

Todd Energy Limited  
Mangahewa-D Wellsite  
Monitoring Programme Report  
2013-2014

Technical Report 2014–54

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## Executive summary

Todd Energy Limited previously established a hydrocarbon exploration site located off Rimutauteka Road, Tikorangi, within the New Plymouth district, in the Waitara catchment. This wellsite was initially established for earlier exploration efforts, and has since had minor upgrades and boundaries extended to accommodate drilling and associated equipment. The site is call Mangahewa-D wellsite. This report covers the period from January 2013 to August 2014. During this period one well was drilled (MHW16), tested, hydraulically fractured and is now in production.

This report for Todd Energy Limited describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess Todd Energy Limited's environmental performance in relation to drilling operations at the Mangahewa-D wellsite during the period under review, and the results and environmental effects of Todd Energy Limited's activities.

**During the monitoring period, Todd Energy demonstrated a high level of environmental performance at the Mangahewa wellsite.**

Todd Energy Limited holds eight resource consents for the activities at the Mangahewa-D wellsite, which include a total of 123 consent conditions setting out the requirements that Todd Energy Limited must satisfy. Todd Energy Limited holds consent 7403-1 to take groundwater; consent 7404-1 to take water from the Manganui River; consent 7405-1 to discharge emissions to air associated with production activities; consent 7406-1 to discharge emissions to air associated with exploration activities; consent 7407-1 to discharge treated stormwater, treated produced water, treated surplus drill water and treated water collected from the flare pit into a manmade drain and then into an unnamed tributary of the Manganui River; consent 7408-1 to discharge stormwater and sediment from earthworks associated with wellsite construction onto and into land in the vicinity of an unnamed tributary of the Manganui River; consent 7410-1 to discharge solid drilling wastes from hydrocarbon exploration onto and into land via mix-bury cover; and consent 7912-1 to discharge contaminants associated with hydraulic fracturing activities into land.

The Council's monitoring programme for the period under review included 24 inspections of the site and surrounding environment, at approximately fortnightly intervals, 18 stormwater samples, two surface water samples, two groundwater samples, one hydraulic fracture fluid sample and one return fracture fluid sample. Analysis showed that all of the samples obtained were compliant. Furthermore, biomonitoring surveys were conducted prior to the commencement of and following the completion of hydraulic fracturing activities at the Mangahewa-D wellsite, which concluded that activities at the Mangahewa-D wellsite did not cause any impacts on the macroinvertebrate communities within an unnamed tributary of the Manganui Stream, as there was no change detected between the pre and post hydraulic fracturing activities biomonitoring surveys performed.

Todd Energy Limited notified the Council of its intention to combust gas at the Mangahewa-D wellsite on 10 February 2013, 24 April 2013, 14 May 2014 and 14 June 2014. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. Two complaints were received from nearby residents in relation to smoke issues arising from flaring activities at the Mangahewa-D wellsite. However, following inspections and further investigations these complaints could not be

substantiated, as no consent conditions were contravened. In addition, Todd Energy Limited were prompt to identify and resolve flaring issues according to on-site best practice. Furthermore, during routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the wellsite were observed. The drilling fluids and cuttings were disposed of at a consented off site facility.

In the period under review, two resource consent breaches were observed and recorded during routine monitoring inspections. On 7 June 2013 the second skimmer pit (located on the exploration side of the wellsite) was inspected and found to have failed due to external pressure on the lining via groundwater intrusion, causing the lining to balloon inwards and substantially decreasing the storage capacity of the pit. This contravened Section 15(1)(a) of the Resource Management Act and special conditions 5 and 8 of resource consent 7407-1. Abatement notice 12028 was issued. The skimmer pits were repaired and back to full operational and compliant capacity in due course. This was achieved by pumping out the groundwater that had collected behind the lining. The discharge pipe at the exit of the second pit was also elevated, which allowed for more storage capacity within the pit. On 14 February 2014 inspection found that drilling had commenced prior to the Council receiving the required 7 day notification, which contravened special condition 3 of resource consent 7407-1, and Infringement notice EAC-20226 was issued. Neither of these incidents has environmental consequences of any significance, but represented administrative non-compliance.

During the monitoring period, Todd Energy Limited demonstrated a high level of environmental performance, but compliance with the resource consents needs to be improved. The site was generally neat, tidy, and well maintained and site staff were cooperative with requests made by officers of the Council, with any required works being completed quickly and to a satisfactory standard.

This report includes recommendations for future drilling operations at this site.

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# **1. Introduction**

## **1.1 Compliance monitoring programme reports and the Resource Management Act 1991**

### **1.1.1 Introduction**

This report is for the period January 2013 to August 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Todd Energy Limited. During this period one well was drilled (MHW16), tested, hydraulically fractured and is now in production.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Todd Energy Limited that relate to exploration activities at Mangahewa-D wellsite located off Rimutauteka Road in the New Plymouth District.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of Todd Energy Limited's use of water, land, and air.

### **1.1.2 Structure of this report**

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consent held by Todd Energy Limited in the Waitara catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the Mangahewa-D wellsite during exploration activities.

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

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

Section 4 presents recommendations to be implemented during future drilling operations.

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

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

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

- (a) the neighbourhood or the wider community around 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 (eg, recreational, cultural, or aesthetic);
- (e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' in as much as is appropriate for each 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 Resource Management Act 1991, 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, including impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, to move closer to achieving sustainable development of the region's resources.

#### 1.1.4 Evaluation of environmental and consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder during the period under review, this report also assigns an overall rating. The categories used by the Council, 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 2012-2013 year, 35% 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 59% demonstrated a good level of environmental performance and compliance with their consents.

## 1.2 Process description

### Site description

Todd Energy Limited holds the 18 year Petroleum Mining Permit No. 38150 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 44.36 Km<sup>2</sup>. The Mangahewa-D wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Mangahewa-D wellsite is located approximately 9 km along Rimutauteka Road and approximately 5 km from Tikorangi, as per Figure 1. The Mangahewa-D wellsite was initially established for previous exploration efforts and has since had minor upgrades and boundaries extended to accommodate drilling and associated equipment. The establishment of the wellsite involved the removal of topsoil to create a firm level foundation on which to erect the drilling rig and house the associated equipment. Site establishment also involved the installation of:

- Wastewater control, treatment and disposal facilities;
- A system to collect and control stormwater and contaminants;
- A gas combustion system; and
- Other on-site facilities such as accommodation, parking and storage.

The nearest residence is approximately 640 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.



**Figure 1** Aerial view depicting the locality of the Mangahewa-D wellsite, with approximate regional location (inset)



**Figure 2** Aerial view of the original Mangahewa-D wellsite (left) and aerial view of the Mangahewa-D wellsite post boundary extension and facility upgrade (right)

### Well development

The process of drilling a well can take a few weeks to several months, depending on the depth of the well, the geology of the area, and whether the well is vertical or horizontal.

Drilling fluids, more commonly known as 'drilling muds', are required in the drilling process for a number of reasons, including:

- As a safety measure to ensure that any pressurized liquids encountered in the rock formation are contained;
- To transport drill cuttings to the surface;
- To cool and lubricate the drilling bit;
- To provide information to the drillers about what is happening down hole and the actual geology being drilled; and
- To maintain well pressure and lubricate the borehole wall to control cave-ins and wash-outs.

The well is drilled progressively using different sized drill bits. The width of the well is widest at the surface as smaller drill bits are used as the well gets deeper. Once each section of the well is drilled, a steel casing is installed. Cement is then pumped down the well to fill the annulus (the space between the steel casing and the surrounding country rock). This process is repeated until the target depth is reached, with each section of steel casing interlocked with the next.

Production tubing is then fitted within the steel casing to the target depth. A packer is fitted between the production tubing and casing to stop oil/gas/produced water from entering the annulus. The packer is pressure tested to ensure it is sealed.

The construction aspects that are most important for a leak-free well include the correct composition and quality of the cement used, the installation method, and the

setting time. The aim is to ensure that the cement binds tightly to the steel casing and the rock, and leaves no cavities through which liquids and gases could travel.

Once the well is sealed and tested the casing is perforated at the target depth, allowing fluids and gas to flow freely between the formation and the well.

### **Management of stormwater, wastewater and solid drilling waste**

The Mangahewa-D wellsite is located approximately 20 m to the north west of the nearest waterbody which is an unnamed tributary of the Manganui River.

Management systems were put in place to avoid any adverse effects on the surrounding environment from exploration and production activities on the wellsite. There are several sources of potential contamination from water and solid waste material which require appropriate management. These include:

- Stormwater from 'clean' areas of the site [e.g. parking areas] which run off during rainfall. There is potential that this runoff will pick up small amounts of hydrocarbons and silt due to the nature of the activities on-site;
- Stormwater which collects in the area surrounding the drilling platform and ancillary drilling equipment. This stormwater has a higher likelihood of contact with potential contaminants, particularly drilling mud;
- Produced water which flows from the producing formation and is separated from the gas and water phase at the surface; and
- Drill cuttings, mud and residual fluid which are separated from the liquid waste generated during drilling.

An important requirement of the site establishment is to ensure that the site is contoured so that all stormwater and any runoff from 'clean' areas of the site flow into perimeter drains. The drains direct stormwater into a skimmer pit system on-site consisting of two settling ponds. Any hydrocarbons present in the stormwater float to the surface and can be removed. The ponds also provide an opportunity for suspended sediment to settle. Treated stormwater is then discharged from the wellsite onto and into land, and consequently into an unnamed tributary in the Waitara catchment.

Drilling mud and cuttings brought to the surface during drilling operations are separated out using a shale shaker. The drilling mud and some of the water is then reused for the drilling process. Cuttings were collected in bins located at the base of the shaker and disposed of offsite at a consented facility.

### **Hydraulic fracturing**

In late 2012 the Parliamentary Commissioner for the Environment released an interim report on hydraulic fracturing within New Zealand. The purpose of this report is firstly to assess the environmental risks with hydraulic fracturing, and secondly to assess whether the policies, laws, regulations and institutions in New Zealand are adequate for managing these risks. The following discussion has been based upon this report.

The first known hydraulic fracturing operation was in 1989 at Petrocorp's Kaimiro-2 gas well in Taranaki. Since then, almost all of the hydraulic fracturing that has taken place in New Zealand has been done within the Taranaki region.

By the early 2000's New Zealand started exploring options for more unconventional ways of getting access to natural gas, and especially oil. These are considered to be more expensive than conventional drilling, but as the price of oil has risen and new technologies have been developed, these unconventional methods are growing.

The most common unconventional source of oil and gas in the Taranaki region has been extracting natural gas and oil from 'tight sands'. The boundary between tight sands and conventional reservoirs is ill-defined and generally based on whether the reservoir will have an economic production flow without hydraulic fracturing.

The process of hydraulic fracturing involves using a fracturing fluid, which is primarily water (typically made up of around 95-97% treated water). This fluid also contains various chemicals, including the three main components, which are:

- An inert proppant which keeps the induced fracture open when pumping is stopped, such as medium grained sand, or small ceramic pellets;
- A gelling substance to carry the proppant into the cracks; and
- A de-gelling substance to thin the gel to allow the fracturing fluid to return to the surface while leaving the proppant in the fractures.

The chemicals associated with the fracturing fluid are trucked to the site, stored in concentrated form, and mixed immediately before the hydraulic fracturing commences.

After the casing is perforated at the desired depth, the fracturing fluid is injected under high pressure into the well and is forced through the small holes into the rocks, creating cracks. This high downhole pressure is maintained for a brief period of time (approximately 1 hour) in order to exceed the fracture strength of the reservoir rock and cause artificial fractures.

Once a fracture has been initiated, the fracturing fluid and proppant are carried into the fracture. The placement of proppant in the fractures is assisted by the use of cross-linked gels. These are solutions, which are liquid at the surface but, when mixed, form long-chain polymer bonds and thus become gels that transport the proppant into the formation.

Once in the formation these gels 'break' back with time and temperature to a liquid state and are flowed back to surface as back flow without disturbing the proppant wedge, trapped in the hydraulic fracture. With continued flow, formation hydrocarbon fluids should be drawn into the fracture, through the perforations into the wellbore and to the surface.

### **Flaring from exploration activities**

It is possible that flaring may occur during the following activities:

- Well testing and clean-up;
- Production testing;



- Emergencies; and
- Maintenance and enhancement activities [well workovers].

## 1.3 Resource consents

### 1.3.1 Background

Todd Energy Limited holds eight resource consents related to activities at the Mangahewa-D wellsite site, as follows:

- Water Permit 7403-1; granted 19 November 2008,
- Water Permit 7404-1; granted 19 November 2008,
- Discharge Permit 7405-1; granted 5 February 2009,
- Discharge Permit 7406-1; granted 5 February 2009,
- Discharge Permit 7407-1; granted 28 November 2008,
- Discharge Permit 7408-1; granted 28 November 2008,
- Discharge Permit 7410-1; granted 5 February 2009 and
- Discharge Permit 7912-1; granted 9 September 2011,

Each of the consent applications were processed on a non-notified basis as Todd Energy Limited obtained the landowner approvals as an affected party, and the Council were satisfied that the environmental effects of the activity would be minor. The consents are discussed in further detail below.

Copies of the consents can be found within Appendix I of this report.

### 1.3.2 Water abstraction permit (groundwater)

Section 14 of the *Resource Management Act 1991* (RMA) stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

The Council determined that the application to take groundwater fell within Rule 49 of the Regional Freshwater Plan for Taranaki (RFP) as the rate and daily volume of the groundwater abstraction might exceed that of the permitted activity (Rule 48). Rule 49 provides for groundwater abstraction as a controlled activity, subject to two conditions:

- *The abstraction shall cause not more than a 10% lowering of static water-level by interference with any adjacent bore;*
- *The abstraction shall not cause the intrusion of saltwater into any fresh water aquifer.*

Any produced water will be from reserves far below that which is used for domestic or farm purposes. Shallow groundwater (which does not have any saltwater content) was protected by casing within the bore hole. Given these factors, the abstraction would not cause the above effects.

In granting the consent it was considered that the taking of groundwater was unlikely to have any adverse effect on the environment.



The Council was satisfied that the proposed activity would meet all the standards for a controlled activity. It was therefore obliged to grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Volume and rate of abstraction;
- Daily timing of abstraction;
- Effects on adjacent bores, the aquifer, river levels, wetlands and sea water intrusion;
- Fitting of equipment to regulate flows and to monitor water volumes, levels, flows and pressures;
- Payment of administrative charges;
- Monitoring and report requirements;
- Duration of consent; and
- Review of the conditions of consent and the timing and purpose of the review.

Todd Energy Limited holds water permit 7403-1 to take groundwater that may be encountered as produced water during exploration and production operations at the Mangahewa-D wellsite.

This permit was issued by the Council on 19 November 2008 under Section 87(d) of the RMA. It is due to expire on 1 June 2021.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed within Table 6, Section 3.3.

### **1.3.3 Water abstraction permit (surface water)**

Section 14 of the *Resource Management Act 1991* (RMA) stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

The Council determined that the application to take surface water fell within Rule 16 of the Regional Freshwater Plan for Taranaki (RFP) as the rate and daily volume of the groundwater abstraction might exceed that of the permitted activity (Rule 15). Rule 15 provides for surface water abstraction as a permitted activity, subject to the following conditions:

- *The rate of abstraction for anyone property described in a particular certificate of title shall not exceed 1.5 l/s; or 5 l/s for not more than 30 mins/day for temporary taking and use of surface water;*
- *The volume of extraction for any one property described in a particular certificate of title shall not exceed 50 m<sup>3</sup> in any one day;*
- *No more than 25% of the instantaneous flow, measured at the point of abstraction shall be taken.*

In granting the consent it was considered that the taking of surface water was unlikely to have any adverse effect on the environment.

The Council was satisfied that the proposed activity would meet all the standards for a discretionary activity. It was therefore obliged to grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Payment of administrative charges;
- Volume and rate of abstraction;
- Abstraction records;
- Implementation of the best practicable option; and
- Appropriate screen installation on intake structure.

Todd Energy Limited holds water permit 7404-1 to take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production activities at the Mangahewa-D wellsite.

This permit was issued by the Council on 19 November 2008 under Section 87(d) of the RMA. It is due to expire on 1 June 2021.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed within Table 7, Section 3.3.

#### **1.3.4 Air discharge permit (production activities)**

Section 15(1)(c) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Council determined that the application to discharge emissions to air associated with the production activities at the Mangahewa-D wellsite fell within Rule 11 of the RAQP.

The standard/term/condition of Rule 11 states that the:

- *Flare or incinerator point is a distance equal to or greater than 300 metres from any dwelling house.*

Todd Energy Limited holds air discharge permit 7405-1 to discharge emissions to air during flaring from well workovers and in emergency situations, and to discharge miscellaneous emissions associated with production activities at the Mangahewa-D wellsite.

This permit was issued by the Council on 5 February 2009 under Section 87(e) of the RMA. It is due to expire 1 June 2027.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 8, Section 3.3.

### **1.3.5 Air discharge permit (exploration activities)**

Section 15(1)(c) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Council determined that the application to discharge emissions to air associated with the exploration activities at the Mangahewa-D wellsite fell within Rule 9 of the Regional Air Quality Plan (RAQP).

