

Future directions for the management of oil and gas operations in the Taranaki region

Review of the Regional Freshwater Plan for Taranaki

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The contents of this working paper are accurate to the best of the Council's knowledge at the time of drafting the working paper.

Executive summary

This working paper entitled *Future directions for the management of oil and gas operations in the Taranaki region* (the report) addresses issues associated with the oil and gas exploration and production industry with a focus on developing rules to be included in the *draft Regional Freshwater and Land Plan for Taranaki* (draft Plan).

The working paper is one of a suite of documents contributing to the Taranaki Regional Council's (the Council) review of the *Regional Freshwater Plan for Taranaki* (the Freshwater Plan) and the *Regional Soil Plan for Taranaki* (the Soil Plan).

The working paper seeks to formulate an effective and efficient regulatory regime for the oil and gas industry that provides an appropriate level of certainty for investment while allowing for the appropriate controls to be set to avoid, remedy and mitigate adverse environmental effects.

Key findings outlined in this working paper include:

- The extraction of hydrocarbons in Taranaki began in 1866. Since this date and particularly over the life of the Freshwater Plan, the oil and gas industry has undergone significant growth and development.
- The Taranaki basin is currently New Zealand's only commercially hydrocarbon producing area, home to over 70 producing wells and over 900 kilometres (km) of pipelines.
- There are a number of statutory documents and regulatory authorities contributing to the safe and efficient operation of the oil and gas industry. Notably the Ministry of Business, Innovation and Employment (MBIE) is the primary regulator of well integrity, this Council should not duplicate this function.
- The potential environmental effects associated with oil and gas operations that fall within the Council's functions (outlined in the Resource Management Act 1991 (RMA)) primarily relate to impacts on surface water, groundwater, soil and air.
- The Council has learnt from its experiences, and has adapted and maintained a watching brief in respect of regulatory control overseas to ensure the oil and gas industry continues to be appropriately regulated according to international best practice.
- Amendments to the Freshwater Plan are required to give effect to developments in industry practices, altered community values and central government policy and legislation.

A number of changes to the Freshwater Plan (to be included in the draft Plan) are proposed to account for developments in the industry over the life of the Freshwater Plan, including the Council's experiences in regulating the environmental effects associated with oil and gas operations in Taranaki and relatively rapid technological changes in the industry. Changes in community values and central government policy and legislation have also been considered. Proposed amendments to the Freshwater Plan include:

- Amending the definition of a well and bore and include definitions of hydraulic fracturing, deepwell injection, land farming, water based muds, synthetic based muds, gas injection, produced water, water flooding and the freshwater/saltwater interface.

- Including dedicated permitted activity rules for undertaking a seismic survey, gas injection and the taking of saline produced water
- A permitted activity rule for the well structure if it meets the requirements of the HSE Petroleum Regulations (2013)
- Requiring a contingency plan for the use of pipelines carrying hydrocarbons under, on or over the bed of a river or stream
- A new dedicated restricted discretionary activity rule for hydraulic fracturing
- Amending the standards, terms and conditions of rules 41 and 42 (addressing the discharge of surplus drilling water and produced water and discharges associated with landfarming) to better reflect industry best practice.

The proposed changes represent minor changes and improvements, it has not been necessary to make major changes based on the results of comprehensive compliance and state of the environment monitoring that have been publically reported to the community. The changes also look to avoid duplication, particularly on the regulation of well integrity.

It is recommended that the draft working paper be used for targeted consultation with key industry stakeholders, relevant regulatory authorities, including district councils and MOBIE, and members of the Freshwater Plan focus group. Stakeholder feedback will be considered and will contribute to the compilation of the draft Plan.

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1. Introduction

1.1 Purpose

The purpose of this working paper is to examine fresh water management issues associated with the oil and gas exploration and production industry to inform the review of the *Regional Freshwater Plan for Taranaki* (Freshwater Plan).

1.2 Background

The oil and gas industry, which includes both exploration and processing facilities, has had and continues to have a strong presence in Taranaki.

The extraction of hydrocarbons in Taranaki began in 1866 from the Alpha well located at Port Taranaki (Photo 1 below). Since these early operations, the oil and gas industry in Taranaki has experienced significant growth.

The Taranaki basin is currently New Zealand's only commercially hydrocarbon producing basin. There are over 70 producing wells in Taranaki extracting hydrocarbons from underground rock formations for processing above ground. Servicing these wells is approximately 900 kilometres (km) of pipelines, which are used to transport hydrocarbon liquids from producing wells to processing facilities and then on to consumers.



Photo 1 Alpha well Port Taranaki

Since the 1950s the number of wells drilled in Taranaki has increased exponentially (Figure 1). Of note, the number of wells in the region has more than doubled since the Freshwater Plan was adopted in 2001.

In that time the oil and gas industry has undergone significant change. There has been a significant increase in the number of productive wells in the region and the new technologies are being used to drill wells and stimulate production in a safer and more efficient way. Associated with this growth are flow on effects with consequences for the region's environment and economy.

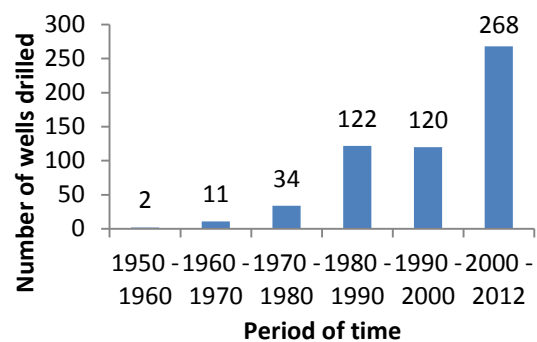


Figure 1 Onshore and offshore wells drilled in Taranaki from 1950 to 2012

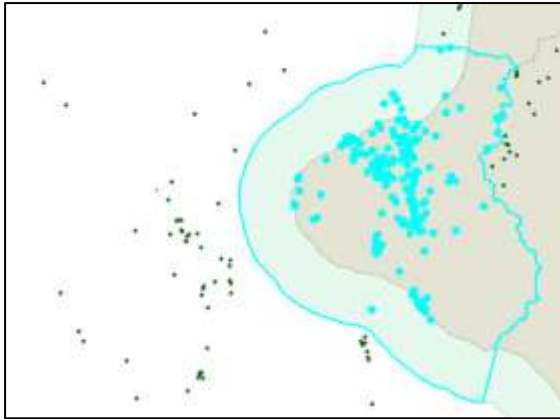


Figure 2 Location of wells included in Figure 1

The Freshwater Plan includes a suite of objectives, policies and rules that explicitly address oil and gas operations in Taranaki. However, it has been twelve years since the Taranaki Regional Council (the Council) adopted the Freshwater Plan.

Given the Council has commenced a review of the Freshwater Plan it is timely to examine issues associated with the oil and gas industry. Amendments to the Freshwater Plan must be drafted with consideration of other regulatory regimes implemented by central government and territorial authorities that impact upon the oil and gas industry.

This working paper has been drafted with the purpose of informing the wider review of the Freshwater Plan. It is proposed that this working paper be used to provide a basis for targeted consultation with key industry stakeholders, relevant regulatory authorities, including district councils and MOBIE, and members of the Freshwater Plan focus group. Following consultation, draft issues, objectives, policies and rules will be refined and incorporated into a draft plan entitled the *Regional Freshwater and Land Plan for Taranaki* (draft Plan) that will be publicly notified for submissions.

The revised Freshwater Plan will need to provide for the economic and social benefits associated with oil and gas operations, while

avoiding, remedying or mitigating any potential for adverse environmental effects.

The Working paper proposes minor changes and improvements. It has not been necessary to make major changes based on the results of comprehensive compliance and state of the environment monitoring that have been publically reported to the community. The changes also look to avoid duplication, particularly on the regulation of well integrity.

1.3 Scope

The scope of this working paper focuses on managing environmental effects associated with the oil and gas industry in Taranaki.

Issues addressed in this working paper primarily relate to environmental effects for which provision is included in the Resource Management Act 1991 (RMA). However, there is some overlap with health and safety matters, which are the responsibility of other agencies under the *Health and Safety Act in Employment 1992* (HSEA) and the *Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013* (HSE Petroleum Regulations).

It is important to note that the following is not a complete analysis of every activity undertaken by the petroleum industry. A number of other relevant activities are addressed in separate working papers e.g. river and stream bed modifications.

1.4 Structure

The working paper has five sections.

Section 1 introduces the working paper, including its purpose, background, scope and structure.

Section 2 sets out the statutory and planning context through which fresh water management issues relating to the oil and gas industry are regulated in Taranaki.

Section 3 provides an overview of relevant activities undertaken by the oil and gas industry to explore, extract and process hydrocarbons and their associated effects on the environment.

Section 4 reviews the Council's experiences in relation to the implementation of Freshwater Plan provisions for the oil and gas industry.

Section 5 outlines the basis for proposed amendments to the Freshwater Plan.

Section 6 sets out the summary and conclusions for the report.

2. Statutory and planning context

The petroleum industry is regulated by a number of central, regional and local authorities. Relevant statutory and regulatory documents address issues of environmental management and workplace health and safety separately, however, often functions of these regulatory regimes address similar issues, resulting in a degree of overlap.

This section sets out the statutory and planning context for the oil and gas industry in the Taranaki region.

