

Cheal Petroleum Limited Deep Well Injection
Monitoring Programme
Annual Report
2017-2018

Technical Report 2018-60

ISSN: 1178-1467 (Online)
Document: 2092311 (Word)
Document: 2115846 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD
October 2018

Executive summary

Cheal Petroleum Limited (the Company) operate a number of wellsites within the Taranaki Region, most notably their Cheal wellsites located south of Stratford. Each wellsite contains varying numbers of producing wells and associated production infrastructure. This report for the period July 2017 to June 2018 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) in relation to the Company's deep well injection (DWI) activities. The report details the results of the monitoring undertaken, assesses the Company's environmental performance during the period under review and the environmental effects of their DWI activities.

The Company held four resource consents for DWI activities during the review period, which included a total of 68 conditions setting out the requirements that the Company must satisfy. All four consents were exercised during the period.

During the monitoring period, the Company demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the year under review included 15 site inspections, two injectate samples and nine groundwater samples collected for physicochemical analysis. The monitoring programme also included a significant data review component, with all injection data submitted by the Company assessed for compliance on receipt.

The monitoring showed that the Company's DWI activities were being carried out in compliance with the conditions of the applicable resource consents. There is no evidence of any issues with any injection well currently in use, or the ability of the receiving formation to accept injected fluids. The results of groundwater quality monitoring undertaken show no adverse effects of the activity at monitored locations. Inspections undertaken during the monitoring year found sites being operated in a professional manner and there were no Unauthorised Incidents in relation to any of the Company's DWI consents.

During the year, the Company demonstrated a high level of environmental and administrative performance with the resource consents.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the Company over the last several years, this report shows that the Company's performance remains at a high level.

This report includes recommendations to be implemented during the 2018–2019 monitoring period.

Table of contents

		Page
1	Introduction	1
1.1	Compliance monitoring programme reports and the Resource Management Act 1991	1
1.1.1	Introduction	1
1.1.2	Structure of this report	1
1.1.3	The Resource Management Act 1991 and monitoring	1
1.1.4	Evaluation of environmental and administrative performance	2
1.2	Process description	3
1.3	Resource consents	4
1.4	Monitoring programme	9
1.4.1	Introduction	9
1.4.2	Programme liaison and management	9
1.4.3	Site inspections	9
1.4.4	Injectate sampling	9
1.4.5	Groundwater sampling	10
1.4.6	Assessment of data submitted by the Company	12
2	Results	13
2.1	Inspections	13
2.2	Injectate monitoring	13
2.3	Groundwater sampling	13
2.4	Injection monitoring	16
2.5	Investigations, interventions, and incidents	23
3	Discussion	25
3.1	Discussion of site performance	25
3.2	Environmental effects of exercise of consents	25
3.3	Evaluation of performance	25
3.4	Recommendations from the 2016-2017 Annual Report	36
3.5	Alterations to monitoring programmes for 2018-2019	36
3.6	Exercise of optional review of consent	36
4	Recommendations	37
	Glossary of common terms and abbreviations	38
	Bibliography and references	40
	Appendix I Resource consents held by Cheal Petroleum Limited	

List of tables

Table 1	Consents held by the Company during the Review period	5
Table 2	Location of groundwater monitoring sites	10
Table 3	Results of injectate sampling undertaken by the Council (2017-2018)	14
Table 4	Results of the Company's monthly injectate sampling (2017-2018)	14
Table 5	Results of groundwater sampling undertaken by the Council in relation to the Cheal-A wellsite	15
Table 6	Results of groundwater sampling undertaken by the Council in relation to the Cheal-B wellsite	15
Table 7	Results of groundwater sampling undertaken by the Council in relation to the Cheal-E wellsite	16
Table 8	Summary of injection activity during the 2017-2018 monitoring year	16
Table 9	Summary of the Company's historical injection activity since 2009	17
Table 10	Summary of injection occurring under consent 9545-2 (2013-2018)	17
Table 11	Summary of injection occurring under consent 10254-1 (2016-2018)	18
Table 12	Summary of injection occurring under consent 10304-1.1 (2016-2018)	18
Table 13	Summary of injection occurring under consent 10354-1 (2017-2018)	18
Table 14	Summary of performance for consent 9545-2	26
Table 15	Summary of performance for consent 10254-1	28
Table 16	Summary of performance for consent 10304-1.1	30
Table 17	Summary of performance for consent 10354-1	33
Table 18	Evaluation of environmental performance over time	35

List of figures

Figure 1	DWI schematic (www.epa.gov/uic)	4
Figure 2	Location of the DWI consents held by the Company during the period under review	8
Figure 3	Location of monitoring sites in relation to the Company's DWI wellsites	11
Figure 4	Total daily injection volume consent 9545-2 (2017-2018)	18
Figure 5	Total daily maximum injection pressure 9545-2 (2017-2018)	19
Figure 6	Daily injection volume and daily average injection pressure consent 9545-2 (2013-2018)	19
Figure 7	Total daily injection volume consent 10254-1 (2017-2018)	20
Figure 8	Total daily maximum injection pressure 10254-1 (2017-2018)	20
Figure 9	Daily injection volume and average daily pressure consent 10254-1 (2012-2018)	20
Figure 10	Total daily injection volume consent 10304-1.1 (2017-2018)	21
Figure 11	Total daily injection pressure consent 10304-1.1 (2016-2018)	21

Figure 12	Total daily injection volume and average daily pressure consent 10304-1.1 (2016-2018)	22
Figure 13	Total daily injection volume consent 10354-1 (2017-2018)	22
Figure 14	Maximum daily injection pressure consent 10354-1 (2017-2018)	23
Figure 15	Total daily injection volume and average daily pressure consent 10354-1 (2017-2018)	23

1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2017 to June 2018 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Cheal Petroleum Limited (the Company) for deep well injection (DWI) activities. During the period under review, the Company held four resource consents for the subsurface injection of fluids by DWI. The consents authorise discharges from three separate wellsites within the Company's Cheal oil and gas field, located south of Stratford.

The resource consents held by the Company permit the discharge of a range of fluids by DWI, including produced water, contaminated stormwater, waste drilling fluids, hydraulic fracturing (HF) fluids, production sludges and compatible groundwater abstracted specifically for injection purposes. The consents include a number of special conditions which set out specific requirements the Company must satisfy.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the DWI consents held by the Company. This is the ninth report to be prepared by the Council to cover the Company's DWI discharges and their effects.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites through annual programmes;
- the resource consents held by the Company for DWI activities;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted by the Company.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2018-2019 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act 1991 and monitoring

The *Resource Management Act 1991* (RMA) primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

- a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
- b. physical effects on the locality, including landscape, amenity and visual effects;
- c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

- d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and
- e. risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by the Company, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. Administrative performance is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

High: No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

Improvement required: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

Poor: Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

High: The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

Good: Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

Improvement required: Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

Poor: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

The process of DWI involves injecting fluids deep underground into geological formations which are confined from overlying groundwater aquifers by low permeability strata. Injection wells are also designed and constructed to provide multi barrier protection against contaminant migration to groundwater systems.

The subsurface injection of fluids by DWI is often used as a method for disposing of waste fluids generated during oil and gas exploration and production activities. The greatest volume of waste fluids generated through these activities is saline water (brine) that is drawn to the surface with hydrocarbons through producing wells ('produced water'). The DWI consents currently held by the Company also authorise the injection of fluid types other than produced water. The range of fluid types authorised for injection varies by consent, but includes compatible groundwater, well workover fluids, well drilling fluids, HF fluids and HF return fluids.

In addition to providing a means to dispose of waste fluids, the subsurface injection of fluids by DWI is also an established oilfield technique for regulating reservoir pressure as a means of enhancing the rate of hydrocarbon recovery from a reservoir. This process, commonly referred to as water flooding, is often implemented when natural reservoir pressures become reduced due to ongoing production. Fluids can also be heated prior to injection to reduce the viscosity of the oil being produced, improving its flow toward a producing well and upward through the wellbore itself.

The Cheal reservoir is depleted, due to production over time, therefore water flooding for enhanced hydrocarbon recovery is the primary purpose of injection at the Cheal wellsites.

A schematic representation of injection wells for both waste discharge and enhanced oil recovery is presented in Figure 1.

Further details regarding hydrocarbon exploration and production in Taranaki, the DWI process and its history within region can be found in previous compliance reports published by the Council (see Bibliography).

1.3 Resource consents

Sections 15(1)(b) and (d) of the RMA stipulate that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Company held four discharge consents covering their DWI activities during the review period. All four consents were exercised during the 2017-2018 monitoring year (Table 1).

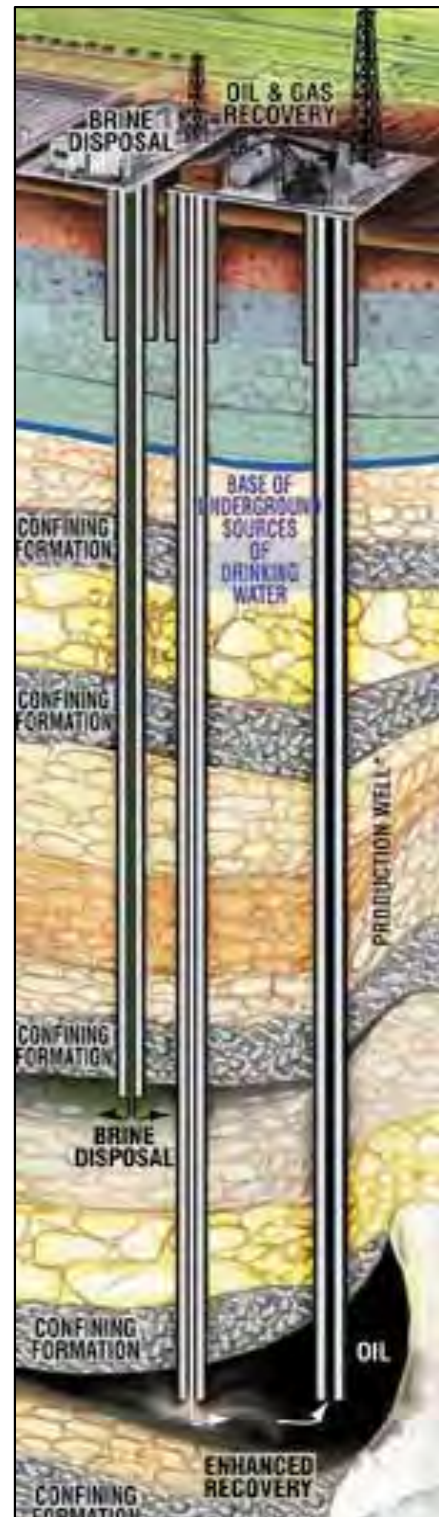


Figure 1 DWI schematic
(www.epa.gov/uic)

Table 1 Consents held by the Company during the Review period

Consent Number	Wellsite	Status	Injection Well(s)	Formation	Site id.	Issued	Expiry
9545-2	Cheal-A	Active	Cheal-A4	Urenui	GND2328	28/08/2015	01/06/2035
10254-1	Cheal-B	Active	Cheal-B3	Mount Messenger	GND2571	11/04/2016	01/06/2034
10304-1.1	Cheal-E	Active	Cheal-E7	Mount Messenger	GND2572	15/06/2016	01/06/2034
10354-1	Cheal-A	Active	Cheal-A2	Mount Messenger	GND2570	08/11/2016	01/06/2035
		Active	Cheal-A7		GND2678		

Consent **9545-2** was issued by the Council on 28 August 2015 under Section 87(e) of the RMA. It is due to expire on 1 June 2035. The consent authorises the discharge of produced water from hydrocarbon exploration and production operations reservoir compatible workover fluids and HF return fluids into the Urenui Formation by deep well injection at the Cheal-A wellsite.