The standard/term/conditions associated with Rule 9 are as follows:

- *Flare or incinerator point is at least 300 metres from any dwelling house;*
- *The discharge to air from the flare must not last longer than 15 days cumulatively, including of testing, clean-up, and completion stages of well development or work-over, per zone to be appraised; and*
- *No material to be flared or incinerated, other than those derived from or entrained in the well steam.*

Provided the activities were conducted in accordance with the applications and in compliance with the recommended special conditions, then no significant effects were anticipated.

Todd Energy Limited holds air discharge permit 7406-1 to discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stem testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite.

This permit was issued by the Council on 5 February 2009 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 9, Section 3.3.

### **1.3.6 Water discharge permit (treated stormwater and treated produced water)**

Section 15(1)(a) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

The Council determined that the application to discharge treated stormwater, treated produced water and surplus drill water fell within Rule 44 of the RFWP, which provides for a discharge as a discretionary activity.

The discharge of stormwater may result in contaminants (e.g. sediment, oil) entering surface water. These contaminants have the potential to smother or detrimentally

affect in-stream flora and fauna. On-site management of stormwater, as discussed in 1.2 above, is necessary to avoid/remedy any adverse effects on water quality.

Todd Energy Limited holds water discharge permit 7407-1 to discharge treated stormwater, produced water. Surplus drill water and water collected from the flare pit from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River.

This permit was issued by the Council on 28 November 2008 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed in Table 10, Section 3.3.

### **1.3.7 Water discharge permit (stormwater and sediment – earthworks)**

Section 15(1)(a) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

Council considered that the application fell under Rule 27 of the RFWP as a controlled activity (which may be non-notified without written approval), subject to one standard/term/condition to be met:

- *A site erosion and sediment control management plan shall be submitted to the Taranaki Regional Council.*

Todd Energy Limited supplied a site erosion and sediment control management plan in support of the application.

The Council was satisfied that the activity would meet all the standards for a controlled activity. It was therefore obliged to grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Approval of a site erosion and sediment control management plan and the matters contained therein;
- Setting of conditions relating to adverse effects on water quality and the values of the waterbody;
- Timing of works;
- Any measures necessary to reinstate the land following the completion of the activity;
- Monitoring and information requirements;
- Duration of consent;
- Review of conditions of consent and the timing and purpose of the review; and
- Payment of administrative charges and financial contributions.

Todd Energy Limited holds water discharge permit 7408-1 to discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D

wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment.

This permit was issued by the Council on 28 November 2008 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 11, Section 3.3.

### **1.3.8 Land discharge permit (mix-bury-cover)**

Sections 15(1)(b) and (d) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The discharge of contaminants associated with mix-bury cover, onto and into land where contaminants may reach water, is a discretionary activity under Rule 44 of the RFWP.

Todd Energy Limited holds discharge permit 7410-1 to discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury cover.

This permit was issued by the Council on 5 February 2009 under Section 87(e) of the RMA. It is due to expire on 1 June 2027. Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed in Table 12, Section 3.3.

### **1.3.9 Discharges to land (hydraulic fracturing)**

Sections 15(1)(b) and (d) of the *Resource Management Act 1991* (RMA) stipulate that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The discharge of contaminants associated with hydraulic fracturing, onto and into land where contaminants may reach water, is a discretionary activity under Rule 44 of the RFWP.

The rule is a “catch all” rule as there is currently no specific rule for the discharge of hydraulic fracturing contaminants. The rule is set out below:

*Discharge of contaminants onto or into land restricted by s15(1)(b) [where contaminants may reach water] and s15(1)(d) [where the discharge is from industrial or trade premises] of the Resource Management Act 1991 which is not expressly provided for in Rules 21-42 or which is provided for but does not meet the standards, terms or conditions and any other discharge of*

*contaminants to land which is provided for in Rules 21-42 but which does not meet the standards, terms or conditions of those rules [irrespective of whether the discharges are from industrial or trade premises or are likely to reach water].*

Provided the activities were to be conducted in accordance with the application and in compliance with the recommended special conditions, then no significant effects were anticipated.

Todd Energy Limited holds discharge permit 7912-1 to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3,325 mTVDSS (true vertical depth sub-surface), beneath the Mangahewa-D wellsite.

This permit was issued by the Council on 14 November 2012 under Section 87(e) of the RMA. It is due to expire on 1 June 2016.

Consent conditions were imposed on Todd Energy Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 13, Section 3.3.

## **1.4 Monitoring programme**

### **1.4.1 Introduction**

Section 35 of the *Resource Management Act 1991* (RMA) sets out obligation/s upon the Council to: gather information, monitor, and conduct research on the exercise of resource consent and the effects arising, within the Taranaki region and report upon these.

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

The monitoring programme for exploration well sites consists of seven primary components. They are:

- Programme liaison and management;
- Site inspections;
- Chemical sampling;
- Solid wastes monitoring;
- Air quality monitoring;
- Discharges to land (hydraulic fracturing and deep well injection); and
- Biomonitoring surveys.

The monitoring programme for the Mangahewa-D wellsite focused primarily on programme liaison and management, site inspections, chemical sampling, discharges to land and biomonitoring surveys. However, all seven components are discussed below.

### 1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

### 1.4.3 Site inspections

Inspection and examination of wellsites is a fundamental and effective means of monitoring and are undertaken to ensure that good environmental practices are adhered to and resource consent special conditions complied with.

The inspections are based on internationally recognised and endorsed wellsite monitoring best-practice checklists developed by the Alberta Energy Resources Conservation Board and the USEPA, adapted for local application.

The inspections also provide an opportunity for monitoring officers to liaise with staff about on-site operations, monitoring and supervision; discuss matters of concern; and resolve any issues in a quick and informal manner.

Inspections pay special attention to the ring drains, mud sumps, treatment by skimmer pits and the final discharge point from the skimmer pit on to land and then any potential receiving waters.

During each inspection the following are checked:

- Weather;
- Flow rate of surface waters in the general vicinity;
- Flow rate of water take;
- Whether pumping of water was occurring;
- General tidiness of site;
- Site layout;
- Ring drains;
- Hazardous substance bunds;
- Treatment by skimmer pits/sedimentation pits;
- Drilling mud;
- Drill cuttings;
- Mud pit capacity and quantity contained in pit;
- Sewage treatment and disposal;
- Cementing waste disposal;
- Surface works;
- Gas combustion systems, whether flaring was in progress, and if there was a likelihood of flaring, whether the Council had been advised;
- Discharges;
- Surface waters in the vicinity for effects on colour and clarity, aquatic life and odour;
- Site records;
- General observations; and
- Odour (a marker for any hydrocarbon and hazardous chemical contamination).

#### **1.4.4 Chemical sampling**

The Council may undertake sampling of discharges from site and from sites upstream and downstream of the discharge point to ensure that resource consent special conditions are complied with and to determine whether site activities were causing any adverse effects within the receiving environment.

#### **1.4.5 Solid wastes**

The Council monitors any disposal of drill cuttings on site via mix-bury cover to ensure compliance with resource consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

In recent times consent holders have opted to remove drilling waste from the site by contractor and dispose of it at licensed disposal areas (land farming), which are monitored separately.

#### **1.4.6 Air quality monitoring**

Air quality monitoring is carried out in association with the well testing and clean-up phase, where flaring can occur.

Assessments are made by Inspecting Officers of the Council during site inspections to ensure that operators undertake all practicable steps to mitigate any effects from flaring gas.

Inspecting Officers check that that plant equipment is working effectively, that there is the provision of liquid and solid separation, and that on site staff have regard to wind direction and speed at the time of flaring.

It is also a requirement that the Council and immediate land owners are notified prior to any gas being flared when practicable. This requirement was checked to ensure compliance with consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

#### **1.4.7 Discharges to land (hydraulic fracturing)**

Sampling and analysis of the hydraulic fracturing, return flow fluids and nearby bores were carried out during the period under review. In addition, inspections of the site and surrounding land and water were carried out to ensure that no observable effects had occurred as a result of the discharge to land. Pre and post hydraulic fracturing reports were submitted by the consent holder detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment.

#### **1.4.8 Biomonitoring surveys**

Biomonitoring surveys in any nearby streams may be carried out pre and post occupation of the wellsite to assess whether the activities carried out on site, and associated discharges have had any effect on ecosystems.



## **2. Results**

### **2.1 Water**

#### **2.1.1 Inspections**

The Mangahewa-D wellsite, adjacent land and streams were inspected 24 times during this monitoring period. Below is a copy of the comments that were noted on the day of each inspection.

##### **9 January 2013**

Well testing continued on-site. The site was tidy and clean. Spot cleaning of the site was being undertaken. A pilot flare was burning with no smoke visible. Skimmer pits were inspected and found not to be discharging at the time of inspection. Samples were obtained from the second pit of both the exploration and production site skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges (refer to Figure 3).

##### **21 January 2013**

Skimmer pits were inspected and found not to be discharging at the time of inspection. Samples were obtained from the second pit of both the exploration and production site skimmer pits.

##### **7 February 2013**

It was observed that works to construct the new flare pit were in progress. The bulk storage tanks had been repositioned and lined with plastic. Council officers were advised that the bund had been hydro-tested to ensure the bund was effective. The site had been spot cleaned with waste taken to a consented off-site facility. Skimmer pits were inspected and found not to be discharging at the time of inspection. Samples were obtained from the second pit of both the exploration and production site skimmer pits. No issues were raised at the time of inspection.

##### **1 March 2013**

Extended testing was in progress. Gas was being piped through to the McKee Production Station. Condensate and produced water was being trucked from the site. Small amounts of flaring was taking place on-site. The site appeared clean and tidy with ring drains in a good working order. Bunding around tanks also appeared in good condition. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges.

##### **27 March 2013**

Testing / production was in progress on-site. Oil and produced water was being trucked from the site, whilst gas was being exported from the site via pipelines. Inspection found that the site was in a clean and tidy condition with no sign of recent spills or possible pollutants on site. Ring drains were in a tidy condition. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits to ensure that the discharge would comply with resource consent conditions if a discharge occurred.

**3 May 2013**

No flaring was occurring at the time of inspection. The site was in a clean and tidy condition with one well being tested. Ring drains appeared in good working order directing all storm water to the skimmer pits. Skimmer pits were full but not discharging at the time of the inspection. A sample was obtained from the second skimmer pit to ensure that the discharge would comply with resource consent conditions if a discharge occurred.

**7 June 2013**

Extended testing / production activities were continuing on-site with construction activities of the production facilities anticipated to commence soon. The pilot flare was burning in the flare pit on-site. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges. Inspection also found that the second skimmer pit (of the exploration side of the wellsite) had failed due to external pressure on the lining, causing the lining to balloon inwards within the pit and greatly reducing the storage capacity. Possible cause may be groundwater pressure on the external lining of the pit. This contravened Section 15(1)(a) of the Resource Management Act and special conditions 5 and 8 of resource consent 7407-1. Abatement notice 12028 was issued.

**27 June 2013**

A site inspection was conducted in relation to Abatement notice 12028. Skimmer pits were inspected and were still in a workable order, however works were yet to be completed to comply with consent conditions. The outlet pipe for the second pit had been lifted, thus increasing the volume of the pit. The pit was lined however the groundwater was still causing the lining to balloon within the pit. Work to remedy this was expected to be completed in following days. No samples were obtained. Site inspection found that testing / production was continuing on-site with all gas being directed to the McKee Production Station. A pilot flare was also burning contained within the flare pit for safety purposes. Construction of production facilities was commencing on-site.

**28 June 2013**

A site inspection was conducted in relation to Abatement notice 12028. Inspection found that the skimmer pits had been repaired by pumping out the ground water that had collected behind the lining allowing the lining to fall back against the walls of the pit. The discharge pipe had also been lifted at the exit of the second pit. This allowed for more containment within the pit so that the extra hydrostatic pressure from within the pit would prevent groundwater from collecting behind the lining again. At time of inspection the Abatement notice was being complied with.

**29 January 2014**

Contractors were on-site remediating old skimmer pits. Activities occurring included the completion of the exit goose neck pipe. Perimeter drains feeding to the new skimmer pit location was anticipated to be completed within the coming week. Sediment controls implemented until the 'V' drains were to be completed included a settling pond with silt cloth prior to surface water entering a scruffy dome. Flare liner works were being carried out to link the flare chamber which was to be situated on

the other side of the pad; it was outlined that a change in consent conditions may be required. However, consents were compliant at time of inspection.

#### **14 February 2014**

At time of inspection drilling was continuing on-site. Water based muds were being used with drilling at approximately 1500m TVD. Drilling had commenced prior to the Council receiving the required 7 day notification, which contravened special condition 3 of consent 7407-1 and Infringement notice EAC-20226 was issued. The flare pit was inspected and found to be containing water. This water was being used on-site for drilling activities. Adequate free board remained within the pit to handle any rainfall event in the near future. Chemicals were stored on-site in a clean and tidy manner with no sign of spills. Area about the mud and cuttings tank was found to be clean and tidy. Ring-drains were inspected and found that works were required to ensure that all stormwater collected on-site was directed to the skimmer pits via an appropriately constructed ring-drain system. It was outlined to site staff to ensure that the ring-drain running along the front of the flare pit towards the skimmer pits was repaired as recent earthworks to install flare lines from the rig to the flare pit meant that the drain was less effective than desired. Also site staff were instructed to carry out works to a portion of drain behind the camp near the emergency exit gate in the boundary fence, to ensure that stormwater was contained at this point. It may simply involve building up the outer wall of the ring drain along a small portion prior to the stormwater entering the culvert installed under the track leading to the emergency exit.

#### **25 February 2014**

Drilling was continuing on site. Inspection found that the ring drains in place about the site appeared appropriate, however it was recommended that they were inspected by staff on-site during a period of wet weather to ensure that they were working appropriately and directing all storm water to the skimmer pits without pooling or ponding. Skimmer pits were inspected and found to be empty hence no samples were taken. The flare pit was inspected and found to be clean. The chemical store and area about the mud tanks were both clean and tidy with no sign of spills in the vicinity. It appeared that a spill had occurred previously from the septic tanks. At the time of inspection a small leak in a join leading to the septic tanks was observed. This was raised with on-site staff who agreed to rectify the issue.

#### **13 March 2014**

Drilling was continuing on-site. The site was found to be clean and tidy. All ring-drains were found to be in a good working order, however, it was advised that the ring-drains should be inspected during anticipated heavy rainfall events. Chemical stores, cementing equipment and cuttings tank areas were all inspected and found to be clean and tidy. Any spills about the cuttings tank were found to have been cleaned immediately. The flare pit was inspected. No flaring had occurred during the drilling operation. The flare pit was inspected and found to have stormwater collected within the lined pit, which had previously been tested and used to make drilling muds. There was sufficient storage within the lined pit to hold and contain any further stormwater. Skimmer pits on-site remained empty. The site was well managed and compliant with resource consent conditions at time of inspection.

**20 March 2014**

Inspection found that drilling was continuing on-site. Total depth had been obtained and the well was being logged at the time of inspection. It was anticipated that casing and cementing of the bottom hole would be carried out in the coming week.

Inspection found that all ring-drains were in a good working order, with all stormwater being directed to the skimmer pits. Skimmer pits were inspected and although some stormwater was present in the first pit, the second pit remained empty. Due to the total volume of the skimmer pits and the small amount of stormwater in the base of the first pit (approximately 0.5m) no samples were taken. The receiving environment was inspected and the farm drain was found to be dry with grass growing in the base. No discharge had yet occurred from the skimmer pits during the drilling operation. The pit was inspected and found to contain some stormwater in its base. Flaring had not occurred on-site in conjunction with the drilling operation. The area about the chemical storage containers was clean and free of any spills. A small spill of drilling mud was observed between the mud tanks and the rig. Sawdust had been placed on the spill to soak up the liquid portion of the spill. Discussions were held with on-site staff and it was arranged for the spill to be cleaned up. There was no indication that this spill had tracked across the ground. The bunds about the pumps and machinery on-site contained water as a result of recent rain. There was little storage capacity remaining within the impermeable secondary spills containments. Site staff were advised of this and had agreed to remove the stormwater. In general the site was found to be well managed with appropriate measures in place to protect the surrounding environment.

**31 March 2014**

Inspection found that drilling at the site had been completed and the rig was being dis-assembled and transported to the Mangahewa-E wellsite in Tikorangi. Some chemicals remained on-site; however they were stored within a lockable container. Cranes were on-site as part of the rig move operation. No flaring had occurred as part of the drilling operation. The blow out preventer had been removed from the well and the well was shut in. The ring-drains were inspected and found to be in a good operational order. Skimmer pits remained relatively empty. No discharge from the skimmer pits had occurred during the drilling operation due to the extended period of fine weather. No samples were taken at the time of inspection. Following the removal of the drilling rig from site, the metallised area was to be scraped clean with fresh metal replaced on-site. Well testing activities would then be undertaken. No issues were noted at the time of inspection.

**15 April 2014**

The testing phase of the well had commenced on-site, infrastructure was being installed to allow flow testing of two wells. A new one million litre holding tank had been installed on site. Discussions were held with on-site staff regarding the ring drain and pad area next to the skimmer pits, a remediation plan was in place to re-contour the 'V' drains and remove some of the loose sediment once the flare line tie-in was complete, otherwise the site was clean and tidy. The second skimmer pit was approximately 1/5 full, it was likely the rig may have pumped from here when last on-site. Consequently the pits were not likely to discharge imminently. No sample was obtained.