2.1 Early developments in petroleum legislation in New Zealand

The history of petroleum law in New Zealand demonstrates a progression from an early reliance upon private property rights as the basis for managing exploration and development, to a period of central regulation in all aspects of the petroleum industry, through to the present deregulation and withdrawal of central government from commercial involvement.

Petroleum was first recognised as a mineral of interest to the Crown following the Mining Amendment Act 1892 in which “*petroleum and all other mineral oils*” were included within the definition of a ‘mineral’.

Following the first commercial strike of significance in 1909, calls were made for a better legislative basis for petroleum development. In 1911 the definition of a mineral in the Mining Act 1892 was amended to remove ‘petroleum and mineral oils’ and a *quasi* separate regime introduced.

Amendments also gave the Government (New Zealand or British) the right of pre-emption over all production and the power to take

over the working and management of production, storage and refining facilities.

In 1919 the petroleum regime was extended to private land, making it unlawful to undertake prospecting or production activities on private land without a licence. In 1927 the Petroleum Bill was introduced and included a prohibition against any prospecting or mining for petroleum on Crown or private land without a licence, payment of compensation for degradation of land, payment of a royalty to the owner of the petroleum and the imposition of a common carrier obligation of oil wells and refineries in times of emergency.

Pre 1937 there was no statutory assertion that the Crown had ownership of petroleum and mineral gases ‘wherever they might lie’. Ownership of land included all that was to be found under it.

The Petroleum Act 1937 changed this legal understanding. Under section 3(1) of the Petroleum Act, all petroleum in its natural condition ‘on or below the surface of any land within the territorial limits of New Zealand’ was declared to be the property of the Crown, regardless of the ownership of the land above. ‘Land’ included land covered by water, the foreshore, and the seabed to the outer limits of the territorial sea. Expropriation by the Crown was seen as the only practical way of ensuring developers could conveniently acquire and secure exclusive interests in the resource, thus encouraging exploration and development.

Amendments to the Petroleum Act in 1955 resulted in a more attractive exploration regime and in that year the Shell Group, British Petroleum and Todd Brothers Ltd formed a consortium (Shell-BP-Todd) to

undertake a comprehensive programme of exploration in Taranaki. This marked the beginning of a new era of large scale exploration and discovery which has largely been sustained to the present day.

The Petroleum Act was repealed by the Crown Minerals Act 1991.

2.2 The Crown Minerals Act 1991

The Crown Minerals Act 1991 (CMA) sits atop the government’s minerals programmes and the regulations, which together regulate the prospecting, exploration and production of Crown-owned minerals¹.

Administered by the Ministry of Business Innovation and Employment (MBIE), the CMA governs the allocation of rights to and the management of all petroleum in its natural state in New Zealand (Section 10).

The term ‘minerals’, in a legal and geological sense, includes all naturally-occurring inorganic substances beneath or at the surface of the Earth, including petroleum. However, in the CMA regime, a distinction is often made between ‘petroleum’ and ‘other minerals’, or simply ‘minerals’. This distinction reflects the inherently different activities associated with the exploration and production of petroleum compared to other predominantly land-based mineral groups.

Consequently some of the laws and policies governing the exploration and production of petroleum in New Zealand differ from those governing non-petroleum minerals. The following definition of petroleum is included in the CMA:

“Petroleum means —

- a) any naturally occurring hydrocarbon (other than coal) whether in a gaseous, liquid, or solid state; or*
- b) any naturally occurring mixture of hydrocarbons (other than coal) whether in a gaseous, liquid, or solid state; or*
- c) any naturally occurring mixture of 1 or more hydrocarbons (other than coal) whether in a gaseous, liquid, or solid state, and 1 or more of the following, namely hydrogen sulphide, nitrogen, helium, or carbon dioxide—”*

Details of how the CMA is administered and applied in regard to petroleum are set out in the Minerals Programme for Petroleum 2013 and the Crown Minerals (Petroleum) Regulations 2007.

2.2.1 Minerals Programme for Petroleum 2013

The Minerals Programme for Petroleum 2013 establishes policies, procedures and provisions which provide for the efficient allocation of rights to petroleum, and a fair financial return to the Crown from its extraction. The Minerals Programme for Petroleum was prepared on the basis that the desired outcome was to promote the responsible discovery and development of New Zealand’s petroleum resources that contribute substantially to our economy.

The fundamental policy objective of the Minerals Programme for Petroleum 2013 is stated as:

“To promote the responsible discovery and development of New Zealand’s petroleum resources that contribute substantially to our economy, consistent with:

- The efficient allocation of permits;*
- The Crown obtaining a fair financial return from the extraction of petroleum; and*

¹ They are collectively referred to as the CMA regime.

- *Having due regard to the principles of the Treaty of Waitangi.”*

A number of other additional policies are included in the programme that collectively promote a safe, efficient and effective approach to the exploration and extraction of petroleum resources.

There are three types of petroleum permits; prospecting, exploration and mining. A short explanation pertaining to each permit is included below:

- Petroleum prospecting permits are conducted for the purpose of investigating an area to establish its potential for future exploration of petroleum resources.
- Petroleum exploration permits are granted for the purpose of undertaking work to identify petroleum deposits and evaluating the feasibility of mining any discoveries made.
- Petroleum mining permits are for the development of a petroleum field to allow the extraction and production of petroleum.

2.2.2 Crown Minerals (Petroleum) Regulations 2007

The Crown Minerals (Petroleum) Regulations 2007 were introduced under Section 105(1) of the Crown Minerals Act 1991.

The Crown Minerals (Petroleum) Regulations 2007 set out how the New Zealand Government expects operators to supply information regarding their proposed permit applications, prospecting and exploration activities and reporting during the life of the permit and after a permit’s expiry or relinquishment.

Part 1 of the Crown Minerals (Petroleum) Regulations 2007 deals with the correct manner in which documents and forms should

be formulated and submitted to the secretary when applying for permits under the CMA. Part 2 requires notification of certain exploration and production activities.

Part 3 relates to mining operations. One provision in Part 3 that, arguably, imposes a substantive obligation on the employer is Regulation 35, stating that *“all well drilling operations must be undertaken in accordance with recognised good exploration and mining practice”* (good oil field practice). There is no definition of ‘well drilling operations’ in the regulations (although the same term is defined in the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013).

Part 4 addresses reports, records, samples and related matters. Part 5 deals with the way in which royalties are paid to the Crown and Part 6 relates to miscellaneous matters. Various schedules outline the information to be included in applications when notifying activities and producing reports.

2.3 Resource Management Act 1991

The stated purpose of the Resource Management Act 1991 (RMA), outlined in Section 5, is to promote the sustainable management of natural and physical resources. Included within this purpose is the need to avoid, remedy or mitigate any adverse effects of activities on the environment.

Part 3 of the RMA (sections 9 – 16) outlines the duties and restrictions that relate to the use of natural and physical resources that govern the way in which regional councils and territorial authorities manage their respective regulatory responsibilities.

Under section 30 of the RMA [functions of regional councils], regional councils are

responsible for controlling discharges of contaminants to the environment, the use of water, uses of river and lake beds, activities in the coastal marine area and control of the use of land for purposes such as soil conservation and water quality.

Section 9 of the RMA addresses restrictions on the use of land. A resource consent is only required if the activity contravenes a regional rule, for example, if an activity does not comply with the standards, terms or conditions of a permitted activity rule. The construction and drilling of a well for example is addressed under Section 9 of the RMA.

Under section 31 of the RMA territorial authorities are required to control the effects of the use of land (for example noise, light and traffic effects etc.).

Resource consents for petroleum exploration activities are commonly required under the RMA. These activities are explained in detail in the following chapters.

The RMA provides for a hierarchy of policies and plans and other statutory powers to enable central and local government to carry out their functions. These include a national policy statements, regional policy statements, regional plans and district plans.

2.4 Health and Safety in Employment Act 1992

The HSEA (administered by MBIE) regulates occupational health and safety for all economic activities.

There are close synergies between managing health and safety in the oil and gas industry and managing potential environmental effects of petroleum exploration and production activities. Although the Council has no environmental legal obligation under the HSEA, its content is a key consideration in

establishing an integrated regulatory framework for the petroleum industry.

Two sets of regulations have been introduced under the HSEA that relate specifically to the oil and gas industry:

- The Health and Safety in Employment (Pipelines) Regulations 2013 relate to matters associated with the operation of pipelines and typically apply to pipelines carrying gas or oil from production facilities to distribution points.
- The Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013 (HSE Petroleum Regulations) relate to health and safety issues associated with the exploration and extraction of hydrocarbons, both onshore and offshore.

Of particular relevance to the review of the Freshwater Plan is the HSE Petroleum Regulations². The Council participated in this review process.

2.4.1 Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013

The HSE Petroleum Regulations contain detailed, often prescriptive, requirements for the design, construction, maintenance, suspension and abandonment of petroleum operations and related well-drilling operations including hydraulic fracturing. The HSE Petroleum Regulations, which were historically administered by the Department of Labour, are now administered by a specialist High Hazards Unit in MBIE. This new unit has specific responsibilities for enforcement of health and safety

² These regulations have recently undergone a review and came into effect on June 2013.

requirements in the mining, geothermal and petroleum industries.

