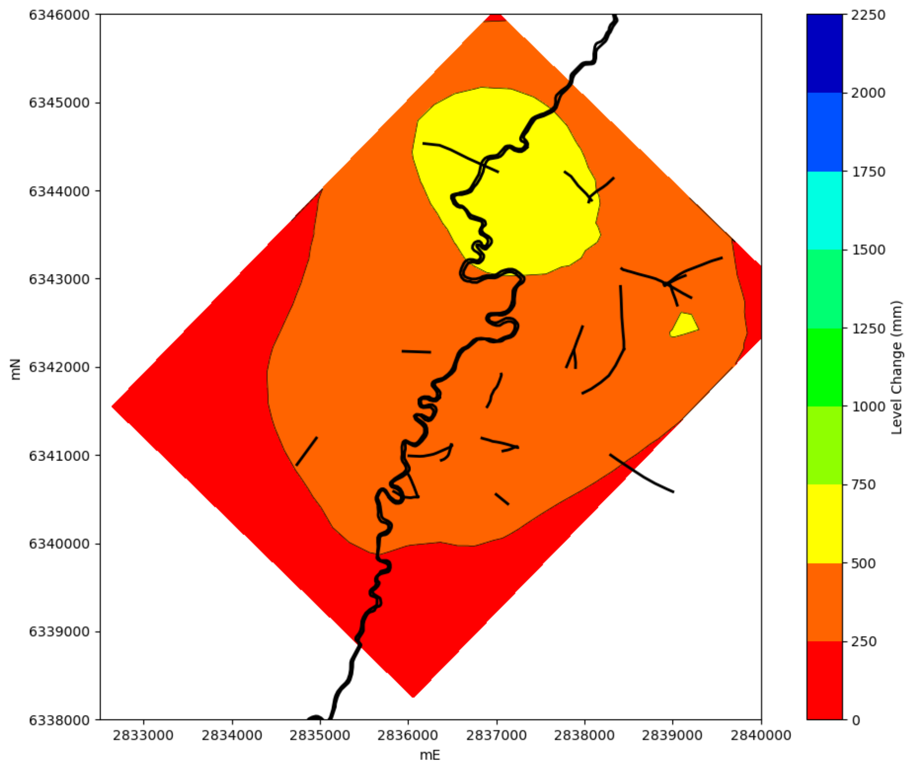

Figure 6-12: Predicted subsidence between 2020 and 2070 for Scenario 1A

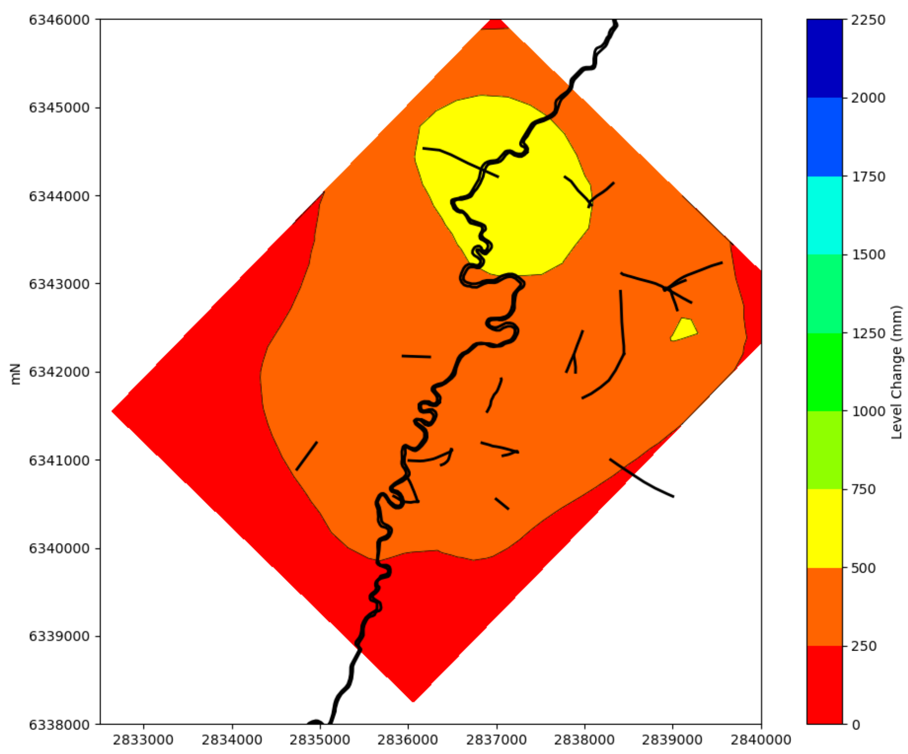

Figure 6-13: Predicted subsidence between 2020 and 2070 for Scenario 1B

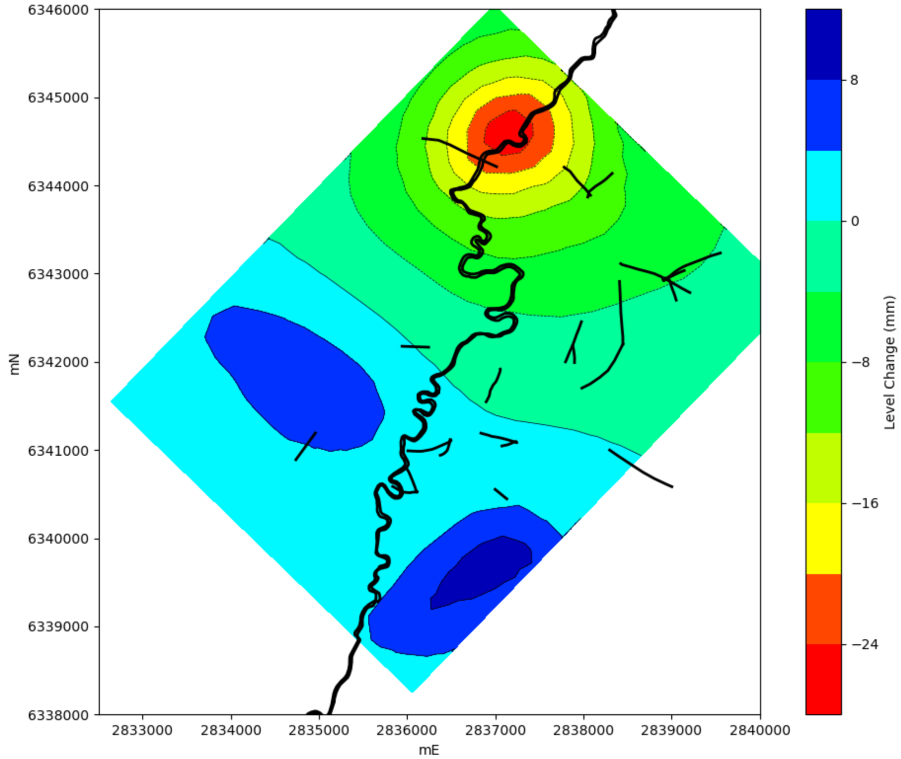

Figure 6-14: Calculated difference in predicted subsidence over the period 2020 and 2070 between Scenarios 