

Greymouth Petroleum Limited
Kowhai-B Exploration Wellsite
Monitoring Programme Report
Technical Report 2013–82

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Executive summary

Greymouth Petroleum Limited established a hydrocarbon exploration site located on Ngatimaru Road, Tikorangi, within the New Plymouth district, in the Waiau catchment. The site is called Kowhai-B wellsite. This report covers the period from 20 November 2012- 6 August 2013. During this period, a wellsite was established, and a wellsite drilled, tested, and fractured. The wellsite is now in production.

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

Greymouth Petroleum Limited holds a total of 7 resource consents for the activities at the Kowhai-B wellsite, which include a total of 86 consent conditions setting out the requirements that Greymouth Petroleum Limited must satisfy. Greymouth Petroleum Limited holds consent **9208-1** to take groundwater; consent **9205-1** to discharge emissions to air associated with exploration activities; consent **9209-1** to discharge stormwater and sediment from earthworks during construction onto and into land; consent **9207-1** to discharge contaminants in associated with hydraulic fracturing activates into land; consent **9206-1** to discharge produced water, well workover fluids, well drilling fluids and contaminated stormwater from hydrocarbon exploration and production into land by deep well injection; consent **9204-1** to discharge emissions to air associated with production activities; and consent **9203-1** to discharge treated stormwater and produce water associated with exploration activities to land.

The Council's monitoring programme for the period under review included 15 inspections of the site and surrounding environment, at approximately fortnightly intervals. In total 7 stormwater samples and 6 ground water samples were collected for analysis. In addition, a detailed groundwater monitoring programme was implemented and undertaken to determine whether there were effects from hydraulic fracturing that took place on-site.

The monitoring showed that, in general, good processes and procedures were implemented. A strong focus on the environment by all personnel ensured that the site was mostly clean and tidy.

Any spills on-site were quickly cleaned up to avoid the potential for a contaminant to travel to surface water. The site's stormwater system worked effectively.

Owing to the distance of the wellsite to the nearest stream being approximately 30m, the stream was visually inspected by an Inspecting Officer on each occasion. Chemical analysis or a bio-monitoring survey were un-necessary as no evidence of effects on the stream environment were observed by the Inspecting Officer.

Staff on-site were cooperative with requests made by officers of the Council, with any required works being completed quickly and to a satisfactory standard.

Flaring was carried out onsite during the well clean up and testing phase. Two complaints were received from nearby residents in relation to smoke issues. Neither complaint could be substantiated.

The drilling fluids and cuttings were disposed off site.

During the monitoring period, Greymouth Petroleum Limited demonstrated a high level of environmental performance and compliance with the resource consents. The site was generally neat, tidy, and well maintained.

This report includes recommendations for future drilling operations at this and other sites.

Production testing at the site is on going to evaluate the productivity of the hydrocarbon bearing formations targeted in this drilling programme.

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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 20 November 2012 – 6 August 2013 by the Taranaki Regional Council (the Council) on the monitoring programme associated with recourse consent held by Greymouth Petroleum Limited (GPL). During the period under review, GPL established a wellsite, drilled and tested a well, and hydraulically fractured the target formation.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Greymouth Petroleum Limited that relate to exploration activities at Kowhai-B wellsite located off Ngatimaru Road, Tikorangi in the New Plymouth District.

One of the intents of the Resource Management Act 1991 (the Act) 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 Greymouth Petroleum Limited's use of water, land, and air, and is the first report by the Council for the site.

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 Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consent held by Greymouth Petroleum Limited in the Waiau 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 Kowhai-B 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 Act primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

- (a) The neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
- (b) Physical effects on the locality, including landscape, amenity and visual effects;
- (c) Ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
- (d) Natural and physical resources having special significance (e.g. recreational, cultural, or aesthetic); and
- (e) Risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' in as much as appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Act to assess the effects of the exercising of consents. In accordance with section 35 of the Act, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, (covering both activity and impact 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, and considered responsible resource utilisation 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(s) during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions.
- a **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or minor at most, or, 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, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and any inconsequential non-compliances with conditions were resolved positively, co-operatively, and quickly.

- **improvement desirable (environmental) or improvement desirable (administrative compliance)** (as appropriate) indicates that the Council may have been obliged to record a verified unauthorised incident involving measurable environmental impacts, and/or, there were measurable environmental effects arising from activities and intervention by Council staff was required and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.
- **poor performance (environmental) or poor performance (administrative compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or 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 management

Greymouth Petroleum Limited holds a 15 year Petroleum Mining Permit No. 51378 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 68.120 Km². The Kowhai-B wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Kowhai-B wellsite is located approximately 5.5 km along Ngatimaru Road, approximately 6.5km from Waitara.

The Kowhai-B wellsite was established in 2012 and involved the removal of topsoil to create a firm level platform on which to erect a drilling rig and house 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 flare pit; and
- Other on-site facilities such as accommodation, parking and storage.

The nearest residence is approximately 400 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.

Well creation

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 Kowhai-B wellsite is located approximately 30m to the west of the nearest waterbody which is an unnamed tributary of the Waiau catchment.

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 Waiau 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 fracking, 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. There has been unsuccessful attempts to undertake hydraulic fracturing for coal seam gas in Southland, as well as a coal seam gas pilot plant in the Waikato.

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 hydraulic 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 hydraulic fracturing fluid to return to the surface while leaving the proppant in the fractures.

The chemicals associated with the hydraulic 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 hydraulic 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 hydraulic fractures.

Once a fracture has been initiated, the hydraulic 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].

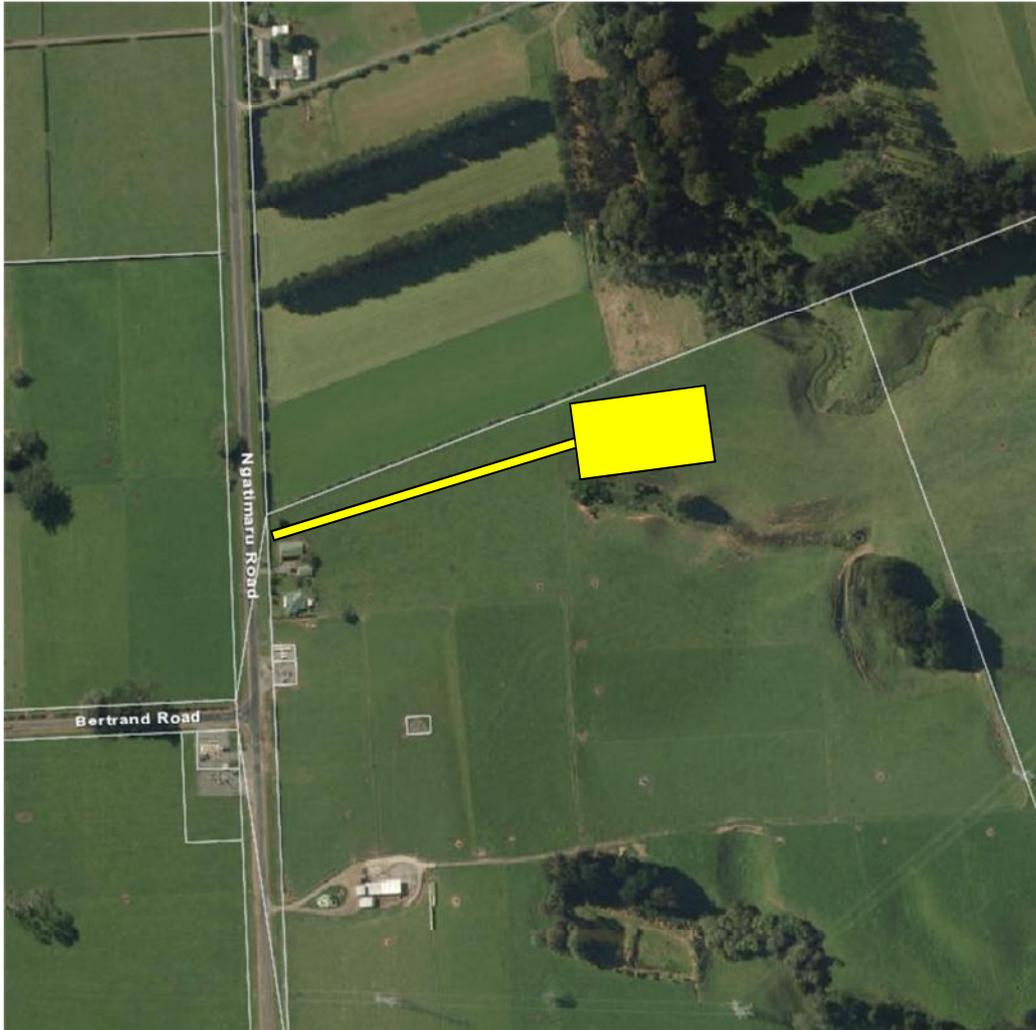


Photo 1 Aerial view showing the location of Kowhai-B wellsite.

