Origin Energy Resources New Zealand Limited Deep Well Injection Monitoring Programme Annual Report 2015-2016

Technical Report 2016-60

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Executive summary

Origin Energy Resources New Zealand Ltd (the Company) operates a number of wellsites within the Taranaki region, most notably their Manutahi, Rimu and Kauri wellsites, located between Hawera and Patea. Each wellsite contains varying numbers of producing wells and associated production infrastructure. This report for the period July 2015 to June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) in relation to the Company's deep well injection (DWI) activities. The report details the results of the monitoring undertaken, assesses the Company's environmental performance during the period under review and the environmental effects of their DWI activities.

The Company held two resource consents for DWI activities during the review period, which included a total of 20 conditions setting out the requirements that the Company must satisfy. Only one of the consents was exercised during the period being reported.

During the monitoring period, Origin Energy Resources (NZ) Limited demonstrated an overall high level of environmental performance.

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

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

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

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

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 2016–2017 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 2015 to June 2016 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Origin Energy Resources New Zealand Limited (the Company) for deep well injection (DWI) activities. During the period under review, the Company held two resource consents for the subsurface injection of fluids by DWI. The consents authorise discharges from two separate wellsites in the South Taranaki region.

The resource consents held by the Company permit the discharge of a range of fluids by DWI, including heated water and produced water. 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 fourth report to be prepared by the Council to cover the Company's DWI discharges and their effects.

1.1.2 Structure of this report

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

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though 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 2016-2017 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' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

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

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

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

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

Environmental Performance

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

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

  For example:

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

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

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

Administrative performance

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

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

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

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

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents

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 heated water and waste drilling fluids.

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

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

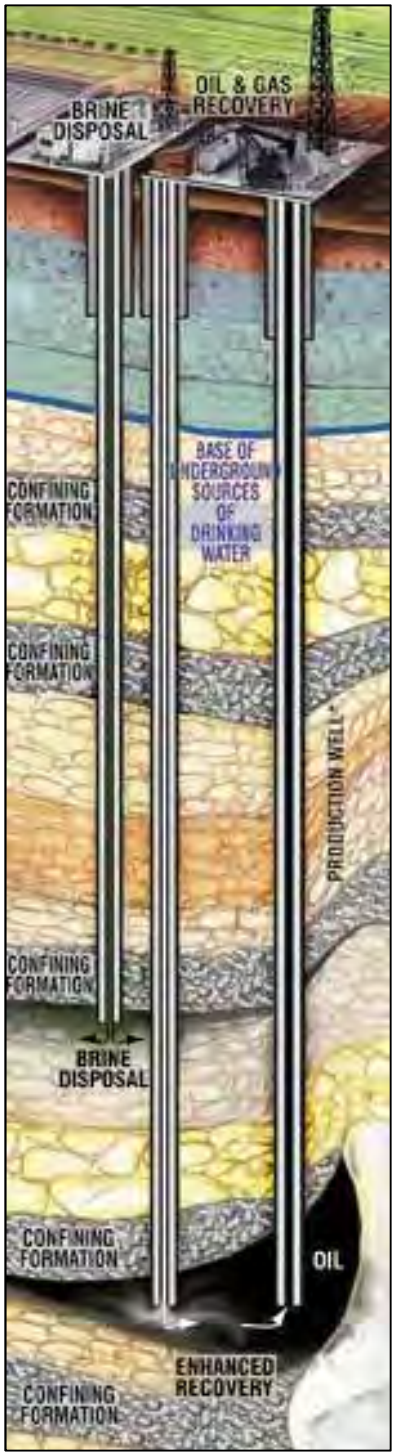

Figure 1 DWI schematic (www.epa.gov/uic)

The Company operates a water flood programme within its oil and gas field to improve production and counteract production issues caused by the high viscosity of oil within the field.

The fluid to be injected at the Manutahi-D wellsite, the only site currently undertaking DWI, is heated prior to injection down two of the wells (D-2H and D-4H ST2) to provide heat energy into the reservoir; replace void space; and flush oil through to the producing well. Oil and water separation takes place on-site. Hydrocarbon liquids are pumped to Rimu Production Station (RPS) via pipeline. Produced water is retained on site for reinjection via the hot water system.

An injection water storage facility is located at Kauri-F, the nearest wellsite to the Manutahi D wellsite, to accept bore water and treated production water transferred via road tankers from the Kupe Production Station.

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

1.3 Resource consents

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

The Company held two discharge consents covering their DWI activities (Table 1). The locations of the consents are displayed on Figure 2.

Table 1 DWI consents held by the Company during the 2015-2016 monitoring year

Consent	Wellsite	Status	Injection well(s)	Formation	Issued	Expiry
6544-1	Kupe Production Station	Not exercised	None identified	None identified	21/06/2010	01/06/2039
7905-1	Manutahi-D	Active	D-2H, and D-4H ST2	Manutahi	16/09/2011	01/06/2028

N/A – not applicable

Consent **6544-1** was issued by the Council on 21 June 2005 under Section 87(e) of the RMA. It is due to expire on 1 June 2039. The consent authorises the discharge of produced water from hydrocarbon production operations at Kupe Production Station, Inaha, Manaia. There is no record of this consent having been given effect to. The lapse date under condition 8 in the consent was extended in June 2015 to 30 June 2020.

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

- Condition 1 states how the activity must be undertaken;
- Condition 2 refers to best practicable option;
- Conditions 3, 5 and 7 refer to the Company's process monitoring and data submission requirements;
- Condition 4 prohibits the discharge from endangering or contaminating any freshwater aquifer;

- Condition 6 requires injection pressure to remain below that required to fracture the injection interval;
- Condition 8 is a lapse clause; and
- Condition 9 is a review provision.

A detailed summary of the history of this consent can be found in previous compliance reports published by the Council (see Bibliography).

