

Todd Energy Limited
Deep Well Injection
Monitoring Programme
Annual Report
2013-2014
Technical Report 2014-98

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Executive summary

The following Annual Report by the Taranaki Regional Council (the Council) encompasses the monitoring period 1 July 2013 – 30 June 2014. The report details the deep well injection (DWI) consents held by Todd Energy Limited (the Company) during the period under review. The report also outlines the Company's DWI activities during this period, discusses the monitoring programme implemented by the Council and its results, and also provides an assessment of Company performance with regard to consent compliance.

During the period under review, the Company held four resource consents for the injection of fluids by DWI, permitting discharges from three separate wellsites in northern Taranaki. The consents permit the discharge of a range of fluids, including waste drilling fluids, produced water, contaminated stormwater, hydraulic fracturing (HF) fluids and production sludges. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

During the year under review Todd Energy Limited demonstrated a high level of environmental performance.

During the 2013-2014 monitoring period, the Company exercised DWI consents 1315-1 and 4182-2. Consent 1315-1 permits the discharge of fluid waste generated by oil and gas exploration by DWI at the McKee Disposal-1 well located at the Tuhua-B wellsite, Otaraoa Road, Tikorangi. Consent 4182-2 permits the discharge of fluid waste generated by oil and gas exploration by DWI, at the McKee-1 well at the McKee-A wellsite, Otaraoa Road, Tikorangi.

The monitoring programme implemented by the Council in respect of the Company's DWI activities included inspections of injection operations, the review and assessment of injection data submitted by the Company and groundwater monitoring.

During the period under review, the Council carried out two routine DWI inspection visits. Inspection visits included liaising with on-site staff, identification of the active injection well(s), viewing of the injection well monitoring equipment and injection logs, and the spot sampling of the injectate. In addition to the DWI inspection visits, the Tuhua-B wellsite and McKee-A wellsite were visited by Council staff on seven separate occasions in the 2013-2014 monitoring period for inspections relating to other consents held by the Company for various activities at the site.

As required by the special conditions of the consents held by the Company, process monitoring data and injection records were supplied to the Council, and were reviewed on submission. In total 30,239 cubic metres (m³) of fluids were discharged under consent 1315-1, and 10,866 m³ under consent 4182-2.

Groundwater monitoring carried out by the Council in the vicinity of the Tuhua-B wellsite and the McKee-A wellsite does not indicate any contamination of shallow aquifers due to injection operations.

The information gathered during inspection visits and the data supplied by the consent holder for Council audit have been used in compiling this report.

The Council did not receive any complaints or register any unauthorised incidents associated with any of the Company's DWI activities during the 2013-2014 monitoring period.

During the year under review Todd Energy Limited demonstrated a high level of environmental performance and a high level of administrative performance and compliance with the resource consents.

For reference, in the 2013-2014 year, 60% 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 29% demonstrated a good level of environmental performance and compliance with their consents.

This report includes recommendations to be implemented during the 2014-2015 monitoring period.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

The following Annual Report covers the monitoring period 1 July 2013 – 30 June 2014. During the period under review, Todd Energy Limited (the Company) held four resource consents for the disposal of wastes by deep well injection (DWI) from three separate wellsites across the northern Taranaki area. The resource consents held by the Company permit the discharge of a range of fluids by DWI, including waste drilling fluids, produced water, contaminated stormwater, hydraulic fracturing (HF) fluids, and production sludges. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

The following report provides details of the DWI consents held by the Company during the period under review, and outlines their DWI activities during this period. The report also outlines the compliance monitoring programme implemented by the Taranaki Regional Council (the Council) with regard to these activities, discusses its results, and provides an assessment of the Company's performance with regard to consent compliance. The report concludes with recommendations regarding the future monitoring of the Company's DWI activities.

1.1.2 Structure of this report

The following report comprises five sections as follows:

- Section 1 of this report is a background section. It sets out general information about compliance monitoring under the relevant legislation and the Council's obligations and general approach to monitoring sites through dedicated monitoring programmes. Also covered in this section are the details of the individual resource consents held by the Company, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted on the Company's well sites;
- Section 2 presents the results of monitoring during the period under review, including technical data;
- Section 3 outlines any incidents, interventions and incidents that occurred during period under review;
- Section 4 discusses the results, their interpretation, and their significance for the environment; and
- Section 5 presents recommendations to be implemented in the 2014 - 2015 monitoring period.

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

1.1.3 The *Resource Management Act (1991)* and monitoring

The *Resource Management Act (1991)* (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 a discharger, and may include cultural and socio-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 (e.g., 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 discharge source. 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 performance of resource users against regional plans and consents. Compliance monitoring, (covering both activity and impact), also enables the Council to continuously assess its own performance in resource management as well as that of resource users, particularly consent holders. It also enables the Council to continually re-evaluate its approach to resource management, and ultimately, through the refinement of methods, and considered responsible resource utilisation, to move closer to achieving sustainable development of the regions resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the consent holder/s during the period under review, this report also assigns a rating as to each Company's 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 (i.e. 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 compliance

- **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 2013-2014 year, 60% 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 29% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

1.2.1 Background

The Taranaki Basin occupies an area of approximately 100,000 square kilometres and is the most explored and commercially successful hydrocarbon producing area in New Zealand. Oil and gas exploration and development has been on-going in the region for nearly 150 years. Since the first well in 1865, over 600 exploration and production wells have been drilled. While the majority of the basin is offshore, the majority of the producing wells are onshore. The geology of the basin is derived from diverse episodes of tectonic activity. The Cretaceous to Quaternary basin fill is up to 9,000 m thick in places.

The modern era of exploration began in New Zealand in 1955 when a Shell-BP-Todd consortium explored a large part of the Taranaki region. The groups first well (Kapuni-1), discovered gas-condensate in Late Eocene Kapuni Group strata, and marked the beginning of New Zealand's natural gas industry. The Kapuni Field commenced commercial production in 1970. The next major discovery was the off-shore Maui field in 1969, which was in full production by 1979. Maui is New Zealand's largest hydrocarbon field to date. Many smaller fields were discovered between 1979 and 1999, including the McKee, Mangahewa, Ngatoro, Kaimiro and Rimu fields. More recent discoveries include the Pohokura gas field in 2001.

Overall, the Taranaki Basin remains relatively under-explored compared to many comparable rift complex basins of its size and potential.

1.2.2 Deep well injection (DWI)

DWI is often utilised as liquid waste disposal technology and provides an alternative to the surface disposal of such material. The DWI process utilises specially designed injection wells to pump liquid waste into deep geological formations, hydrocarbon reservoirs or confined saline aquifers. The receiving formations generally contain

water that is too saline to be of any potential use. Impermeable geological seals overlying the injection intervals restrict any potential vertical migration of injected wastes into shallow freshwater aquifers.

A typical injection well consists of concentric casing, cemented into the surrounding rock, which extend into permeable saline formations, at depths far below the base of potentially useable freshwater aquifers. Waste is then injected into the receiving formation by pressure generated by surface pumps. International standards (adopted in the Taranaki Region) for the construction of disposal wells emphasise the importance of surface casing extending to depths below the base of the freshwater zones and that it is cemented back to surface. The standards also highlight the requirement for internal casing strings to be cemented back up the hole to seal off and isolate the disposal interval from the overlying freshwater zones, providing a multi-barrier approach to the protection of freshwater resources. As part of the resource consent application procedure for DWI activities, applicants are required to submit information that details both the design and construction specifications of the injection well(s) and illustrates well integrity and the isolation of the well bore from surrounding formations.

In Taranaki, contaminants disposed of by DWI are generally limited to produced water, saline groundwater, contaminated stormwater, waste drilling fluids, HF fluids, and production sludges. The Council has approved, on specific occasions, the discharge of small volumes of other specified contaminants by DWI. Any application to discharge waste material not specifically licenced by the relevant resource consent is assessed by the Council on a case by case basis. The Council will assess the composition of the waste for consistency with those specifically approved for disposal. In some cases, a new consent may be required.