The current consent has seventeen special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a "Injection Operation Management Plan" prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;
- Condition 3 stipulates that there shall be no injection after 1 June 2030;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Urenui Formation, below 1,300 m TVD;
- Condition 6 limits the discharge rate to 200 m³ per day;
- Condition 7 limits the wellhead pressure to 4,000 psi or 276 bar;
- Condition 8 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Conditions 9, 10 and 11 refer to process monitoring and data submission requirements;
- Conditions 12, 13 and 14 refer to local groundwater quality monitoring requirements;
- Condition 15 stipulates the annual reporting requirements;
- Condition 16 is a notification requirement; and
- Condition 17 is a review condition.

A variation to the consent (9545-2.1) was issued on 18 July 2018, removing the limits on pressure and volume and changing the date required for data submittal, to bring the consent in line with the Company's more recently issued DWI consents.

Consent **10254-1** was issued by the Council on 11 April 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2034. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.

The current consent has seventeen special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a "Injection Operation Management Plan" prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;

- Condition 3 stipulates that there shall be no injection after 1 June 2029;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,600 m TVD;
- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

Consent **10304-1.1** was issued by the Council on 15 June 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2034. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-E wellsite for the purpose of water flooding.

The current consent has seventeen special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a "Injection Operation Management Plan" prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;
- Condition 3 stipulates that there shall be no injection after 1 June 2029;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,600 m TVD;
- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

Consent **10354-1** was issued by the Council on 11 November 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2035. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-A wellsite.

The current consent has seventeen special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a "Injection Operation Management Plan" prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;
- Condition 3 stipulates that there shall be no injection after 1 June 2030;
- Condition 4 requires the best practicable option to be adopted for fluid injection;

- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,665 m TVD;
- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

A variation to the consent (10354-1.1) was issued on 18 July 2018, changing the minimum depth of injection from 1,665 to 1,600 m BGL.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report (Appendix I).

Figure 2 shows the location of the DWI consents held by the Company during the period under review.



Figure 2 Location of the DWI consents held by the Company during the period under review

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders.

The monitoring programme for the Company's DWI sites consisted of five primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Company's Cheal-B wellsite was visited once and the Company's Cheal-A and Cheal-E wellsites were visited six times during the monitoring period. With regard to consents for DWI activities, the main points of interest are general housekeeping and any processes with potential or actual discharges, including any surface water runoff, and their receiving environments.

An additional two visits to the Company's Cheal-A wellsite were undertaken by Council Officer's for injectate sampling purposes, as outlined in Section 1.4.4.

1.4.4 Injectate sampling

Injectate samples were obtained for analysis in the Council's IANZ accredited laboratory on two occasions during the monitoring period. The sampling of injectate is carried out in order to characterise the general chemical nature of the discharge and also the variation in its chemical composition across the monitoring period.

Injectate samples were collected from the bulk storage tank at the Cheal-A Production Station identified on-site as tank T-0504 and T-0505 (Figure 3). The injectate samples were analysed for the following parameters:

- pH;
- conductivity;
- suspended solids;
- chlorides; and
- total petroleum hydrocarbons.

1.4.5 Groundwater sampling

Groundwater samples were obtained on two occasions in the vicinity of the Cheal wellsites during the monitoring period. This sampling is a continuation of the groundwater monitoring component of this programme which was initiated during the 2013-2014 monitoring period.

Four monitoring sites were sampled during the review period, including two dedicated monitoring bores which were installed by the Company under the conditions of consents 10254-1 and 10304-1.1. One in the vicinity of the Cheal-B wellsite (GND2543) and one in the vicinity of the Cheal-E wellsite (GND2592).

Details of the groundwater monitoring sites currently included in the monitoring programme are listed below in Table 2. The location of the groundwater sites in relation to the wellsite being monitored is illustrated in Figure 3.

Table 2 Location of groundwater monitoring sites

Site code	Wellsite	Distance from injection well (m)	Cased depth (m)	Screened/open interval (m)	Total depth (m)	Groundwater level (m BMP)	Aquifer
GND1139	Cheal-A	415	0-36.0	36.0-54.0	54.0	6.1	Volcanics
GND0492	Cheal-A	357	0-19.5	19.5- 30.5	30.5	7.0	Volcanics
GND2543	Cheal-B	<50	0-14.1	14.1-32.1	32.1	1.1	Volcanics
GND2592	Cheal-E	<50	0-30.7	18.7-30.7	30.7	0.2	Volcanics

Groundwater samples obtained during the first round of sampling carried out were analysed in the Council's own IANZ accredited laboratory, while samples obtained during the second round of sampling were sent to Hill Laboratories Limited (Hills) for analysis. Samples were analysed for a range of parameters including the following, which are required under Condition 17 of the consent:

- pH;
- conductivity;
- chlorides; and
- total petroleum hydrocarbons (TPH).

The parameters above are deemed sufficient to enable identification of any significant changes in groundwater quality related to DWI activities. The change in analysing laboratories over the course of the monitoring year did result in a slight increase in the detection limit reported for TPH (0.5 vs. 0.7 g/m³)

In addition to the standard range of analyses above, baseline samples have been collected from all monitored sites and analysed by Hills for general ion chemistry, BTEX and dissolved gas concentrations. These more detailed analyses will allow a more in depth assessment of variations in groundwater composition should the need arise in the future.



Figure 3 Location of monitoring sites in relation to the Company's DWI wellsites

1.4.6 Assessment of data submitted by the Company

A significant component of the monitoring programme is the assessment of consent holder submitted data. The Company is required to submit a wide range of data under the conditions of their DWI consent.

As required by the conditions of their consent, the Company has submitted an Injection Operation Management Plan for each active injection well. The plans are required to include the operational details of the injection activities and to identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plans are also required to detail the action(s) to be taken by the consent holder if trigger conditions are reached. The Company was also required to submit well construction details, an assessment of the local geological environment, results of well integrity testing and details of the proposed monitoring plan for the injection well.

The Company is also required to maintain continuous records of injection volumes, and average and maximum injection pressures, and to characterise the chemical characteristics of all waste types being discharged. This data is submitted to the Council on a monthly basis where it is assessed for compliance against the relevant consent conditions.

2 Results

2.1 Inspections

Routine inspections of the Company's wellsites were conducted during the period under review. Inspections included undertaking a general visual assessment of the operational equipment, storage facilities and associated equipment. The inspecting officer concluded that the wellsites were in good condition and being well managed. There were no issues noted specific to any of the Company's DWI consents.

The bulk storage facilities at the Cheal-A Production Station were also visited by a Council officer on two occasions during the monitoring year for the purpose of injectate sampling. No issues were noted by staff during these visits.

2.2 Injectate monitoring

Samples of injectate were obtained from the Company's Cheal-A Production Station on 17 October 2017 and 26 April 2018. All fluids for disposal are handled and controlled through the production station. The samples were submitted to the Council's laboratory on the same day for physicochemical analysis.

The results of the sample analyses undertaken by the Council are included below in Table 3. The range of results for each analyte since 2013 are also presented for comparison. The Company also undertakes analysis of injectate at each well monthly. The range of results provided to the Council for the 2017-2018 monitoring year are presented in Table 4.

The concentrations of each analyte measured over the 2017-2018 period are within the expected range for Injectate samples at these sites.

2.3 Groundwater sampling

The results of analyses carried out during the period are set out below in Table 5, Table 6, Table 7 and Table 8. The minimum and maximum range of historical data has also been provided for comparison.

During the period reported a low level hydrocarbon concentration was recorded at site GND2592, located at the Cheal-E wellsite. The measured concentration was at the limit of detection for the analysing laboratory (0.5 g/m³ TPH). Low concentrations of hydrocarbons, including toluene at concentrations well below drinking water standards, have been recorded at this site historically, as have high concentrations of dissolved methane gas (33-38 mg/L). Carbon isotope analysis has shown that the source of this gas is biogenic, meaning it is being generated by the decomposition of organic matter in shallow groundwater zones, as opposed to thermal generation in deep hydrocarbon reservoirs. Given the presence of large amounts of shallow organic matter in locality of the wellsite, including Ngaere swamp deposits, it is possible that trace concentration of hydrocarbons are also present in groundwater as a result of the decomposition of this material. There are no indications in any of the results received that would indicate that observed concentrations of these analytes are attributable to DWI activities.

All other water quality results show there have been no significant changes in groundwater composition at any of the sites since monitoring commenced, demonstrated by the relatively narrow ranges between minimum and maximum analyte concentrations recorded, since monitoring commenced. The variations in analyte concentrations at each site are a result of natural seasonal fluctuation and sampling variability.

