Drilling for oil and gas in New Zealand:

Environmental oversight and regulation

June 2014

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

Acknowledgements

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Photography

Cover: Steel casing used to line wells.
Photo from Parliamentary Commissioner for the Environment archives

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Commissioner's Overview

About six years ago, I recall suggesting to the Electricity Commission that it should be an Electricity and Gas Commission, akin to those in some other countries. With production from the large Maui natural gas field down to about a quarter of its peak, I was told firmly that gas was a 'sunset industry' in New Zealand. Roll on a couple of years and some were predicting the mainstay of our energy future would be the vast lignite reserves in Southland. Solid Energy has just sold two thousand hectares of farmland the state owned enterprise had bought because it lay atop seams of lignite.

Now gas is back. In part due to the technique of hydraulic fracturing or 'fracking', more wells are being drilled in Taranaki and the amount of gas and oil extracted in the region is rising. As in many other countries, there has been considerable opposition to fracking in New Zealand, and in November 2012, I released a report on the subject. In writing that report it became clear that much of the concern was not about fracking *per se*, but about the spread of the industry that the technique can enable. Consequently, the report dealt with the whole process of drilling for oil and gas, from choosing a well site right through to the abandonment of the well.

This second report on drilling for oil and gas moves from assessing the environmental impacts associated with drilling for oil and gas to analysing the complex system of laws, agencies, and processes that oversee and regulate the industry. It is restricted to drilling on land, so does not cover the offshore exploratory drilling that has become a focus of public concern in the wake of the Rena oil spill.

Taranaki has long been the country's oil and gas region, but we are now seeing drilling for oil in the shales of the East Coast Basin – in Manawatu, in Gisborne, and now in Hawke's Bay. Fracking will almost certainly be required if exploration wells are to yield this "*unconventional*" oil in commercial quantities and become production wells. This may be a very different proposition from the 'tightsands' fracking that has been done in Taranaki for over twenty years.

The company drilling these deep exploration wells in the East Coast Basin compares the rock formations with the Bakken and Eagle Ford shales in the United States. There the extraction of oil and gas has led to 'pockmarking' of the landscape with thousands of wells. As the International Energy Agency has pointed out in its landmark 'Golden Rules' study, "*unconventional resources are less concentrated than conventional deposits and do not give themselves up so easily*", and "*might need more than one well per square kilometre*".

The rapidity with which unconventional oil and gas wells have multiplied in some parts of North America and Australia has left regulators scrambling to catch up. This investigation has found that this country may find itself in the same position.

The recent guidelines produced by the Ministry for the Environment contain a great deal of useful information, but do little more than describe how the industry is managed in Taranaki.

But simply extrapolating the Taranaki experience to other regions is not adequate, even if there are no shortcomings in how the industry is managed in Taranaki.

Hawke's Bay is, for instance, very different to Taranaki in a number of relevant ways, apart from the difference in the rock formations. The region is drier and very reliant on two key aquifers. There are major known earthquake faults running through Hawke's Bay, so wells may be more vulnerable to damage from seismic activity, and

therefore more likely to leak into groundwater. Increasingly, Hawke's Bay identifies itself as a premium food and wine region, and there may be conflicts between this and a mushrooming oil and gas industry. Oil and gas wells are not drilled in industrial parks on the outskirts of cities, and landowners cannot legally prevent wells being drilled on their land. The Mayor of Hastings, Lawrence Yule, is to be congratulated for the leadership he showed last year in engaging with the Hawke's Bay community in an oil and gas symposium.

Across the Tasman, the controversy over fracking has largely been focused on the thousands of coal seam gas wells in Queensland and New South Wales. The 'dewatering' of coal seams for extracting methane lowers the water table and can contaminate groundwater. While this was not a problem in the experimental fracking of relatively deep coal seams in Waikato, it could be very different if coal seam gas wells were to be drilled in some areas of the country, such as Canterbury.

At the end of my interim report in 2012, I made a commitment to evaluating whether government oversight and regulation of oil and gas production in New Zealand is adequate for managing the environmental risks of the industry. Even without the potential for rapid growth, I have not found it to be adequate. The improvements that I judge are needed are in the form of six recommendations in the last chapter.

The first recommendation is for guidance and direction from the Government in the form of a national policy statement, paying particular attention to unconventional oil and gas. While extrapolation from Taranaki is not adequate, it makes no sense for various councils to all be 'reinventing the wheel'.

A major theme in this report is the unjustified variation in council plans and consent conditions. Not only is this inefficient, it undermines public trust in regulators, because of the confusion and frustration experienced by those who are concerned about the industry. The Minister for the Environment has proposed a national planning template with standardised layout and terminology – this will help, but more is needed.

The Environmental Protection Authority would be well-placed to play a useful role here. When it was created three years ago, the intent was that it evolve into a technically skilled environmental agency focused on implementation. Its staff must now be developing considerable knowledge of the industry because of their involvement in evaluating applications for offshore drilling.

The second recommendation is focused on regional council plans – some of these are being, or are soon to be, revised. That virtually all of these plans have rules for drilling bores that do not distinguish between drilling for water and drilling for oil and gas shows how unprepared the country's environmental regulators are for a potentially rapid expansion of the industry.

In Taranaki, remarkably, a resource consent is not needed to drill for oil and gas. Outside Taranaki, drilling an oil and gas well generally does require a consent from the regional council, but the council does not have the option of saying 'no'.

Overseas, the opposition toward fracking has grown as wells have multiplied across a region. The impacts of an individual well are generally small – it is the cumulative effect of many wells on the landscape, on the risk to groundwater, and so on, that matters most. The Resource Management Act has never been well-suited to managing cumulative effects because of the way precedents are created. The straw

that breaks the camel's back generally receives consent more readily than the first straw.

Moreover, because councils are judging the impacts of single wells to be "*minor*", none of the applications for resource consents associated with drilling for oil and gas are being publicly notified. Understandably, some perceive this as 'regulatory capture', that is, seeing councils as acting in the benefit of the industry, rather than in the public interest.

The third recommendation in the report is concerned with the design, construction, and operation of oil and gas wells. Ensuring the wells have what the industry calls 'integrity' is vital for protecting the health and safety of the workers at the well site, as well as protecting the environment. The updated Petroleum Exploration and Extraction Regulations put into effect last year are a great improvement in this area, but there is a need to ensure that the well is cased adequately when it passes through freshwater layers.

The fourth recommendation is focused on who pays when something goes wrong. In particular, it is not enough to abandon wells and assume they will never leak. In Canada, well operators pay a levy into a fund that is then available for cleaning up any contamination in the future. Such a fund can also be used to pay for monitoring the environment – necessary for detecting contamination. Monitoring is a recurring theme in the report, with New Zealand clearly out of step with international 'best practice'.

The fifth recommendation deals with one of the risks at well sites – the spilling or leaking of hazardous substances – a risk that is common to many industrial workplaces. The Environmental Protection Authority sets controls designed to prevent this, but must rely on others to enforce them. This is a systemic issue that is much wider than this particular industry.

Under law, the few highly trained inspectors in the High Hazards Unit are responsible for enforcing the controls on hazardous substances at well sites, although this role would be far more sensibly done by regional council staff. The expertise of the High Hazards Unit should be reserved for the complexities of well design and construction.

The last recommendation addresses the disposal of waste from wells, specifically solid waste. The unhelpfully named 'landfarming' refers to the practice of spreading out solid waste on paddocks, mixing it with topsoil, and then fertilising and resowing pasture. The microbes in the soil break down the hydrocarbons in the waste. Limits are put on contaminants like heavy metals that do not biodegrade.

Last year, landfarming in Taranaki became national news, with the country's largest dairy company deciding to not take milk from any new landfarms. There are instances of cattle grazing on landfarmed areas before the bioremediation is complete. Regardless of the actual risk, this is not acceptable, and the situation needs resolving. The waste from the few exploration wells now being drilled in the East Coast Basin is being trucked to Taranaki for disposal. This will not be tenable if wells begin to multiply there – again there is a need to 'get ahead of the game'.

The focus of this report is on the local environmental impacts of drilling for oil and gas. Some are potentially large. A well leaking into the Heretaunga aquifer or groundwater in the Poverty Flats could be very damaging, although it is unlikely.

But there are, of course, other problems with water quality, in particular the diffuse nitrogen challenge that was the subject of the last report I released.

However, I would not want this report to be interpreted as my giving a big tick to the expansion of the oil and gas industry in New Zealand, because the biggest issue is not a local environmental effect, but the global effect of climate change. From my perspective as Environment Commissioner, I would much rather see a bigger focus on 'green growth' in this country.

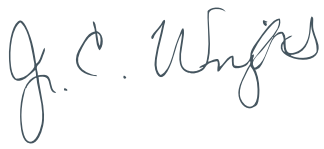
That said, we need to be careful about what we mean by 'green growth'. Natural gas is the most benign of the fossil fuels, and when it is used as an energy source instead of coal, carbon dioxide emissions are generally lower. However, the potential for using natural gas as a 'transition fuel' to a lower carbon economy is very limited in this country.

The Government has committed to reducing our greenhouse gas emissions to five percent below our 1990 emissions by 2020, but there is no plan for achieving this – neither the Energy Strategy nor the greatly weakened Emissions Trading Scheme will do it.

Perhaps I have become particularly sensitive, but I seem to be increasingly hearing that it is pointless for our small country to reduce our emissions of greenhouse gases because our contribution to the global total is insignificant. But this is a recipe for inaction everywhere. The Minister of Climate and Environment in Norway – another small country – recently said it better than I can:

"*Norway accounts for 0.04 per cent of global greenhouse gas emissions. In isolation, what we do is of little significance. But we cannot think like that. Every Chinese city, every U.S. state, every coal power plant emission is small in the larger whole. We will not get anywhere if we just point at each other.*"

During my time as New Zealand's Environment Commissioner, I have often made recommendations about the need for a strong response on climate change. I will continue to do so.



Dr Jan Wright

Parliamentary Commissioner for the Environment

1

Introduction

Oil, natural gas, and coal are called ‘fossil fuels’ because they originate from plants and animals that lived millions of years ago. When these plants and animals died, they were buried by layers of sediment. As they sank deeper into the earth they were squeezed under pressure and ‘cooked’ by heat, slowly being transformed into hydrocarbons – sometimes oil, sometimes gas, and sometimes coal.

The technique known as hydraulic fracturing – fracking – has made it possible to extract oil and gas that was previously inaccessible. Fracking fluid is pumped down wells under pressure to create cracks in rock and enable the oil and gas contained within to flow out to the surface.

In New Zealand, the Government is actively encouraging expansion of the oil and gas industry. *Onshore*, drilling for oil and gas has largely been confined to Taranaki, but exploratory drilling is beginning elsewhere, particularly in the east of the North Island. At the same time, *offshore* exploration for oil and gas is also increasing, with drilling occurring in the deep sea off Taranaki and Otago in 2013 and 2014.

Until 2011, the word ‘fracking’ was virtually unknown in New Zealand, but by July that year the national media were running regular reports about fracking. A number of groups and individuals began to oppose or question the practice, and some called for a moratorium. In response to the increasing public concern the Parliamentary Commissioner for the Environment undertook an investigation into the use of fracking, which led to an interim report in 2012.

During the preparation of that report, it became clear that while there were specific concerns about the impacts of fracking itself, most of the concern was about what fracking enables – that is, the expansion of the onshore oil and gas industry within and beyond Taranaki, and all that might come with this. For instance, one person wrote to the Commissioner: “*Do we on the East Coast want to look like a mini-Texas? I think not!! This is not New Zealand’s image*”.

It is for this reason that although the interim report was focused on fracking, it included examination of the environmental impacts of a well over its lifetime, with fracking only one of several stages. To illustrate why this is important, consider the need to dispose of waste. Some have expressed concern about the composition of fracking fluid and how it is disposed of when it flows back out of the well. But this is a small problem compared with dealing with the salty 'produced water' that flows out of all wells along with the oil and gas over the years that the well is in production.

The great environmental issue associated with any development of fossil fuels is, of course, climate change. When they are burned, oil, natural gas, and coal all increase the concentration of carbon dioxide in the atmosphere. Both fracking and deep sea drilling provide access to what is sometimes called 'unconventional' oil and gas, and so raise questions about whether and how New Zealand can pursue fossil fuel extraction while still responding to climate change and the need to move to a low-carbon future.

Source: Taranaki Stories Database, Puke Ariki Museum.

Figure 1.1: The drilling crew of the first well at Kapuni in Taranaki in 1959.

1.1 The purpose of this report

The Parliamentary Commissioner for the Environment is an independent Officer of Parliament, with functions and powers granted by the Environment Act 1986. She provides Members of Parliament with independent advice in their consideration of matters that may have impacts on the quality of the environment.

In her 2012 interim report on fracking, the Commissioner found that there are four physical aspects of onshore oil and gas extraction that need to be done well.[1]

- Choose the well site carefully
- Design and construct the well to prevent leaks
- Prevent spills and leaks on the surface
- Store and dispose of waste with care

Public concern expressed about fracking has largely focused on the potential for the practice to contaminate groundwater. Good management of the four aspects above is key to reducing this and other environmental risks, particularly in areas where the industry is expanding rapidly.

The interim report on fracking also contained three findings relating to government oversight and regulation of onshore oil and gas extraction, namely that:

- Oversight is complex and fragmented
- Regulation may be too light-handed
- A 'social licence' to operate is yet to be earned

The third of these follows from the first two. If government oversight of the oil and gas industry is understandable and transparent, and regulation is seen to be adequate, then what some call a 'social licence' to operate is more likely to exist.

In this report, the focus moves from assessing the physical impacts of fracking (and the expansion of the industry that it enables) to analysing the system of laws, agencies, and processes that oversee and control onshore oil and gas extraction. At the end of the report, recommendations on addressing weaknesses in the system are made.

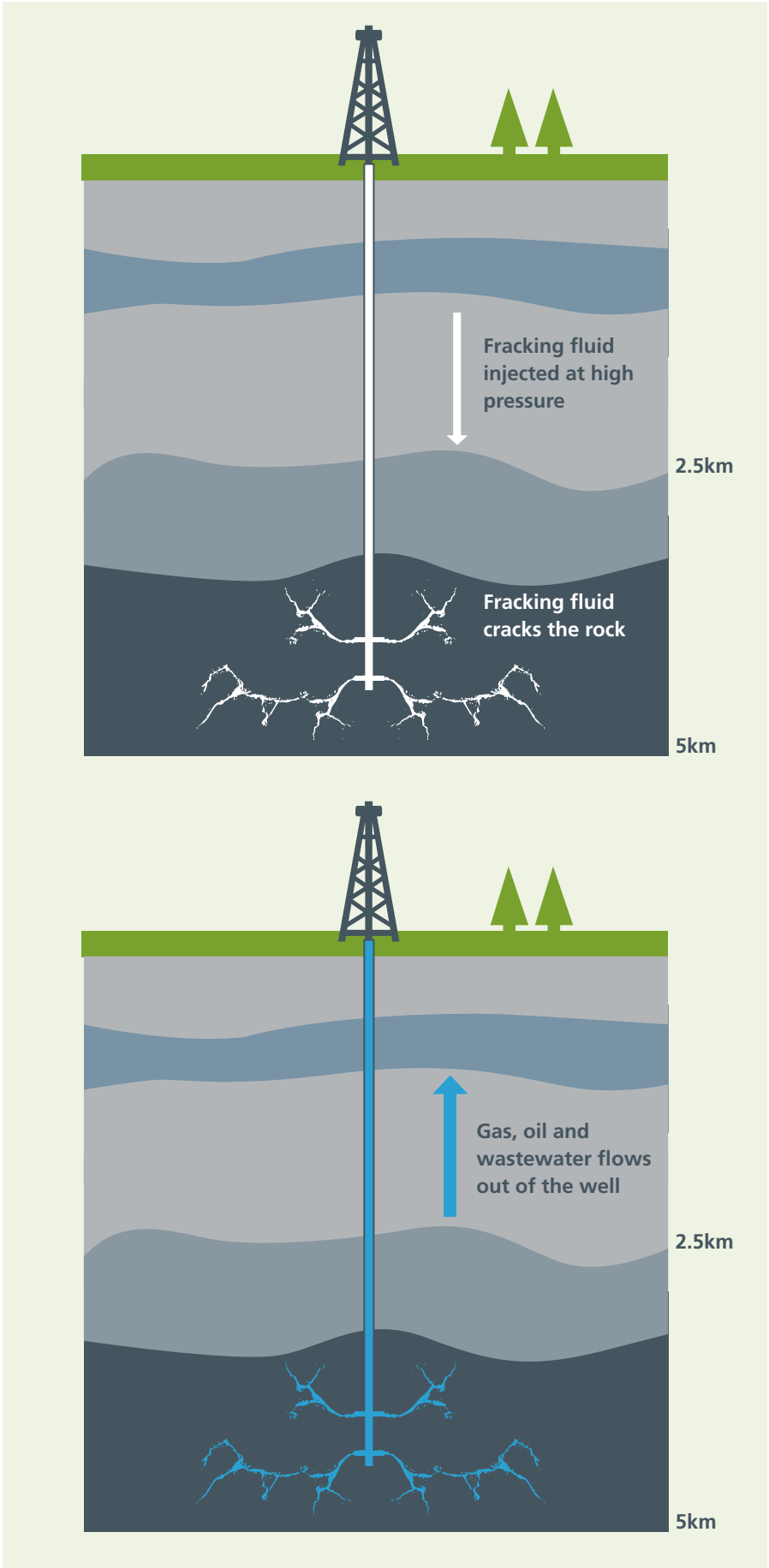


Figure 1.2: Cracking impermeable rock using hydraulic fracturing (fracking) so 'unconventional' oil and gas can flow out.

1.2 What has happened since the interim report?

The oil and gas industry has continued to grow in New Zealand, and has been described as being "*on the cusp of a boom*."[2] While public concern about fracking remains, the greatest opposition is now focused on the exploratory drilling in the deep sea.[3]

In New Zealand, there are three different types of rocks containing hydrocarbons where fracking is or could be used to extract oil and gas.

Sandstone and 'tightsands'

Oil and gas in Taranaki is generally found in sandstone. To date, most of this oil and gas has been obtained through conventional drilling without fracking. In situations where the sandstone has very low permeability, fracking can be used to release the oil and gas. The lower the permeability, the 'tighter' the sands.[4] Fracking operations have been carried out on fourteen wells in Taranaki since the interim report.[5]

Shale

Most of the fracking that has taken place in the United States to date has been done to extract natural gas from shale. Exploratory drilling into shale is beginning to occur in the east of the North Island with wells drilled or soon to be drilled near Dannevirke and Gisborne. Fracking may be used in these exploratory wells to assess whether or not to proceed to development and extraction, and fracking may be essential for commercial production.[6]

Coal seam gas

Methane – the main component of natural gas – is formed along with coal, and this 'coal seam gas' can be extracted. If the coal is naturally fractured enough, the methane can be obtained without fracking.[7] But in many cases, the coal must be fracked to release the methane – most of the fracking in Australia to date is of this type. Coal seam gas has been extracted using fracking by Solid Energy in a demonstration plant in Waikato.[8]

Each year companies can bid for the right to explore for petroleum within areas of land (and sea). In 2013, ten exploration permits were granted, with five onshore – three in Taranaki and two in Gisborne. Recently the areas available for bidding in 2014 have been announced.

Changes have also been made to the regulation of the industry since the interim report. The Petroleum Exploration and Extraction Regulations have been updated, and a new Health and Safety Reform Bill has been introduced to the House. The Crown Minerals Act has been amended, so that its purpose is now to "*promote*" prospecting, exploration, and extraction of minerals.

Guidelines for managing the environmental aspects of oil and gas exploration under the Resource Management Act have been published by both Taranaki Regional Council and the Ministry for the Environment.

Beyond New Zealand the amount of oil and gas made available by fracking continues to increase.[9] However, concerns about the use of the technology continue.

Currently, 17 countries or states have moratoria on fracking.[10] Those in the United Kingdom and Romania have been lifted recently, and it is expected that some other countries will lift their own as they finish investigations into fracking and make regulatory changes.[11] New reports appear frequently on both the environmental and economic issues relating to oil and gas, and fracking specifically.[12] Some reports have considered the implications of the increased availability of oil and gas on climate change.[13]

Over the course of this investigation a number of groups and individuals supplied material to the Commissioner. This material ranged from detailed 'submissions' from companies including Todd Energy and community groups including Climate Justice Taranaki, to articles, comments, and suggestions from the public.

All of this material was considered as part of the investigation and proved very useful.

1.3 What this report does not cover

This report is about the environmental effects of onshore oil and gas extraction and how these effects are managed in New Zealand. This report does not cover (in any detail):

- The economic and social benefits and costs of onshore oil and gas extraction
- Māori cultural and spiritual views, ownership of oil and gas resources, and Treaty of Waitangi settlement issues relating to oil and gas
- The management and protection of historic places
- Offshore oil and gas activities, including in the deep sea
- Access to Crown or private land to extract oil and gas
- The use of fracking for other purposes, such as geothermal power generation

1.4 What comes next

The remainder of the report is structured as follows.

Chapter 2 is an overview of the system of laws, agencies, and processes that govern onshore oil and gas extraction in New Zealand.

Chapters 3 through 6 describe and analyse these laws, agencies, and processes with regard to the four physical aspects of oil and gas exploration identified in the interim report as particularly important for protecting the environment. These are:

- Location of the well site
- Design and construction of the well
- Surface spills and leaks
- Waste disposal

Chapter 7 examines two aspects of particular importance to those concerned about fracking and the expansion of the industry in the areas where they live: public involvement in decision making; and the proactive provision of information.

Chapter 8 contains the conclusions of the investigation and six recommendations from the Commissioner. It ends with a note on climate change.

Source: TAG Oil

Figure 1.3: Cheal Production Station and Cheal-A well site near Stratford in Taranaki.

2

Government oversight of the oil and gas industry

The focus of this report is on the system of laws, agencies, and processes that oversee and control onshore oil and gas extraction in relation to the environment.

There are four main laws that control different aspects of the oil and gas industry in New Zealand (see Figure 2.1).

- The Crown Minerals Act is implemented by New Zealand Petroleum and Minerals, a division within the Ministry of Business, Innovation and Employment.
- The Resource Management Act is implemented by regional and district councils. The Ministry for the Environment also has a role.
- The Health and Safety in Employment Act is implemented by WorkSafe New Zealand, a standalone regulatory agency established in December 2013, located within the Ministry of Business, Innovation and Employment.
- The Hazardous Substances and New Organisms Act is implemented by the Environmental Protection Authority.

This chapter outlines the main steps oil and gas companies must take to comply with these laws.