Produced water makes up the greatest volume of waste fluids generated by oil and gas exploration and production activities. Produced water is water that is present in a hydrocarbon bearing reservoir, brought to the surface as crude oil or natural gas is extracted from it. The composition of this produced fluid is dependent on whether crude oil or natural gas is being produced and generally includes a mixture of either liquid or gaseous hydrocarbons, formation water, dissolved or suspended solids, produced solids such as sand or silt, and injected fluids and additives that may have been placed in the formation as a result of exploration, hydraulic fracturing, and/or production activities. Produced waters may contain, in addition to salts, hydrocarbon residues and free oil, and traces of process additives including anti-scaling agents, anti-corrosion agents and biocides. Proportionally, higher quantities of water are produced from a hydrocarbon field as more oil or gas is extracted and the productive life of the field diminishes. The volume of produced water requiring disposal is therefore expected to increase as many producing fields approach the end of their lives, and as more fields are discovered and developed.

Produced water and drilling fluid wastes are typically highly saline and contain hydrocarbon residues and system additives. Without treatment to an acceptable standard, the surface disposal of large volumes of produced water is not a suitable disposal option, particularly where the discharge can enter surface or groundwater systems. The salts and other contaminants contained within the discharge can adversely affect soil or freshwater biological systems and the quality of water resources used for supply purposes. Although there are methods to treat produced

waters to a suitable standard for surface disposal, such as gas/steam stripping, biological and chemical adsorption, and activated carbon, they are generally not practical or economically viable. The injection of produced waters into deep geological formations by DWI is presently the most cost-effective option for the disposal of this type of waste, and more importantly, is an environmentally sound disposal option.

Produced waters have been disposed of by DWI in Taranaki since the development of the Kapuni Field in 1970. The collection, handling, treatment and disposal of produced water from a producing field are major undertakings and, if not appropriately managed, can have lasting adverse environmental effects. However, under appropriate geological and operational conditions, the disposal of produced waters by DWI should have no more than negligible environmental effects.

The injection of fluids into hydrocarbon bearing reservoirs is also an established oilfield technique for regulating reservoir pressure and/or as a means of enhancing the rate of oil recovery from a reservoir. This process is often referred to as water flooding. Water flooding is a secondary recovery process that is often implemented when natural reservoir pressures decline due to the removal of reservoir fluids during production. The injection of produced fluids back into the reservoir can increase reservoir pressure and stimulate production by driving reserves toward a production well. In certain cases, injected water is heated and injected through a well annulus to reduce oil viscosity, improving oil deliverability through the wellbore. Typically, either produced waters or freshwater, or a combination of the two, are used for water flooding.

Regional councils are responsible for monitoring environmental effects from hydrocarbon exploration and development activities under the RMA. Sections 15 and 30 of the RMA give regional councils the responsibility for regulating the discharge of contaminants into the environment. The discharge of contaminants onto or into land that may result in water contamination may not take place unless expressly allowed by a rule in a regional plan, resource consent or other relevant regulations. The control of DWI activities through the resource consenting process and subsequent compliance monitoring is an appropriate regulatory regime. In the Taranaki region, the discharge of contaminants by DWI requires resource consent from the Council. The activity falls under Rule 51 of the Regional Freshwater Plan for Taranaki and is classified as a discretionary activity. The application may be non-notified if no parties are deemed to be adversely affected by the proposed activity.

At the time of writing, there were a total of 19 current resource consents for DWI in Taranaki. However, several resource consents have been issued for relatively short-term activities during exploration phase drilling, and several others have not been, and may never be exercised.

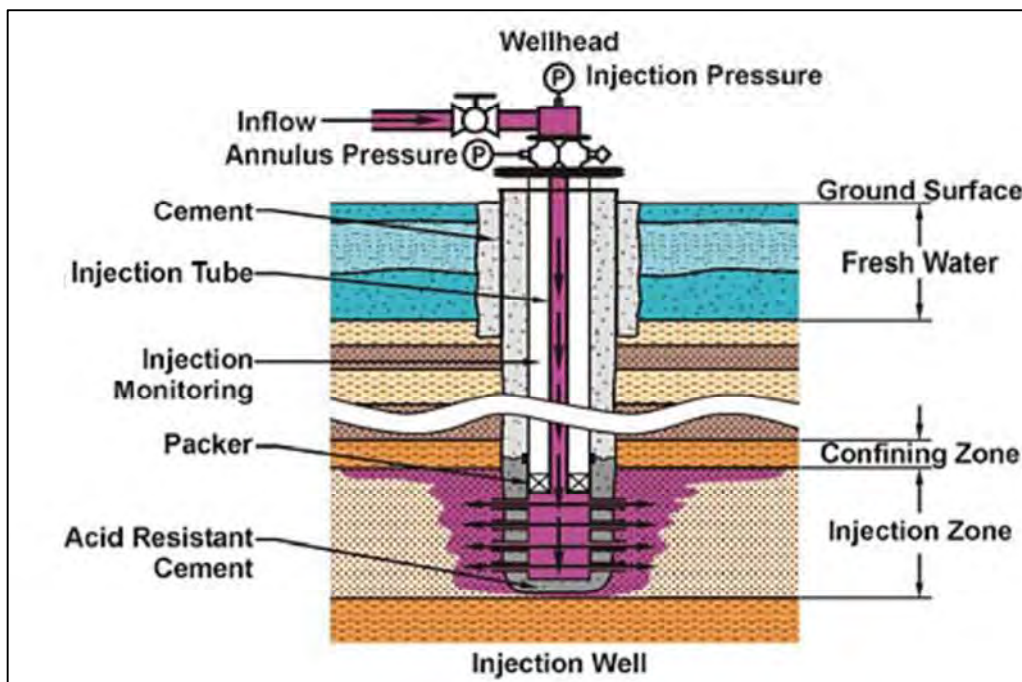


Figure 1 DWI schematic representative of Taranaki sites¹

1.3 Potential environmental effects of exercising a DWI consent

The most significant adverse potential environment effect of discharging waste fluids by DWI is the contamination of freshwater aquifers during or following the discharge. Potential pathways for contamination of a freshwater aquifer can be created by the rupture of geological seal confining the injection interval, or failure of the grout seal in either the disposal well or any other well that penetrates the disposal interval. There is also potential for fluids to be forced upward from the injection interval through transmissive faults or fractures in the geological formations overlying the injection interval. Faults or fractures may have formed naturally prior to injection, or may be created by the waste dissolving the rocks of the confining zone. Artificial fractures may also be created by injecting wastewater at excessive pressures or by thermal processes.

There is also the potential for shallow groundwater to be contaminated by surface activities associated with DWI operations, particularly the handling, storage and transport of waste fluids. In all cases, the risk of contamination by spillage or unintended discharge of fluids being managed can be adequately mitigated by ensuring wastes are stored and transported in appropriately constructed and tested storage vessels and pipelines.

In each of the scenarios outlined above, the potential risk can be adequately mitigated by appropriate assessment, design, operation and monitoring of DWI activities. Appropriately engineered technology, regional and local geologic characterisation, and site specific modelling are typically combined at the planning stage of a disposal well to ensure that fluids discharged by DWI will be contained

¹ <https://upstrm.wordpress.com/tag/injection-wells/>

within the intended disposal interval. The assessment of resource consent applications and setting of appropriate conditions address these issues.

1.4 Resource consents

The protection of groundwater quality is of primary concern to the Council when processing resource consent applications for DWI activities. Section 15(1)(b) of the RMA stipulates that no person may discharge any contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant originated as a result of natural processes from that contaminant) entering water, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or national regulations.

Table 1 lists the consents held by the Company during the period under review, the wellsites to which the consents relate and the injection wells in use at each site. All of the resource consents were issued by the Council under Section 87(e) of the RMA.

Table 1 Summary of DWI consents held by the Company during the 2013-2014 period

Consent Number	Wellsite	Injection Well(s)	Formation
1315-1	Tuhua-B	McKee Disposal-1	Mount Messenger
3895-2	Tuhua-B	All other wells	Mount Messenger
4182-2	McKee-A	McKee-1	McKee
5052-2	McKee-B	McKee-4	Mount Messenger

A summary of the consents held by the Company for DWI activities during the 2013-2014 monitoring period is included below.