**1 May 2014**

At time of inspection all equipment in relation to the recent drilling operation had been removed. Equipment was on-site in relation to the work-over of a previously drilled well on-site. Activity was being undertaken in relation to this work-over. Testing equipment had also been set up on-site to test the well following the completion of the workover. Condensate and produced water tanks had been set up on-site within a bunded area. Chemicals were beginning to be imported onto site for the pending hydraulic fracturing programme. Some liquid chemicals were being stored within a steel container with an internal bund. Other non-hazardous chemicals were on-site with further bunding/ drip trays arranged to arrive that day for appropriate storage. Earthworks were being undertaken to re-establish the ring drain along the edge of the site adjacent to the flare pit. It was advised to consider placing some silt and sediment controls below the earth-worked section to treat any stormwater from this area of the site prior to entry into the skimmer pit treatment system. Discussions were held with on-site staff regarding blocking a drain that led from the ring drain around the top end of the skimmer pits. The gradient of the drains may have prevented stormwater flowing off-site via this path; however some soil in the top end of the tie-in drain would ensure that this did not occur. The skimmer pits were inspected and found not to be discharging. A sample was obtained from the second pit of the exploration site skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges. The pits appeared very turbid in colour indicating the presence of suspended solids within the pits. The discharge point and receiving waters were inspected. The receiving waters were found to be running clean and clear. No sign of suspended solids within the receiving waters were noted at the time of the inspection. Ground water samples were obtained from the bore recently drilled on-site to provide background readings prior to the commencement of the hydraulic fracturing programme.

**16 May 2014**

Inspection found that one zone of the Mangahewa-16 (MHW16) well had been hydraulically fractured. A delay had been encountered in bringing a coil-tubing unit to site, resulting in a halt of hydraulic fracturing activities. It was anticipated that hydraulic fracturing activities were to recommence during the following week. Fracturing equipment remained set up on-site. Inspection found that all chemicals were stored within or above designated bunding systems. All liquid chemicals were stored appropriately with lids in place. Dry chemicals were being stored out of the weather. The flare pit was inspected and found to contain water. No flaring was occurring at the time of inspection and no flaring had yet occurred on-site in relation to the fracturing programme for the MHW16 well. Ring drains were in place and silt and sediment retention devices within the drains near the entry to the skimmer pits appeared to be working well retaining a reasonable quantity of silt. Skimmer pits were inspected and were found to be full but not discharging. A sample was obtained from the second pit of the exploration site skimmer pits to ensure compliance with resource consent conditions should a discharge have occurred. Receiving waters were visually inspected and found to be flowing clean and clear.

**29 May 2014**

Inspection was conducted with regards to the hydraulic fracturing activities of MHW16. The site was very active with wire coil tubing and HF equipment on-site. All chemical areas on-site were correctly bunded or stored in such a manner that any potential spills were contained within a sump. The site appeared clean and tidy, yet

some ponding on the pad was to be addressed when heavy equipment had left the site and conductors had been installed. Skimmer pits were not discharging at time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits. Receiving water were visually inspected and no impact from recent discharges. It was outlined to site staff that a small diesel spill was to be addressed so contaminant did not reach the ring drain and a small settling area prior to storm water entry to the skimmer pits was to be either filled in or lined with an impervious material. Consents were compliant at time of inspection.

#### **4 June 2014**

Inspection was conducted post hydraulic fracturing. Contractors were on-site completing a well clean via coil tubing. The small diesel spill identified during the previous inspection had since been cleaned up, as had the settling area prior to stormwater entering skimmer pits which had been filled in. The site appeared clean and tidy with all chemicals correctly bunded and covered. Skimmer pits were inspected and found to be discharging. Samples were obtained of the discharge, as were two downstream samples. No upstream sample was obtained as no flow was found. Consents were compliant at time of inspection.

#### **4 July 2014**

At the time of inspection the wells were shut in while associated equipment was being demobilised. The site appeared clean and tidy with no signs of spills. The perimeter drain at the entrance to the site was ponding and surface water was not being directed to the skimmer pits. Site staff were advised that the ponding about areas of the pad, ring-drain and by the clip tank at the rear of the site were to be addressed prior to the rig returning to site, and that priority was to be placed on the ring-drain at the entrance to the site. Skimmer pits were not discharging at time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits. An inspection of the flare pit showed no hydrocarbon sheen present on the surface of the water present within the pit.

#### **9 July 2014**

At the time of inspection the exploration area of the site was virtually empty aside from tank bunds, vertical tanks and portacombs. The vertical tanks were in the process of being cleaned and removed. Inspection was conducted of the proposed piped section of ring drain and pad extension area. Skimmer pits were not discharging at time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits. The receiving water were visually inspected and showed no impact from recent discharges. It was outlined to staff that interim silt controls were to be implemented until the site re-grading and perimeter drain upgrades were carried out.

#### **18 July 2014**

Contractors were on-site installing conductors for the next drilling campaign. The tank bund was in the process of deconstruction, the water contained within the bund was released to skimmer pits and the remaining fluids were to be removed via truck. The lower pad buried pipes had been pulled up to allow conductors to be placed. The site still required works to improve ring drains and re-grade the pad, however were on-site assessing these aspects during inspection. Skimmer pits were not discharging at time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits. Consents were compliant during inspection.

## 28 August 2014

Contractors were on-site to commence laying buried pipes to the new drilling platform and continue levelling the new drilling pad. The northern section of perimeter drain had been piped to a cellar next to the skimmer pits, a section of the eastern perimeter drain (adjacent to the flare pit) had also been piped to this cellar. It was outlined to site staff that the base of the cellar was required to have an impervious lining as a dead store of approximately 500 mm existed. No surface drains had yet been implemented to divert surface water from the pad area (where perimeter drains had been piped) to the skimmer pit system. Perimeter drain works were still required in the section adjacent to the security hut and production area. Skimmer pits were not discharging at time of inspection. A sample was obtained from the second pit of the exploration site skimmer pits. Receiving waters were visually inspected and no areas of concern were observed. Consents were compliant at time of inspection.

### 2.1.2 Results of discharge monitoring

During the period under review a total of 18 stormwater samples were obtained. Stormwater was not observed discharging from the skimmer pits located on the production section of the wellsite; however, three samples were obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges. Stormwater was observed discharging from the skimmer pits located on the exploration section of the wellsite on one occasion; one sample was obtained in conjunction with this. The remaining 14 stormwater samples were obtained from the second skimmer pit located on the exploration section of the wellsite to ensure compliance with consent conditions in anticipation of potential discharges.

Analysis of the samples obtained showed that all but four of the discharges would have complied with resource consent conditions should a discharge have occurred. Results are detailed in Table 1 and sampling locations can be seen in Figure 3.



**Figure 3** Aerial view of the Mangahewa-D wellsite highlighting the approximate extents of the original (exploration) and new (production) sections of the wellsite, in addition to the localities of the skimmer pits.

**Table 1** Results of stormwater samples obtained from the Mangahewa-D wellsite during the monitoring period

Date	Chloride <i>g/m<sup>3</sup></i>	Hydrocarbons <i>g/m<sup>3</sup></i>	pH <i>pH</i>	Suspended solids <i>g/m<sup>3</sup></i>	Sampling location
09 Jan 2013	6.2	<0.5	9.2	10	Exploration skimmer pits
09 Jan 2013	3.8	<0.5	8.2	6	Production skimmer pits
21 Jan 2013	5.6	<0.5	9.3	19	Exploration skimmer pits
21 Jan 2013	4.0	<0.5	9.1	12	Production skimmer pits
07 Feb 2013	4.8	0.6	7.0	23	Exploration skimmer pits
07 Feb 2013	3.7	<0.5	7.7	34	Production skimmer pits
01 Mar 2013	5.2	<0.5	9.0	18	Exploration skimmer pits
27 Mar 2013	5.9	0.5	7.1	15	Exploration skimmer pits
03 May 2013	4.0	<0.5	6.9	13	Exploration skimmer pits
07 Jun 2013	1.7	9.0	6.8	69	Exploration skimmer pits
01 May 2014	4.5	4.6	6.8	140	Exploration skimmer pits
16 May 2014	10.1	<0.5	6.7	45	Exploration skimmer pits
29 May 2014	14.6	<0.5	7.0	32	Exploration skimmer pits
04 Jun 2014	29.8	<0.5	7.1	3	Exploration pit discharge
04 Jul 2014	6.9	1.9	7.0	54	Exploration skimmer pits
09 Jul 2014	8.1	<0.5	7.1	28	Exploration skimmer pits
18 Jul 2014	4.0	<0.5	6.8	41	Exploration skimmer pits
28 Aug 2014	10.8	<0.5	7.1	20	Exploration skimmer pits

During the month of January 2013 three samples obtained returned elevated pH levels. Upon investigation it was considered that this was due to photosynthetic activity of algae growing in the skimmer pit under hot, sunny and dry conditions, rather than any chemical source. It was considered by Council officers that should enough rain fall to cause a discharge, the pH would fall to well within consent limits prior to any discharge occurring.

A sample obtained on 1 May 2014 returned elevated levels of suspended solids (140 g/m<sup>3</sup>). Although this value exceeds condition 13 (100 g/m<sup>3</sup>) of consent 7407-1, no actual non-compliances occurred as this sample was obtained from the skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges. No discharges containing elevated levels of suspended solids were found to have been released from the skimmer pits into the receiving environment.

All sewage was directed for treatment through a septic tank system and removed by contractor to a licensed disposal facility.

### 2.1.3 Results of receiving environment monitoring

During the period under review, one sample was obtained in conjunction with the stormwater discharge on 4 June 2014 from an unnamed tributary of the Manganui River. In addition, another sample was also obtained from an unnamed tributary of the Waitara River in relation to the hydraulic fracturing activities of well MHW16. No exceedences were recorded in relation to consent 7407-1. Results are detailed in Table 2 and sampling locations can be seen in Figure 4.



**Table 2** Results of surface water samples obtained during the monitoring period under review

Parameter	Unit	Downstream of skimmer pit discharge	Post fracturing surface water sample
Chloride	g/m <sup>3</sup>	27.0	9.68
Hydrocarbons	g/m <sup>3</sup>	<0.5	<0.5
pH	pH	7.2	7.2
Suspended solids	g/m <sup>3</sup>	9	4

**Figure 4** Surface water sampling locations during the period under review

The receiving surface water body was inspected regularly in conjunction with site inspections. No effects were observed and the stream appeared clear with no visual change in colour or clarity. In addition, no odour, oil, grease films, scum, foam or suspended solids were observed in the stream as a result of activities at the Mangahewa-D wellsite during the monitoring period.

## 2.2 Air

### 2.2.1 Inspections

Air quality monitoring inspections were carried out in conjunction with general compliance monitoring inspections. See Section 2.1.1 for comments concerning site inspections.

### 2.2.2 Results of discharge monitoring

Todd Energy Limited notified the Council of its intention to combust gas at the Mangahewa-D wellsite on 10 February 2013, 24 April 2013, 14 May 2014 and 14 June 2014. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. During this time a flare pit was largely employed for the combustion of gas and to maintain a pilot flare for emergency gas combustion / depressurisation.

Two complaints were received from nearby residents in relation to smoke issues arising from flaring activities at the Mangahewa-D wellsite. However, following further inspections and investigations these complaints could not be substantiated, as no consent conditions were contravened. It was found that on 18 June 2014 the black smoke events were a result of inadequate oxygen entering the flare pit. This lack of oxygen was attributed to the high volume of gas being directed to the flare pit. Todd Energy Limited confirmed that complete separation of liquids out of the flare gas flow was occurring at the surface during these combustion periods. A small pump was being utilised on-site for flame suppression by water spray, however this was too small and so a larger pump was subsequently implemented at site. Furthermore, Todd Energy Limited avoided directing such large volumes of gas to the flare pit to prevent a similar situation from occurring again.

During routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the Mangahewa-D wellsite were observed. From observations during site inspections, including the inspection of the flare log maintained by Todd Energy Limited, it appeared that special conditions relating to the control of emissions to air from the combustion of hydrocarbons were complied with, other than as noted above.

### **2.2.3 Results of receiving environment monitoring**

No chemical monitoring of air quality was undertaken during the testing phase of the Mangahewa-D wellsite as gas combustion activities were minimal and the controls implemented by Todd Energy Limited did not give rise to any concerns with regard to air quality.

### **2.2.4 Other ambient monitoring**

No other ambient air sampling was undertaken, as the controls implemented by Todd Energy Limited did not give rise to any concerns with regard to air quality.

## **2.3 Land**

### **2.3.1 Inspections**

Land monitoring inspections were carried out in conjunction with general compliance monitoring inspections. See Section 2.1.1 for comments concerning site inspections.

### **2.3.2 Results of discharge and receiving environment monitoring (hydraulic fracturing)**

Todd Energy Limited notified the Council of the proposed hydraulic fracturing discharge operations for well MHW16. The Council developed the Mangahewa-D wellsite Groundwater Monitoring Programme in consultation with Todd Energy Limited. This monitoring programme included one sampling location which was purpose built in relation to the recent hydraulic fracturing stimulation of well MHW16. The site selected is designed to provide a sample set representative of groundwater abstractions in the area surrounding the site. Table 3 outlines the

details of the site selected for inclusion in the programme. Figure 5 shows the sampling site in relation to the wellsite.

**Table 3** Mangahewa-D wellsite associated groundwater monitoring bore details

Site No.	Easting (m)	Northing (m)
GND2459	1711104	5673532



**Figure 5** Aerial photo depicting the locality of the Mangahewa-D wellsite and associated groundwater monitoring bore

The monitoring programme provides for an initial 12 months of groundwater monitoring. Groundwater samples will be obtained from the sampling site recorded in Table 3 at the following specified intervals:

- Pre-hydraulic fracturing (baseline sample); and
- Three months after initial hydraulic fracturing event.

When hydraulic fracturing activities are completed at the wellsite, a minimum of one sample is then obtained on an annual basis.

The original wellsite groundwater monitoring programmes involved the analysis for certain parameters. However, the range of parameters being analysed for has evolved since the first consent for hydraulic fracturing was issued. Therefore, the groundwater monitoring programme was subsequently revised and approved by the Chief Executive of the Council. As such, the Council decided the Mangahewa-D wellsite groundwater monitoring programme should follow the latest range. The revised parameters that were analysed are as follows:

- pH;
- Conductivity;

- Major ions (Ca, Mg, K, Na, total alkalinity, bromide, chloride, nitrate-nitrogen, and sulphate);
- Trace metals (barium, copper, iron, manganese, nickel and zinc);
- Total petroleum hydrocarbons;
- Formaldehyde;
- Dissolved methane and ethane gas;
- Methanol;
- Glycols;
- Benzene, toluene, ethylbenzene, and xylenes (BTEX); and
- Carbon-13 composition of any dissolved methane gas discovered ( $^{13}\text{C-CH}_4$ ).

In order to assess whether the discharge of fracturing fluids had contaminated or put at risk usable freshwater aquifers above the stated point of discharge, groundwater samples were taken as per the monitoring programme outlined above.

The results of the groundwater monitoring programme are detailed in Table 4.

**Table 4** Pre and post hydraulic fracturing results obtained from groundwater monitoring bore GND2459

Parameter	Unit	Pre-frac 1 May 2014	Post-frac 26 August 2014
Alkalinity (total)	g/m <sup>3</sup> CaCO <sub>3</sub>	99	112
Barium	mg/kg	0.024	0.0172
Benzene	g/m <sup>3</sup>	<0.0010	<0.0010
Bicarbonate	g/m <sup>3</sup> HCO <sub>3</sub>	120.8	137
Bromine (dissolved)	g/m <sup>3</sup>	0.059	0.050
Calcium	g/m <sup>3</sup>	13.0	10.1
Chloride	g/m <sup>3</sup>	12.8	12.7
Conductivity	mS/m@20C	23.1	25.2
Copper (dissolved)	g/m <sup>3</sup>	0.0023	0.0014
Dissolved oxygen	g/m <sup>3</sup>	-	0.01
Ethane	g/m <sup>3</sup>	<0.003	0.005
Ethylbenzene	g/m <sup>3</sup>	<0.0010	<0.0010
Ethylene	g/m <sup>3</sup>	<0.003	<0.003
Ethylene glycol	g/m <sup>3</sup>	<4	<4
Formaldehyde	g/m <sup>3</sup>	<0.02	0.03
Hardness (total)	g/m <sup>3</sup> CaCO <sub>3</sub>	54	45
Hydrocarbons	g/m <sup>3</sup>	<0.7	<0.7
Iron (dissolved)	g/m <sup>3</sup>	2.5	2.5
Manganese (dissolved)	g/m <sup>3</sup>	0.191	0.24
Magnesium	g/m <sup>3</sup>	5.2	4.7
Mercury (dissolved)	g/m <sup>3</sup>	<0.00008	<0.00008
Methane	g/m <sup>3</sup>	0.46	13.7
Methanol	g/m <sup>3</sup>	<2	<2
Nickel	mg/kg	0.0008	0.0005
Nitrate nitrogen	g/m <sup>3</sup> N	0.003	<0.002
Nitrite/nitrate nitrogen	g/m <sup>3</sup> N	0.044	<0.002
Nitrite nitrogen	g/m <sup>3</sup> N	0.041	<0.002

Parameter	Unit	Pre-frac 1 May 2014	Post-frac 26 August 2014
pH	pH	7.4	7.3
Potassium	g/m <sup>3</sup>	5.5	5.3
Propylene glycol	g/m <sup>3</sup>	<4	<4
Sodium	g/m <sup>3</sup>	24	37
Sulphate	g/m <sup>3</sup>	1.2	<0.5
Sum of Anions	meq/l	2.4	2.6
Sum of Cations	meq/l	2.4	2.8
Temperature	Deg.C	12.3	14.6
Toluene	g/m <sup>3</sup>	<0.0010	0.0070
Total dissolved solids	g/m <sup>3</sup>	145	179
meta-Xylene	g/m <sup>3</sup>	<0.002	<0.002
ortho-Xylene	g/m <sup>3</sup>	<0.0010	<0.0010
Zinc (dissolved)	g/m <sup>3</sup>	0.040	1.98

The results in Table 4 show parameters that are all within the typical range for background Taranaki shallow groundwater. It is considered that the slight variations seen between samples are not a result of hydraulic fracturing operations, but are natural variances in groundwater between sites and as seasons change. No levels or changes in levels are of any environmental significance.