Local authorities are entitled to rely on the High Hazards Unit to administer the HSE Petroleum Regulations to ensure well integrity is appropriately established and monitored, without all affected local authorities across New Zealand having to duplicate or replicate specific specialist expertise in this area. The reality is the requirements associated with environmental protection that relate to well integrity are precisely those that relate to health and safety.

The HSE Petroleum Regulations address well integrity through general duties (s10), the safety case regime (s21-43), and well operations (s63-67), including the well examination scheme (s71-72). Each of these is addressed below and their role in environmental management assessed.

General Duties

The duty holder must take all practicable steps to ensure that an installation, and activities on it, is safe for any person on or near it. The installation must at all times possess such integrity as is reasonably practicable. Integrity in relation to an installation, and wells connected to it, is defined as structural soundness and strength, and stability.

Hence, well integrity should prevent any unplanned escape of fluids from the well or from strata to which the well is connected. This matter is considered in more detail in the well control measures section below.

Safety Case

The safety case applies to an installation and includes the wells by which petroleum is extracted. It includes a detailed safety management system that provides for all activities that will, or are likely to, take place on, or in connection with, the installation.

Performance monitoring of the system includes an overview of the arrangements in place for independent and competent persons to verify that safety-critical elements remain effective (schedule 1, (m) (iv)) and arrangements are in place for the periodic assessment of the installation's (which includes well integrity (schedule 1 (m) (v))).

The provision of a safety case means well integrity risks have been identified, monitored, and managed so that there should not be any unplanned escape of fluids from the well. An 'as far as reasonably practicable' test is applied to this requirement.

Interestingly the safety case process has many elements of a resource consent process under the RMA, except there is no public input process. The High Hazards Unit has an active role in processing a safety case application and an on-going role through investigating any safety incidents or other matters that could affect the safety case and safety of the installation. If approval of a safety case is withdrawn the installation could not operate.

Well Operations

The well operator's primary duty under the HSE Petroleum Regulations is to ensure that the well is designed, constructed, commissioned, equipped, operated, maintained, modified, suspended, and abandoned so that: so far as reasonably practicable, there can be no unplanned escape of fluids from the well; and issued to the health and safety of persons from the well or anything in it, or from strata to which the well is connected, are as low as is reasonably practicable (s64).

A well operator must assess conditions below ground before a well is designed (s66) in order to comply with the primary duty set out above. Well operations are required to continue to assess conditions below ground

during well operations (s67). Well operations mean drilling, completion, suspension, or abandonment of a well (s3).

A well operator must take all reasonable steps to ensure that every part of a well is composed of suitable material (s69) in order to comply with the primary duty set out above.

A well operator is required to prepare and implement a well examination scheme before the design of a well is commenced or adopted (s71). The scheme means arrangements for examinations of wells that are recorded in writing and suitable for ensuring (together with the assistance of any other measures the well operator may take) that the well is designed, constructed, operated, maintained, modified, suspended, and abandoned so that – so far as reasonably practicable, there can be no unplanned escape of fluids from the well; risks to health and safety of persons from the well or anything in it, or from strata to which the well is connected, are as low as reasonably practicable; and conducted by an independent and competent person. ‘Independent’ and ‘competent’ are defined in section 3 of the regulations. Transition provisions apply in sections 71(5)–(6).

A well operator must retain records relating to the well examination scheme including revision of the scheme, examination and testing carried out, the findings of any examination and testing carried out and remedial actions recommended and performed (s72).

A well operator must give notice of well operations (s73) 21 days before commencement. Schedule 7 of the HSE Regulations sets out the comprehensive information that is required to be provided, which includes well integrity information.

A well operator must make and retain daily well operation reports and store these at an address notified by the Secretary and must make them available to an inspector on request (s76). The well operations addressed include drilling, completion, workover, suspension or abandonment, and any other operation involving substantial risk of unplanned escape of fluids from the well.

A well operator must notify any dangerous occurrence as soon as practicable. A dangerous occurrence is defined in the HSE regulations and includes: an event that did not cause, but might reasonably have caused, a major accident; the failure of any part of a well whose failure would cause or contribute to, or whose purpose is to prevent or limit the effect of, the unintentional release of fluids from a well or a reservoir being drawn on by a well; damage to, or failure of, a safety critical element that required intervention to ensure it will operate as designed; an unintended collapse of and installation or part of an installation (noting a well is included in the definition of an installation); and damage to an installation caused by earthquakes or other natural events that had the potential to cause death or serious harm of any person.

A duty holder must prepare an emergency response plan for the installation (s79) and regularly review and test it (s80). The plan is for responding to emergencies that occur while petroleum workers are working on an installation.

2.5 Hazardous Substances and New Organisms Act 1996

The purpose of the Hazardous Substances and New Organisms Act 1996 (HSNO) is to protect the environment and the health and safety of communities, by preventing or managing the adverse effects of hazardous substances and new organisms. In doing so the HSNO requires approval from the Environmental Protection

Agency to import or manufacture a hazardous substance. HSNO provides the following definition of a hazardous substance:

hazardous substance means, unless expressly provided otherwise by regulations, any substance—

(a) with 1 or more of the following intrinsic properties:

(i) explosiveness:

(ii) flammability:

(iii) a capacity to oxidise:

(iv) corrosiveness:

(v) toxicity (including chronic toxicity):

(vi) ecotoxicity, with or without bioaccumulation; or

(b) which on contact with air or water (other than air or water where the temperature or pressure has been artificially increased or decreased) generates a substance with any 1 or more of the properties specified in paragraph (a)

Section 142 of the HSNO Act states that:

‘Every person exercising a power or function under the Resource Management Act 1991 relating to the storage, use, disposal, or transportation of any hazardous substance shall comply with the provisions of this Act and with regulations and notices of transfer made under this Act’.

The licensing of hazardous substances is also carried out by the EPA. Proof of authorisation for use in New Zealand and disclosure of the composition of the various trademarked compounds can be sought either from EPA, or directly from the user by requesting proof of their HSNO approval and the consequent documentation as stipulated by the EPA.

It should be noted that discharges associated with hydrocarbon exploration and production may include mixtures of compounds that could include hazardous substances that do not fall within the scope of previously granted

HSNO approvals.³ The Council must consider the potential environmental effects of any discharge to land, air or water.

2.6 National Policy Statement Freshwater Management

The National Policy Statement for Freshwater Management 2011 (NPS) was prepared by the government and adopted in 2011.⁴ Under Section 55 of the RMA regional council must give effect to national policy statements.

The NPS sets out objectives and policies that direct local government to manage water in an integrated and sustainable way while providing for economic growth. These objectives and policies are broad and no specific reference to oil and gas operations is made.

Notwithstanding the above, objectives and policies relating to water quality, water quantity and integrated management apply. Accordingly there are national policy directives for regional councils to effectively manage the effects of oil and gas operations on fresh water resources.

The following objectives are of particular relevance when proposing amendments to the Freshwater Plan:

Objective A1 – To safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably

³ The Council must be able to apply its own discretion in these circumstances to ensure any adverse environmental effects associated with the discharge of a hazardous substance can be avoided, mitigated or remedied.

⁴ The NPS recently under went review. Through this review central government have proposed a number of amendments. None of the proposed changes affect the approach to managing environmental effects associated with oil and gas activities proposed in this report.

managing the use and development of land, and of discharges of contaminants.

Objective B1 - To safeguard the life-supporting capacity, ecosystem processes and indigenous species, including their associated ecosystems of fresh water, in sustainably managing the taking, using, damming or diverting of fresh water.

Objective C1 - To improve integrated management of fresh water and the use and development of land in whole catchments, including the interactions between fresh water, land, associated ecosystems and the coastal environment.

Objective D1 - To provide for the involvement of iwi and hapū, and to ensure that tāngata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding fresh water planning, including on how all other objectives of this national policy statement are given effect to.

Policies through which these objectives are to be achieved are predominantly concerned with the setting of limits on water quality and quantity in regional plans. In setting these limits the Council must give adequate consideration to the petroleum industry and the activities that may impact upon the quality and quantity of fresh water in Taranaki.

2.7 Regional Policy Statement for Taranaki

The Regional Policy Statement for Taranaki (RPS) sets out broad objectives and policies for the Taranaki region to promote the integrated management of resources in the region. Regional and district plans must give effect to the RPS.

The following objectives are of particular relevance to oil and gas operations:

Objective WQU 1 - To maintain and enhance surface water quality in Taranaki's rivers, streams, lakes and wetlands by avoiding, remedying or mitigating any adverse effects of point source and diffuse source discharges to water.

Objective GWR 1 - To sustainably manage the use of groundwater in the Taranaki region by:

- a) enabling people and communities to take and use groundwater to meet their needs while avoiding, remedying or mitigating adverse effects arising from that use; and*
- b) avoiding, remedying or mitigating adverse effects on groundwater quality from over abstraction, intensive agricultural land uses, the discharge of contaminants, and poor well and bore construction.*

Objective GWR 2 - To improve knowledge of groundwater resources in Taranaki to promote the sustainable management of groundwater resources.

Objective ENE 1 - To promote the exploration, development, production, transmission and distribution of energy to meet the energy supply needs of the region and New Zealand in a manner that avoids, remedies or mitigates adverse effects on the environment.

Objective ENE 3 - To increase efficiency in the exploration, development use, production, transmission and distribution of energy.