Resource Consent: 1315-1

“To discharge fluid waste generated by oil and gas exploration and production activities to the Mount Messenger Formation by deep well injection at the Tuhua-B wellsite”

Background:

Consent 1315-1, which permits the discharge of waste fluids by DWI at the Tuhua-B wellsite, Foreman Road, Tikorangi, was originally granted to Petrocorp Exploration Limited (Petrocorp) on 8 August 1984.

The original consent allowed for the discharge of up to 392 m³/day of wastewater into the Waikiekie Formation, via any well drilled on the named wellsite. An application was received from Petrocorp on 21 January 1985, seeking an increase in the permitted injection volume to 898 m³/day. A revised consent was granted on 13 March 1985.

Following their procurement of the site, the consent was transferred to Fletcher Challenge Energy Taranaki (FCET) in 1999. There is no record of the consent being exercised under their ownership. On 11 January 1999, an application was received from FCET to increase the permitted discharge volume to 1,000 m³/day, and amend the legal description of the consented location and the name of the injection

formation from Waikiekie to the Mount Messenger. A revised consent was granted on 8 February 1999.

The consent was transferred to Shell Todd Oil Services Limited (STOS) in March 2002, but was not exercised under their tenure.

The consent was transferred to the Company on 31 May 2006.

A variation to the consent was granted on 1 October 2013 which included the changing of the purpose of the consent and adding thirteen conditions to take the total number of conditions to 17 (described below).

The injection of waste under consent 1315-1 is carried out via the McKee Disposal-1 well (Photo 1). The injection well is perforated between 1,267 and 1,350 metres below ground level (m BGL), and this is the zone into which injection occurs.

The Council waived its option to review this consent in June 2003 and June 2009 as it was deemed that the consent conditions were adequate to deal with the potential adverse effects of the activity. Optional reviews of the consent and its conditions are provided for in June annually. The consent is due to expire on 1 June 2033.

The current consent has 17 special conditions, as summarised below:

- Special condition 1 required to consent holder to submit an “Injection Operation Management Plan” prior to exercising the consent;
- Special condition 2 requires the consent holder to submit well completion information following drilling;
- Special condition 3 requires the discharge to cease 5 years prior to consent expiry date to allow for on-going environmental monitoring after the discharge has ceased;
- Special condition 4 refers to the BPO requirements;
- Special condition 5 requires injected fluids to be contained within the Mount Messenger Formation, deeper than 1,200 m BGL;
- Special condition 6 prohibits the fracturing of the geological seals confining the injection zone;
- Special condition 7 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 8 limits the range of fluids that may be injected;
- Special conditions 9, 10, 11 & 12 refer to process monitoring and data submission requirements;
- Special condition 13, 14 & 15 relate to the requirement for the consent holder to implement a groundwater monitoring programme;
- Special condition 16 is an annual reporting requirement; and
- Special condition 17 is a review provision;



Photo 1 The Tuhua-B wellsite and McKee Disposal-1 well

Resource Consent: 3895-2

"To discharge waste drilling fluids, water, produced water and stormwater from hydrocarbon exploration and production operations by deepwell injection at the Tuhua-B Wellsite"

Background:

Consent 3895-1, which permitted the discharge of waste fluids by DWI at the Tuhua-B wellsite, Foreman Road, Tikorangi, was originally granted to Petrocorp on 19 December 1990. The original consent permitted the discharge of up to 50 m³/day of waste drilling fluids by DWI into the Urenui and Waikiekie (Mount Messenger) Formations.

While the original consent specified Tuhua-5 as the injection well, the Council later confirmed that the discharge could occur via any well drilled on this wellsite.

The consent was transferred to FCET in 1999, and there is no record of it being exercised during their ownership.

The consent was subsequently transferred to STOS in March 2002, but was not exercised under their ownership. In November 2003, STOS applied for the consent to be renewed and for the conditions of the consent to be varied. STOS also applied for the consent to cover the discharge of waste sourced from other sites. Consent 3895-2 was issued on 20 November 2003.

On 31 May 2006, the consent was transferred to the Company.

The McKee Disposal-1 well is currently being used for the injection of waste at the Tuhua-B wellsite, operating under consent 1315-1 (see above).

The Council waived its option to review this consent in June 2009 as it was deemed that the consent conditions were adequate to deal with the potential adverse effects of the activity.

There is no record of the consent 3895-2 ever being exercised, as all injection from the Tuhua-B wellsite has been via the McKee Disposal-1 well, under consent 1315-1.

The consent lapsed on 17 September 2013.

Resource Consent: 4182-2

“To discharge fluid waste generated by oil and gas exploration and production activities to the McKee Formation by deep well injection at the McKee-A wellsite”

Background:

Consent 4182-1, which permitted the discharge of waste fluids by DWI at the McKee-A wellsite, Otaraoa Road, Tikorangi, was originally granted to Petrocorp on 2 December 1992. The original consent permitted the discharge of up to 1,021 m³/day of produced water and treated stream water by DWI into the McKee Formation for reservoir water-flooding purposes.

The consent was later transferred to FCET in 1999. On 11 January 1999 an application was received seeking an increase in the maximum permitted injection volume to 1,500 m³/day. A revised consent was granted on 8 February 1999. On 7 September 1999 an additional application was received seeking an increase in the maximum permitted injection volume to 4,000 m³/day. A revised consent was granted on 20 September 1999.

The consent was transferred to STOS on 27 March 2002 STOS applied for a renewal of the consent in June 2003, and consent 4182-2 was subsequently granted on 24 June 2003.

Consent 4182 was transferred to Todd Energy Limited on 31 May 2006. In May 2009, the consent holder lodged an application to the Council for a change of consent purpose and conditions. The Company proposed to use an existing well (McKee-1) on the McKee-A wellsite for the DWI of hydrocarbon contaminated production sludges, recovered from the McKee-A flare pit and the McKee-Mangahewa Production Station, into the McKee Formation. The variation specifically sought to amend the purpose of the consent to allow for the disposal of a greater range of waste material including waste drilling fluids, HF fluids, water, produced water, stormwater and production sludges. A revised consent was granted on 22 June 2009.

A further variation to the consent was granted on 1 October 2013. This included the changing of the consent purpose, and the addition of 8 special conditions.

The McKee-1 well is perforated between 2,300 MBGL and 2,387 m BGL, and this is the zone into which injection occurs.

Optional reviews of the consent and its conditions are provided for in June annually. The consent is due to expire on 1 June 2033.

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

- Special condition 1 required to consent holder to submit an “Injection Operation Management Plan” prior to exercising the consent;
- Special condition 2 requires the consent holder to submit well completion information following drilling;
- Special condition 3 requires the discharge to cease 5 years prior to consent expiry date to allow for on-going environmental monitoring after the discharge has ceased;
- Special condition 4 refers to the BPO requirements;
- Special condition 5 requires injected fluids to be contained within the McKee Formation, below deeper than 2,300 m BGL;
- Special condition 6 prohibits the fracturing of the geological seals confining the injection zone;
- Special condition 7 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 8 limits the range of fluids that may be injected;
- Special condition 9, 10,11 & 12 refer to process monitoring and data submission requirements;
- Special condition 13, 14 & 15 relate to the requirement for the consent holder to implement a groundwater monitoring programme;
- Special condition 16 is an annual reporting requirement; and
- Special condition 17 is a review provision.

Resource Consent: 5052-2

“To discharge fluid waste generated by oil and gas exploration and production activities to the Mount Messenger Formation by deepwell injection”

Background:

Consent 5052-1, which permitted the discharge of waste fluid by DWI at the McKee-B wellsite, Otaraoa Road, Tikorangi, was originally granted to FCET on 13 November 1996. The original consent permitted the discharge of up to 750 m³/day of water and/or produced water into the McKee Formation via the McKee-2A and McKee-4 wells for reservoir water-flooding purposes.

An application was received on 11 January 1999 seeking a change in the conditions of consent to allow for a maximum permitted injection volume of 3,200 m³/day for water flooding purposes. A revised consent was granted on 8 February 1999.

On 11 May 2000, the consent holder applied for a change in consent conditions to allow for the discharge of up to 3,000 m³/day of produced water via McKee-4 into the Matemateaonga Formation for waste disposal purposes. A revised consent was granted on 17 May 2000. It should be noted that while earlier versions of the consent referred to the Matemateaonga Formation, injection at the stated depths actually occurred below the base of the Matemateaonga Formation.