In conjunction with the groundwater monitoring programme, prior to the initial hydraulic fracturing process of well MHW16 at the Mangahewa-D wellsite, a sample of the fracture fluid was obtained. Once hydraulic fracturing had commenced, fracture fluids returning to the well head (known as return or 'flowback' fluids) were also sampled and analysed for the same parameters as the groundwater samples. A site inspection was undertaken during the hydraulic fracturing operation, on 16 May 2014. This inspection found that there were no observed effects from the discharge. The results of each hydraulic fracturing campaign for each well at the Mangahewa-D wellsite returned levels that are of no environmental significance. Results are detailed in Table 5.

**Table 5** Hydraulic fracture fluid and return hydraulic fracture fluid/produced water results obtained from well MHW16

Parameter	Unit	Fracture fluid 25 May 2014	Return fluid 14 Jun 2014
Alkalinity (total)	g/m <sup>3</sup> CaCO <sub>3</sub>	-	2300
Barium	mg/kg	-	29
Benzene	g/m <sup>3</sup>	0.0016	4.5
Bicarbonate	Deg.C	-	22
Bicarbonate	g/m <sup>3</sup> HCO <sub>3</sub>	-	1995
Bromine (dissolved)	g/m <sup>3</sup>	-	14.2
Calcium	g/m <sup>3</sup>	-	47
Chloride	g/m <sup>3</sup>	-	3700
Conductivity	mS/m@20C	-	1605
Copper (dissolved)	g/m <sup>3</sup>	-	0.006
Ethane	g/m <sup>3</sup>	-	0.29
Ethylbenzene	g/m <sup>3</sup>	<0.0010	0.37
Ethylene	g/m <sup>3</sup>	-	<0.004

Ethylene glycol	g/m <sup>3</sup>	460	74
Formaldehyde	g/m <sup>3</sup>	-	0.7
Hardness (total)	g/m <sup>3</sup> CaCO <sub>3</sub>	-	155
Hydrocarbons	g/m <sup>3</sup>	174	220
Iron (dissolved)	g/m <sup>3</sup>	-	14.4
Manganese (dissolved)	g/m <sup>3</sup>	-	3.0
Magnesium	g/m <sup>3</sup>	-	9
Mercury (dissolved)	g/m <sup>3</sup>	-	<0.011
Methane	g/m <sup>3</sup>	-	3.0
Methanol	g/m <sup>3</sup>	6	5
Nickel	mg/kg	-	<0.03
Nitrate nitrogen	g/m <sup>3</sup> N	-	<0.2
Nitrite/nitrate nitrogen	g/m <sup>3</sup> N	-	<0.2
Nitrite nitrogen	g/m <sup>3</sup> N	-	<0.2
pH	pH	-	6.6
Potassium	g/m <sup>3</sup>	-	530
Propylene glycol	g/m <sup>3</sup>	43	<4
Sodium	g/m <sup>3</sup>	-	3700
Sulphate	g/m <sup>3</sup>	-	66
Sulphur (dissolved)	g/m <sup>3</sup>	-	22
Toluene	g/m <sup>3</sup>	0.0029	3.7
Total dissolved solids	g/m <sup>3</sup>	-	13000
ortho-Xylene	g/m <sup>3</sup>	0.0037	0.79
meta-Xylene	g/m <sup>3</sup>	0.005	1.7
Zinc (dissolved)	g/m <sup>3</sup>	-	0.06

### 2.3.3 Results of discharge and receiving environment monitoring (mix-bury-cover)

Consent 7410-1 to discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover at the Mangahewa-D wellsite was not exercised during the monitoring period under review. Drilling muds, drilling cuttings and drilling wastes were disposed of at a consented off-site facility.

### 2.3.4 Land status

The well site was constructed on a flat rural dairy farming area. Relatively minor earthworks were required to construct the site. The land had not been reinstated at the time of the last inspection (28 August 2014) as the Todd Energy Limited were preparing for the commencement of further drilling activities at the Mangahewa-D wellsite.

## 2.4 Biomonitoring surveys

Biomonitoring surveys were performed prior to the commencement of flow testing and fracturing activities on 15 April 2014, and another following the completion of site activities on 28 August 2014 at the Mangahewa-D wellsite to determine whether or not consented discharges of treated stormwater, produced water, surplus drill water and water collected from the flare pit into a manmade drain and then into an unnamed

tributary of the Manganui River have had a detrimental effect upon the macroinvertebrate communities of this stream.

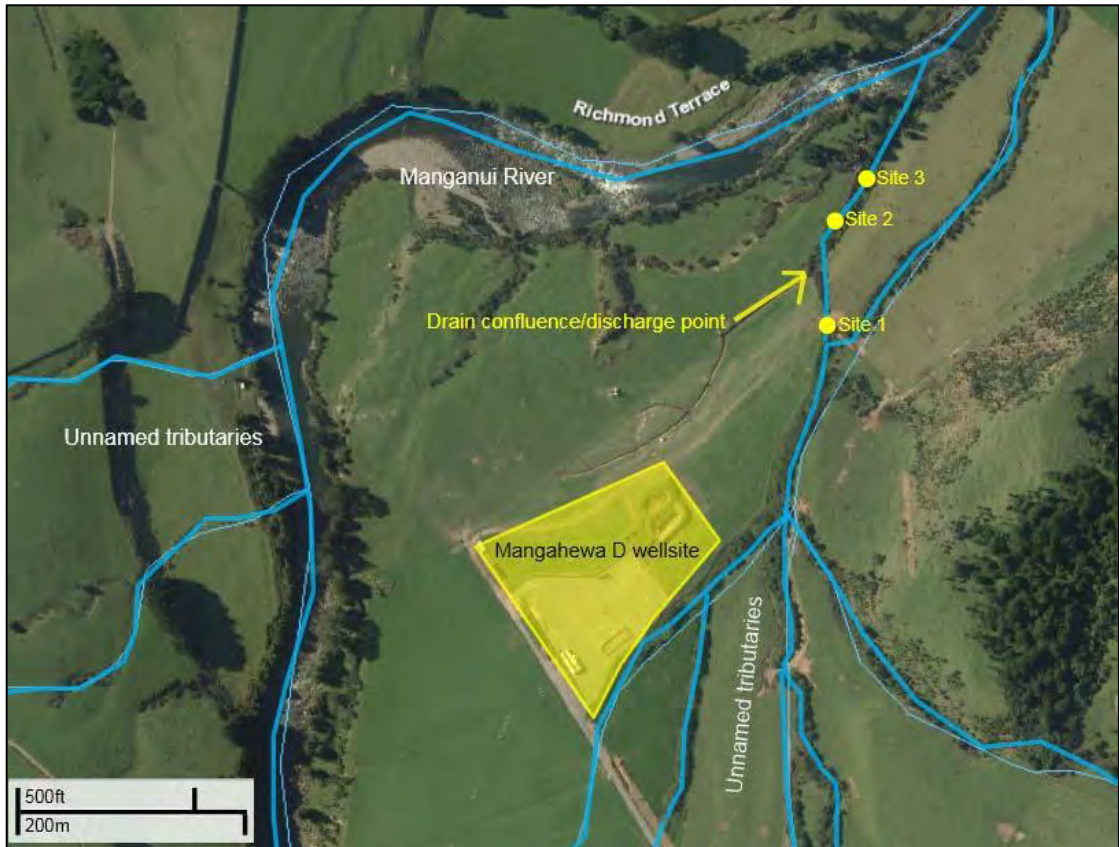
Both the pre and post hydraulic fracturing biomonitoring surveys were undertaken at three established sites; 55 m upstream of drain confluence (site 1), 60 m downstream of drain confluence (site 2) and 100 m downstream of drain confluence (site 3), as seen in Figure 6.

The Council's vegetation sweep' sampling technique was used at the three sites to collect streambed macroinvertebrates from the unnamed tributary of the Manganui River. This has provided baseline data for any future assessment of consented discharge effects from the Mangahewa-D wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI<sub>S</sub> scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI<sub>S</sub> takes into account taxa abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI<sub>S</sub> between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Summaries of each biomonitoring survey are as follows. A complete copy of the biomonitoring surveys can be found within Appendix II of this report.





**Figure 6** Biomonitoring sites in an unnamed tributary of the Manganui River in relation to the Mangahewa-D wellsite

#### 15 April 2014

The April 2014 survey of three sites was undertaken prior to hydraulic fracturing at the Mangahewa D wellsite. Taxa richnesses were moderate and similar to the median taxa richness recorded by similar 'control' sites elsewhere in the region. The macroinvertebrate communities of the stream contained relatively high proportions of 'tolerant' taxa but also moderate proportions of 'moderately sensitive' taxa. A total of 27 taxa was found through the reach of the stream surveyed, with six of these taxa (22%) found at all three sites and nine taxa (33%) found at any two of these sites. Only one 'tolerant' taxon was abundant at all three sites.

There were no significant differences in SQMCI<sub>s</sub> score between sites, however there was a significant (Stark, 1998) increase in MCI score from site 1 to site 3, which can be attributed to slight differences in habitat, in particular to the increased macrophyte and algal cover recorded at site 1. The MCI scores indicated that the stream communities were of poor 'health' (TRC, 2013) and not significantly (Stark, 1998) different to the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region.

#### 28 August 2014

The August 2014 survey was undertaken following hydraulic fracturing activities at the Mangahewa D wellsite. Taxa richness at site 1 and site 2 were moderate and similar to the median richness recorded at 'control' sites in similar streams elsewhere in the region. Taxa richness at site three however, was much higher than that recorded by the pre-drill survey and higher than the median richness recorded by



'control' sites in similar streams elsewhere in the region. This can be attributed to seasonal differences and slight changes in habitat from the pre-HF to post-HF surveys. A total of 35 taxa was found through the reach of the stream surveyed, with eight of these taxa (23 %) found at all three sites and 11 taxa (31 %), found at any two of these sites.

The MCI scores recorded at site 1 and site 2 in the pre-HF survey indicated that the stream communities were of poor 'health' (TRC, 2013), but similar to the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. Site 3 recorded an MCI score significantly (Stark, 1998) higher than the median of similar 'control' sites elsewhere in the region and indicated that the stream communities at this site were of 'fair' health.

A comparison of the pre-HF and post-HF survey results showed no significant variation in MCI and SQMCI<sub>s</sub> scores between surveys at all three sites. Slight variations in MCI and SQMCI<sub>s</sub> score and taxa richness between sites and surveys is considered to be due to habitat variability rather than a change in water quality. There was no indication from the results of the two surveys that the hydraulic fracturing activities at the Mangahewa D wellsite have impacted on the biological communities of the unnamed tributary of the Mangahewa D wellsite.

## **2.5 Contingency plan**

Todd Energy Limited has provided a general contingency plan, as required by Condition 4 of resource consent 7407-1 with site specific maps. The contingency plan has been reviewed and approved by officers of the Council.

## **2.6 Investigations, interventions and incidents**

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

Incidents may be alleged to be associated with a particular site. If there is 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 period under review, two resource consent breaches were observed and recorded during routine monitoring inspections.

On 7 June 2013 the second skimmer pit (located on the exploration side of the wellsite) was inspected and found to have failed due to external pressure on the lining via groundwater intrusion, causing the lining to balloon inwards and substantially decrease the storage capacity of the pit. This contravened Section 15(1)(a) of the Resource Management Act and special conditions 5 and 8 of resource consent 7407-1. Abatement notice 12028 was issued.



**Photo 1** Ballooned lining of the second skimmer pit due to groundwater intrusion, located on the exploration section of the Mangahewa-D wellsite

The skimmer pits were repaired and back to full operational and compliant capacity in due course. This was achieved by pumping out the groundwater that had collected behind the lining. In addition the discharge pipe at the exit of the second pit was also elevated, which allowed for more storage capacity within the pit.

On 14 February 2014 inspection found that drilling had commenced prior to the Council receiving the required 7 day notification, which contravened special condition 3 of consent 7407-1, and Infringement notice EAC-20226 was issued. Neither of these events had any environmental consequences.

Two complaints were received from nearby residents in relation to smoke issues arising from flaring activities at the Mangahewa-D wellsite. However, following further inspections and investigations these complaints could not be substantiated, as no consent conditions were contravened. It was found that the black smoke events on 18 June 2014 were a result of inadequate oxygen entering the flare pit. This lack of oxygen was attributed to the high volume of gas being directed to the flare pit. A small pump was being utilised on-site for flame suppression, however this was too small and so a larger pump was subsequently implemented at site. Todd Energy Limited also confirmed that complete separation of liquids out of gas flows was occurring at the surface during these combustion periods. Furthermore, Todd Energy Limited has since avoided directing such large volumes of gas to the flare pit to prevent a similar situation from occurring again.

Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. Todd Energy Limited staff would quickly take steps to ensure that requests made by Council Inspecting Officers were adhered to without delay.

### **3. Discussion**

#### **3.1 Discussion of consent exercise**

Of the eight resource consent relating to the Mangahewa-D wellsite, consents 7403-1 (to take groundwater), 7404-1 (to take water from the Manganui River), 7405-1 (to discharge emissions to air associated with production activities), 7406-1 (to discharge emissions to air associated with exploration activities), 7407-1 (to discharge treated stormwater, produced water, surplus drill water and water collected from the flare pit into a manmade drain and then into an unnamed tributary of the Manganui River), 7408-1 (to discharge stormwater and sediment associated with construction activities) and 7912-1 (to discharge contaminants associated with hydraulic fracturing activities into land) were exercised and actively monitored.

The discharge of solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover as permitted by resource consent 7410-1 was not exercised during the period under review. The drilling fluids and cuttings were disposed of at a consented off site facility.

Monitoring has shown that the management on-site ensured that no effects to the environment occurred during the monitoring period.

#### **3.2 Environmental effects of exercise of consents**

##### **Stormwater**

The discharge of stormwater from earthworks has the potential for sediment and other contaminants to enter surface water where it may detrimentally affect in-stream flora and fauna. To mitigate these effects, Todd Energy Limited established perimeter drains during the construction of the wellsite, and care was taken to ensure runoff from disturbed areas was directed into the drains or directed through adequate silt control structures.

Once the well was constructed, attention was given to controlling stormwater that ran off the wellsite and the associated plant and equipment.

Adverse effects on surface water quality can occur if contaminated water escapes through the stormwater system. Interceptor pits are designed to trap sediment and hydrocarbons through gravity separation. Any water that is unsuitable for release via the interceptor pits was directed to the drilling sumps, or removed for off-site disposal.

Todd Energy Limited also undertook the following mitigation measures in order to minimize off-site adverse effects:

- All stormwater was directed via perimeter drains to the skimmer pits for treatment prior to discharge;
- Additional bunding was constructed around the bulk fuel tank, chemical storage area, and other areas where runoff from areas containing contaminants could occur;
- Regular inspections of the interceptor pits occurred; and
- Maintenance and repairs were carried out as required or directed.

Interceptor pits do not discharge directly to surface water, instead they discharge onto and into land where the discharge usually soaks into the soil before reaching any surface water. However, if high rainfall had resulted in the discharge reaching the surface water, significant dilution would have occurred.

There are numerous on-site procedures included in drilling and health and safety documentation that are aimed at preventing spills on-site, and further procedures that address clean-up to remedy a spill situation before adverse environmental effects have the opportunity to occur (e.g. bunding of chemicals and bulk fuel).

### **Groundwater**

Small amounts of groundwater may have been encountered as produced water during operations at the wellsite. It was anticipated that the abstraction of groundwater would not impact on any groundwater resource and that the groundwater would not be affected as it would be protected by the well casing.

### **Flaring**

The environmental effects from flaring have been evaluated in monitoring reports prepared by the Council in relation to the flaring emissions from specific wells in the region.

The Council has previously undertaken field studies at two wells (one gas, and the other producing oil and heavier condensates); together with dispersion modelling at a third site<sup>1</sup>. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.<sup>2</sup>

In brief, the previous studies found that measurements of carbon monoxide, carbon dioxide, and methane concentrations to be safe at all points downwind, including within 50 m of the flare pit. Measurements of suspended particulate matter found concentrations typical of background levels, and measurements of PM<sub>10</sub> found compliance with national standards even in close proximity to the flare. Beyond 120 m from the flare pit, concentrations of polyaromatic hydrocarbons (PAH) approached background levels, as did levels of dioxins beyond 250 m from the flare.

