

Cheal Petroleum Ltd

Deep Well Injection Monitoring Programme Annual Report 2021-2022

Technical Report 2022-77



Working with people | caring for Taranaki

Taranaki Regional Council
Private Bag 713
Stratford

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Executive summary

Cheal Petroleum Ltd (the Company) operate a number of wellsites located within their Cheal oil and gas field, south of Stratford. Each wellsite contains varying numbers of producing wells and associated production infrastructure. This report for the period July 2021 to June 2022 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.

During the monitoring period, the Company demonstrated a high level of environmental performance and high level of administrative performance.

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.

The Council's monitoring programme for the year under review included four annual site inspections, two injectate samples and seven 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 formations to accept injected fluids. The results of groundwater quality monitoring undertaken show no adverse effects of the activity on local groundwater resources. 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 performance and a high level of administrative performance with the resource consents.

For reference, in the 2021-2022 year, consent holders were found to achieve a high level of environmental performance and compliance for 88% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 10% 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 2022-2023 monitoring period.

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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 2021 to June 2022 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Cheal Petroleum Ltd (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, 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 12th 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 *Resource Management Act 1991* (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 2022-2023 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 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' in as much 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 consent holders, this report also assigns a rating as to each Company's environmental and administrative performance during the period under review. The rating categories are high, good, improvement required and poor for both environmental and administrative performance. The interpretations for these ratings are found in Appendix II.

For reference, in the 2021-2022 year, consent holders were found to achieve a high level of environmental performance and compliance for 88% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 10% of the consents, a good level of environmental performance and compliance was achieved.¹

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.

¹ The Council has used these compliance grading criteria for more than 18 years. They align closely with the 4 compliance grades in the MfE Best Practice Guidelines for Compliance, Monitoring and Enforcement, 2018

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 holds four resource consents the details of which are summarised in Table 1 below. Summaries of the conditions attached to each permit are set out in Section 3 of this report.

A summary of the various consent types issued by the Council is included in Appendix I, as are copies of all permits held by the Company during the period under review.

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



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

Table 1 Resource consents held by the Company during the 2021-2022 monitoring year

Consent number	Purpose	Granted	Review	Expires
<i>Discharges of waste to land</i>				
9545-2.1	To discharge produced water from hydrocarbon exploration and production operations, reservoir compatible workover fluids and hydraulic fracturing return fluids into the Urenui Formation by deep well injection at the Cheal-A wellsite for the purpose of water flooding	28 Aug 2015	June annually	1 June 2035
10254-1	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.	11 Apr 2016	June annually	1 Jun 2034
10304-1.1	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	15 Jun 2016	June annually	1 Jun 2034
10354-1.1	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 for the purpose of water flooding.	8 Nov 2016	June annually	1 Jun 2035



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;
- 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-A, Cheal-B and Cheal-E wellsites were visited once in relation to the Company's DWI monitoring programme. The main points of interest during routine inspections with regard to DWI consents are general housekeeping and any processes with potential or actual discharges, including any surface water runoff, and their receiving environments.

In addition to the programmed DWI inspections, Council Officers also visited the Company's Cheal-A wellsite on two occasions for injectate sampling purposes and the Cheal-A and Cheal-E wellsites on a further three occasions as part of the Company's Production Station monitoring programme.

1.4.4 Injectate sampling

Injectate samples were obtained for analysis 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.

There are six wells utilised for the injection of fluids for the purpose of water flooding at the Company's DWI wellsites. One of the six wells (Cheal-A7) has been modified to enable the injection of fluids into the Urenui formation under consent 9545-2.1 and the Mount Messenger formation under consent 10354-1.1. A summary of the details for each injection well is included in Table 2 and locations are displayed in Figure 3.

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 by Hill Laboratories Ltd (Hills) for the following parameters:

- pH;
- conductivity;
- suspended solids;

- chlorides; and
- total petroleum hydrocarbons.

Table 2 Injection well details

Wellsite	Consent	Injection well	TRC bore id.	Formation
Cheal-A	9545-2.1	Cheal-A4	GND2328	Urenui
		Cheal-A7	GND2678	Urenui
	10354-1.1	Cheal-A2	GND2570	Mount Messenger
		Cheal-A7	GND2678	Mount Messenger
Cheal-B	10254-1	Cheal-B3	GND2571	Mount Messenger
Cheal-E	10304-1.1	Cheal-E4	GND2714	Mount Messenger
		Cheal-E7	GND2572	Mount Messenger

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 installed by the Company under the conditions of consents 10254-1 and 10304-1.1. One site, GND0492, was removed from the monitoring programme during the review period as the wellhead is damaged and no longer suitable for sampling. GND3172 which is located slightly closer to the wellsite was added to the programme in its place.

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

Table 3 Groundwater monitoring site details

Site code	Wellsite	Distance from wellsite (m)	Screened/open depth (m)	Drilled depth (m)	Aquifer
GND1139	Cheal-A	415	36.0-54.0	54.0	Volcanics
GND0492	Cheal-A	357	19.5-30.5	30.5	Volcanics
GND3172	Cheal-A	350	unknown	unknown	Volcanics
GND2543	Cheal-B	<50	14.1-32.1	32.1	Volcanics
GND2592	Cheal-E	<50	18.7-30.7	30.7	Volcanics

Groundwater samples taken by the Council were sent on behalf of the Company to Hills and analysed for a range of parameters including the following:

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

The parameters above are deemed sufficient to enable identification of any significant changes in groundwater quality related to DWI activities.

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

Groundwater samples are collected following standard groundwater sampling methodologies and generally in accordance with the National Environmental Monitoring Standards (NEMS) for discrete groundwater quality sampling (2019).

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 consents.

As required by the conditions of their consents, 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.

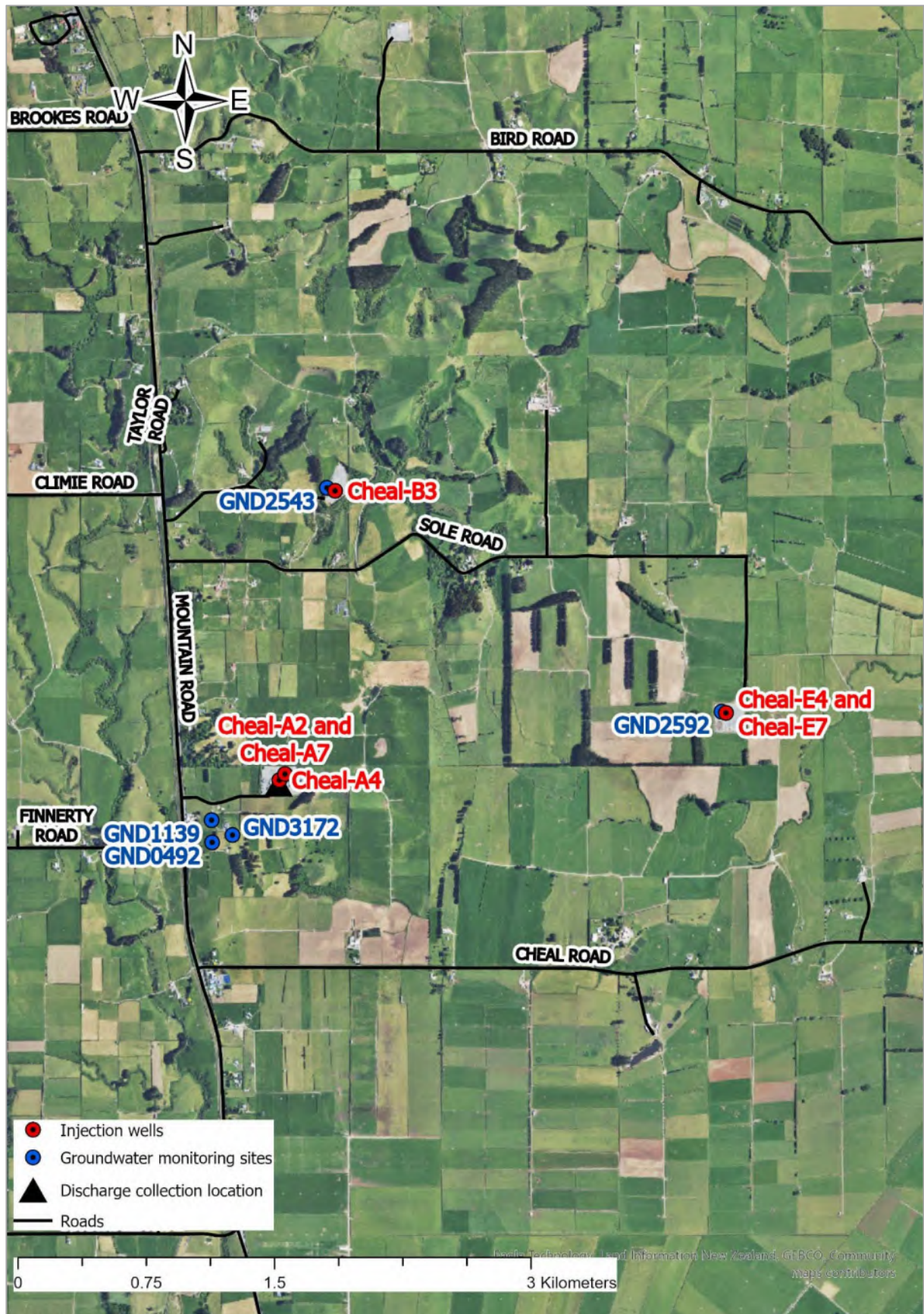


Figure 3 Location of monitoring sites in relation to the Company's DWI injection wells

2 Results

2.1 Inspections

The routine inspections undertaken at each active wellsite during the monitoring year included 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. No visual impacts were seen in the receiving environments inspected.