On 27 March 2002, consent 5052 was transferred to STOS, but was not exercised under their ownership.

On 31 May 2006, the consent was transferred to the Company. A revised consent was issued to the consent holder on 17 May 2007, allowing for the disposal of waste drilling and HF fluids, in addition of up to 3,000 m³/day of produced water via the McKee-4 well.

On 27 May 2014, consent 5052-2 was granted following a renewal application by the company. The revised consent included changing the purpose, the expiry and review dates and adding 10 conditions. The revised consent stipulates the injection interval as being within the McKee Formation.

The McKee 4 well is perforated between 946 mbgl and 1,118 mbgl, and this is the zone into which injection occurs. The McKee-4 well has not been used for injection activities since 31 August 2008.

Optional reviews of the consent and its conditions are provided for in June annually. The consent is due to expire on 1 June 2033.

The consent has eight special conditions, as summarised below:

- Special condition 1 required to consent holder to submit an “Injection Operation Management Plan” prior to exercising the consent;
- Special condition 2 requires the consent holder to submit well completion information following drilling;
- Special condition 3 requires that no fluids be injected after 1 June 2028.
- Special condition 4 refers to the BPO requirements;
- Special condition 5 requires the injected fluids to be confined to the Mount Messenger Formation, and to be injected at a minimum depth of 945 m BGL;
- Special condition 6 prohibits the fracturing of the geological seals confining the injection zone;
- Special condition 7 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 8 limits the range of fluids that may be injected;
- Special conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Special condition 13, 14 & 15 relate to the requirement for the consent holder to implement a groundwater monitoring programme;
- Special condition 16 is an annual reporting requirement;
- Special condition 17 is a lapse clause; and
- Special condition 18 is a review provision.

Figure 2 shows the location of the DWI consents held by the Company during the period under review. Copies of the consent certificates are attached in Appendix I.

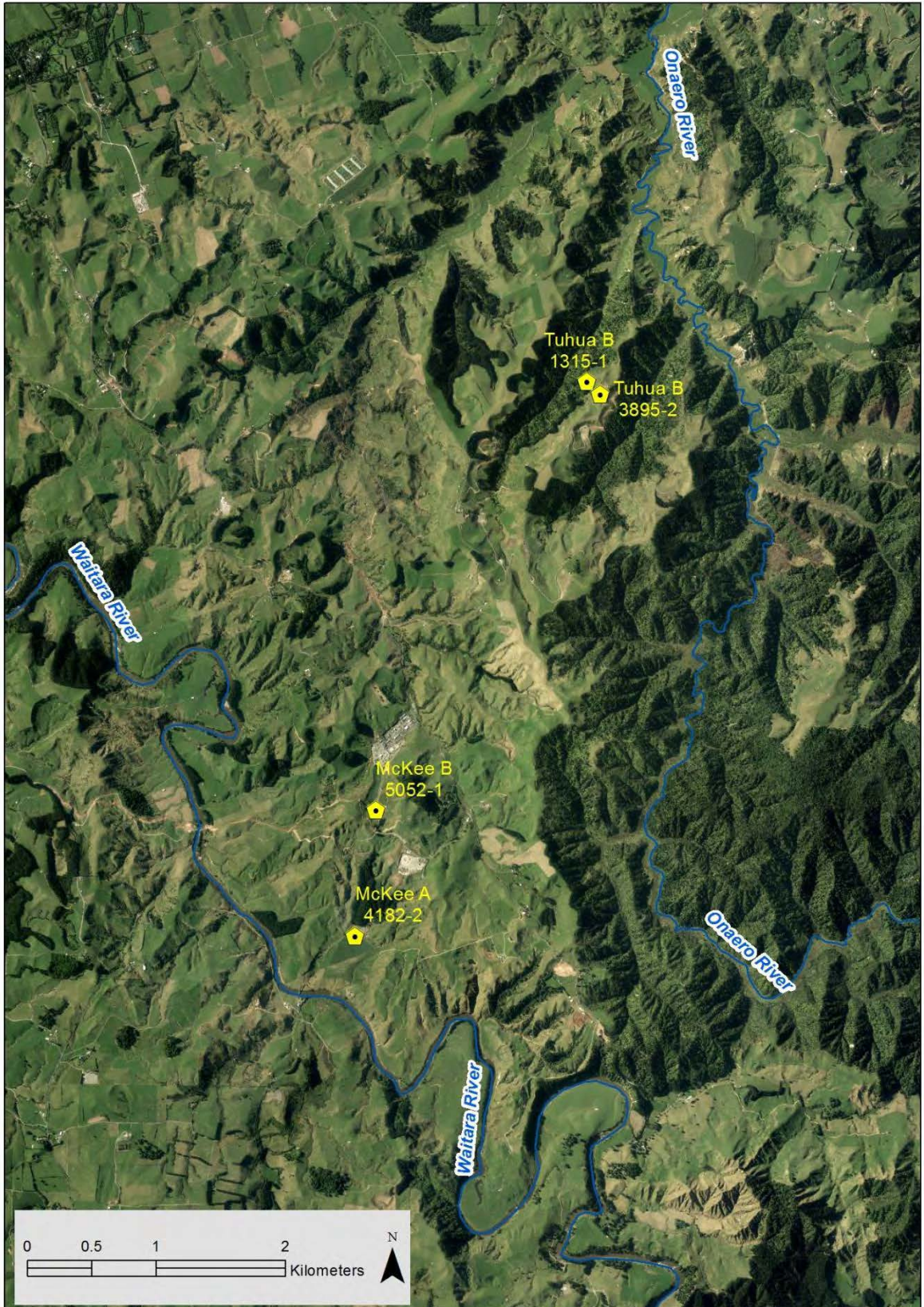


Figure 2 Resource consents for DWI held by the Company during the period under review

1.5 Monitoring programme

1.5.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor, and conduct research on the effects arising from consented activities within the Taranaki region and report upon these.

To perform its statutory obligations, the Council may be required to take 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 implemented by the Council in relation to the Company's DWI activities consisted of four main components:

- Programme design, liaison and management;
- Site inspections and injectate sampling;
- Assessment of data submitted by the consent holder; and
- Groundwater quality monitoring.

Each component of the monitoring programme is discussed in further detail below.

1.5.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council during annual reviews of existing monitoring programmes, and the scoping and design of future monitoring requirements. Significant time is spent managing compliance monitoring programmes throughout the monitoring year, and liaising with resource consent holders over consent conditions, their interpretation and application. The Council also undertakes discussion during preparation for any consent reviews, renewals, or new consent applications, and provides advice on environmental management strategies, the content of regional plans, and various other associated matters.

1.5.3 Site inspections and injectate sampling

The monitoring programme provides for physical inspections to be undertaken at all active DWI sites operated by the Company. The inspections include an examination of the injection wellhead, viewing the monitoring equipment and the spot sampling of the injectate for laboratory analysis. 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. Samples of the injectate were collected from a storage tank located at the McKee Production Station, which stores fluids prior to injection. The tank is identified by the Company as tank T100.

Table 2 Location of injectate sampling sites

Consent	Wellsite	Injection well	Site code	Sample point
1315-2	Tuhua-B wellsite	McKee-Disposal-1	GND1749	Tank T100 (McKee Production Station)
4182-2	McKee-A wellsite	McKee-1	GND0443	Tank T100 (McKee Production Station)

Samples of injectate were submitted to Council laboratory for analysis. Samples were analysed for the following parameters:

- pH;
- Conductivity;
- Alkalinity;
- Suspended solids;
- Chlorides; and
- Total petroleum hydrocarbons.

1.5.4 Consent holder data submission requirements

The resource consents held by the Company for DWI include conditions which require the Company to submit injection data and supporting information to the Council within specified timeframes. The injection data submitted by the consent holder forms the basis for assessing consent compliance. The major information requirements are as follows:

1. Information on the disposal well and injection zone

The conditions of the resource consents exercised by the Company required them to submit management plans for the operation of each injection well(s). The plans were 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 information requested is required to demonstrate that the exercise of the consent will not contaminate or endanger any actual or potentially useable freshwater aquifer.