In achieving these objectives a number of policies are included in the RPS that must be given effect to when making decisions regarding Taranaki's natural and physical resources.

Policy GWR 4 - Groundwater quality will be maintained and enhanced by:

- a) managing the discharge of contaminants to land and water such that any actual or potential adverse effects on groundwater quality are avoided, remedied or mitigated;*
- b) managing the siting, drilling, construction or alteration of wells and bores;*
- c) managing old, damaged and unused wells or bores;*
- d) controlling deep well injection of wastewater or other contaminants to groundwater to ensure there is no significant risk of degradation to useable groundwater resources; and*
- e) promoting land use practices that minimise as far as practicable the potential for adverse effects on groundwater quality.*

Policy ENE 4 - Provisions shall be included that appropriately recognise the importance of corridors to facilitate the ongoing operation, maintenance, upgrading and development of energy transmission and the need to protect such corridors from activities that impede their efficient operation.

Policy MIN 1 - Provision will be made to enable appropriate use and development of the region's mineral resources in a way that avoids, remedies or mitigates adverse effects on the environment.

Policy MIN 2 - The adverse effects of subdivision, use and development activities that may be incompatible with mineral extraction activities by mainly limiting their operations or compromising their ability to extract minerals, will be avoided, remedied or mitigated.

2.8 Regional Freshwater Plan for Taranaki

The Council's fresh water management responsibilities under the RMA are primarily addressed through the Freshwater Plan. The Freshwater Plan became operative on 8 October 2001.

The following objectives in the Freshwater Plan are of particular relevance to oil and gas operations.

OBJ 3.1.4 To safeguard the life-supporting capacity of water and aquatic ecosystems from the adverse effects of the use and development of fresh water.

OBJ 4.1.1 To recognise and provide for the cultural relationship and values of Iwi and hapu of Taranaki with water, and with ancestral land and sites, wāhi tapu and other taonga associated with fresh water, and the beds of rivers and lakes, in a manner reflective of their status as Tangata Whenua and in accordance with Tikanga Maori.

OBJ 6.2.1 To maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point-sources.

OBJ 6.3.1 To maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to water from diffuse source.

OBJ 6.5.1 To avoid, remedy or mitigate adverse effects on groundwater quality from bore and well drilling, construction or alteration.

OBJ 6.5.2 To promote the sustainable management of groundwater while avoiding, remedying or mitigating adverse effects on

groundwater quality from the discharge of contaminants.

These objectives are given effect to through a framework of policies and rules that allow for different activities to be carried out with varying levels of consideration by consent officers.

POL 3.1.3 The life-supporting capacity of fresh water will be safeguarded and the adverse effects of activities on aquatic habitats and fresh water ecosystems will be avoided, remedied or mitigated having regard to:

- a) the maintenance of biological and physical processes;*
- b) the existing and potential productivity, diversity, importance and variability of aquatic ecosystems;*
- c) habitat characteristics, including habitats for aquatic species at different stages of their life cycle, habitats of threatened, vulnerable or rare species, and habitats for terrestrial life that use the water body;*
- d) the significance of indigenous flora and fauna, including the habitat of indigenous fish;*
- e) the habitat of trout.*

POL 4.1.1 Wāhi tapu and other sites or features of historical or cultural significance to Iwi and hapu of Taranaki, and the cultural and spiritual values associated with fresh water, will be protected from the adverse effects of activities, as far as practicable.

POL 6.2.1 In managing point-source discharges to land and water, the Taranaki Regional Council will recognise and provide for the different values and uses of surface water including:

- a) natural, ecological and amenity values;*
- b) the relationship of Tangata Whenua with water;*

- c) the maintenance and enhancement of aquatic ecosystems, and water quality for fisheries and fish spawning;*
- d) use of water for water supply purposes;*
- e) use of water for contact recreation.*

POL 6.5.1 Drilling and well or bore construction or alteration will be managed to prevent aquifer cross-contamination and aquifer contamination from the surface due to open or unsealed bores or wells, or contamination from other drilling activities.

POL 6.5.2 Old, damaged and unused wells or bores will be managed to prevent adverse effects on groundwater quality from contamination.

POL 6.5.3 The Taranaki Regional Council will manage the discharge of contaminants to land and water such that any actual or potential adverse effects on groundwater quality are avoided, remedied or mitigated.

The Freshwater Plan includes rules that explicitly address environmental effects associated with the oil and gas industry, both directly and indirectly. Included in Appendix 1 are those rules that target activities undertaken by the oil and gas industry. Other relevant rules that may also apply to the oil and gas industry relate to:

- Stormwater discharges
- River and stream bed modification
- The taking and use of surface and groundwater
- Land drainage
- Impact on wetlands.

2.9 District council plans

In addition to regional plans, oil and gas operators are required to comply with the district plan provisions of territorial authorities. The Taranaki Region has three territorial authorities; the South Taranaki, New Plymouth and Stratford district councils.

Section 31 of the RMA states that territorial authorities have control over any actual or potential effects associated with the use, development or protection of land.

Environmental effects associated with the oil and gas industry that are captured under district council plans include:

- Amenity
- Light
- Noise
- Traffic
- Dust.

Each district council has its own plan though which objectives, policies and rules are implemented to manage environmental effects. Typically the approaches applied by district councils to manage effects associated with the oil and gas industry are similar, however, some provisions do differ between districts i.e. buffer distances, allowable truck movements or noise levels.

3. Oil and gas operations – environmental risks and mitigation

This section outlines the process through which hydrocarbons are discovered, extracted and processed into a marketable product. This process can be broadly divided into upstream (exploration and production) and downstream (refining and processing of crude oil and gas products) operations.

In relation to each operation, associated potential environmental effects on fresh water and soil conservation are identified and evaluated. Over the life of the Freshwater Plan, the Council has commissioned a number of studies focusing on varying aspects of the oil and gas industry in Taranaki. Relevant reports include:

- Review of regulation of deepwell injection under the Resource Management Act (2013)
- Radioactivity releases in hydrocarbon exploration (including fracturing activities) (2013)
- Hydraulic Fracturing for Oil and Gas Development: Environmental Concerns and Regulation (2012)
- Upstream oil and gas environmental regulation stocktake and assessment (2012)
- An Assessment of the Effects of Hydraulic Fracturing on Seismicity in the Taranaki Region (2012)
- Hydrogeologic Risk Assessment of Hydraulic Fracturing for Gas Recovery in the Taranaki Region (2011)
- Pattle Delamore Partners Ltd (2013) Review of Petroleum Waste land Farming
- Dr D C Edmeades (agKnowledge Ltd) (2013) The Taranaki Landfarms are they “Fit for Purpose”

- Guidelines for the control of drilling waste disposal onto and into land (2005)⁵
- Guide to regulating oil and gas exploration and development activities under the Resource Management Act (2013)
- A Guide to Regional Plans in Taranaki - for oil and gas exploration and production activities (2001).

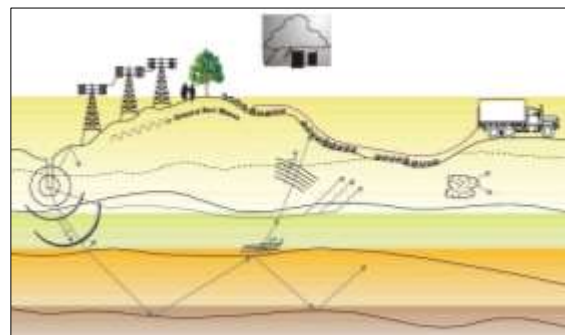
3.1 Exploration

3.1.1 Seismic surveys

The activity

Seismic testing is the most widely used geophysical method of exploration. Seismic testing provides the most detailed analysis of geological strata and allows for the greatest level of confidence in predicting the presence of hydrocarbons.

Seismic testing involves releasing shock waves through the earth to be reflected back to the surface from deep rock strata of differing properties. The reflected waves are recorded by sensitive measuring instruments called geophones. By measuring the time it takes for a sound wave to be reflected, the depth of each reflecting layer can be calculated. The intensity of the reflection is correlated to rock composition (see Figure 3).



⁵ These guidelines are currently under review and due for completion by the end of 2013.

Figure 3 Schematic representation of what a seismic survey could look like

On land, shockwaves can be generated by explosives, dropping weights or using a vibrating panel. Seismic surveys typically involve the drilling of small diameter shot holes to depths of between three and forty metres on a grid based pattern across large areas of land.

Environmental effects

The risk of seismic testing resulting in adverse environmental effects is largely dependent on the number and depth of holes drilled, the size of the explosives used and the depth and quality of the surrounding groundwater resource. Potential environmental effects associated with seismic testing are associated with surface water and groundwater contamination and loss of aquifer pressure.

Groundwater could become contaminated from seismic testing as a result of surface runoff entering uncapped or poorly abandoned holes, or during drilling due to losses of drilling muds to fresh water bearing formations.

Associated with the detonation of explosives is a release of energy that may impact upon the surrounding rock strata, water bodies and infrastructure in close proximity to the shot hole. This release of energy could result in leakages from effluent storage facilities, modify the beds of river and streams or impact the integrity of bores used for water supply.

Where artesian conditions are encountered, there is a risk of contributing to the dewatering of groundwater reservoirs and generating surface drainage issues.