Additional inspections were also undertaken during the monitoring year, for the purpose of injectate sampling and as part of the Company's production station monitoring programme. No issues in relation to the Company's DWI activities 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 6 December 2021 and 11 May 2022. The samples were sent to Hills on the same day for physicochemical analysis.

The results of the sample analyses undertaken by the Council are included below in Table 4. The range of results for each analyte since 2013 are also presented for comparison.

The Company also undertakes analysis of injectate monthly. The range of results provided to the Council for the 2021-2022 monitoring year are presented in Table 5. The results show that two distinct produced water fluid streams are injected. The first supplies the Cheal-E wellsites and the second the Cheal-A and Cheal-B wellsites. The results provided monthly for each well are included as Appendix III.

The concentrations of each analyte measured over the 2021-2022 period are within the expected range for injectate samples at these sites.

Table 4 Results of injectate sampling undertaken by the Council

Parameter	Unit	Minimum	Maximum	TRC213771	TRC211824
Date	-	01-Jul-13 to 30-Jun-22		6-Dec-21	11-May-22
pH	pH	6.0	8.7	7.9	7.3
Electrical conductivity	mS/m @ 25°C	740	4,576	3,990	4,140
Suspended solids	g/m ³	4	1,940	67	74
Chloride	g/m ³	1,890	18,300	16,000	16,200
Total petroleum hydrocarbons	g/m ³	13	520	47	27

Table 5 Results of injectate sampling undertaken by the Company (2021-2022)

Parameter	Unit	Minimum	Maximum
Date	-	01-Jul-21 to 30 Jun 22	
pH	pH units	5.22	7.56
Electrical conductivity	mho/cm	0.04	22.9
Suspended solids	g/m ³	10	1,600
Temperature	°C	1	32
Salinity	TDS g/m ³	7,410	25,850
Chloride	g/m ³	7,510	17,130
Total petroleum hydrocarbons	g/m ³	25	1,500

2.3 Groundwater sampling

Groundwater samples were obtained from two sites located in the vicinity of the Cheal-A wellsite (GND1139 and (GND3172) and one site each in the vicinity of the Cheal-B (GND2543) and Cheal-E wellsites (GND2592). Routine groundwater sampling was undertaken on 21 December 2021 and 11 May 2022. Samples were not collected from GND0492 during the monitoring period as this bore has now been removed from the monitoring programme. This bore has now been replaced within the programme by GND3172 which is located slightly closer to the wellsite. A baseline sample was collected from GND3172 on 11 May 2022.

The results of analyses carried out during the period are set out below in Table 6, Table 7, Table 8 and Table 9. The minimum and maximum range of historical data has also been provided for comparison.

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

Table 6 Groundwater monitoring results Cheal-A wellsite GND1139

Parameter	Unit	Minimum	Maximum	TRC213768	TRC226447
Date	-	01-Jul-12 to 30-Jun-22		21-Dec-21	11-May-22
Time	NZST	-	-	12:25	12:00
pH	pH	6.7	7.1	7.1	7.0
Electrical conductivity	$\mu\text{S}/\text{cm}@25^{\circ}\text{C}$	160	228	204	212
Chloride	g/m^3	9	14	13	13
Total petroleum hydrocarbons	g/m^3	<0.5	1.4	<0.7	<0.7

Table 7 Baseline groundwater monitoring results Cheal-A wellsite GND3172

Parameter	Unit	TRC226450	Parameter	Unit	TRC226450
Date	-	11-May-22	Date	-	11-May-22
Time	NZST	12:45	Time	NZST	09:50
pH	pH	7.2	Dissolved zinc	g/m^3	0.0015
Alkalinity	$\text{g}/\text{m}^3 \text{CaCO}_3$	44	Bromide	g/m^3	0.11
Bicarbonate	$\text{g}/\text{m}^3 \text{HCO}_3$	54	Chloride	g/m^3	16.9
Hardness	$\text{g}/\text{m}^3 \text{CaCO}_3$	65	Nitrite	$\text{g}/\text{m}^3 \text{N}$	< 0.002
Electrical conductivity	$\mu\text{S}/\text{cm}@25^{\circ}\text{C}$	222	Nitrate	$\text{g}/\text{m}^3 \text{N}$	8.6
Temperature	$^{\circ}\text{C}$	17.9	Nitrite and nitrate	$\text{g}/\text{m}^3 \text{N}$	8.6
Dissolved barium	g/m^3	0.01	Sulphates	g/m^3	6.9
Dissolved calcium	g/m^3	16.4	Benzene	g/m^3	< 0.0010
Dissolved copper	g/m^3	0.0012	Toluene	g/m^3	< 0.0010
Dissolved iron	g/m^3	<0.2	Ethylbenzene	g/m^3	< 0.0010
Dissolved magnesium	g/m^3	5.8	m-Xylene	g/m^3	< 0.002
Dissolved manganese	g/m^3	<0.0005	o-Xylene	g/m^3	< 0.0010
Dissolved mercury	g/m^3	< 0.00008	Ethane	g/m^3	< 0.003
Dissolved nickel	g/m^3	<0.0005	Ethylene	g/m^3	< 0.004
Dissolved potassium	g/m^3	3.7	Methane	g/m^3	<0.002
Dissolved sodium	g/m^3	17	Total hydrocarbons	g/m^3	< 0.7

Table 8 Groundwater monitoring results Cheal-B wellsite GND2543

Parameter	Unit	Minimum	Maximum	TRC213769	TRC226448
Date	-	01-Jul-15 to 30-Jun-22		6-Dec-21	11-May-22
Time	NZST	-	-	9:50	11:20
pH	pH	7.1	7.6	7.4	7.4
Electrical conductivity	$\mu\text{S}/\text{cm}@25^{\circ}\text{C}$	222	265	222	225
Chloride	g/m^3	14	17	14	15
Total petroleum hydrocarbons	g/m^3	<0.5	<0.7	<0.7	<0.7

Table 9 Groundwater monitoring results Cheal-E wellsite GND2592

Parameter	Unit	Minimum	Maximum	TRC213770	TRC226449
Date	-	01-Jul-16 to 30-Jun-22		6-Dec-21	11-May-22
Time	NZST	-	-	11:40	10:15
pH	pH	6.9	7.8	7.3	7.3
Electrical conductivity	$\mu\text{S}/\text{cm}@25^{\circ}\text{C}$	801	1,166	1,108	1,149
Chloride	g/m^3	15	22	17	17
Total petroleum hydrocarbons	g/m^3	<0.5	1.7	<0.7	<0.7

2.4 Provision of consent holder data

The Company provided records of their injection activities during the 2021-2022 monitoring period, including daily injection volumes, pumping duration and maximum and average injection pressures. All data was provided within the consented timeframes.

Table 10 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 11.

The volume of fluids discharged during the review period was significantly lower than in previous years, likely a result of reduced production at the Cheal wellsites. The greatest volume of fluid (44%) was injected via the Cheal-A7 dual completion well at the Cheal-A wellsite during the monitoring period.