1.3 Resource consents

1.3.1 Background

Greymouth Petroleum Limited holds 7 resource consents related to exploration activities at the Kowhai-B wellsite site, as follows:

- Water Permit **9208-1**; granted 23 February 2012,
- Discharge Permit **9203-1**; granted 23 February 2012,
- Discharge permit **9204-1**; granted 28 February 2012,
- Discharge Permit **9205-1**; granted 28 February 2012,
- Discharge Permit **9206-1**; granted 11 May 2012,
- Discharge Permit **9207-1**; granted 29 March 2012 and
- Discharge permit **9209-1**; granted 23 February 2012,

Each of the consent applications were processed on a non-notified basis as Greymouth Petroleum 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 and the Council reports describing the associated activities are contained within Appendix I of this report.

1.3.2 Water abstraction permit (groundwater)

Section 14 of the Act 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 may have exceeded 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.*

Greymouth Petroleum Limited holds water permit **9208-1** to take groundwater that may be encountered as produced water during exploration and production operations at the Kowhai-B wellsite.

Any produced water will be from reserves far below that which is used for domestic or farm purposes. In addition, there are no known groundwater abstractions within a radial distance of 1100 m from the proposed wellsite. Shallow groundwater (which does not have any saltwater content) was to be 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.

This permit was issued by the Council on 23 February 2012 under Section 87(d) of the Act. It is due to expire on 1 June 2027.

Consent conditions were imposed on Greymouth Petroleum 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.

A copy of the permit is attached to this report in Appendix 1.

1.3.3 Water discharge permit (treated stormwater and treated produced water)

Section 15(1)(a) of the Act 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.

Greymouth Petroleum Limited holds water discharge permit 9203-1 to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Kowhai-B wellsite onto and into land.

Consent conditions were imposed on Greymouth Petroleum 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.

This permit was issued by the Council on 23 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2027.

A copy of the permit is attached to this report in Appendix I.

1.3.4 Water discharge permit (stormwater and sediment – earthworks)

Section 15(1)(a) of the Act 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.*

Greymouth Petroleum 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.

Greymouth Petroleum Limited holds water discharge permit **9209-1** to discharge stormwater and sediment from earthworks during construction of the Kowhai-B wellsite onto and into land.

This permit was issued by the Council on 23 February 2012 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2017.

Consent conditions were imposed on Greymouth Petroleum 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.

A copy of the permit is attached to this report in Appendix I.

1.3.5 Air discharge permit (exploration activities)

Section 15(1)(c) of the Act 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 Kowhai-B 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.

Greymouth Petroleum Limited holds air discharge permit **9205-1** to discharge emissions to air from hydrocarbon exploration activities including flaring or incineration of petroleum or combustion of returned hydraulic fracturing fluids associated with well development or redevelopment and testing or enhancement of well heads production flows at the Kowhai-B wellsite.

This permit was issued by the Council on 28 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2027.

Consent conditions were imposed on Greymouth Petroleum 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.

A copy of the permit is attached to this report in Appendix I.

1.3.6 Air discharge permit (production activities)

Section 15(1)(c) of the Act 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 Kowhai-B 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.*

Greymouth Petroleum Limited holds air discharge permit **9204-1** to discharge emissions to air associated with production activities at the Kowhai-B wellsite including flaring associated with emergencies and maintenance and minor emissions from other miscellaneous activities.

This permit was issued by the Council on 28 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2027.

Consent conditions were imposed on Greymouth Petroleum 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.

A copy of the permit is attached to this report in Appendix I.

1.3.7 Discharges to land (hydraulic fracturing)

Sections 15(1)(b) and (d) of the Act 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 Act 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.

Greymouth Petroleum Limited holds discharge permit **9207-1** to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3,000 mTVDSS (true vertical depth sub-surface), beneath the Kowhai-B wellsite.

This permit was issued by the Council on 29 March 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2015.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 12, Section 3.3.

A copy of the permit is attached to this report in Appendix I.

1.3.8 Discharge permit (produced water)

Section 15(1)(a) of the Act 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 discharge of contaminants associated with produced water, onto and into land where contaminants may reach water, is provided for as a discretionary activity under Rule 44 of the RFWP.

Greymouth Petroleum Limited holds discharge permit **9206-1** to discharge produced water, well work over fluids, well drilling fluids and contaminated stormwater from hydrocarbon exploration and production operations into land by deepwell injection below 1185mTVD at the Kowhai-B wellsite.

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

This permit was issued by the Council on 11 May 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2016.

A copy of the permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the Act 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
- Ecological surveys.

The monitoring programme for the Kowhai-B wellsite focused primarily on programme liaison and management, site inspections, and discharges to land. 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;
- 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.

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.

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 staff onsite have regard to wind direction and speed at the time of flaring.

The flare pit is also inspected to ensure that solid and liquid hydrocarbons are not combusted within the flare pit.

It is also a requirement that the Council and immediate land owners are notified prior to any gas being flared. This requirement was checked to ensure compliance with the conditions.

1.4.7 Discharges to land (hydraulic fracturing)

Sampling and analysis of the return flow of hydraulic fracturing fluids and nearby bores were carried out during site inspections. These inspections of the site and surrounding land and water were carried out to ensure that no observable effects have 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 Ecological surveys

Ecological surveys in any nearby streams may be carried out pre and post occupation of the well site to assess whether the activities carried out on-site, and associated discharges have had any effect on ecosystems. However, as the Kowhai-B wellsite is still being occupied, and the fact that visual inspections of the receiving water didn't show any effects from the discharges, no ecological surveys have been undertaken during this monitoring period.

2. Results

2.1 Water

2.1.1 Inspections

The Kowhai-B wellsite, adjacent land and streams were inspected **15** times during this monitoring period.

Below is a copy of the comments that were noted on the day of each inspection.

20 November 2012

The site was neat and tidy, there was no flaring occurring at time of inspection and there was no stormwater discharge from site. The access track was constructed. It was a good flat site with gentle contour to adjacent water body. There were archaeological staff on site to assess historical values of site. No soil had been disturbed at the time of inspection.

9 January 2013

The conductor had been set and drilling of the surface casing was set to commence. The site was tidy and dry. Bunding had been set up around the Halliburton truck and water tanks. The skimmer pits and flare pit had been lined with plastic. Both skimmer pits were empty. The bulk fuel tank had its own steel bund. Site improvements were discussed with the site manager.

21 January 2013

Stormwater samples were taken from the skimmer pit system for analysis to confirm whether resource consent conditions were being complied with. Stormwater was not discharging from the site at the time of inspection.

12 February 2013

The site was very dry due to lack of rain. There were no signs of leaks or contamination on site. The skimmer pits were inspected and found to be empty. The Council inspecting officer also discussed with the site manager the possible flooding of bunded area about chemical stores when raining, and advised of alternative storage options.