In summary, the studies established that under combustion conditions of high volume flaring of gases with some light entrained liquids etc., atmospheric concentrations of all contaminants had reduced by a distance of 250 m downwind to become essentially typical of or less than elsewhere in the Taranaki environment (e.g. urban areas). These levels are well below any concentrations at which there is any basis for concern over potential health effects.

The measures to be undertaken by Todd Energy Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality included:

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<sup>1</sup> Taranaki Regional Council, *Fletcher Challenge Energy Taranaki Ltd, Mangahewa 2 Gas Well Air Quality Monitoring Programme Report 1997 - 98*, August 1998.

<sup>2</sup> Taranaki Regional Council: *Atmospheric Dispersion Modelling of Discharges to Air from the Flaring of Fracturing Fluid*, Backshall, March 2013; and *Investigation of air quality arising from flaring of fracturing fluids -emissions and ambient air quality*, Technical Report 2012- 03, Taranaki Regional Council May 2012.

- The use of a test separator to separate solids and fluids from the gas during all well clean-ups, and workover activities where necessary, thus reducing emissions to air. In particular, this would reduce the potential for heavy smoke incidents associated with elevated PAH and dioxin emissions;
- Records of flaring events are kept by Todd Energy Limited and provided to the Council;
- Every endeavor was made by Todd Energy Limited to minimise the total volume of gas flared while ensuring that adequate flow and pressure data was gathered to inform their investment decision; and
- Every endeavor was made by Todd Energy Limited to minimise smoke emissions from the flare. It was found necessary during the period under review to increase the capacity of smoke suppression equipment (while noting that no consent non-compliance was found).

### **Odour and dust**

Suppression of dust with water was to be implemented if it was apparent that dust may be travelling in such a direction to adversely affect off-site parties. Odour may stem from the product, flare, or some of the chemicals used on-site. Care was taken to minimize the potential for odour emissions (e.g. by keeping containers sealed, and ensuring the flare burnt cleanly).

### **Hazardous substances**

The use and storage of hazardous substances on-site has the potential to contaminate surface water and soils in the event of a spill. In the unlikely event of a serious spill or fire, the storage of flammable materials could have resulted in air, soil and water contamination.

Todd Energy Limited was required to implement the following mitigation measures:

- All potentially hazardous material were used and stored in accordance with the relevant Hazardous Substances and New Organisms regulations;
- All areas containing hazardous chemicals were bunded;
- Sufficient separation of chemicals from the flare pit were maintained for safety reasons;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system was implemented to provide secondary containment on-site; and
- A spill contingency plan was prepared that sets out emergency response procedures to be followed in the event of a spill.

### **Hydraulic fracturing**

The process of hydraulic fracturing results in some chemicals (e.g. clay stabilisers) being absorbed into the rock, where some may be residually trapped near the fracture face. The chemicals used in the fracturing process are classified as hazardous substances. However, these additives used in the process make up less than 5% of the total volume of fluid, the remaining being water and proppant. In a concentrated form some of the chemicals used in the fluid are toxic, but prior to the activity they

are highly diluted as part of the process. The majority of the fluid returns to the surface for controlled disposal at a consented facility.

Hence, there is a discharge of contaminants (energy, chemicals, water and inert sand/ small ceramic pellets) to land at considerable depth that has minor and temporary changes to the physical and chemical condition of the land (reservoir) in a way that does not affect other foreseeable users of the land and water resources.

The interval fractured is generally over 3 km below the surface. It is isolated by a considerable thickness of impermeable rock. The reservoir sands are known to contain hydrocarbons at pressures that exceed hydrostatic pressure, proving that the cap rock is relatively impermeable to the flow of water and hydrocarbons over very long time scales and high pressures.

The potential for the hydraulic fracturing activities to trigger seismic activity, particularly if located near faults within the formation has also been raised as a concern by some individuals. However, hydraulic fracturing is designed to create certain fractures in the rock and on a geological scale these are insignificant. The fissures created by the fracturing discharge are generally less than 400 m long, several mm wide and roughly 20 m thick into reservoir rock. These are very small features on a geological scale, and are not envisaged to create any increased risk of significant seismic activity.

The risk of the reservoir being fractured with a failure of the geological seal causing fracture fluids to migrate upwards and contaminate groundwater resources is considered extremely low. This is a result of numerous geological seals acting as natural barriers that stop any fracture fluids migrating upward.

Concern has also been raised that shallow groundwater may become contaminated from chemicals used in the hydraulic fracturing process. It is alleged that fluids may return to the surface via poorly sealed well casing or via cracks created through the fracturing process, rendering groundwater unsafe for human consumption. These hydro-geological risks of hydraulic fracturing affecting potable groundwater arise from two potential sources. The integrity of the well being used for the hydraulic fracturing, including the well casing and cement programme; and the geologic integrity of the reservoir seal and seals above this.

As a result of fracture design and modelling, coupled with extensive monitoring, the potential for groundwater to be impacted by hydraulic fracturing of a properly constructed well is extremely low and highly unlikely.

### **Summary**

There were no significant adverse environmental effects observed to water, land or air as a result of the wellsite activities during the monitoring period.

### 3.3 Evaluation of performance

A tabular summary of Todd Energy Limited's compliance record for the period under review is set out in Tables 6 to 13.

**Table 6** Summary of performance for consent 7403-1 to take groundwater that may be encountered as produced water during hydrocarbon exploration and production operations at the Mangahewa-D wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The abstraction must not cause more than a 10% lowering of static water level by interference with any adjacent bore	Sampling	Yes
2. The abstraction does not cause the intrusion of salt water into any freshwater aquifer	Water sampling adjacent bores pre/post drilling	Yes
3. A well log to 1,000 m must be submitted to the Council	Well log to 1,000 m submitted	Yes
4. Consent holder shall maintain records of abstraction and make available to the Council	Information not requested	N/A
5. Consent shall lapse if not implemented by date specified	Confirmed by inspection	N/A
6. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

**Table 7** Summary of performance for consent 7404-1 to take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production operations at the Mangahewa-D wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Volume of water abstracted shall not exceed 100 cubic metres per day, at a rate not exceeding 25 litres per second	Inspection of abstraction logs	Yes
2. Consent holder shall install and maintain a water meter	Inspection	Yes
3. Consent holder shall make available electronic records of water abstraction	Inspection	Yes
4. Consent holder shall maintain a record of abstractions and make available to the Council upon request	Inspection of abstraction logs	Yes



Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent	Inspections	Yes
6. Intake structure must be appropriately screened to avoid the entrainment of fish	Inspection of structure	Yes
7. Consent shall lapse if not implemented by date specified	Confirmed by inspection	N/A
8. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

**Table 8** Summary of performance for consent 7405-1 to discharge emissions to air during flaring from well workovers and in emergency situations, and to discharge miscellaneous emissions associated with production activities at the Mangahewa-D wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. 24hrs notice of flaring to the Council when flaring is longer than 5 minutes in duration	Inspection of records	Yes
2. At least 24hrs notice prior to flaring required to notify nearby residents when practicable	Notification	Yes
3. No alteration to equipment or processes that may alter the nature or quality of the flare	Inspection	Yes
4. Consent holder shall have regard to prevailing wind speed and direction	Inspection	Yes
5. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection flare	Yes
6. If effective separation could not be achieved, the consent holder shall reinstate effective separation as soon as possible; if separation could not be achieved within 3 hours, combustion must cease	Inspection of flare and company records	N/A
7. No liquid or solid hydrocarbons are to be combusted in the flare	Inspection of flare	Yes

8. Best practicable option to be adopted	Inspections, procedures and processes	Yes <sup>3</sup>
9. Only substances originating from the well stream shall be combusted within the flare	Inspection	Yes
10. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	Yes
11. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	Yes
12. Opacity of smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale	Inspection	Yes
13. Control of carbon monoxide	Inspection of company records	Yes
14. Control of nitrogen oxides	Inspection of company records	Yes
15. The discharge shall not be discharged at a rate/quantity so that it is toxic/noxious or hazardous	Inspection of company records	Yes
16. Control of other emissions	Inspection of company records	Yes
17. Analysis of typical gas and condensate stream from field to be made available to the Council	Not requested	N/A
18. The consent holder shall record the time, duration and cause of all smoke emitting incidents and submit to the Council	No smoke emitting incidents recorded	Yes
19. The consent holder shall record and log all flaring events longer than 5 minutes (10 minutes aggregate or longer than 120 minutes) including time, duration and reason	Inspection of company records	Yes
20. The consent holder shall provide a report to the Council during May of each year	Report received	Yes
21. Consent shall lapse if not implemented	Confirmed by inspection	N/A
22. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		<b>High</b>
Overall assessment of administrative performance in respect of this consent		<b>High</b>

<sup>3</sup> Capacity of smoke suppressant equipment increased during period

**Table 9** Summary of performance for consent 7406-1 to discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stream testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent shall not be exercised for more than 15 days per zone for up to six zones per well, for up to eight wells	Inspection of records	Yes
2. Council must be notified 24hrs prior to initial flaring of each zone	Notification	Yes
3. At least 24hrs notice prior to flaring required to notify nearby residents when practicable	Notification	Yes
4. No alterations made to plant equipment that will alter the nature or quantity of flare emissions	Inspection, plant procedures and processes	Yes
5. Consent holder shall have regard to prevailing and predicted wind speed and direction with commencement of flaring	Inspection	Yes
6. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit	Yes
7. If separation could not be implemented / maintained, the consent holder shall notify the Council	Notification	Yes
8. No liquid or solid hydrocarbons shall be combusted within the flare pit	Inspection of flare pit	Yes
9. Gas shall be combusted so that emissions of smoke are minimised	Inspection	Yes
10. Best practicable option to be adopted	Inspections, procedures and processes	Yes <sup>4</sup>
11. Only substances originating from the well stream shall be combusted in the flare pit	Inspection	Yes
12. No offensive odour or smoke beyond the boundary	Inspection	Yes
13. Opacity of smoke emissions shall not exceed level 1 on Ringelmann Scale	Inspection	Yes – two complaints received regarding smoke; not substantiated
14. Control of carbon monoxide	Inspection of company records	Yes
15. Control of nitrogen oxides	Inspection of company records	Yes

<sup>4</sup> Capacity of smoke suppression equipment increased during period

Condition requirement	Means of monitoring during period under review	Compliance achieved?
16. Consent holder shall not discharge any contaminant to air that is liable to be hazardous, toxic or noxious at or beyond the boundary of the wellsite	Inspections	Yes
17. Control of other emissions	Inspection of company records	Yes
18. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
19. The consent holder shall record the time, duration and cause of all smoke emitting incidents and submit to the Council	Smoke incident on 18 June 2013 recorded and submitted to the Council	Yes
20. Log all flaring including time, duration, zone, volumes flared and smoke events	Inspection of company records	Yes
21. Consent shall lapse if not implemented	Consent exercised	N/A
22. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

**Table 10** Summary of performance for consent 7407-1 to discharge treated stormwater; produced water; surplus drill water; and water collected from the flare pit; from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspections, procedures and processes	Yes
2. Maximum stormwater catchment area shall be no more than 19,000 m <sup>2</sup>	Plans, procedures and processes	Yes
3. 7 days written notice prior to site works and drilling	Notification received	No – drilling commenced without prior notification. Infringement notice issued.
4. Council to approve the contingency plan in relation to the wellsite prior to exercise of consent	Contingency plan approved	Yes
5. The stormwater system shall be designed, managed and maintained in accordance with information submitted	Comparative inspections in accordance with information submitted	Yes

6. All runoff from the site shall flow to a perimeter drain and skimmer pit without ponding	Inspection	Yes
7. Stormwater pits to be lined with impervious material	Inspection	Yes
8. Skimmer pits shall have a combined capacity of no less than 170 m <sup>3</sup>	Inspection	No – groundwater intrusion resulting in limited storage capacity. Abatement notice issued.
9. Rainwater collected within the flare pit to be tested prior to discharge	Inspection of company records	Yes
10. Consent holder shall notify the Council 48hrs prior to the discharge of contaminated water from the flare pit through the skimmer pit system	Notification received	Yes
11. Perimeter drains and skimmer pits shall be installed prior to the commencement of any site works	Inspection	Yes
12. Hazardous substances storage areas shall be bunded with drainage to appropriate recovery systems	Inspection	Yes
13. Constituents in discharges shall meet the following standards: a) pH 6.0 – 9.0 b) Suspended solids <100 g/m <sup>3</sup> c) Hydrocarbon <15 g/m <sup>3</sup> d) Chloride 50 g/m <sup>3</sup>	Physicochemical sampling	Yes
14. Following a mixing zone of 25 m , discharges shall not give rise to a temperature increase of more than 2°C	Physicochemical sampling	Yes
15. Following the mixing zone, the discharge shall not give rise to adverse effects in/on the receiving waters	Inspection and sampling	Yes
16. The Council shall be advised in writing 48 hrs prior to reinstatement of the site	Site still occupied / in use	N/A
17. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
18. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		Poor

**Table 11** Summary of performance for consent 7408-1 to discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions	-	N/A
2. Runoff derived from exposed soil shall pass through settlement ponds or traps	Inspection	Yes
3. The consent holder shall mitigate and minimise the amount of sediment discharged / suspended in the Manganui River or its tributaries as a result of activities at site	Inspection	Yes
4. 7 days written notice prior to site earthworks commencing	Notification received	Yes
5. Concentration of suspended solids in the discharge shall not exceed 100gm <sup>3</sup>	Physicochemical sampling	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Inspection	Yes
7. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
8. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

**Table 12** Summary of performance for consent 7410-1 to discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Discharges are to take place in accordance with information submitted in support of application	Confirming discharges were undertaken in accordance with information submitted	N/A
2. Consent holder to adopt best practicable option at all times	Inspection, procedures and processes	Yes
3. The Council to be notified 48hrs prior to and completion of each mix-bury-cover discharge	Notification received	N/A
4. Records of composition, volumes and quantities of material to be discharged shall be kept and supplied to the Council	Inspection of Company records	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Volume of solid drilling wastes discharged shall not exceed 1500 m <sup>3</sup> per well from up to 8 wells	Inspection, procedures and processes	N/A
6. Discharge areas for waste from individual wells are to be kept separate and distinct	Inspection of company records	N/A
7. No discharges shall occur within 12 months of any previous mix-bury-cover discharge at the site	Inspection of company records	N/A
8. As far as practicable, all fluids shall be removed from the drilling wastes	Inspection, procedures and processes	N/A
9. All sumps are to be permeable	Inspection	N/A
10. Drilling waste to be mixed with uncontaminated soil	Sampling soil prior to mixing	N/A
11. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil	Inspection, procedures and processes	N/A
12. Each mix-bury-cover discharge shall be re-vegetated and maintained with pasture cover	Inspection	N/A
13. The cover material is to be compacted and contoured so that stormwater is directed away from the mix-bury-cover site.	Inspection	N/A
14. Mix-bury-cover discharge sites are to be as far above the groundwater table as practicable	Inspection	N/A
15. Mix-bury-cover discharge sites must be 30m from any water body, spring or bore	Inspection	N/A
16. The total loading of trace elements in waste is not to exceed Alberta Energy and Utilities Board, 1996, G-50 guidelines	Inspection of company records	N/A
17. Chloride levels in each mix-bury-cover shall not exceed 1,600kg	Physicochemical sampling	N/A
18. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Physicochemical sampling	N/A
19. The hydrocarbon content of solid drilling waste shall not exceed 15mg/kg	Physicochemical sampling	N/A

20. Various parameters in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
21. Various metals in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
22. Hydrocarbon concentrations in the soil covering the mix-bury-cover shall comply with agreed guideline values	Physicochemical sampling	N/A
23. Level of salts in surface & ground water not to exceed 2,500g/m <sup>3</sup>	Physicochemical sampling	N/A
24. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A
25. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised

**Table 13** Summary of performance for consent 7912-1 to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3325mTVDSS, beneath the Mangahewa-D wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Any discharge shall occur at or below 3,325 mTVDss	Inspection of Company records	Yes
2. Exercise of consent shall not contaminate or put at risk any useable freshwater	Sampling fresh water bores pre/post discharge	Yes
3. Consent holder shall undertake sampling programme	Inspection and sampling fresh water bores pre/post discharge	Yes
4. Sampling programme shall follow recognised field parameters	Inspection, procedures and processes	Yes
5. Sampling programme shall follow recognised field procedures	Inspection, procedures and processes	Yes
6. Consent holder to undertake well and equipment pressure testing	Inspection of company records	Yes
7. A pre-fracturing discharge report is to be provided to the Council 14 days prior to the second and subsequent discharges	Pre-fracturing discharge report received	Yes
8. Consent holder shall provide notification prior to each hydraulic fracture discharge	Notification received	Yes
9. A post-fracturing discharge report is to be provided to the Council within 60 days after the discharge has ceased	Post-fracturing discharge report received	Yes



Condition requirement	Means of monitoring during period under review	Compliance achieved?
10. The reports outlined in conditions 7 and 9 must be emailed to consents@trc.govt.nz	Reports received via email	Yes
11. The consent holder shall provide access to a location where samples of hydraulic fracturing fluids and return fluids can be obtained by the Council officers	Provided	Yes
12. Consent holder to adopt best practicable option at all times	Inspection, Physicochemical sampling, procedures and processes	Yes
13. The fracture fluid shall be comprised of no less than 95% water	Sample of discharge and return fluids	Yes
14. Notice of Council to review consent	No provision for review	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

During the monitoring period, Todd Energy Limited demonstrated a high level of environmental performance. A 'poor' rating for administrative compliance for 1 of the 7 consents that were exercised meant that the overall level of administrative compliance with the resource consents was rated as 'good'. The incidents that occurred in respect of resource consent 7406-1 and 7407-1 have been discussed in Section 2.6.