The Council holds a significant volume of information regarding the Company's Mangahewa wells and the underlying geology in the Mangahewa/McKee area. Data has been gathered where submitted as part of resource consent applications, during specific site investigations, and as part of various compliance monitoring programmes.

2. Discharge records

For each well used for DWI during the period under review, the consent holder was required to provide discharge records. Specific data requirements included the following:

- Injection volumes;
- Injection pressures;
- Injection rate; and
- Analytical results for injectate samples.

The Company provided all discharge records required by consents 1315-1 and 4182-2 during the reporting period. The Council is satisfied that the data provided by the Company, in conjunction with the results of the analysis of injectate samples obtained by the Council, provides a representative assessment of fluids injected during the 2013-2014 monitoring period.

3. Annual reporting

The Company was required to submit annual written reports to the Council providing a summary of all injection data gathered over the previous 1 July to 30 June period. Annual reports also require the Company to detail how compliance has been achieved with the special conditions of consents exercised during the monitoring period. The Company's annual written report for the 2013-2014 period was received by the Council on 22 August 2014. The report met the reporting requirements of the relevant resource consents.

1.5.5 Groundwater quality monitoring

A programme of groundwater monitoring in the vicinity of the Company's active injection sites was initiated during 2012-2013 period. The programme provides for biannual sampling of groundwater from selected groundwater abstraction sites during each monitoring year.

In order to select suitable sampling sites for inclusion in the monitoring programme, surveys of water abstraction sites within a 1 km radius of the Tuhua-B and McKee-A wellsites were carried out. Initially, a desktop review of data held by the Council was conducted, including a search of the Council 'wells' database. The desktop review indicated that the Council held no records of groundwater abstractions in the areas of investigation. Following the desktop review, a field survey was undertaken to identify any groundwater abstraction sites that may not have been registered with the Council. No suitable groundwater sampling sites were located during the field survey.

During the 2013-2014 monitoring period, another field survey was conducted following discussions with the company. On this occasion, three suitable groundwater sampling sites were identified. Two groundwater spring discharge areas (GND2453 and GND2454) were located in the vicinity of the Tuhua-B wellsite. GND2453 and 2454 were located in the vicinity of the Tuhua-B wellsite. As required by the conditions of consent 4182-2, the company was required to install a groundwater monitoring well in the vicinity of the McKee-A wellsite, as no suitable existing sampling sites could be located. The installation of the well was completed on 19 March 2014.

Details of the sites selected for inclusion in the monitoring programme are listed below in Table 3.

Table 3 Location of groundwater sampling sites

Site code	Type	Distance from injection wellhead (m)	Casing depth (m)	Total depth (m)	High static water level (m)	Aquifer	Comment
GND2453	Spring	169	NA	NA	NA	Volcanics	Downgradient of Tuhua-B wellsite
GND2454	Spring	161	NA	NA	NA	Volcanics	Downgradient of Tuhua-B wellsite
GND2455	Bore	38	13.5	28.5	0.91	Volcanics	Downgradient of McKee-A wellsite

2. Results

2.1 Site inspections and injectate sampling

During the period under review, the Council carried out two routine DWI inspections at the McKee Production Station. The production station serves as a central fluid collection and storage facility, and is also the site from which all injection is controlled and monitored. Routine DWI inspections included undertaking a general visual assessment of the operational equipment, storage facilities and associated equipment. No operational issues were identified during the inspections and all equipment appeared in good condition. Company personnel were able to assist by detailing the status of injection equipment, outlining the injection operations being carried out by the Company at that time, and also providing real-time monitoring data on request.

As part of the monitoring programme, spot samples of the injectate were obtained during inspection visits on 22 October 2013 and 24 April 2014. The injectate samples were submitted to the Council's IANZ accredited laboratory for physicochemical analysis. The results of the analysis are included below in Table 4.

The concentrations of each analyte are within the expected range for produced water samples.

Table 4 Results of injectate sampling undertaken by the Council (2013-2014)

Parameter	Unit	Site GND1749 & GND0443 (Sample point T100)	
		22/10/13	24/4/14
Time	NZST	13:30	12:00
TRC sample number	-	TRC137387	TRC149833
pH	pH Units	8	8
Conductivity @ 20°C	mS/m @ 20°C	2,120	2,290
Alkalinity	g/m ³ CaCO ₃	2,770	3,020
Chloride	g/m ³	14,600	7,680
Total petroleum hydrocarbons	g/m ³	128	79

2.2 Assessment of data provided by the consent holder

The Company provided a record of injection data for the 2013-2014 monitoring period, including the injection volumes, rates and pressure data. Table 5 outlines the Company's injection activities during the period under review.

The injection data provided by the Company is summarised in Table 6.

The injection volume and pressure data provided by the Company for injection carried out under consent 1315-1 is presented graphically in Figures 3 and 4. The injection data for consent 4182-2 is presented in Figures 5.

Table 5 Summary of DWI activities during the period under review (2013-2014)

Consent	Wellsite	Injection wells	Total volume discharged (m ³) 01/07/13 – 30/06/14	Discharge period		TRC well ID
				From	To	
1315-1	Tuhua-B	McKee Disposal-1	30,239	01/07/2013	30/06/2014	GND1749
3895-2	Tuhua-B	Other wells	-	-	-	-
4182-2	McKee-A	McKee-1	10,866	01/07/2013	30/06/2014	GND0443
5052-1	McKee-B	McKee-4	-	-	-	-
Total			41,105	01/07/13	30/06/14	-

Table 6 Summary of the Company's 2013-2014 injection data

	1315-1 - McKee Disposal-1 injection well		
	Volume injected (m ³)	Pressure (Bar)	Injection rate (m ³ /hr)
Total	30,239		
Daily maximum	759	70	41
Daily average	210	29	12
	4182-2 - McKee-1 injection well		
	Volume injected (m ³)	Pressure (Bar)*	Injection rate (m ³ /hr)
Total	10,866		
Daily maximum	336	0	97
Daily average	123	0	55

* Well is in vacuum – no pressure required to inject waste.