Consent **7905-1** was issued by the Council on 16 September 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2028. The consent authorises the discharge of fluids for water flooding purposes at the Manutahi-D wellsite.

A waterflood trial was carried out in September 2011, which resulted in the injection of 113 m^3 of heated fluids into the Manutahi Formation. The water flooding programme commenced in August 2012.

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

- Condition 1 states that prior to exercising the consent, the consent holder shall submit an updated "Injection Operation Management Plan";
- Condition 2 refers to the injection well and receiving formation information requirements;
- Condition 3 limits the injection pressure;
- Condition 4 limits the volume of waste that can be injected;
- Condition 5 requires the consent holder to adopt best practicable option;
- Conditions 6 and 7 relate to the monitoring of injected wastes and provision of data;
- Condition 8 requires the consent holder to notify the Council prior to the first exercising of the consent;
- Condition 9 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Condition 10 is a lapse clause; and
- Condition 11 is a review provision.

Copies of the consent certificates are attached in Appendix I.

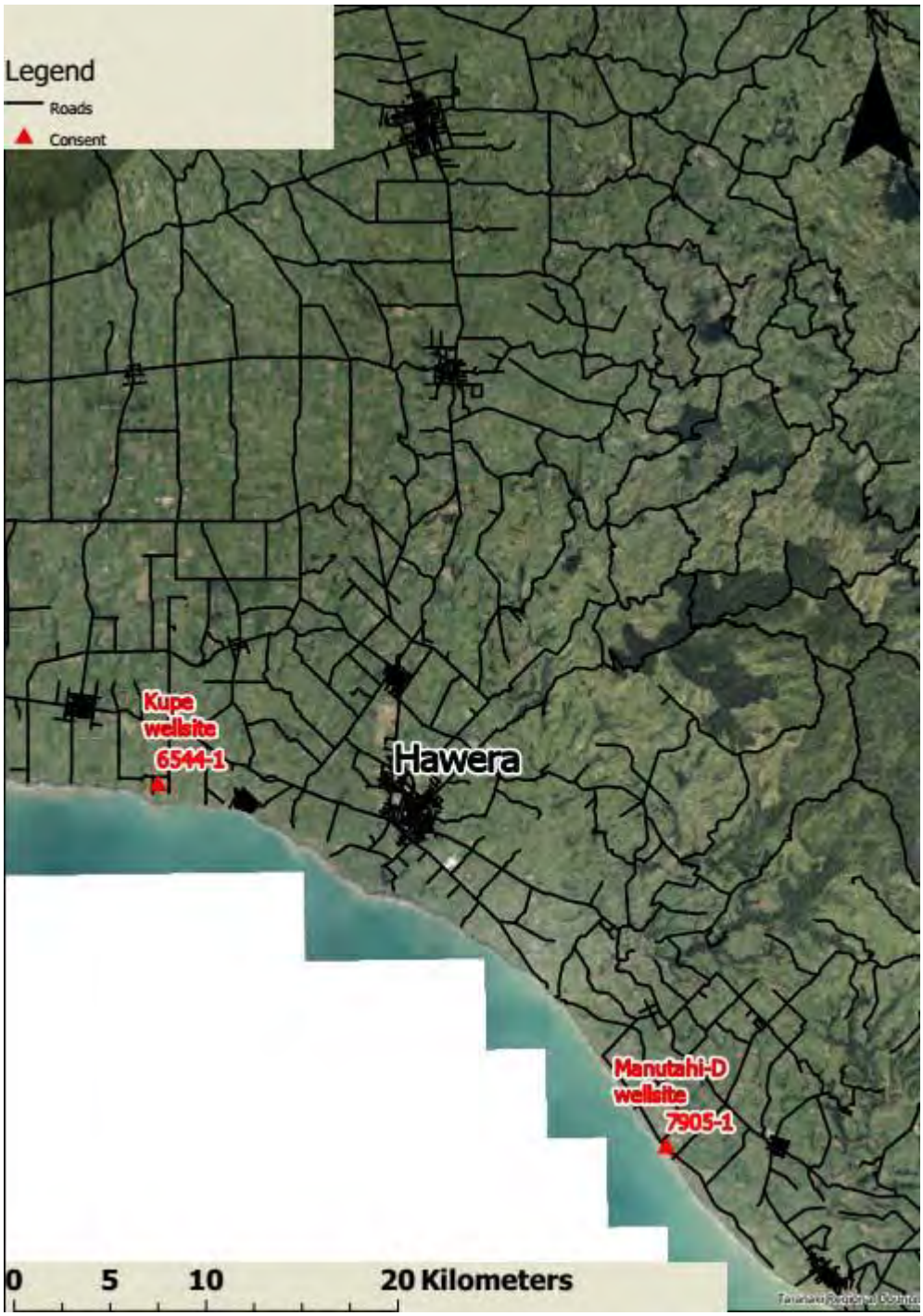

Figure 2 Consent locations

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 active DWI site consisted of five primary components.

1.4.2 Programme liaison and management

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

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- 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 Manutahi-D wellsite was inspected by Council Officer's on two occasions during the monitoring period. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. Sources of data being collected by the Company were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

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

1.4.4 Injectate sampling

Injectate samples were obtained for analysis in the Council's IANZ accredited laboratory on two occasions during the monitoring period. The sampling of injectate is carried out in order to characterise the general chemical nature of the discharge and also the variation in its chemical composition across the monitoring period. Injectate samples were collected from the bulk storage tanks at the Manutahi-D wellsite, identified on-site as tank 041.

The injectate samples were analysed for the following parameters:

- pH;
- conductivity;
- alkalinity;
- chlorides; and

- total petroleum hydrocarbons.