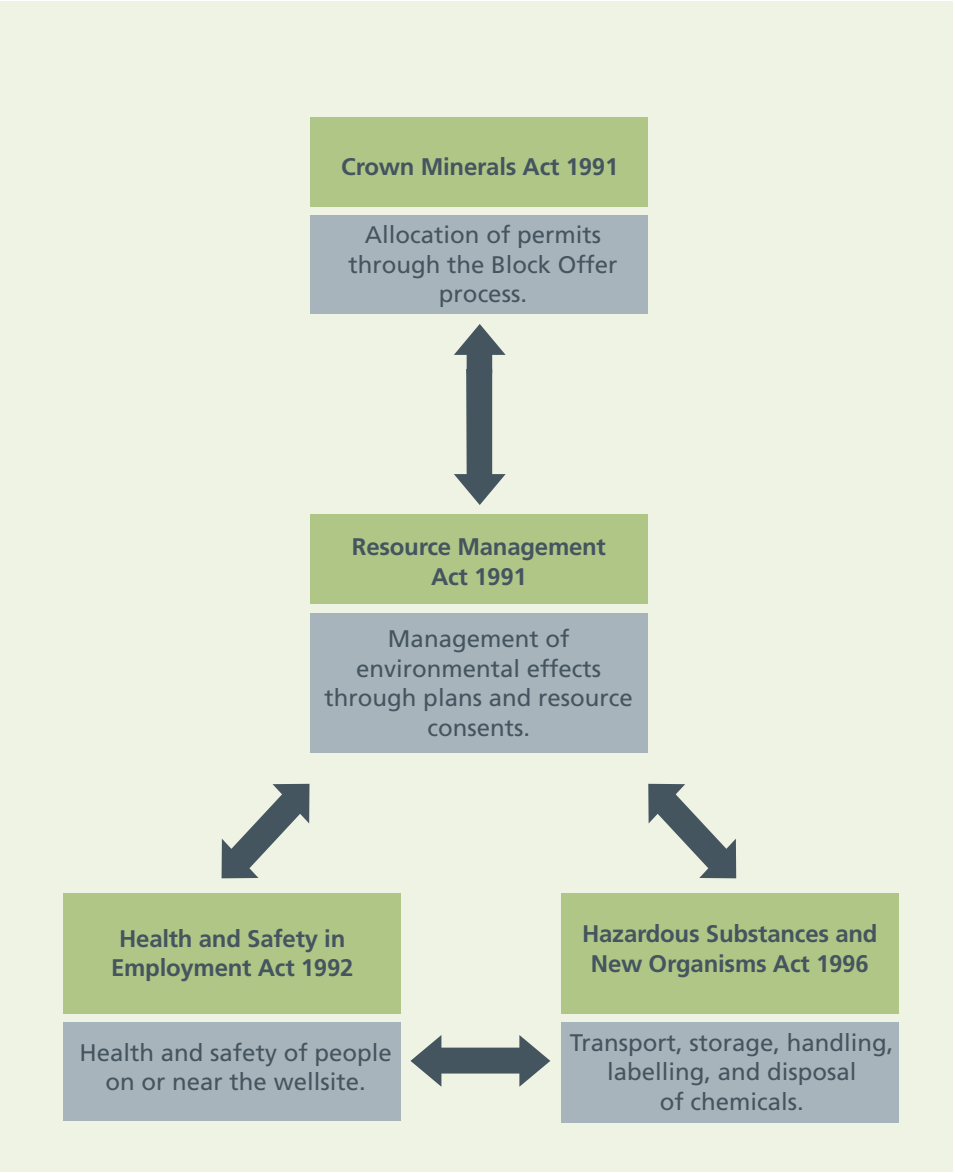


Figure 2.1: Four main laws govern onshore oil and gas extraction in New Zealand.

2.1 Obtaining permits to drill for oil and gas

Permits to look for and extract oil and gas are allocated under the Crown Minerals Act. The purpose of this act is "*to promote prospecting for, exploration for, and mining of Crown owned minerals for the benefit of New Zealand*".[14] As such, its focus is economic, not environmental.

Companies obtain permits to explore for oil and gas through the annual 'Block Offer' process run by New Zealand Petroleum and Minerals (see Figure 2.2).[15]

The process begins with an invitation for companies to nominate areas of land to be included in a future Block Offer. Blocks are then proposed, and consultation takes place before the blocks are confirmed. Consultation is only required with iwi and hapu, although councils are also usually consulted.[16,17]

Once the blocks have been offered, companies bid for permits to explore within blocks. Each company is 'credit-checked'; this includes an assessment of its technical and financial capability, and its environmental and safety record.[18] Then, in line with the economic purpose of the Crown Minerals Act, the permit to undertake exploratory drilling in a particular block is normally given to the company with a work programme that "*has the best information-gathering value and that is most likely to find petroleum deposits in a timely manner*".[19]

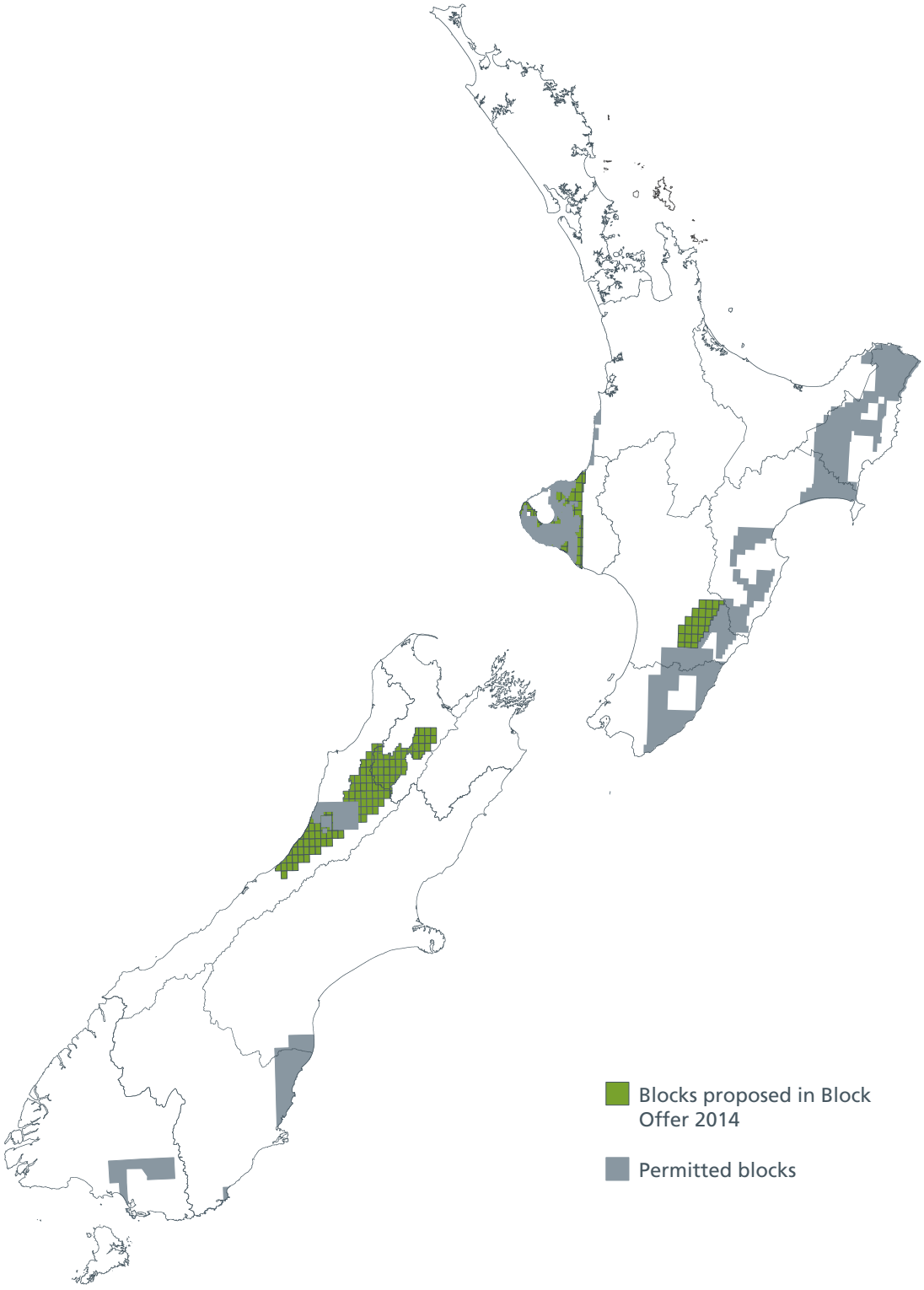
Ownership of petroleum is vested in the Crown. Before drilling can begin, a company must arrange access with the landowner. If a landowner refuses to grant access, an access arrangement is determined by an arbitrator. It can be a shock to landowners to discover that they can be forced to allow private companies on to their land to drill for oil and gas.

Access arrangements are also required between companies and relevant Ministers before drilling can take place on Crown land. The majority of Crown land lies within the conservation estate. Drilling can take place on the 60% of the conservation estate that is not listed on Schedule 4 of the Crown Minerals Act with the agreement of both the Minister of Conservation and the Minister of Energy and Resources. Petroleum exploration can take place on Schedule 4 land, but is very restricted.[20]

All national parks are listed on Schedule 4. But due to its significance for Māori, Egmont National Park is completely off limits for drilling, as are the Tītī Islands off the coast of Stewart Island/Rakiura.[21]

When an exploratory well indicates that commercial quantities of oil and gas can be extracted, the company holding the exploration permit can then apply for a petroleum mining permit, provided the application is made before the exploration permit expires.

In addition to holding a petroleum permit, an oil and gas company must take steps to comply with New Zealand environmental, health and safety, and hazardous chemicals regulations.



GIS data: MBIE NZP&M, Statistics NZ

Figure 2.2: New Zealand's large petroleum basins occur both onshore and offshore. The Government opens up parts of these for oil and gas exploration through 'block offers'. The map shows the currently permitted blocks and the 2014 block offer for onshore oil and gas exploration.

2.2 Managing the environmental effects of oil and gas wells

The environmental effects of onshore oil and gas extraction are managed by regional and district councils under the Resource Management Act (RMA). Controls are set in two ways – through policies and rules in council plans, and through conditions in resource consents.

Consents are not required when an activity is "*permitted*" in a council plan. This does not necessarily mean the activity is unconstrained. For instance, in Taranaki drilling for oil and gas is a permitted activity, but subject to a number of standards.[22]

Consents are required, but *must* be granted, when an activity is "*controlled*" in a council plan. In Hawke's Bay, Manawatu-Whanganui, and Waikato, drilling for oil and gas is a controlled activity. The council can impose conditions, but only in relation to the areas of 'control' identified in the plan.

Consents are required, and *may* be granted, when an activity is "*discretionary*" in a council plan. In the Gisborne region, drilling for oil and gas is a discretionary activity.

When an application is made for a resource consent, the council must consider the effects of the activity on people and on the environment. If the effects are considered to be "*more than minor*", the consent application is 'notified' and members of the public can make submissions on the application. Notification can be limited to 'affected' parties, such as those living within a certain distance of a well site.

Both regional councils and district councils prepare plans and grant resource consents, but have different areas of responsibility. In general, regional councils are responsible for managing the more 'environmental' matters such as protecting water and soil from contamination. District councils are responsible for the more 'people' matters such as noise, the light from flaring, and heavy traffic movements.[23]

The Ministry for the Environment is able to assist with the management of the environmental effects of the oil and gas industry in two ways. The first is through developing National Policy Statements and National Environmental Standards – these 'RMA instruments' can be used when consistent environmental management across the country is sought. The second way is through the provision of guidance. In March 2014, the Ministry released guidelines on managing the environmental effects of onshore oil and gas development, including fracking.[24]

2.3 Protecting health and safety

In August 2011, the High Hazards Unit was established within the Department of Labour following the review of the tragic death of 29 men at the Pike River Mine. The petroleum, mining, and geothermal industries are all classed as 'high hazard' because, although failure is rare, "*its consequences, in human, environmental and economic costs, can be catastrophic*".[25]

Now the High Hazards Unit sits within WorkSafe New Zealand, recently established as a stand-alone health and safety regulatory agency, located within the Ministry of Business, Innovation and Employment.

There is an important link between protecting the environment and protecting the health and safety of employees at an oil and gas well site. If, for instance, a well fails and leaks oil and gas – most dramatically illustrated by a well 'blowout' – both workers and the environment can be at risk.

Health and safety in the oil and gas industry is primarily regulated under the Petroleum Exploration and Extraction Regulations 2013.[26] These regulations were updated in June 2013, and accompanying guidance documents are being developed.

Under the updated regulations, oil and gas companies must either produce a 'safety case' or a 'major accident prevention policy' for oil and gas wells, identifying major hazards and describing how they will be managed.[27] A significant change from the earlier regulations is the requirement for approval of these plans by the High Hazards Unit before the well begins operating.

The updated regulations also require well examination schemes that are to be conducted by an "*independent and competent person*".[28]

Source: TAG Oil

Figure 2.3: Oil and gas drilling is a 'high hazard' industry and everybody on well sites must wear safety gear. Here gas is being flared during well testing at TAG Oil's Cheal-C well site in 2012.

2.4 Controlling hazardous substances

A range of chemicals are used in oil and gas operations.

Those that are considered hazardous need to be approved by the Environmental Protection Authority before they can be used in New Zealand.[29] Regulations set under the Hazardous Substances and New Organisms Act (HSNO) also set controls on how these substances are to be transported, stored, handled, labelled, and disposed of.

WorkSafe New Zealand is legally responsible for enforcing the HSNO regulations and can send inspectors out to well sites. Councils can also choose to play an enforcement role on well sites.

Councils also have a role in managing the use of chemicals under the RMA.

The next five chapters examine how well these laws and agencies manage the environmental effects of onshore oil and gas extraction.

Source: Parliamentary Commissioner for the Environment archives

Figure 2.4: Tanks of gas condensate and produced water at one of Todd Energy's Mangahewa well sites in 2013. The tanks are surrounded by a bund – a raised enclosure designed to capture any liquids in the event of a spill or leak.

3

Watch where you drill

Choosing the well site carefully is the first of the four physical aspects of onshore oil and gas exploration and extraction to 'get right' to limit the risk of environmental damage.

"*Watch where you drill*" is one of the International Energy Agency's Golden Rules.[30] The risk of environmental damage and the impact on communities from drilling, fracking, and other well activities depend, in large part, on the location of the well.

This chapter begins with an outline of why "*watching where you drill*" is important for managing the environmental impacts of oil and gas exploration and extraction.

The remainder of the chapter examines how the location of wells is controlled in New Zealand, with an inevitable focus on Taranaki. Both onshore and offshore, most of the exploratory wells and all of the production wells are located in this single region of the country, though this may soon change.

In theory, New Zealand Petroleum and Minerals could consider the environmental effects of well location when issuing permits, but this would require changing the purpose of the Crown Minerals Act. This is because the purpose of that act is to promote the extraction of oil and gas, not to protect the environment.[31]

It falls then to councils to control the location of oil and gas wells under the Resource Management Act. As described in Chapter 2, both regional and district councils can do this through rules in council plans and through conditions attached to resource consents.

3.1 Why does well location matter?

The geology and hydrogeology of the area where a well site is located is of particular importance from an environmental perspective.

Drilling a well through a freshwater aquifer increases the risk of contaminants getting into water. Although a carefully designed and built well should not leak, some do.[32]

The risk of contaminating aquifers is greater if a well is drilled into a shallow coal seam than into deeper shale rock or tight sands. Coal seams are themselves aquifers, within which the methane is held by the pressure of the water.[33] In coal seam gas extraction, the methane is released along with the water – a process known as 'dewatering'. Where coal seams are connected to other aquifers, water can flow between them, potentially lowering the water table and providing pathways for methane to get into water wells.

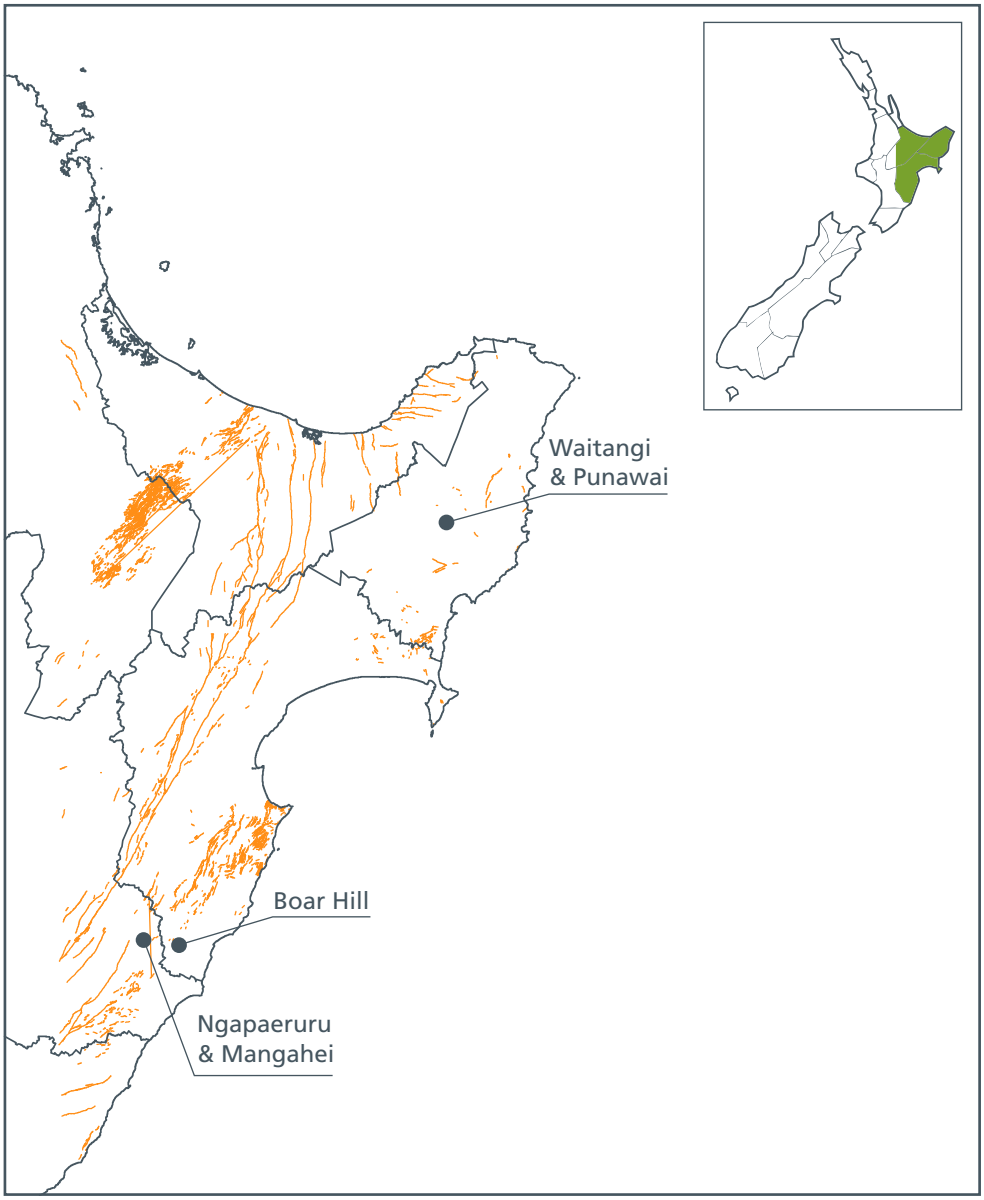
Although this was not an issue with the wells that Solid Energy drilled into a deep coal seam in Waikato, it is a major concern in Australia. In Queensland, the effect of coal seam gas wells on groundwater must be modelled before drilling can go ahead.[34]

Much of the concern about fracking has also focused on its potential to generate earthquakes. The process of fracking itself causes only very tiny earthquakes. But if fracking fluid finds its way into an already stressed fault, the fault might slip triggering a small earthquake. The largest earthquake that has been attributed to fracking anywhere in the world measured 3.8 on the Richter scale.[35]

During the production phase of a well, so-called 'produced water' comes up with the oil and gas from deep in the earth. In Taranaki, this wastewater is generally disposed of by injecting it deep into the ground in either old wells or wells drilled specifically for this purpose. Earthquakes up to 5.3 on the Richter scale have been attributed to the reinjection of wastewater.[36]

Because the frequency of naturally occurring earthquakes in this geologically active country is so high and because stressed faults are likely to slip at some stage, some might view increased earthquake risk as a very minor issue. Nevertheless, it is desirable to avoid locating wells, particularly those used for the reinjection of wastewater, in the vicinity of major faults.

Putting aside the potential for triggering earthquakes, there is another more compelling reason for drilling carefully in seismically active areas. Natural earthquakes can damage wells, potentially allowing contaminants to leak into aquifers, and possibly lead to well blowouts and fires.



GIS Data: GNS Science, Statistics NZ

Figure 3.1: Known active fault lines (in orange) and exploratory wells in the East Coast Basin.

Another concern about the location of a well is its potential to damage valuable ecosystems such as native vegetation or freshwater fish habitats. While drilling for oil and gas is very restricted within the 40% of the conservation estate that is listed on Schedule 4 of the Crown Minerals Act, it can take place in other areas that have high conservation value.

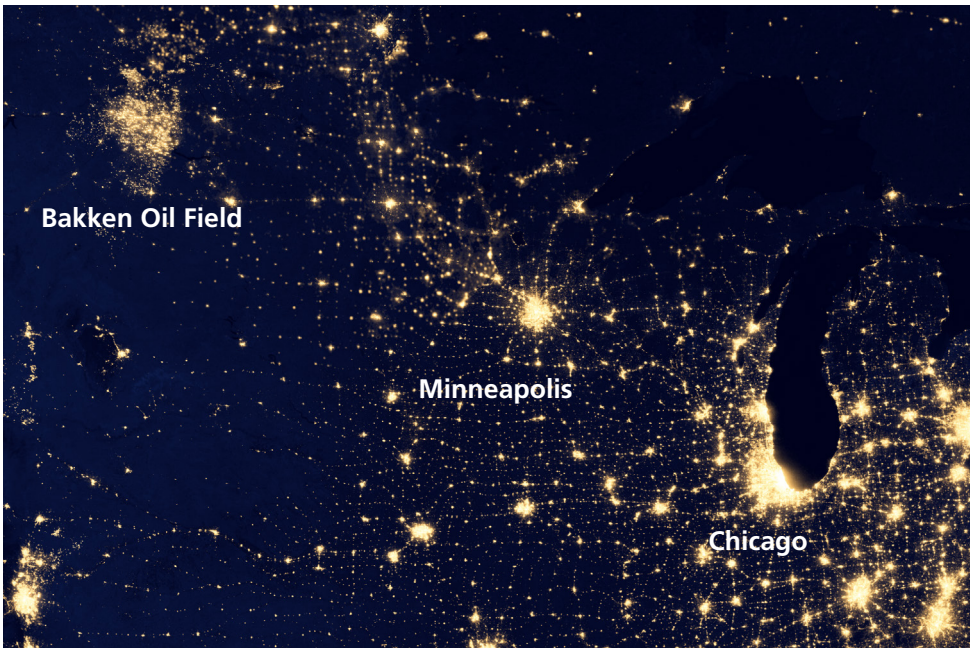
The location of a well also has impacts on people who live and work in the vicinity, and this has been the focus of much of the concern in Taranaki. The drilling and operation of oil and gas wells is an industrial activity, and like some others, is accompanied by the 'nuisance' impacts of dust, noise, odour, and truck traffic, as well as the light from flaring natural gas, and air pollutants that could potentially affect people's health. But this is not an industry confined to an industrial park on the outskirts of a city, but one that 'pops up' on farmland.