15 March 2013

Drilling had completed on the site. The rig close down process was taking place with the rig being moved to another location. The site was busy with moving operations taking place however the site appeared to be rather clean and tidy for this stage of the operation.

There had been some small spills on the site as a result of moving equipment. These spills were being cleaned up. The ring drain had sandbags and silt fencing in place prior to the skimmer pits in an effort to reduce the suspended solids in the skimmer pits during the impending wet period which would be following an extended period of dry weather. Advice was given to ensure the site was clean and tidy prior to the pending wet weather. Skimmer pits were not discharging at the time of inspection, however samples were taken from the first skimmer pit to ensure that discharge would comply with conditions should a discharge occur.

23 March 2013

The site inspection was conducted during hydraulic fracturing activities. A general site inspection was carried out. Tanks associated with hydraulic fracturing activities were earth banded with no sign of any leaking components. Skimmer pits and ring drain were checked and both appeared to be in a good working order. The flare pit was also inspected as flaring was expected to begin in the next few weeks. The flare pit was clean and tidy, however some of the plastic lining of the pit had been exposed. This lining would have to be covered up prior to flaring to prevent any damage to the lining.

There had been an initial spill in relation to the hydraulic fracturing activities which was quickly contained to a small area onsite. The ring drain and skimmer pits were not contaminated. The spill was quickly cleaned up with a sucker truck called to the site prior to the continuation of the operation. The faulty equipment was replaced and the operation proceeded without any further issues. Samples of the fracturing fluid were collected to be analysed. The site of the spill would be further cleaned, with possible, contaminated material removed from site.

27 March 2013

An inspection was completed onsite in relation to both compliance monitoring and the Council receiving a complaint in relation to the burning of material at the site in or about the flare pit. An inspection of the site was conducted and found that activities on site were undertaken within the conditions of resource consent 9205-1. Inspection found that there was no evidence to suggest that material other than gas was being combusted on site. General site inspection found that the site was in a clean and tidy manner. The ring drains were in good condition with all site drainage being directed to the ring drain, through sediment traps and into the skimmer pits.

4 April 2013

At the time of inspection testing was taking place on site with the first zone being tested. The flare pit was in operation. There were orange flames, with no black smoke being produced.

Machinery in relation to the fracturing activities had been removed from the site and the area of the site where the previous spill of fracturing fluid occurred had been scraped of the gravel and fresh gravel replaced. The skimmer pits and ring drains were inspected. The skimmer pits were not discharging at the time of inspection, however samples were taken to ensure that discharge would comply with consent conditions should a discharge occur.

18 April 2013

There was no activity on site at the time of inspection. Testing and flaring had stopped however more may occur in the future. There were personnel onsite and the site appeared to be clean and tidy with skimmer pits and ring drains in good working order. The skimmer pits were not discharging at the time of inspection, however samples taken were to ensure that discharge would comply with consent conditions should a discharge occur.

24 April 2013

The well was shut in with no flaring, testing or production at the site at the time of inspection. Staff remained on site and the site was in a clean and tidy condition.

Bunding about the storage tanks appeared to be in good working order with no damage from the recent heavy rain in the region. Skimmer pits were full but not discharging at the time of the inspection. Samples were taken from the second skimmer pit to ensure discharge would comply with consent conditions should a discharge occur.

The ring drains were inspected and appeared to be in a good working order, directing all storm water through the skimmer pits prior to discharge from the site. The flare pit was inspected and was clean and tidy at the time of inspection.

25 May 2013

Investigation on site followed a complaint regarding smoke being produced as a result of flaring onsite. Records kept on site show that flaring had been continuous on site since 21 May 2013 at 1415hrs. Some black smoke was produced as a result of the flaring, however this quickly dissipated about the flare with no offensive smoke or environmental effects. Smoke was not considered to be offensive at time of inspection. Consent conditions were being complied with at the time of inspection.

7 June 2013

Inspection of the site found that the site was in a clean and tidy condition. Testing with the associated flaring had been completed on site with no intention to complete any further testing at this stage. The flare log had been recorded and a copy had been received by the Council. The pilot flare was burning in the flare pit at time of inspection.

A thermal oxidiser had also been tested on site however this testing had been completed. A pipeline was being laid to the site to allow full production of the well in the coming months. The skimmer pits were not discharging at the time of the inspection, however samples were taken to ensure that the discharge would comply with consent conditions should a discharge occur.

11 June 2013

The ring drains were in a working order, however there were shipping containers onsite, and when they are removed the ring drains would need to be checked again to ensure they had not been damaged during removal. The thermal oxidiser was on site but not in use, and the pilot flare was being flared in the pit for safety purposes. Overall the site was clean and tidy at time of inspection.

25 June 2013

The inspection was undertaken with the site manager. The storm water systems were inspected and found to be operating in accordance with the information and site plans as submitted to Council. Skimmer pits were not discharging off site and shut off valves were fitted to all outlets as required.

25 July 2013

The site inspection found that work was continuing on site to link the well into the installed pipeline. Earth bund had been moved onsite within the ring drain area. The skimmer pits were full but not discharging at the time of inspection. The pilot flare was burning in the flare pit, however no smoke observed as a result.

The large shipping containers had been removed from the site. The ring drain along the edge of the site (opposite the earth bunding) required work to increase its volume and to ensure that any stormwater collected in this drain flows toward the skimmer pit treatment system and does not pool within the drain. There were some silt controls along the ring drain next to the earth bund which should help to prevent suspended solids entering the skimmer pit treatment system.

2.1.2 Results of abstraction and discharge monitoring

During the period under review, stormwater was not observed discharging. There were 7 skimmer pit stormwater samples collected during the review period for this report and chemical analysis of the stormwater was carried out. All of the stormwater samples except one were collected from the second skimmer pit at the Kowhai-B wellsite. The exception was collected from the first skimmer pit.

Analysis of the samples collected showed that all but one of the discharges would have been in compliance with resource consent conditions should a discharge have occurred (see further below).

All sewage was directed for treatment through a septic tank system and removed by contractor to a licensed disposal facility. Inspections of the stormwater discharge found it to be mostly clear. No odours were found to be associated with the discharge.

Table 1 Results of water samples taken from the skimmer pits on seven occasions during the monitoring period

Parameters	Consent limit	21 January 2013	12 February 2013	15 March 2013	04 April 2013	18 April 2013	24 April 2013	07 June 2013
Chloride (g/m ³)	50	12.6	14.6	34	18.1	17.1	10.5	5.1
pH	6-9	7.2	9.4	8.1	7.6	7.9	7.4	7.0
Suspended Solids (g/m ³)	100	74	8	39	42	35	51	59
Hydrocarbon (g/m ³)	15	<0.5	<0.5	1.4	<0.5	<0.5	<0.5	1.3

On 12 February 2013, a sample taken from the skimmer pit showed an elevated pH. Upon investigation it was considered that this was due to the consequences of photosynthetic activity of algae growing in the skimmer pit under hot, sunny and dry conditions, rather than any chemical source. The water level in the pit was very low at the time of inspection. 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. No remedial action was required by the council.

2.1.3 Results of receiving environment monitoring

The authorised discharges offsite were onto land from the skimmer pits. It is considered that the discharge was unlikely to reach a surface water body due to the small catchment area of the site.

The receiving surface water body was visually inspected in conjunction with site inspections. No effects were observed and the stream appeared clear with no visual change in colour or clarity. There was also no odour, oil, grease films, scum, foam or suspended solids observed in the stream 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 above for comments concerning site inspections.