1.4.5 Groundwater sampling

Groundwater samples were also obtained on two occasions during the monitoring period from monitoring bore GND2372. This sampling is a continuation of the groundwater monitoring component of this programme which was initiated during the 2012-2013 monitoring period. Site details are summarised in Table 2 and the location of the monitoring bore (GND2372) in relation to the Manutahi-D wellsite is displayed on Figure 3.

Table 2 Details of groundwater sampling sites

Site code	Wellsite	Distance from injection well (m)	Casing depth (m)	Screened interval (m)	Total depth (m)	Groundwater level (m BGL)	Aquifer
GND2372	Manutahi-D	71	0-15.0	15.0-25.0	26.0	7.0	Volcanics

Groundwater samples are analysed in the Council's IANZ accredited laboratory for a basic range of chemical parameters as follows:

- 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, baseline samples have been collected and analysed by Hill Laboratories Limited for general ion chemistry, BTEX and dissolved gas concentrations. These more detailed analyses will allow a more in depth assessment of variations in groundwater composition should the need arise in the future.

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 respective 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, rates and 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 groundwater monitoring site and injection wells

2. Results

2.1 Site inspections

Two routine inspections of the Company's Manutahi-D wellsite were conducted during the period under review (9 September 2015 and 2 June 2016). Inspections included undertaking a general visual assessment of the operational equipment, storage facilities and associated equipment. The inspecting officer noted that Manutahi-D site was well managed and tidy with no evidence of any off-site effects or environmental impacts. Site bunding was sufficient and site drainage systems were working effectively without issue. There were no issues noted specific to the Company's DWI consent.

The site was also visited by Council officers on two occasions during the monitoring year for the purpose of injectate sampling. This involved accessing the Company's bulk liquid storage tanks at the wellsite. No issues were noted by staff during these visits.

2.2 Injectate sampling

Samples of injectate were obtained from the Company's only active injection site (Manutahi-D) on 13 October 2015 and 3 May 2016. The samples were submitted to the Council's laboratory on the same day for physicochemical analysis.

The results of the sample analyses are included below in Table 3. The range of results for each analyte over the previous two monitoring periods is also presented for comparison.

The concentrations of each analyte measured over the 2015-2016 period are within the expected range for produced water samples at this site.

Table 3 Results of injectate sampling undertaken by the Council (2015-2016)

Parameter	Unit	Manutahi-D 11/04/13 – to date		Manutahi-D (Tank T-041)	
		Minimum	Maximum	13/10/2015	03/05/2016
Time	NZST	-	-	10:45	9:45
TRC sample number	-	-	-	TRC153252	TRC161543
Total alkalinity	g/m^3 $CaCO_3$	107	579	237	122
pH	pH Units	6.9	8.0	7.4	7
Conductivity @ 20^{0}C	mS/m @ 20^{0}C	566	1,780	1,610	1,620
Chloride	g/m^3	2,240	7,340	7,340	6,670
Total petroleum hydrocarbons	g/m^3	1	780	260	22
Suspended solids	g/m^3	21	2,100	2,100	22

The Company also provided analytical results of their monthly sampling of injectate as per the requirement of condition 7 of consent 7905-1 (Table 4).

The range of concentration for each parameter illustrates the variability in the composition of injectate across the monitoring period. The composition varies depending on the origin and volumetric proportion of each fluid type being injected at the time of sampling.

Table 4 Results of the Company's monthly injectate sampling (2015-2016)

Parameter	Unit	Jul 2015	Aug 2015	Sep 2015	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016
pH	pH Units	7.3	7.0	7.0	7.1	7.2	6.9	7.6	6.5	6.9	7.2	7.2
Conductivity	mS/m	1,702	1,291	1,460	1,050	1,740	1,725	1,640	1,243	1,565	1,742	900
Total Suspended Solids	g/m^3	45	113	31	17	36	29	96	84	43	126	40
Temperature	^{o}C	11.8	19.3	20.5	19.7	17.2	21.1	26.2	24.7	22.0	19.1	14.2
Salinity	-	9.9	7.3	8.4	5.9	10.2	10	9.5	-	9	10.2	5
Chloride	g/m^3	6,378	4,422	6,142	5,911	5,990	5,864	6,321	4,556	6,038	6,195	5,978
Total Petroleum Hydrocarbons	g/m^3	21.1	68.4	16	5.9	90	12.5	13	86.8	6.9	63.8	8.4

2.3 Groundwater sampling

Groundwater samples were obtained from monitoring bore GND2372, on 13 October 2015 and 03 May 2016.

All groundwater samples were collected following standard groundwater sampling methodologies and generally in accordance with the National Protocol for State of the Environment Groundwater Sampling in New Zealand (2006).

The results of analyses carried out are set out below in Table 5.

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

All results are within the ranges expected for shallow Taranaki groundwater.

Table 5 Results of groundwater sampling undertaken by the Council at site GND2372

Sample details	Unit	Range		GND2372	
TRC sample number	-	Minimum	Maximum	TRC153253	TRC161472
Sample date	-	2013-2016	2013-2016	13-Oct-15	03-May-16
Sample time	NZST	-	-	13:05	10:00
Static water level	mbtoc	20.74	21.80	20.74	20.78
Chloride	g/m^3	62.8	68.5	68.5	68
Electrical conductivity	mS/m@20oC	44.8	45.4	45.4	44.8
Dissolved oxygen	g/m^3	0.18	3.45	1.52	3.45
pH	pH	7.2	7.4	7.4	7.4
Temperature	^{o}C	14.5	16.4	14.5	16.4
Total hydrocarbons	g/m3	<0.5	0.7	<0.5	<0.5

2.4 Assessment of data provided by the consent holder

The Company provided records of their injection activities during 2015-2016 monitoring period, including daily injection volumes, pumping duration and injection pressure.

Table 6 provides an overview of the Company's injection activities across all consents during the monitoring period. It shows that consent 7905-1 was the only consent exercised by the Company during this period.