Overseas, the effect on the landscape of fracking for natural gas in some areas has been dramatic. The hundreds of wells drilled into some shale fields in the United States, like the Bakken field in North Dakota, are clearly visible from space (see Figure 3.2). A rapidly expanding oil and gas industry in New Zealand could have a cumulative effect on landscapes, though eventually it would fall away as wells were progressively abandoned.

There is potential for this impact on landscape to unfold in parts of the North Island through wells being drilled into shale rock formations. Shales are usually impermeable, so wells are much more likely to be fracked. Distances between wells can be as little as the length of the cracks created by fracking – on the order of a kilometre.

In the North Island East Coast Basin, Waipawa black shale sits above Whangai source rock, and has been described as having very similar geological properties to the Bakken and Eagle Ford shales in North America.[37] On average, the permeability of the East Coast Basin rock formations is lower than the permeability of the sandstone in Taranaki, though both vary over a wide range. This means that fracking is more likely to be required to release oil and gas in the east of the North Island than in Taranaki.[38]

For all the reasons outlined above, a thorough assessment of well location is vital – both underground and on the surface. It becomes increasingly important as the industry expands – in Taranaki and potentially into other regions of the country.



Source: NASA

Figure 3.2: At night, the flaring of gas in North America's Bakken Oil Field is clearly visible from space. The shales in the East Coast of the North Island have been described as similar to the Bakken.

3.2 Regional councils and well location

Regional councils are responsible for managing the impacts of the oil and gas industry on the biophysical environment. Thus, regional councils need to assess potential well locations to prevent them being located in places that might lead to the contamination of surface water or groundwater. Regional councils should also ensure that oil and gas wells are not drilled near major faults, or within (or close to) valuable ecosystems.

Taranaki

In Taranaki, the drilling of a bore – whether it be for oil and gas, or for water – is currently a "*permitted*" activity.[39] This means that a resource consent is not required for drilling and constructing a well, provided it complies with certain criteria in the regional Freshwater Plan.[40]

The rule for drilling a bore contains six criteria. Although all six apply to water wells or bores, only two apply to oil and gas bores.[41] The criterion that addresses the potential for an oil and gas well to contaminate aquifers or leak from the surface is the requirement to case and seal the bore. There is a presumption that a properly cased and sealed bore will not leak.

The Taranaki Regional Council is aware that its current rule governing the drilling of bores is inadequate. A council review document refers to the need to "*recognise the different environmental effects and regulatory oversight associated with drilling a well for hydrocarbon exploration and production compared with a bore to take water.*"[42] Consequently, the council has proposed a number of rules for its new Freshwater Plan that apply specifically to the oil and gas industry.

The proposed rule for drilling an oil and gas well still classifies it as a permitted activity, but it does include one criterion governing its location. A well must be at least 500 metres from adjacent bores (including water bores) and at least 25 metres from surface water. However, these distances are the same as those for water bores in the existing rule, so do not "*recognise the different environmental effects*" associated with drilling a hydrocarbon exploration well and a water bore. Allowing an oil and gas well to be drilled a mere 25 metres from a significant wetland, for instance, seems extraordinarily permissive.

The review document, does, however, contain very different proposed rules for fracking and for deep well injection of wastewater, with these activities classified as "*restricted discretionary*". This would mean that resource consents would be required for these activities, with the conditions in the consents addressing matters listed in the rules. The matters listed in these proposed rules do include location relative to faults and the potential for groundwater contamination.

The proposed rule for drilling an oil and gas well is an improvement on the current rule, but does not go far enough in dealing with three risks associated with well location that are the responsibility of regional councils – water contamination, proximity to major faults, and damage to ecosystems.

Water contamination:

The proposed rule contains two improvements. The first is to require the use of water-based drilling muds when drilling through the freshwater layer. The second is the restriction on distance from other bores, though there is no rationale given in the review document for the proposed distances. But critically, the proposed rule, like the current rule, appears to rely on the presumption that properly constructed wells do not leak.

Proximity to major faults:

Drilling an oil and gas well will not trigger earthquakes, so there would seem to be no need to assess its proximity to faults. However, if a consent to frack is sought after the well has been drilled, it is too late to move the well away from major faults. More importantly, a natural earthquake can damage a well and cause it to leak.

Damage to ecosystems:

Nothing in the proposed rule for drilling oil and gas wells, for fracking, or for deep well injection of waste covers the location of the well relative to vulnerable ecosystems.

Outside Taranaki

Outside Taranaki, different approaches to well location are being taken across the country. In general, rules in current plans do not distinguish between drilling water bores and drilling for oil and gas. Resource consents for both are required in most regions.

The first wells to be drilled and fracked successfully outside Taranaki were the ten pilot wells drilled into coal seams near Huntly in Waikato by Solid Energy between 2005 and 2011.[43] Under the regional plan, this was a "*controlled*" activity, with two criteria dealing with well location.[44]

Two regional councils have received and processed applications for drilling exploratory wells into shale in the east of the North Island.

- Horizons Regional Council has granted consents for two wells near Dannevirke, and one has been drilled.
- Gisborne District Council has granted consent for two wells that are to be drilled near Te Karaka.

Horizons Regional Council classifies drilling a bore as a controlled activity.[45] The council must grant consent, but can set conditions on a number of aspects, including location. But if the well is to be drilled in a rare, threatened, or at-risk habitat, then it becomes a "*discretionary*" activity and the council can decline the consent.[46]

Gisborne District Council classifies drilling a bore as a discretionary activity, and so may refuse to grant a consent.[47] If a consent is granted, the council is free to set conditions on any aspects of the activity.

In considering the consent applications for exploratory drilling, both councils sought advice on the potential for water to become contaminated and the potential for a natural earthquake to damage the wells.[48]

A comparison of how other regional councils would deal with the drilling of oil and gas wells in their plans reveals that no two are alike, even down to the definition of a 'bore'.[49] Few regional councils identify areas of their region where oil and gas activity would be prohibited or more restricted than elsewhere.

Source: TAG Oil

Figure 3.3: The exploratory Ngapaeruru-1 well being drilled near Dannevirke.

3.3 District councils and well location

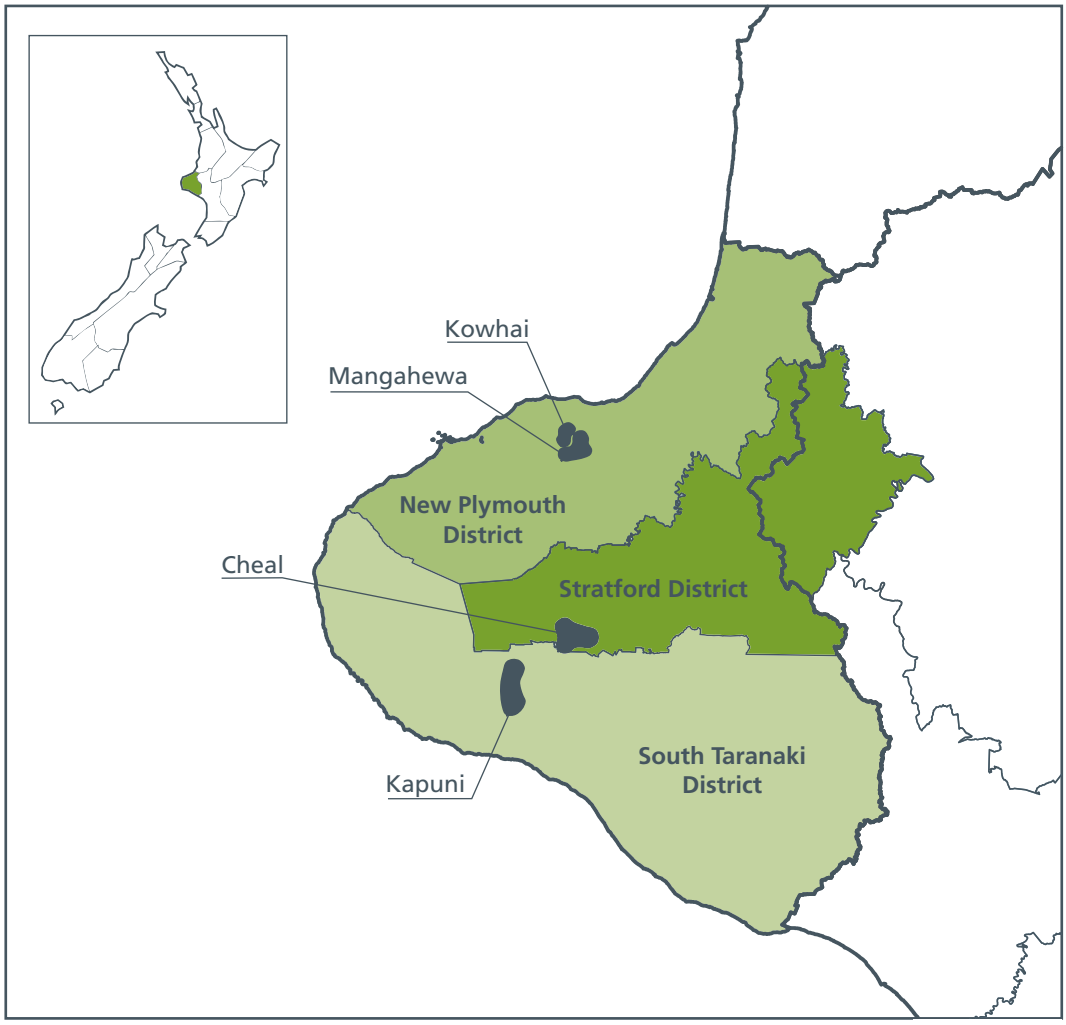
District councils are responsible for managing the impacts of the oil and gas industry that come from the way in which land is used. For well sites, this includes managing things such as noise, light from flaring gas, and disturbance from heavy traffic.[50]

These impacts affect people who live and work in the vicinity of oil and gas wells, so well location is a major factor in determining how serious these impacts are. Indeed, much of the local concern expressed about fracking is not about fracking itself, but about the impacts on people that come with the expansion of the oil and gas industry.

Taranaki

There are three district councils in Taranaki – New Plymouth, Stratford, and South Taranaki. All three have oil and gas wells within their boundaries (see Figure 3.4).

Like regional councils, district councils are able to control well location through zoning rules in plans, but this is only done at a very high level. Most of Taranaki outside the national park is zoned as rural, and this allows for oil and gas drilling.



GIS data: MBIE NZP&M, Statistics NZ

Figure 3.4: Three district councils lie within the Taranaki region – New Plymouth, Stratford and South Taranaki. Part of Stratford district falls outside the Taranaki region. The map also shows key oil and gas fields referred to in this report.

There are three impacts that have caused particular concern in Taranaki and are the responsibility of the district councils – flaring, noise, and hazardous substances. District council management of hazardous substances is assessed in Chapter 5.

Flaring is the burning of natural gas at a well site. The light from flaring at night is a nuisance for those who live nearby. Flaring is controlled by regulations under the Crown Minerals Act, but these are concerned with the economic cost of wasting natural gas, not with people prevented from sleeping by bright light.[51] The latter is for the district councils to manage.

The *noise* from a well site is greatest when the well is being drilled. Once a well has moved into production, there is ongoing noise from the compressing of natural gas so it can be piped to a production station.

There are differences in the way in which the three district councils manage noise. Although all three set 45 decibels as the night time limit for those who are 'affected' in the rural zone, there are differences in *how* and *where* it is measured.

- In New Plymouth and South Taranaki, noise is measured with 'older' technical standards than in Stratford.[52]
- In New Plymouth and Stratford, noise levels are measured 20 metres from the side of a 'dwelling'; in South Taranaki, they are measured from the legal boundary of the property.[53]

Source: Dr Murry Cave

Figure 3.5: Natural gas can be flared during well testing, equipment maintenance, and in emergencies. The noise and glare from flaring disturbs those who live nearby.

Variation in the way in which different district councils manage such impacts from the oil and gas industry is not necessarily a bad thing, but there should be a rationale for it. Unjustified variation is not only inefficient, but a source of confusion and frustration for concerned citizens. Another issue in Taranaki is that enforcement of conditions in consents seems to be largely reactive – someone must phone up and complain, and by the time an enforcement officer arrives the company may no longer be in breach of the condition. Again this can undermine public confidence (see Box 3.1).

Box 3.1 Not all complaints are trivial

Sometimes complaints by local residents about environmental matters are dismissed as 'nimbyism' – 'not in my back yard'. But companies cannot always be trusted to 'do the right thing' and complaints should be taken seriously.

In February 2013, the New Plymouth District Council received complaints about noise from residents in the vicinity of TAG Oil's Sidewinder Extension Well Site. The council found that the company had "*on a number of occasions significantly exceeded the noise limits provided for in its resource consents*", and issued the company with two noise abatement notices. But when the company failed to comply, the council was left with no option but to take the company to the Environment Court. The Court prohibited TAG Oil from recommencing drilling until it had "*taken sufficient further mitigation steps*" to comply with the noise limit conditions.[54]

Outside Taranaki

Two district councils outside Taranaki have been involved in the consenting of applications for exploratory wells – the Tararua District Council with the wells near Dannevirke and the Gisborne District Council for the wells near Te Karaka.

It may be that the district councils in the east of the North Island face a particular challenge, namely planning for the cumulative effect on landscapes of many wells. As discussed in section 3.1, drilling and fracking in shale in North America has dramatically and rapidly altered landscapes. Because district councils are responsible for how land is used, they are responsible for protecting landscapes.

3.4 Summary

The risk of environmental damage and the impacts on people from an oil and gas well site depend in large part on the location of the well.

Under New Zealand law, responsibility for assessing and controlling the location of oil and gas wells falls on regional and district councils.

- Regional councils need to assess what is under the surface – drilling through important aquifers and near major earthquake faults should be avoided. They should also ensure that drilling does not take place within or near valuable ecosystems.
- District councils are responsible for protecting people from the variety of 'nuisances' caused by locating heavy industry in the countryside. Some of these, like the heavy traffic associated with well construction, are temporary. Others, like the constant noise of compressors at a gas site that can continue for years, are more serious.

Almost all the oil and gas wells in New Zealand are in Taranaki, but the ability to frack shale and coal seams may see a significant spread of this industry into other regions of the country. The rules and standards in council plans are inadequate for controlling the impacts of this complex industry.

It is particularly worrying that regional plans do not, on the whole, distinguish between the drilling of an *oil and gas* well and the drilling of a *water* well.

Taranaki Regional Council has proposed a separate set of rules for oil and gas, including the ability for much greater control of both fracking and the injection of wastewater into the ground. But the drilling of an oil and gas well is proposed to remain *permitted*, and still controlled by standards that are more suited for a water bore.

There is little consistency in the way regional plans are written. Further variation exists within regions, with district councils also each going their own way.

The three district councils within Taranaki all have oil and gas wells within their boundaries, and again systematic comparison is challenging. Variation across regions and districts is not in itself undesirable, but unjustified variation is. So much complexity and fragmentation does not engender public trust, but rather confusion and frustration.

Justified variation in approach and control will become increasingly important and require a lot more forward thinking if the industry starts to grow significantly beyond Taranaki. For instance:

- Coal seam gas wells in Canterbury, for example, would be very different from tightsands wells in Taranaki, and possibly also very different from the deep experimental coal seam gas wells in Waikato. Aquifers in Canterbury could be much more vulnerable.

- Drilling and fracking shale in the east of the North Island could also be very different from drilling and fracking tight sands in Taranaki. The shale in this part of the country varies greatly in its porosity and permeability. It could be possible for shale wells to multiply in some areas with a dramatic effect on landscape, as has happened in North America.[55]

"*Watch where you drill*" is one of the International Energy Agency's Golden Rules. Another closely related Golden Rule, "*Be ready to think big*", draws attention to the need to think hard about the cumulative effects of rapid growth.[56] In Australia and North America, the speed at which fracking has enabled wells to spread across big areas of land is in itself a cause of public disquiet.

Yet there is little evidence of hard thinking about dealing with potential cumulative effects in New Zealand. The Taranaki Regional Council's guide to regulating oil and gas exploration and development offers virtually no guidance on how councils should deal with the cumulative effects of increased activity. The Ministry for the Environment's guidelines refer several times to the need to consider and manage the cumulative effects of the petroleum industry, but do not provide any guidance for how this is to be done.

Well location – "*watching where you drill*" – is the first (and most wide-ranging) of the four physical aspects of the onshore oil and gas industry that it is particularly important to 'get right' for managing the effects on the environment and people. The relatively 'hands-off' approach to well location in Taranaki seems to rest on the assumption that properly designed and constructed wells do not leak. This – 'well integrity', as it is called – is the focus of the next chapter.

4 Maintain well integrity

Ensuring well integrity must remain the highest priority to prevent contamination.[57]

The Royal Society of London

Designing and constructing a well to a high standard is the second of the four physical aspects of onshore oil and gas exploration and extraction to 'get right' to limit the risk of environmental damage.

The term used is 'well integrity'. A well that has 'integrity' will not leak because it is able to withstand the pressure that is exerted on it. This could be pressure from oil and gas coming out of a well or pressure from fracking fluid pumped into a well. It could be pressure from wastewater being injected into a deep well to get rid of it. And, in New Zealand, wells need to be built to withstand frequent earthquakes.

Well failure can harm both people and the environment. In New Zealand, well integrity is regulated under two laws. One – the Health and Safety in Employment Act – is concerned with protecting employees who work at well sites. The other – the Resource Management Act – is concerned with protecting the environment. While these laws apply independently of each other, they overlap in practice.

This chapter begins with an outline of why well integrity matters for protecting the environment. Then four guidelines on government oversight and regulation of well integrity are presented.

The remainder of the chapter describes and critiques the management of well integrity in New Zealand.

4.1 Why well integrity matters

If a well fails, there are three ways in which escaping gases and liquids can harm the environment and people.

- A blowout is a sudden and uncontrolled release of gases and liquids from a well, either at the surface or below ground. Blowouts can lead to fires and are a major health and safety hazard. They can also lead to contamination of soil and water.
- A leak of gases and liquids *at the surface* can also contaminate soil and water. Leaking natural gas can explode and endanger workers at the well site.
- A leak of gases and liquids from a well *below the ground* can lead to gases and liquids getting into surrounding rock and migrating into an aquifer.

After a well is drilled, multiple steel casings are cemented to each other and to the surrounding rock (see Figure 4.1). This must be done to high technical standards.

Unfortunately, even wells designed to high standards can fail, usually due to deterioration of the cement seal.[58] A study of over 300,000 oil and gas wells in Alberta, Canada found that around 5% had leaked at some stage during their operation.[59] In Pennsylvania, a study of wells where fracking is used to extract gas from the Marcellus Shale Field found problems with the casing or cement in 1 to 3% of them.[60]

Two particularly controversial cases of groundwater contamination occurred in the town of Dimock in Pennsylvania and in the town of Pavillion in Wyoming. In such cases, it is difficult to know whether the cause of such contamination was well failure, or contaminants migrating up from the production zone.[61] In some cases also, contamination may be naturally present or due to some other source, but it is not possible to know this if baseline monitoring has not been done, as was the case in Dimock and Pavillion.

In New Zealand, there have been recorded failures of well integrity. One was the McKee-13 well blowout in 1995, which took 35 hours to get under control.[62] Another occurred more recently in the Cheal Oil Field, when hot water injected to enhance oil recovery leaked from patches on two production wells into another deep rock formation.[63]

There are also cases of old, abandoned wells leaking in New Zealand. These were abandoned before modern abandonment practices were adopted by the industry in 1965. There are also wells abandoned poorly both before and after 1965 that are considered to be at risk of failing and releasing gas into the atmosphere.[64]

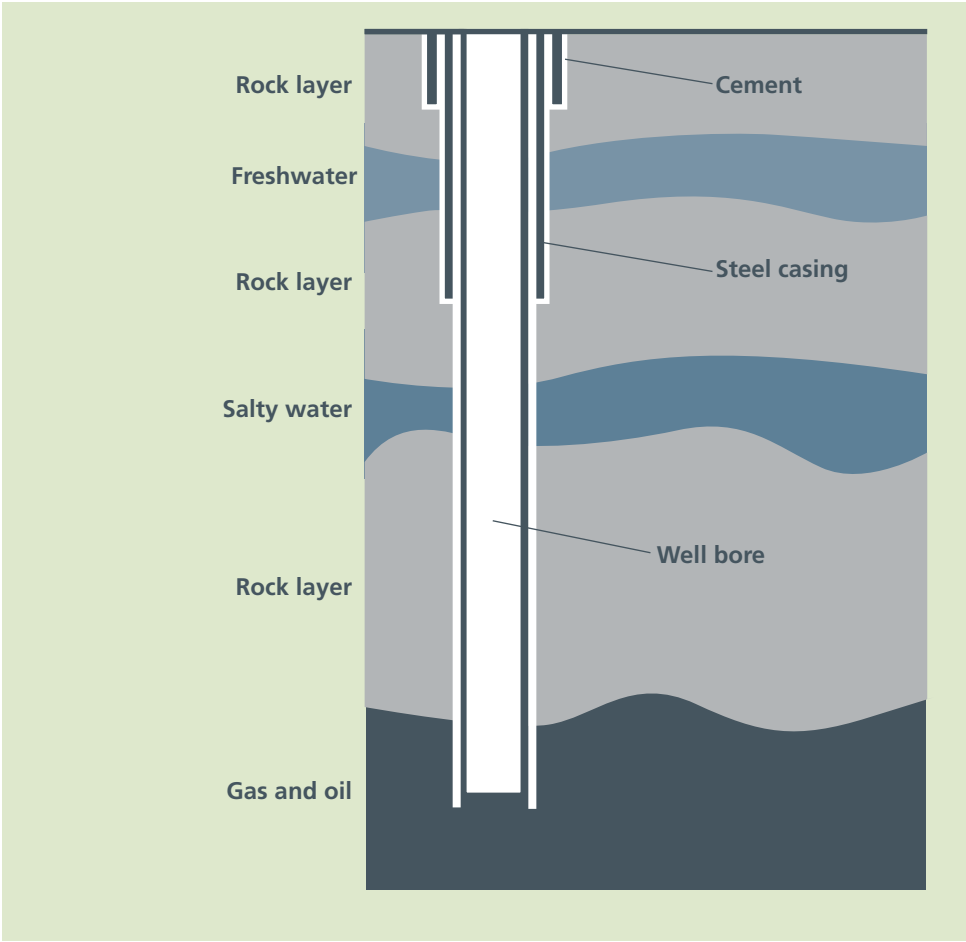


Figure 4.1: Diagram showing well casing. Two layers of casing usually extend through freshwater zones.