Mitigation measures

The environmental effects associated with seismic surveys can be mitigated by managing the drilling, detonation of explosives and

abandonment process involved in undertaking a seismic survey.

By restricting the location and depth of holes drilled to insert and detonate charges and ensuring that shot holes are open only temporarily (i.e. remediated and abandoned immediately after the explosives are detonated), seismic surveys can be undertaken with little risk of producing adverse environmental effects.⁶

3.1.2 Establishing the wellsite

The activity

Once a field is proven for development and the relevant permits (required by MBIE) are obtained, a wellsite is established to undertake exploratory drilling. Although seismic surveys can be used to predict the location of hydrocarbon bearing formations, drilling a well is the only way to confirm the production capacity of a hydrocarbon reservoir.

Wellsites typically cover an area of 1.0-1.5 ha and include the necessary equipment to drill the well and house the workers that live temporarily on the wellsite. Establishing a wellsite involves constructing roads, culverts, wellsite ring drains and skimmer pits, removing top soil, levelling land and laying geotextile cloth and aggregate. A wellsite should be accessible, contained, level, have a relatively impermeable surface and provide foundations for the drilling rig and other site equipment.

Drains and skimmer pits allow for stormwater (possibly contaminated) to be collected and transported to a location on the wellsite

⁶ New Brunswick Natural Gas Group, 2012, Responsible Environmental Management of Oil and Gas Activities in New Brunswick - Recommendations for Public Discussion

where it can be stored, without the risk of ground water infiltration, until it can be appropriately treated prior to disposal.

Infrastructure and equipment on a wellsite could include, but is not limited to, a derrick, drilling mud handling equipment, power generators, cementing equipment, tanks for fuel, water and hazardous substances and provision for the treatment and disposal of wastes (Photo 2). The support camp is self-contained and generally provides accommodation, eating facilities, sewage amenities and communications.



Photo 2 A wellsite in Taranaki

Environmental effects

Environmental risks typically associated with constructing and operating a wellsite primarily relate to surface water and groundwater contamination.

If not managed appropriately, the discharge of stormwater from earthworks and wellsite activities can result in sediment entering waterways, smothering in-stream flora and fauna. Sediment in the waterways can also alter stream habitat, change ecological and amenity values and temporarily affect water supplies.

If ponding is allowed to occur or if skimmer pits are not properly constructed and lined, there is a risk that contaminants could leach through the soil profile and impact groundwater.

Mitigation

Earthworks undertaken to establish a wellsite in Taranaki are managed in accordance with standards, terms and conditions in relevant rules in the Freshwater Plan.

In addition to guidelines⁷, 'Soil Erosion and Sediment Control Plans' can be required as a component of resource consent applications to ensure the necessary mitigation measures are in place to minimise adverse environment effects.

When constructing a wellsite, conditions associated with stormwater discharge resource consents ensure that drains are constructed to transport contaminants without the risk of ponding or infiltration i.e. constructed with suitable material and with the necessary gradient to promote the flow of liquids. Similarly, skimmer pits must be constructed and lined to prevent the discharge of contaminants to groundwater via infiltration (leakage). Resource consents address the discharge from the skimmer pits where there is a loss of control of the discharge.

It has been the Council's experience that providing appropriate mitigation measures are implemented, the risk to the environment is minimal. The Parliamentary Commissioner for the Environment (PCE) came to a similar conclusion through her investigation of hydraulic fracturing, stating that "*managing the environmental effects when building a well site is usually relatively straightforward*".

⁷ Taranaki Regional Council, 2006, Guidelines for Earthworks in the Taranaki region.

3.1.3 Drilling, casing and cementing a well to access and explore for hydrocarbons

The activity

Before drilling begins a section of conductor pipe is driven into place, generally by way of impact (percussion drilling⁸). The conductor pipe supports the drilling and casing of the well which is carried out using a rig designed specifically for hydrocarbon exploratory drilling operations. Sequentially deeper holes are drilled to install the surface casing, intermediate casing (if necessary) and the production casing. Each segment of the casing is smaller in diameter than the one above (Figure 4).

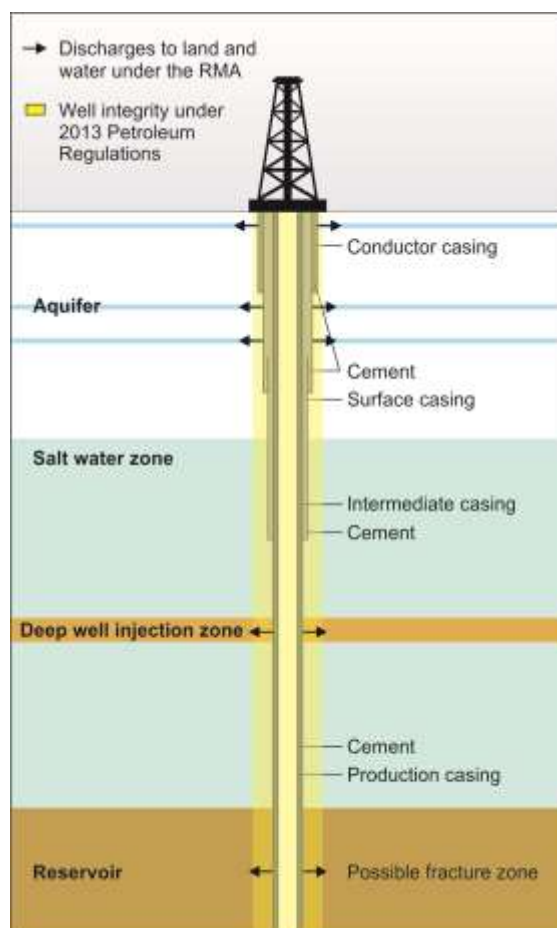


Figure 4 Schematic representation of a cased well

⁸ A local drilling contractor is generally employed to install the conductor casing using their own portable drilling equipment.

Drilling a well utilises a drill string, consisting of a drill bit, drill collars (heavy weight pipe to put weight on the bit) and drill pipe. The drill string is suspended at the surface from the drilling derrick (main structure of the drilling rig) and rotated (most commonly by a top drive unit and in some cases a rotatory table).

Drilling mud is circulated down the centre of the drill string and up the space between the drill string and hole. Drilling mud serves to lubricate the drilling string, remove formation cuttings, maintain pressure control inside the well and stabilise the hole being drilled.

Drilling mud is generally a mixture of either water or synthetic oils, together with added clays, fluid loss control additives, density control additives and viscosifiers.

Once the desired depth is reached the casing is installed and cemented in place. The purpose of cementing the casing is to isolate the different formations through which the well is drilled (including full isolation from groundwater resources) and to provide structural support to the well.

Cementing is accomplished by pumping the cement down the inside of the casing, and circulating it back up the outside of the casing. The placement of cement around the casing is one of the primary factors contributing to well integrity.

Environmental effects

The environmental risks typically associated with drilling, casing and cementing a well include, potential contamination of groundwater by drilling muds, loss of aquifer pressure and aquifer cross contamination. These effects are most likely to occur prior to casing and cementing the well. Once the integrity of the well is properly established the risk of these effects occurring is very low.

Although unlikely, there is risk of a well blowout⁹ occurring. A well blowout could result in the contamination of surface water, groundwater and soil.

Losses of drilling mud to the formations through which a well is drilled can be experienced. The potential for adverse environment effects associated with losses of drilling mud is largely dependent on the location of the loss relative to useable sources of groundwater and the mud composition i.e. is it water or synthetic based.

Where drilling intersects groundwater held under pressure artesian conditions can arise. If the flow of water is not controlled, water can enter the hole and aquifers can be temporarily impacted. The risk of inflow is highest during drilling and is significantly reduced once the integrity of the well is established.

When a well or bore is drilled to intersect multiple aquifers, a vertical pathway for the exchange of each aquifers contents is created. If drilling links an aquifer below the freshwater/saltwater interface to an aquifer containing a useable fresh water resource, there is potential for contamination to occur.

Poor well construction could compromise zonal isolation and create pathways for leakages around the annulus of the well.

Mitigation

By managing the properties of drilling mud, the well operator can control hydrostatic pressure in a well, avoiding well blowouts, minimising groundwater takes and maintaining well integrity until the cement

⁹An uncontrolled flow of reservoir fluids into the wellbore, and sometimes catastrophically to the surface. A blowout may consist of salt water, oil, gas or a mixture of these.

and casing can be installed.¹⁰ These impacts are low risk and temporary in nature.

The composition of drilling mud must be managed with an understanding of the location of useable groundwater resources and the fresh water/ saltwater interface. The use of water based fluids in the upper sections of the well is preferred by the Council over synthetic and oil based fluids due to the reduced risk of contaminating groundwater resources.

The application of cement to land (subsurface) involves similar risks to the environment to those associated with the discharge of drilling mud down the well. Like drilling mud, cement must be designed correctly to avoid the contamination of fresh water reservoirs. Cement must hold the appropriate properties (density and viscosity) to avoid any significant losses.

Critical to well construction and development is the maintenance of well integrity to ensure hydrocarbon bearing formations are isolated from overlying fresh water aquifers.

Regulating the integrity of wells drilled for the purpose of oil and gas exploration and development is primarily the responsibility of the High Hazards Unit within MBIE under the HSE Petroleum Regulations. Specific regulations targeting well integrity are discussed in Section 2.4.1.