Table 7 presents the historical data for consent 7905-1. The data presented shows that the volume of fluid being injected under consent 7905-1 decreased annually from 2012 to 2015 and then increased again in the 2015-2016 reporting period. The annual volumes fluctuate dependent on the volume of hydrocarbons produced via the producing wells. DWI injection at the site is used to maintain pressures within the formation and provide heat which decreases the viscosity of the hydrocarbons and aids in recovery. The maximum daily injection volume has fluctuated slightly since 2012 and the maximum injection pressures have decreased very slightly over the same period. The average pressure in each well fluctuates dependent on the number of days each well operates and the volume of fluid injected in the month. Figure 4 and Figure 5 illustrate the cumulative (via both wells) injection volumes since 2012 and over the monitoring period. Figure 6, Figure 7, Figure 8 and Figure 9 illustrate the daily maximum pressures for the D-2H and D-4HST2 wells since 2012 and over the monitoring period.

Table 6 Summary of injection activity during the 2015-2016 monitoring year

Consent	Wellsite	Injection wells	Total volume discharged (m^3)	Discharge period		TRC well ID
				From	To	
6544-1	Kupe Production Station	Not identified	0	-	-	-
7905-1	Manutahi-D	D-2H	6,794.554	01/07/2015	30/06/2016	GND2307
		D-4H ST	12,481.713	01/07/2015	30/06/2016	GND2309
Total			19,276.27	-	-	-

Table 7 Summary of injection activity during the 2015-2016 monitoring year

Manutahi-D Injection wells GND2307 (D-2H) and GND2309 (D-4HST) Consent 7905-1					
Year	Annual Volume (m^3)	Max. injection volume (m^3/day)	Max. injection rate (m^3/day)	Max. injection pressure (bar)	Avg. injection pressure GND2307/GND2309 (bar)
Consent limit	-	318	-	50	-
2015-2016	19,276	198	198	39	23/22
2014-2015	11,310	133	133	39	17/17
2013-2014	20,827	146	146	40	31/31
2012-2013	23,677	144	144	41	21/17

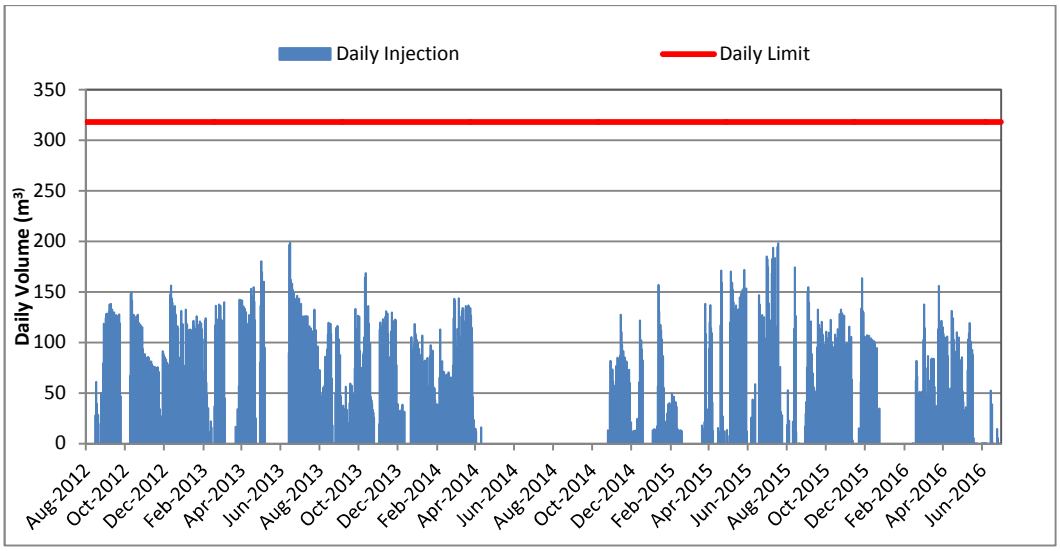

Figure 4 Manutahi-D consent 7905-1 daily cumulative injection volume (2012-2016)

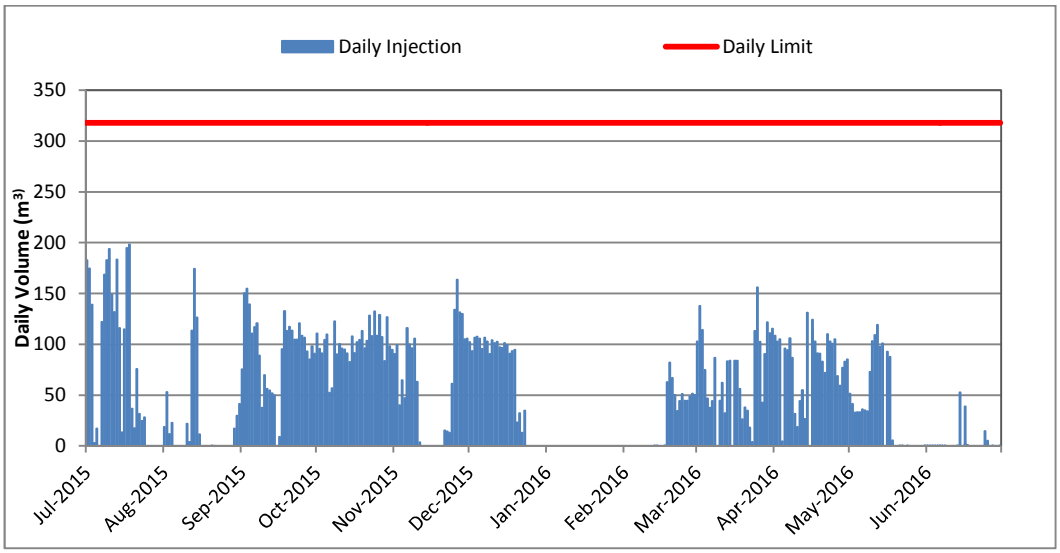

Figure 5 Manutahi-D consent 7905-1 daily cumulative injection volume (2015-2016)