4.2 Government oversight and regulation of well integrity

Controversy over fracking in a number of countries around the world has led, and continues to lead, to the preparation of reports on how government agencies should manage the risks associated with the industry. Many of these reports contain guidelines for oversight and regulation of well design, construction, and maintenance.

Review of these guidelines reveals four key requirements for the maintenance of well integrity. Three are aimed at *preventing* well failure and one at *detecting* failure.[65]

Preventing well failure

1. Put in place regulations that require companies to design and construct wells in accordance with high standards that are regularly updated as technology develops and lessons are learned. Standards can be prescriptive – specifying design details – or they can be based on goals, such as ensuring the well does not provide a pathway for oil and gas to get into aquifers.
2. Oversee the design and construction to ensure it complies with the standard, including performing well integrity tests after construction and at other times during operations. Because this oversight requires a high level of technical expertise, it is often best done by an independent 'well examiner'.
3. Consider well integrity from an environmental perspective as well as from a health and safety perspective. Health and safety regulation is the first line of defence against well failure, but additional environmental measures may be necessary. For instance, additional well casings or more stringent well testing may be needed in an environmentally sensitive area.

Detecting well failure

4. Establish an environmental monitoring system to detect any leaking from the well. This involves first undertaking baseline monitoring – measuring the 'normal' concentrations of contaminants before the well is drilled. Measurements should then be taken at intervals during the operation of the well, and continued for some time after the well is abandoned.[66]

In the next three sections, the 'system' for overseeing and regulating well integrity in New Zealand is examined.

4.3 Health and safety and well integrity

As described in section 2.3, the High Hazards Unit is responsible for regulating health and safety in the oil and gas industry. Regulations aimed at protecting the health and safety of employees in the industry were enacted in 1999, but were amended in 2013 to "*bring New Zealand into line with best practice in the United Kingdom and Australia*".[67]

These regulations comply well with the first two guidelines listed in section 4.2.

First, an operator is legally required to design, construct, and operate the well in such a way that "*there can be no unplanned escape of fluids*" during the lifetime of the well or after its abandonment, and to ensure that health and safety risks "*are as low as is reasonably practicable*".[68] This includes specification of the standards that will be followed and an assessment of below ground conditions and scale diagrams of the well's design.[69] The operator must also submit a comprehensive safety assessment to the High Hazards Unit for approval before drilling begins.[70]

Source: Dr. Murry Cave

Figure 4.2: A blowout is a sudden and uncontrolled release of gases and liquids from a well. Here water erupts from a blowout at a coal seam gas well near Greymouth in 1995.

Second, an operator must put in place a well examination scheme to ensure the well is actually built and operated in accordance with the regulations. This includes testing of the well once it is constructed and throughout the well's life (see Box 4.1). The scheme must be overseen by an "*independent and competent person*".[71]

These regulations place the responsibility – and most of the cost – for ensuring well integrity on the operator. However, the cost of conducting 'on-the-ground' well inspections is borne by the High Hazards Unit. Currently, the High Hazards Unit has four inspectors – including the Chief Inspector – covering all oil and gas wells and geothermal wells. However, this is expected to increase to eight inspectors, including one new Deputy Chief Inspector, later this year.[72] These inspectors are also tasked with reviewing safety assessments of existing wells – safety cases were only required for offshore wells under the old regulations.[73]

Box 4.1 Testing the integrity of a well

There are a number of different tests that are used to verify the integrity of a well during construction and at other key times during its operation, including the following:

Pressure test:
The central casing is pressurised to the maximum operating pressure and monitored to see if this pressure is maintained over time. A significant drop in pressure indicates a leak.

Wireline log:
Instruments on a wireline are lowered down the well to take magnetic, electrical, and acoustic measurements to provide information about the rock structure, reservoir quality, and fluid content and properties. One type of wireline log is a cement bond log, which is used to check the strength of the cement bond between the casing and the surrounding rock.

4.4 The environment and well integrity

The health and safety regulations serve indirectly to protect the environment because they ensure that wells are designed and constructed to prevent well failure. But those who work in the High Hazards Unit have no mandate for protecting the environment.

This means health and safety inspectors are not required to ensure the design of the well in an environmentally sensitive area is adequate. Nor are they required to monitor the environment to see if a well is leaking. Indeed, inspectors cannot take environmental effects of leaks into account if they have no potential for harming people. And they have no responsibility for the integrity of abandoned well sites, since they are not workplaces.

The responsibility for managing well integrity from an environmental perspective falls on the regional councils because they are responsible for discharges to water, soil, and air. How regional councils are doing this is examined in this section, beginning with Taranaki.

Taranaki

As described in Chapter 3, drilling a well in Taranaki is a permitted activity, but it must be "*cased and sealed to prevent the potential for aquifer cross-contamination or leakage from the surface*".[74] The council considers they have no need to check compliance with this rule, because: "*The reality is the requirements associated with environmental protection that relate to well integrity are precisely those that relate to health and safety addressed in the petroleum regulations*".[75]

As a result, Taranaki Regional Council does not set particular conditions for the integrity of any well or require monitoring to detect well failure.

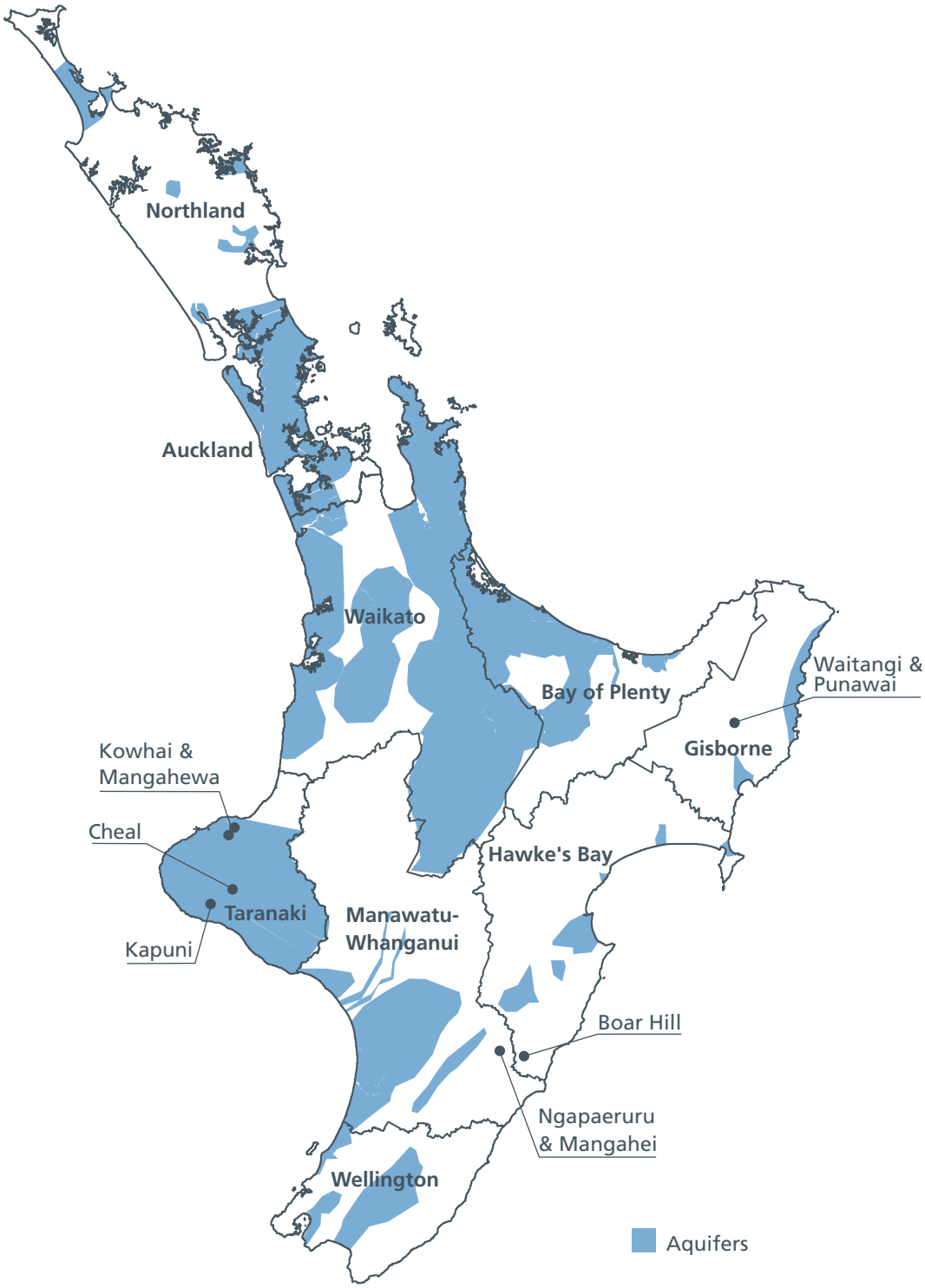
However, when a well in Taranaki is to be used for deep well injection, resource consent is required, and extra conditions to prevent well failure can be imposed. The same applies when a well is to be fracked, although it was not until 2011 that the council began to require consents for fracking.

An approved groundwater monitoring programme is also required as part of consent for fracking and for deep well injection. The monitoring programme for the Mangahewa-A well site, for instance, requires sampling prior to the frack, and at 1 week, 3 months, and 1 year afterwards.[76]

Outside Taranaki

As described in section 3.2, two councils – Horizons and Gisborne – have granted consents for exploratory wells into shale. These wells may be fracked and potentially could become production wells. As part of the consent process, both councils commissioned the same independent expert to provide specialist advice on well integrity.[77] As a result, conditions specifying design and construction standards and programmes of surface and groundwater monitoring have been put in the consents.[78]

If any of these exploratory wells go into production or require fracking, further consents will generally be required, bringing the opportunity to impose additional conditions to reduce the risk of well failure or increase the extent of monitoring.[79]



GIS data: NZ Hydrological Society, Statistics NZ

Figure 4.3: Main known aquifers in the North Island, exploratory wells in the East Coast Basin and key well sites in Taranaki. Special care must be taken when drilling wells through or near aquifers.

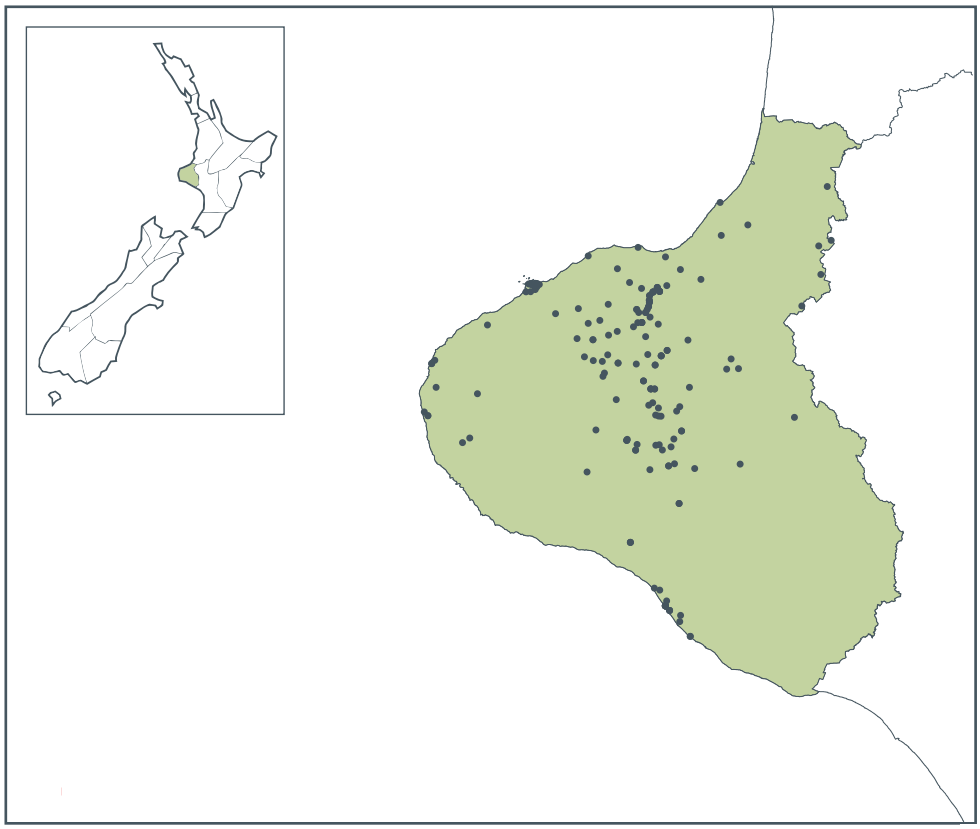
4.5 Who should pay to fix a leaking well?

It is the legal responsibility of the well operator to identify any failure of well integrity and to fix any leaks.[80]

In considering an application for a drilling permit, New Zealand Petroleum and Minerals assesses whether a company has the financial resources to complete the proposed drilling programme. This should include the ability to pay to fix any leaks or problems with the well. However, companies are not required to have any particular amount of public liability insurance for onshore wells, to cover the cost of any clean up needed if the well fails.[81] Nor have councils required oil and gas companies to pay bonds as conditions in consents.[82]

The bigger challenge comes once a well has been abandoned. The likelihood of an abandoned well leaking increases with its age. Moreover, there is no guarantee that the company that drilled the now abandoned well will still be operating in New Zealand (see Figure 4.4).

Under law, once a well has been abandoned and 'signed off' by the High Hazards Unit and the councils, any leaks from the well become the responsibility of the owner or occupier of the land.[83] But what tends to happen is that the cost of cleaning up contamination from historic economic activities falls on the public, whether it is paid by local government or from the Ministry for the Environment's Contaminated Sites Remediation Fund. The remediation of the contaminated site at Mapua near Nelson and the Tui mine at Te Aroha are expensive examples of this.



GIS data: MBIE NZP&M, Statistics NZ

Figure 4.4: Abandoned oil and gas wells in Taranaki.

4.6 Summary

*"Well designs should be reviewed by the well examiner from **both** a health and safety perspective and an environmental perspective".*[84]

There is no debate about the importance of well integrity for protecting both the health and safety of employees and the environment.

It is sensible for councils to rely on the High Hazards Unit to examine most technical aspects of well integrity – there is no need for duplication. But regional councils still have a responsibility to ensure wells do not leak and contaminate the environment. And they should ensure that monitoring programmes are set up so that signs of well failure are detected.

The two councils that have recently given resource consent for the drilling of exploratory wells into shale – Horizons and Gisborne – have considered well integrity in their consenting process, including commissioning independent expert advice to assist council staff.

In contrast, drilling a well in Taranaki is a permitted activity, and so Taranaki Regional Council does not consider environmental aspects of well integrity. However, as described in Chapter 3, the council does require consents for fracking and for deep well injection of wastewater. Additional casings or more stringent well testing may be required to meet the conditions of these consents.

An important aspect of well integrity from an environmental perspective is monitoring of the surrounding environment to detect well failure, both during well operations and after the well has been abandoned.

Baseline monitoring – taking samples before the well is drilled – is critical. In many of the much-publicised cases of water contamination in the United States, it has not been possible to ascertain the cause and responsibility because baseline monitoring has not been done. It is concerning that the recent guidelines prepared by the Ministry for the Environment say only that baseline monitoring should "*ideally*" be done.[85]

Groundwater monitoring programmes, including baseline monitoring, have been set up for the recently approved wells in Gisborne and Manawatu. In Taranaki, groundwater monitoring programmes have only been set up for wells that have required consent – those used for deep well injection of wastewater and those that have been fracked since consents for this were required.

However, few groundwater monitoring programmes cover the entire lifetime of well activities. But the older a well is, the more likely it is to leak. And after wells are abandoned and sealed off, there appears to be little if any further monitoring.[86] The only monitoring of abandoned wells appears to be when complaints of possible leakage are received from the public. Some very old abandoned wells in Taranaki are known to leak and the council regularly undertakes visual inspections.[87]

The need for monitoring abandoned wells is recognised by the Ministry of Business, Innovation and Employment, but was excluded from consideration in the recent Ministry for the Environment guidelines.[88] Long-term monitoring need not be onerous – an annual test of the soil, air, or groundwater near the well might suffice.

Finally, the likelihood that an abandoned well will leak increases over time. Currently, the cost of any clean-up needed falls on the owner of the land and the public, not the company.

Source: Parliamentary Commissioner for the Enviroment archives

Figure 4.5: A fracking operation taking place at one of Todd Energy's Mangahewa well sites in Taranaki in 2012.

5

Surface spills and leaks

Most of the accidents and ground water intrusions [in North America] seem to be due to incorrect handling, which could be avoided.[89]

European Parliament

Preventing and managing spills and leaks at well sites is the third aspect of onshore oil and gas extraction to 'get right' to limit the risk of environmental damage.

The previous chapter dealt with leaks due to the failure of well integrity. Such leaks are rare although potentially much more serious. Spills and leaks from mishandling fluids on the surface will almost inevitably occur and can result in the contamination of soil and water. Several of the International Energy Agency's Golden Rules address the management of surface spills and leaks.[90]

Spills and leaks of potentially harmful substances are, of course, not unique to the oil and gas industry. A recent example was the spilling of thousands of litres of weedkiller into a stream when a truck crashed in Waikato.[91] New Zealand also has a particular legacy of sites contaminated in the past by timber treatment chemicals and agricultural pesticides.

This chapter begins by describing how surface spills and leaks can damage the environment and cites some instances when this has happened. The remainder of the chapter examines how government agencies oversee and regulate the management of surface spills and leaks at well sites in New Zealand. Two laws are relevant – the Hazardous Substances and New Organisms Act (HSNO) and the Resource Management Act (RMA).

Some of the substances that can be spilled or leak at well sites are classed as 'hazardous' by the Environmental Protection Authority (EPA). Under the HSNO Act, the EPA imposes controls on hazardous substances, but a number of agencies are given responsibility for enforcing these controls.

Under the RMA, both regional and district councils have roles in the management of spills and leaks.

5.1 Why surface spills and leaks matter

Spills and leaks of chemicals, wastewater, and oil and gas are the most common cause of soil and water contamination associated with well sites. They can occur during transport, handling, storage, and use. Trucks can roll, storage tanks and pits can leak or overflow, and pipes can burst.

In a recent incident at an exploration well site in Taranaki, equipment failure led to oil collecting in a flare pit, leaching into a tile drain, through a manhole, and into a stream.[92] In another more serious case, hundreds of litres of oil and produced water leaked from a pipeline into a stream and was detected when noticed by a local farmer.[93]

An important factor in managing spills and leaks is the control of stormwater. In 1999, heavy rain flooded an exploratory well site near Wairoa, and appeared to sediment and contaminate a spring that provided water for seven households and thousands of stock.[94]

Overseas there are examples of far more serious spills and leaks. In a recent incident in Australia, an oil and gas company spilled 7,000 litres of salty wastewater killing many of the trees in a nearby forest.[95] In another, in the United States, a mixture of returning fracking fluid and produced water overflowed from retention pits into a stream and killed fish for several kilometres downstream, including a nationally threatened species.[96]

Source: Taranaki Regional Council

Figure 5.1: In October 2010, a leak from the Rimu underground oil pipeline was found by a farmer. The clean-up included the removal of contaminated soil.

5.2 Hazardous Substances and New Organisms Act

The first law that is relevant to the management of spills and leaks is the Hazardous Substances and New Organisms Act (HSNO).

Many of the chemicals transported, stored, and used in oil and gas extraction are 'hazardous' and must be approved by the Environmental Protection Authority (EPA) before they can be manufactured or imported. This includes the oil and gas produced from a well.[97]

The EPA assesses the characteristics of hazardous substances and imposes controls that must be followed by everyone who handles them.[98] Controls could include requirements for containment during transport and storage, rules for labelling, use, and disposal, and certification of some sites, equipment, and people who handle certain substances.

Despite these controls, spills of hazardous substances can still occur. Regulations for managing spills in emergencies have been set under the HSNO Act.[99] All oil and gas sites must have an emergency response plan that includes backup containment systems such as bunds and drains, and materials for cleaning up spills. These plans (and others) must be approved by an independent test certifier before hazardous substances can be brought on site.

The EPA does not itself carry out inspections to check compliance with these controls. Instead various agencies are charged with inspecting and enforcing them.[100]

For oil and gas production sites, this responsibility primarily falls on inspectors from the High Hazards Unit as part of their enforcement of health and safety regulations.[101] However, at the time of writing, the High Hazards Unit has four inspectors who must cover all oil and gas well sites and all geothermal well sites, although four more inspectors are being recruited. In 2013, they visited four onshore oil and gas well sites.[102] There are about 60 active well sites in New Zealand.[103]

These inspectors are highly trained technical experts in the management and regulation of the oil and gas industry. Checking compliance with HSNO controls does not seem to be an efficient use of their limited time.

While council staff are visiting well sites to check compliance with their requirements under the RMA, they are also empowered to inspect and enforce the HSNO controls.[104] Currently, it appears this power is seldom used, if at all.