Table 3 Results of injectate sampling undertaken by the Council (2017-2018)

Parameter	Unit	Cheal Production Station			
		Minimum	Maximum	Tanks T0504 and T0505	
Date	-	July 2013- to June 2018		25 Oct 2017	30 Apr 2018
Time	NZST	-	-	09:15	09:30
TRC sample number	-	-	-	TRC163446	TRC182040
pH	pH Units	6.0	8.0	8.0	NR
Electrical conductivity	mS/m @ 20°C	957	4,140	2,030	957
Suspended solids	g/m3	16	1,940	130	16
Chloride	g/m ³	3,360	18,300	7,330	3,360
Total petroleum hydrocarbons	g/m ³	22	520	510	240

NR – result not provided by the lab

Table 4 Results of the Company's monthly injectate sampling (2017-2018)

Parameter	Location	Cheal-A2			Cheal-B3			Cheal-E7			Cheal-A4		
-	Unit	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
-	Date	July 2017- June 2018			July 2017- June 2018			July 2017- June 2018			July 2017- June 2018		
pH	pH units	6.9	8.2	7.7	4.0	8.2	7.4	7.0	8.2	7.8	7.0	8.1	7.7
Electrical conductivity	mho/cm	0.0051	0.0183	0.0104	0.0043	0.0214	0.0097	0.0041	0.0214	0.0097	0.0042	0.0176	0.0096
Suspended solids	g/m ³	12	1924	402	13	306	74	15	412	93	16	563	125
Temperature	Deg°C	17.4	34.0	27.8	6.6	24.0	13.8	12.0	33.0	22.2	3.0	39.0	23.1
Salinity	TDS g/m ³	1,100	7,500	2,649	1,260	9,180	3,928	1,300	9,180	2,961	1,450	10,440	3,485
Chloride	mg/L	1,860	13,800	4,480	2,100	15,300	5,243	2,180	15,300	4,688	2,420	17,400	5,750
Total petroleum hydrocarbons	g/m ³	54	1,450	637	9	1,810	425	5	1,050	251	43	40,000	3,776

Table 5 Results of groundwater sampling undertaken by the Council in relation to the Cheal-A wellsite

Sample details	Units	GND1139			
TRC sample number	-	Minimum	Maximum	TRC173702	TRC182037
Sample date	-	July 2012 to June 2018		25 Oct 2017	30 Apr 2018
Sample time	NZST			9:05	14:55
pH	pH	6.7	7.1	6.7	7.0
Electrical conductivity	mS/m	14.5	20.6	18.6	18.8
Chloride	g/m ³	9.4	14.2	13.4	14.0
Total hydrocarbons	g/m ³	<DL	1.4	<0.5	<0.5
Sample details	Units	GND0492			
TRC sample number	-	Minimum	Maximum	TRC173703	TRC182036
Sample date	-	July 2011 to June 2018		25 Oct 2017	07 May 2018
Sample time	NZST			10:05	12:37
pH	pH	6.6	8.1	6.6	6.9
Electrical conductivity	mS/m	11.1	21.5	16.3	17.5
Chloride	g/m ³	10.5	22.3	18.4	19.5
Total hydrocarbons	g/m ³	<DL	<DL	<0.5	<0.5

Table 6 Results of groundwater sampling undertaken by the Council in relation to the Cheal-B wellsite

Sample details	Units	GND2543			
TRC sample number	-	Minimum	Maximum	TRC173704	TRC182038
Sample date	-	July 2015 to June 2018		25 Oct 2017	01 May 2018
Sample time	NZST			12:10	10:30
pH	pH	7.1	7.3	7.1	7.2
Electrical conductivity	mS/m	20.9	24	21.1	20.9
Chloride	g/m ³	15.7	16.9	16.5	15.7
Total hydrocarbons	g/m ³	<DL	<DL	<0.5	<0.5

Table 7 Results of groundwater sampling undertaken by the Council in relation to the Cheal-E wellsite

Sample details	Units	GND2592				
TRC sample number	-	Minimum	Maximum	TRC173705	TRC182039	TRC182832
Sample date	-	July 2016 to June 2018		25 Oct 2017	01 May 2018	07 Jun 2018
Sample time	NZST			13:30	2:20	11:30
pH	pH	6.9	7.8	6.9	7.1	7.8
Electrical conductivity	mS/m	72.5	105.2	92.3	95.5	105.2
Chloride	g/m ³	14.8	21.5	18.4	19.4	17.1
Total hydrocarbons	g/m ³	<DL	1.7	<0.5	0.5	< 0.7

Note: <DL - below lab detection limit

2.4 Injection monitoring

The Company provided records of their injection activities during the 2017-2018 monitoring period, including daily injection volumes, pumping duration and maximum and average injection pressures. All data was provided within the consented timeframes.

Table 8 provides an overview of the Company's injection activities across all consents during the monitoring period and the total annual injection volumes for all sites combined since 2009 are presented in Table 9.

DWI was undertaken by the Company at the Cheal A, Cheal-B and Cheal-E wellsites during the monitoring period.

The greatest volume of discharge during the review period was undertaken at the Cheal-A wellsite with 35% of the total volume of fluids injected via the Cheal-A2 well under consent 10354-1. No discharge was undertaken via the Cheal-A7 well, which injects into the same formation at the same site.

The volume of fluids discharged has increased significantly during the period of review in comparison to previous years in response to the requirements of the Cheal water flooding programme.

Table 8 Summary of injection activity during the 2017-2018 monitoring year

Consent	Wellsite	Injection well	Total volume discharged (m ³) 01/07/17 – 30/06/18	Discharge period		Well ID
				From	To	
9545-2	Cheal-A	Cheal-A4	19,217.20	01/07/2017	30/06/2018	GND2328
10254-1	Cheal-B	Cheal-B3	23,722.19	01/07/2017	30/06/2018	GND2571
10304-1.1	Cheal-E	Cheal-E7	32,475.04	01/07/2017	30/06/2018	GND2572
10354-1	Cheal-A	Cheal-A2	39,980.51	05/07/2017	30/06/2018	GND2570
10354-1	Cheal-A	Cheal-A7	0.00	N/A	N/A	GND2678
Total			115,394.94	-	-	-

Table 9 Summary of the Company's historical injection activity since 2009

Period	Total volume discharged (m ³)	Period	Total volume discharged (m ³)
2017-2018	115,394	2012-2013	14,660
2016-2017	60,957	2011-2012*	9,793
2015-2016	16,988	2010-2011*	9,792
2014-2015	17,630	2009-2010*	9,792
2013-2014	12,880	2007-2009	No injection

Note *volume was reported from 2009-2012 (29,377 m³) so total has been averaged over the three year period.

Table 11, Table 12, Table 13 and Table 14 summarise the data for each active site during the review period.

At the Cheal-A wellsite (Cheal-A4 well) the maximum injection pressure of 98.72 bar was recorded on 26 January 2018. The maximum daily volume of 114.98 m³ was recorded on 8 October 2017 and the maximum daily average injection rate of 9.7 m³/hr was recorded on 15 December 2017.

At the Cheal-B wellsite the maximum injection pressure of 96.37 bar was recorded on 10 January 2018. The maximum daily volume of 588.73 m³ was recorded on 10, 15 and 16 October 2017 and the maximum daily average injection rate of 24.5 m³/hr, was recorded on most days, between 3 and 24 October 2017.

At the Cheal-E wellsite the maximum injection pressure of 85.91 bar was recorded on 21 May 2018. The maximum daily volume of 197.72 m³ was recorded on 18 July 2017 and the maximum daily average injection rate of 8.56 m³/hr, was recorded on 21 July 2017.

At the Cheal-A wellsite (Cheal-A2 well) the maximum injection pressure of 94.29 bar was recorded on 26 January 2018. The maximum daily volume of 342.67 m³ was recorded on most days between 1 and 25 October 2017 and the maximum daily average injection rate of 14.28 m³/hr was recorded on all days between 1 and 25 October 2017.

All submitted data was within consented limits.

Table 10 Summary of injection occurring under consent 9545-2 (2013-2018)

Deep well injection undertaken at Cheal-A wellsite via the Cheal-A4 injection well					
Year	Annual volume (m ³)	Max. injection volume (m ³ /day)	Maximum injection rate* (m ³ /hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
Consent limit	-	200	-	276	-
2017-2018	19,217	115	9.7	99	77
2016-2017	20,119	129	13.3	104	74
2015-2016	16,988	123	5.3	104	53
2014-2015	14,705	117	13.4	140	69
2013-2014	12,880	142	12.0	209	58

Table 11 Summary of injection occurring under consent 10254-1 (2016-2018)

Deep well injection undertaken at Cheal-B wellsite via the Cheal-B3 injection well					
Year	Annual volume (m ³)	Max. injection volume (m ³ /day)	Maximum injection rate (m ³ /hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
2017-2018	23,722	589	24.5	96	53
2016-2017	34,006	268	65.6	97	63

Table 12 Summary of injection occurring under consent 10304-1.1 (2016-2018)

Deep well injection undertaken at Cheal-E wellsite via the Cheal-E7 injection well					
Year	Annual volume (m ³)	Max. injection volume (m ³ /day)	Maximum injection rate* (m ³ /hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
2017-2018	32,475	198	8.6	86	60
2016-2017	6,833	198	11.8	81	33

Table 13 Summary of injection occurring under consent 10354-1 (2017-2018)

Deep well injection undertaken at Cheal-A wellsite via the Cheal-A2 injection well					
Year	Annual volume (m ³)	Max. injection volume (m ³ /day)	Maximum injection rate (m ³ /hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
2017-2018	39,981	343	14.3	94.3	25

The daily volume, maximum daily injection pressure and a comparison of volume and average daily pressure over the entire data record for consent 9545-2 (Cheal-A4 well) is presented in Figure 4, Figure 5 and Figure 6. A visual assessment of the data indicates that:

- Both maximum pressures and volumes have remained relatively stable over the review period; and
- Increases in daily pressures generally respond to increases in daily injection volumes.