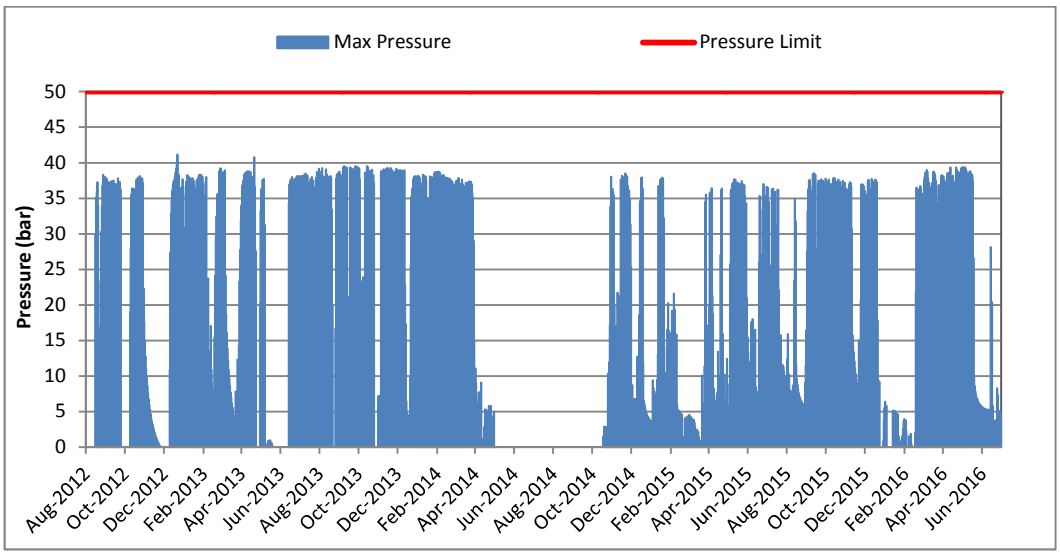

Figure 6 Manutahi-D (D-2H well) consent 7905-1 daily maximum injection pressure (2012-2016)

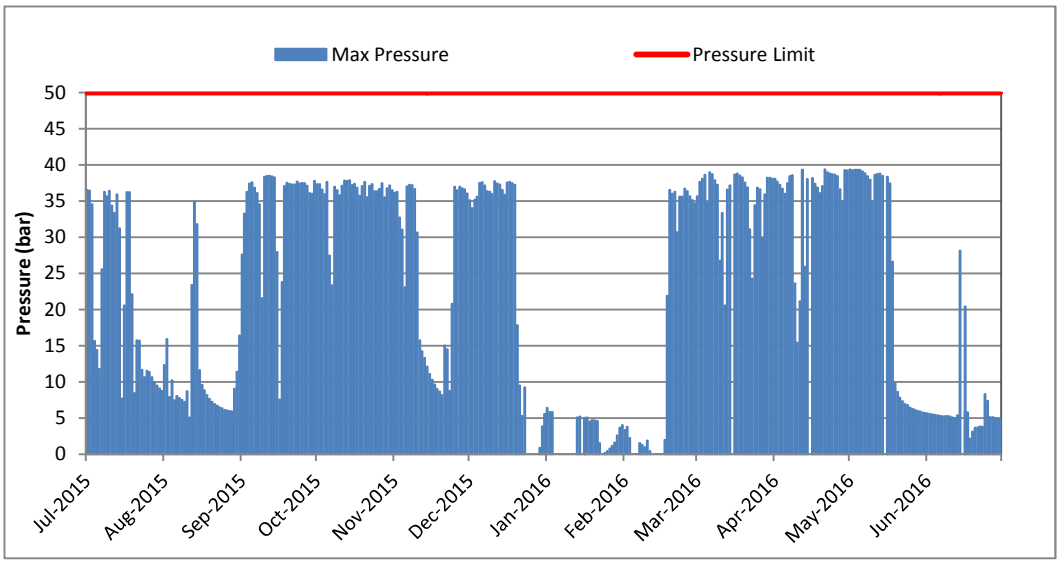

Figure 7 Manutahi-D (D-2H) consent 7905-1 daily maximum injection pressure (2015-2016)

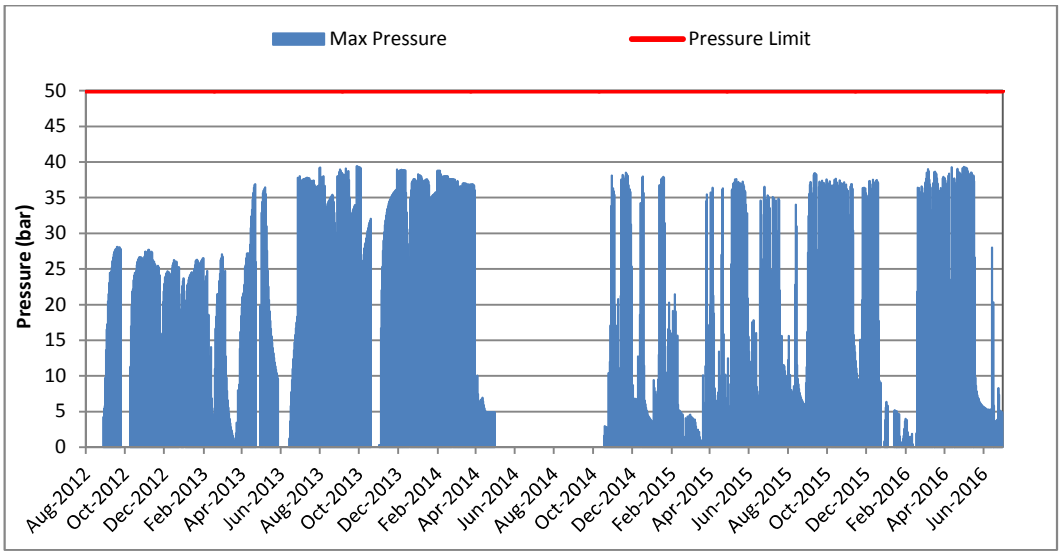

Figure 8 Manutahi-D (D-4HST2) consent 7905-1 daily maximum injection pressure (2012-2016)