In the past, some councils were contracted by the Department of Labour to enforce HSNO controls in workplaces. Taranaki Regional Council was one of two regional councils contracted, but when the Department ended the contract, council staff ceased enforcing the HSNO controls. While the primary responsibility fell back on the Department, the Council could have continued to enforce HSNO rules, but has not to date.[105]

There would clearly be a gain in efficiency if council staff did enforce the HSNO controls. After all, regional council staff visit well sites far more frequently than inspectors from the High Hazards Unit will ever be able to do.[106]

District councils are also empowered to enforce HSNO controls, but do not visit well sites regularly and many lack the necessary capability.[107]

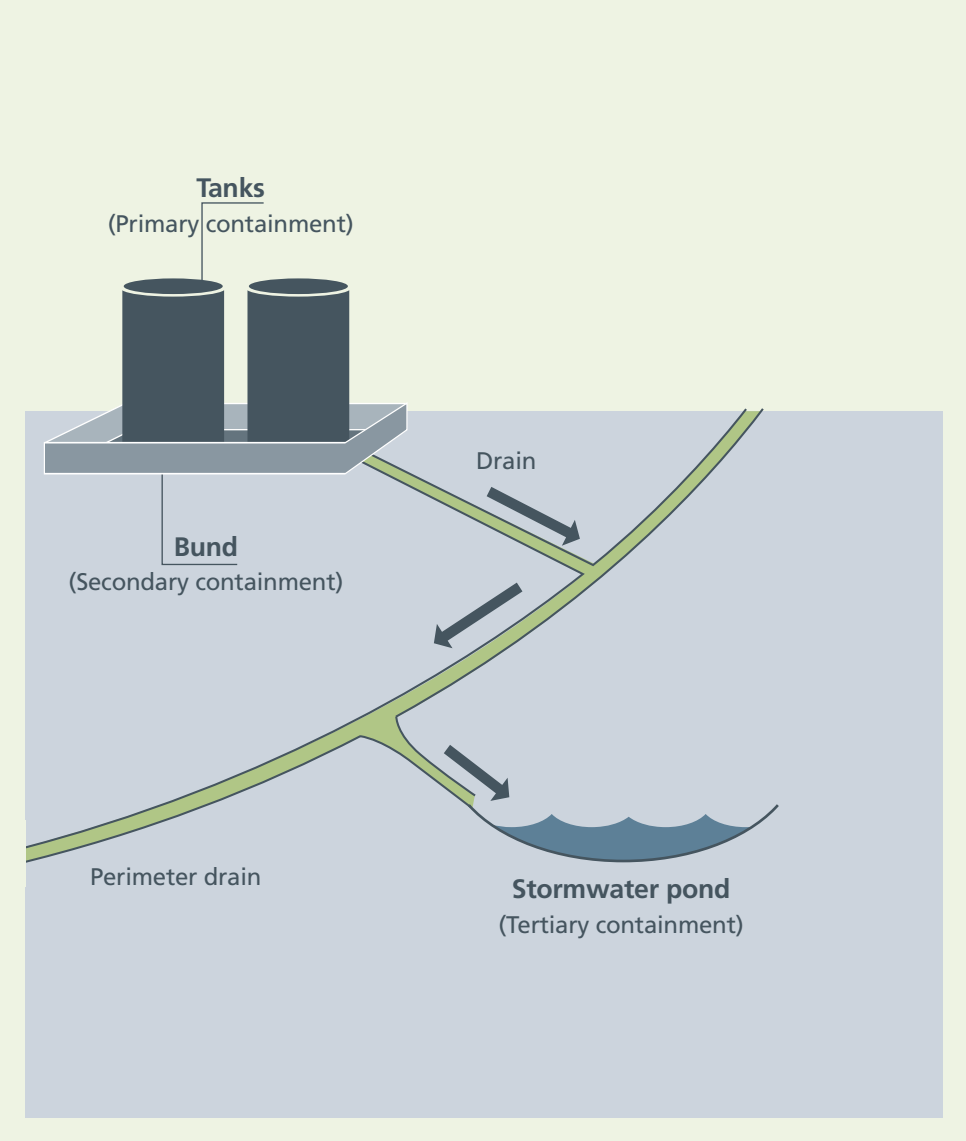


Figure 5.2: Three levels of containment of liquids at well sites - tanks, bunds, and stormwater ponds.

5.3 Resource Management Act

The second law that is relevant to the management of spills and leaks is the Resource Management Act (RMA). Both regional and district councils have responsibilities in the management of hazardous substances.

HSNO controls alone are not sufficient for managing the risk of spills and leaks at oil and gas sites. For instance, the HSNO Act does not cover all the substances associated with oil and gas activities that could cause environmental damage if they were to spill or leak. For example, the produced water extracted along with oil and gas is not classed as 'hazardous' by the EPA, although the heavy metals and salt present in it could cause environmental damage were it to leak.

Concern about the nature of the constituents of fracking fluid is frequently expressed. Councils can require operators to disclose in resource consent applications what chemicals are to be used, and require the use of 'greener' fracking fluids.[108] However, the very large tanks of diesel and produced water stored at well sites would likely do far more environmental damage than most fracking fluid constituents were they to find their way into a stream.[109]

Strengthening HSNO controls

Councils cannot weaken HSNO controls, but they can choose to strengthen them.[110] Regional councils would generally do this by adding conditions to discharge consents and district councils by adding conditions to land use consents.

Why might a council feel the need to strengthen a HSNO control for a particular well site?

As an example, consider the design of the bund wall built around tanks containing hazardous substances – a vital part of preventing surface spills and leaks from causing damage.

HSNO regulations require that tanks containing hazardous liquids must be surrounded by a bund wall that has a capacity of 110% of the capacity of the largest tank within the wall.[111] Therefore, if the largest tank has a capacity of 1000 litres, the bunding system must have a capacity of 1100 litres.

Under the RMA, a regional council might regard the 110% rule as inadequate at a particular well site because the site is located in a high rainfall area or a hazardous liquid might be washed into a nearby stream. A district council might regard the 110% rule as inadequate at a particular well site because a hazardous liquid might be washed on to an area where children play.

However, different councils have dealt with this simple aspect of well site design in a confusing number of ways at both regional and district level.

An examination of some land use consents granted for well sites by the three district councils in Taranaki reveals variable bunding capacity conditions both between and within councils, including:

- 110% of the largest tank within the bund wall (the HSNO rule);
- 120% of the largest tank within the bund wall;
- 50% of the total volume of all the tanks within the bund wall;[112]
- 120% of the total volume of all the tanks within the bund wall.[113,114]

This variation appears to be driven by the use of external consultants and interactions with oil and gas companies, rather than by the risks at different well sites. For the concerned citizen, such arbitrariness in consent conditions is very disturbing.

Source: Fiona Clark

Figure 5.3: Many hazardous substances are handled on oil and gas well sites.

Monitoring

The EPA does not have any role in monitoring water and soil to see if they have become contaminated by hazardous substances, but regional councils do. Some spills and leaks are obvious and will be picked up through visual inspections. Sampling of stormwater in stormwater ponds can be used to detect more subtle leaks. However, it is also very important to monitor water in the vicinity of the well site.

Taranaki Regional Council requires monitoring of surface water as part of its stormwater discharge consents, including monitoring of temperature, biochemical oxygen demand (BOD), and aquatic life. However, the council notes it has "severely *scaled back*" biological surveys around new exploration sites in recent years "*because of the lack of any effects being found*".[115,116]

Gisborne District Council and Horizons Regional Council have required programmes of stormwater, surface water, and groundwater monitoring before, during, and after drilling operations – at least for a period of time.[117] Neither council requires monitoring of any effects on aquatic life in surface water around the well site.[118]

Source: Taranaki Regional Council

Figure 5.4: The overflow drain from a stormwater pond discharges across pasture into a stream.

5.4 Summary

The controls set by the EPA on substances go a long way toward reducing the risk of spills and leaks of hazardous substances on oil and gas sites. But while these controls may be adequate, their enforcement may not be.

The main responsibility for enforcing these controls falls on the inspectors in the High Hazards Unit, but they are only able to make occasional site visits. However, regional council staff visit well sites frequently, and while they are there checking compliance with their own requirements, it makes sense for them to also check compliance with the HSNO controls.

Councils are able to supplement and strengthen the HSNO controls. Duplication (or triplication) of effort is clearly a problem when something as simple as the capacity of bunding systems is dealt with by three levels of government.

There is another aspect to this unnecessary complexity. Members of the public who are concerned about fracking and other aspects of the industry cannot help but be confused and frustrated.

The conclusions on environmental monitoring from the previous chapter equally apply here. While regular visual monitoring by council inspectors, and *ad hoc* sampling in response to incidents or complaints are to be encouraged, they cannot be relied on to detect pollution from a spill or a leak. The overall lack of systematic monitoring programmes that require baseline sampling and ongoing testing for the lifetime of the well (and beyond) – particularly for indicators of ecological health – is disappointing.

6 The disposal of waste

Waste disposal is the last of the four physical aspects of onshore oil and gas that must be properly managed to minimise the risk of environmental damage. Managing the waste from onshore oil and gas extraction is a major issue internationally, particularly in areas where fracking has enabled rapid expansion of the industry. Consequently, many international reports include principles or guidelines for oversight and regulation of waste from the industry.

Oil and gas activities generate a great deal of waste. Tonnes of rock are unearthed during the drilling process, and large volumes of 'produced water' flow out of wells along with oil and gas. This water coming from deep within the earth contains hydrocarbons, salts, and heavy metals.

Some waste from the oil and gas industry is relatively harmless, but some is contaminated and should be disposed of carefully to avoid polluting water and soil, and potentially bioaccumulation in plants and animals. In New Zealand, the primary responsibility for overseeing and regulating the disposal of waste from the oil and gas industry falls on regional councils.

This chapter begins by describing the different kinds of waste produced at oil and gas sites and the disposal methods used in Taranaki.

- Liquid waste is disposed of by pumping it deep into the ground – deep well injection.
- Solid waste is either spread on to land – 'landfarming' – or buried in the ground – 'mix-bury-cover'.

In the next three sections, these disposal methods are examined and some concerns about them are raised.

At the end of the chapter, the focus falls on the issue of waste disposal from the oil and gas industry outside Taranaki. The waste from the exploratory wells being drilled in the east of the North Island is being trucked to Taranaki for disposal.[119] But if the oil and gas industry begins to develop significantly in this part of the country and others, waste disposal will become an issue. Regional councils in these areas need to be prepared.

6.1 Methods for disposal of oil and gas waste

Some of the waste generated at oil and gas sites is common to many activities. For instance, the stormwater that builds up after heavy rain may contain contaminants in the same way as runoff from a major city road.

There are four sources of waste that are more specific to the oil and gas industry – drilling waste, well workover fluids, produced water, and fracking fluid that returns to the surface.

- Drilling waste consists of rock cuttings with some drilling 'mud' residue. Drilling mud is used to lubricate the drill and allow the rock cuttings to flow back up to the surface.
- Well workover fluids may include brines used to clean out drilling mud residue prior to cementing a bore, and acids used to increase the permeability of the rock formation. Fracking fluid is sometimes classed as a well workover fluid.
- Produced water is the water that flows up out of the well along with the oil and gas. It contains residual hydrocarbons such as benzene, and heavy metals. What is in the produced water depends to a considerable extent on the type of source rock. Shales will typically 'produce' much saltier water than sandstone, and are more likely to contain radioactive substances (see Box 6.1). The water in coal seams can be very pure if the seam is shallow.
- Fracking fluid flowback is the proportion of the fracking fluid that comes back out of the well for a time after a frack, but this is very small in volume compared with the produced water that continues to flow over the life of the well. Any potentially harmful constituents are very dilute, in comparison with the concentrated form in which they are brought on to the site.

There are two main methods now used for disposing of waste from the oil and gas industry in Taranaki.[120]

Deep well injection

Deep well injection is used to dispose of liquid waste – produced water, well workover fluids, fracking fluid flowback, and contaminated stormwater.

The liquid waste is pumped down a well and into a layer of rock capable of absorbing the liquid. A suitable reservoir will be porous and permeable, and isolated from groundwater by cap rock. Depleted production wells can be used or a waste disposal well can be drilled for this purpose near a production well. Solid waste cannot be disposed of this way as even small particles can block the process of injection.

As noted in Chapter 3, the injection of liquid waste in this way has been known to trigger small to moderate earthquakes. There is also the possibility of contaminating aquifers.

In Taranaki, deep well injection has been used since 1970. There are currently 20 resource consents for deep well injection; at the time of writing, nine injection wells are in use.[121]

Landfarming and mix-bury-cover

Historically at well sites, drilling muds were disposed of in sumps. These were covered over when finished and left in place at the site. However, sumps are no longer used and modern practices consist of two methods – landfarming and mix-bury-cover.

Landfarming is used to dispose of drill cuttings and drilling mud, sludges, and contaminated soil. These solid wastes are spread as a slurry on the land and mixed in with the top soil and sometimes other organic matter such as sawdust. Over time, microbes in the soil break down the hydrocarbons, but not the salts or heavy metals. Eventually, the land can be resown in pasture.

There are currently 11 farms in Taranaki, with one or more parts of the land consented for landfarming. Another four held consents in the past, but two were surrendered when the waste disposal was completed, and the other two expired before waste disposal began.[122,123]

Mix-bury-cover is also used to dispose of solid waste. The waste is buried, often in a sump hole beside the well, after being mixed with soil. It should be buried above the water table, but below the reach of plant roots. Because the waste is not mixed with soil at the surface as it is in landfarming, microbial breakdown of hydrocarbons is much slower.

There are currently 38 sites in Taranaki where mix-bury-cover has been used to dispose of oil and gas waste.[124]

Source: Taranaki Regional Council

Figure 6.1: The Brown Road Landfarm in Waitara.

6.2 Deep well injection

The injection of liquid waste from oil and gas sites into the ground is a well-established method and has been used in Taranaki since the 1970s. Almost all the liquid waste is produced water that has come up out of the ground with the oil and gas, so returning it deep underground makes sense.

Overseeing and regulating the disposal of waste from the oil and gas industry is primarily the responsibility of regional councils.

Two aspects of deep well injection of liquid waste require particular consideration – groundwater contamination and earthquakes.

First, the council should ensure that contaminated liquids cannot migrate into 'useable' groundwater. This requires that the separation distance between the injection zone and freshwater aquifers is adequate, and that physical barriers to migration (cap rocks) are present.

As discussed in Chapter 3, Taranaki Regional Council currently classes deep well injection as a discretionary activity.[125] This classification means the Council can consider any matters before deciding whether to grant the consent and, if granted, what conditions to impose.

The Council is proposing to change the classification of deep well injection to restricted discretionary, thus reserving control over a number of matters, some of which relate to the risks of groundwater contamination and induced earthquakes.[126]

An independent review of the Council's regulation of deep well injection found it measured up well against North American practices. The reviewer recommended two improvements – widening the definition of 'useable' groundwater, and introducing an 'area of review' to set the monitoring area around a site.[127] The Council is currently considering its response to these recommendations.[128]

Taranaki Regional Council requires geological and hydrological information to be provided in applications for consent for deep well injection. This allows assessment of the risk of liquid waste migrating into groundwater.[129]

The Council also requires an approved programme of groundwater monitoring as a condition for granting a consent for deep well injection, which includes a requirement for baseline sampling before injection begins. This requirement for baseline data is a recent change, as earlier consents only contained conditions that groundwater monitoring could be "*requested by the Council if any potential contamination was suspected*".[130] There is not yet any requirement for monitoring of groundwater after the well has been abandoned.[131]

Recent programmes have required groundwater sampling twice a year, but only at sites actively disposing of waste.[132] The Council's practice is for its own staff to design and run the sampling programmes needed to meet the conditions they have set in consents, and to analyse the results.

Second, the council should ensure that liquid waste is injected well away from active faults and faults in brittle rock to reduce the chance of inducing an earthquake.[133]

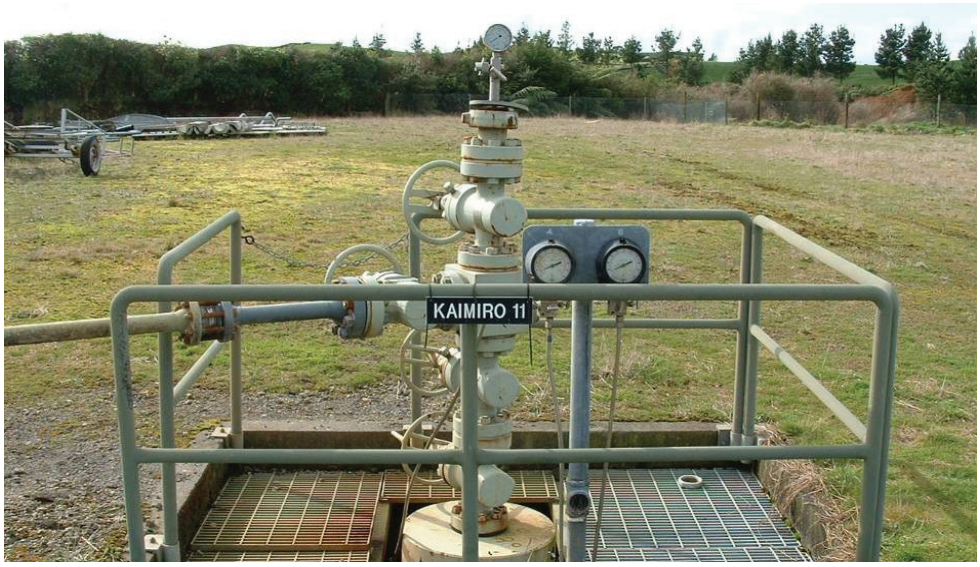
There are two aspects to earthquake risk – natural earthquakes and induced earthquakes.

Natural earthquakes may damage the integrity of a well. Taranaki Regional Council requires major faults and shear zones to be identified in an application for a consent for deep well injection (or fracking), along with the action to be taken to deal with any risk. For instance, a well near a major fault may be designed to withstand greater force.

The Council does not require any assessment of the risk of induced earthquakes, instead relying on a study undertaken by the Institute of Geological and Nuclear Sciences that found the risk to be negligible.[134] This appears to be at odds with the recommendation about induced seismicity from The Royal Society of London.

However, there are other requirements that partly address the risk of induced seismicity from deep well injection. These include regulations set under the Health and Safety in Employment Act and consent conditions that reduce the risk, through, for example, controlling the rate at which the liquid waste is injected.[135]

In an assessment of induced seismicity prepared for an application for exploratory drilling in Hawke's Bay, the authors recommend that a seismic monitoring network is installed before well operations begin.[136]



Source: Taranaki Regional Council

Figure 6.2: Kaimiro-11 is a Taranaki deep well injection site operated by Greymouth Petroleum. This well discharges liquid waste at a depth of 1600 metres.

6.3 Landfarming and mix-bury-cover

Both mix-bury-cover and landfarming have been used as a way of disposing of waste from the oil and gas industry in Taranaki since the mid 1990s. Taranaki Regional Council has classified both as controlled activities with conditions on what can be disposed, where and how it will be done, and on monitoring requirements.[137]

Since at least 2005, the Council has considered that landfarming is preferable to mix-bury-cover, because mix-bury-cover is slower at breaking down hydrocarbons.[138,139] It is also difficult to ensure that the waste is below the root zone and unable to leach down into the water table.[140] However, the Council is still receiving and processing applications for mix-bury-cover, although it may change its policy to "*signal landfarming as the more favoured option*".[141]

Source: Taranaki Regional Council

Figure 6.3: A mix-bury-cover site beside an exploratory well near Stratford in Taranaki.

Landfarming is a bioremediation treatment process – it relies on microbes in the soil to break down the contaminants into harmless substances. But not all the contaminants are biodegradable, and different kinds of contaminants raise different concerns.

- Hydrocarbons, which form the bulk of the contaminants, are biodegradable. It is very important that limits are put on the aromatic hydrocarbons because too much on a landfarm will kill off many of the microbes and slow the bioremediation process.[142]
- Heavy metals are not biodegradable. Cadmium is a particular concern because it bioaccumulates in animals.[143]
- Salts are also not biodegradable, and can stunt the growth of many plants, although grasses can tolerate relatively high levels.

Taranaki Regional Council granted the first landfarm consent in 1996,[144] with the standards used for landfarming in Alberta, Canada, as a starting point.[145]

The conditions in landfarming consents have evolved over the years. For instance, in 2010 returned fracking fluid was disposed of using this method at a property near Waitara as one type of generic "*drilling*" or "*oily*" waste that was provided for by the consent. Now if any fracking fluid is to be disposed of on to a landfarm, it must be included specifically in the resource consent.[146]

Landfarming in Taranaki generally takes place on sandy soils, prone to wind erosion.[147] After disposal of the waste, the area is fertilised and sown with grass. While this does have the economic benefit of converting poor soil into pasture, there is the risk that contaminants (and fertiliser) will be washed out of the topsoil by the frequent Taranaki rain, as they are not tightly held in the loose sandy soil. So while contaminant levels in the soil may drop, they may rise in surface water and groundwater.

This makes the monitoring of surface water and groundwater within and near landfarms particularly important. As with the monitoring of stormwater consents, sampling of surface water and groundwater around landfarms in the past has been a mix of visual inspections and sampling.[148] It is good to see, as with deep well injection, that baseline monitoring is now required.[149]

Last year, landfarming in Taranaki became national news. One of the dairy companies involved, Fonterra, takes milk from six landfarms, but in June 2013 announced that they would not take milk from any new landfarms because of the high cost of testing the milk.[150]

Adding to this, the local activist group, Climate Justice Taranaki, has highlighted cases of cattle on landfarmed paddocks before consents have been surrendered and in some cases, before contaminants had fallen to the required concentrations.[151]

The response from Taranaki Regional Council is that this is "*not a normal practice in our experience*".[152] While it may not be normal, there are cases where cows have been observed on landfarmed areas without any stand-down period. For instance, the author of a 2011 monitoring report states approvingly:

> *The paddocks where muds had been spread were inspected and looked good. Pasture had died off in the areas where the mud was thickly applied, but the other areas looked healthy and almost no sign of the application was visible. Cows were grazing one paddock where muds had been applied and were working the mud into the soil nicely with their hoof action.*[153]

It seems, in this case at least, that the mixing of the drilling mud with the topsoil was being done by the cows.

The Council does not support livestock grazing on landfarms until the conditions in the consent are met and it is surrendered. However, it has no policy on this matter as it considers that "*animal and food safety issues are the responsibility of the Ministry for Primary Industries*."[154]

The Ministry for Primary Industries is currently sampling milk from landfarms as part of its food safety programme.[155,156] Fonterra has been testing milk from landfarms and some mix-bury-cover sites for a range of contaminants, including heavy metals and hydrocarbons, but has not detected any contamination of milk supply.[157]

Source: Taranaki Regional Council

Figure 6.4: Cattle on an area where drilling waste was recently disposed at the Spence Road Landfarm in Kakaramea in 2005.

Box 6.1 Radioactive substances in waste from oil and gas wells

Overseas, there have been examples where elevated levels of radioactive material have been associated with the oil and gas industry.[158] So it is not surprising that with rapid growth of the industry in New Zealand, concern has been expressed about two kinds of radioactive substances that could be present in waste from oil and gas wells and in wellhead gases.

- Radioactive tracers can be used for various purposes including testing well integrity.
- Naturally occurring radioactive materials (NORMs) can come up from deep within the earth's crust.

Taranaki Regional Council has taken radiation measurements at landfarming sites and at places where waste has been stockpiled. The National Radiation Laboratory (now the Institute of Environmental Science and Research) has reviewed and interpreted the results, and found that all were within normal background radiation levels.[159] The Council has also collected samples of produced water and sludge from four different oil and gas fields. Analysis of these samples by the National Radiation Laboratory showed the levels of radioactivity in these samples to be far below the level at which any control would be required.[160]

Radioactive tracers and NORMs are regulated under the Radiation Protection Act 1965. This law is administered by the Office of Radiation Safety, a unit within the Ministry of Health. Anyone who handles or disposes of a radioactive substances must be given a licence by the Office of Radiation Safety. At the time of writing, the Office of Radiation Safety is in discussions with WorkSafe New Zealand on the inspection and enforcement of controls on radioactive substances.[161]

There is no reason for regional councils to duplicate any of the functions of the Office of Radiation Safety, but they should be requiring that oil and gas companies are meeting the requirements of the Radiation Protection Act. In particular, because shales typically have higher levels of radioactivity than sandstone, samples of the produced water and sludge from wells drilled in the East Coast Basin should be taken and tested by an accredited lab.[162]

6.4 Summary

The disposal of waste from the oil and gas well sites in Taranaki has changed significantly over the years. Years ago waste would have been put into streams and into pits.

Disposing of *liquid waste* by injecting it deep into the ground makes sense – after all, the produced water that forms most of the liquid waste comes from underground rock formations. The practice in Taranaki is now relatively well controlled. Monitoring still needs improvements, though it is good to see that a requirement for baseline measurements has now been introduced.