3.1.4 Hydraulic fracturing

Hydraulic fracturing is a well stimulation technique used to increase the flow of hydrocarbon fluids from formations that would otherwise not flow at commercially attractive rates. There are other well stimulation techniques, such as gas injection

¹⁰ New Brunswick Natural Gas Group, 2012, Responsible Environmental Management of Oil and Gas Activities in New Brunswick - Recommendations for Public Discussion

(discussed in Section 3.1.6), but hydraulic fracturing is usually undertaken in what are described as tight gas, coal seam or shale reservoirs that are characterised by low permeability¹¹.

Hydraulic fracturing is a separate activity from drilling and whilst drilling is a requirement to access a reservoir, the decision to undertake a hydraulic fracturing operation is usually made subsequent to drilling based on the flow of hydrocarbons and geological data.

Put simply hydraulic fracturing is the controlled creation and enlargement of localised artificial fractures in a low permeability reservoir by pumping fluids from the surface at pressures sufficient to crack the reservoir rock in the immediate vicinity of the well. A 'proppant' (usually ceramic beads) is placed in the newly created fractures to keep them open. The pressure is then released and fluids return to the surface. The objective is to create a permanent and permeable pathway from the reservoir to the wellbore, so that hydrocarbon fluids will flow to the surface at commercially attractive rates (Figure 5).

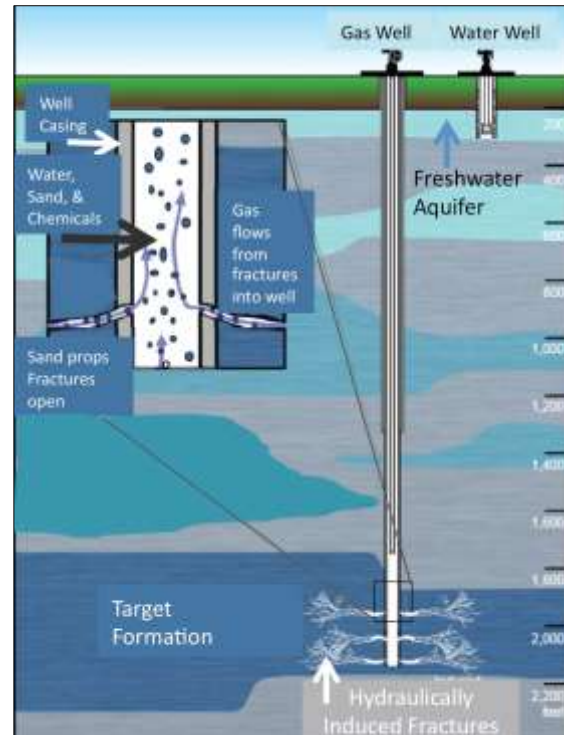


Figure 5 Schematic representation of a well and its target formation that have undergone hydraulic fracturing

Environmental effects

There have been some concerns regarding the potential environmental risks associated with hydraulic fracturing. These risks primarily relate to surface water, groundwater and land contamination.

If hydraulic fracturing operations are carried out in accordance with best practice, it is unlikely that contaminants will reach overlying fresh water aquifers.¹²

Notwithstanding the above, although unlikely, it is not impossible. There are four potential routes through which contaminants could reach fresh water resources:

- 1) leakage from the hydraulic fracturing well casing due to defective installation or cementing

¹¹ Permeability is the degree of interconnection between the pores, and therefore a measure of how easily a fluid can pass through rock.

¹² Parliamentary Commissioner for the Environment, 2012, Evaluating the environmental impacts of fracking in New Zealand: An interim report.

operation is functional and safe. These investigations are submitted as a component of resource consent applications¹⁵ or undertaken as a requirement of resource consent conditions.

Similar issues are also addressed under the HSE Petroleum Regulations through specific provisions discussed in Section 2.4.1. The Council relies on these investigations to confirm the integrity of the well and surrounding geological strata as sufficient to contain pressures exerted during hydraulic fracturing operations.

Consent conditions also control the subsurface point of discharge and require the resource consent holder to ensure that hydraulic fracturing does not result in contaminants reaching any useable groundwater or surface water. A monitoring programme must be implemented to ensure consent conditions are complied with.¹⁶

3.1.5 Discharge of tracers

The activity

Tracers are routinely used in both the drilling and flow enhancement (stimulation by fracturing) of wells. They may be either chemical or radioactive, including beta or gamma forms of radiation.

Radioactive tracers emit gamma or beta radiation capable of penetrating well casing and being detected by wireline conveyed instruments. Matters such as well integrity, the placement of equipment, identification of target formations and extent of fracturing fluid penetration, can be assessed using such tracers.

¹⁵ Shell Todd Oil Services, 2012, Assessment of Environmental Effects (AEE) for hydraulic fracture stimulation at four existing wellsites within the Kapuni field.

¹⁶ Taranaki Regional Council, 2013, Tag Oil (NZ) Ltd Company Groundwater Monitoring Programme.

It should be noted that not all field operators in Taranaki use radioactive tracers, and likewise, not all uses of radioactive tracers relate to fracturing. As noted above such tracers can be an integral part of a conventional well drilling operation. Changes in formation temperature can also be used to indicate formation penetration for a hydraulic fracture operation.

Environmental effects

The inappropriate use of radioactive tracers could result in the contamination of surface water, groundwater and soil.

Contamination could occur both at wellsites where tracers are applied and at landfarms where waste containing tracers is disposed of.

Mitigation

The use of radioactive materials in New Zealand and any questions around radioactivity exposure are matters under the jurisdiction of the Ministry of Health, and all enquiries or concerns are appropriately addressed by that agency in the first instance.

Users of radioactive tracers must satisfy requirements imposed by the Radiation Protection Act 1965, Radiation Protection Regulations 1982 and Codes of Safe Practice.

The Office of Radiation Safety administers (under the direction of the Ministry of Health) these statutes, regulations and codes of practice.¹⁷ This involves a wide range of regulatory activities including licensing, issuing consents and maintenance of codes of safe practice.

¹⁷ These statutes were formerly administered by the National Radiation Laboratory until this organisation was transferred to the Institute of Environmental Science and Research (ESR). The Office of Radiation Safety oversees a contract between the Ministry of Health and ESR for the provision of radiation services.

3.1.6 Gas injection

The activity

Gas injection is a widely used secondary recovery method for hydrocarbon production. Produced gas¹⁸ is injected into a formation through gas injection wells, increasing formation pressure to force hydrocarbons to the surface through producing wells.

Environmental effects

The potential environmental risks typically associated with gas injection include groundwater and land contamination.

Mitigation

Providing the integrity of the gas injection well has been proven (regulated by MBIE through the HSE Petroleum Regulations) and formation pressure in the target reservoir does not exceed that recorded when the well initially started to flow, the risk of any environmental effects is minor. Initial pressure is a function of the confining nature of overlying geology. If this is exceeded geological integrity may be adversely affected. Operators undertaking gas injection operations in Taranaki apply these best practice controls to effectively and efficiently stimulate production.

3.1.7 Taking of water

The activity

Securing access to reliable sources of water is an important component of most oil and gas operations, particularly drilling and hydraulic fracturing. Water can be obtained from a number of different sources, including surface water, ground water and municipal water suppliers.

Water use associated with the oil and gas industry in Taranaki is not a significant issue, nor is it likely to be in the future.

In addition to takes of water that are planned for (generally a resource consent is required), minor takes of groundwater occur during hydrocarbon exploration and production.

These minor takes of water can occur from both the fresh and saline water zones. Saline water is abstracted with hydrocarbons and must be separated out. Such water is termed produced water and is usually disposed of by deepwell injection into the saline zone. These takes are considered insignificant and their associated effects on the environment minor.

Environmental effects

Reduced flows or water levels can lead to a reduction in water depth, velocity, wetted area and waste dilution capacity, all of which can affect aquatic ecosystems.

Reduced flows can also affect the natural character a water body, including its intrinsic, cultural and recreational values such as swimming and fishing.

Mitigation

Environmental effects associated with water takes are not unique to the oil and gas industry. Water takes are regulated across the Taranaki region to ensure water levels remain sufficient to maintain the life supporting capacity of rivers and streams.

Water abstractions for the purpose of drilling or fracturing a well are planned for, meaning volumes can be estimated and appropriate conditions set. Conditions generally set limits on the volume and/or rate of a water take to ensure adverse effects are avoided, remedied or mitigated.

3.1.8 Deepwell injection

The activity

Deepwell injection allows for suitable treated and untreated liquid waste to be disposed of into geologic formations that are isolated

¹⁸ The gas can also entrain light oils (condensates).

from fresh water aquifers. Isolated formations that have a high permeability and porosity allow for large quantities of industrial waste to be disposed of. Deepwell injection has been used to dispose produced water, return fluids (including hydraulic fracturing fluids), drilling muds and contaminated stormwater at a number of different wellsites in Taranaki.

Environmental effects

Risks to the environment are typically associated with the contamination of groundwater and land.

The routes through which contaminants could reach fresh water resources are the same as those associated with hydraulic fracturing. However, because contaminants are injected at lower pressures for permanent disposal, there is a decreased risk associated with containing pressure inside the well and an increased risk of fluid migration from the target formation.