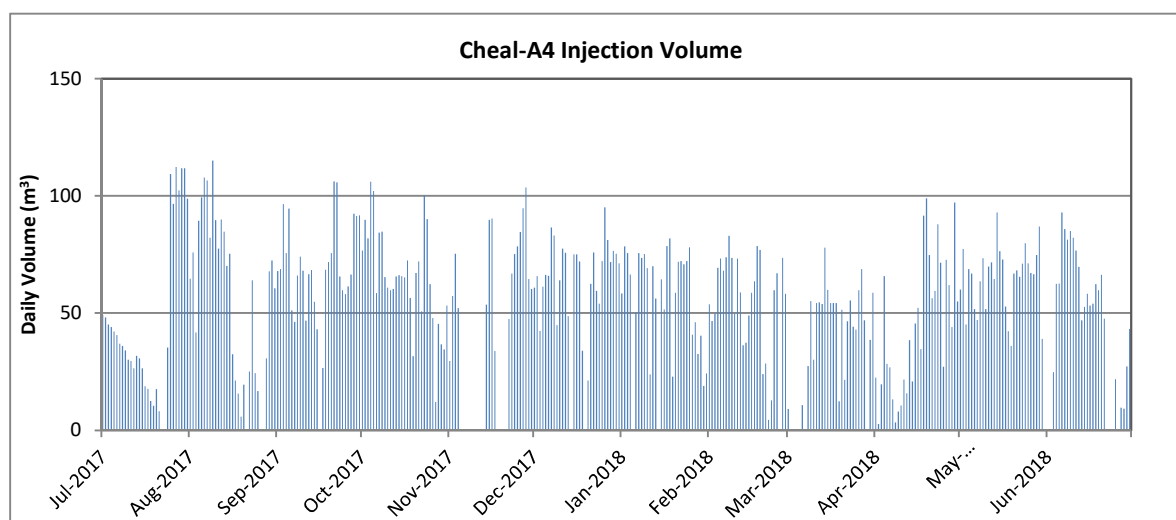


Figure 4 Total daily injection volume consent 9545-2 (2017-2018)

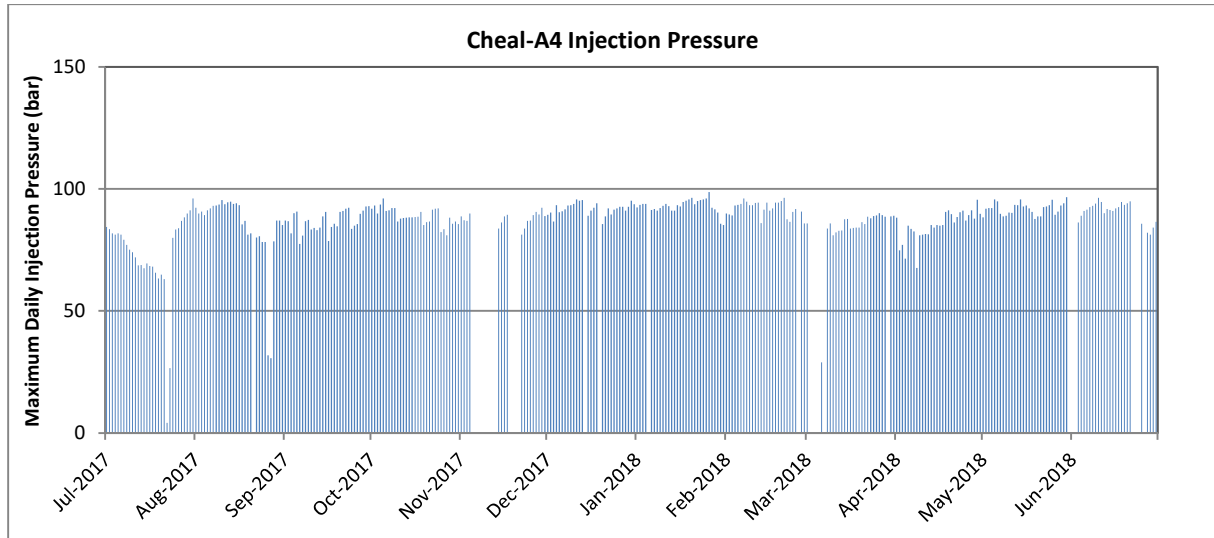


Figure 5 Total daily maximum injection pressure 9545-2 (2017-2018)

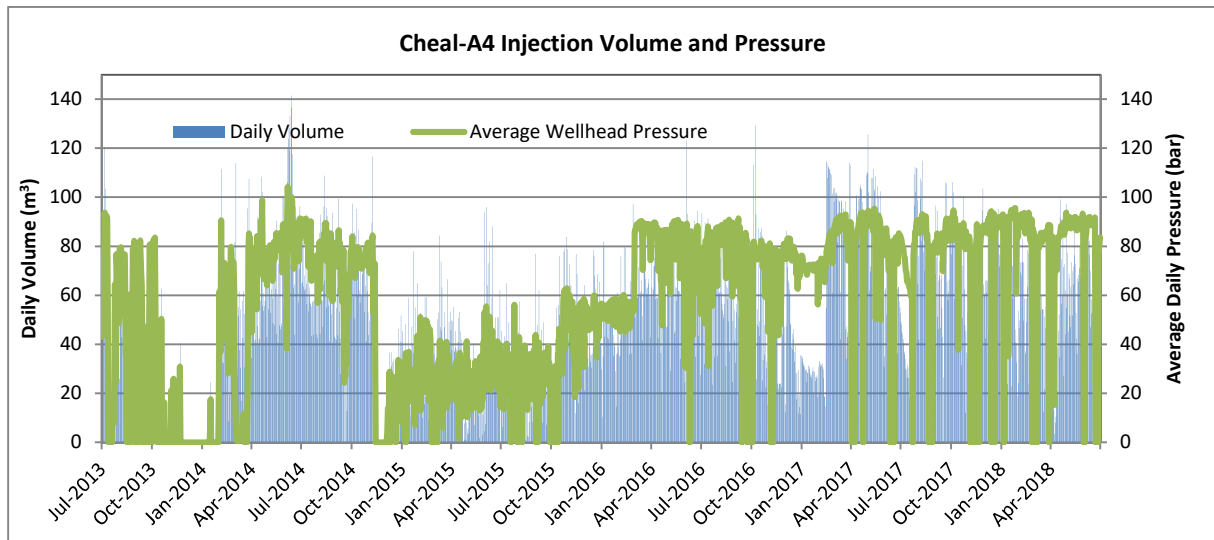


Figure 6 Daily injection volume and daily average injection pressure consent 9545-2 (2013-2018)

The daily volume, maximum daily injection pressure and a comparison of volume and average daily pressure over the entire data record for consent 10254-1 (Cheal-B) is presented in Figure 7, Figure 8 and Figure 9. A visual assessment of the data indicates that:

- Significantly more fluid was discharged via the Cheal-B3 well in October 2017 than any other month; and
- Increases in pressure do not appear to be directly linked to increased injection volumes.

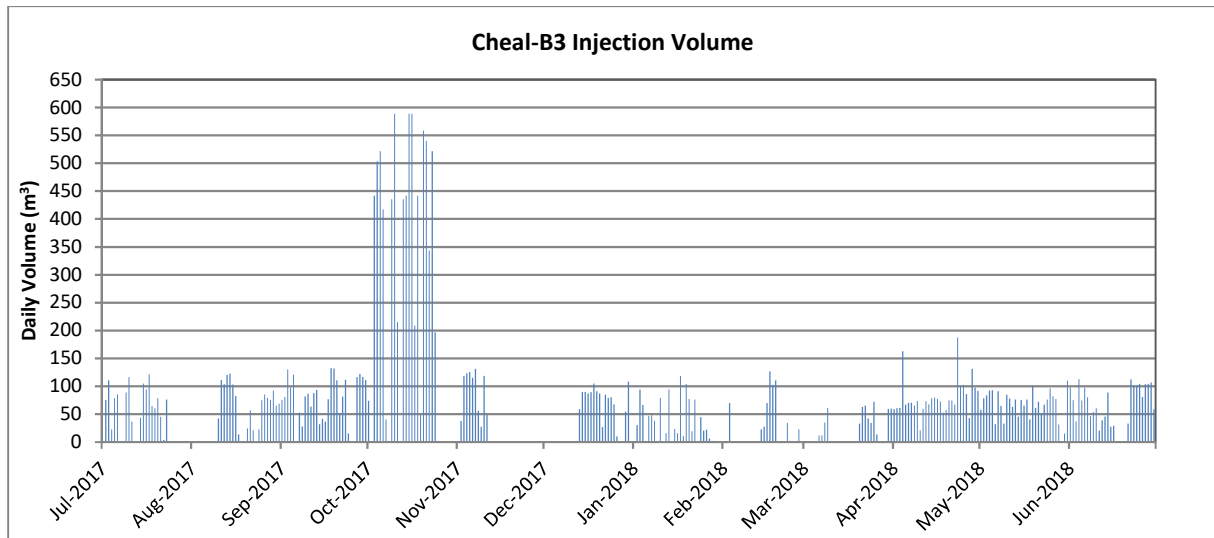


Figure 7 Total daily injection volume consent 10254-1 (2017-2018)

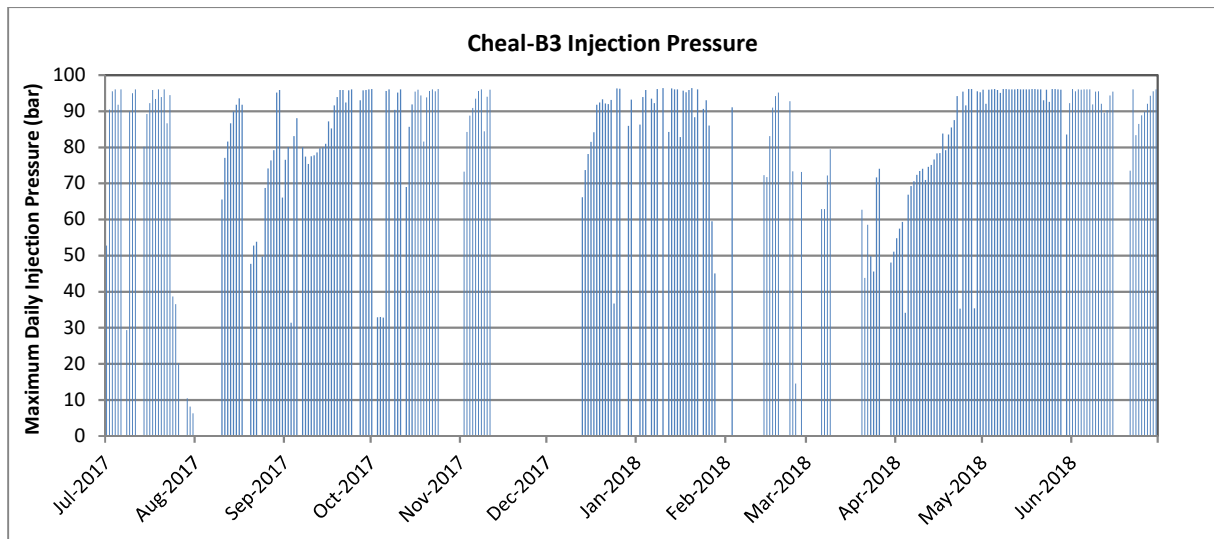


Figure 8 Total daily maximum injection pressure 10254-1 (2017-2018)