### 3.4 Exercise of optional review of consents

Each resource consent includes a condition which allows the Council to review the consent, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of the resource consent, which were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time. The next provisions for review are in 2015.

Based on the results of monitoring during the period under review, it is considered that there are no grounds that require a review to be pursued for any of the consents. A recommendation to this effect is presented in section 4.

### 3.5 Alterations to monitoring programmes

In designing and implementing the monitoring programmes for air and water discharges and water abstractions at wellsites in the region, the Council takes into account the extent of information made available by previous and other authorities, its relevance under the Act, the obligations of the Act in terms of monitoring emissions/discharges and effects, and of 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 wellsite processes within Taranaki.

The Council has routinely monitored wellsite activities for more than 20 years in the region. This work has included in the order of hundreds of water samples and biomonitoring surveys in the vicinity of wellsites, and has demonstrated robustly that a monitoring regime based on frequent and comprehensive inspections is rigorous and thorough, in terms of identifying any adverse effects from wellsite and associated activities. Furthermore, with regard to hydraulic fracturing activities, baseline groundwater monitoring samples have demonstrated that hydraulic fracturing discharges have not given rise to any significant adverse effects on groundwater aquifers within the region. However, the Council had for a time not routinely required the imposition of additional targeted physicochemical and biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects.

In addition, the Council has also noted a desire by some community areas or individuals for a heightened level of information feedback and certainty around the results and outcomes of monitoring at wellsites. The Council has therefore moved to extend the previous regime, to make the sampling and extensive analysis of groundwater and surface waters in the general vicinity of a wellsite where hydraulic fracturing occurs, and biomonitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities.

Therefore, it is proposed that for any further work at the Mangahewa-D wellsite, the new standard programme will continue to be repeated, notwithstanding the lack of any effects or concerns previously found. A recommendation to this effect is attached to this report.

## 4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the monitoring of future consented activities at Mangahewa-D wellsite continue to include biomonitoring surveys;
3. THAT the monitoring of future consented activities continue to include sampling and extensive analysis of both groundwater and surface waters in the general vicinity of the Mangahewa-D wellsite where hydraulic fracturing occurs;
4. THAT, subject to the findings of monitoring of any further activities at the Mangahewa-D wellsite consents 7403-1, 7404-1, 7405-1, 7406-1, 7407-1, 7408-1, 7410-1 and 7912-1 shall not be reviewed in 2015.

## Glossary of common terms and abbreviations

The following abbreviations and terms may have been used within this report:

Al*	Aluminium.
As*	Arsenic.
Biomonitoring	Assessing the health of the environment using aquatic organisms.
BOD	Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate.
BODF	Biochemical oxygen demand of a filtered sample.
Bund	A wall around a tank to contain its contents in the case of a leak.
CBOD	Carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate .
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
cu*	Copper.
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh g/m <sup>3</sup>	Elevated flow in a stream, such as after heavy rainfall. Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
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.

l/s	Litres per second.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH <sub>4</sub>	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH <sub>3</sub>	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO <sub>3</sub>	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
PM <sub>10</sub>	Relatively fine airborne particles (less than 10 micrometre diameter).
Resource consent	Refer Section 87 of the RMA. Resource consent 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.
SS	Suspended solids.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
Zn*	Zinc.

\*an abbreviation for a metal or other analyte may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form.

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



**Appendix I**  
**Resource consents**





**Water 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: 19 November 2008

Commencement Date: 19 November 2008

**Conditions of Consent**

Consent Granted: To take groundwater that may be encountered as produced water during hydrocarbon exploration and production operations at the Mangahewa-D wellsite at or about (NZTM) 1711141E-5673516N

Expiry Date: 1 June 2021

Review Date(s): June 2015

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

### **General conditions**

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### **Special conditions**

1. The consent holder shall ensure the abstraction does not cause more than a 10% lowering of static water-level by interference with any adjacent bore.
2. The consent holder shall ensure the abstraction does not cause the intrusion of, or cross-contamination with salt water into any freshwater aquifer.
3. The consent holder shall submit, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a summary well log to a depth of 1000 metres. The report shall:
  - a) provide a log to show the true vertical depth to all geological formation tops intersected within the freshwater zone;
  - b) identify the true vertical depth to, and thickness of, any freshwater aquifers intersected by the well;
  - c) identify the true vertical depth to the freshwater- saline water interface in the well.
4. The consent holder shall maintain records of abstraction including date, volume of groundwater abstracted per day, water quality reports and shall make these records available to the Chief Executive, Taranaki Regional Council, upon request.
5. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 7403-1

6. 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 2015, 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

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**Director-Resource Management**



**Water 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: 19 November 2008

Commencement Date: 19 November 2008

**Conditions of Consent**

Consent Granted: To take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production operations at the Mangahewa-D wellsite at or about (NZTM) 1711141E-5673516N

Expiry Date: 1 June 2021

Review Date(s): June 2015

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

## Consent 7404-1

### General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### Special conditions

1. The volume of water taken shall not exceed 100 cubic metres per day, at a rate not exceeding 25 litres per second.
2. Before exercising this consent the consent holder shall install, and thereafter maintain, a water meter. The water meter shall be tamper-proof and shall measure and record the rate and volume of water taken to an accuracy of  $\pm 5\%$ .
3. The consent holder shall make available electronic records of water taken to the Council at a frequency and in a format to be advised by the Chief Executive Taranaki Regional Council.
4. The consent holder shall maintain a record of the abstraction including date, pumping hours and daily volume abstracted and make these records available to the Chief Executive, Taranaki Regional Council, no later than 31 July of each year, or earlier upon request.
5. Notwithstanding the terms and conditions of this consent the consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent, including, but not limited to, the efficient and conservative use of water.
6. The consent holder shall ensure that the intake structure is appropriately screened to avoid the entrainment of fish.
7. This consent shall lapse five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 7404-1

8. 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 2015, 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

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**Director-Resource Management**





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

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

Decision Date: 5 February 2009

Commencement Date: 5 February 2009

**Conditions of Consent**

Consent Granted: To discharge emissions to air during flaring from well workovers and in emergency situations, and to discharge miscellaneous emissions associated with production activities at the Mangahewa-D wellsite at or about (NZTM) 1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021 and/or within six months receiving a report pursuant to condition 20

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owners: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

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

### **General conditions**

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### **Special conditions**

#### **Information and notification**

1. The consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable if the consent holder does not have access to email.
2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 1000 metres of the site of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.
3. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other site emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent , without prior consultation with the Chief Executive, Taranaki Regional Council.

#### **Emissions from the site**

4. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects.
5. All gas that is flared must first be treated by effective liquid and solid separation and recovery to ensure that smoke emission during flaring is minimised.

## Consent 7405-1

6. If separation required by special condition 5 cannot be implemented or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall immediately advise the Compliance Manager, Taranaki Regional Council, and shall in any case re-establish liquid and solid separation and recovery within three hours.
7. Subject to special condition 6, no liquid or solid hydrocarbons shall be combusted through the gas flare system, other than in an emergency.
8. Notwithstanding any other condition of this consent the consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare or any other emissions to air from the Mangahewa-D wellsite [including use of a separator during well clean-up].
9. Only substances originating from the well stream and treated as outlined by conditions 5, 6, 7, and 8 shall be combusted within the flare pit.
10. There shall not be any offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
11. All permanent hydrocarbon storage vessels shall be fitted with vapour recovery systems.
12. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
13. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [ $\text{mg}/\text{m}^3$ ] [eight-hour average exposure], or  $30 \text{ mg}/\text{m}^3$  one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.
14. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [ $\mu\text{g}/\text{m}^3$ ] [24-hour average exposure], or  $200 \mu\text{g}/\text{m}^3$  [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.
15. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.

## Consent 7405-1

16. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:
- a) by more than 1/30<sup>th</sup> of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
  - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

### **Recording and reporting information**

17. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C<sub>6</sub> or higher number of compounds.
18. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
19. The consent holder shall record and maintain a log of all continuous flaring events longer than five minutes duration, and any intermittent flaring lasting for an aggregate of ten minutes or longer in any 120-minute period. The log shall contain the date, the start and finish times of the flaring event, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 20.
20. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:
- i) detailing any energy efficiency measures implemented on the site;
  - ii) detailing smoke emissions as required under condition 18;
  - iii) detailing any measures undertaken or proposed to reduce smoke emissions;
  - iv) detailing any measures undertaken or proposed to reduce flaring;
  - v) addressing any other issue relevant to the minimisation or mitigation of emissions from the flare;
  - vi) detailing any complaints received and any measures undertaken to address complaints; and

**Lapse and Review**

21. This consent shall lapse on 31 March 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. 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 within six months of receiving a report prepared by the consent holder pursuant to condition 20 of this consent, and/or by giving notice of review during the month of June 2015 and/or June 2021, for any of the following purposes:
  - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time;
  - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
  - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
  - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Mangahewa-D.

Signed at Stratford on 15 November 2013

For and on behalf of  
Taranaki Regional Council

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**Director-Resource Management**



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

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

Decision Date: 5 February 2009

Commencement Date: 5 February 2009

**Conditions of Consent**

Consent Granted: To discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stem testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite at or about (NZTM)  
1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owners: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

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

### **General conditions**

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### **Special conditions**

#### **Exercise of consent**

1. Flaring shall not occur on more than 15 days per zone for up to six zones per well, for up to eight wells.

#### **Information and notification**

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the initial flaring of each zone being commenced. Notification shall include the consent number and a brief description of the activity consented and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable if the consent holder does not have access to email.
3. At least 24 hours before any flaring, the consent holder shall provide notification to all residents within 1000 metres of the wellsite of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.
4. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other wellsite emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent, without prior consultation with the Chief Executive, Taranaki Regional Council.



## Flaring

5. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects.
6. All gas that is flared during well clean-up, drill stem testing, initial testing, well workovers, or production testing, or at any other time, must first be treated by effective liquid and solid separation and recovery, to ensure that smoke emission during flaring is minimised.
7. If separation required by condition 6 cannot be implemented or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall immediately advise the Compliance Manager, Taranaki Regional Council, and shall in any case re-establish liquid separation and recovery within three hours.
8. Subject to special condition 7, no liquid or solid hydrocarbons shall be combusted through the gas flare system.
9. The gas shall be combusted so that emissions of smoke are minimised.
10. Notwithstanding any other condition of this consent the consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare or any other emissions to air from the Mangahewa-D wellsite [including use of a separator during well clean-up].
11. Only substances originating from the well stream and treated as outlined by conditions 6, 7, 8, 9, and 10 shall be combusted within the flare pit.
12. There shall not be any offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
13. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
14. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [ $\text{mg}/\text{m}^3$ ] [eight-hour average exposure], or 30  $\text{mg}/\text{m}^3$  one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.

## Consent 7406-1

15. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare, so that whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [ $\mu\text{g}/\text{m}^3$ ] [24-hour average exposure], or 200  $\mu\text{g}/\text{m}^3$  [1-hour average exposure] at or beyond the boundary of the property where the wellsite is located.
16. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.
17. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, so that whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:
  - a) by more than 1/30<sup>th</sup> of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
  - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

### Recording and reporting information

18. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure  $\text{C}_6$  or higher number of compounds.
19. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
20. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, logs of all flaring, including time, duration, zone, and volumes of substances flared.

### **Lapse and Review**

21. This consent shall lapse on 31 March 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. 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 2014 and/or June 2020, for any of the following purposes:
  - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time;
  - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
  - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
  - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Mangahewa-D wellsite.

Signed at Stratford on 15 November 2013

For and on behalf of  
Taranaki Regional Council

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**Director-Resource Management**



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

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

Decision Date  
(Change): 1 October 2013

Commencement Date  
(Change): 1 October 2013 (Granted: 28 November 2008)

**Conditions of Consent**

Consent Granted: To discharge treated:

- stormwater;
- produced water;
- surplus drill water; and
- water collected from the vumu flare pit;

from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
(Property owner: KV & SJ Collins)

Legal Description: Rimutauteka 1A Blk X Waitara SD (Discharge source & site)

Grid Reference (NZTM) 1711186E-5673665N

Catchment: Waitara

Tributary: Manganui

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

### General conditions

- a. On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b. Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c. The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### Special conditions

1. Notwithstanding any other condition of this consent, 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 associated with the discharge of contaminants from the site.
2. Stormwater discharged shall be collected from a catchment area of no more than 19,000 m<sup>2</sup>.
3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 7 days prior to any site works commencing, and again in writing at least 7 days prior to any well drilling operation commencing. Notification shall include the consent number and a brief description of the activity consented and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable if the consent holder does not have access to email.
4. The consent holder shall prepare and maintain a contingency plan that details measures and procedures to be undertaken that will, to the satisfaction of the Chief Executive, Taranaki Regional Council, prevent spillage or accidental discharge of contaminants not authorised by this consent and avoid, remedy or mitigate the environmental effects of such a spillage or discharge.
5. Subject to the other conditions of this consent, the design, construction, management and maintenance of the stormwater system shall be undertaken in accordance with the information submitted in support of application 7595, and in particular, Drawing No. 13285-01, Sheets 1-5, prepared by BTW Company Limited, dated August 2013.
6. All runoff from the site flow to a perimeter drain and skimmer pits. Perimeter drains shall be designed, including by having a positive grade and low permeability, to ensure that stormwater runoff flows directly to the skimmer pits without ponding.
7. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls.

## Consent 7407-1

8. Skimmer pits shall have a combined capacity of no less than 170 m<sup>3</sup> before being discharged.
9. Before being discharged, rainwater collected in the vumu flare pit shall be tested and test results shall be provided to the Chief Executive, Taranaki Regional Council. If contaminant levels do not meet the standards specified in condition 13 of this consent, the water shall be trucked off site for appropriate disposal.
10. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours, prior to the discharge of contaminated water from the vumu flare pit through the skimmer pit system. Notification shall include the consent number and a brief description of the activity consented and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz).
11. Perimeter drains and skimmer pits necessary to comply with the conditions of this consent shall be installed before any site works commences. Site works includes the introduction of a drilling rig, drilling equipment or any other associated equipment or facilities to the site for any purpose other than for the construction of the site.
12. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps, or other appropriate recovery systems, and not to the stormwater catchment.
13. Constituents in the discharge shall meet the standards shown in the following table.

<b>Constituent</b>	<b>Standard</b>
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm <sup>-3</sup>
total recoverable hydrocarbons	Concentration not greater than 15 gm <sup>-3</sup> (as determined by infrared spectroscopic technique)
Chloride	Concentration not greater than 50 gm <sup>-3</sup>

This condition shall apply at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

14. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to an increase in temperature of more than 2 degrees Celsius.
15. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:
  - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
  - b) any conspicuous change in the colour or visual clarity;
  - c) any emission of objectionable odour;
  - d) the rendering of fresh water unsuitable for consumption by farm animals;
  - e) any significant adverse effects on aquatic life.

## Consent 7407-1

16. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable if the consent holder does not have access to email.
17. This consent shall lapse on 31 December 2013, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
18. 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 2009, 2010, 2011, 2012, 2015 and/or June 2021, 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

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**Director-Resource Management**



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

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

Decision Date: 28 November 2008

Commencement Date: 28 November 2008

**Conditions of Consent**

Consent Granted: To discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment at or about (NZTM) 1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

### General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### Special conditions

1. This consent authorises the discharge of stormwater and sediment from earthworks associated with the construction of a 100 metres x 80 metres wellsite and a 1 kilometres long access track.
2. If any area of soil is exposed, all run off from that area shall pass through settlement ponds or sediment traps with a minimum total capacity of 50 cubic metres.
3. The consent holder shall take all reasonable steps to:
  - a. minimise the amount of sediment discharged to the Manganui River or its tributaries;
  - b. minimise the amount of sediment that becomes suspended in the Manganui River or its tributaries; and
  - c. mitigate the effects of any sediment in the Manganui River or its tributaries.

Subject to condition 1, undertaking work in accordance with *Guidelines for Earthworks in the Taranaki region [2006]*, by the Taranaki Regional Council, will achieve compliance with this condition.

4. At least 7 working days prior to the commencement of works the consent holder shall notify the Taranaki Regional Council of the proposed start date for the work. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable only if the consent holder does not have access to email.
5. The concentration of suspended solids in the discharge shall not exceed 100 gm<sup>-3</sup>. This condition shall apply prior to the entry of the stormwater into water at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.
6. All earthwork areas shall be stabilised vegetatively or otherwise as soon as is practicable immediately following completion of soil disturbance activities.

Consent 7408-1

7. This consent shall lapse on 31 December 2013, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
8. 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 2015 and/or June 2021, 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

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**Director-Resource Management**



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

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

Decision Date: 5 February 2009

Commencement Date: 5 February 2009

**Conditions of Consent**

Consent Granted: To discharge solid drilling wastes [drilling cuttings and residual drilling fluids] from hydrocarbon exploration activities onto and into land via mix-bury-cover at or about (NZTM) 1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood  
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

## Consent 7410-1

### General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
  - i) the administration, monitoring and supervision of this consent; and
  - ii) charges authorised by regulations.