2.2.2 Results of discharge monitoring

Kowhai-B wellsite notified the Council of its intention to test the well and flare gas intermittently between 19 March 2013 and 17 May 2013. During inspections of the site the Inspecting Officer found there were no offensive or objectionable odours, smoke or dust associated with activities at Kowhai-B wellsite. There were two occasions when the Taranaki Regional Council received complaints regarding smoke from flaring at the Kowhai-B wellsite. Following each complaint, on 27 March and 25 May 2013, an Inspectorate Officer visited the site and found that the smoke was not considered as being offensive and the consent conditions were being complied with at the time of the inspection.

It appeared that Greymouth Petroleum Limited took all practicable steps to mitigate any effects of smoke, which included ensuring that plant equipment was working effectively and having regard to wind direction and speed. In regard to the smoke issue noted above no offensive or objectionable smoke or odours were observed by Inspecting Officers.

The flare pit was inspected during most inspections to ensure that solid and liquid hydrocarbons were not combusted within the flare pit. There was no evidence to suggest that solid and liquid hydrocarbons were being combusted through the gas flare system.

From observations during site inspections, including the inspection of the flare log maintained by Greymouth Petroleum Limited, it appeared that special conditions relating to the control of emissions to air from the flaring of hydrocarbons were complied with.

2.2.3 Results of receiving environment monitoring

No monitoring of the receiving environment was carried out as inspections found no offensive or objectionable odours, smoke or dust that were associated with activities at the site.

No chemical monitoring of air quality was undertaken during the testing phase of the Kowhai-B wellsite as the controls implemented by Greymouth Petroleum Limited did not give rise to any concerns with regard to air quality.

As mentioned in Section 2.2.2, visual inspections of the flare, the flare pit and surrounding area were carried out and no effects were observed.

During monitoring inspections of the site the Inspecting Officers found there were no offensive or objectionable odours, smoke or dust associated with activities at the Kowhai-B wellsite.

2.2.4 Other ambient monitoring

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

2.3 Land

2.3.1 Inspections (hydraulic fracturing)

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

2.3.2 Results of receiving environment monitoring (hydraulic fracturing)

Only 1 well has been established at the Kowhai-B wellsite.

Greymouth Petroleum Limited notified Council of the proposed hydraulic fracturing discharge operation for 1 well. The Council developed the Kowhai-B wellsite Groundwater Monitoring Programme in consultation with Greymouth Petroleum Limited. This monitoring programme included 3 sampling locations which were selected based on their proximity to the Kowhai-B wellsite and their individual construction and usage characteristics. The site selection is designed to provide a sample set representative of groundwater abstractions in the area surrounding the site. Table 2 outlines the details of the sites selected for inclusion in the programme. Photo 2 overleaf shows the sampling sites in relation to the discharge site.

Table 2 Sampling site details

Site No.	Depth (m)	Easting (m)	Northing (m)
GND2324	unknown depth to aquifer	1711045	5678057
GND2318	unknown depth to aquifer	1711305	5678621
GND2319	unknown depth to aquifer	1710544	5677823



Photo 2 Aerial view showing the approximate location of Kowhai-B wellsite and the three groundwater sampling locations

The monitoring programme provides for an initial 12 months of groundwater monitoring. Groundwater samples will be obtained from the sampling sites recorded in Table 2 at the following specified intervals:

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

During the initial hydraulic fracturing event, a sample of the hydraulic fracturing fluids used and fluids returning to the well head was obtained and analysed for the same parameters as the groundwater samples. Table 3 below provides the results from the return hydraulic fracturing fluid from the Greymouth Petroleum Limited well which was hydraulic fractured during the monitoring period.

Table 3 Composite of return hydraulic fracturing fluid from Kowhai-B wellsite

Parameter	Unit	02 April 2013
Total Alkalinity	g/m ³ CaCO ₃	810
Barium	mg/kg	0.135
Benzene	g/m ³	0.21
Calcium	g/m ³	22
Chloride	g/m ³	230
Conductivity	mS/m@20°C	213
Copper (dissolved)	g/m ³	0.005
Ethylbenzene	g/m ³	0.026
Dissolved ethane gas	g/m ³	<0.003
Ethylene	g/m ³	<0.003
Iron (dissolved)	g/m ³	0.004
Formaldehyde	g/m ³	<0.15
Ethylene glycol	g/m ³	<4
Total petroleum hydrocarbons	g/m ³	-
Hardness	g/m ³ CaCO ₃	86
Potassium	g/m ³	1.0
Methanol	g/m ³	<2
Dissolved methane gas	g/m ³	0.004
Magnesium	g/m ³	0.4
Manganese (dissolved)	g/m ³	0.0010
Sodium	g/m ³	0.4
Nickel	mg/kg	0.006
Nitrate/nitrite nitrogen	g/m ³ N	0.002
Nitrite nitrogen	g/m ³ N	0.002
Nitrate nitrogen	g/m ³ N	0.002
pH	pH	6.8
Sulphate	g/m ³	2
Toluene	g/m ³	<0.010
Xylene-1	g/m ³	<0.005
Xylene-2	g/m ³	0.006
Zinc (dissolved)	g/m ³	0.004
Bicarbonate	g/m ³ HCO ₃	988.2
Total Dissolved Solids	g/m ³	-

The original Kowhai-B wellsite Groundwater Monitoring Programme 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. As such, the Council decided the Kowhai-B wellsite Groundwater Monitoring Programme should follow the latest range. Therefore, the groundwater monitoring programme was subsequently revised and approved by the Chief Executive of the Council (and hence the consent holder is deemed to be in compliance with the groundwater monitoring conditions of the consent). The revised parameters that were analysed are as follows:

- pH;
- Conductivity;
- Total dissolved solids;

- 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 ($^{13}\text{C-CH}_4$).

A site inspection was undertaken during the first hydraulic fracturing operation, on 23 March 2013. As part of the inspection, the Inspecting Officer inspected the site and surrounding area to determine whether there were any effects from the hydraulic fracturing operation. This inspection found that there were no observed effects from the discharge.

No bio-monitoring surveys of receiving surface waters were carried out as the controls implemented by Greymouth Petroleum Limited did not give rise to any concerns with regard to effects on surface water quality during fracturing activities, and the Council's inspections confirmed any absence of visual effects.

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 outlined within Table 4 – 6 for the three sites.

Table 4 Groundwater monitoring results for site GND2319

Parameter	Unit	Pre-frac 14 March 2013	Post-frac 09 July 2013
Total Alkalinity	g/m ³ CaCO ₃	46	29
Barium	mg/kg	0.0071	-
Benzene	g/m ³	<0.0010	<0.0010
Bromide	g/m ³	0.35	-
Calcium	g/m ³	12.1	11.6
Chloride	g/m ³	22	14.8
Conductivity	mS/m@20°C	16.7	13.8
Copper (dissolved)	g/m ³	<0.0005	0.0005
Ethylbenzene	g/m ³	<0.0010	<0.0010
Dissolved ethane gas	g/m ³	<0.003	<0.003
Ethylene	g/m ³	<0.0003	<0.004
Iron (dissolved)	g/m ³	0.83	0.35
Formaldehyde	g/m ³	<0.02	<0.02
Ethylene glycol	g/m ³	<4	<4
Total petroleum hydrocarbons	g/m ³	<0.7	<0.7
Hardness	g/m ³ CaCO ₃	45	39
Potassium	g/m ³	5.7	3.0

Parameter	Unit	Pre-frac 14 March 2013	Post-frac 09 July 2013
Methanol	g/m ³	<2	<2
Dissolved methane gas	g/m ³	0.33	0.013
Magnesium	g/m ³	3.5	2.4
Manganese (dissolved)	g/m ³	0.78	0.041
Sodium	g/m ³	12.3	8.3
Nickel	mg/kg	<0.0005	-
Nitrate/nitrite nitrogen	g/m ³ N	<0.002	0.36
Nitrite nitrogen	g/m ³ N	<0.002	0.013
Nitrate nitrogen	g/m ³ N	<0.002	0.35
pH	pH	6.8	6.4
Sulphate	g/m ³	<0.5	13.3
Toluene	g/m ³	<0.0066	<0.0010
Xylene-1	g/m ³	<0.0010	<0.0010
Xylene-2	g/m ³	<0.002	<0.002
Zinc (dissolved)	g/m ³	<0.021	<0.0048
Bicarbonate	g/m ³ HCO ₃	56	35
Total dissolved solids	g/m ³	80	88