Mitigation

Deepwell injection has been used by several oil and gas companies in Taranaki to dispose of fluids from hydrocarbon exploration and production operations. A precautionary approach has been adopted by the Council to manage the potential environmental effects associated with deepwell injection. All deepwell injection activities in Taranaki are subject to standards adopted from the hazardous substances US regulatory regime.

Already discussed in Section 3.1.4 were studies commissioned by the Council to investigate the hydrogeologic and seismic risks associated with hydraulic fracturing in Taranaki. Conclusions drawn in relation to hydraulic fracturing apply to deepwell injection and similar mitigation measures are required to avoid contamination of useable groundwater.

Any application seeking to dispose of waste by deepwell injection must demonstrate to the Council the suitability of the geological formation, injection zone and well to prevent any migration of fluids into overlying fresh water aquifers. These considerations are also made when establishing compliance with the HSE Petroleum Regulations.

On-going monitoring must be carried out to verify the injection well's mechanical integrity, operational condition and to determine compliance with consent conditions.

3.1.9 Landfarming

The activity

Land farming involves the disposal of predominantly drilling wastes (cuttings and mud) on land. Waste is incorporated into soil allowing natural bioremediation and various soil processes to biodegrade, transform and assimilate wastes.

The application of drilling waste to land in Taranaki and overseas has become an established method of disposing waste contaminated by hydrocarbons in an environmentally acceptable manner. Optimal land spreading techniques balance the discharge of waste against the soil's capacity to assimilate its constituents (Photos 3 and 4).

Dependent on the concentration of hydrocarbons in the waste distributed to landfarms, the waste may be stored in pits or applied directly to the spreading area. Pits allow for the temporary storage of waste until there is a sufficient volume at the landfarm to make the spreading process economical and efficient. Pits should be lined and of sufficient capacity to avoid any overflow to the surrounding environment.

Environmental effects

Failure to appropriately manage land farming operations could contaminate surface water,

groundwater and soil and impact upon sites of cultural significance.

Overloading of contaminants in soil could reduce productive capacity. Excess salts and chlorides impact on the health of soil biota restricting the use of land in the future i.e. the potential for pasture establishment.



Photo 3 Prior to spreading at a landfarm in Taranaki



Photo 4 Post spreading at a landfarm in Taranaki

Contamination of surface water and groundwater can occur by way of seepage through the soil profile to groundwater and stormwater runoff to nearby streams and rivers.

Mitigation

Before landfarming can commence appropriate baseline data is collected for surface water and groundwater quality, flow paths and soil characteristics. This information allows the Council to assess site suitability for

a landfarming operation. If resource consent is granted, monitoring by the Council ensures consent conditions are complied with.

Site selection is crucial to removing the risk of contaminants entering surface water. Sites without any overland watercourses are preferred for landfarming operations. If a site is in close proximity to water bodies (i.e. streams, lakes and farm drains) buffer zones are established to prevent overland flow from discharging into waterways.

The greatest risk of groundwater contamination occurring at landfarms is through leakage from storage pits. While the Council now requires pits to be lined as an additional precaution/requirement, the natural sealing effect of barite and bentonite (common mud waste constituents) can provide an adequate seal.

Studies conducted in Canada, USA, Belgium and Croatia¹⁹ have indicated that if wastes are applied correctly, land farming does not adversely affect soils.

The Council has developed guidelines²⁰ for the disposal of drilling wastes onto land. These guidelines are based on the G-50 Guideline²¹ produced by the Alberta Energy and Utilities Board, Canada.

The Council reviewed the G-50 Guideline in 2003 and again in 2005 to assess its appropriateness for use in Taranaki. The review incorporated local research into environmental effects associated with disposal of drilling wastes, and biodegradation and attenuation conditions in Taranaki. Likely

¹⁹ Bates 1988; Genouw et al. 1994; Kistic et al. 2009; Hubalek et al 2007; Vail, 2002)

²⁰ Taranaki Regional Council, 2005, Guidelines on the disposal of drilling wastes onto and into land

²¹ Alberta Energy and Utilities Board, 1996, G-50 Guideline for Drilling Waste Management; Drilling Waste Management, 2012

environmental effects and loading rates have been assessed against national guidelines and criteria for soil and water quality.

More recently the Council has commissioned investigations²² focusing on varying aspects of landfarming operations in Taranaki to ensure best practice environmental controls are being implemented. These investigations confirmed that the Council's approach to managing environmental effects associated with landfarms is largely appropriate. Some minor recommendations were made.

3.1.10 Mix-bury-cover

The activity

Like landfarming, mix-bury-cover is a method of disposing solid drilling wastes to land. The mix-bury-cover disposal method involves mixing solid drilling waste with clean soil and burying the mixed material below the major rooting zone²³ and above the water table.

Mix-bury-cover is typically used when the solid drilling waste is not contaminated with hydrocarbons.

Environmental effects

The environmental risks are typically associated with the contamination of surface water, groundwater and soil.

Mitigation

In addition to informing the management of landfarming operations, the document *Guidelines on the disposal of drilling wastes onto and into land* also applies to mix-bury-cover operations.

An investigation carried out by Fletcher Challenge Energy Taranaki Limited into mix-bury-cover discharges throughout 1999/2000

²² Pattle Delamore Partners Ltd (2013) Review of Petroleum Waste land Farming and Dr D C Edmeades (agKnowledge Ltd) (2013) The Taranaki Landfarms are they "Fit for Purpose"

²³ Zone in which plant roots extend in soil.

at the Ohanga-A and Toetoe-A wellsites concluded that mix-bury-cover can be undertaken with little risk to the environment providing best practice is adopted.

3.2 Production and processing

3.2.1 Well completion and the on-going extraction of hydrocarbons

The activity

Well completion occurs if the reservoir is able to be produced profitably. Well completion essentially means 'finishing off' a well so reservoir fluids can be produced efficiently and safely to the surface for the life of the well.

Well completion includes the installation of production tubing, downhole communication equipment, tools to monitor and control the flow of fluids and safety devices. It may also include artificial lifts (pumps).

A producing well that has undergone completion requires what is termed a 'christmas tree' to monitor and control downhole pressure. Additional infrastructure (e.g. roads and fencing) is also required for monitoring, maintenance and safety purposes.

If exploratory drilling fails to confirm the presence of hydrocarbons under the necessary conditions to allow a profit to be derived from their extraction, the well is abandoned (see Section 2.4.1 for regulations relating to abandonment in the HSE Petroleum Regulations).

Environmental effects

Although completing the well does not involve additional environmental effects, the well must be monitored throughout its life to ensure well integrity is maintained and that

surface activities on-site have not led to spillages etc.

Mitigation

Once a well is completed or abandoned the associated wellsite must undergo remediation to avoid and/or mitigate any environmental effects.

If a well is abandoned the Council requires through a resource consent condition that the wellsite site be completely re-vegetated and landscaped, returning the site, as best possible, back to its original condition prior to exploratory drilling or a desirable alternative use.

3.2.2 Pipelines

The activity

Pipelines provide the safest most reliable and efficient method of transporting liquid and gas necessary for the exploration and production of hydrocarbons. The Taranaki region contains an extensive network of oil and gas and associated product pipelines.

Pipelines in Taranaki run from various oil and gas field to production stations, the Maui and Kapuni gas treatment plants, the Omata Tank Farm, Port Taranaki, major industrial petrochemical processing plants, power stations in Stratford and McKee and to industrial and domestic consumers throughout the North Island. Figure 7 presents the network of most onshore pipelines in Taranaki.



Figure 7 Taranaki's network of onshore pipelines

The installation of pipelines can be rapid (0.5km a day in rural areas, 100-200m a day in urban areas), although the preparation and construction phase is much longer.

Environmental effects

Environmental effects are typically associated with surface water, groundwater and soil contamination, loss of instream habitat affecting aquatic fauna and flora and the creation of temporary barriers restricting fish migration.

Consideration of environmental effects by the Council is generally limited to situations where pipelines impact upon the bed of a river or stream during installation. However, the potential for leaks to occur must also be considered when regulating their installation and use.

The discharge of contaminants (most likely sediment) to streams resulting from earthworks and the clearing of vegetation in a

prior to discharge. Ring drains should be designed with a gradient to transport runoff directly to treatment facilities without any ponding, reducing the risk of groundwater contamination.

Any produced water collected during refinement should be treated and disposed of by deepwell injection.

4. Factors driving regulatory change

4.1 Experiences over the life of the Plan

The Freshwater Plan has a statutory life span of ten years. It is reasonable to expect that following a ten year period of implementation, monitoring and enforcement, amendments to the Freshwater Plan would be required to give effect to developments in industry practices, altered community values and central government policy and legislation.

The petroleum industry has experienced significant growth in the last ten years. This growth has required the Council to adapt and learn from its experiences, and to maintain a watching brief in respect of regulatory control overseas, to ensure the local industry continues to be appropriately regulated.

This section reviews the Council's experiences in relation to the implementation of Freshwater Plan provisions for the petroleum industry.

4.1.1 Drilling and construction of hydrocarbon exploration wells

Currently the Freshwater Plan regulates the drilling of bores for water abstraction and wells for hydrocarbon exploration under the same rule (Rule 46).²⁴

The draft Plan should 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.