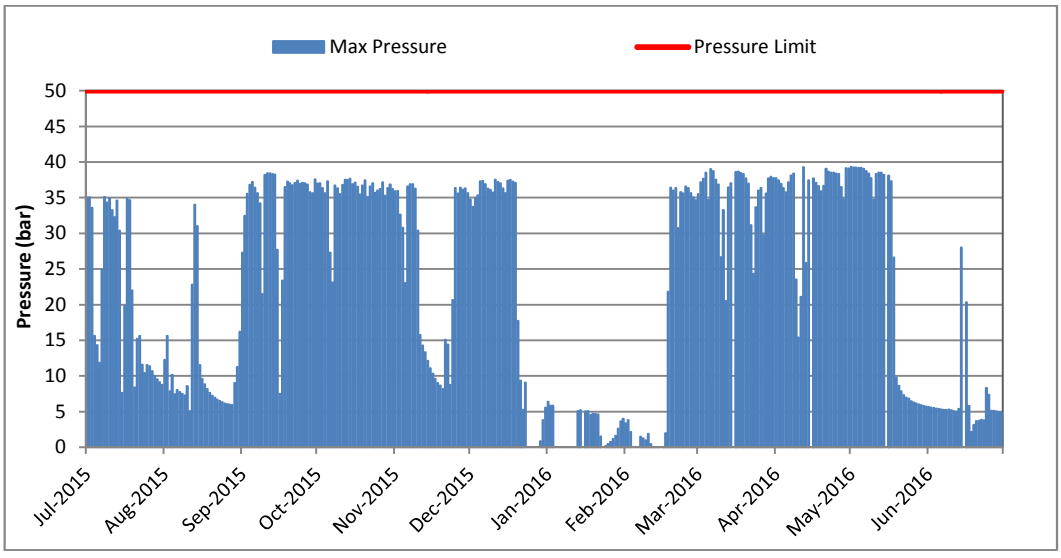

Figure 9 Manutahi-D (D-4HST2) consent 7905-1 daily maximum injection pressure (2015-2016)

2.5 Investigations, interventions, and incidents

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

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

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

In the 2015-2016 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 one resource consent for the injection of fluids by DWI (7905-1). The exercised consent authorises the injection of heated fluids into the Mangahewa Formation. Injection into the Formation is via the D-2H and D-4HST2 injection wells.

The wells are fitted with engineering controls and in built safety systems to protect the wellbore against any process or subsurface related failures. In the event of any sudden pressure losses or increases, safety systems isolate the wellbore and shut down the injectate pumping system. It should also be noted that maximum pressure that can be generated by the injectate pumps is well below the safe operating pressures of the wellhead, casing and tubing.

The operation of the injection well is monitored by Company staff, with automated systems recording the injection data required under the conditions of their consent. Throughout the monitoring period this data was submitted to the Council at the specified frequency.

A review of the 2015-2016 injection data provided by the Company shows that a total of 19,794.55 m^3 of fluid was injected under consent 7905-1. The majority (12,481.71 m^3) of fluid was injected via the D-2H injection well. The remaining 6,794.55 m^3 was discharged via the D-4HST2 well. The data also shows that the maximum daily volume injected was 198 m^3, which occurred on 18 July 2016. The maximum injection pressure of 39.4 bar was recorded on 1 May 2016 in the D-2H injection well. Both the daily injection volumes and maximum injection pressures recorded were well within the respective limits of 318 m^3/day and 50 bar.

An assessment of the injection data record over the lifetime of the consent (2012-2016) shows annual volumes fluctuate from year to year. The site is used purely for water flooding and the volume injected is dependent on the volume of fluid and heat required to aid in hydrocarbon abstraction via the producing wells rather than the volume of fluid that requires disposal.

Routine inspections of the Company's Manutahi-D wellsite 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.

3.2 Environmental effects of exercise of consents

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

The groundwater monitoring component of this programme continued during the period under review, with two samples being taken from monitoring sites in the vicinity of the Company's only active injection well. The results of the monitoring carried out show that the groundwater composition at the monitored location has

remained stable since the commencement of monitoring during the 2012-2013 period. 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 2015-2016 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 Table 8.

Table 8 Example Summary of performance for consent 7905-1

Purpose: ***To discharge heated water, including produced water to ground at the Manutahi-D wellsite for water flooding purposes***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Consent holder must submit an Injection Operation Management Plan	Receipt of satisfactory Injection Operation Management plan	Yes
2. Provision of well and injection zone information	Receipt of satisfactory information	Yes
3. Injection pressure must not exceed 50 Bar (721 PSI)	Assessment of consent holder records	Yes
4. Daily volume of fluid injected must not exceed 318 m^3	Assessment of consent holder records	Yes
5. The consent holder shall at all times adopt the best practicable option	Assessment of consent holder records and site inspection notices	Yes
6. Provision of records for discharge volumes, rates, and pressures	Receipt of well discharge data	Yes
7. Provision of records of chemical analysis of discharge	Receipt of discharge analytical results	Yes
8. Notification provision	Received five working days prior to consent exercise	Yes
9. No contamination of freshwater aquifers	Assessment of consent holder records	Yes
10. Lapse clause	Receive notice of exercise of consent	Yes
11. Review provision	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of consent compliance and administrative performance in respect of this consent		**High**

N/A = not applicable

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

3.4 Recommendations from the 2014-2015 Annual Report

In the 2014-2015 Annual Report, it was recommended:

1. That discharge records are provided to the Council at the end of each month, as per special condition 6 in Consent 7905-1.