Table 10 Summary of injection activity during the 2021-2022 monitoring year

Consent	Wellsite	Injection well	Total volume discharged (m³) 01/07/21 – 30/06/22	Discharge period		Well ID
				From	To	
9545-2.1	Cheal-A	Cheal-A4	2,192.92	01/07/2021	30/06/2022	GND2328
		Cheal-A7	12,621.68	01/07/2021	30/06/2022	GND2678
10354-1.1		Cheal-A2	217.24	01/07/2021	30/06/2022	GND2570
		Cheal-A7	3,191.67	01/07/2021	30/06/2022	GND2678
10254-1	Cheal-B	Cheal-B3	7,140.60	17/03/2022	22/05/2022	GND2571
10304-1.1	Cheal-E	Cheal-E4	4,351.96	01/07/2021	30/06/2022	GND2714
		Cheal-E7	5,836.07	01/07/2021	30/06/2022	GND2572

Consent	Wellsite	Injection well	Total volume discharged (m³) 01/07/21 – 30/06/22	Discharge period		Well ID
				From	To	
Total			35,552.14	-	-	-

Table 11 Summary of the Company's historical injection activity by year

Period	Total volume discharged (m ³)	Period	Total volume discharged (m ³)
2021-2022	35,552	2014-2015	17,630
2020-2021	94,526	2013-2014	12,880
2019-2020	135,379	2012-2013	14,660
2018-2019**	111,556	2011-2012*	9,793
2017-2018	115,394	2010-2011*	9,792
2016-2017	60,957	2009-2010*	9,792
2015-2016	16,988	2007-2009	No injection

Note *volume was reported from 2009-2012 (29,377 m³) so total has been averaged over the three year period.** volume has been updated since publication of the 2018-2019 report.

2.4.1 Summary of injection at the Cheal-A wellsite

2.4.1.1 Consent 9545-2.1

The Cheal-A4 and Cheal-A7 wells inject into the Urenui formation at the Cheal-A wellsite. A total of 51% of all fluids injected during the year were disposed of via the Cheal-A wellsite.

Table 12 provides a summary of the historical data for the Cheal-A wellsite under consent 9545-2.1.

The volume of fluid being injected into the Urenui formation via the Cheal-A4 well has fluctuated over recent years in response to the requirements of the water flood programme. Injection pressures in the well remained relatively consistent over the review period (Figure 4).

The volume of fluid being injected under consent 9545-2.1 increased significantly once the Cheal-A7 well was incorporated into the Company's water flood programme during the 2018-2019 period.

Figure 5 illustrates the influence of the water flood programme, whereby sustained periods of injection have led to increased pressure within the targeted formation. Conversely, a reduction in pressure is evident when injection volumes are reduced. This pattern of rising and reducing injection pressure in response to the volume of fluid being injected is also evident in the longer term injection data record for each well (Figure 6).

Table 12 Summary of injection occurring under consent 9545-2.1 (2013-2022)

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)
2021-2022	2,193	58	5.9	99	24
2020-2021	14,027	99	14.3	103	66

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)
2019-2020	23,141	104	4.4	97	87
2018-2019*	15,106	105	5.7	100	69
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
Deep well injection at Cheal-A wellsite via the Cheal-A7 injection well					
2021-2022	4,365	100	10.5	87	59
2020-2021	18,008	96	18.4	95	73
2019-2020	22,666	97	20.5	95	71
2018-2019	10,950	134	4.1	101	49

Note * consent limits removed in July 2018

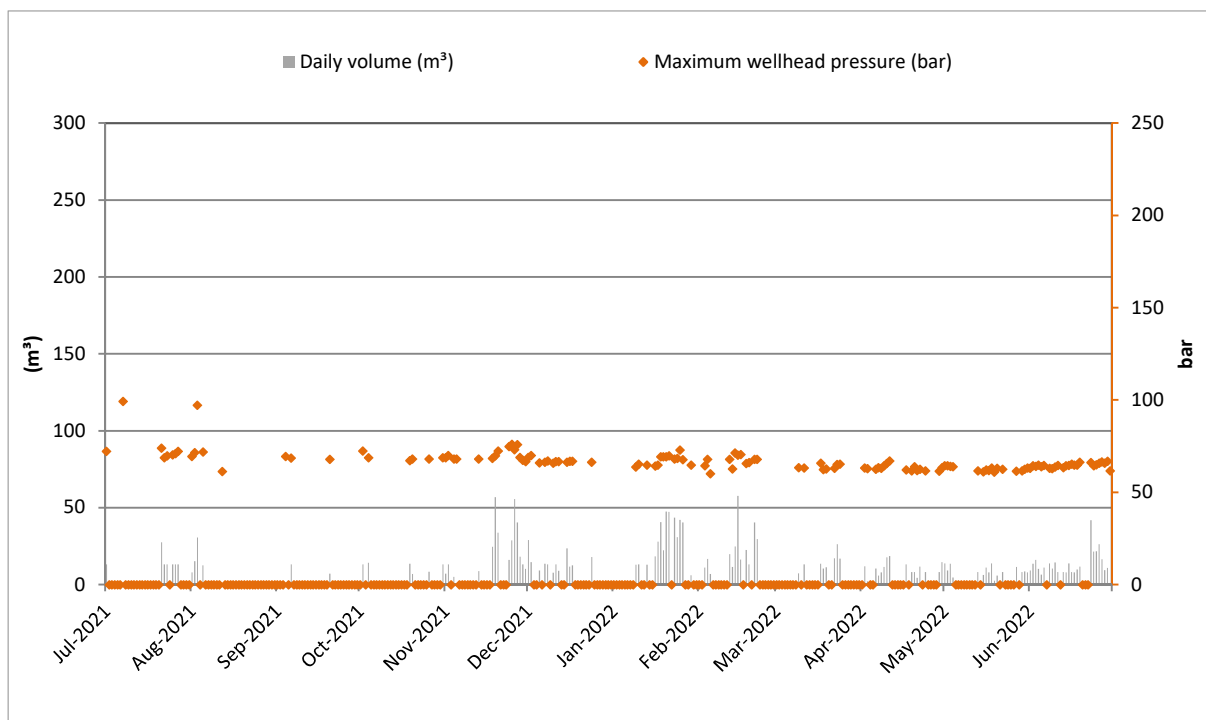


Figure 4 Cheal-A4 well: Daily injection volumes and injection pressures (2021-2022)

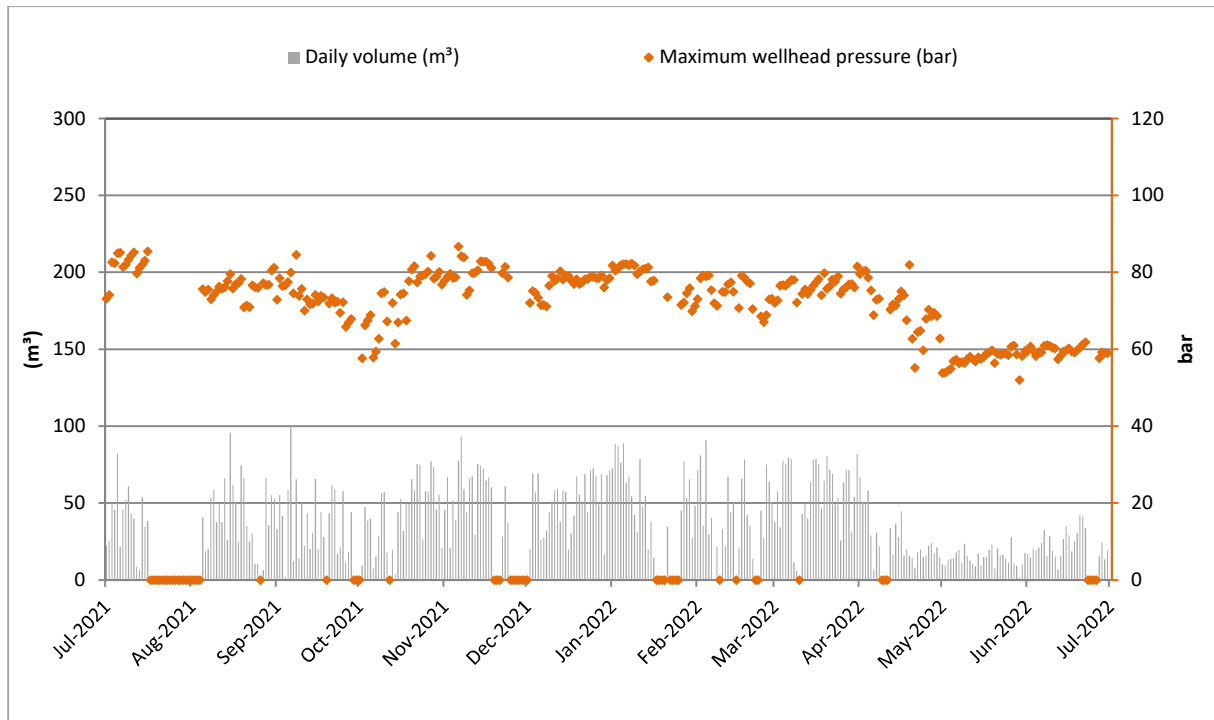


Figure 5 Cheal-A7 well: Daily injection volumes and injection pressures (2021-2022)