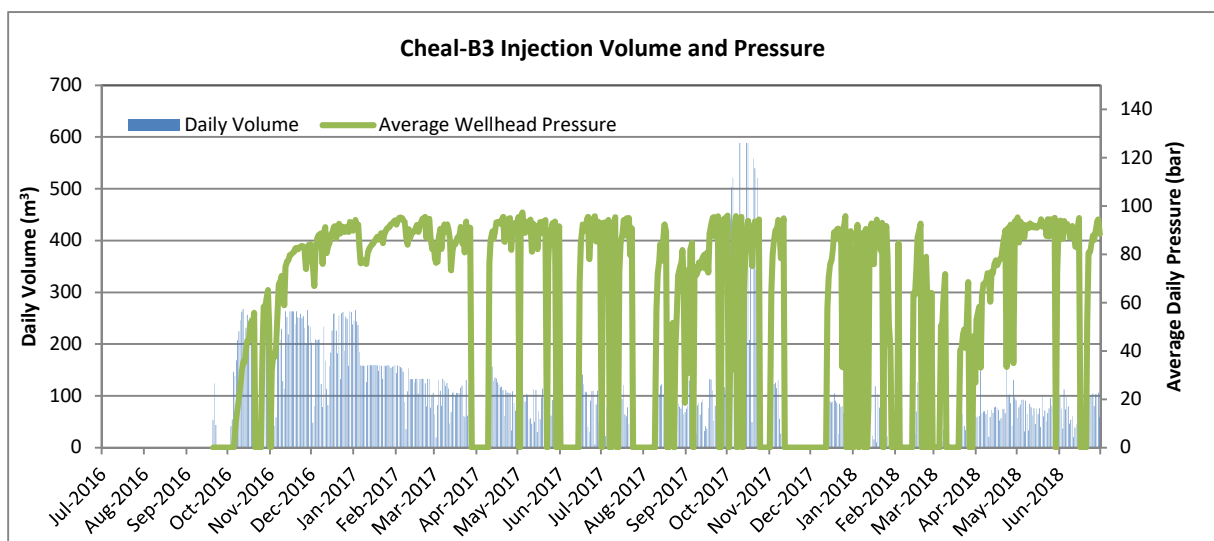


Figure 9 Daily injection volume and average daily pressure consent 10254-1 (2012-2018)

The daily volume, maximum daily injection pressure and a comparison of volume and average daily pressure over the entire data record for consent 10304-1.1 (Cheal-E) is presented in Figure 10, Figure 11 and Figure 12. A visual assessment of the data indicates that:

- Injection commenced at the Cheal-E wellsite on 1 April 2017; and
- Injection pressures have steadily increased since injection began in contrast to injection volumes which have slowly decreased, indicating the success of the water flood programme.

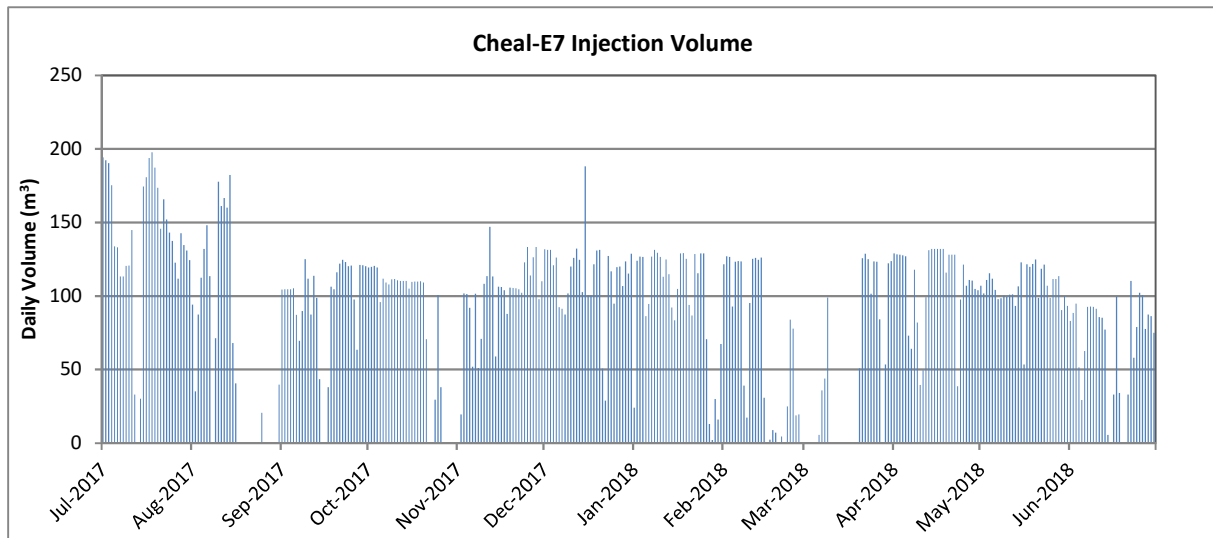


Figure 10 Total daily injection volume consent 10304-1.1 (2017-2018)

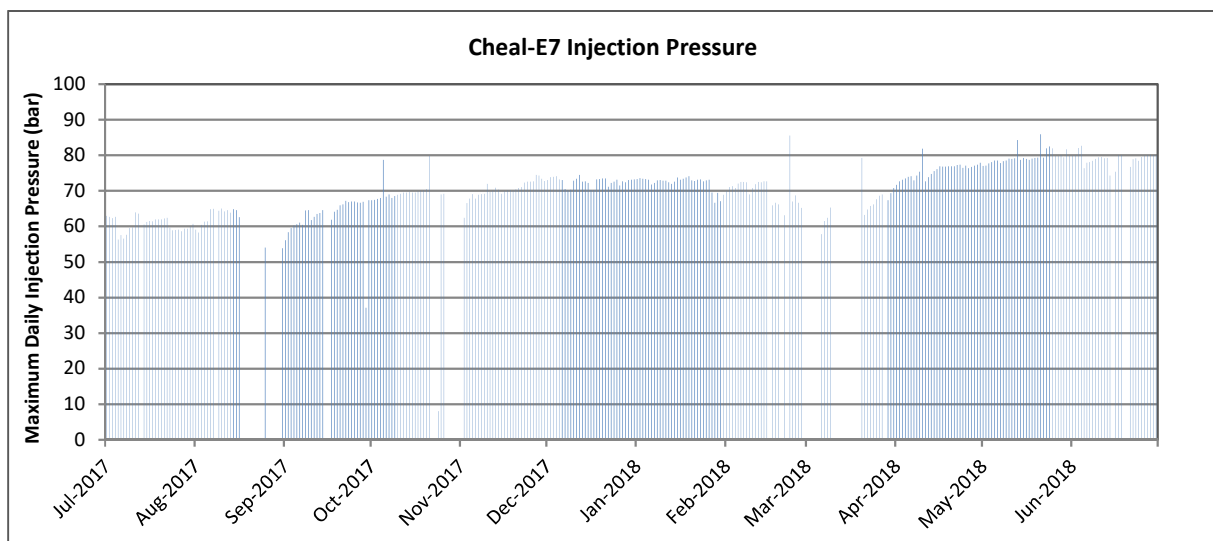


Figure 11 Total daily injection pressure consent 10304-1.1 (2016-2018)

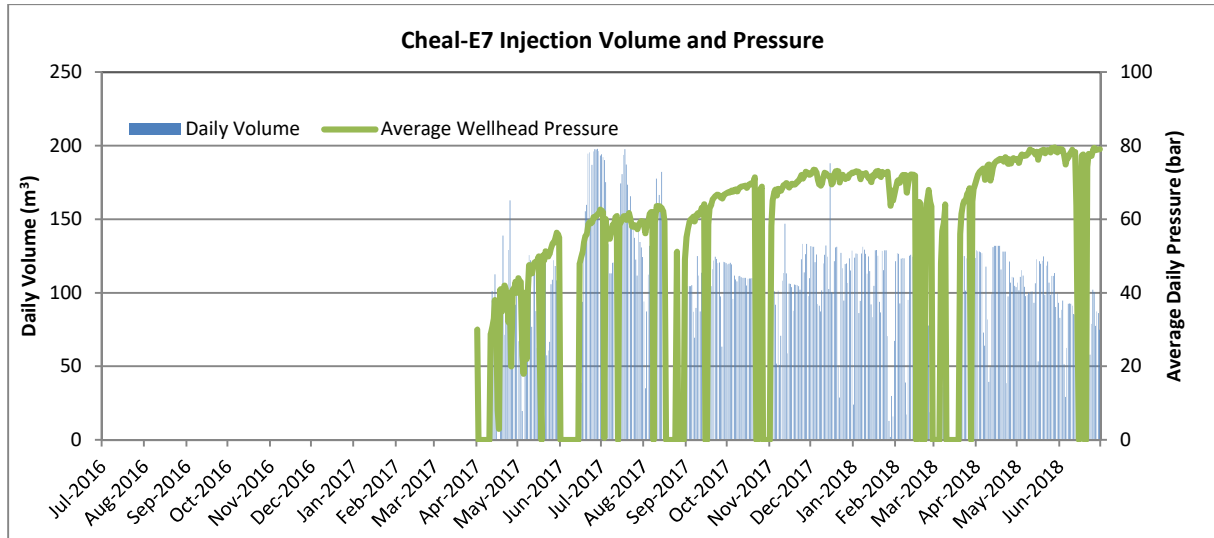


Figure 12 Total daily injection volume and average daily pressure consent 10304-1.1 (2016-2018)

The daily volume, maximum daily injection pressure and a comparison of volume and average daily pressure over the entire data record for consent 10354-1 (Cheal-A2 well) is presented in Figure 13, Figure 14 and Figure 15. A visual assessment of the data indicates that:

- Wellhead pressures generally increase with higher volumes of injection; and

Injection pressures have steadily increased over time indicating the success of the water flood programme at the Cheal-A wellsite.