1B and 1A. A positive value means greater subsidence for Scenario 1B and a negative value means less subsidence.

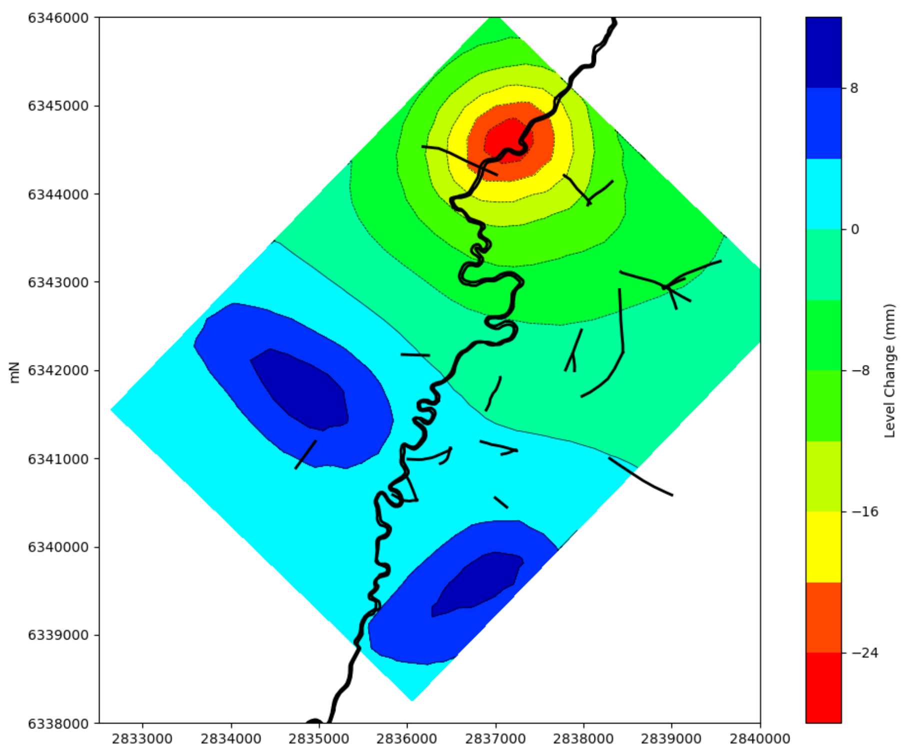

Figure 6-15: Calculated difference in predicted subsidence over the period 2020 and 2070 between Scenarios 2A and 2B. A positive value means greater subsidence for Scenario 2B and a negative value means less subsidence.