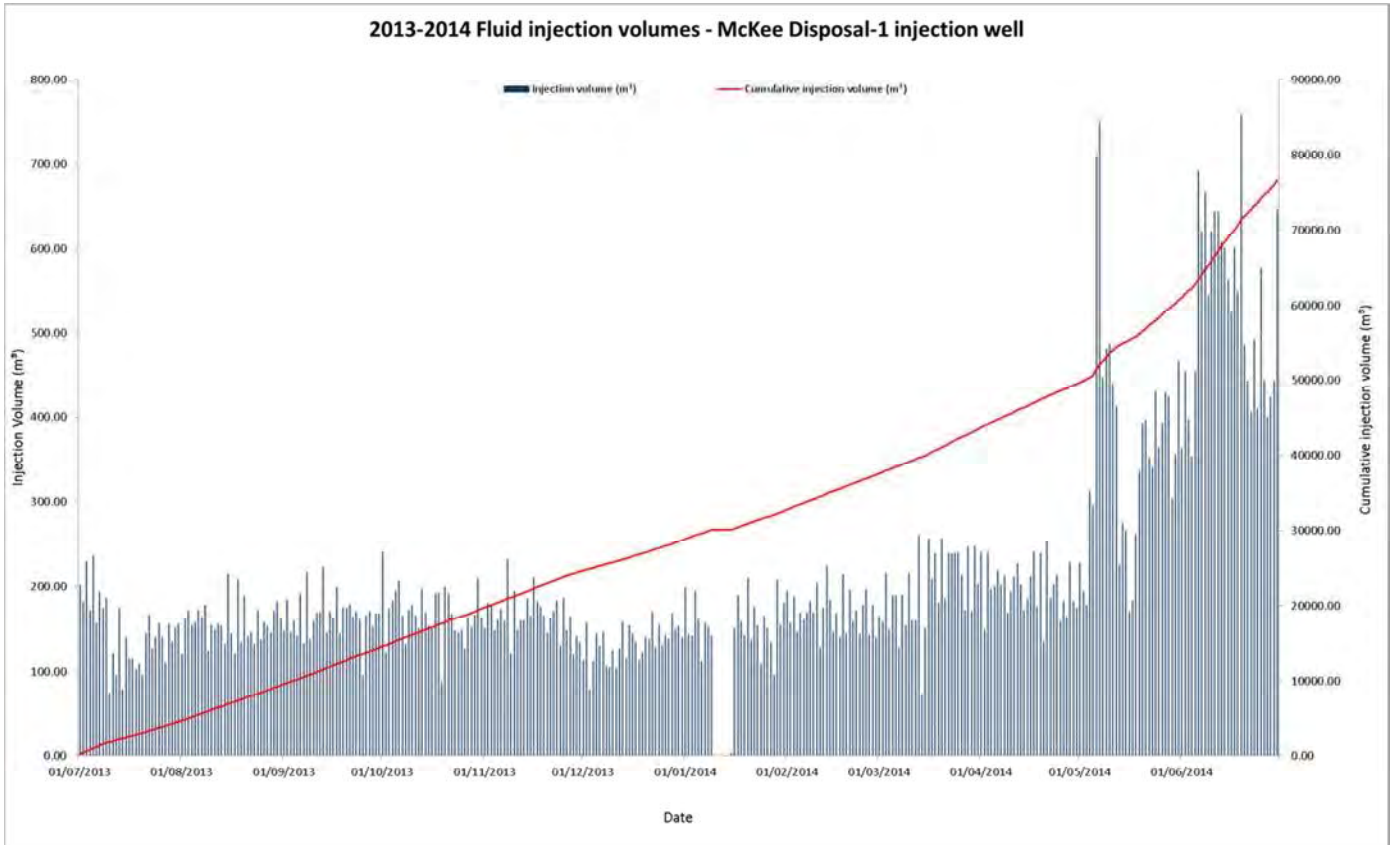


Figure 3 2013-2014 Fluid injection volumes - McKee Disposal-1 well (1315-1)

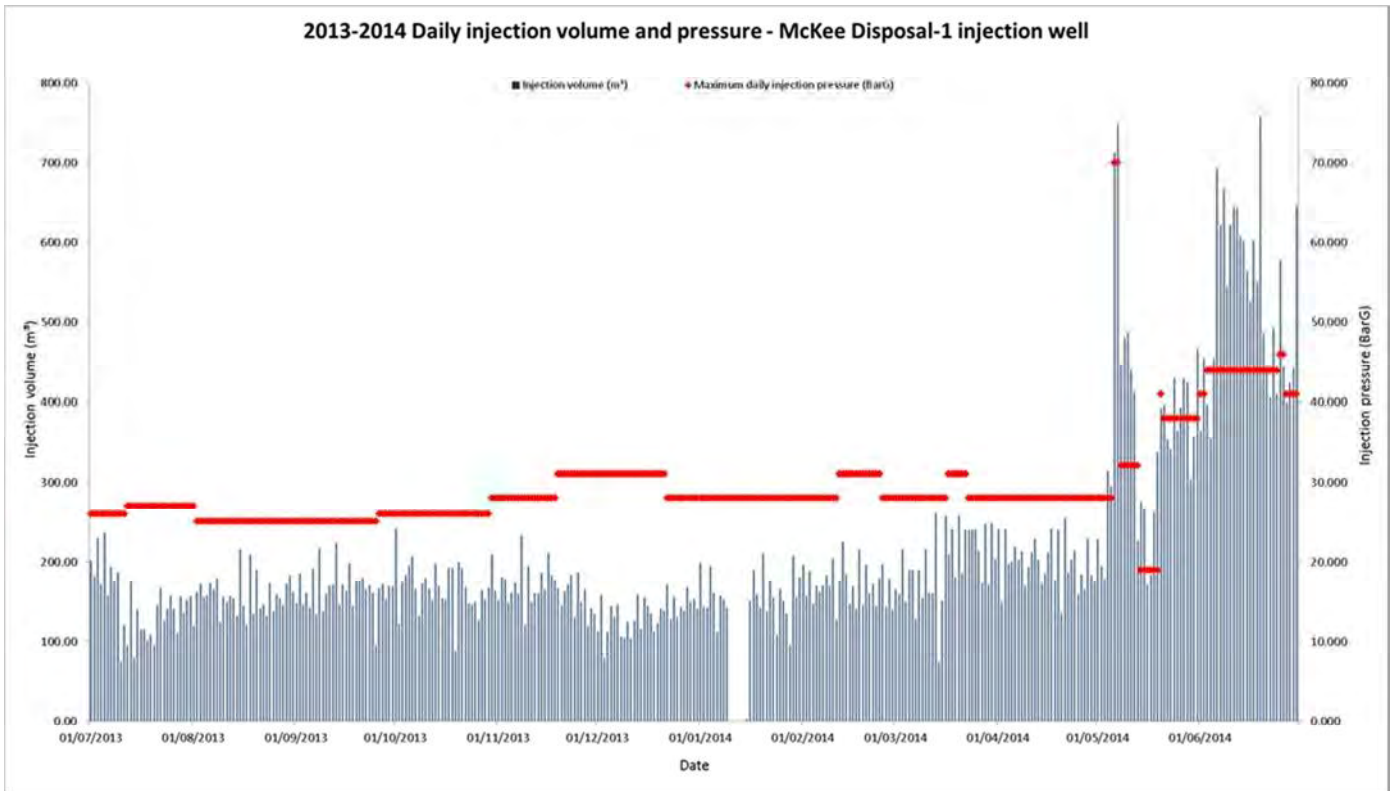


Figure 4 2013-2014 Daily injection volumes and pressures - McKee Disposal-1 well (1315-1)

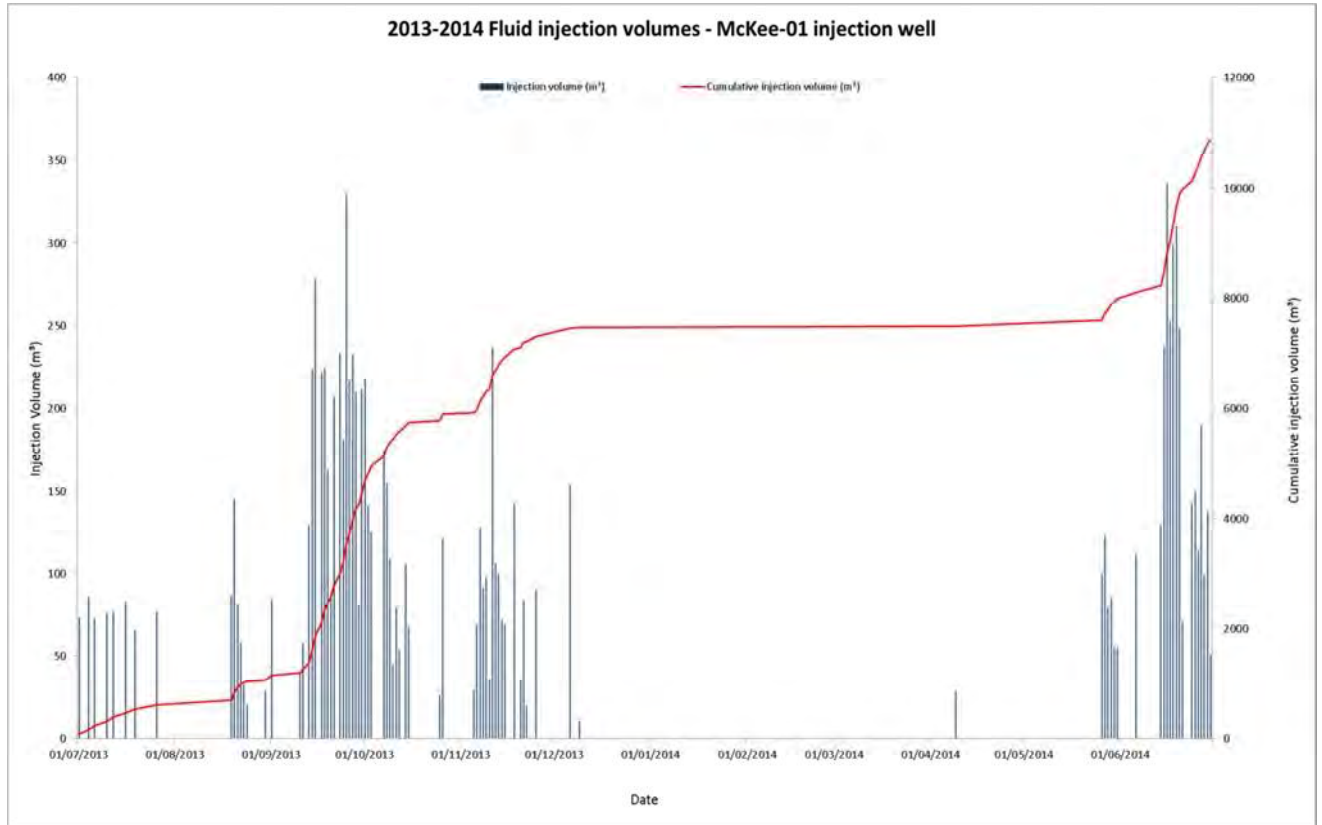


Figure 5 2013-2014 Fluid injection volumes - McKee-1 injection well (4182-2)

In addition to the Council's injectate sampling (Section 2.1), the Company also provided analytical results for samples of produced water injected via the McKee Disposal-1 and McKee-1 injection wells.