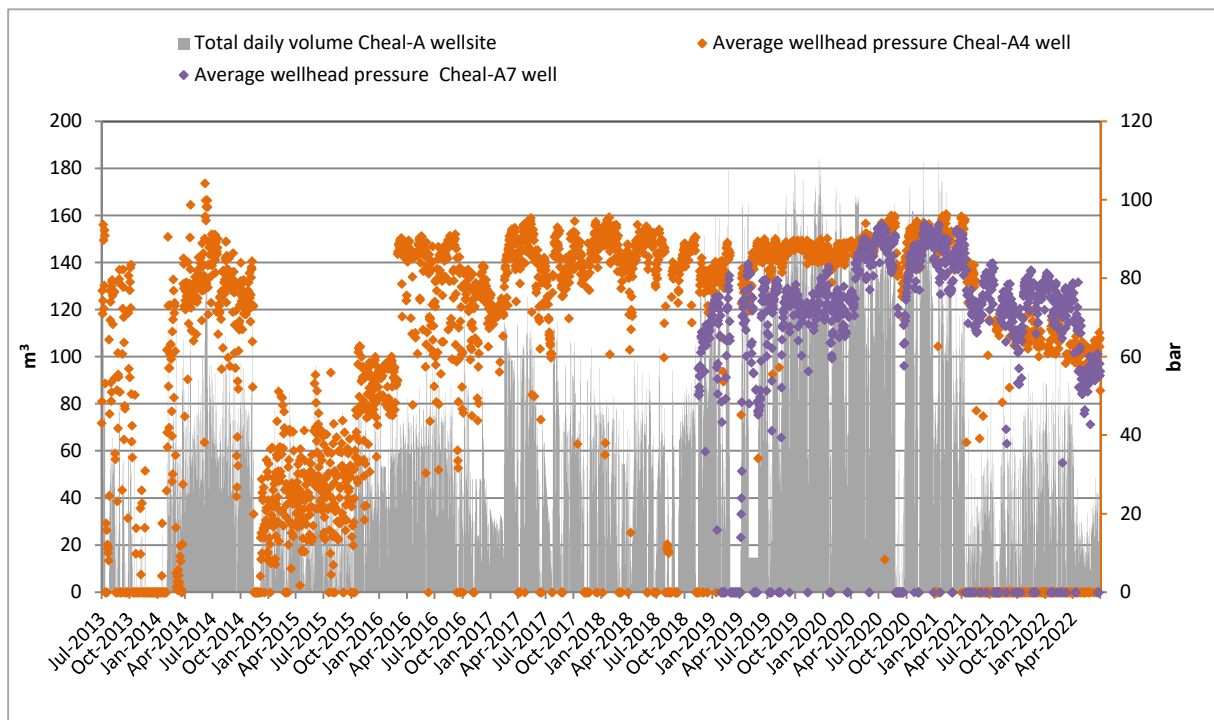


Figure 6 Cheal-A wellsite: Daily injection volumes and injection pressures (2013-2022)

2.4.1.2 Consent 10354-1.1

The Cheal-A2 and Cheal-A7 wells inject into the Mount Messenger formation at the Cheal-A wellsite.

The Cheal-A7 well is a dual completion well that is also used for injection into the Urenui formation under consent 9545-2.1 discussed in Section 2.4.1.1 above.

A total of 51% of all fluids injected during the year were disposed of via the Cheal-A wellsite.

Table 13 provides a summary of the historical data for the Cheal-A wellsite under consent 10354-1.1. The volume of fluid being injected into the Mount Messenger formation via the Cheal-A2 well has reduced significantly since the addition of the Cheal-A7 well to the water flood programme (Table 13). There was minimal injection via the Cheal-A2 well during the monitoring period and overall injection into the Mount Messenger formation at the wellsite has gradually reduced over the last few years.

Figure 7 and Figure 8 illustrate that pressures fluctuate in response to injection in both wells. Figure 9 illustrates a similar pattern over the longer term record whereby higher volumes and/or more sustained periods of injection correspond with increased pressures, and a decrease in formation pressures generally coincide with a reduction in injection volume. The graph also shows that pressures within the formation have remained generally stable during the monitoring period despite a reduction in injection volumes, indicating the effectiveness of the water flooding programme in maintaining pressures within the formation.

Table 13 Summary of injection occurring under consent 10354-1.1 (2017-2022)

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)
2021-2022	217	41	5.1	83.6	1.6
2020-2021	8,062	106	4.5	94.9	30
2019-2020	16,822	144	6.7	75.4	37
2018-2019	31,780	242	10.1	100.4	35
2017-2018	39,981	343	14.3	94.3	25
Deep well injection at Cheal-A via the Cheal-A7 injection well					
2021-2022	3,192	44	2.7	103.6	63
2020-2021	8,139	68	6.6	103.6	72
2019-2020	14,115	107	5.2	91.8	71
2018-2019	3,271	90	4.1	82.0	20

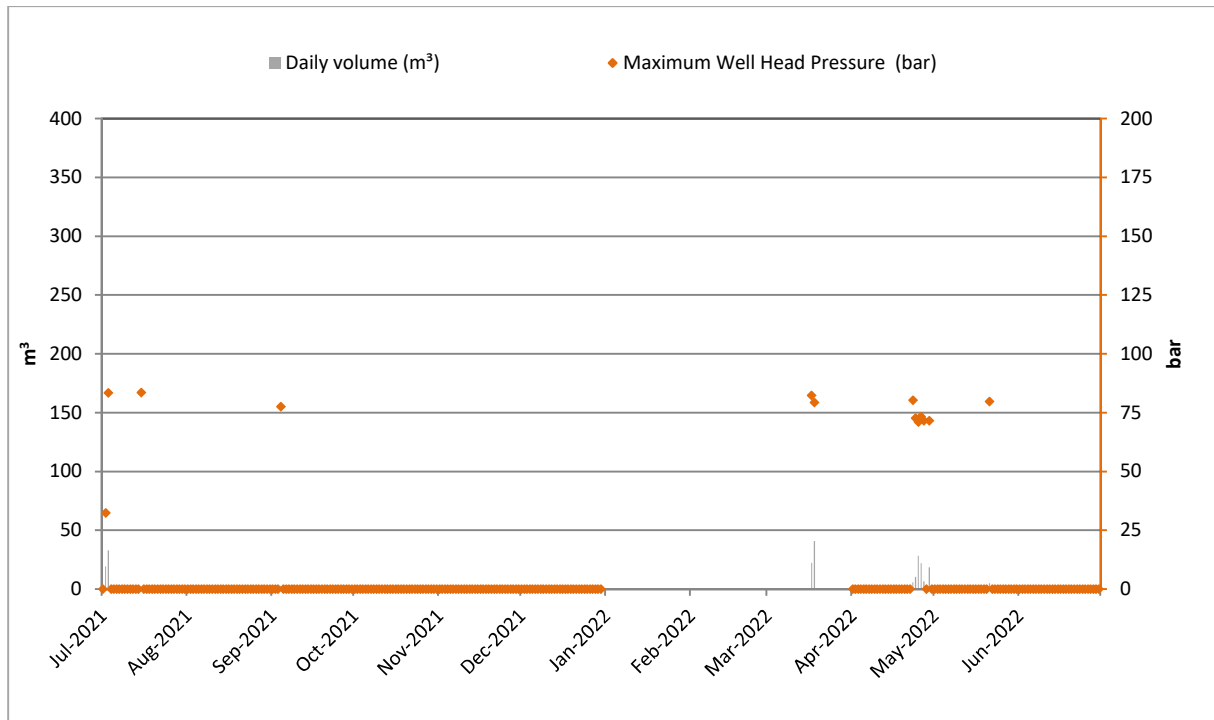


Figure 7 Cheal-A2 well: Daily injection volumes and injection pressures (2021-2022)