Table 5 Groundwater monitoring results for site GND2324

Parameter	Unit	Pre-frac 14 March 2013	Post-frac 09 July 2013
Total alkalinity	g/m ³ CaCO ₃	44	32
Barium	mg/kg	0.079	0.043
Benzene	g/m ³	<0.0010	<0.0010
Bromide	g/m ³	<0.05	<0.05
Calcium	g/m ³	13.2	11.2
Chloride	g/m ³	32	7.5
Conductivity	mS/m@20°C	22.7	12.9
Copper (dissolved)	g/m ³	0.0008	<0.0005
Ethylbenzene	g/m ³	<0.0010	<0.0010
Dissolved ethane gas	g/m ³	-	-
Ethylene	g/m ³	<0.003	<0.004
Iron (dissolved)	g/m ³	1.79	0.72
Formaldehyde	g/m ³	<0.02	<0.02
Ethylene glycol	g/m ³	<4	<4
Total petroleum hydrocarbons	g/m ³	-	-
Hardness	g/m ³ CaCO ₃	47	37
Potassium	g/m ³	12.4	6.2
Methanol	g/m ³	<2	<2
Dissolved methane gas	g/m ³	-	-
Magnesium	g/m ³	3.4	2.2
Manganese (dissolved)	g/m ³	0.26	0.27
Sodium	g/m ³	15.8	6.1
Nickel	mg/kg	<0.0005	<0.0005
Nitrate/nitrite nitrogen	g/m ³ N	<0.002	0.194
Nitrite nitrogen	g/m ³ N	<0.002	0.003
Nitrate nitrogen	g/m ³ N	<0.002	0.192

Parameter	Unit	Pre-frac 14 March 2013	Post-frac 09 July 2013
pH	pH	6.0	6.1
Sulphate	g/m ³	12.3	14.6
Toluene	g/m ³	<0.0010	<0.0010
Xylene-1	g/m ³	<0.0010	<0.0010
Xylene-2	g/m ³	<0.002	<0.002
Zinc (dissolved)	g/m ³	0.002	0.067
Bicarbonate	g/m ³ HCO ₃	54	39
Total dissolved solids	g/m ³	136	90

Table 6 Groundwater monitoring results for site GND2318

Parameter	Unit	Pre-frac 14 March 2013	Post-frac 09 July 2013
Total alkalinity	g/m ³ CaCO ₃	55	29
Barium	mg/kg	0.069	0.043
Benzene	g/m ³	<0.0010	<0.0010
Bromide	g/m ³	<0.05	-
Calcium	g/m ³	11.5	12.3
Chloride	g/m ³	28	21
Conductivity	mS/m@20°C	22.9	17.7
Copper (dissolved)	g/m ³	<0.0010	0.0005
Ethylbenzene	g/m ³	<0.0010	<0.0010
Dissolved ethane gas	g/m ³	<0.003	<0.003
Ethylene	g/m ³	<0.003	<0.004
Iron (dissolved)	g/m ³	2.0	<0.02
Formaldehyde	g/m ³	<0.02	<0.02
Ethylene glycol	g/m ³	<4	<4
Total petroleum hydrocarbons	g/m ³	<0.7	<0.7
Hardness	g/m ³ CaCO ₃	44	41
Potassium	g/m ³	15	10.4
Methanol	g/m ³	<2	<2
Dissolved methane gas	g/m ³	-	-
Magnesium	g/m ³	3.7	2.6
Manganese (dissolved)	g/m ³	0.147	0.0088
Sodium	g/m ³	14.1	11.5
Nickel	mg/kg	<0.0005	<0.0005
Nitrate/nitrite nitrogen	g/m ³ N	0.078	1.88
Nitrite nitrogen	g/m ³ N	<0.014	<0.002
Nitrate nitrogen	g/m ³ N	0.065	1.88
pH	pH	7	6.2
Sulphate	g/m ³	7.8	13.4
Toluene	g/m ³	<0.0010	<0.0010
Xylene-1	g/m ³	<0.0010	<0.0010
Xylene-2	g/m ³	<0.002	<0.002
Zinc (dissolved)	g/m ³	<0.0045	0.0132
Bicarbonate	g/m ³ HCO ₃	67	35
Total dissolved solids	g/m ³	126	118

The results in Tables 4 to 6 above, from the pre and post-hydraulic fracturing discharge show parameters that are all within the typical range for background Taranaki shallow groundwater.

It is considered that the slight variations seen in Tables 4 to 6 are not a result of hydraulic fracturing operations, but are natural variances in groundwater between sites and as seasons change. No levels are of any environmental significance.

2.3.3 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 (25 July 2013) as the well was still currently producing, and the site is still in use.

2.4 Contingency plan

Greymouth Petroleum Limited has provided a general contingency plan, as required by Condition 7 of recourse consent **9203-1**, with site specific maps which cover all onshore sites that they operate. The contingency plan has been reviewed and approved by officers of the Council.

2.5 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, there were two incidents recorded by the Inspecting Officers during inspections.

On 26 March 2013, a complaint was received regarding flaring activities at the Kowhai-B wellsite at Ngatimaru Road, Tikorangi. A site inspection found that flaring was being undertaken at the Kowhai-B wellsite and that this was in accordance with consent conditions **9205-1**.

On 25 May 2013 a further complaint was received regarding flaring activities at the Kowhai-B wellsite. A subsequent investigation on site found that although some smoke was being emitted on site as a result of flaring this quickly dissipated about the flare and no offensive smoke or environmental effects were observed onsite.

Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. Greymouth Petroleum 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 7 resource consent relating to the Kowhai-B wellsite, consents **9208-1** (take groundwater), **9205-1** (air discharge associated with exploration), **9203-1** (to discharge treated stormwater and produced water), **9209-1** (to discharge stormwater and sediment from earthworks during construction), and **9207-1** (discharge to land – hydraulic fracturing) were exercised and actively monitored.

Flaring in association with production activities was not exercised during the monitoring period as permitted by resource consent **9204-1** (air discharge associated with production).

Discharges of produce, well workover fluids, well drilling fluids and contaminated stormwater into land via deep well injection was not exercised during the monitoring period as permitted by resource consent **9206-1**. Drilling waste was transported off site to a consented facility. It is considered that all remaining resource consent conditions were complied with during the monitoring period, including the provision of various pieces of information (contingency plan, notifications etc.).

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, Greymouth Petroleum 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.

Greymouth Petroleum 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 if required.

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 site¹. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.²

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 PM₁₀ 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.

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

² 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 measures to be undertaken by Greymouth Petroleum Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality included:

- 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 Greymouth Petroleum Limited and provided to the Council;
- Every endeavor was made by Greymouth Petroleum 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 Greymouth Petroleum Limited to minimise smoke emissions from the flare.

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.

Greymouth Petroleum 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;
- Ignition sources were not permitted on any site;
- 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 of the chemicals (e.g. clay stabilisers) being absorbed into the rock and some get residually trapped near the fracture face. The chemicals used in the hydraulic fracturing process are chemicals that 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. 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 was 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. Hydraulic fracturing is designed to create certain fractures in the rock and on a geological scale these are insignificant. The fissures created by the hydraulic fracturing discharge will be 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 seismic activity.

The risk of the reservoir being fractured with a failure of the geological seal causing hydraulic fracturing 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 hydraulic fracturing 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 hydraulic 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.