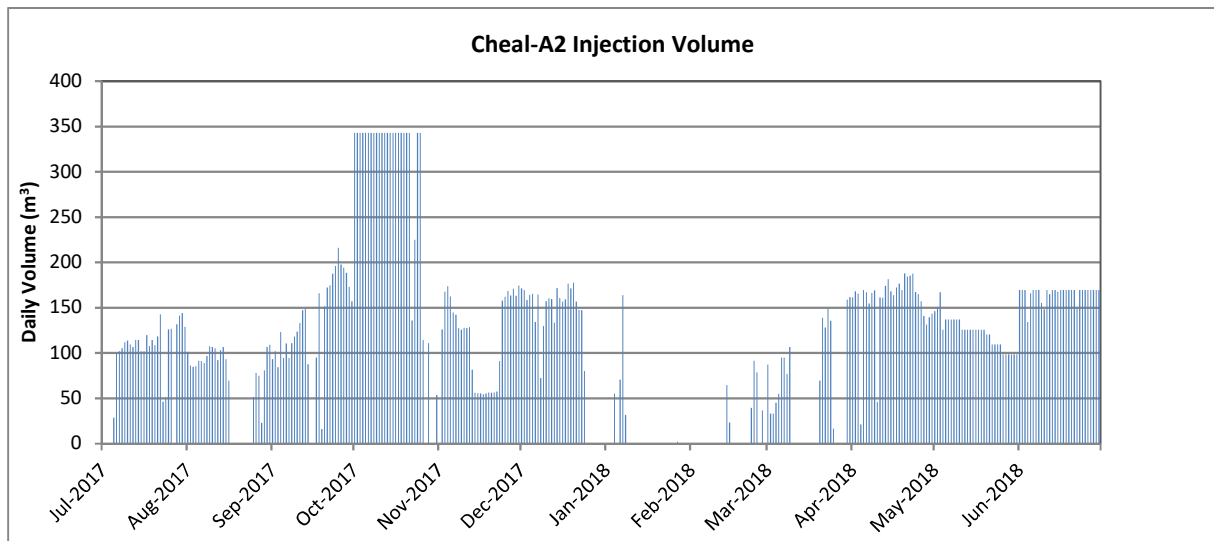


Figure 13 Total daily injection volume consent 10354-1 (2017-2018)

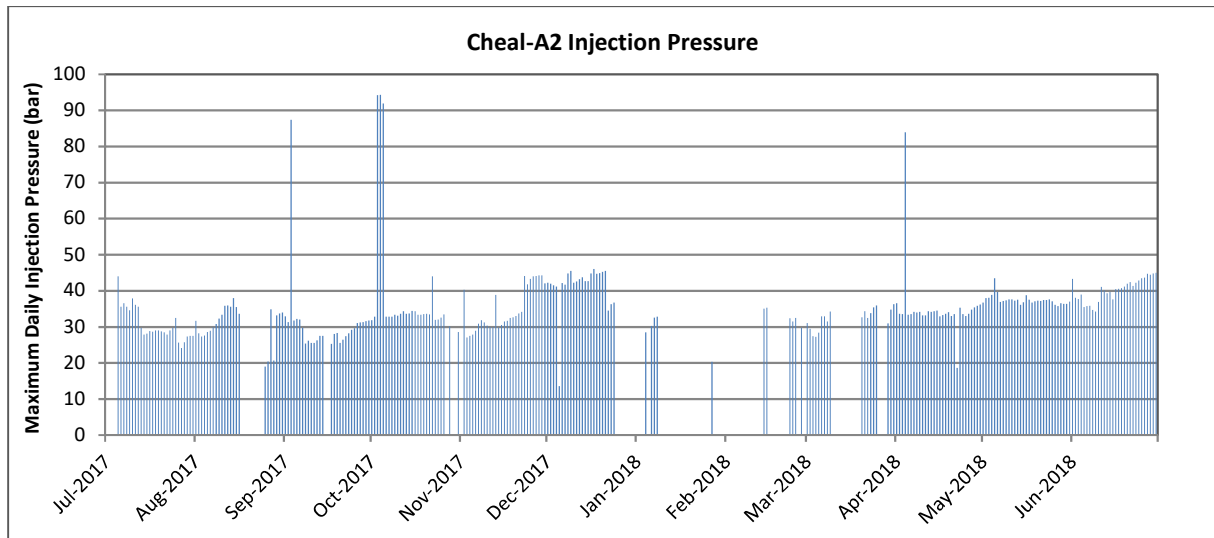


Figure 14 Maximum daily injection pressure consent 10354-1 (2017-2018)

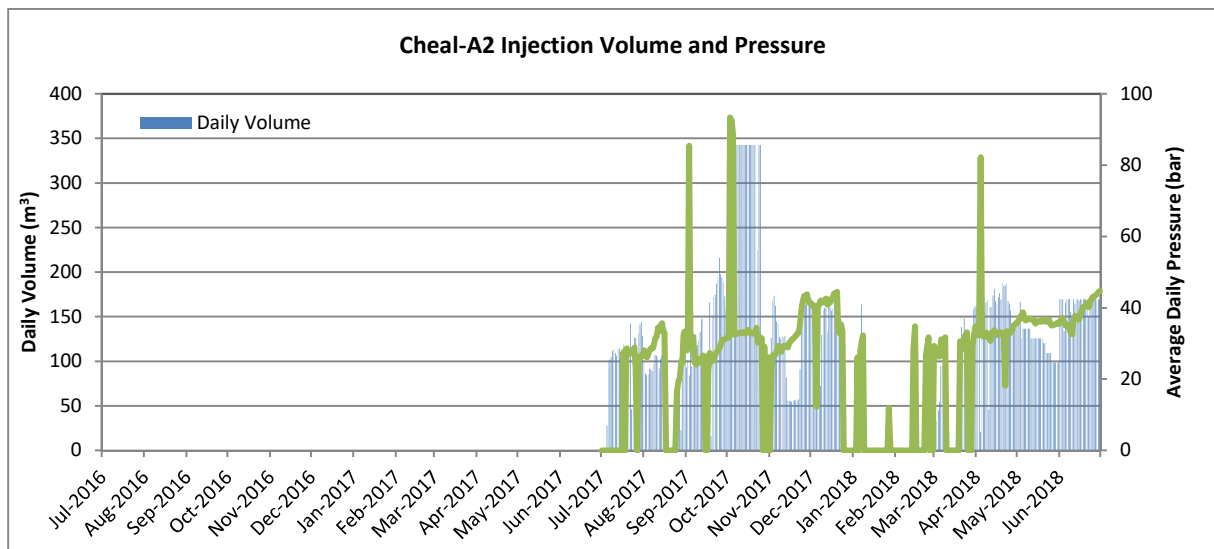


Figure 15 Total daily injection volume and average daily pressure consent 10354-1 (2017-2018)

2.5 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the Company. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The incident register includes events where the Company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2017-2018 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans.

3 Discussion

3.1 Discussion of site performance

During the period under review, the Company exercised four resource consents (9545-2, 10254-1, 10304-1.1 and 10354-1) for the injection of fluids by DWI. These consents licensed discharges of various forms of fluid into the Mount Messenger Formation, via the Cheal-A2, Cheal-B3 and Cheal-E7 injection wells and the Urenui Formation via the Cheal-A4 injection well. The main source of fluids for injection was produced water from the Company's Cheal oil and gas reservoir. Injection at all the Cheal disposal sites is predominantly used for enhanced oil recovery using water flooding techniques.

Injection wells are fitted with engineering controls and in built safety systems. Well integrity is constantly assessed by monitoring injection and annular pressures. In the event of any sudden pressure losses or increases, indicating a loss of tubing or annular pressure, safety systems isolate the wellbore and shut down the injectate pumping system. It should also be noted that maximum pressure that can be generated by the injectate pumps is well below the safe operating pressures of the wellhead, casing and tubing.

The operation of the injection well is monitored by Company staff, with automated systems recording the injection data required under the conditions of their consent. Throughout the monitoring period this data was generally submitted to the Council at the specified frequency. There is no evidence of any issues with any injection well currently in use, or the ability of the receiving formation to accept injected fluids.

Routine inspections of the Company's wellsites conducted during the period under review found them to be in good condition and being well managed. The Council was not required to enter any incidents in relation to the exercising of the Company's DWI consents during the review period, nor were any complaints received from the public in relation to these consents.

Monitoring during the year shows that the Company's DWI activities were being carried out in compliance with the conditions of the applicable resource consents.

3.2 Environmental effects of exercise of consents

To date, no adverse environmental effects have been recorded by the Council in relation to any DWI consent exercised by the Company.

The groundwater monitoring component of this programme continued during the period under review, with a minimum of two samples being taken from monitoring sites in the vicinity of the Company's active injection wells. The results of the monitoring carried out show that the groundwater composition at each site has remained stable since the commencement of monitoring. Some very minor fluctuations in analyte concentrations are attributable to seasonal variations in water composition and standard sampling variability. There is no evidence to suggest that injection activities undertaken by the Company during the review period have had any adverse effect on local groundwater quality.

All results are within the ranges expected for shallow Taranaki groundwater and indicate that there has been no contamination by DWI fluids.

Compliance with the conditions of the Company's DWI consents exercised during the 2017-2018 monitoring period is summarised below in Section 3.3.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 14 to 17 and an evaluation of the Company's environmental performance in relation to their DWI activities since 2007 is presented in Table 18.

Table 14 Summary of performance for consent 9545-2

Purpose: To discharge produced water from hydrocarbon exploration and production operations, reservoir compatible workover fluids and hydraulic fracturing return fluid into the Urenui Formation by deep well injection at the Cheal-A wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. By 1 October 2015, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," by 1 October 2015.	Yes
2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information by 1 October 2015.	Yes
3. No injection permitted after 1 June 2030.	Assessment of injection records and site inspection notices.	N/A
4. The consent holder shall at all times adopt the best practicable option.	Assessment of consent holder records and site inspection notices.	Yes
5. The injection of fluids shall be confined to the Urenui Formation, deeper than 1,300 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The volume discharged should not exceed 200 m ³ /day	Review and analysis of injection data.	Yes
7. The maximum wellhead pressure should not exceed 4,000 psi or 276 bar	Review and analysis of injection data.	Yes
8. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water).	Assessment of injection records and results of groundwater sampling and analysis programme.	
9. Maintain full records of injection data.	Receipt and assessment of injection data.	Yes
10. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes

Purpose: To discharge produced water from hydrocarbon exploration and production operations, reservoir compatible workover fluids and hydraulic fracturing return fluid into the Urenui Formation by deep well injection at the Cheal-A wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
11. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 15th day of the following month.	Receipt of satisfactory data by the date specified.	Yes
12. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 June 2015,	Yes
13. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons.	Implementation of Groundwater Monitoring Programme and assessment of results.	Yes
14. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken.	Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken	Yes
15. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period.	Receipt of satisfactory report by 31 August each year.	Yes
16. Notification of commencement of activity.	Receipt of notification	Yes
17. Consent review provision.	N/A	N/A