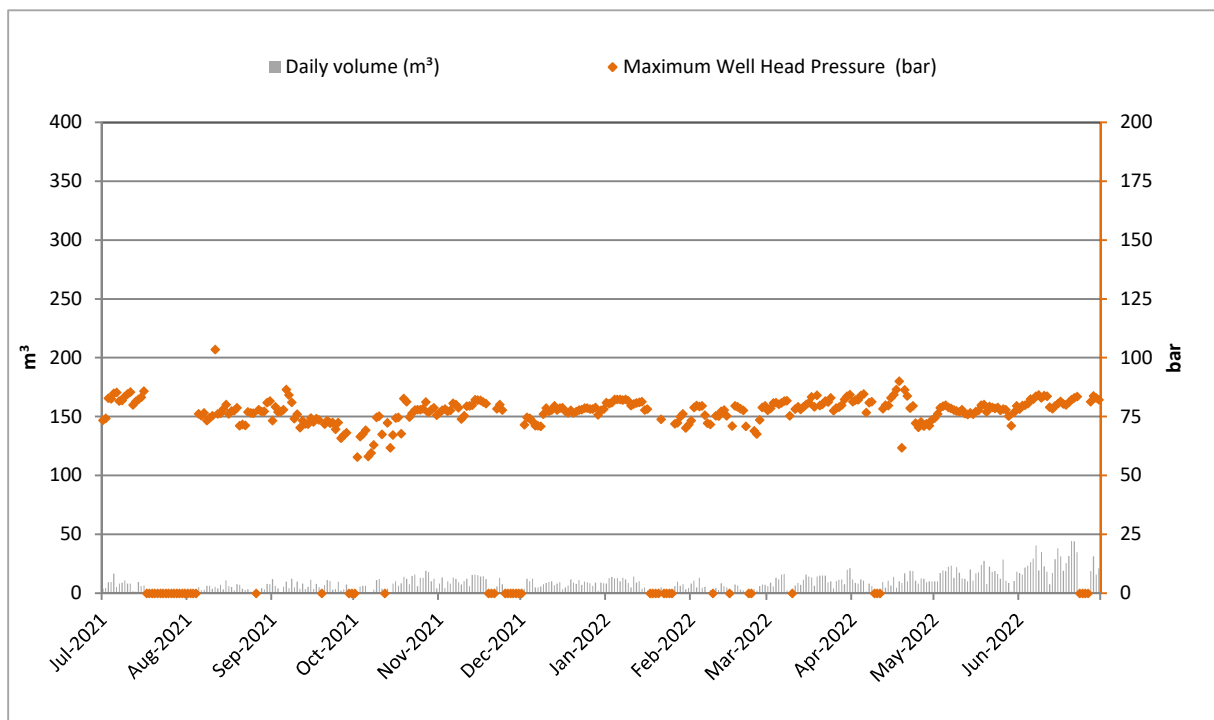


Figure 8 Cheal-A7 well: Daily injection volumes and injection pressures (2021-2022)

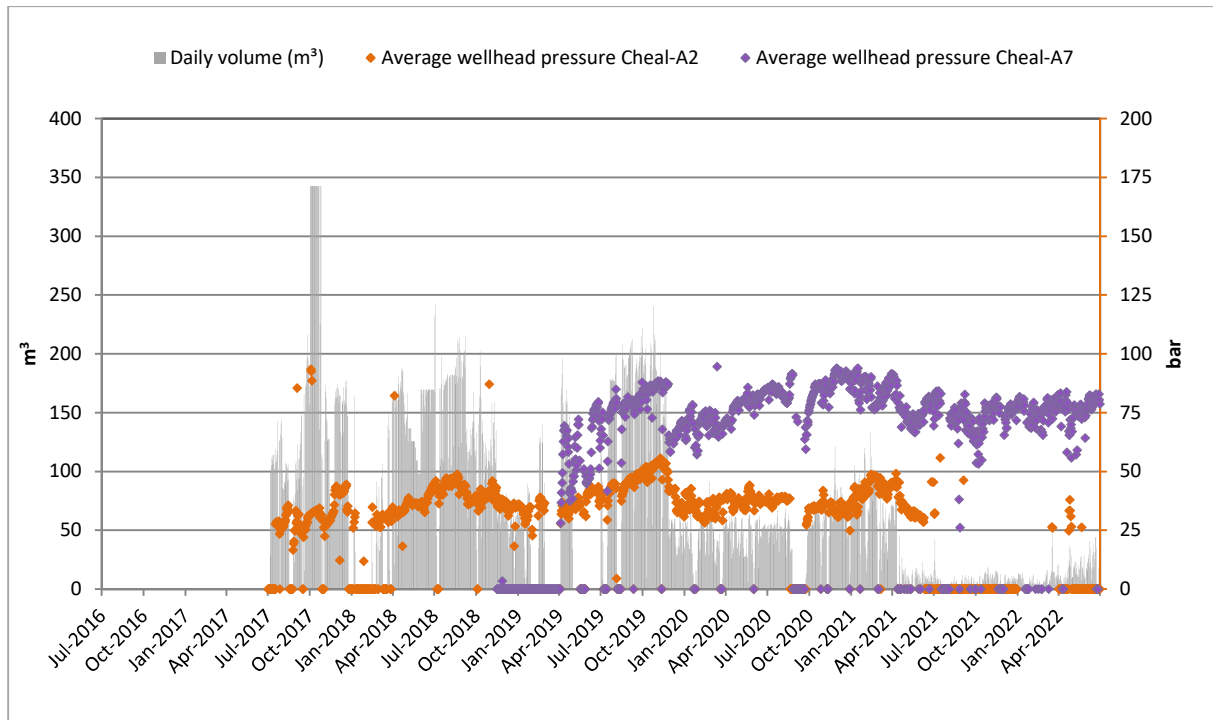


Figure 9 Cheal-A wellsite: Daily injection volumes and injection pressures (2017-2022)

2.4.2 Summary of injection at the Cheal-B wellsite (consent 10254-1)

The Cheal-B3 well injects into the Mount Messenger formation at the Cheal-B wellsite. Injection at the wellsite accounted for 20% of the total volume of fluid discharged by the Company during the period under review. Table 14 provides a summary of the historical data for the Cheal-B wellsite.

The volume of fluid being injected into the Mount Messenger formation via the Cheal-B3 well fluctuates from year to year in response to the requirements of the water flood programme. Figure 10 and Figure 11 illustrate a pattern of rising and reducing injection pressure in response to the volume of fluid being injected over both the short and longer term injection data record, indicating the success of the programme.

Table 14 Summary of injection occurring under consent 10254-1 (2016-2022)

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)
2021-2022	7,141	88	17.5	102	45
2020-2021	17,094	132	16.3	101	70
2019-2020	22,444	129	44.5	103	81
2018-2019	16,252	127	10	97	65
2017-2018	23,722	589	24.5	96	53
2016-2017	34,006	268	65.6	97	63

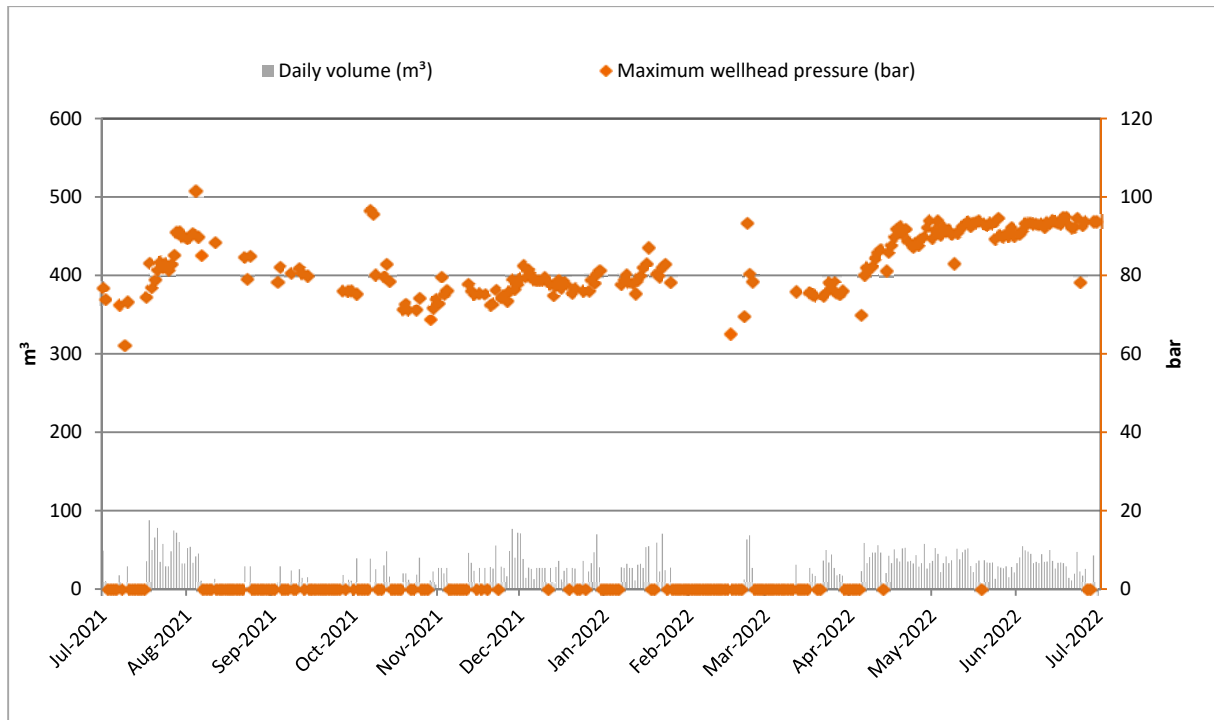


Figure 10 Cheal-B3 well: Daily injection volumes and injection pressures (2021-2022)