Throughout the hydraulic fracturing operation, the activity is carefully monitored by Greymouth Petroleum Limited to track exact composition, volume and pressure of all fluids being injected into the sub-surface environment. 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 environmental effects observed to water, land or air as a result of the exploration drilling and fracturing during the monitoring period. There were no unauthorised discharge to water or the air observed from the Kowhai-B wellsite.

3.3 Evaluation of performance

A tabular summary of Greymouth Petroleum Limited's compliance record for the period under review is set out in Tables 7- 13.

Table 7 Summary of performance for Consent 9208-1 to take groundwater that may be encountered during exploration and production operations at Kowhai-B 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	Complaints	Yes – no complaints were received
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 shall lapse if not implemented by date specified	Notification received and confirmed by inspection	N/A
5. 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		Good

Table 8 Summary of performance for Consent 9204-1 to discharge emissions to air associated with production activities including flaring associated with emergencies and maintenance and minor emissions from other miscellaneous activities at the Kowhai-B 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	Notification received 24hrs prior to flaring	N/A – consent not exercised
2. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	N/A – consent not exercised
3. Only substances originating from well stream to be combusted in flare pit	Visual inspection of site	N/A – consent not exercised
4. Best practicable option adopted	Visually inspecting site, procedures & processes	N/A – consent not exercised
5. No offensive odour or smoke beyond boundary	Assessment by investigating officer	N/A – consent not exercised
6. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A – consent not exercised
7. Control of carbon monoxide	Chemical analysis of emissions	N/A – consent not exercised
8. Control of other emissions	Chemical analysis of emissions	N/A – consent not exercised

Condition requirement	Means of monitoring during period under review	Compliance achieved?
9. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A – consent not exercised
10. Log all flare events longer than 5 minutes (10 minutes aggregate or longer than 120 minutes) including time, duration, zone and reason for flare	Inspection of Company records	N/A – consent not exercised
11. Consent shall lapse if not implemented by date specified	Notification of flaring received/not received	N/A – consent not exercised
12. Notice of Council to review consent	No provision for review during period	N/A – consent not exercised
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised

Table 9 Summary of performance for Consent 9205-1 to discharge emissions to air from flaring of hydrocarbon exploration activities including flaring of petroleum from natural deposits and combustion of returned hydraulic fracturing fluids associated with well

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Flaring shall not occur for more than 15 days per zone, for up to four zones per well, for up to 8 wells	Inspection of records	Yes
2. 24hrs notice of flaring to the Council for initial flare of each zone	Notification received 24hrs prior to flaring	Yes
3. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	Yes
4. No liquid or solid hydrocarbons are to be combusted in the flare pit	Inspection of flare pit and flare	Yes
5. Best practicable option adopted	Visually inspecting site, procedures & processes	Yes
6. No offensive odour or smoke beyond boundary	Assessment by investigating officer	Yes
7. Control of carbon monoxide	Inspections confirming chemical analysis not required	N/A
8. Control of other emissions	Inspections	N/A
9. Analysis of typical gas and crude oil stream from field to be made available to the Council	Available upon request	N/A
10. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A
11. Log all flaring including time, duration, zone and volumes flared	Inspection of Company records	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
12. Report to the Council the time, duration and cause of each smoke incident	Inspection of Company records	N/A
13. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes
14. Notice of Council to review consent	No provision for review during period	N/A
15. 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

Table 10 Summary of performance for Consent 9203-1 to discharge treated stormwater, and produced water from hydrocarbon exploration and production operations at the Kowhai-B wellsite onto and into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. 7 days written notice prior to site works and drilling	Notification received	Yes
3. Max stormwater catchment area 7,500 m ²	Inspection of site and records	Yes
4. All discharges to be directed for treatment through skimmer pit. Stormwater pits to be impermeable	Visual inspection of stormwater system	Yes
5. Constituents in the discharge shall meet standards	Sampling of discharge	Yes
6. Discharge of chloride shall not exceed 50 ppm	Sampling of discharge	Yes
7. Maintain a contingency plan	Contingency plan received and approved	Yes
8. The stormwater system shall be designed, managed and maintained in accordance with information submitted	By comparing submitted & approved plans with the built site inspection	Yes
9. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A – consent exercised
10. 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

Table 11 Summary of performance for Consent 9209-1 to discharge stormwater and sediment from earthworks during construction of the Kowhai-B wellsite onto and into land.

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. 7 days written notice prior to site earthworks	Notification received	Yes
3. 7 days written notice prior to site operations and drilling	Notification received	Yes
4. All runoff shall pass through settlement ponds or traps with a minimum capacity of 100 m ³	Site erosion and sediment control plan submitted	Yes
5. Condition 4 will not apply when site is stabilised	Visual inspection	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Visual inspection	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 12 Summary of performance for the original Consent 9207-1 to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3000 mTVD beneath the Kowhai-B wellsite.

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Any discharge shall occur below 3,000 mTVDSS	Inspection of Company records	Yes
2. Exercise of consent shall not contaminate or put at risk freshwater aquifers	Sampling fresh water bores pre/post discharge	Yes
3. Consent Holder shall undertake sampling programme	Sampling fresh water bores pre/post discharge	Yes
4. Sampling programme shall follow recognised field procedures	Visual inspection	Yes
5. All sampling shall be submitted to the Council	Notification received	Yes
6. Consent Holder shall undertake pressure testing pre-fracturing	Notification received	Yes
7. A pre-fracturing discharge report is to be provided to the Council within 10 days prior to the second and subsequent discharges	Pre-fracturing discharge report submitted 10 days prior to discharge	Yes
8. Consent holder shall notify the Council of a pre-fracturing discharge	Notification received	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
9. A post-fracturing discharge report is to be provided to the Council within 7 days after the discharge has ceased	Post-fracturing discharge report submitted within 7 days	Yes
10. The report must be emailed to consents@trc.govt.nz	The report is emailed to consents@trc.govt.nz	Yes
11. The consent holder shall provide access to a location where samples of hydraulic fracturing fluids and return fluids can be obtained.	Access provided	Yes
12. Best practicable option adopted at all times	Visually inspecting site, procedures & processes	Yes
13. The fracture fluid shall be comprised of no less than 95% water	Sample of discharge and return fluids analysed	Yes
14. 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

Table 13 Summary of performance for Consent 9206-1 to discharge produced water, well work over fluids, well drilling fluids and contaminated storm water from hydrocarbon exploration and production operations into land by deepwell injection below 1185 mTVD at the Kowhai-B wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder shall submit an Injection Operation Management Plan to council	Report received	N/A – consent not exercised
2. Consent holder shall provide log information to the Council	Information received	N/A – consent not exercised
3. Injection pressure shall not exceed 26.1 bar (379 PSI)	Notification received/not received	N/A – consent not exercised
4. Injection rate shall not exceed 14.3 m ² / hr (1.5 bpm)	Notification received/not received	N/A – consent not exercised
5. Volume of fluid Intentioned shall not exceed 300 m ³ / day	Notification received/not received	N/A – consent not exercised
6. Injection of fluid shall be confined to the Mount Messenger Formation deeper than 1/185 m TVD	Notification received/not received	N/A – consent not exercised
7. Best practicable option adopted at all times	Visually inspecting site, procedures & processes	N/A – consent not exercised
8. Fluids originating from the site may be discharged	Notification received/not received	N/A – consent not exercised
9. Consent Holder shall keep daily records and submit to council	Notification received/not received	N/A – consent not exercised

Condition requirement	Means of monitoring during period under review	Compliance achieved?
10. Records must be made available to the council	Report Received	N/A – consent not exercised
11. Contaminants shall not reach ground water	Notification received/not received	N/A – consent not exercised
12. Sampling programme shall follow recognised field procedures	Visual inspection	N/A – consent not exercised
13. Discharge shall meet certain standards	Sample of discharge fluids analysed	N/A – consent not exercised
14. Sampling programme shall follow recognised field procedures	Visual inspection	N/A – consent not exercised
15. The report must be emailed to consents@trc.govt.nz	The report is emailed to consents@trc.govt.nz	N/A – consent not exercised
16. 5 days' notice to Council of any site works or drilling operations	Check that notification has been received by the Council	N/A – consent not exercised
17. 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

During the monitoring period, Greymouth Petroleum Limited demonstrated a high level of environmental performance and compliance with the resource consents. The incidents that occurred in respect of resource consent 9205-1 have been discussed in Section 2.5. The site was generally neat, tidy, and well maintained.