Purpose: To discharge produced water from hydrocarbon exploration and production operations, reservoir compatible workover fluids and hydraulic fracturing return fluid into the Urenui Formation by deep well injection at the Cheal-A wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 15 Summary of performance for consent 10254-1

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Before exercising, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," before exercising the consent.	Yes
2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information before exercising the consent.	Yes
3. No injection permitted after 1 June 2029.	Assessment of injection records and site inspection notices.	N/A
4. The consent holder shall at all times adopt the best practicable option.	Assessment of consent holder records and site inspection notices.	Yes
5. The injection of fluids shall be confined to the mount Messenger Formation, deeper than 1,600 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The consent holder shall ensure that the exercise of this consent does not result in fracturing of geological seals.	Review and analysis of injection data.	Yes
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water).	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
8. Limits the range of fluids that can be discharged under the consent.	Assessment of consent holder records and injectate sample analysis.	
9. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
10. The consent holder will maintain daily injection data records.	Receipt of satisfactory data.	Yes
11. If not carried out by an IANZ accredited laboratory, analysis shall be carried out in accordance with QA plan which has been certified by the Chief Executive QA/QC	Inspection of QA plan	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28th day of the following month.	Receipt of satisfactory data by the date specified	Yes
13. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent,	Yes
14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons.	Implementation of Groundwater Monitoring Programme and assessment of results.	Yes

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
15. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken.	Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken	
16. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period.	Receipt of satisfactory report by 31 August each year.	Yes
17. Consent review provision.	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 16 Summary of performance for consent 10304-1.1

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite for the purpose of water flooding.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Before exercising the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," before exercising the consent.	Yes
2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information before exercising the consent.	Yes
3. No injection permitted after 1 June 2029.	Assessment of injection records and site inspection notices.	N/A

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite for the purpose of water flooding.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
4. The consent holder shall at all times adopt the best practicable option.	Assessment of consent holder records and site inspection notices.	Yes
5. The injection of fluids shall be confined to the mount Messenger Formation, deeper than 1,600 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The consent holder shall ensure that the exercise of this consent does not result in fracturing of geological seals.	Review and analysis of injection data.	Yes
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water).	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
8. Limits the range of fluids that can be discharged under the consent.	Assessment of consent holder records and injectate sample analysis.	
9. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
10. The consent holder will maintain daily injection data records.	Receipt of satisfactory data.	Yes
11. If not carried out by an IANZ accredited laboratory, analysis shall be carried out in accordance with QA plan which has been certified by the Chief Executive QA/QC	Inspection of QA plan	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28th day of the following month.	Receipt of satisfactory data by the date specified	Yes

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite for the purpose of water flooding.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
13. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent,	Yes
14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons.	Implementation of Groundwater Monitoring Programme and assessment of results.	Yes
15. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken.	Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken	
16. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period.	Receipt of satisfactory report by 31 August each year.	Yes
17. Consent review provision.	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 17 Summary of performance for consent 10354-1

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-A wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Before exercising the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," before exercising the consent.	Yes
2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information before exercising the consent.	Yes
3. No injection permitted after 1 June 2029.	Assessment of injection records and site inspection notices.	N/A
4. The consent holder shall at all times adopt the best practicable option.	Assessment of consent holder records and site inspection notices.	Yes
5. The injection of fluids shall be confined to the mount Messenger Formation, deeper than 1,600 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The consent holder shall ensure that the exercise of this consent does not result in fracturing of geological seals.	Review and analysis of injection data.	Yes
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water).	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
8. Limits the range of fluids that can be discharged under the consent.	Assessment of consent holder records and injectate sample analysis.	
9. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
10. The consent holder will maintain daily injection data records.	Receipt of satisfactory data.	Yes

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-A wellsite.

Condition requirement	Means of monitoring during period under review	Compliance achieved?
11. If not carried out by an IANZ accredited laboratory, analysis shall be carried out in accordance with QA plan which has been certified by the Chief Executive QA/QC	Inspection of QA plan	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28th day of the following month.	Receipt of satisfactory data by the date specified	Yes
13. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent,	Yes
14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons.	Implementation of Groundwater Monitoring Programme and assessment of results.	Yes
15. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken.	Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken	

Purpose: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-A wellsite.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
16. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period.	Receipt of satisfactory report by 31 August each year.	Yes
17. Consent review provision.	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

During the year, the Company demonstrated a high level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4.

Table 18 Evaluation of environmental performance over time

Year	Consent number	High	Good	Improvement required	Poor
2016-2017	9545	1			
	10254	1			
	10304	1			
	10354	1			
2015-2016	4728	Not exercised			
	9545	1			
	10254	Not exercised			
	10304	Not exercised			
2014-2015	4728	Not exercised			
	9545	1			
2013-2014	4728	Not exercised			
	9545	1			
2012-2013	4728			1	
	9545	1			
2009-2012	4728			1	
2007-2009	4728	1			
Totals		9		2	

Note * not exercised during monitoring period

During the year, the Company demonstrated a high level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4.

3.4 Recommendations from the 2016-2017 Annual Report

In the 2016-2017 Annual Report, it was recommended:

1. THAT monitoring of consented activities in the 2017-2018 year continues at the same level as in the 2016-2017 monitoring period.
2. THAT there is no requirement at this time for a consent review to be pursued or grounds to exercise the review options.

The recommendations above were implemented during the period under review

3.5 Alterations to monitoring programmes for 2018-2019

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki exercising resource consents.

It is proposed the range of monitoring carried out during the 2017-2018 period be continued during the 2018-2019 monitoring period. Recommendations to this effect are included in Section 4 of this report.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site(s) in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2018-2019.

3.6 Exercise of optional review of consent

Resource consents 9545-2, 10254-1, 10304-1.1 and 10354-1 provide for optional reviews in June 2019. Condition 17 allows the Council to review each consent, if there are grounds that the conditions are not adequate to deal with any adverse effects on the environment arising from the exercise of the resource consent, which were either not foreseen at the time the application was considered or which was not appropriate to deal with at the time.

Based on the results of monitoring in the year under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds that require a review to be pursued or grounds to exercise the review option.

4 Recommendations

1. THAT in the first instance, monitoring of consented activities in the 2018-2019 year continue at the same level as in 2017-2018.
2. THAT should there be issues with environmental or administrative performance in 2018-2019, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
3. THAT the option for a review of resource consents in June 2019, as set out in the respective consent conditions not be exercised.

Glossary of common terms and abbreviations

Aquifer (freshwater)	A formation, or group or part of a formation that contains sufficient saturated permeable media to yield exploitable quantities of fresh water.
BPO	Best practicable option
Conductivity	A measure of the level of dissolved salts in a sample. Usually measured at 20°C and expressed as millisiemens per metre (mS/m) or as Total Dissolved Solids (g/m ³).
Confining layer	A geological layer or rock unit that is impermeable to fluids.
Deep well injection (DWI)	Injection of fluids at depth for disposal or enhanced recovery.
Fracture gradient	A measure of how the pressure required to fracture rock in the earth's crust changes with depth. It is usually measured in units of "pounds per square inch per foot" (psi/ft) and varies with the type of rock and the strain of the rock.
g/m ³	Grams per cubic metre. A measure of concentration which is equivalent to milligrams per litre (mg/L), or parts per million (ppm).
Hydraulic fracturing (HF)	The process of increasing reservoir permeability by injecting fluids at pressures sufficient to fracture rock within the reservoir ("fracking").
Injectate	Fluid disposed of by deep well injection.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
IR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
m BGL	Metres below ground level.
m BMP	Metres below measuring point.
mS/m	Millisiemens per metre.
m TVD	Metres true vertical depth
m ³	Cubic metre.
pH	Numerical system for measuring acidity in solutions, with 7 as neutral. Values lower than 7 are acidic and higher than 7 are alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.

Produced water	Water associated with oil and gas reservoirs that is produced along with the oil and gas. Typically highly saline with salt concentrations similar to seawater and containing low levels of hydrocarbons.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
UI	Unauthorised Incident.
Water flooding	A method of thermal recovery in which hot water is injected into a reservoir through specially distributed injection wells. Hot water flooding reduces the viscosity of the crude oil, allowing it to move more easily toward production wells.

For further information on analytical methods, contact a Science Services Manager.

Bibliography and references

- Stevens G. 2001. Taranaki: In: *Groundwaters of New Zealand*, M.R. Rosen and P.A. White (eds). New Zealand Hydrological Society Inc., Wellington. P381-386.
- Environmental Services Association of Alberta (2017), Where does toluene come from? Petrogenic families and biogenic loners, power point presentation for Watertech 2017, accessed on 19 September 2017 at <http://www.esaa.org/wp-content/uploads/2017/04/2017-42.pdf>
- Heiden A.C. et al, (1999) Toluene emissions from plants, *Geophysical Research Letters*, Vol 26, Pages 1283-1286, 1 May 1999.
- Taranaki Regional Council (2017). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2016-2017)*. Technical Report 2017-21. Document number 1850117.
- Taranaki Regional Council (2016). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2015-2016)*. Technical Report 2015-19. Document number 1719526.
- Taranaki Regional Council (2015). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2014-2015)*. Technical Report 2015-19. Document number 1546589.
- Taranaki Regional Council (2015). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2013-2014)*. Technical Report 2014-93. Document number 1468596.
- Taranaki Regional Council (2013). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2012-2013)*. Technical Report 2013-34. Document number 1233811.
- Taranaki Regional Council (2013). *TAG Oil (NZ) Ltd Company Groundwater Monitoring Programme Compliance Report (2011-2012)*. Technical Report 2012-80. Document number 1160304.
- Taranaki Regional Council (2013). *Cheal Petroleum Ltd Deep Well Injection Monitoring Programme Triennial Report (2009-2012)*. Technical Report 2012-67. Document number 1133945.
- Taranaki Regional Council (2010). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Biennial Report (2007-2009)*. Technical Report 2009-92. Document number 717351.
- Ministry for the Environment (2006). *A National Protocol for State of the Environment Groundwater Sampling in New Zealand*. Ref. ME781.