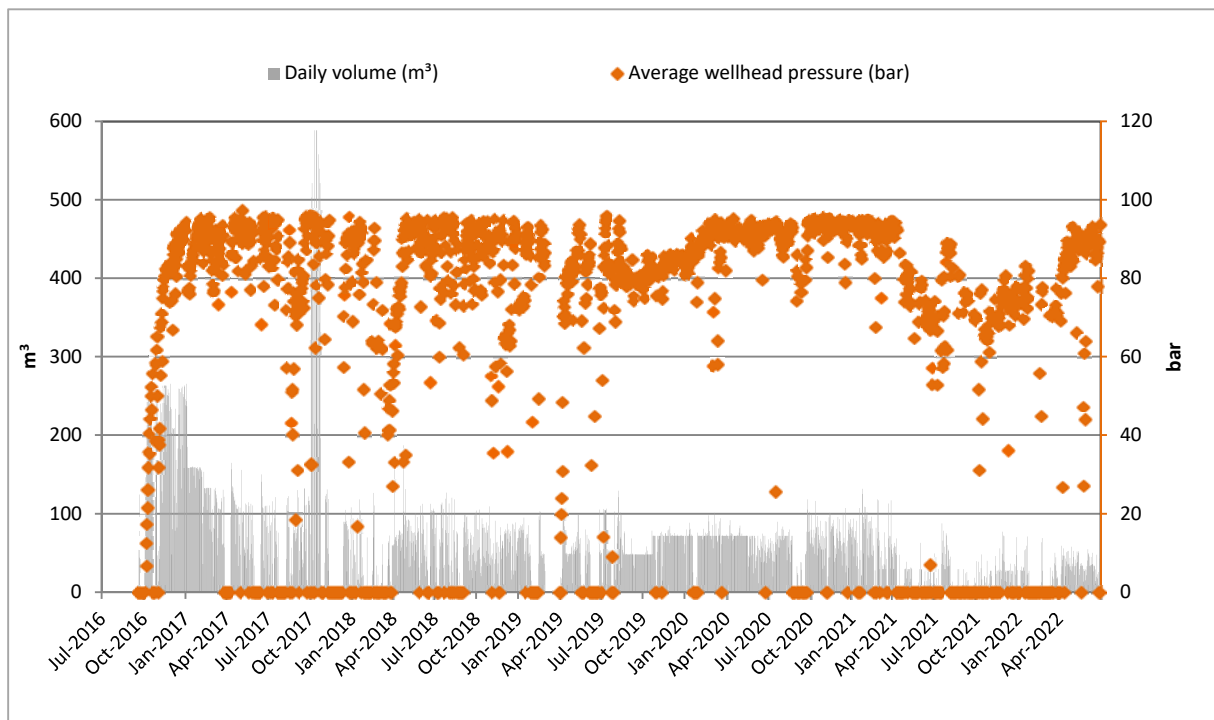


Figure 11 Cheal-B3 well: Daily injection volumes and injection pressures (2016-2022)

2.4.3 Summary of injection at the Cheal-E wellsite (consent 10304-1.1)

The Cheal-E4 and Cheal-E7 wells inject into the Mount Messenger formation at the Cheal-E wellsite. Injection at the wellsite accounted for 28% of the total volume of fluid discharged by the Company during the period under review.

Table 15 provides a summary of the historical data for the Cheal-E wellsite. Figure 12 and Figure 13 illustrate the influence of the water flood program during the reporting period with a reduction in pressure evident when injection volumes are reduced. This pattern of rising and reducing injection pressure in response to the volume of fluid being injected is also evident in the longer term injection data record for each well (Figure 14).

Table 15 Summary of injection occurring under consent 10304-1.1 (2016-2022)

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)
2021-2022	2,702	59	5.8	92	51
2020-2021	13,204	96	4.3	95	65
2019-2020	10,772	77	34.6	99	44
2018-2019	14,246	131	6.0	101	55
2017-2018	32,475	198	8.6	86	60
2016-2017	6,833	198	11.8	81	33
Deep well injection undertaken at Cheal-E wellsite via the Cheal-E4 injection well					
2021-2022	4,352	76	7.8	57	22
2020-2021	15,991	83	4.6	74	32
2019-2020	25,418	135	42.2	99	21
2018-2019	23,223	157	19.1	101	50

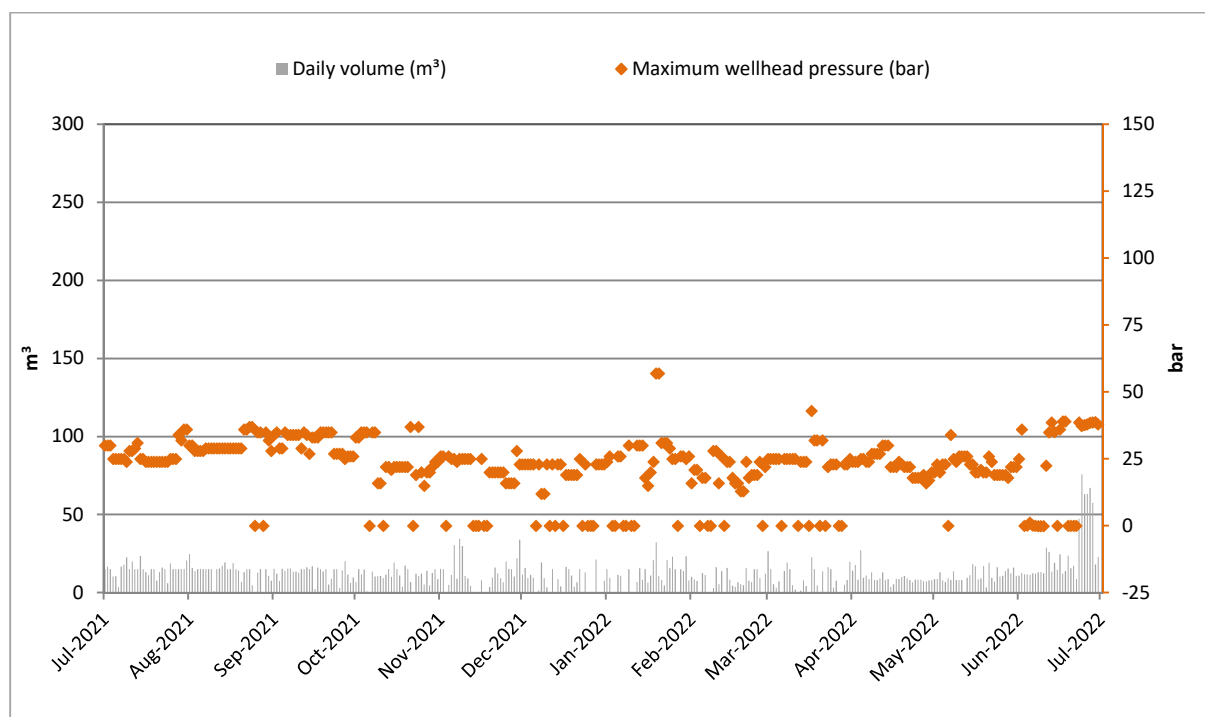


Figure 12 Cheal-E4 well: Daily injection volumes and injection pressures (2021-2022)