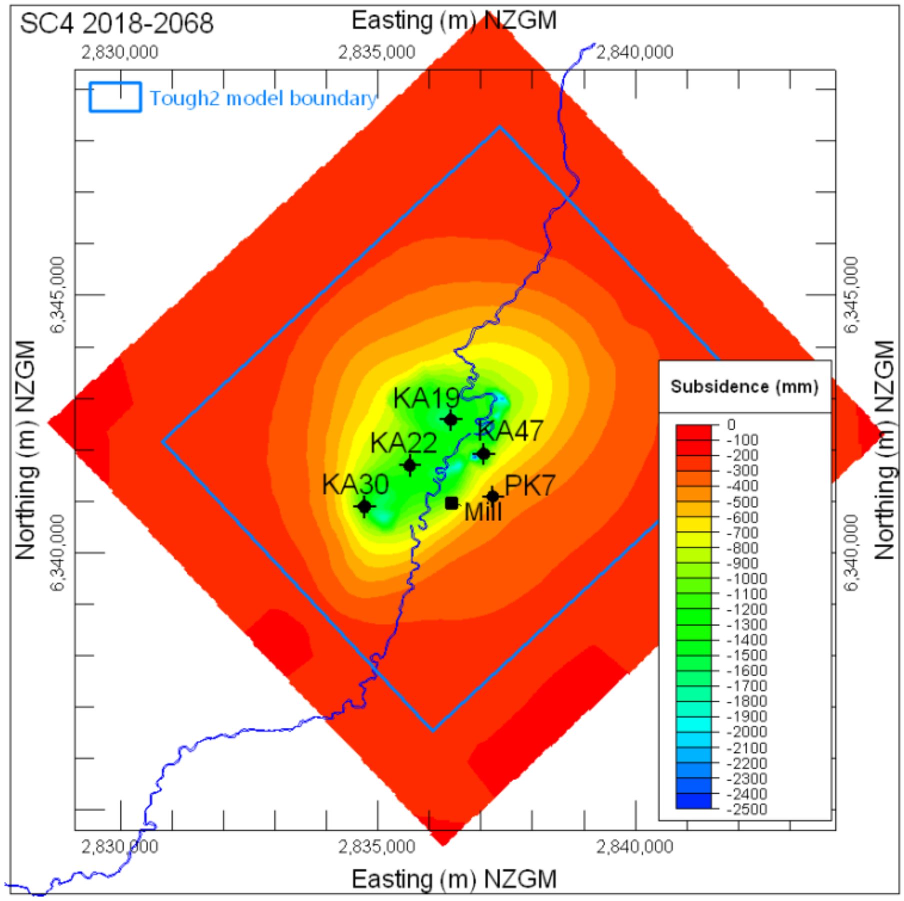

Figure 6-16: Predicted subsidence from the 2019 Geomechanics Technologies model over the period 2018 and 2068 for a scenario comparable to Scenario 1A.

7. COMMENT ON REINJECTION ISSUE RAISED IN THE SUBMISSION BY TE RUNAGA O NGATI AWA

7.1 The submission by TRONA states:

> *"There is various research which suggests reinjection is very important for all types of geothermal reservoirs."*

7.2 As a general statement, this is valid. But the way that the Kawerau system has responded to extraction in the past means that reinjection is a less important component than in other reservoirs.

7.3 As extraction from the Kawerau reservoir increased in the past, the pressure decline was small and relatively stable (Grant, 2013). This indicates that there is a substantial level of natural recharge occurring in the reservoir, which is not a common occurrence. The reservoir model was calibrated to include the effects of this natural recharge, and predictions from the model demonstrate that delaying reinjection of the East Bank river discharge has a negligible effect on the state of the reservoir.

7.4 In my opinion, reinjection is less important for maintaining reservoir conditions at Kawerau than in other geothermal systems.

8. COMMENT ON ISSUES RAISED IN THE OFFICER'S REPORT

8.1 The officer's report presents the comments by Dr. Jonathon Clearwater that the assessment of subsidence I made in my report (Burnell, 2020) are subject to some uncertainty. However, Ms Pappon concludes the following:

> *"Therefore, I believe it is reasonable to assume that the potential adverse effects on the geothermal system and therefore other geothermal users associated with the continued discharge of geothermal fluid to the river are likely to be appropriate, despite the uncertainty resulting from the Subsidence Model not being calibrated to the most recent version of the Kawerau Reservoir Model."*

8.2 I agree with the reporting officer's comments, which are further supported by the updated estimates I have made of the potential future subsidence at Kawerau. As I discussed in Section 6.25:

> *"In my opinion, the predicted extra subsidence caused by the current proposal will be negligible."*

9. REFERENCES

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April 2021