### Special conditions

1. The exercise of this consent shall be undertaken substantially in accordance with the documentation submitted in support of application 6126. In the case of any contradiction between the documentation submitted in support of application 6126 and the conditions of this consent, the conditions of this consent shall prevail.
2. Notwithstanding any other condition of this consent, 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 associated with the discharge of contaminants from the site, including but not limited to effects on any water body or soil.

### Notification and reporting requirements prior to discharge

3. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to commencement, and upon completion of each mix-bury-cover discharge. Notification shall include the consent number and a brief description of the activity consented and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification by fax or post is acceptable if the consent holder does not have access to email.
4. For each mix-bury-cover discharge, the consent holder shall provide a record of the volume, composition [including concentrations of nitrogen, chloride, hydrocarbons, and trace elements to show that the discharge complies with conditions 16 to 19], types of drilling fluids used, and the location of the discharge area, to the Chief Executive, Taranaki Regional Council, prior to the discharge.

### Discharge methods and limits

5. The volume of solid drilling wastes discharged shall not exceed 1500 m<sup>3</sup> per well from up to 8 wells.

## Consent 7410-1

6. Mix-bury-cover discharge areas for wastes from individual wells shall be kept separate and distinct.
7. No mix-bury-cover discharge shall occur within 12 months of any previous mix-bury-cover discharge at the site.
8. As far as practicable, all fluids shall be removed from the drilling wastes prior to discharge.
9. If sumps are used as drilling waste holding receptacles on the site, and the sump is to be used for a disposal area, the impermeable liner shall be perforated, and where possible removed, so that it no longer encloses the solid drilling wastes.
10. The solid drilling wastes shall be mixed with uncontaminated soil in a mixing ratio of 1 part solid drilling wastes to a minimum of 3 parts uncontaminated soil.
11. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil.
12. Each mix-bury-cover discharge area shall be revegetated, and thereafter maintained with pasture cover:
  - a) within 6 months of the completion of the discharge, or
  - b) if the discharge area is part of the active wellsite area, upon reinstatement of the site.
13. The consent holder shall compact, contour, and maintain the soil overlying the mix-bury-cover discharge to ensure that at all times all surface stormwater is directed away from the mix-bury-cover discharge area.
14. The mix-bury-cover discharge shall, as far as practicable, occur above the groundwater table.
15. The edges of the mix-bury-cover discharge area shall be at least 30 metres from any surface water body, spring, or any pre-existing groundwater supply bore.
16. The total loading of trace elements in the solid drilling wastes for each distinct mix-bury-cover discharge area shall not exceed the limits shown below:

<b>Trace element</b>	<b>Total loading limit</b>
boron	10 kg
cadmium	3 kg
chromium	200 kg
copper	400 kg
lead	200 kg
nickel	50 kg
vanadium	200 kg
zinc	600 kg

## Consent 7410-1

17. The loading of chloride shall not exceed 1,600 kg for each distinct mix-bury-cover discharge area.
18. The loading of nitrogen shall not exceed 400 kg for each distinct mix-bury-cover discharge area.
19. The hydrocarbon content of the solid drilling waste shall not exceed 0.0015% [15 mg/kg] on a dry weight basis.

### Receiving environment limits

20. At all times, parameters in the soil overlying the mix-bury-cover discharge area [less than 0.5 metre depth] shall not exceed the limits shown below:

<b>Parameter</b>	<b>Limit</b>
Conductivity	290 mSm <sup>-1</sup>
Total dissolved salts	2500 gm <sup>-3</sup>
Sodium	460 gm <sup>-3</sup>
Chloride	700 gm <sup>-3</sup>

21. At all times the levels of metals in the soil overlying the mix-bury-cover discharge area [less than 0.5 metre depth] shall comply with the limits shown below:

<b>Metal</b>	<b>Limit</b>
arsenic	20 mg kg <sup>-1</sup>
cadmium	1 mg kg <sup>-1</sup>
chromium	600 mg kg <sup>-1</sup>
copper	100 mg kg <sup>-1</sup>
lead	300 mg kg <sup>-1</sup>
mercury	1 mg kg <sup>-1</sup>
nickel	60 mg kg <sup>-1</sup>
zinc	300 mg kg <sup>-1</sup>

22. At all times the levels of hydrocarbons in the soil covering the mix-bury-cover discharge area [less than 0.5 metre depth] shall comply with the guideline values for the designated soil type in the surface layer set out in Tables 4.12 and 4.15 of the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999], appended to this consent.
23. The exercise of this consent shall not cause the level of total dissolved salts within any surface water or ground water to exceed more than 2500 gm<sup>-3</sup>.

### Lapse and review

24. This consent shall lapse on 31 March 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.



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25. 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 following each mix-bury-cover discharge, and/or during the month of June 2015 and/or June 2021, 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

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**Director-Resource Management**

Consent 7410-1

**Appendix 1**

Tables 4.12 and 4.15 of the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999].

**Table 4.12 Tier 1 soil acceptance criteria *Agricultural use*<sup>(1,3,6)</sup> ALL PATHWAYS  
(all values mg/kg)**

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
<b>SAND</b>			
MAHs			
Benzene	1.1 <sup>(v)</sup>	1.9 <sup>(7,v)</sup>	2.4 <sup>(7,v)</sup>
Toluene	(68) <sup>(4,v)</sup>	(94) <sup>(4,m)</sup>	(230) <sup>(4,v)</sup>
Ethylbenzene	(53) <sup>(4,v)</sup>	(92) <sup>(4,7,v)</sup>	(120) <sup>(4,v)</sup>
Xylenes	(48) <sup>(4,v)</sup>	(130) <sup>(4,7,v)</sup>	(180) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	70 <sup>(v)</sup>	80 <sup>(v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(d)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>SANDY SILT</b>			
MAHs			
Benzene	1.1 <sup>(v)</sup>	1.9 <sup>(v)</sup>	2.4 <sup>(v)</sup>
Toluene	(82) <sup>(4,v)</sup>	(170) <sup>(4,v)</sup>	(240) <sup>(4,v)</sup>
Ethylbenzene	(59) <sup>(4,v)</sup>	(92) <sup>(4,v)</sup>	(140) <sup>(4,v)</sup>
Xylenes	(59) <sup>(4,v)</sup>	(130) <sup>(4,v)</sup>	(180) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	83 <sup>(v)</sup>	(130) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(d)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>SILTY CLAY</b>			
MAHs			
Benzene	1.7 <sup>(v)</sup>	4.6 <sup>(v)</sup>	12 <sup>(v)</sup>
Toluene	(210) <sup>(4,v)</sup>	(950) <sup>(4,v)</sup>	(3,000) <sup>(4,v)</sup>
Ethylbenzene	(110) <sup>(4,v)</sup>	(800) <sup>(4,v)</sup>	(2,800) <sup>(4,v)</sup>
Xylenes	(160) <sup>(4,v)</sup>	(710) <sup>(4,v)</sup>	(2,200) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	(330) <sup>(4,v)</sup>	(1,100) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(d)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>

## NOTES:

1. Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
2. NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
3. Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
4. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
5. Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
6. The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation
7. Due to the nature of boundary conditions in volatilisation model, calculated criteria for sandy soils are higher than that for silt soil type. Therefore, the criteria for sand are set equal to the criteria for silt. Refer Appendix 4D for details.

**Table 4.12 (CONTINUED)**  
**Tier 1 soil acceptance criteria *Agricultural use* <sup>(1,3,6)</sup> ALL PATHWAYS**  
**(all values mg/kg)**

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
<b>CLAY</b>			
MAHs			
Benzene	2.7 <sup>(v)</sup>	8.8 <sup>(v)</sup>	(26) <sup>(4,v)</sup>
Toluene	(320) <sup>(4,v)</sup>	(2,400) <sup>(4,v)</sup>	(8,500) <sup>(4,v)</sup>
Ethylbenzene	(160) <sup>(4,v)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Xylenes	(250) <sup>(4,v)</sup>	(1,800) <sup>(4,v)</sup>	(6,500) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	(360) <sup>(4,v)</sup>	(1,200) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>PUMICE</b>			
MAHs			
Benzene	1.2 <sup>(v)</sup>	2.4 <sup>(v)</sup>	3.1 <sup>(v)</sup>
Toluene	(73) <sup>(4,v)</sup>	(240) <sup>(4,v)</sup>	(350) <sup>(4,v)</sup>
Ethylbenzene	(48) <sup>(4,v)</sup>	(140) <sup>(4,v)</sup>	(220) <sup>(4,v)</sup>
Xylenes	(53) <sup>(4,v)</sup>	(180) <sup>(4,v)</sup>	(260) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	140 <sup>(v)</sup>	(220) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>PEATS AND HIGHLY ORGANIC SOILS</b>			
MAHs			
Benzene	5.7 <sup>(v)</sup>	10 <sup>(v)</sup>	13 <sup>(v)</sup>
Toluene	(2,500) <sup>(4,v)</sup>	(2,900) <sup>(4,v)</sup>	(3,800) <sup>(4,v)</sup>
Ethylbenzene	(2,200) <sup>(4,v)</sup>	(2,500) <sup>(4,v)</sup>	(3,200) <sup>(4,v)</sup>
Xylenes	(1,700) <sup>(4,v)</sup>	(2,000) <sup>(4,v)</sup>	(2,600) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	(2,700) <sup>(4,v)</sup>	(3,500) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>

## NOTES:

- Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
- NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
- Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
- Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
- Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
- The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation

**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): 14 November 2012

Commencement  
Date (Change): 14 November 2012 (Granted: 9 September 2011)

**Conditions of Consent**

Consent Granted: To discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3325mTVDSS, beneath the Mangahewa-D wellsite at or about (NZTM) 1711149E-5673522N

Expiry Date: 1 June 2016

Review Date(s): June 2013, June 2014, June 2015

Site Location: Mangahewa-D wellsite, Rimutauteka Road, New Plymouth  
(Property owner: KV & SJ Collins)

Legal Description: Rimutauteka 1A Blk X Waitara SD  
(Discharge source & site)

Catchment: Waitara

Tributary: Manganui

*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. Any discharge shall occur at or below 3325 mTVDSS.  
Note: mTVDSS = metres true vertical depth sub sea, i.e. the true vertical depth in metres below sea level.
2. 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). Usable fresh groundwater is defined as any groundwater having a Total Dissolved Solids concentration of less than 1000 mg/l.
3. 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 to assess compliance with condition 2 (the 'Monitoring Programme'). The Monitoring Programme shall be certified by the Chief Executive, Taranaki Regional Council ('the Chief Executive'), before this consent is exercised, and shall include:
  - (a) the location of the discharge point(s);
  - (b) the location of sampling sites; and
  - (c) sampling frequency with reference to a hydraulic fracturing programme.
4. All water samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
  - (a) pH;
  - (b) conductivity;
  - (c) total dissolved solids;
  - (d) major ions (Ca, Mg, K, Na, total alkalinity, bromide, chloride, nitrate-nitrogen, and sulphate);
  - (e) trace metals (barium, copper, iron, manganese, nickel, and zinc);
  - (f) total petroleum hydrocarbons;
  - (g) formaldehyde;
  - (h) dissolved methane and ethane gas;
  - (i) methanol;
  - (j) glycols;
  - (k) benzene, toluene, ethylbenzene, and xylenes (BTEX); and
  - (l) carbon-13 composition of any dissolved methane gas discovered ( $^{13}\text{C-CH}_4$ ).

*Note: The samples required, under conditions 3 and 4 could be taken and analysed by the Council or other contracted party on behalf of the consent holder.*

5. All sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive 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 International Accreditation New Zealand (IANZ) accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive within 30 days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 2.

*Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 2.*

6. The consent holder shall undertake well and equipment pressure testing prior to any hydraulic fracture programme on a given well to ensure any discharge will not affect the integrity of the well and hydraulic fracturing equipment.
7. Any hydraulic fracture discharge shall only occur after the consent holder has provided a comprehensive 'Pre-fracturing discharge report' to the Chief Executive. The report shall be provided at least 14 days before the discharge is proposed to commence and shall detail the hydraulic fracturing programme proposed, including as a minimum:
  - (a) the specific well in which each discharge is to occur and the intended fracture interval(s) ('fracture interval' is the discrete subsurface zone to receive a hydraulic fracture treatment);
  - (b) the number of discharges proposed and the geographical position (i.e. depth and lateral position) of each intended discharge point;
  - (c) the total volume of fracture fluid planned to be pumped down the well and its intended composition, including a list of all contaminants and Material Safety Data Sheets for all the chemicals to be used;
  - (d) the results of the reviews required by condition 12;
  - (e) results of modelling showing an assessment of the likely extent and dimensions of the fractures that will be generated by the discharge;
  - (f) the preventative and mitigation measures to be in place to ensure the discharge does not cause adverse environmental effects and complies with condition 2;
  - (g) the extent and permeability characteristics of the geology above the discharge point to the surface;
  - (h) any identified faults within the modeled fracture length plus a margin of 50%, and the potential for adverse environmental effects due to the presence of the identified faults;
  - (i) the burst pressure of the well and the anticipated maximum well and discharge pressures and the duration of the pressures; and
  - (j) details of the disposal of any returned fluids, including any consents that are relied on to authorise the disposal.

*Note: For the avoidance of doubt, the information provided with a resource consent application would usually be sufficient to constitute a 'Pre-fracturing discharge report' for any imminent hydraulic fracturing discharge. The Pre-fracturing discharge report provided for any later discharge may refer to the resource consent application or earlier Pre-fracturing discharge reports noting any differences.*

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8. The consent holder shall notify the Taranaki Regional Council of each discharge by emailing [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz). Notification shall include the date that the discharge is to occur and identify the 'Pre-fracturing discharge report', required by condition 7, which details the discharge. Where practicable and reasonable notice shall be given between 3 days and 14 days before the discharge occurs, but in any event 24 hours notice shall be given.
9. At the conclusion of a hydraulic fracturing programme on a given well, the consent holder shall submit a comprehensive 'Post-fracturing discharge report' to the Chief Executive. The report shall be provided within 60 days after the programme is completed and, as a minimum, shall contain:
  - (a) confirmation of the interval(s) where fracturing occurred for that programme, and the geographical position (i.e. depth and lateral position) of the discharge point for each fracture interval;
  - (b) the contaminant volumes and compositions discharged into each fracture interval;
  - (c) the volume of return fluids from each fracture interval;
  - (d) an analysis for the constituents set out in conditions 4(a) to 4(k), in a return fluid sample taken within the first two hours of flow back, for each fracture interval if flowed back individually, or for the well if flowed back with all intervals comingled;
  - (e) an estimate of the volume of fluids (and proppant) remaining underground;
  - (f) the volume of water produced with the hydrocarbons (produced water) over the period beginning at the start of the hydraulic fracturing programme and ending 50 days after the programme is completed;
  - (g) an assessment of the extent and dimensions of the fractures that were generated by the discharge, based on modelling undertaken after the discharge has occurred and other diagnostic techniques, including production analysis, available to determine fracture length, height and containment;
  - (h) the results of pressure testing required by condition 6, and the well and discharge pressure durations and the maximum pressure reached during the hydraulic fracture discharge;
  - (i) details of the disposal of any returned fluids, including any consents that are relied on to authorise the disposal;
  - (j) details of any incidents where hydraulic fracture fluid is unable to pass through the well perforations (screen outs) that occurred, their likely cause and implications for compliance with conditions 1 and 2; and
  - (k) an assessment of the effectiveness of the mitigation measures in place with specific reference to those described in the application for this consent.
10. The reports described in conditions 7 and 9 shall be emailed to [consents@trc.govt.nz](mailto:consents@trc.govt.nz) with a reference to the number of this consent.
11. The consent holder shall provide access to a location where the Taranaki Regional Council officers can obtain a sample of the hydraulic fracturing fluids and the return fluids.



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12. 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 minimize any actual or likely adverse effect of the activity on the environment by, as a minimum, ensuring that:
  - (a) the discharge is contained within the fracture interval;
  - (b) regular reviews are undertaken of the preventative and mitigation measures adopted to ensure the discharge does not cause adverse environmental effects; and
  - (c) regular reviews of the chemicals used are undertaken with a view to reducing the toxicity of the chemicals used.
13. The fracture fluid shall be comprised of no less than 95% water and proppant by volume.
14. The Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June each year, for the purposes of:
  - (a) ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
  - (b) further specifying the best practicable option as required by condition 12; and/or
  - (c) ensuring hydraulic fracturing operations appropriately take into account any best practice guidance published by a recognised industry association or environmental regulator.

Signed at Stratford on 15 November 2013

For and on behalf of  
Taranaki Regional Council

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**Director-Resource Management**



## **Appendix II**

### **Biomonitoring surveys**



To Job Manager, Callum McKenzie  
From Scientific Officer, Brooke Thomas  
Report No BT037  
Date October 2014

## **Biomonitoring of an unnamed tributary of the Manganui River before and after hydraulic fracturing at Mangahewa D wellsite by Shell Todd Oil Services Ltd, April 2014 & August 2014.**

### **Introduction**

These biological surveys were performed before and after hydraulic fracturing (HF) at the Mangahewa D wellsite. The intention of these surveys was to determine the health of the macroinvertebrate communities prior to hydraulic fracturing, which then allowed a comparison with the health of the macroinvertebrate communities following hydraulic fracturing. This provided an indication as to whether the hydraulic fracturing activities had an influence on the macroinvertebrate community of the stream.