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 2014 and 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. A recommendation to this effect is presented in section 4.

3.5 Alterations to monitoring programmes for hydraulic fracturing activities

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 bio-monitoring 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. Accordingly 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 the case of the Kowhai-B wellsite, the monitoring programme was based on this pre-existing regime. Given that the primary effects of concern (had they occurred) would have involved the vertical migration of sediment, hydraulic fracturing fluids and/or hydrocarbons, all of which are easily detectable through inspection and visual scrutiny, this represented an appropriate and well-grounded approach. The wide-ranging scope of the routine inspections in this particular programme to include adjacent waterways and feedback from local residents should particularly be noted.

However, 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 where hydraulic fracturing is to occur or has occurred. Notwithstanding the long track record of a demonstrable suitability of an inspection-based monitoring programme, 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 bio-monitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities. This extended programme is in place and continues at Kowhai-B wellsite.

It is proposed that for any further work at the Kowhai-B wellsite, the new standard programme will 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 Company be asked to inform the Council of the intention to either drill, test or undertake reinstatement;
3. THAT the monitoring of future consented activities at Kowhai-B wellsite be extended to include the sampling and extensive analysis of both groundwater and surface waters in the general vicinity of a wellsite where hydraulic fracturing occurs;
4. THAT the monitoring of future consented activities at Kowhai-B wellsite be extended to include an ecological survey;
5. THAT, subject to the findings of monitoring of any further activities at the Kowhai-B wellsite consents 9203-3, 9203-4, 9203-5, 9203-8 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
<i>E.coli</i>	<i>Escherichia coli</i> , 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 ³	elevated flow in a stream, such as after heavy rainfall grammes per cubic metre, and equivalent to milligrammes 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 ₄	ammonium, normally expressed in terms of the mass of nitrogen (N)
NH ₃	unionised ammonia, normally expressed in terms of the mass of nitrogen (N)
NO ₃	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 ₁₀	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 held by
Greymouth Petroleum Limited
Kowhai-B Wellsite**



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 23 February 2012

Commencement Date: 23 February 2012

Conditions of Consent

Consent Granted: To discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Kowhai-B wellsite onto and into land at or about (NZTM) 1711151E-5677770N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

Catchment: Waiau

General condition

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

Special conditions

- 1. 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. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 working days before any site works commencing, and again in writing at least 7 working days before 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.
- 3. Stormwater discharged shall be collected from a catchment area of no more than 7500 m².
- 4. All stormwater and produced water shall be directed for treatment through the skimmer pit(s) before being discharged. All stormwater pits shall have impermeable side walls and floor to prevent leakage.
- 5. Constituents in the discharge shall meet the standards shown in the following table.

<u>Constituent</u>	<u>Standard</u>
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm ⁻³
total recoverable hydrocarbons	Concentration not greater than 15 gm ⁻³ [as determined by infrared spectroscopic technique]
chloride	Concentration not greater than 50 gm ⁻³

- 6. The discharge shall have a chloride concentration no greater than 50 ppm.
- 7. The consent holder shall maintain a contingency plan that, to the satisfaction of the Chief Executive, Taranaki Regional Council, details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

Consent 9203-1

8. 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 adverse effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and emailed to worknotification@trc.govt.nz.
9. This consent shall lapse on 31 March 2017, 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.
10. 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 23 February 2012

For and on behalf of
Taranaki Regional Council


Director-Resource Management



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 28 February 2012

Commencement
Date: 28 February 2012

Conditions of Consent

Consent Granted: To discharge emissions to air associated with production activities at the Kowhai-B wellsite, including:

- flaring associated with emergencies and maintenance; and
- minor emissions from other miscellaneous activities at or about (NZTM) 1711149E-5677744N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

General condition

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

Special conditions

1. Other than in emergencies, 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.
2. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.
3. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.
4. 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, including, but not limited to, having 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 (other than for the maintenance of a pilot flare flame).
5. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
6. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
7. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM₁₀) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.
8. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 7, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.

Consent 9204-1

9. 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 C₅ or higher number of compounds.
10. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:
 - a) the date, time and duration of all flaring episodes;
 - b) the zone from which flaring occurred;
 - c) the volume of substances flared;
 - d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.
11. This consent shall lapse on 31 March 2017, 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.
12. 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 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; and/or
 - b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Signed at Stratford on 28 February 2012

For and on behalf of
Taranaki Regional Council


Director-Resource Management



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

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Please quote our file number
on all correspondence

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 28 February 2012

Commencement
Date: 28 February 2012

Conditions of Consent

Consent Granted: To discharge emissions to air from hydrocarbon exploration activities at the Kowhai-B wellsite, including:

- flaring or incineration of petroleum recovered from natural deposits; and
- combustion of returned hydraulic fracturing fluids associated with well development or redevelopment and testing or enhancement of well head production flows at or about (NZTM) 1711149E-5677744N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

*For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document*
www.trc.govt.nz

General condition

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

Special conditions

1. Flaring from each zone shall not last longer than 15 days, cumulatively, from a maximum of 4 zones per well and a maximum of 8 wells.
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.
3. To the greatest extent practicable, all gas that is flared must first be treated by effective liquid and solid separation and recovery.
4. Subject to special condition 3 above, no liquid or solid hydrocarbons shall be combusted through the gas flare system (with the exception of the flow of returned hydraulic fracturing fluids to flare when undertaken for safety reasons). Where returned hydraulic fracturing fluids are to be combusted in the flare pit, the consent holder shall ensure that the flare pit is lined using an impermeable membrane.
5. 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, including, but not limited to, having 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 (other than for the maintenance of a pilot flare flame).
6. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
7. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM₁₀) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.

8. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 7, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.
9. 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 C₆ or higher number of compounds.
10. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
11. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council upon request, a 'flaring log' that includes:
 - a) the date, time and duration of all flaring episodes;
 - b) the zone from which flaring occurred;
 - c) the volume of substances flared;
 - d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.
12. Further to condition 11 above, the consent holder shall, for every contingency event of flaring of returned hydraulic fracturing fluids when undertaken for safety reasons, provide to the Chief Executive, Taranaki Regional Council, within 30 days a record of time, duration, reason for the contingency flaring being required, prevailing weather conditions at the time, the quantity of fluids discharged to air (whether by combustion within the flare or by evaporation or volatilisation), and any complaint or enquiry received from the public including any neighbour.
13. This consent shall lapse on 31 March 2017, 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.
14. The Taranaki Regional Council may review, amend, delete or add to the conditions of this consent up to three times during the period March 2012 and March 2013, for the purpose of ensuring that any additional information of the possible effects of the exercise of this consent in relation to the flaring (including evaporation or volatilisation) of hydraulic fracturing fluids and having considered whether the conditions appropriately take account of any additional information.