Appendix I

Resource consents held by Cheal Petroleum Limited

(For a copy of the signed resource consent
please contact the TRC Consents department)

Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of
Consent Holder: Cheal Petroleum Limited
PO Box 402
New Plymouth 4340

Decision Date: 28 August 2015

Commencement Date: 28 August 2015

Conditions of Consent

Consent Granted: To discharge produced water from hydrocarbon exploration and production operations, reservoir compatible workover fluids and hydraulic fracturing return fluids into the Urenui Formation by deepwell injection at the Cheal-A wellsite

Expiry Date: 01 June 2035

Review Date(s): June 2023 & June 2029

Site Location: Cheal-A wellsite, 4273 Mountain Road, Ngaere
(Property owners: J & R Lightoller)

Legal Description: Pt Secs 24 Blk VI Ngaere SD (site of discharge)

Grid Reference (NZTM) 1712361E-5639489N

Catchment: Waingongoro

Tributary: Mangawharawhara

*For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document*

General condition

- a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. By 1 October 2015, the consent holder shall submit an "Injection Operation Management Plan." The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. By 1 October 2015, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design, construction its structural integrity, including an up to date well construction diagram;
 - (c) an assessment of the suitability of the injection well for the proposed activity; and
 - (d) details of how the integrity of the injection well will be monitored and maintained;

(Note: The information required by condition 2 may be included within the "Injection Operation Management Plan" required by condition 1).

3. There shall be no injection of any fluids after 1 June 2030.
4. The consent holder shall at all times adopt the best practicable option, as defined in Section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment.
5. The injection of fluids shall be confined to the Urenui Formation, deeper than 1,300 metres true vertical depth.
6. The volume discharged shall not exceed 200 cubic metres per day.
7. The injection pressure at the wellhead shall not exceed 4,000 psi (276 bars). If exceeded, the injection operation shall be ceased immediately and the Chief Executive of the Taranaki Regional Council informed immediately.
8. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/l.

Consent 9545-2.0

9. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
10. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
 - (a) type of fluid;
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

The analysis required by condition 10 above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months.

11. The information required by conditions 9 and 10 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 15th day of the following month.
12. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR), to assess compliance with condition 8. The Monitoring Programme shall be designed to characterise local groundwater quality, and be submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 October 2015, and shall include:
 - (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 metres radially from the point of injection. It is a requirement that at least one suitable monitoring bore be located within 500 metres of the well head. If no suitable existing bores are available, it will be necessary for the Monitoring Programme to include installation of, and sampling from, a suitable bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

13. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
 - (a) pH;
 - (b) conductivity;

- (c) chloride; and
- (d) total petroleum hydrocarbons.

Note: The samples required, under conditions 12 and 13, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

14. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An IANZ accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 8.

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 12.

15. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) an assessment of injection well performance;
 - b) an assessment of the on-going integrity and isolation of the wellbore;
 - c) an assessment of the on-going integrity and isolation of the receiving formation; and
 - d) an updated injection modelling report, demonstrating the ability of the receiving formation to continue to accept additional waste fluids.
16. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 days prior to the first exercise of this consent. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
17. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2023 and June 2029, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 28 August 2015

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of
Consent Holder: Cheal Petroleum Limited
PO Box 402
New Plymouth 4340

Decision Date: 8 November 2016

Commencement Date: 8 November 2016

Conditions of Consent

Consent Granted: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deepwell injection at the Cheal-A wellsite

Expiry Date: 1 June 2035

Review Date(s): June annually

Site Location: Cheal-A wellsite, 4273 Mountain Road, Stratford

Grid Reference (NZTM) 1712371E-5639468N

Catchment: Waingongoro

Tributary: Mangawharawhara

*For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document*

General condition

- a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. Before exercising the consent, the consent holder shall submit an "Injection Operation Management Plan." The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. Before exercising the consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design and its structural integrity;
 - (c) an assessment of the suitability of the injection well for the proposed activity;
 - (d) details of how the integrity of the injection well will be monitored and maintained;
 - (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
 - (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

(Note: The information required by condition 2 may be included within the "Injection Operation Management Plan" required by condition 1).

3. There shall be no injection of any fluids after 1 June 2030.
4. The consent holder shall at all times adopt the best practicable option, as defined in Section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment.
5. The injection of fluids shall be confined to the Mount Messenger Formation, and be injected at a minimum depth of 1,665 metres true vertical depth below ground level.
6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/L.

8. Only the following types of fluid may be discharged:
- (a) produced water;
 - (b) well drilling fluids;
 - (c) well workover fluids, including hydraulic fracturing fluids; and
 - (d) compatible groundwater.

(Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
- (a) type of fluid (as listed in condition 8);
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity;
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

The analysis required by condition 9(c) above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months.

10. Once the consent is exercised, the consent holder shall keep daily records of the:
- (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.
12. The information required by conditions 9 and 10 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 28th day of the following month.

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, and shall include:
- (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 metres from the point of injection. It is a requirement that at least one suitable monitoring bore be located within 500 metres of the well head. If no suitable existing bores are available, it will be necessary for the Monitoring Programme to include installation of, and sampling from, a suitable bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
- (a) pH;
 - (b) conductivity;
 - (c) chloride; and
 - (d) total petroleum hydrocarbons.

Note: The samples required, under conditions 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. All groundwater sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This Plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An IANZ accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information.

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) an assessment of injection well performance;
 - b) an assessment of the on-going integrity and isolation of the wellbore;
 - c) an assessment of the on-going integrity and isolation of the receiving formation; and
 - d) an updated injection modeling report, demonstrating the ability of the receiving formation to continue to accept additional waste fluids and an estimation of remaining storage capacity.

17. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June each year, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 8 November 2016

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of
Consent Holder: Cheal Petroleum Limited
PO Box 402
New Plymouth 4340

Decision Date
(Change): 6 June 2018

Commencement Date
(Change): 6 June 2018 (Granted Date: 15 June 2016)

Conditions of Consent

Consent Granted: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite for the purpose of water flooding

Expiry Date: 1 June 2034

Review Date(s): June annually

Site Location: Cheal-E wellsite, Sole Road, Ngaere
(Property Owner: J O'Neill)

Grid Reference (NZTM) 1714369E-5639714N

Catchment: Patea

Tributary: Ngaere

*For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document*

General condition

- a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. Before exercising the consent, the consent holder shall submit an "Injection Operation Management Plan." The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. Before exercising the consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design and its structural integrity;
 - (c) an assessment of the suitability of the injection well for the proposed activity;
 - (d) details of how the integrity of the injection well will be monitored and maintained;
 - (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
 - (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

(Note: The information required by condition 2 may be included within the "Injection Operation Management Plan" required by condition 1).

3. There shall be no injection of any fluids after 1 June 2029.
4. The consent holder shall at all times adopt the best practicable option, as defined in Section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment.
5. The injection of fluids shall be confined to the Mount Messenger Formation, and be injected at a minimum depth of 1,600 metres true vertical depth below ground level.
6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/L.

Consent 10304-1.1

8. Only the following types of fluid may be discharged:
- (a) produced water;
 - (b) well drilling fluids;
 - (c) well workover fluids, including hydraulic fracturing fluids; and
 - (d) compatible groundwater.

(Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
- (a) type of fluid (as listed in condition 8);
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity;
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

The analysis required by condition 9(c) above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months.

10. Once the consent is exercised, the consent holder shall keep daily records of the:
- (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.
12. The information required by conditions 9 and 10 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 28th day of the following month.

Consent 10304-1.1

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, and shall include:
- (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 metres from the point of injection. It is a requirement that at least one suitable monitoring bore be located within 500 metres of the well head. If no suitable existing bores are available, it will be necessary for the Monitoring Programme to include installation of, and sampling from, a suitable bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
- (a) pH;
 - (b) conductivity;
 - (c) chloride; and
 - (d) total petroleum hydrocarbons.

Note: The samples required, under conditions 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. All groundwater sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This Plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An IANZ accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information.

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) an assessment of injection well performance;
 - b) an assessment of the on-going integrity and isolation of the wellbore;
 - c) an assessment of the on-going integrity and isolation of the receiving formation; and
 - d) an updated injection modeling report, demonstrating the ability of the receiving formation to continue to accept additional waste fluids and an estimation of remaining storage capacity.

Consent 10304-1.1

17. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June each year, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 6 June 2018

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of
Consent Holder: Cheal Petroleum Limited
PO Box 402
New Plymouth 4340

Decision Date: 11 April 2016

Commencement Date: 11 April 2016

Conditions of Consent

Consent Granted: To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite

Expiry Date: 1 June 2034

Review Date(s): June annually

Site Location: Cheal-B wellsite, Taylor Road, Ngaere
(Property owner: R & C Taylor)

Grid Reference (NZTM) 1712616E-5640740N

Catchment: Patea

Tributary: Ngaere

*For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document*

General condition

- a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. Before exercising the consent, the consent holder shall submit an "Injection Operation Management Plan." The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. Before exercising the consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design and its structural integrity;
 - (c) an assessment of the suitability of the injection well for the proposed activity;
 - (d) details of how the integrity of the injection well will be monitored and maintained;
 - (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
 - (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

(Note: The information required by condition 2 may be included within the "Injection Operation Management Plan" required by condition 1.)

3. There shall be no injection of any fluids after 1 June 2029.
4. The consent holder shall at all times adopt the best practicable option, as defined in Section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment.
5. The injection of fluids shall be confined to the Mount Messenger Formation, and be injected at a minimum depth of 1,600 metres true vertical depth below ground level.
6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/L.

8. Only the following types of fluid may be discharged:
- (a) produced water;
 - (b) well drilling fluids;
 - (c) well workover fluids, including hydraulic fracturing fluids; and
 - (d) compatible groundwater.

(Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
- (a) type of fluid (as listed in condition 8);
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity;
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

The analysis required by condition 9(c) above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months.

10. Once the consent is exercised, the consent holder shall keep daily records of the:
- (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.
12. The information required by conditions 9 and 10 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 28th day of the following month.

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, and shall include:
- (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 metres from the point of injection. It is a requirement that at least one suitable monitoring bore be located within 500 metres of the well head. If no suitable existing bores are available, it will be necessary for the Monitoring Programme to include installation of, and sampling from, a suitable bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

14. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
- (a) pH;
 - (b) conductivity;
 - (c) chloride; and
 - (d) total petroleum hydrocarbons.

Note: The samples required, under conditions 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. All groundwater sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This Plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An IANZ accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information.

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) an assessment of injection well performance;
 - b) an assessment of the on-going integrity and isolation of the wellbore;
 - c) an assessment of the on-going integrity and isolation of the receiving formation; and
 - d) an updated injection modeling report, demonstrating the ability of the receiving formation to continue to accept additional waste fluids and an estimation of remaining storage capacity.

17. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June each year, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 11 April 2016

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