As presented in Table 6 and Table 7 below, the maximum and mean values associated with the results of these analyses illustrate the variability in the composition of injectate across the monitoring period.

The composition of the injectate varies depending on the origin and volume of fluids transferred from each individual source at the time of injection.

Table 7 Range of contaminants in McKee Disposal-1 injectate samples (2013-2014)

Parameter	Unit	Number of samples	Maximum value	Minimum value	Mean value
pH	pH units	4	7.8	7.6	7.7
Chloride	g/m ³	3	6,700	5,900	6,433
Alkalinity	g/m ³	3	3,500	3,200	3,367
Suspended solids	g/m ³	4	34	11	17
Total dissolved solids	g/m ³	3	15,300	14,000	14,633
Total petroleum hydrocarbons	ppm	1	1	1	1

Table 8 Range of contaminants McKee-1 injectate samples (2013-2014)

Parameter	Unit	Number of samples	Maximum value	Minimum value	Mean value
pH	pH units	6	7.6	6.7	7.1
Chloride	g/m ³	6	14,200	8,200	11,417
Alkalinity	g/m ³	5	2,100	1,280	1,542
Suspended solids	g/m ³	6	250	22	71
Total dissolved solids	g/m ³	6	37,000	19,300	23,883
Total petroleum hydrocarbons	ppm	1	8	8	8

3. Investigations, interventions and incidents

The monitoring programme for the period was based on what was considered to be an appropriate level of monitoring, review of data and liaison with the consent holder. During the monitoring period, matters may arise which require additional activity by the Council, for example provision of advice and information, investigation of potential or actual causes of non-compliance or failure to maintain best 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 and reported or 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 2013-2014 monitoring period, there were no incidents recorded by the Council associated with any of the Company's DWI consents.

4. Discussion

During the period under review, the Company exercised two resource consents for the injection of fluids by DWI. These consents licensed discharges of various forms of fluid into the Mount Messenger and McKee Formations, via the McKee Disposal-1 and McKee-1 injection wells. The main source of fluids for injection was produced water from the Company's Mangahewa and McKee fields.

The Company exercised consent 1315-1 for the entire course of the 2013-2014 monitoring period. During the period under review, a total of 30,239 m³ of fluid was injected under the consent, at an average of 210 m³/day. The average injection pressure was 29 bar, with a maximum pressure of 70 bar. The fluids were injected into the Mount Messenger Formation, via the McKee Disposal-1 injection well, at a depth between 1,267 and 1,350 m BGL.

Consent 1315-1 does not specify any limits on injection pressure or discharge volume.

During the 2013-2014 monitoring period, the Company also utilised consent 4182-2 for the disposal of fluid by DWI. The consent was exercised on an intermittent basis only. The fluids were injected into the McKee Formation, via the McKee-1 injection well, at a depth between 2,300 and 2,392 m BGL. During the period under review, a total of 10,866 m³ of fluid was injected under the consent, at an average of 123 m³/day. No pump pressure was required to inject fluids into the McKee Formation, as the McKee-1 well is in a state of vacuum which creates a suction effect.

Consent 4182-2 does not specify any limit for discharge volume. Special condition 5 specifies that injection pressure must remain below the pressure that would fracture the receiving formation. Since no pump pressure is required to inject waste via the McKee-1 well, it is very unlikely that fracturing would occur.

During the 2013-2014 period, consent holder performance was assessed on compliance with consent conditions, with a particular emphasis on record keeping requirements and information provision, and the analysis of the information and data provided. Compliance with the conditions of the DWI consents exercised during the 2013-2014 period is summarised below in Section 4.1.

For each of the wells used for DWI during the monitoring period, the consent holder has provided sufficient information regarding well construction and the injection zone to satisfy the relevant consent and monitoring programme information requirements.

Based on the assessment of the injection data submitted by the consent holder, there is no evidence to suggest that DWI activities at either of the Company's active injection sites has resulted in the vertical migration of contaminants outside of the intended injection interval.

If deemed necessary, the Council may request further information from the consent holder that illustrates that the wells being used for the injection of waste and the receiving formation remain secure.

No complaints were received from the public with regard to any of the Company's DWI activities during the period under review, and no incidents were recorded by the Council.

4.1 Discussion of site performance

During the period under review, the Company exercised DWI consents 1315-1 and 4182-2. A summary of the Company's level of compliance with the special conditions attached to consent 1315-1 is provided in Table 9, and consent 4182-2 in Table 10.

Table 9 Summary of Company performance with regard to consent 1315-1 (2013-2014)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
Consent 1315-1: To discharge fluid waste generated by oil and gas exploration and production activities to the Mount Messenger Formation by deep well injection at the Tuhua-B wellsite.		
1. Prior to exercising the consent, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan."	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.	Yes
3. No injection permitted after 1 June 2027.	Assessment of injection records and site inspection notices.	Yes
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 1200 metres below ground level.	Review of "Injection Operation Management Plan," well construction log and injection data.	Yes
6. The injection of fluids does not result in fracturing of geological seals confining the injection zone	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable freshwater (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 full records of injection data.	Receipt and assessment of injection data.	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
10. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
11. Ensure that the analysis required by 10 (c) is carried out in an International Accreditation New Zealand (IANZ) accredited laboratory	Assessment of injection data	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28 th 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 freshwater resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification.	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 consent compliance and administrative performance in respect of this consent		High

Table 10 Summary of Company performance with regard to consent 4182-2 (2013-2014)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
Consent 4182-2: To discharge fluid waste generated by oil and gas exploration and production activities to the McKee Formation by deep well injection at the McKee-A wellsite.		
1. Prior to exercising the consent, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan."	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.	Yes
3. No injection permitted after 1 June 2028.	Assessment of injection records and site inspection notices.	Yes
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 McKee Formation, deeper than 2,300 metres below ground level.	Review of "Injection Operation Management Plan," well construction log and injection data.	Yes
6. The injection of fluids does not result in fracturing of geological seals confining the injection zone	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
7. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable freshwater (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 full records of injection data.	Receipt and assessment of injection data.	Yes
10. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
11. Ensure that the analysis required by 10 (c) is carried out in an International Accreditation New Zealand (IANZ) accredited laboratory	Assessment of injection data	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28 th 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 freshwater resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification.	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 consent compliance and administrative performance in respect of this consent		High

Overall in 2013-2014, the Company achieved a **'high'** standard of environmental performance and a **'high'** standard of administrative performance with respect to consents 1315-1 and 4182-2. The criteria associated with a **'high'** level of environmental performance and a **'high'** level of administrative performance are outlined in Section 1.1.4 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.

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.

4.2 Environmental effects of exercise of discharge permit

The most significant potential adverse environment effect arising as a result of fluid injection is the contamination of freshwater aquifers. The protection of groundwater is fundamental to the protection of surface water and consequently, groundwater should be protected to the greatest extent practicable from serious or irreversible damage arising from human activity.