Disposing of *solid waste* through mix-bury-cover has been better controlled in recent years, but it is surprising that Taranaki Regional Council still give consents for the practice when it sees it as inferior to landfarming. There is no way of dealing with the legacy of an unknown and unidentified number of waste sump sites from the past, but it is disturbing that records for some consented sites are incomplete.

Bioremediation of contaminated drilling cuttings through the process known as landfarming is a much better option. Hydrocarbons, including the toxic ring compounds like benzene, can be broken down by microbes in the soil and rendered harmless. But limits for the persistent contaminants, particularly those that can bioaccumulate, must be set and checked through systematic sampling of soil and water.

There is one well-publicised problem with the landfarming in Taranaki. There is nothing in place to prevent dairy cows or other stock grazing on landfarmed areas before the bioremediation is complete, and before targets for persistent contaminants are met – or at least before the consent has been surrendered. This situation needs to be resolved.

All the waste from the new exploratory wells being drilled in the east of the North Island is being trucked to Taranaki for disposal. But this is not tenable if the industry starts to grow in other regions. The Royal Society of London's advice is clear – "*Options for treating and disposing of wastes should be planned from the outset.*"[163]

Planning for the disposal of waste from oil and gas wells outside Taranaki requires much more than extrapolating from what is done in Taranaki. The injection of liquid waste into the ground using purpose-drilled wells could be done in many parts of the country, but the risk of damage by natural earthquakes could be high in some areas, so location is all-important.

Landfarming elsewhere may prove to be a challenge. Because of the way in which shale has been compacted under heavy pressures over millennia, the produced water coming out of wells in the east of the North Island would almost certainly contain greater concentrations of heavy metals, salts, and radioactive substances.

In Taranaki, landfarming has been done on poor quality land near the coast. For the farmers involved, the fertilising and sowing of new pasture has been an incentive. But on what kind of land, and where, might landfarming take place in other parts of the country? Would persistent contaminants be leached from the soil and find their way into streams? These questions and others need to be proactively addressed.

7 Holding the decision-makers to account

Quis custodiet ipsos custodes? Who watches the watchers?[164]

In the last four chapters, the focus was on physical aspects of onshore oil and gas exploration and production. The ways in which different government agencies oversee and regulate the industry were described and analysed.

But regardless of assurances from regulators, this is an industry that continues to worry many people. The speed at which the industry (enabled by fracking) has grown in parts of North America and Australia in particular has led to decision-makers playing catch-up to gain greater public trust. Industry executives themselves refer to the challenge of obtaining "*a social licence to operate*".[165]

Two critical requirements for building trust are public involvement in the decision-making process, and proactive disclosure of information. If these are present, decision-makers can be held to account. With adequate accountability, the quality of decisions can improve over time, and poor environmental outcomes are less likely.

Public involvement and transparency are also vital for avoiding real or perceived 'regulatory capture' – a regulator acting for the benefit of an industry rather than in the public interest. Regulatory capture may have contributed to the Macondo (Deepwater Horizon) blowout and oil spill in the Gulf of Mexico in 2010. A Federal Government review of the incident recommended the development of "*…a transparent process and public notification policy…*"[166]

There are two sections in this chapter. The first examines the involvement of the public in the decisions made by local government about oil and gas exploration and production. The second looks at the importance of providing information proactively.

7.1 Public involvement in decision-making

Public input allows for different perspectives and pertinent information to be provided to council decision-makers. It also provides the opportunity for independent expert assessments to be put forward by others concerned by oil and gas developments, such as the dairy and horticulture sectors, iwi, and environmental groups.

There is no need for the public to be involved in low-risk routine decisions. But public input is essential when policies and rules are being set in council plans, and is often desirable when applications are made for resource consents.

Setting policies and rules in council plans

Regional and district plans are developed in consultation with the public under the Resource Management Act. Therefore, this process provides the opportunity for public input into the policies and rules that affect the oil and gas industry. In their statutory plans councils can set controls on particular 'activities' such as drilling an exploration well. They can also set out how they will manage the cumulative effects of these activities.[167]

Most statutory plans were developed some time ago, before a rapid expansion of the onshore oil and gas industry was contemplated. A number of councils are currently revising their plans and some are taking the potential for oil and gas development into account.[168] However, the recently developed 'One Plan' for the Manawatu-Whanganui region contains very little on oil and gas activities despite it being one of the regions where exploration wells are currently being drilled. The plans for Gisborne and Hawke's Bay remain current until 2016, so there will soon be the opportunity to consider new policies and rules for oil and gas development in consultation with the public, other industries, interest groups, and iwi.

Because of this overall lack of public involvement in the development of policies and rules for oil and gas extraction, much attention falls on the consenting process.

Responding to applications for resource consents

Most individual oil and gas activities require resource consents from councils before they can proceed. When a council receives an application for a resource consent, it must consider whether or not the application should be notified. If an application is publicly notified, anyone can make a submission on it to the council, and ask to be heard at the subsequent hearing.[169]

If the council considers that the environmental impacts of the activity are likely to be "*more than minor*", it must publicly notify the application for the consent. Even when a council considers the impacts to be minor, it can still publicly notify the consent application, if "*special circumstances exist*".[170]

Exploratory oil and gas wells are now being drilled in the East Coast Basin – in Manawatu and Gisborne. Applications for consents to drill in Hawke's Bay are being prepared. These have the potential to be the beginning of a rapidly growing oil and gas industry in this part of the country – indeed, many are hoping that this will be the case. If this happens, it would mean a new kind of oil and gas extraction in New Zealand – wells drilled into shale and likely to be reliant on fracking, and in areas with different seismicity and hydrology to that of Taranaki.[171]

Although it could be argued that these are "*special circumstances*", neither Horizons Regional Council nor Gisborne District Council publicly notified the applications for the consents for drilling these exploratory wells.

There are two further issues regarding public involvement in the consideration of individual proposals for oil and gas developments.

- 'Bundling' of related consents.
- Joint hearings by regional and district councils.

The consents required for developing an exploratory well may be 'bundled' together with others that will be, or are very likely to be, needed later in the process.[v] This is considered good practice because:

> *Unless all the effects, positive and negative, of a proposal are assessed together, the consideration of them required to make the ultimate judgement whether the consent should be granted or refused may be incomplete, and the balancing of them may be distorted.*[173,174]

In 2012, two companies in a joint venture prepared applications for consents for an exploratory well at Boar Hill in Hawke's Bay. All aspects of the proposed well, including the establishment of the site, drilling, and fracking were covered. This bundle of applications was not lodged.[175]

In contrast, the consenting process followed for the exploratory Punawai-1 well to be drilled near Gisborne was sequential. Applications for establishing the well site were lodged in June 2012 and approved in July 2012. Then applications for drilling the well were lodged in September 2012 and approved in September 2013. It is not yet known whether fracking will be required for this well.[176]

Those concerned about fracking and indeed the potential expansion of the industry understandably see a sequential application process as 'the thin end of the wedge'.

Where both regional and district councils are holding hearings for the same proposed development, they may hear the applications jointly. Indeed joint hearings must be held for all related consents, unless councils decide applications are "s*ufficiently unrelated*", and the company applying for the consents agrees.[177]

Like bundling consent applications, joint hearings are considered to be good practice, although it seems that no joint hearings have been held for proposed oil and gas developments.[178]

The combined effect of not publicly notifying consent applications and of separating related consents, means that there is very little opportunity for the public to comment on individual developments. This leads to concern that oil and gas activities, including fracking, are being 'rubber stamped' by councils with as little public input and scrutiny as possible.[179]

7.2 Transparency - proactive provision of information

Access to information is important for public involvement, but more broadly for holding decision-makers to account. While most documents can be obtained on request, the proactive provision of information can only help increase public trust.[180, 181]

It is particularly important that the public have ready access to two kinds of information.

- Documents describing what decisions have been made and why they have been made.
- Reports on compliance and monitoring.

Decision documents

Councils vary greatly in how they provide information on the decisions they make about individual oil and gas developments.

The documents that lay out the consenting decisions that have been made – and why they were made – can usually be obtained on request, but are not generally available on council websites. These include the decisions on whether to publicly notify an application, and on who qualifies as an "*affected*" party.

Gisborne District Council stands out with its proactive approach to the provision of information on oil and gas developments. It has a dedicated website page for each well site with links to the company's consent application, all the supporting documents including consultants' reports commissioned by the council, and the decisions on notification and on the consent itself.

This completeness and consistency is very desirable because a single case of unnecessary secrecy can damage public trust.

For example, the Stratford District Council commissioned an independent expert assessment of a consent application for a new well site. The assessment, which was highly critical, was not included in the documents provided for the hearing of the affected parties. Subsequently it was obtained by a member of the public and became national news.[182]

Compliance and monitoring reports

Taranaki Regional Council is to be commended for publishing many of its compliance reports on its website. But again, public trust would be greater if all their compliance reports were available online. Also, measurements of contaminants at one site are often spread across different reports and not statistically analysed, so it is not possible for the reader to see whether or not there is a problem.[183]

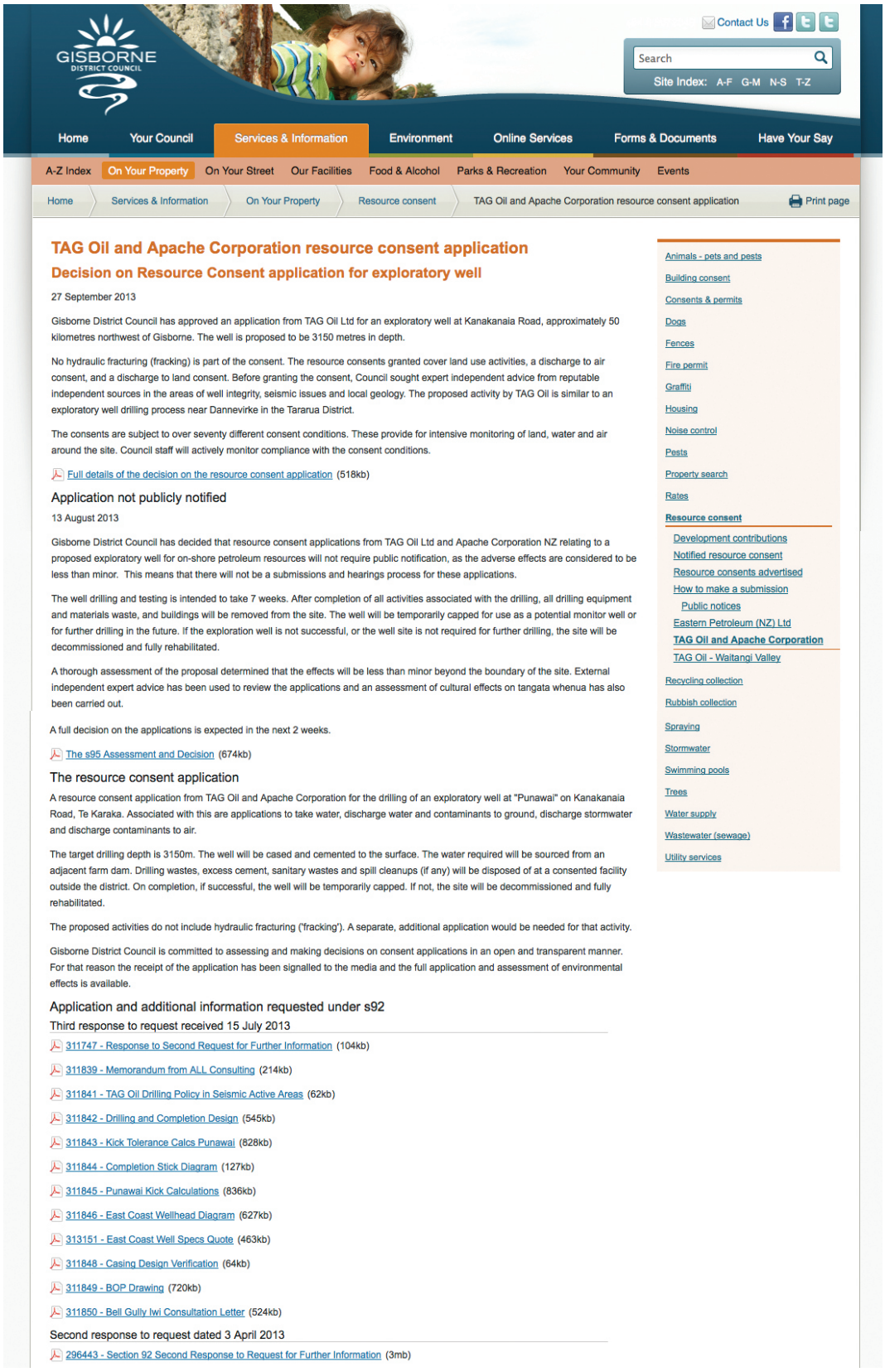


Figure 7.1: Screen-grab from the Gisborne District Council website showing information on the resource consents it has granted for the Punawai-1 exploratory well.

7.3 Summary

Excluding public involvement in the consenting process may make it easier and quicker to gain consent for new oil and gas developments, but it reduces the quality of decision-making and the accountability of regulators for their decisions.

The ability to challenge consenting decisions is especially important where council plans have been developed without explicit consideration of oil and gas activities. In these cases, the consenting process effectively sets the 'ground rules', yet the public is excluded from participation because applications for consents are not notified.

Proactively providing information on decisions, compliance, and monitoring is also important for engendering trust. Much of the public concern over oil and gas extraction in New Zealand, and fracking in particular, appears to stem from a lack of trust in regulators that is fuelled by low levels of transparency.

8 Conclusions and recommendations

Many countries experiencing expansion of the oil and gas industry have made, or are making, extensive reforms and improvements to their systems of governance and regulation. This investigation has been focused on the adequacy of New Zealand's laws, agencies, and processes for managing the environmental risks of the onshore oil and gas industry.

Virtually all the oil and gas wells drilled in New Zealand are in Taranaki. Even in this region with its long history of the industry, the drilling of many more wells in recent years has raised a variety of concerns. Outside Taranaki, exploratory wells have been drilled in the East Coast Basin at various times in the past, but none have yielded commercial quantities of oil. Now with both a rising price of oil and the use of increasingly sophisticated hydraulic fracturing – fracking – we could see wells begin to proliferate across the countryside. This, and potentially, the extraction of coal seam gas in other parts of the country, is new territory for New Zealand.

Extensive reform of New Zealand's laws, agencies, and processes is not yet required for effective management of the local environmental effects of onshore oil and gas extraction, but elsewhere, the pressures created by a rapidly expanding industry have led to big changes. In New South Wales, the responsibility for regulating exploratory coal seam gas wells has been centralised within the Environmental Protection Agency. In Queensland, an Office of Groundwater Impact Assessment has been created to do the complex modelling of aquifer drawdown required for approval of new coal seam gas wells. New Zealand is still largely in an exploration phase, but this could change quite rapidly. The 'Taranaki approach' cannot be simply extrapolated across a country of such varying geology and hydrogeology.

The recommendations in this chapter range from the need for forward thinking and direction at the national level to improvements needed in specific current practices. The six recommendations cover the following.

- Provision of direction through a national policy statement.
- Revision of regional council plans.
- 'Integrity' of oil and gas wells.
- Liability for contamination.
- Enforcement of controls on hazardous substances.
- Disposal of solid waste from drilling.

The expansion of the oil and gas industry onshore in New Zealand – and potentially, offshore – sits within the much broader frame of climate change. Climate change will have impacts that extend far beyond any localised effects of new methods of extracting oil and gas. The final section in this chapter is a note on this – the greatest environmental challenge of all.

8.1 Providing national direction

New Zealand has an opportunity to 'get ahead' of an expanding oil and gas industry and put in place policies and rules to protect the environment. In many parts of the world, regulators are scrambling to catch up with a rapidly expanding industry. But we can avoid this situation by establishing ground rules now while we remain mostly in an exploration phase.

An immediate priority is the East Coast Basin in the east of the North Island, which ranges from Gisborne District to the Wairarapa. The shales in this area are likely to require fracking, and potentially hold billions of barrels of oil. The East Coast Basin has been compared to large oil fields in North America. Commercial production, at even a fraction of the scale of these fields, would radically change both the environment and economy of this part of the country.

The Government is actively encouraging exploration for oil and gas in the East Coast Basin and elsewhere. Because the Crown owns the resource, the Government receives a financial return on production in the form of royalties. However, the responsibility for managing the environmental impacts of oil and gas expansion rests on regional and district councils.

The Government therefore has an obligation to support, guide, and where necessary direct, councils on how they need to prepare for and manage what could be a very rapidly growing industry. The challenges are nationally significant. And it is unfair and inefficient to leave councils to each work out their own response to this situation, especially when many have much more immediate and pressing issues to deal with.

Most councils are unprepared for expansion of the oil and gas industry. Rules in plans are generally inadequate, and often vary widely without justification. Conditions in consents are similarly variable. This does nothing to reassure those who are concerned about the industry. When those who live near wells discover that different rules and conditions apply in the next district for no discernable reason, they cannot help but wonder which, if any, are 'best practice'.

Unfortunately, the 'Guidelines' report published recently by the Ministry for the Environment does little to assist. This report, which has been written by consultants with input from the industry and council staff, is a useful description of the *status quo*, but does not give guidance.

One reform proposed by the Minister for the Environment holds promise for reducing some of the unnecessary and confusing variation in council plans. The introduction of a national planning template with a standardised layout and terminology would go a long way to making council plans clearer and simpler. The Minister has rightly pointed out that there is no reason for different councils to specify different ways of measuring noise levels, for example, a point also made in Chapter 3 of this report.

However, neither improved 'guidelines' nor a planning template will go far enough to provide the necessary direction to councils. To do so requires the use of a national policy statement – an NPS.

An NPS could give clear direction to both regional and district councils on how they should deal with the onshore oil and gas industry in their policy statements and plans, focusing on areas where industry expansion is likely. It could include straightforward matters like requirements for monitoring, but also direct councils

to plan for how they will deal with bigger challenges like the cumulative effects on landscape, and the interaction between oil and gas activities and other land uses. An NPS would also provide an avenue for public involvement in consideration of the critical issues that have polarised communities overseas.

The development of technical and environmental standards should be done in conjunction with preparing an NPS. For instance, the provision of model rules for plans and technical guidance on solid waste disposal would be very helpful for councils.

1. I recommend that:

The Minister for the Environment directs the Ministry for the Environment to prepare a national policy statement on onshore oil and gas exploration and production.

8.2 Improving regional plans

Aligning the environmental regulation of onshore oil and gas by creating clear and consistent national policy is very important, but would of course take some time. This report has identified a number of specific omissions or inadequacies in council plans (particularly regional council plans), and there is no need for councils to wait before addressing these.

A number of regional councils are currently, or soon will be, revising their plans. These councils thus have an opportunity to propose revised rules for the oil and gas industry. This exercise is particularly important for the North Island regions in the East Coast Basin where rapid expansion of oil and gas is most likely. But it is also an opportunity for the Taranaki Regional Council to reconsider its proposed new rules.

In most existing plans, the same rule covers drilling a bore for extracting oil and gas and drilling a bore for extracting water. Unfortunately, this is the case even in Manawatu where oil and gas wells are now being drilled, despite the Horizons One Plan only having been recently developed. It is also the case in Taranaki Regional Council's proposed new plan.

Importantly, plan development is also the time for wide consultation on how the industry might develop in the region – consultation with individuals, public interest groups, and representatives of other sectors that may have concerns, such as agriculture, horticulture, and tourism.

The drilling of exploratory oil and gas wells is underway in the East Coast Basin of the North Island, with the aim of being able to extract commercial quantities of 'unconventional' oil. Yet in Manawatu, in Gisborne, and in Hawke's Bay, this has begun without the public or representatives of other sectors having the opportunity to express their concerns because consents are not being publicly notified. And because the drilling of an oil and gas well in these regions is a 'controlled' activity (and 'permitted' in Taranaki), councils cannot decline applications if they meet the conditions in the plan. This means that the ability of councils to consider the location of wells is limited.

In regional plans, the drilling of an oil and gas well should be classified as a 'discretionary' activity. This would enable councils to retain the right to decline applications, consider all relevant environmental effects, and impose conditions appropriate to the location. Unless this is done, there is no ability to comply with the International Energy Agency's Golden Rule – "*watch where you drill*". Without the ability to decline applications for drilling, councils may find themselves concerned about the cumulative effects of many wells, but powerless to do anything about it.

In developing their plans, regional councils should also consider whether they need to prohibit drilling for oil and gas in particular areas. One reason for such a prohibition might be the need to protect certain aquifers. The Ruataniwha and Heretaunga aquifers in Hawke's Bay are not protected in this way, despite popular belief.

Fracking, and waste disposal (deep well injection, landfarming, and mix-bury-cover) should also be classified in plans as 'discretionary' activities.

The absence of public notification of any of the consents associated with oil and gas wells is a source of public distrust. Councils should make explicit in their plans the circumstances when consents will be publicly notified and when they will not be. This

might mean, for instance, publicly notifying the application for drilling the first well in a new location.

The separation of applications for related consents can also fuel distrust in the process, and apart from any other concern, is inefficient. At the very least, the consents associated with establishing a well site and for drilling the well should be 'bundled' together.

Another kind of separation that causes confusion and frustration follows from the different responsibilities of regional councils and district councils. When gas is flared at a well, the regional council is responsible for protecting residents from the air pollutants and the district council for protecting them from the noise and glare. Wherever possible, regional councils should hold joint hearings with district councils.

Finally, regional plans should set out core requirements for environmental monitoring in the vicinity of wells and waste disposal sites. This should include baseline sampling before the activity begins and sampling after the activity ends.

Revising plans takes time, but not all of the above need wait for a new plan. For instance, regional councils can require consents for establishing well sites and for drilling wells to be 'bundled' together now, and can incorporate improved environmental monitoring programmes into consent conditions.

***2. I recommend that**:*

Regional councils review the objectives and rules in their plans that are relevant to the oil and gas industry and:

- **classify drilling an oil and gas well, fracking, and waste disposal methods as 'discretionary' activities;**
- **identify areas where oil and gas drilling can take place and where it cannot;**
- **set out core requirements for environmental monitoring;**
- **require applications for consents for establishing well sites and for drilling wells to be 'bundled' together;**
- **make explicit the circumstances when consents will be publicly notified and when they will not be;**
- **hold joint hearings with district councils whenever possible;**
- **identify and plan for the cumulative effects of an industry that may expand very rapidly.**

8.3 Ensuring a well has 'integrity'

Designing, constructing, and operating an oil and gas well so that it will not leak or blow out is vital for protecting both workers and the environment. The responsibility for protecting workers lies with the High Hazards Unit. The responsibility for protecting the environment lies with regional councils.

Regional councils can rely on the expertise of the inspectors in the High Hazards Unit to a large extent – a well with 'integrity' will generally protect both workers and the environment. But different councils have taken different approaches to this.

Taranaki Regional Council relies completely on the High Hazards Unit when it comes to considering well integrity. At the other extreme, in consenting new wells in the East Coast Basin, Horizons Regional Councils and Gisborne District Council both commissioned a consultant to provide specialist advice on well integrity, and then specified design and construction standards in consents.