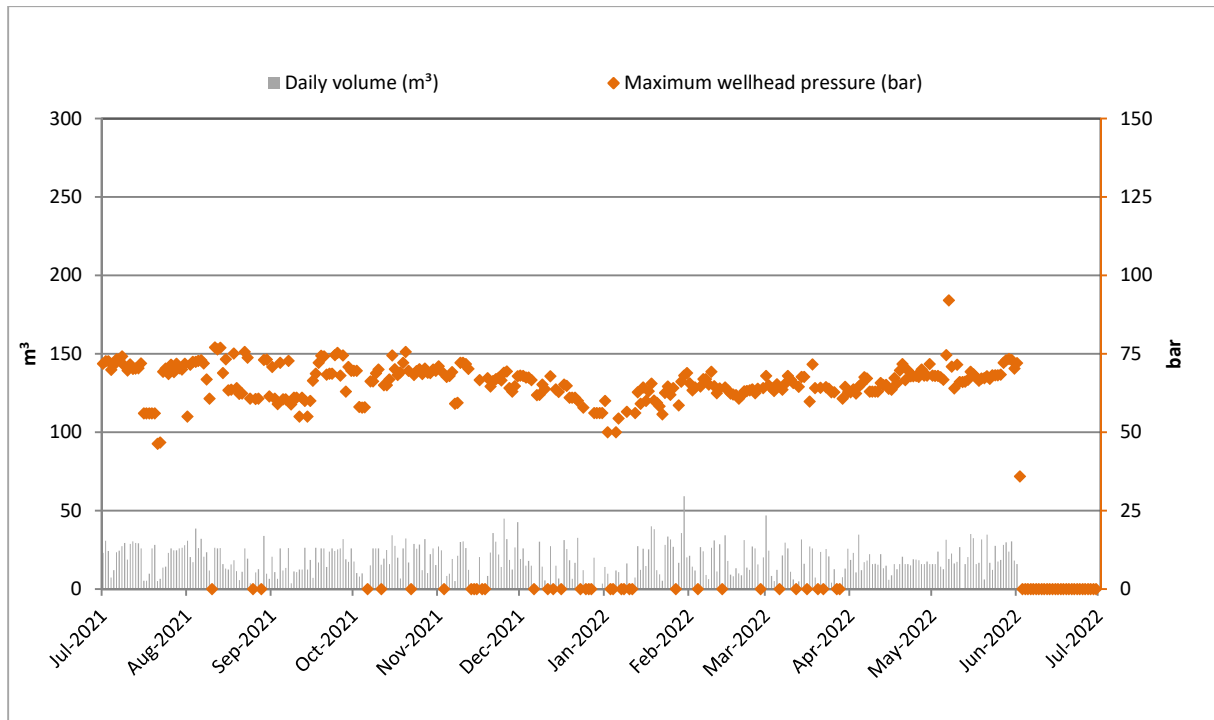


Figure 13 Cheal-E7 well: Daily injection volumes and injection pressures (2021-2022)

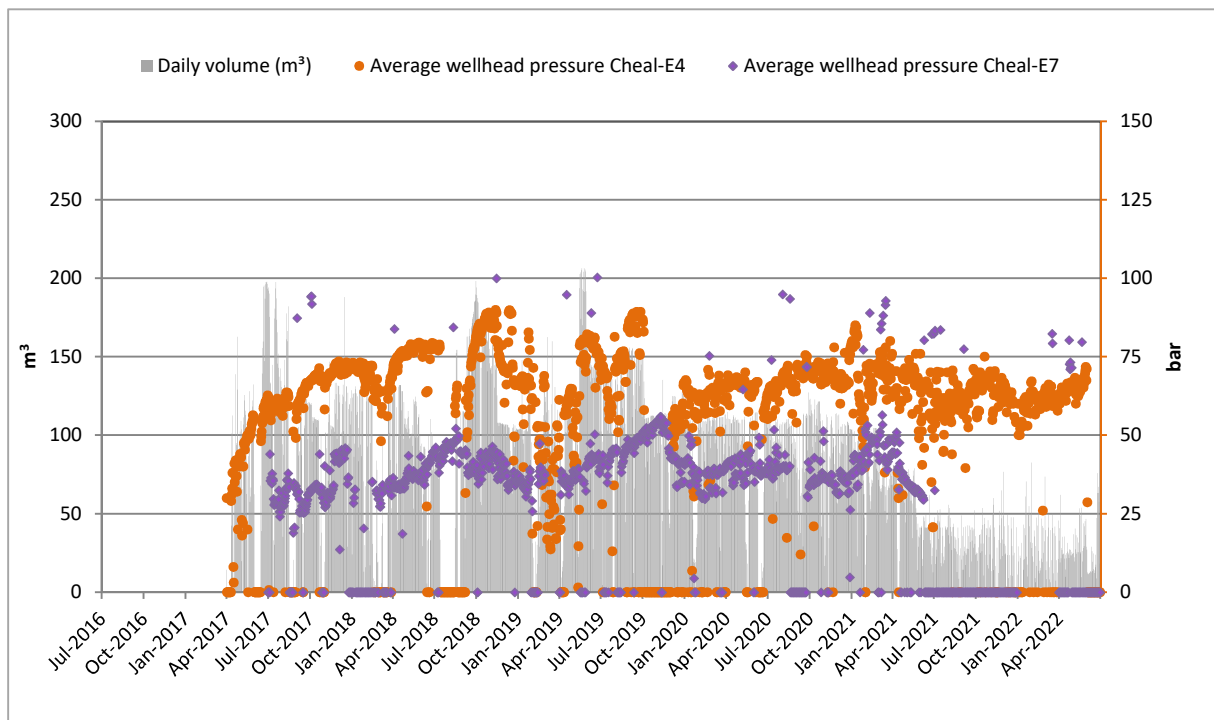


Figure 14 Cheal-E wellsite: Daily injection volumes and injection pressures (2016-2022)

2.5 Incidents, investigations, and interventions

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.

For all significant compliance issues, as well as complaints from the public, the Council maintains a database record. The record includes events where the individual/organisation concerned has itself notified the Council. Details of any investigation and corrective action taken are recorded for non-compliant events.

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 individual/organisation is indeed the source of the incident (or that the allegation cannot be proven).

In the 2021-2022 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 (9545-2.1, 10254-1, 10304-1.1 and 10354-1.1) 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-A7, Cheal-B3, Cheal-E4 and Cheal-E7 injection wells and the Urenui Formation via the Cheal-A4 and Cheal-A7 injection wells.

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 changes, safety systems isolate the wellbore and shut down the injectate pumping system. It should also be noted that the 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 systems recording the injection data required under the conditions of their consent. Throughout the monitoring period this data was 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

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 seven samples being taken from four 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.

Compliance with the conditions of the Company's DWI consents exercised during the 2021-2022 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 16-19. An evaluation of the environmental performance in relation to the DWI activities at the Cheal DWI wellsites since 2009 is presented in Table 20.

Table 16 Summary of performance for consent 9545-2.1

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 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	Yes
9. 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?
10. Maintain full records of injection data	Receipt and assessment of injection 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	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 1 June 2015	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	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?
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 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 m 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

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?
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	Yes
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	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

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?
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	Yes
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 Overall assessment of administrative performance in respect of this consent		High High

Table 18 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

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?
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 m 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	Yes
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	Inspection of QA plan	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?
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	Yes
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 19 Summary of performance for consent 10354-1.1

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-A 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 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 mount Messenger Formation, deeper than 1,600 m 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	Yes
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	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-A 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	N/A
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

N/A = not applicable

Table 20 Evaluation of environmental performance over time

Year	Consent	High	Good	Improvement	Poor
2021-2022	9545	1	-	-	-
	10254	1	-	-	-
	10304	1	-	-	-
	10354	1	-	-	-
	9545	1	-	-	-

Year	Consent	High	Good	Improvement	Poor
2020-2021	10254	1	-	-	-
	10304	1	-	-	-
	10354	1	-	-	-
2019-2020	9545	1	-	-	-
	10254	1	-	-	-
	10304	1	-	-	-
	10354	1	-	-	-
2017-2018	9545	1	-	-	-
	10254	1	-	-	-
	10304	1	-	-	-
	10354	1	-	-	-
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	-
Totals	-	24	0	2	0

*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 Appendix II.

3.4 Recommendations from the 2020-2021 Annual Report

In the 2020-2021 Annual Report, it was recommended:

1. THAT in the first instance, monitoring of consented activities in the 2021-2022 year continue at the same level as in 2020-2021.
2. THAT should there be issues with environmental or administrative performance in 2021-2022, 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 2021, as set out in the respective consent conditions not be exercised.

The recommendations above were implemented during the period under review.

3.5 Alterations to monitoring programmes for 2022-2023

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 2021-2022 period be continued during the 2022-2023 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 2022-2023.

3.6 Exercise of optional review of consent

Resource consent 9545-2.1, 10254-1, 10304-1.1 and 10354-1.1 provide for an optional review in June 2023. Condition 17 of all four consents allow the Council to review the 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 on any consent.

4 Recommendations

1. THAT in the first instance, monitoring of consented activities in the 2022-2023 year continue at the same level as in 2021-2022.
2. THAT should there be issues with environmental or administrative performance in 2022-2023, 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 2023, as set out in the respective consent conditions not be exercised.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Aquifer (freshwater)	A formation, or group or part of a formation that contains sufficient saturated permeable media to yield exploitable quantities of fresh water.
Bar	Measurement of pressure.
BTEX	Benzene, toluene, ethylbenzene and xylene
BPO	Best practicable option.
Conductivity	A measure of the level of dissolved salts in a sample. Usually measured at 25°C and expressed as microsiemens per centimetre (µS/cm) 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.
µS/cm	Microsiemens per centimetre
mS/m	Millisiemens per metre.
m TVD	Metres true vertical depth.

m ³	Cubic metre.
N/A	Not applicable.
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.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
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).
RMA	Resource Management Act 1991 and including all subsequent amendments.
SS	Suspended solids.
TDS	Total dissolved solids in a solution.
Temp	Temperature, measured in °C (degrees Celsius).
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 an Environment Quality Manager.