Well engineering technology, regional and local geologic characterisation, and site specific modelling are typically combined at the planning stage of a injection well to ensure that injected fluids are contained within the intended injection interval. This information is typically supplied to the Council when an application for consent to discharge fluids by DWI is lodged, and used to assess the potential for adverse environmental effects resulting from the proposed activity.

The DWI consents exercised during the period under review permit discharges into the Mount Messenger Formation via the McKee Disposal-1 well, and into the McKee Formation via the McKee-1 injection well.

Discharges to the Mount Messenger Formation via the McKee Disposal-1 well occur at depths in excess of 1,267 m BGL. The receiving formation is overlain by several hundred metres of low permeability strata, including the Urenui Formation. The Urenui Formation, comprised of impermeable siltstones and mudstones, forms an extensive aquitard (Stevens, 2001). The geological formations overlying the receiving formation provide extensive vertical isolation from shallow freshwater aquifers, and ensure that the injected fluids remain within the intended zone. At present all produced water from the McKee & Mangahewa Production Station is injected via the McKee Disposal-1 well.

Testing of McKee Disposal-1 well was carried out by the Company in January 2014. During the test, the tubing head pressure dropped below zero (negative pressure) indicating that the injection interval has not become over-pressured (no pressure increase), and remains suitable for continued injection via the well.

Discharges to the McKee Formation via the McKee-1 well occur at depths in excess of 2,300 m BGL. The McKee Formation is also overlain by a number of low permeability confining geological units, including, the Turi, Otaraoa, and Urenui Formations. These formations, due to their low permeability, act as confining layers and prevent the vertical migration of injected fluids from the injection zone.

Discharges from both injection wells occur at depths well below the freshwater/saltwater interface. The interface depth, based on logging information from McKee Formation wells, is estimated to occur within the Matemateaonga Formation, at a depth of approximately 125 m below sea-level in northern areas of the McKee Field to 275 m below sea-level in the south. The interface is therefore likely to be encountered between approximately 305 and 455 m BGL in the vicinity of the Tuhua-B wellsite and between 225 and 375 m BGL in the vicinity of the McKee-A wellsite. The injection via both the McKee disposal-1 and the McKee-1 wells are therefore both well below any potentially useable freshwater resource.

The natural geological characteristics of the strata overlying the injection intervals, the engineering of the injection wells, the planning and monitoring of injection activities, and their regulation, all contribute to minimise the potential for any adverse environmental effect resulting from DWI activities.

4.3 Recommendations from the previous monitoring report

In the 2012-2013 Annual Report, it was recommended:

1. THAT the range of monitoring carried out during the 2012-2013 period in relation to the Company's DWI activities be continued during the 2013-2014 monitoring period.

The recommendation was implemented in the 2013-2014 period.

2. THAT the Company ensures that injectate analysis is carried out for the full range of parameters, and at the required frequencies, as stipulated in the resource consents for active injection sites.

The recommendation was implemented in the 2013-2014 period.

3. THAT the Company installs a suitable groundwater monitoring well in the vicinity of active injection wells where there are no suitable existing groundwater monitoring sites available.

The Company installed a groundwater monitoring well in the vicinity of the McKee-A wellsite. Two existing sites suitable for sampling are located in the vicinity of the Tuhua-b wellsite.

4. THAT sampling of shallow groundwater in the vicinity of active injection wells be carried out on a biannual basis.

A single sample was obtained from each sampling location during the 2013-2014 monitoring period. Biannual sampling will begin during the 2014-2015 monitoring period.

5. 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.

There was no review of any other DWI consent held by the Company during the 2013-2014 period as it was deemed that the conditions of each consent were adequate to deal with the potential adverse effects of the activity.

4.4 Alterations to the monitoring programme for 2014-2015

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, the obligations of the RMA in terms of monitoring emissions/discharges and effects, and subsequently reporting to the regional community, 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 in the 2013-2014 period be continued in the 2014-2015 period. Groundwater samples will be obtained on a biannual basis. Recommendations to this effect are attached to this report.

4.5 Exercise of optional review of consents

Optional reviews of consents 1315-1, 5052-2 and 4182-2 are next provided for in June 2015.

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.

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

A recommendation to this effect is included in Section 5 of this report.

5. Recommendations

1. THAT the range of monitoring carried out during the 2013-2014 period in relation to the Company's DWI activities be continued during the 2014-2015 monitoring period.
2. THAT sampling of shallow groundwater in the vicinity of active injection wells be carried out on a biannual basis.
3. 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 are 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/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.
Freshwater/saline water 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 (“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.
m ³	Cubic metre.
MBGL	Metres below ground level.
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).
RMA	Resource Management Act 1991 and subsequent amendments.
TRC	Taranaki Regional Council (the Council).
TVD	True vertical depth.
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.

Bibliography and references

Taranaki Regional Council. 2011. Todd Energy Limited Deep Well Injection Monitoring Programme, Triennial Report, 2009-2012. Technical Report 2011-86. Document number 1108053.

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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. 2011. Todd Energy Limited Deep Well Injection Monitoring Programme, Triennial Report, 2009-2012. Technical Report 2011-86. Document number 1108053.

Appendix I

DWI consents exercised in 2013-2014 period

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

Name of
Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date
(Change): 1 October 2013

Commencement Date
(Change): 1 October 2013 (Granted: 24 June 2003)

Conditions of Consent

Consent Granted: To discharge fluid waste generated by oil and gas exploration and production activities to the Mckee Formation by deep well injection at the McKee-A wellsite

Expiry Date: 1 June 2033

Review Date(s): June Annually

Site Location: McKee-A wellsite, Otaraoa Road, Tikorangi

Legal Description: Pt Lot 6 DP 658 Blk XIV Waitara SD
(Discharge source & site)

Grid Reference (NZTM) 1715113E-5670963N

Catchment: Waitara

*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 January 2014, 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 January 2014, 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 2028.
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 injected fluids shall be confined to the McKee Formation, deeper than 2,300 metres 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.

Consent 4182-2

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 fluids may be discharged:
 - (a) produced water;
 - (b) well workover fluids, including hydraulic fracturing return fluids;
 - (c) well drilling fluids;
 - (d) production sludges;
 - (e) contaminated stormwater; and
 - (f) other fluids, that if discharged, will cause no greater environmental risk than those fluids listed above, and certified as such by the by the Chief Executive, Taranaki Regional Council.
9. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
10. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
 - (a) type of fluid (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 10(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.

11. If the analysis required by condition 10(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 10. 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 4182-2

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 designed to characterise local groundwater quality, and be submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 January 2014, and shall include:
- (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 m 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 0 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 0.

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 4182-2

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 15 November 2013

For and on behalf of
Taranaki Regional Council

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: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date
(Change): 1 October 2013

Commencement Date
(Change): 1 October 2013 (Granted: 8 August 1984)

Conditions of Consent

Consent Granted: To discharge fluid waste generated by oil and gas exploration and production activities to the Mount Messenger Formation by deep well injection at the Tuhua-B wellsite

Expiry Date: 1 June 2023

Review Date(s): June Annually

Site Location: Tuhua-B-wellsite, Otaraoa Road, Tikorangi, Waitara
(Property owner: HJ, JK & CJ Megaw)

Legal Description: Lot 3 DP 15159 Blk XI Waitara SD (Discharge source & site)

Grid Reference (NZTM) 1716911E-5675265N

Catchment: Onaero

Tributary: Pukemai

*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 January 2014, 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 January 2014, 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 2018.
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 injected fluids shall be confined to the Mount Messenger Formation, deeper than 1,200 metres 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 1315-1

8. Only the following fluids may be discharged:
 - (a) produced water;
 - (b) well workover fluids, including hydraulic fracturing return fluids;
 - (c) well drilling fluids;
 - (d) production sludges;
 - (e) contaminated stormwater; and
 - (f) other fluids that if discharged will cause no greater environmental risk than those fluids listed above, and certified as such by the by the Chief Executive, Taranaki Regional Council.

9. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.

10. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
 - (a) type of fluid (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 10(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.

11. If the analysis required by condition 10(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 10. 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 1315-1

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 designed to characterise local groundwater quality, and be submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 January 2014, and shall include:
- (a) the location of sampling sites;
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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 0 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 0.

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 1315-1

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 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