There is just one aspect of well design and construction where the High Hazards Unit cannot be relied on to protect the environment. It is the need to ensure that the well is cased adequately when it passes through freshwater layers. This is not needed to protect the safety of workers, but it is needed to prevent the well leaking into aquifers.

There are at least two ways of dealing with this.

The first is to amend the Petroleum Exploration and Extraction Regulations, directing the High Hazards Unit to include the protection of the environment in assessing the design of a well. This has the advantage of using the expertise within the High Hazards Unit, but may require an amendment to the Crown Minerals Act.

The second is to include the protection of freshwater layers as a condition in consents for drilling oil and gas wells, including those used for the disposal of liquid waste. There would be no need to duplicate the work of the High Hazards Unit in assessing other aspects of well design. Of course, either way regional councils must still ensure the environment surrounding the well is monitored so any leaks can be detected.

3. I recommend that:

The Minister of Labour amend the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013 to require that environmental protection be included in the assessment of well design.

or

Regional councils include the protection of freshwater layers as a condition in consents for drilling oil and gas wells.

8.4 Paying when something goes wrong

Even with the best systems and intentions, oil and gas activities can cause contamination of the environment. The chance of an accident is low but it is not zero, and cleaning up after an incident can be costly. While the number of wells to date is relatively few, if the oil and gas industry rapidly grows, the number of incidents will be likely to increase.

While a well is active, companies should hold public liability insurance that is sufficient to cover the cost of cleaning up the damage caused by an incident such as a blowout or a leak. For offshore wells, a particular level of insurance cover is required, but there is no such requirement for onshore wells. When a company bids for an exploration permit, it is 'credit-checked' – this includes assessing whether it has the financial resources to carry out its drilling programme. The 'credit-check' should also include an assessment of whether the insurance cover is adequate.

A liability regime that deals with leaks from abandoned wells is a greater challenge. Once a consent is surrendered, the legal liability for any future problems lies with the landowner who may be unaware of the legacy issue.

In Alberta and Saskatchewan, operators pay a levy into a fund that is then available for cleaning up leaks from abandoned wells. This type of system should be introduced in New Zealand where the cost of cleaning up contamination from historic economic activities often falls on the taxpayer. The Tui mine at Te Aroha is an expensive recent example.

Some may argue that such a fund should be paid for out of the revenue from royalties. But royalties are the payments by companies for the right to profit from the oil and gas they extract.

The fund should also be used to pay for the long term monitoring of abandoned wells, including those used for the disposal of liquid waste, after the consent has been surrendered.

4. I recommend that:

The Minister of Energy and Resources:

a) requires the adequacy of public liability insurance held by companies bidding for exploration permits to be assessed by New Zealand Petroleum and Minerals as part of 'credit checking';

and

b) ensure that the oil and gas industry bears the cost of ongoing monitoring of abandoned oil and gas wells and the remediation of future leaks, by, for example, the imposition of an annual levy.

8.5 Enforcing the controls on hazardous substances

Many of the chemicals transported to, and stored and used at oil and gas well sites are classed as 'hazardous' under the Hazardous Substances and New Organisms Act. Under this Act, the Environmental Protection Authority sets a range of controls on these substances, but has no direct role in ensuring compliance with these controls.

The responsibility for inspecting and enforcing these controls falls on the inspectors from WorkSafe New Zealand, and its High Hazards Unit. However, these inspectors are highly trained specialists who are necessarily focused on the technical details of well design and construction. Moreover, they operate under the Health and Safety in Employment Act and so the health and safety of workers is their primary focus.

Regional councils are legally able to enforce the controls on hazardous substances when they are visiting well sites to check compliance with the conditions in their resource consents. But they do not have to do this, despite staff visiting well sites much more frequently than inspectors from the High Hazards Unit will ever be able to do.

It would be both sensible and efficient for regional council staff to be required to enforce the controls on hazardous substances. This could be done by amending section 97 of the Hazardous Substances and New Organisms Act 1996, or by another method. Under section 23, the councils would be able to recover the cost from the industry.

5. I recommend that:

The Minister for the Environment amend legislation (or regulations) so that regional councils are legally responsible for enforcing the provisions of the Hazardous Substances and New Organisms Act 1996 on oil and gas work sites.

8.6 Dealing with solid waste from oil and gas wells

In Taranaki, liquid waste from oil and gas wells is pumped back down into the earth, generally in wells drilled for the purpose – a process known as deep well injection. This will also be an appropriate way of disposing of liquid waste in other parts of the country.

The disposal of solid waste is a bigger challenge. Mix-bury-cover is seen by Taranaki Regional Council as inferior to landfarming because of the difficulty of isolating the waste in a region with high rainfall and a high water table. However, mix-bury-cover may be preferable to landfarming in drier regions.

While Taranaki Regional Council may see landfarming as the best way of disposing of solid waste from oil and gas wells, there are clearly some issues that need resolution.

Although there is no evidence yet that landfarming is contaminating milk, the country's largest dairy company has indicated it will not take milk from any new landfarms. The New Zealand dairy industry has learned from recent experience that the perception of contamination can be as damaging to export markets as the reality of contamination. And regardless of the actual food safety risk, cattle trampling drilling waste into paddocks does not inspire confidence.

The situation with landfarming in Taranaki needs urgent attention. Since the regional council considers that it is not responsible for animal welfare or food safety, the Food Safety Authority should step in. Someone must take responsibility for deciding when livestock can be put back on to landfarmed pasture, and for ensuring that the current 'hands off' situation does not continue. This issue is not confined to dairy farming – beef cattle or sheep, for instance, may graze landfarmed pasture.

There is also a wider issue, namely whether landfarming will be an appropriate way of disposing of waste from oil and gas wells outside Taranaki. Allowable contaminant levels that are appropriate for the sandy coastal soils of Taranaki may not be appropriate elsewhere. It is worth noting that landfarming has been prohibited in New South Wales where rock cuttings from drilling are often used as roadfill.

6. I recommend that:

The Minister for Food Safety and the Minister for the Environment convene a working group, including regional council staff and agricultural representatives, to:

a) resolve the situation with livestock on landfarmed sites in Taranaki;

and

b) consider how solid waste from oil and gas wells in the East Coast Basin should be disposed of before wells begin to proliferate.

8.7 Climate change

Much of the concern about the expansion of the oil and gas industry in New Zealand, and about fracking in particular, is about the biggest environmental challenge of all – climate change.

In Mexico in 2010, New Zealand committed, along with many other countries, to a maximum temperature rise of 2 degrees Celsius above pre-industrial levels. But our response to this global challenge has been underwhelming.

The Emissions Trading Scheme has been repeatedly weakened and the country's carbon dioxide emissions continue to rise. That New Zealand met its Kyoto target at the end of 2012 is largely due to a boom in planting forests in the mid 1990s. By 2020, these forests will be harvested, and it is difficult to see how the country will meet the target the Government has committed to achieving by that year.

In considering how expansion of the industry within New Zealand might affect the country's emissions of carbon dioxide – the main greenhouse gas, it is useful to distinguish between oil and natural gas.

Most of the oil produced within New Zealand is not used in New Zealand because the Marsden Point refinery is geared around 'medium sour' crude oil imported from other countries. Almost all the oil extracted from New Zealand wells is exported for refining. New Zealand has no policy of being self-sufficient in transport fuels (as it did in the Think Big era), and oil is easily shipped internationally. Consequently, there is no direct relationship between the amount of oil extracted in New Zealand and the amount of oil used in New Zealand, apart from the oil used by the industry itself.

The situation with gas is much more complex.

Natural gas is the most benign of the fossil fuels; it burns cleanly and provides more energy for each molecule of carbon dioxide emitted than any other fossil fuel. When natural gas is burned instead of coal, about half as much carbon dioxide is emitted. If natural gas is used to generate electricity in a combined cycle power plant instead of coal, the carbon dioxide difference is even greater.

This has led to the concept of natural gas as a 'transition fuel' – that plentiful gas from fracking can enable the transition to a low carbon economy based on renewable forms of energy. Certainly, a significant fall in carbon dioxide emissions in recent years in the United States is partly due to 'fracked gas' replacing coal.

There are some major questions about natural gas playing the role of a transition fuel. For instance, one effect of burning gas instead of coal in power plants in the United States is downward pressure on the international price of coal, so it is likely some other countries will burn more coal.

Another question is about the escape of natural gas into the atmosphere from gas fields – 'fugitive emissions', since methane, the main component of natural gas is a powerful greenhouse gas in its own right. This is an active area of research, and the estimates of fugitive emissions are very dependent on many factors, including location. There are, of course, also fugitive emissions of methane from coal mines.

Within New Zealand, some in the industry have claimed that natural gas obtained by fracking will be a transition fuel to a low carbon future because it would replace coal. In some respects this might be the case, but in others, it would not be.

The opportunity to replace coal with natural gas in New Zealand is very limited, because only a small proportion of our energy comes from burning coal. Using gas instead of coal in dairy factories would lower carbon dioxide emissions from this source. However, the use of coal to generate electricity is being phased out, and the availability of plentiful cheap gas could lead to the construction of baseload gas power plants instead of geothermal, wind, or hydro power plants.

Potentially, natural gas from New Zealand could be exported and substitute for coal in another country such as China. However, exporting natural gas requires compressing it to a liquid, and this can only be done economically at a very large scale, as can be seen in photographs of the liquefied natural gas (LNG) plants being built in Queensland. It would take a very big find of natural gas for New Zealand to become an exporter of LNG, and help other countries 'transition away' from coal.

Transitions, by their nature, should only be temporary. The International Energy Agency is clear that replacing coal with gas is "*… far from enough on its own to put us on a carbon emissions path consistent with an average global temperature rise of not more than two degrees Celsius.*"

There is one scenario that could play out in New Zealand that would significantly increase the country's carbon dioxide emissions. The company that is drilling exploratory wells in Manawatu, Gisborne, and Hawke's Bay is hoping to find oil in commercial quantities, and sees the East Coast Basin as comparable with the Bakken Oil Field in North America. As shown in the satellite photograph in this report, an enormous volume of gas is being flared at the Bakken Oil Field. This is because the oil is worth so much more than the gas, and there is not the infrastructure to transport and process the gas.

If production wells begin to multiply across the East Coast Basin, there could be huge pressure to relax the current restrictions on flaring gas. The gas would be worth little beside the oil, and much of it could be flared. The best that could be said for this is that flaring would be better than venting since methane is such a powerful greenhouse gas.

How this and other scenarios play out will depend on the climate change policies of successive Governments. New Zealand has set targets for reducing emissions and has some policies in place. What is missing is a plan that links these policies, and others that will be needed, to the greenhouse gas targets that have been set. Oil and gas will continue to have a role in New Zealand's energy mix for some time to come, but that role will need to diminish over time.

While there are many concerns about the impacts of expanding the oil and gas industry in New Zealand, ultimately it is the effect on the world's climate that matters the most.

Notes

1 Parliamentary Commissioner for the Environment, 2012.

2 The Vote. *Does New Zealand need more mining?* http://www.3news.co.nz/Does-New-Zealand-need-more-mining/tabid/1785/articleID/318515/Default.aspx [Accessed 31 March 2014].

3 For instance, the Texas-based oil company Anadarko recently undertook exploratory drilling at depths of 1400 and 1600 metres off the Taranaki coast. This is nearly fourteen times as deep as the water below the Maui platform, and about as deep as the sea where the huge oil leak occurred from a well in the Gulf of Mexico in 2010.

4 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 fracking. International Energy Agency, 2012, p. 21.

5 Ministry of Business, Innovation and Employment. *Spreadsheet of stocktake of wells fracked as of 30 April 2014*.

6 There is a long history of exploratory drilling for oil in the east of the North Island. Two factors now make it more likely that a well can produce commercial quantities of oil – fracking and the higher price of oil.

7 A number of coal seam gas wells have been drilled without fracking on the West Coast, although none are currently in production.

8 Solid Energy drilled a number of wells in Waikato across two permit areas. Fracking was used on eight wells in one of these permit areas. These wells have now been either suspended or abandoned by filling with cement. The state-owned enterprise has also drilled wells in coal seams in Taranaki – these have also been suspended. Pers. comm., Solid Energy, 17 August 2012.

9 See, for instance, International Energy Agency, 14 March 2014, *IEA releases Oil Market Report for March*, press release.

10 Countries with moratoria are France, Ireland, Netherlands, Bulgaria, Czech Republic, and Luxembourg. In the United States and Canada there are currently moratoria in Delaware, Hawaii, Maryland, Massachusetts, New York, North Carolina, Vermont, Nova Scotia, and Newfoundland and Labrador. In Australia, there is a moratorium in Victoria, and in Germany, there is a moratorium in North Rhine-Westphalia. Information sources available from the Parliamentary Commissioner for the Environment on request.

11 For example, the moratorium in the Czech Republic is due to expire in May 2014, and the moratorium in Victoria is due to expire in July 2015.

12 See, for instance, European Commission, 2014; International Risk Governance Council, 2013; United Kingdom Department of Energy and Climate Change, 2013.

13 See, for instance, London School of Economics, 2013.

14 There are three kinds of petroleum and mineral permits – prospecting, exploration, and mining (extraction). Prospecting permits allow companies to assess whether an area might contain petroleum using techniques like surveying, but not drilling. Exploration permits usually involve drilling and testing wells. Mining permits are required before oil and gas can be produced and sold.

15 In the past, oil and gas companies could choose to apply for areas of New Zealand that they were interested in using the Priority-In-Time permit process. This option was removed in February 2013 and now permits are granted solely using bidding processes such as the Block Offer process. Minerals Programme for Petroleum 2013, section 7.2, p. 36.

16 Minerals Programme for Petroleum 2013, sections 2.4, 7.3, pp. 13, 37.

17 In Block Offer 2013, two blocks offered on the East Coast were reduced in size after iwi and hapu requested that part of each be removed due to the large number of culturally significant sites. Ministry of Business, Innovation and Employment, 2013a, pp. 23-32.

18 An assessment of a company's health, safety and environmental record was introduced in the recent changes to the Minerals Programme for Petroleum in 2013, section 5.4, p. 21.

19 Minerals Programme for Petroleum 2013, section 7.2, p. 36.

20 Crown Minerals Act, s61 (1A).

21 The Sugar Loaf Islands off the coast of Taranaki are also off limits for drilling because they lie within a Marine Protected Area. Minerals Programme for Petroleum 2013, section 3.1, p. 17.

22 Note that when a company is unable to meet the standards required for a permitted activity, it can still undertake the activity if it is granted a resource consent.

23 Councils that are unitary authorities perform the functions of both regional and district councils. The Gisborne District Council is a unitary authority.

24 Ministry for the Environment, 2014.

25 WorkSafe New Zealand. High hazards, http://www.business.govt.nz/worksafe/about/what-we-do/high-hazards/ [Accessed 1 April 2014].

26 These regulations are made under the Health and Safety in Employment Act, and are called the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013.

27 Safety cases are not required if the production from a well is low. Instead a similar, but smaller, 'major accident prevention policy' is required. Low production is defined as less than 820 barrels of oil per year, less than 15 million cubic feet of gas per day over a year, and less than 50 tonnes of LPG on site at any time. Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, Parts 3, 4.

28 Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, r71.

29 The Hazardous Substances and New Organisms Act does not cover radioactive substances, such as the radioactive tracers used to monitor the fractures during fracking. These are regulated under the Radiation Protection Act 1965, which is administered by the Office of Radiation Safety in the Ministry of Health, with scientific advice from the Institute of Environmental Science and Research.

30 International Energy Agency, 2012, p. 44. The importance of well location is highlighted in many other reports, including The Royal Society and Royal Academy of Engineering, 2012; European Commission, 2014; New South Wales Chief Scientist and Engineer, 2013; International Risk Governance Council, 2013.

31 Permit boundaries can be drawn to restrict where a well can be drilled, but only for commercial or cultural reasons, not for environmental reasons (see section 2.1). Moreover, permits to explore for oil and gas are granted for very large areas, not for specific sites. During the 2014 Block Offer process, several Hawke's Bay councils expressed concerns about the Heretaunga Plains aquifer and the Ruataniwha Plains aquifer. The Heretaunga Plains aquifer was not included in the Block Offer because oil and gas companies did not express an interest in drilling in the area – not as reported because it was excluded to protect the aquifer. (Ministry of Business, Innovation and Employment, 2014, pp. 18-22).

32 Watson and Bachu, 2009; Vidic et al., 2013. Well design and construction is the subject of Chapter 4.

33 Some coal seams will be overlain by impermeable cap rocks – the deeper they are, the more likely this is. The coal seams that were fracked in Solid Energy's trials in Waikato were overlain with cap rocks (Solid Energy, 2012).

34 The modelling is done by the Office of Groundwater Impact Assessment.

35 British Columbia Oil and Gas Commission, 2012, p. 4.

36 Zoback, 2012, p. 38.

37 "*The Waipawa and Whangai formations are regarded as high-quality source rocks that compare technically to successful commercial tight-oil plays in North America, such as the Bakken Shale and Eagle Ford discoveries*". TAG Oil, 5 May 2014, *TAG Receives Consent to Drill Exploration Well on Waitangi Hill, Targeting Fractured Source Rocks*, press release.

38 Permeability is, of course, only one of several properties of rock formations that affect drilling and fracking decisions. Porosity and brittleness are also particularly important. Peppering of wells into shale at high density across the countryside can potentially be avoided by drilling out horizontally.

39 Taranaki Freshwater Plan, Rule 46. A 'bore' is defined as being more than 20 metres deep; less than this, it is a water 'well'.

40 While Taranaki Regional Council does not require a consent for drilling a well, it does require other associated consents including ones for flaring and the discharge of stormwater.

41 Moreover, one of these two criteria seems irrelevant for oil and gas bores, namely that the "*bore shall be located not less than 50m from any effluent treatment pond, septic tank, silage stack or pit*".

42 Taranaki Regional Council, 2013b, p. 30.

43 In 1995, two wells were drilled into the Ohai coal seam in Southland, but fracking was unsuccessful – no useful methane was extracted.

44 Waikato Regional Plan, Rule 3.8.4.7. The council can also set further conditions on the location of a well, including to protect significant ecosystems.

45 Horizons One Plan, Rule 15-13.

46 Horizons One Plan, Rules 12-6 and 12-7.

47 Gisborne Transitional Plan, Rule 5.1. This plan does not contain a definition of a bore and uses 'bore' and 'water bore' interchangeably. The transitional plan states that a resource consent is required. Under the Resource Management Act s369(1)(b), this means drilling a bore in Gisborne is a discretionary activity.

48 See RPS Group, 2013a; RPS Group, 2013b; Kamp, 2013; Furlong, 2013a; Furlong, 2013b. Matters considered included the location of the well relative to important aquifers, whether there could be any hydrological connection between the well and these aquifers, the geology of the ground the well would be drilled through, and whether the infrastructure at the well site could withstand earthquakes.

49 Taranaki is not the only region where drilling a bore is classified as a permitted activity. For instance, Otago Regional Council classifies the drilling of an oil and gas well as a permitted activity, but it is restricted to drilling on land that is not above a number of identified aquifers. Drilling on land that is above these aquifers is controlled. Regional Water Plan for Otago, updated 1 March 2012, Rule 14.2.

50 Resource Management Act, s31.

51 Minerals Programme for Petroleum 2013, pp. 55-56. Flaring is allowed during emergencies and equipment failure, and during initial testing of a well as long as it does not exceed 30 days. It can also be allowed by the Minister of Energy and Resources or the Chief Executive of the Ministry of Business, Innovation and Employment.

52 New Plymouth District Council and South Taranaki District Council use NZS 6801:1991, NZS 6802:1991, and NZS 6803:1984 for noise measurement. Stratford District Council uses NZS 6801:2008, NZS 6802:2008, and NZS 6803:1999 for noise measurement.

53 New Plymouth District Plan, Standard 7.12; Stratford District Plan, Rule B2.1.9; South Taranaki District Plan, Rule 10.02.1.

54 *New Plymouth District Council v Tag Oil (NZ) Ltd* [2013] ENV 112, para 2.

55 The Ministry of Business, Innovation and Employment estimates that if large-scale production is feasible on the East Coast, 1800 to 3600 wells could be drilled. Ministry of Business, Innovation and Employment, 2013b.

56 International Energy Agency, 2012, p. 47.

57 The Royal Society and Royal Academy of Engineering, 2012, p. 4.

58 Dusseault et al., 2000.

59 Watson and Bachu, 2009.

60 Vidic et al., 2013. Under a new law in Pennsylvania, the operator is liable for any gas that turns up in a water well within 1,000 feet of an oil or gas well or 2,500 feet of an unconventional well unless it can be proved otherwise (2012 Oil and Gas Act (58 Pa.C.S. §§ 3218)).

61 New York City Department of Environmental Protection, 2009, p. 45 and United States Environmental Protection Agency, 2011, pp. 37-38.

62 Poor casing design, inadequate cementing, and poor drilling control were identified as contributing factors. Department of Labour, 1996.

63 Oil from Cheal has a high wax content, so hot water is used to heat the oil so that the wax does not settle out and block the well. The hot water leak occurred more than 1300 metres below ground, where the wells had been perforated and patched up when no oil and gas was found in that layer. It was reported by the company that well integrity had been breached. Taranaki Regional Council, 2010a; Letter from TAG Oil to Taranaki Regional Council, 7 September 2011.

64 Taranaki Regional Council, 2003, p. 19. See also, Parliamentary Commissioner for the Environment, 2012, p. 48.

65 See, for instance, International Risk Governance Council, 2013; International Energy Agency, 2012; The Royal Society and Royal Academy of Engineering, 2012.

66 Environmental monitoring is not only needed to detect leaks from a well, but also to detect the migration of fluid between rock strata, or surface spills or leaks.

67 Hon Simon Bridges, 29 May 2013, *New safety regulations for petroleum,* press release.

68 Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, r64, r68.

69 New Zealand does not have its own national standards for well design and construction, operation, and abandonment. Companies choose which standards they follow – for example, see Todd Energy, 2012, pp. 72-74. Under the new regulations, the High Hazards Unit checks that the standards being used by companies are appropriate for use in New Zealand. For example, the Alberta oil and gas well standards are prescriptive and specific to Alberta's geology. New Zealand has a very different geology than Alberta, so the High Hazards Unit will not sign off a safety case that uses Alberta standards. Pers. comm., High Hazards Unit, 28 March 2014.

70 A "*safety case*" is required for large production wells, and a "*major accident prevention policy*" is required for small production wells and all exploratory wells. Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, Parts 3, 4.

71 Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, r71.

72 Pers. comm., High Hazards Unit, 28 March 2014.

73 The review of regulations was triggered by the tragic death of 29 men at the Pike River Mine in November 2010. In the early stages of the mine's development, there was one health and safety inspector responsible for all underground and opencast coal mines, quarries, and tunnels. In April 2008, a second inspector was appointed. Macfie, 2013, pp. 169-170.