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Appendix I

Resource consents held by Cheal Petroleum Ltd

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

Water abstraction permits

Section 14 of the RMA stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14. Permits authorising the abstraction of water are issued by the Council under Section 87(d) of the RMA.

Water discharge permits

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations. Permits authorising discharges to water are issued by the Council under Section 87(e) of the RMA.

Air discharge permits

Section 15(1)(c) of the RMA stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Permits authorising discharges to air are issued by the Council under Section 87(e) of the RMA.

Discharges of wastes to land

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. Permits authorising the discharge of wastes to land are issued by the Council under Section 87(e) of the RMA.

Land use permits

Section 13(1)(a) of the RMA stipulates that no person may in relation to the bed of any lake or river use, erect, reconstruct, place, alter, extend, remove, or demolish any structure or part of any structure in, on, under, or over the bed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Land use permits are issued by the Council under Section 87(a) of the RMA.

Coastal permits

Section 12(1)(b) of the RMA stipulates that no person may erect, reconstruct, place, alter, extend, remove, or demolish any structure that is fixed in, on, under, or over any foreshore or seabed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Coastal permits are issued by the Council under Section 87(c) of the RMA.

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 18 July 2018
(Change):

Commencement Date 18 July 2018 (Granted Date: 28 August 2015)
(Change):

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 deep well injection at the Cheal-A wellsite for the purpose of water flooding

Expiry Date: 1 June 2035

Review Date(s): June annually

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

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 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 Urenui Formation, and be injected at a minimum depth of 1,300 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 9545-2.1

8. Only the following types of fluid may be discharged:
 - (a) produced water;
 - (b) well drilling fluids; and
 - (c) well workover fluids, including hydraulic fracturing fluids.
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 Taranaki Regional 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 Taranaki Regional 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 9545-2.1

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 18 July 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

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 6 June 2018
(Change):

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

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
(Change): 18 July 2018

Commencement Date
(Change): 18 July 2018 (Granted 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 deep well injection at the Cheal-A wellsite for the purpose of water flooding

Expiry Date: 1 June 2035

Review Date(s): June annually

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

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 1,600 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);
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 - (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 Taranaki Regional 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 10354-1.1

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 10354-1.1

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 18 July 2018

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Appendix II

Categories used to evaluate environmental and
administrative performance

Categories used to evaluate environmental and administrative performance

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 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 during investigations of incidents reported to the Council by a third party 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 during investigations of incidents reported to the Council by a third party. 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 during investigations of incidents reported to the Council by a third party. 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.

Appendix III

Injectate Sampling undertaken by
Cheal Petroleum Ltd

Month	Unit	Jul-21						Aug-21					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	7.56	7.56	7.56	7.56	6.69	6.69	-	7.56	7.56	7.56	6.69	6.69
Conductivity	mho/cm	0.044	0.044	0.044	0.044	0.042	0.042	-	0.044	0.044	0.044	0.042	0.042
Total Suspended Solids	g/m ³	930	930	930	930	1600	1600	-	930	930	930	1600	1600
Temperature	° C	2.35	6.02	14.81	14.77	24.42	23.23	-	3.38	27.35	5.80	27.58	25.68
Salinity	g/m ³	21,500	21,500	21,500	21,500	14,460	14,460	-	21,500	21,500	21,500	14,460	14,460
Chloride	g/m ³	14,200	14,200	14,200	14,200	13,300	13,300	-	14,200	14,200	14,200	13,300	13,300
Total petroleum hydrocarbons	g/m ³	258	258	258	258	1,500	1,500	-	258	258	258	1,500	1,500
Month	Unit	Sep-21						Oct-21					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	6.91	6.91	6.91	6.91	7.11	7.11	-	6.79	6.79	6.79	6.82	6.82
Conductivity	mho/cm	0.042	0.042	0.042	0.042	0.041	0.041	-	0.044	0.044	0.044	0.043	0.043
Total Suspended Solids	g/m ³	190	190	190	190	875	875	-	246	246	246	188	188
Temperature	° C	1.17	1.94	28.27	4.53	31.17	27.87	-	2.81	29.81	8.30	27.19	27.58
Salinity	g/m ³	7,440	7,440	7,440	7,440	7,410	7,410	-	18,830	18,830	18,830	14,350	14,350
Chloride	g/m ³	12,800	12,800	12,800	12,800	12,000	12,000	-	12,435	12,435	12,435	13,200	13,200
Total petroleum hydrocarbons	g/m ³	43	43	43	43	95	95	-	88	88	88	40	40
Month	Unit	Nov-21						Dec-21					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	-	6.95	6.95	6.95	6.89	6.89	-	7.40	7.40	7.40	6.96	6.96
Conductivity	mho/cm	-	0.044	0.044	0.044	0.046	0.046	-	0.043	0.043	0.043	0.044	0.044
Total Suspended Solids	g/m ³	-	158	158	158	750	750	-	92	92	92	145	145
Temperature	° C	-	14.60	22.77	11.46	24.17	24.17	-	11.07	32.29	17.69	20.00	19.52
Salinity	g/m ³	-	23,100	23,100	23,100	17,600	17,600	-	22,700	22,700	22,700	17,000	17,000
Chloride	g/m ³	-	15,250	15,250	15,250	16,200	16,200	-	15,050	15,050	15,050	15,600	15,600
Total petroleum hydrocarbons	g/m ³	-	58	58	58	290	290	-	460	460	460	30	30

Month	Unit	Jan-22						Feb-22					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	7.00	7.00	7.00	7.00	6.48	6.48	-	6.50	6.50	6.50	6.55	6.55
Conductivity	mho/cm	22.900	22.900	22.900	22.900	0.046	0.046	-	0.046	0.046	0.046	0.045	0.045
Total Suspended Solids	g/m ³	10	10	10	10	124	124	-	708	708	708	92	92
Temperature	° C	20.20	20.20	20.20	20.20	22.74	22.58	-	15.90	23.90	12.25	21.96	23.14
Salinity	g/m ³	11,200	11,200	11,200	11,200	17,760	17,760	-	24,210	24,210	24,210	16,560	16,560
Chloride	g/m ³	7,510	7,510	7,510	7,510	16,300	16,300	-	16,050	16,050	16,050	15,200	15,200
Total petroleum hydrocarbons	g/m ³	32	32	32	32	300	300	-	195	195	195	25	25
Month	Unit	Mar-22						Apr-22					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	-	6.74	6.74	6.74	6.86	6.86	6.92	6.92	6.92	6.92	6.35	6.35
Conductivity	mho/cm	-	0.044	0.044	0.044	0.039	0.039	0.038	0.038	0.038	0.038	0.043	0.043
Total Suspended Solids	g/m ³	-	522	522	522	362	362	217	217	217	217	219	219
Temperature	° C	-	17.33	27.89	4.75	21.00	20.06	1.69	7.63	31.77	8.92	29.68	28.23
Salinity	g/m ³	-	22,930	22,930	22,930	12,850	12,850	16,900	16,900	16,900	16,900	15,790	15,790
Chloride	g/m ³	-	15,200	15,200	15,200	11,800	11,800	11,200	11,200	11,200	11,200	14,500	14,500
Total petroleum hydrocarbons	g/m ³	-	213	213	213	600	600	63	63	63	63	110	110
Month	Unit	May-22						Jun-22					
Well	-	A2	A4	A7	B3	E4	E7	A2	A4	A7	B3	E4	E7
pH	-	5.22	5.22	5.22	5.22	6.71	6.71	-	6.98	6.98	6.98	6.60	6.60
Conductivity	mho/cm	0.044	0.044	0.044	0.044	0.042	0.042	-	0.043	0.043	0.043	0.041	0.041
Total Suspended Solids	g/m ³	182	182	182	182	101	101	-	255	255	255	29	29
Temperature	° C	6.23	15.20	29.67	23.26	28.10	28.71	-	22.19	27.13	20.38	22.57	21.50
Salinity	g/m ³	25,850	25,850	25,850	25,850	15,680	15,680	-	18,540	18,540	18,540	12,850	12,850
Chloride	g/m ³	17,130	17,130	17,130	17,130	14,400	14,400	-	12,360	12,360	12,360	11,800	11,800
Total petroleum hydrocarbons	g/m ³	70	70	70	70	110	110	-	87	87	87	55	55