Consent 9205-1

15. 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 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; and/or
 - b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Signed at Stratford on 28 February 2012

For and on behalf of
Taranaki Regional Council



Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 11 May 2012

Commencement
Date: 11 May 2012

Conditions of Consent

Consent Granted: To discharge produced water, well workover fluids, well drilling fluids and contaminated stormwater from hydrocarbon exploration and production operations into land by deepwell injection below 1185 mTVD at the Kowhai-B wellsite at or about (NZTM) 1711087E-5677786N

Expiry Date: 1 June 2016

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

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

Catchment: Waiau

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

General condition

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

Special conditions

1. Before this consent is exercised, the consent holder shall submit an "Injection Operation Management Plan" which shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, injection zone or overlying geological formations. The plan will also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. Before this consent is exercised the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a final well completion log for the injection well including subsurface construction details, design of the exterior surface casing, the intermediate protective casing, and the innermost casing, tubing, and/or packer(s);
 - (b) well cementing details, cement bond log and results of annular pressure testing which demonstrates well integrity;
 - (c) details of on-going well integrity monitoring, well maintenance procedures and safe operating limits for the well;
 - (d) a detailed geological log of the well;
 - (e) details and results of the Formation Integrity Testing carried out on the receiving formation and confining layers and an assessment of the results against the estimated modelled values submitted in the consent application;
 - (f) results of an electrical resistivity survey, clearly showing the confirmed depth of freshwater as defined in condition 11; and
 - (g) a full chemical analysis of the receiving formation-water.

(Note: These details can be included within the "Injection Operation Management Plan.")
3. The injection pressure at the wellhead shall not exceed 26.1 bar (379 PSI). If exceeded, the injection operation shall be ceased immediately and the Chief Executive, Taranaki Regional Council informed immediately.
4. The rate of injection shall not exceed 14.3 m³/hr (1.5 bpm).
5. The volume of fluid injected shall not exceed 300 m³/day.
6. The injection of fluids shall be confined to the Mount Messenger Formation, deeper than 1,185 metres Total Vertical Depth.
7. The consent holder shall at all times adopt the best practicable option, as defined in Section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment; in particular, ensuring that the injection material is contained within the injection zone.

Consent 9206-1

8. Only the fluids listed below and originating from the consent holder's operations may be discharged:
 - (a) produced water;
 - (b) well workover fluids, including hydraulic fracturing return fluids;
 - (c) well drilling fluids; and
 - (d) contaminated stormwater.
9. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection pressure (regular logged measurements over each injection period);
 - (b) maximum and average rate of injection; and
 - (c) volume of fluid injected.

During the operation of the well, these records shall be provided to the Chief Executive, Taranaki Regional Council at the end of each month.

10. For each discharge, the consent holder shall record the following information, and provide this to the Chief Executive, Taranaki Regional Council upon request:
 - (a) type of fluid;
 - (b) source of fluid (site name and location);
 - (c) subject to condition 10 (d) below, an analysis of the fluid for:
 - (i) pH;
 - (ii) suspended solids concentration;
 - (iii) temperature;
 - (iv) salinity;
 - (v) chloride concentration;
 - (vi) total hydrocarbon concentration; and
 - (d) the analysis required by condition 10 (c) above is not necessary if a sample of the same type of fluid, from the same source, has been taken and analysed within the previous 6 months.
11. 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.
12. 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 11 (the 'Monitoring Programme'). The Monitoring Programme shall be certified by the Chief Executive, Taranaki Regional Council, before this consent is exercised, and shall include:
 - (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

13. 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 12 and 13, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

14. All sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An International Accreditation New Zealand (IANZ) accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 11.

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

15. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, during the month of May of every year, a summary of all data collected and a report detailing compliance with consent conditions. The report shall also provide and assess data which illustrates the on-going integrity and isolation of the wellbore, well performance and condition. The consent holder shall also provide an updated injection modeling report, illustrating the ability of the receiving formation to continue to accept additional waste fluids and estimating its remaining storage capacity.
16. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 days prior to the first exercise of this consent. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

Consent 9206-1

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

Signed at Stratford on 11 May 2012

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 29 March 2012

Commencement
Date: 29 March 2012

Conditions of Consent

Consent Granted: To discharge contaminants in association with hydraulic fracturing activities into land at depths greater than 3000 mTVD beneath the Kowhai-B wellsite at or about (NZTM) 1711087E-5677788N

Expiry Date: 1 June 2015

Review Date(s): June 2012, June 2013, June 2014

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

Catchment: Waiau

*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. The discharge point shall be deeper than 3000 mTVD.

Note: mTVD = metres true vertical depth, i.e. the true vertical depth in metres below ground 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 (¹³C-CH₄).

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.

Consent 9207-1

8. The consent holder shall notify the Taranaki Regional Council of each discharge by emailing 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 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.

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 29 March 2012

For and on behalf of
Taranaki Regional Council

Director-Resource Management



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

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www.trc.govt.nz

Please quote our file number
on all correspondence

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 23 February 2012

Commencement
Date: 23 February 2012

Conditions of Consent

Consent Granted: To take groundwater that may be encountered during
exploration and production operations at the Kowhai-B
wellsite at or about (NZTM) 1711087E-5677788N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD (Site of take & use)

Catchment: Waiau

General condition

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

Special conditions

1. 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 salt water into any freshwater aquifer.
3. The consent holder shall submit a summary well log to a depth of 1000 metres, within three months of the completion of drilling. The report shall:
 - a) include confirmation of datum from which measurements are referenced;
 - b) provide a log to show the true vertical depth to all geological formation tops intersected within the freshwater zone;
 - c) identify the true vertical depth to, and thickness of, any freshwater aquifers intersected by the well;
 - d) identify the true vertical depth to the freshwater-saline water interface in the well.
4. This consent shall lapse on 31 March 2017, 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.
5. 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 23 February 2012

For and on behalf of
Taranaki Regional Council


Director-Resource Management



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Decision Date: 23 February 2012

Commencement
Date: 23 February 2012

Conditions of Consent

Consent Granted: To discharge stormwater and sediment from earthworks during construction of the Kowhai-B wellsite onto and into land at or about (NZTM) 1711151E-5677770N

Expiry Date: 1 June 2017

Site Location: Kowhai-B wellsite, 451 Ngatimaru Road, Tikorangi
(Property owner: R & B Jupp)

Legal Description: Lot 4 DP 378739 Blk VI Waitara SD
(Discharge source & site)

Catchment: Waiau

General condition

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

Special conditions

1. 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. At least 7 working days before the commencement of earthworks for the purpose of wellsite construction and establishment, the consent holder shall notify the Taranaki Regional Council of the proposed start date for the earthworks. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz.
3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing following the completion of the construction of the Kowhai-B wellsite and before commencement of any operation of the Kowhai-B wellsite. Notification shall be given at least 7 working days before the commencement of the Kowhai-B wellsite operation and shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
4. 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:
 - a) 100 cubic metres for every hectare of exposed soil between 1 November to 30 April; and
 - b) 200 cubic metres for every hectare of exposed soil between 1 May to 31 October;unless other sediment control measures that achieve an equivalent standard are agreed to by the Chief Executive of the Taranaki Regional Council.
5. The obligation described in condition 4 above shall cease to apply, and accordingly the erosion and sediment control measures can be removed, in respect of any particular site or area of any site, only when the site is stabilised.

Note: For the purpose of condition 5, "stabilised" in relation to any site or area means inherently resistant to erosion or rendered resistant, such as by using rock or by the application of basecourse, colluvium, grassing, mulch, or another method to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and as specified in the Taranaki Regional Council's Guidelines for Earthworks in the Taranaki Region, 2006. Where seeding or grassing is used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once, on reasonable visual inspection by an officer of the Taranaki Regional Council, an 80% vegetative cover has been established.

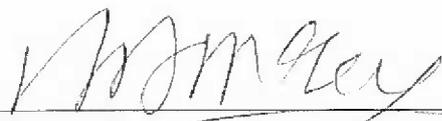
Consent 9209-1

6. All earthworked areas shall be stabilised vegetatively or otherwise as soon as is practicable and no longer than 6 months after the completion of soil disturbance activities.

Note: For the purposes of this condition "stabilised" has the same definition as that set out in condition 5.

Signed at Stratford on 23 February 2012

For and on behalf of
Taranaki Regional Council



Director-Resource Management