74 Taranaki Regional Plan, Rule 46. Recall from Chapter 3 that this requirement is the same for water wells as it is for oil and gas wells.

75 Taranaki Regional Council, 2013a, p. 76.

76 Groundwater monitoring programmes for deep well injection sites require sampling twice a year, with no sampling at sites that are not actively disposing of waste. See, for instance, Taranaki Regional Council. Monitoring Programme – Deep Well: Greymouth Petroleum Acquisitions Company Limited – Deepwell Injection 2013/14.

77 RPS Group, 2013a; RPS Group, 2013b.

78 The groundwater monitoring required in the consents for drilling these exploratory wells is similar to that required in the consents for fracking in Taranaki. Groundwater must be sampled before a well is drilled, once a week while the well is being drilled and tested, and then 1 week, 1 month, 6 months, and 1 year after well drilling and testing is completed. Horizons Regional Council, Consent decision for Ngapaeruru-1 well site, 18 March 2013; Horizons Regional

Council, Consent decision for Mangahei-1 well site, 18 March 2013; Gisborne District Council, Consent decision for Punawai-1 well site, 27 September 2013.

79 Gisborne District Council would require new consents and has yet to develop consent conditions for fracking or for oil and gas production (Pers. comm., Gisborne District Council, 14 March 2014). Horizons Regional Council would only require a consent for production if the well needed structural alteration (Pers. comm., Horizons Regional Council, 4 March 2014).

80 Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013, Part 6; Resource Management Act, s17.

81 Pers. comm., New Zealand Petroleum and Minerals, 28 February 2014. However, before a company begins to drill for oil and gas offshore, it must hold insurance that would cover approximately NZ$26 million of claims for damage from oil pollution. Marine Protection Rules, Part 102 (Certificates of Insurance).

82 Councils can require companies to pay a bond as a condition in granting a resource consent to "*secure the ongoing performance of conditions relating to long-term effects that become apparent during or after the expiry of the consent*" (Resource Management Act, s108A(2)). Councils do not appear to have made use of this provision in relation to oil and gas activities, although they have used it in other situations, such as consenting for gold and coal mines, and landfills. For instance, Waikato District Council required a $100,000 bond from the consent holder in relation to the landfill works at Hampton Downs Road.

83 The enforcement provisions of the Resource Management Act (RMA) do not apply retrospectively, they do not apportion liability between the former and current owner/occupier, as per Voullaire v Jones (1998) 4 ELRNZ 75 (ENC). Under s314(1)(da) of the RMA, the current owner or occupier of land with a leaking well could be ordered to clean up contamination even if the current owner or occupier had no part in causing the contamination. Case law has indicated that the RMA only applies to a leaking well if it was caused after the enactment of the RMA in 1991. There is no formal hierarchy of potential liability under the RMA between polluter, owner, and occupier, and any or all are potentially liable. "*Unlike a number of other countries, New Zealand has no specific legislation dealing with liability for historic contaminated sites.*" *Auckland Waterfront Development Agency Limited v Mobil Oil New Zealand Limited* [2014] NZHC 84, para 92.

84 One of the Royal Society of London's recommendations on well integrity. Emphasis added. The Royal Society and Royal Academy of Engineering, 2012, p. 27.

85 "*Groundwater monitoring bores should ideally be installed before the activity begins at the site to confirm groundwater flow paths and background water quality to provide a comparative baseline*". Ministry for the Environment, 2014, p. 48.

86 Some wells are suspended, which means they are sealed at the surface but not plugged underground. These are at greater risk of leaking.

87 Pers. comm., Taranaki Regional Council, 13 March 2014; Taranaki Regional Council, 2003.

88 A 2013 report from Ministry of Business, Innovation and Employment states: "*Decommissioning of onshore production installations occurs at the end of their commercial life, typically 20-40 years, and involves the removal of buildings and equipment, restoration of the site and continued monitoring of the site after closure*". Ministry of Business, Innovation and Employment, 2013b, p. 52.

89 European Parliament, 2011, p. 27.

90 International Energy Agency, 2012, pp. 45, 48. See also International Risk Governance Council, 2013, p. 22.

91 New Zealand Herald, 7 January 2014, "*Truck crash dumps 2000 litres of weed killer*".

92 The monitoring programme report for this site records that the company blamed the pollution on the malfunction of a separator, which led to about 50 litres of oil leaking. The company pleaded guilty in the Environment Court and was fined $20,000. Taranaki Regional Council, 2011a, pp. 26-27.

93 The incident report records: "*In October 2010 an estimated 200-500 litres of well stream fluid, namely produced oil and water, was found to have leaked into an unnamed tributary of the Manawapou River, with a visibly affected area reaching 80 m downstream from the discharge point. The spill was noticed by a local farmer.*" Taranaki Regional Council, 2010b, p. 1.

94 Pers. comm., Clydebank Rural Water Scheme members, 20 June 2012; Letter from Westech Energy NZ Ltd to the Clydebank Water Supply Scheme, dated 17 June 1999.

95 Sydney Morning Herald, 18 December 2013, "*Santos faces fines for Pilliga coal seam gas salt spill*".

96 Papoulias and Velasco, 2013. The stream became acidic, with the pH dropping to 5.6, and concentrations of heavy metals rose to toxic levels.

97 Oil and gas from a well are neither manufactured nor imported. But in HSNO s2(1), "*manufacture*" is defined as including "*the mining or extraction of any hazardous substance*".

98 Many substances, such as some fracking fluid components, will meet the specifications to be self-approved under a Group Standard. In these cases, no specific EPA approval is given, but the generic controls of the Group Standard will apply. However, the EPA does have the power to intervene and assess a substance at any time.

99 Hazardous Substances (Emergency Management) Regulations 2001. The information and preparedness required depends on the type and quantity of the hazardous substances.

100 HSNO, s97. WorkSafe New Zealand (within which the High Hazards Unit is located) in the Ministry of Business, Innovation and Employment is responsible for the enforcement of HSNO regulations in workplaces. The New Zealand Transport Agency, the Police, the Civil Aviation Authority, and Maritime New Zealand are responsible for the safe transport of hazardous substances. Other agencies with responsibilities for enforcement are councils and the Ministry of Health.

101 To better integrate the High Hazards Unit's enforcement of HSNO controls with its other health and safety responsibilities, the Government has proposed to move the regulations concerning the use of hazardous substances in the workplace from the HSNO Act to the Health and Safety in Employment Act. See Cabinet Minute of Decision, 15 July 2013, "*Improving Health and Safety at Work: Occupational Health and Management of Hazardous Substances*".

102 Pers. comm., High Hazards Unit, 23 April 2014.

103 Over the course of this investigation, it was not possible to determine exactly how many active onshore well sites there are in New Zealand. There is no one central database of the number and location of well sites. The High Hazards Unit is developing a database on well sites as it carries out inspections. The NZPAM GIS doesn't record well sites, but does list 222 onshore active wells. Taranaki Regional

Council has information on 59 well sites on its website.

104 HSNO, s97(1)(h), s97(2).

105 Taranaki Regional Council had a contract with the Department of Labour (later Ministry of Business, Innovation and Employment) to enforce HSNO controls in workplaces from 2004 to 2011. The contracts with councils have not been renewed; the intent is to build the internal HSNO enforcement capability of inspectors in the High Hazards Unit. Pers. comm., Environmental Protection Authority, 14 April 2014, and Taranaki Regional Council, 15 April 2014. See also Minutes of the Consents and Regulatory Committee of the Taranaki Regional Council, 30 April 2013.

106 Taranaki Regional Council has a goal of visiting every well site every 1 to 2 weeks, and production stations, waste treatment and disposal sites 4 to 6 times a year. Taranaki Regional Council, 2013d, p. 43.

107 "*Since 2010, approximately 20% of Territorial Authorities have had no enforcement capability or have not provided data to the EPA on their compliance and enforcement activities*". Environmental Protection Authority, 2013, p. 20.

108 An applicant for a resource consent must show how they are minimising risks, which could include the use of 'greener' fracking fluids (Resource Management Act (RMA), s88). Councils can place conditions in plan rules (RMA, s68) or resource consents (RMA, Part 6) to ensure this happens. Confidentiality agreements can be signed to protect proprietary information (RMA, ss42, 92).

109 The constituents of fracking fluid are at their most concentrated when they are brought on to site to be mixed, but they are only in this form for very short periods of time. The fracking fluid that returns back out of a well after it has been fracked is diluted and far smaller in volume than the produced water that comes out of the well for years. The greatest risk to the environment from fracking fluid is probably the biocide – if a tank of concentrated biocide was to leak into a waterway, it could be very damaging.

110 HSNO, s142.

111 "*If the pooling substances held in a place above ground are in containers, one or more of which have a capacity of 450 litres or more, the secondary containment system must have a capacity of at least 110% of the capacity of the largest container.*" Hazardous Substances (Emergency Management) Regulations 2001, r39(1).

112 South Taranaki District Plan, Rule 11.03.2.

113 Stratford District Council relied on the HSNO controls for the Cheal-G site, while New Plymouth District Council required bunding of 120% of the largest tank for the Kowhai-C well site. However, for the Mangahewa-E site, while New Plymouth District Council relied on HSNO controls.

114 Regional councils are also dealing with this differently. Taranaki Regional Council relies on the HSNO 110% rule. But in granting consents recently for exploratory oil and gas wells, both Horizons Regional Council (Consent decision for Ngapaeruru-1 well site, 18 March 2013, p. 25) and Gisborne District Council (Consent decision for Punawai-1 well site, 27 September 2013, p. 50) have required the bunding capacity to be 120% of the volume of *all* the tanks (not just the largest tank) within the bund wall.

115 Taranaki Regional Council, 2013d, p. 7. The council states it has recently resumed ecological monitoring "*for the sake of public confidence*". Pers. comm., Taranaki

Regional Council, 7 May 2014.

116 For example, the consent conditions for the Turangi-A well site require that any discharges into the stream (after reasonable mixing) do not raise the water temperature by more than 2 degrees (Condition 17); and have no effect on aquatic life (Condition 18). Taranaki Regional Council monitoring reports show that between 2007 and 2012 the stream 20 metres from the stormwater discharge point was sampled twice in 2009 and 34 times in 2010/11. No data on temperature or stream insects or other aquatic species was presented in the reports.

117 Horizons Regional Council has released its first monitoring report on the first well to be drilled near Dannevirke – the Ngapaeruru-1 well. The assessment was based on multiple site visits, visual checks, and sampling of stormwater, surface water, and groundwater. Baseline samples were taken before drilling. Horizons Regional Council, 2013.

118 Horizons Regional Council, Consent decision for Ngapaeruru-1 well site, 18 March 2013; Horizons Regional Council, Consent decision for Mangahei-1 well site, 18 March 2013; Gisborne District Council, Consent decision for Punawai-1 well site, 27 September 2013.

119 TAG Oil and Apache Corporation, 31 July 2012, *Ngapaeruru-1 Exploratory Well Drilling and Testing Waste Management Plan*, p. 7. Gisborne District Council, Consent decision for Punawai-1 well site, 27 September 2013, p. 34.

120 There are other methods for dealing with oil and gas waste. Overseas, solid waste is commonly sent to landfills. The fracking flowback from Solid Energy's coal seam gas wells in Waikato was sent to an industrial waste treatment plant. The most undesirable way of disposing of waste is to discharge it into a stream – fracking fluid flowback and produced water from two coal seam gas exploration wells in Southland was consented to be discharged into a stream in 1995 (Pers. comm., Environment Southland, 6 May 2014).

121 Taranaki Regional Council, 2013d, p. 21. Deep well injection was also used by Solid Energy in Waikato during its coal seam gas operations.

122 Pers. comm., Taranaki Regional Council, 4 March 2014.

123 Data from a landfarm monitoring report gives a sense of the scale at which the process occurs. Over a three year period at the Spence Road landfarm, drilling mud cuttings were spread over an area of 5.2 hectares at an average depth ranging from 19 mm to 300 mm. Taranaki Regional Council, 2006, p.11.

124 Pers. comm., Taranaki Regional Council, 4 March 2014. Taranaki Regional Council advised that 38 mix-bury-cover consents have been exercised out of a total of 83 consents granted. Of the excercised consents, 23 remain current while 15 are either surrendered or expired.

125 Taranaki Freshwater Plan, Rule 51.

126 Taranaki Regional Council, 2013b, pp. 42-44.

127 Zemansky, 2013, p. 22. 'Useable' groundwater is defined in terms of a salinity threshold.

128 "*… the Council is still considering the appropriate depth for the fresh water/salt water interface… In terms of applying the area of interest approach this represented little change from what we already do and we are being more explicit about this with our processing of applications.*" Pers. comm., Taranaki Regional Council, 15 April 2014.

129 Taranaki Regional Council, 2013a, pp. 103-105.

130 Taranaki Regional Council, 2013a, pp. 109-111.

131 Taranaki Regional Council notes in its Oil and Gas Guidelines that it assesses monitoring information on the integrity of the well and the injection zone at the time of consent surrender. The guidelines also state that the provisions for well abandonment under the Health Safety and Employment (Petroleum Exploration and Extraction) Regulations 2013 will also apply to any abandoned well. Taranaki Regional Council, 2013a, p. 112.

132 See, for instance, Taranaki Regional Council, *Monitoring Programme – Deep Well: Greymouth Petroleum Acquisitions Company Limited – Deepwell Injection 2013/14.*

133 The Royal Society and Royal Academy of Engineering, 2012, p. 46.

134 Sherburn and Quinn, 2012, p. v: "*Observations do not support any suggestion that hydraulic fracturing or deep well re-injection activities could trigger in Taranaki a large earthquake, a sequence of moderate-sized earthquakes, or a widespread zone of earthquakes.*" Taranaki Regional Council, 2013a, pp. 59-62, 106.

135 Health Safety and Employment (Petroleum Exploration and Extraction) Regulations 2013, r64, r66, r67.

136 Zemansky et al., 2012, *Induced seismicity and hydrogeological risk of hydraulic fracturing operation at the planned Boar Hill-1 Drilling site*. Appendix C of TAG Oil and Apache Corporation, April 2012, Boar Hill-1 Exploratory Well Drilling and Testing Resource Consent Applications, p. vi. This application is yet to be lodged.

137 Taranaki Freshwater Plan, Rule 42.

138 Taranaki Regional Council, 2005, p. 3.

139 Two consents granted in the last five years for mix-bury-cover disposal do not expire for 18 years – presumably the time considered necessary for successful bioremediation. Taranaki Regional Council, 2011b.

140 "*Such isolation will be difficult to achieve in Taranaki, given the high rainfall, permeable soils and high water table*". Taranaki Regional Council, 2005, Appendix 2, p. 15.

141 Pers. comm., Taranaki Regional Council, 13 March 2014.

142 The aromatic hydrocarbons include BTEX – benzene, toluene, ethylbenzene, and xylenes.

143 For some years in New Zealand, offal from sheep and cattle over 30 months old have been excluded from human consumption because of the bioaccumulation of cadmium which is present as a contaminant in superphosphate (Cavenagh et al., 2013.). One of the chemicals in drilling muds is barium sulphate, and because barium is a heavy metal, this has been a focus of concern for some. However, unlike cadmium, it does not bioaccumulate.

144 Pers. comm., Taranaki Regional Council, 7 May 2014.

145 Taranaki Regional Council, 2005. Contaminant limits are drawn from a number of sources in addition to the Alberta standards. These include Ministry for the Environment, 1999 (revised 2011), *Guidelines for assessing and managing petroleum hydrocarbon contaminated sites* and Ministry for the Environment and

New Zealand Wastewater Association, 2003, *Guidelines for the safe application of biosolids to land in New Zealand*. These guidelines are currently being updated to align with the Taranaki Regional Council oil and gas guidelines 2013, so have been removed from the Taranaki Regional Council website.

146 Returned fracking fluid was disposed of in July 2010 as a generic waste type at 104 Brown Road, Waitara under resource consent 6867-1. In May 2013, returned fracking fluid was disposed of by the same operator at the adjacent property (70 Brown Road, referred to as the 'Wellington' site) under consent 7884-1 which explicitly authorised disposal of "*well workover*" wastes. See also Pers. comm, TRC, 8 April 2013.

147 Taranaki Regional Council, 2005, p. 3.

148 For example, no stream samples were taken at the Geary Road Landfarm between 2005 and 2008. In comparison, water samples were taken at the Hawera Landfarm, in most years between 2005 and 2013. Monitoring reports for these landfarms can be found on the Taranaki Regional Council website.

149 See, for instance, Vanner Landfarm consent, pp. 16-18. The monitoring report from the first year includes water samples taken from upstream of the landfarming area and within the landfarm. Samples were taken of pH, chemicals, and hydrocarbons. Samples of stream insects or other aquatic life like plants or fish were not taken. Taranaki Regional Council, 2013e.

150 Taranaki Daily News, 20 June 2013, "*Fonterra to halt future landfarm collections*".

151 Pers. comm., Climate Justice Taranaki, November 2013.

152 Pers. comm., Taranaki Regional Council, 4 March 2014.

153 Taranaki Regional Council, 2011c, p. 29.

154 Pers. comm., Taranaki Regional Council, 4 March 2014 and 13 March 2014.

155 Ministry for Primary Industries, 2013, p. 13.

156 In April 2014, Minister for Food Safety Nikki Kaye stated: "*We are looking at what is the quickest way to get assurance that there is definitely nothing there and we think that's through milk testing, but we will not rule out sheep and beef testing in the future*". ONENews, 11 April 2014, "*Greens want 'land farm' meat tested for contamination*".

157 Pers. comm., Fonterra, 2 May 2014. The testing by Fonterra has not detected any unexpected contaminants, or any naturally occurring contaminants outside of normal ranges.

158 See, for instance, Warner, et al., 2013 and Brown, 2014.

159 Taranaki Regional Council, 2013c. Radon concentrations in natural gas have not been measured in New Zealand, but have been measured in geothermal steam Advice received from the Institute of Geological and Nuclear Sciences included "*I find it very difficult to conceive of a credible concern for the health of the general public in the vicinity of a natural gas field*", p. 7. See also Taranaki Regional Council, 2013a, pp. 69-71.

160 Taranaki Regional Council, 2013c, pp. 3, 9-11.

161 Pers. comm., Office of Radiation Safety, 5 May 2014.

162 TAG Oil did propose to test for radioactivity in groundwater as part of its application for the Punawai-1 well, although the Gisborne District Council did not include this requirement in the final consent.

163 The Royal Society and Royal Academy of Engineering, 2012, p. 22.

164 Juvenal, *Satire VI*, lines 347-348.

165 See, for instance, "*Obtaining a social licence to operate – a challenge for the industry*", address by Dev Sanyal, Executive Vice President and Group Chief of Staff, BP, Petex 2012 Conference, London. The International Risk Governance Council uses the term "*political legitimacy*" (International Risk Governance Council, 2013, pp. 28-43). See also the International Energy Agency's "*Measure, disclose and engage*" Golden Rule (International Energy Agency, 2012, p. 43).

166 United States Department of the Interior Outer Continental Shelf Safety Oversight Board, 2010, p. 19.

167 A submitter who believes a council plan is still inadequate after consultation can lodge an appeal to the Environment Court. Resource Management Act, s95A, s120.

168 Some of Taranaki Regional Council's proposed changes to its water plan pertinent to the oil and gas industry are cited earlier in this report. Stratford District Council has recently completed consultation on an energy plan. Wellington Regional Council has some draft policies on fracking for inclusion in their draft regional plan.

169 Some consent applications are given "*limited notification*", meaning that only those parties deemed to be affected are able to make submissions. This process is generally used for dealing with district council consents that cover impacts such as noise and the light from flaring gas, where the "*affected*" are residents whose homes are close to the well site. Resource Management Act, s95B.

170 Resource Management Act, s95A (4). The courts have defined this to mean " '*circumstances which were exceptional, abnormal or unusual' but, something less than extraordinary or unique". Peninsula Watchdog Group (Inc) v Minister of Energy* [1996] 2 NZLR 529 (CA), para 536.

171 Some wells drilled into the East Coast Basin may yield some oil and gas without fracking.

172 Councils can require companies to bundle consent applications. Resource Management Act, s91.

173 *Affco NZ Ltd v Far North District Council* [1994] NZRMA 224. See also the RMA Quality Planning Resource website: "*Where more than one activity is involved and those activities are inextricably linked, the general rule is that the activities should be bundled and the most restrictive activity classification applied to the overall proposal. Splitting the proposal into its separate applications for the purposes of notification and assessment of effects could mean that the council failed to look at a proposal in whole.*"

174 The Ministry for the Environment guidelines on onshore oil and gas development give no guidance on bundling, noting that bundling together of consents is desirable, but concluding that "*the bundling principle should be used on a case-by-case basis*." Ministry for the Environment, 2014, p. 91. The guidelines are silent on the issue of joint hearings.

175 TAG Oil and Apache Corporation, April 2012, *Boar Hill-1 Exploratory Well Drilling and Testing Resource Consent Applications*. In 2013, Apache withdrew from its joint venture agreement with TAG Oil. TAG Oil will soon apply for consents for the Boar Hill development. Pers. comm., TAG Oil, 5 May 2014.

176 A sequential process was also followed for TAG Oil's two exploratory wells (Ngapaeruru-1 and Mangahei-1) near Dannevirke. TAG Oil prefers to apply separately for site construction and drill consents to avoid the consenting process delaying construction. Pers. comm., TAG Oil, 5 May 2014.

177 Resource Management Act, s102. See also *Affco NZ Ltd v Far North District Council* [1994] NZRMA 224.

178 "*Joint hearings help to allow all the relevant information to be presented together, maintain consistency in decision-making between district and regional councils, and reduce costs and avoid time delays for applicants, submitters and councils.*" The RMA Quality Planning Resource. *Pre-hearing meetings.* http://www.qualityplanning.org.nz/index.php/consents/notified-consents/pre-hearing-meetings [Accessed 15 May 2014].

179 See, for example, Taranaki Daily News, 5 March 2012, "T*ime to move on? It's time for some facts*".

180 Reports can be requested under the Official Information Act 1982, the Local Government Act 2002, and the Local Government Official Information and Meetings Act 1987. These laws allow some information to be withheld, but decisions to do so can be reviewed by the Ombudsmen.

181 Most relevant environmental information about oil and gas extraction sites is obtained or generated by councils, but some is held by other regulators. For example, the Environmental Protection Authority provides a database of controls on hazardous substances on its website, and New Zealand Petroleum and Minerals provides online a geographic information system (GIS) map of well sites, and a database of petroleum permits.

182 Radio New Zealand, 14 February 2014, "*Oil application report kept secret*".

183 For instance, the 2009/10 and 2010/11 monitoring reports for the Turangi-A well site contain results of stream sampling above and below the well site. Single numbers are given for chloride, conductivity, hydrocarbons, pH, and suspended solids at two monitoring sites. The monitoring reports do not explain if the numbers come from single samples or are an average from a number of samples. No statistical analysis of the differences is presented, and indeed is not possible if only single samples have been taken.

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