2. That all analytes listed in special condition 7 of consent 7905-1 are tested for each month that discharge is occurring at the Manutahi-D wellsite.

3. THAT the range of monitoring carried out during the 2014-2015 period in relation to the Company's DWI activities be continued during the 2015-2016 monitoring period.

4. THAT the Council notes there is no requirement at this time for a consent review to be pursued or grounds to exercise the review options.

All the recommendations from the 2014-2015 report were carried out during the 2015-2016 review period.

3.5 Alterations to monitoring programmes for 2016-2017

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

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/discharges and effects under the RMA; and
- to report 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 emitting to the atmosphere/discharging to the environment.

It is proposed that the range of monitoring carried out during the 2015-2016 period be continued during the 2016-2017 monitoring period.

3.6 Exercise of optional review of consent

The next optional review date for consent 6544-1 is June 2017. The next optional review dates for consents 6544-1 is provided for in June 2017.

The Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent. A review may be required 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.

As the consent has not been exercised, it is considered that there are no grounds that require a review to be pursued or grounds to exercise the review option.

4. Recommendations

1. THAT the range of monitoring carried out during the 2015-2016 period in relation to the Company's DWI activities be continued during the 2016-2017 monitoring period.

2. THAT the Council notes there is no requirement at this time for a consent review to be pursued or grounds to exercise the review options.

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.
Conductivity	A measure of the level of dissolved salts in a sample. Usually measured at 20°C and expressed as millisiemens per metre (mS/m) or as Total Dissolved Solids (g/m3).
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 earths 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.
Freshwater-saline-water interface	The depth in a well at which fresh water becomes saline. The interface may be a gradational or sharp transition, depending on geology. The FW-SW transition is demonstrated by down-hole geophysical logging.
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 ("fraccing").
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.
mS/m	Millisiemens per metre.
m TVD	Metres true vertical depth
m^3	Cubic metre.

pH	Numerical system for measuring acidity in solutions, with 7 as neutral. Values lower than 7 are acidic and higher than 7 are alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Produced water	Water associated with oil and gas reservoirs that is produced along with the oil and gas. Typically highly saline with salt concentrations similar to seawater and containing low levels of hydrocarbons.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
UI	Unauthorised Incident.
Water flooding	A method of thermal recovery in which hot water is injected into a reservoir through specially distributed injection wells. Hot water flooding reduces the viscosity of the crude oil, allowing it to move more easily toward production wells.

For further information on analytical methods, contact the Council's laboratory.

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Ministry for the Environment (2006): A National Protocol for State of the Environment Groundwater Sampling in New Zealand. Ref. ME781.

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Origin Energy Resources NZ, Limited. Injection records for Manutahi D-2H and Manutahi D-4H ST2. August 2012 to July 2013. Document 1222353.

Origin Energy Resources NZ, Limited. Injection records for Waihapa-7A. July 2003 to March 2013. Document 1184677.

Stevens G. (2001): Taranaki : In: Groundwaters of New Zealand, M.R, Rosen and P.A. White (eds). New Zealand Hydrological Society Inc., Wellington. P381-386.

Taranaki Regional Council (2015): Origin Energy Resources New Zealand Limited Deep Well Injection Monitoring Programme Annual Report 2014-2015. Technical Report 2015-23. Doc no. 1549614.

Taranaki Regional Council (2015): Origin Energy Resources New Zealand Limited Deep Well Injection Monitoring Programme Annual Report 2013-2014. Technical Report 2014-94. Doc no. 1461629.

Taranaki Regional Council (2011): Origin Energy Resources New Zealand Limited Deep Well Injection Monitoring Programme Triennial Report 2009-2012. Technical Report 2011-85.

Taranaki Regional Council. Disposal of contaminants by deep well injection; A guide to applicants seeking resource consent to discharge contaminants by deep well injection in Taranaki. Unpublished memorandum September 2005; 12pp. Doc no. 100856.

Appendix I

Resource consents held by Origin Energy Resources New Zealand Limited

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

Discharge Permit

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

Name of Consent Holder:	Origin Energy Resources NZ [Rimu] Limited Private Bag 2022 NEW PLYMOUTH
Change To Conditions Date:	8 December 2008 [Granted: 23 June 1999]

Conditions of Consent

Consent Granted:	To discharge waste drilling fluids from hydrocarbon exploration operations by deepwell injection into the Matemateaonga Formation at the Rimu-A wellsite at or about (NZTM) 1717352E-5611071N
Expiry Date:	1 June 2016
Review Date(s):	June 2010
Site Location:	Rimu-A wellsite, Old South Road, Mokoia [Property owner: M & P Hawken & Tongahoe Farm Limited]
Legal Description:	Lots 4 & 5 DP 9677 Blk XIV Hawera SD
Catchment:	Manawapou

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

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

Conditions 1 to 4 [unchanged]

1. That prior to the exercise of this consent, the consent holder shall submit to the Taranaki Regional Council a log of the well, to the satisfaction of the Chief Executive, to demonstrate the conditions of consent can be met.

2. That the consent holder shall ensure that injection will not contaminate or endanger any actual or potential usable freshwater aquifer.

3. That the consent holder shall keep records of amounts of drilling fluids injected, including injection pressure and rate, and shall make the records available to the Taranaki Regional Council upon request.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2004 and/or June 2010, 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 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.

Condition 5 [new]

5. This consent shall lapse on 31 March 2014 unless the consent is given effect to before the end of that period, or the Taranaki Regional Council fixes a longer period pursuant to section 125 (b) of the Resource Management Act 1991.