### **Methods**

A combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques was used at three sites to collect streambed macroinvertebrates upstream and downstream of the stormwater discharge point in the unnamed tributary of the Manganui River, on 15 April 2014 and 28 August 2014 (Table 1). The 'kick-sampling' technique is very similar to C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001). The 'vegetation sweep' technique is very similar to Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

The Mangahewa D wellsite stormwater was discharged from a skimmer pit onto land near the unnamed tributary of the Manganui River (Figure 1). The three sites monitored in the unnamed tributary of the Manganui River were situated 55m upstream of the drain confluence from the Mangahewa D wellsite (site 1), 60m downstream of the drain confluence (site 2) and 100m downstream of the drain confluence (site 3) ( Table 1).

**Table 1** Biomonitoring sites in the unnamed tributary of the Manganui River related to the Mangahewa D wellsite

Site No.	Site code	GPS Reference (NZTM)	Location
1	MGN000489	E1711359 N5673793	55m upstream of drain confluence
2	MGN000492	E1711376 N5673894	60m downstream of drain confluence
3	MGN000493	E1711392 N5673936	100m downstream of drain confluence



Figure 1 Biomonitoring sites in the unnamed tributary of the Manganui River sampled in relation to the Mangahewa D wellsite

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols of sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

A semi-quantitative MCI value (SQMCI<sub>s</sub>) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The

loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the SQMCI<sub>s</sub> is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

## Results and discussion

During the pre-HF survey the water temperature in the unnamed tributary of the Manganui River ranged from 16.6 °C to 17.2°C. During the post-HF survey the water temperature ranged from 9.5°C to 9.8°C. During the pre-HF survey an uncoloured, clear, very low and very slow flow was recorded at site 1. At site 2 an uncoloured, cloudy, low and very slow flow was recorded, whereas at site 3 the flow was clear, low and slow. During the post-HF survey an uncoloured, moderate and steady flow was recorded at site 1 and an uncoloured, cloudy, moderate and slow flow was recorded at sites 2 and 3.

At all three sites the substrate comprised predominantly of silt, sand and fine and coarse gravels, with varying proportions of cobbles, boulders and wood and roots. Greater proportions of woody debris were noted in the post-HF survey at site 2 and 3, and hard clay was present at site 1. No periphyton was recorded at site 2 or site 3 during the pre-HF survey, whereas at site 1 both mats and filaments of periphyton were widespread. During the post-HF survey, patchy mats and filaments were noted at site 1, while only patchy mats were recorded at site 3 and at site 2 only slippery mats were recorded.

During both the pre-HF and post-HF surveys macrophytes were recorded growing at the edges and on the bed of the stream at site 1, and at the edges of the stream at site 2 and site 3. The bed of the stream was not shaded at site 1 during the pre-HF survey, although it was partially shaded during the post-HF survey. Both site 2 and site 3 were partially shaded by steep banks and overhanging vegetation during both the pre-HF and post-HF surveys.

## Macroinvertebrate communities

Table 2 summarises the results of the two macroinvertebrate surveys performed prior to and following hydraulic fracturing at the Mangahewa D wellsite and includes comparative data for sites of similar streams to the unnamed tributary of the Manganui River. Full results for the pre-HF and post-HF surveys are presented Table 3 and 4 respectively.

**Table 2** Number of taxa, MCI and SQMCI<sub>s</sub> values for the unnamed tributary of the Manganui River prior to and following hydraulic fracturing at Mangahewa D wellsite, together with a summary of results from control sites at a similar altitude (60m) in other lowland coastal streams (TRC, 1999, updated October 2013)

Site No.	Site Code	No of taxa		MCI value		SQMCI <sub>s</sub> value	
		15 Apr 2014	28 Aug 2014	15 Apr 2014	28 Aug 2014	15 Apr 2014	28 Aug 2014
1	MGN000489	19	20	66	71	3.3	3.6
2	MGN000492	16	15	69	77	3.3	3.5
3	MGN000493	13	27	78	85	3.7	3.5
Control sites median result		17 (61 samples)		73 (61 samples)		4.0 (33 samples)	

**Table 3** Macroinvertebrate fauna of the unnamed tributary of the Manganui River sampled on 15 April 2014 prior to HF at the Mangahewa D wellsite

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		MGN000489	MGN000492	MGN000493
	Sample Number		FWB14199	FWB14200	FWB14201
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	-	-	R
NEMERTEA	Nemertea	3	-	R	C
NEMATODA	Nematoda	3	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	A	C
HIRUDINEA (LEECHES)	Hirudinea	3	R	R	R
MOLLUSCA	<i>Gyraulus</i>	3	-	R	-
	Lymnaeidae	3	C	-	-
	<i>Physa</i>	3	A	-	-
	<i>Potamopyrgus</i>	4	VA	VA	A
	Sphaeriidae	3	R	R	-
CRUSTACEA	Ostracoda	1	A	A	R
	<i>Paracalliope</i>	5	C	-	R
EPHEMEROPTERA (MAYFLIES)	<i>Zephlebia group</i>	7	-	-	R
ODONATA (DRAGONFLIES)	<i>Ischnura</i>	4	R	-	-
	<i>Xanthocnemis</i>	4	A	R	-
HEMIPTERA (BUGS)	<i>Sigara</i>	3	C	-	-
COLEOPTERA (BEETLES)	Elmidae	6	-	R	-
	Hydrophilidae	5	R	R	-
TRICHOPTERA (CADDISFLIES)	<i>Psilochorema</i>	6	-	-	R
	<i>Oxyethira</i>	2	A	C	-
	<i>Paroxyethira</i>	2	C	-	-
	<i>Triplectides</i>	5	C	C	C
DIPTERA (TRUE FLIES)	Eriopterini	5	-	-	R
	Orthoclaadiinae	2	R	R	-
	Tanypodinae	5	R	C	-
	<i>Austrosimulium</i>	3	R	-	R
ACARINA (MITES)	Acarina	5	R	R	R
No of taxa			19	16	13
MCI			66	69	78
SQMCIs			3.3	3.3	3.7
EPT (taxa)			1	1	3
%EPT (taxa)			5	6	23
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare      C = Common      A = Abundant      VA = Very Abundant      XA = Extremely Abundant



**Table 4** Macroinvertebrate fauna of the unnamed tributary of the Manganui River sampled on 28 August 2014 following HF at the Mangahewa D wellsite.

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		MGN000489	MGN000492	MGN000493
	Sample Number		FWB14234	FWB14235	FWB14236
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	C	-	-
ANNELIDA (WORMS)	Oligochaeta	1	C	C	VA
	Lumbricidae	5	-	R	-
HIRUDINEA (LEECHES)	Hirudinea	3	R	-	-
MOLLUSCA	Lymnaeidae	3	-	-	R
	<i>Physa</i>	3	C	-	R
	<i>Potamopyrgus</i>	4	XA	VA	XA
	Sphaeriidae	3	R	R	R
CRUSTACEA	Ostracoda	1	R	-	-
	<i>Paracalliope</i>	5	VA	R	A
EPEMEROPTERA (MAYFLIES)	<i>Zephlebia group</i>	7	R	-	R
PLECOPTERA (STONEFLIES)	<i>Acroperla</i>	5	C	C	-
	<i>Zelandobius</i>	5	R	R	C
ODONATA (DRAGONFLIES)	<i>Xanthocnemis</i>	4	C	-	R
	<i>Antipodochlora</i>	5	-	-	R
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	-	-	R
	Hydrophilidae	5	-	-	R
TRICHOPTERA (CADDISFLIES)	Ecnomidae/Psychomyiidae	6	-	-	R
	<i>Hydrobiosis</i>	5	-	R	R
	<i>Psilochorema</i>	6	-	-	R
	<i>Oxyethira</i>	2	A	C	A
	<i>Triplectides</i>	5	C	-	A
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	-	R	C
	Hexatomini	5	-	-	R
	<i>Harrisius</i>	6	-	C	R
	<i>Maoridamesa</i>	3	R	-	R
	Orthoclaadiinae	2	A	C	C
	Tanypodinae	5	R	-	-
	Tanytarsini	3	-	R	-
	Ceratopogonidae	3	R	-	-
	<i>Paradixa</i>	4	R	-	C
	<i>Austrosimulium</i>	3	XA	VA	VA
	Tanyderidae	4	-	R	C
ACARINA (MITES)	Acarina	5	-	-	R
No of taxa			20	15	27
MCI			71	77	85
SQMCIs			3.6	3.5	3.5
EPT (taxa)			4	3	6
%EPT (taxa)			20	20	22
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare    C = Common    A = Abundant    VA = Very Abundant    XA = Extremely Abundant

## Pre-HF survey

### Site 1

A moderate community richness of 19 taxa was found at site 1 (Table 2 and Table 3), two taxa more than the median richness found at similar sites elsewhere in the region (Table 2). The macroinvertebrate community was comprised of a significant proportion of 'tolerant' taxa (74 %), which was reflected in the MCI score of 66 units. This MCI score was slightly lower (7 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 2).

The community at this site was characterised by five 'tolerant' taxa [snails (*Physa* and *Potamopyrgus*), ostracod seed shrimp, dragonfly larvae (*Xanthocnemis*) and axe-head caddis (*Oxyethira*)].

The numerical dominance of many 'tolerant' taxa resulted in a SQMCI<sub>s</sub> score of 3.3 units, which was slightly lower (0.7 unit) than the median score for 'control' sites in similar streams at this altitude (Table 2).

### Site 2

A moderate community richness of 16 taxa was found at site 2 (Table 2 and Table 3), three taxa less than what was found at site 1, and one taxon less than the median richness found at similar sites in the region (Table 2). The macroinvertebrate community was comprised of a high proportion of 'tolerant' taxa (69 %) which was reflected in the MCI score of 69 units. This was an insignificant 3 units higher than recorded at site 1 and an insignificant 4 units fewer than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 2).

The community at this site was characterised by three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*) and ostracod seed shrimp].

The numerical dominance of numerous 'tolerant' taxa resulted in a SQMCI<sub>s</sub> score of 3.3 units, which was an insignificant 0.7 unit less than the median score for 'control' sites in similar streams at this altitude (Table 2), and the same as the upstream control site.

### Site 3

A moderately low community richness of 13 taxa was found at site 3 (Table 2 and Table 3), six taxa less than the upstream control site, and six taxa less than the median richness found at similar sites elsewhere in the region (Table 2). The macroinvertebrate community comprised of similar proportions of 'sensitive' (46 %) and 'tolerant' (54%) taxa, which was reflected in the MCI score of 78 units. This was a significant (Stark, 1998) 12 units higher than that recorded at the upstream 'control' site, nine units higher than that recorded by site 2 and four units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 2).

The community at this site was characterised by one 'tolerant' taxon [snail (*Potamopyrgus*)]. A numerical dominance of one 'tolerant' taxon resulted in the SQMCI<sub>s</sub> score of 3.7 units which was an insignificant 0.3 unit less than the median score for 'control' sites in similar streams at this altitude elsewhere the region (Stark, 1998) (Table 2), and insignificantly higher (by 0.4 unit) than what was recorded at site 1.

## Post-HF survey

### Site 1

A moderate community richness of 20 taxa was found at site 1 (Table 2 and Table 4), one taxon more than that recorded by the pre-HF survey and three taxa more than the median richness found at similar sites elsewhere in the region (Table 2). The macroinvertebrate community continued to contain a significant proportion of 'tolerant' taxa (70 %), which was reflected in the MCI score of 71 units. This result represented an insignificant (Stark, 1998) increase from that recorded in the pre-HF survey (by 5 MCI units) and was similar to the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 2).

The community at this site was characterised by four 'tolerant' taxa [snail (*Potamopyrgus*), orthoclad midges, axe-head caddis (*Oxyethira*) and black sandfly (*Austrosimulium*)], and one 'sensitive' taxon [amphipod (*Paracalliope*)].

The numerical dominance by 'tolerant' taxa was tempered by one very abundant 'sensitive' taxon, resulting in a SQMCI<sub>s</sub> score of 3.6 units, which was slightly higher (by 0.3 unit) than what was recorded by the pre-HF survey, but lower (0.4 unit) than the median score for 'control' sites in similar streams at this altitude (Table 2).

### Site 2

A moderate community richness of 15 taxa was found at site 2 (Table 2 and Table 4), five taxa fewer than found at site 1, one taxon less than what was recorded by the pre-HF survey and two taxa less than the median richness found at similar sites (Table 2). The macroinvertebrate community contained similar proportions of 'tolerant' (53%) and 'sensitive' (47%) taxa, which was reflected in the MCI score of 77 units; eight units higher than what was recorded during the pre-HF survey and an insignificant six units higher than at the upstream 'control' site. This MCI score was insignificantly Stark, 1998) higher (by 4 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 2).

This community was characterised by two 'tolerant' taxa [snail (*Potamopyrgus*) and black sandfly larvae (*Austrosimulium*)].

The numerical dominance by two 'tolerant' taxa resulted in the SQMCI<sub>s</sub> score of 3.5 units, which was slightly higher (by 0.2 unit) than recorded by the pre-HF survey, but lower (by 0.5 unit) than the median score for 'control' sites in similar streams at this altitude (Table 2). The SQMCI<sub>s</sub> score recorded at sites 1 and 2 were very similar (3.6 and 3.5 units respectively) (Table 4).

### Site 3

A high community richness of 27 taxa was found at site 3 (Table 2 and Table 4), 13 taxa more than that recorded in the pre-HF survey and 10 taxa more than the median richness found at similar sites elsewhere in the region (Table 2). Unlike the pre-HF survey the macroinvertebrate community comprised a greater proportion of 'sensitive' taxa (52 %), which was reflected in the MCI score of 85 units; an insignificant (Stark, 1998) seven units higher than the pre-HF survey. This score was a significant (Stark, 1998) 12 units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 2).

This community was characterised by four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), axe-head caddis (*Oxyethira*) and black sandfly larvae (*Austrosimulium*)]; and two 'sensitive' taxa [amphipod (*Paracalliope*) and stick-caddis (*Triplectides*)].

The SQMCI<sub>s</sub> score of 3.5 units recorded at site 3 in this survey represented an insignificant (Stark, 1998) 0.2 unit decrease from the SQMCI<sub>s</sub> score in the pre-HF survey and was 0.5 unit lower than the median score for 'control' sites in similar streams at this altitude elsewhere the region (TRC, 1998 (updated 2013)).

## Summary and Conclusions

A combination of the 'vegetation sweep' and 'kick-sampling' techniques was used at three sites to collect streambed macroinvertebrates from the unnamed tributary of the Manganui River of two sampling occasions. This has provided data to compare with baseline data for the assessment of hydraulic fracturing effects from the Mangahewa D wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI<sub>s</sub> scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI<sub>s</sub> takes into account taxa abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI<sub>s</sub> between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

The April 2014 survey of three sites was undertaken prior to hydraulic fracturing at the Mangahewa D wellsite. Taxa richnesses were moderate and similar to the median taxa richness recorded by similar 'control' sites elsewhere in the region. The macroinvertebrate communities of the stream contained relatively high proportions of 'tolerant' taxa but also moderate proportions of 'moderately sensitive' taxa. A total of 27 taxa was found through the reach of the stream surveyed, with six of these taxa (22%) found at all three sites and nine taxa (33%) found at any two of these sites. Only one 'tolerant' taxon was abundant at all three sites.

There were no significant differences in SQMCI<sub>s</sub> score between sites, however there was a significant (Stark, 1998) increase in MCI score from site 1 to site 3, which can be attributed to slight differences in habitat, in particular to the increased macrophyte and algal cover recorded at site 1. The MCI scores indicated that the stream communities were of poor 'health' (TRC, 2013) and not significantly (Stark, 1998) different to the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region.

The August 2014 survey was undertaken following hydraulic fracturing activities at the Mangahewa D wellsite. Taxa richness's at site 1 and site 2 were moderate and similar to the median richness recorded by 'control' sites in similar streams elsewhere in the region. Taxa richness at site three however, was much higher than that recorded by the pre-drill survey and higher than the median richness recorded by 'control' sites in similar streams elsewhere in the region. This can be attributed to seasonal differences and slight changes in habitat from the pre-HF to post-HF surveys. A total of 35 taxa was found through the reach of the stream surveyed, with eight of these taxa (23 %) found at all three sites and 11 taxa (31 %), found at any two of these sites.

The MCI scores recorded at site 1 and site 2 in the pre-HF survey indicated that the stream communities were of poor 'health' (TRC, 2013), but similar to the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. Site 3 recorded an MCI score significantly (Stark, 1998) higher than the median of similar 'control' sites elsewhere in the region and indicated that the stream communities at this site were of 'fair' health.

A comparison of the pre-HF and post-HF survey results showed no significant variation in MCI and SQMCI<sub>s</sub> scores between surveys at all three sites. Slight variations in MCI and SQMCI<sub>s</sub> score and taxa richness between sites and surveys is considered to be due to habitat variability rather than a change in water quality.

There was no indication from the results of the two surveys that the hydraulic fracturing activities at the Mangahewa D wellsite have impacted on the biological communities of the unnamed tributary of the Mangahewa D wellsite.

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