Signed at Stratford on 8 December 2008

For and on behalf of
Taranaki Regional Council

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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:	Origin Energy Resources (Kupe) Limited Private Bag 2202 NEW PLYMOUTH 4342
Change To Conditions Date:	21 June 2010 [Granted: 21 June 2005]

Conditions of Consent

Consent Granted:	To discharge produced water from hydrocarbon production operations by deepwell injection at the Kupe Production Station site at or about (NZTM) 1699750E-5618461N
Expiry Date:	1 June 2039
Review Date(s):	June 2011, June 2017, June 2023, June 2029, June 2034
Site Location:	Kupe Production Station, west of Inaha Road, east of Kapuni Road [being a paper road] and south of Siggs Road [being a paper road], Inaha, Manaia
Legal Description:	Secs 55 56 Pt Secs 53 54 Sbdn 1 of Pt Sec 53 Sbdn 1 of Pt Sec 54 DP 2201 Blk VII Waimate SD Sec 17 Blk VIII Waimate SD
Catchment:	Kapuni

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

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

Conditions 1 to 7 [unchanged]

1. The exercise of this consent shall be undertaken in general accordance with the documentation submitted in support of application 3514. In the case of any contradiction between the documentation submitted in support of application 3514 and the conditions of this consent, the conditions of this consent shall prevail.

2. 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 adverse effects on the environment from the exercise of this consent.

3. Prior to the exercise of this consent for each individual well to be used for deepwell injection, the consent holder shall submit, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a log of the injection well, and an injection well operation management plan, to demonstrate that special condition 4 of this consent can be met. The report shall:

a) identify the injection zone, including a validated bore log and geophysical log;
b) detail the results of fluid sampled from the injection zone, and the proposed wastes to be injected for maximum and mean concentrations for pH, suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons;
c) demonstrate the integrity of well casing; and
d) outline design and operational procedure to isolate the zone.

4. The consent holder shall ensure that injection will not contaminate or endanger any actual or potential useable freshwater aquifer.

5. The consent holder shall keep daily records of the nature and amounts of all material injected, including injection pressure and rate, and mean concentrations of pH, suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons. The consent holder shall make the records available to the Taranaki Regional Council on a 3 monthly basis, and when there has been a significant pressure change event.

6. The consent holder shall inject fluids at pressures below the pressure that would be required to fracture the injection formation.

7. The consent holder shall provide to the Taranaki Regional Council during the month of May of each year, for the duration of the consent, a written report on all matters required under special conditions 3, 4, 5, and 6 above.

Condition 8 [changed]

8. This consent shall lapse on 30 June 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Condition 9 [unchanged]

9. 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 2011 and/or June 2017 and/or June 2023 and/or June 2029 and/or June 2034, 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 21 June 2010

For and on behalf of
Taranaki Regional Council

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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:	Origin Energy Resources NZ [Rimu] Limited Sustainability Manager Private Bag 2022 NEW PLYMOUTH 4342
Decision Date:	16 September 2011
Commencement Date:	16 September 2011

Conditions of Consent

Consent Granted:	To discharge heated water, including produced water to ground at the Manutahi-D wellsite for water flooding purposes at or about (NZTM) 1719971E-5603672N
Expiry Date:	1 June 2028
Review Date(s):	June 2016, June 2022
Site Location:	Manutahi-D wellsite, Lower Ball Road, Kakaramea [Property Owner: NA Schrider & PW Campbell]
Legal Description:	Lot 5 DP 14553 Blk I Carlyle SD [Discharge source & site]
Catchment:	Mangaroa

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 to section 36 of the Resource Management Act

Special conditions

1. Before this consent is exercised, except for an initial injection trial of up to 64 cubic metres of produced water per well, the consent holder shall submit an updated "Injection Operation Management Plan" which includes the details of this waterflooding pilot project and identifies the conditions that would trigger concerns about the integrity of the well, or the injection zone, and the action to be taken by the consent holder if trigger conditions are reached.

2. Before this consent is exercised the consent holder shall provide to the Chief Executive of the Taranaki Regional Council:

    a) Subsurface construction details, including design of the exterior surface casing, the intermediate protective casing, and the innermost casing, tubing, and packer;
    b) A log of the well, or a representative nearby well, from 0.0 mbgl to 1000 mbgl; clearly showing the freshwater/brine water interface zone;
    c) Annular pressure; pressure testing which demonstrates well integrity [MIT];
    d) Receiving Formation fracture pressure and geological seal fracture pressure;
    e) A chemical analysis of the formation-water;
    f) Cementing details.

3. The injection pressure at the wellhead shall not exceed a maximum injection pressure of 721 PSI [50 Bars].

4. The volume of liquid re-injected shall not exceed 318 cubic metres per day.

5. 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; in particular, ensuring that the injection material is contained within the injection zone.

6. The consent holder shall keep daily records of:

    a) maximum injection pressure;
    b) maximum and average rate of injection; and
    c) volume of fluid injected;

    during operation of the well. These records shall be provided to the Taranaki Regional Council at the end of each month.

7. The consent holder shall measure and record the following constituents of the discharge each month:

   a) pH;
   b) suspended solids concentration;
   c) temperature;
   d) salinity;
   e) chloride concentration; and
   f) total hydrocarbon concentration.

   The consent holder shall provide to Taranaki Regional Council, during the month of May of every year, a summary of all records collected in accordance with this condition.

8. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 working days prior to the first exercise of this consent, except for an initial injection trial of up to 64 cubic metres of produced water per well. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

9. The consent holder shall ensure that the exercise of this consent not contaminate or put at risk actual or potential usable freshwater aquifer.

10. This consent shall lapse on the 30 September 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(b) of the Resource Management Act 1991.

11. 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 2016 and/or June 2022, 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 16 September 2011

For and on behalf of
Taranaki Regional Council

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Director – Resource Management