A lack of explicit provision as a permitted activity for the discharge of drilling fluids and the minor taking of fresh/saline water during drilling has required the Council to require approval for activities associated with minor adverse environmental effects during this phase.

Drilling mud is a significant component of any drilling operation. Traditionally oil based fluids were used to avoid the swelling of shales, resist effects associated with increasing downhole temperatures and restrict the growth of bacteria. Synthetic-based fluids were developed out of an increasing desire to reduce the environmental impact of drilling operations that were utilising oil based drilling fluids, without sacrificing the cost-effectiveness and performance of oil-based systems.

Best practice now promotes the use of water based muds while drilling through the upper formations containing useable groundwater. Synthetic based muds can be used to drill through deeper formations where drilling mud can be discharged without any risk to fresh water resources.

The Council and MBIE are reliant on precisely the same components of well integrity as regulators of work place health and safety and environmental effects. With the recent review and adoption of the HSE Petroleum Regulations, of which the Council was involved, a number of useful provisions have been included that the Council could reference within the Freshwater Plan to ensure the Council can be confident integrity is being appropriately established and monitored.

²⁴ This working paper has a focus on activities undertaken by the petroleum industry, however, some general discussion regarding drilling activities is necessary to provide a context for proposed amendments.

4.1.2 Seismic testing

The Freshwater Plan allows for seismic surveys to be undertaken as a permitted activity. This approach is appropriate for the majority of seismic surveys undertaken in Taranaki, however, there do exist circumstances in which the Council may want to have a greater level of discretion over the environmental controls implemented to manage potential effects i.e when the activity is being undertaken in close proximity to surface water bodies, effluent treatment systems, holding ponds, septic tanks or adjacent bores.

4.1.3 Hydraulic fracturing

The use of hydraulic fracturing, both internationally and in New Zealand has been a point of contention, perceived by some to be an important technological development and by others as an activity with an unacceptable risk of environmental degradation.

This perceived risk and the likely increasing use of the technique in the future, prompted the Council to review the issues, risks and the management of those risks in Taranaki.

In addition to the reports already discussed in Section 3, the Council commissioned GNS Science to produce a report²⁵ presenting background information on environmental concerns associated with the practice of hydraulic fracturing and regulatory mechanisms that have been developed to address these concerns in other jurisdictions (primarily North America).

Well stimulation technology dates back to the 1800s. The first use of fluids under pressure for hydraulic fracturing occurred in Kansas in 1947. Hydraulic fracturing has also been used in the Taranaki region over the last 20 years,

²⁵ GNS Science (2012) Hydraulic Fracturing for Oil and Gas Development: Environmental Concerns and Regulation

albeit at a much smaller scale. Whereas there may be over 10,000 hydraulic fracturing treatments a year performed in the US, there have only been a total of about 60 completed in New Zealand to date (an average of 3/year).

The scale of operations in New Zealand compared to the US and differences in regulatory approaches applied, should be considered when evaluating the US experience with regard to potential environmental effects in Taranaki. A number of lessons have been learnt from failures in the US to appropriately regulate and monitor hydraulic fracturing operations.

The Parliamentary Commission for the Environment (PCE) was instructed by the government to carry out their own investigations to determine how the activity should be dealt with in New Zealand.²⁶

The high-level conclusions from the work completed to date by the PCE and the Council is broadly consistent with similar investigations²⁷ undertaken internationally, that the environmental risk associated with hydraulic fracturing can be managed effectively provided operational best practice is implemented and enforced through regulation and monitoring.

Given that hydraulic fracturing has been confirmed as an activity that can be undertaken with an acceptable level of risk to the environment (providing best practice is adopted), the challenge for the Council and the other relevant regulating authorities is to

²⁶ Parliamentary Commissioner for the Environment, 2012, Evaluating the environmental impacts of fracking in New Zealand: An interim report.

²⁷ The Royal Society and The Royal Academy of Engineering, 2012, Shale gas extraction in the UK: a review of hydraulic fracturing.

ensure best practice is adhered to, while avoiding unnecessary or inappropriate environmental effects, and equally avoiding heavy-handed or duplicated regulation.

Hydraulic fracturing constitutes a discharge of contaminants (energy, chemicals, water and proppant) to land, albeit at depth, from an industrial or trade premise as per section 15(1)(d) of the RMA. Consequently, the Council requires industry to obtain a resource consent for hydraulic fracturing operations.

The Freshwater Plan does not explicitly address hydraulic fracturing activities. A catch all rule (Rule 44) has allowed the Council to process applications to discharge contaminants associated with hydraulic fracturing as a discretionary activity under the RMA.

It is considered appropriate to include a dedicated restricted discretionary activity rule in the draft Plan for Hydraulic Fracturing.

4.1.4 Discharge of tracers

The Council has sought and received assurances from the Ministry of Health that the release of naturally occurring radioactive material (NORMs) and radioactive materials (notably tracers) during hydrocarbon exploration and production (as established in Taranaki) is not harmful to human health.

In addition to these assurances, investigations undertaken by the Council²⁸ have confirmed that radioactive tracers used in well operations are not 'radioactive' in terms of statutory definitions, and indeed they contain levels of radioactivity that are orders of magnitude below those at which controls are required.

²⁸ Taranaki Regional Council, 2013, Radioactivity in hydrocarbon exploration (including fracturing activities).

The Ministry of Health has statutory responsibility to manage risks to public health associated with the use of radioactive materials within the petroleum industry. However, managing the environmental effects associated with the discharge of contaminants, including radioactive materials, into the wider environment from an industrial or trade premise is a matter for Council consideration.

4.1.5 Deepwell injection

Deepwell injection is provided for as a discretionary activity under Rule 51 in the Freshwater Plan. Over the life of the Freshwater Plan the Council has not found any evidence of adverse effects resulting from deepwell injection operations.

The Council commissioned GNS Science to complete a report²⁹ to independently review the way in which deepwell injection is regulated overseas and in Taranaki to ensure best practice was being applied.

The working paper provides a summary of deepwell injection provisions required by the United States Environment Protection Authority (USEPA) and details Canadian regulatory schemes that have been adopted in Alberta and British Columbia.

A brief assessment of the USEPA regulatory programme notes a number of cases in which underground sources of drinking water have become contaminated due to failings in well integrity and negligence in planning for deepwell injection operations, i.e. locating nearby abandoned wells so these do not become a potential pathway for contaminants. This is not an issue for Taranaki.

²⁹ *Review of regulation of deepwell injection under the Resource Management Act.*

Although the working paper demonstrates the significant improvements that have been made to the way in which deepwell injection is regulated, the importance of maintaining well integrity and the on-going monitoring of the wellsite and surrounding area is stressed. The working paper identifies a number of slight improvements that could be made to the Council's regulatory regime. These improvements relate to the application of additional consent conditions.

4.1.6 Water flooding

Water flooding is provided for alongside deepwell injection as a discretionary activity under Rule 51 in the Freshwater Plan. Despite the activities being undertaken for different purposes (water flooding for well stimulation, deepwell injection for disposal), both involve the discharge of contaminants under similar pressures with a similar risk to the environment. It is considered appropriate to continue to regulate water flooding and deepwell injection under the same rule.

4.1.7 Gas injection

Currently the Council relies on the HSE Petroleum Regulations to confirm the integrity of wells for gas injection operations. Over the life of the Freshwater Plan the Council has not found any evidence suggesting that gas injection is having an adverse effect on the environment.

It is considered appropriate to include a permitted activity rule for the gas injection with conditions to manage potential environmental effects.

4.1.8 Pipelines

Pipelines are used to transport water and hydrocarbons around Taranaki. Permitted activity rules in the Freshwater Plan allow for activities associated with the installation, maintenance and use of pipelines to be undertaken without consent, provided that

associated standards terms and conditions that address environmental effects are met.

The potential adverse environmental effects associated with the transportation of hydrocarbons differ from those pipelines transporting other substances i.e. water. Despite this variation in effects, the Freshwater Plan regulates the installation and use of pipelines under the same rules (Rule 61 and 52) pipelines regardless of what they are transporting.

It is considered appropriate to recognise the likely on-going development of pipelines in Taranaki and include provision for the varying scale of effects associated with their on-going use.

4.1.9 Discharge of contaminants surface water

The Freshwater Plan includes a controlled activity rule (Rule 41) that provides for the discharge of surplus drilling water and production water associated with hydrocarbon exploration to water.

Since the Freshwater Plan was adopted in 2001 no consents have been issued under Rule 41. Proposed discharges of surplus drilling water and production water fail to meet the standards, terms and conditions associated with Rule 41. In its current form this rule provides very little value in managing the environmental effects of petroleum operations.

Experience managing and monitoring discharges associated with hydrocarbon exploration shows that surplus drilling water and stormwater³⁰ are generally combined and treated together in skimmer pits prior to discharge. This mixing of drilling surplus water and stormwater associated with hydrocarbon

³⁰ Rule 24 provides for the discharge of stormwater into or onto land and into water.

exploration requires the eventual combined discharge to be processed as a discretionary activity under Rule 43 or 44.

4.1.10 Land farming and mix-bury-cover

Over the life of the Freshwater Plan, landfarming has become the primary method of disposing drilling and other waste associated with petroleum operations.

Recently land farming has generated considerable public debate due to the perceived risk associated with grazing dairy cows on land that has previously been used to dispose hydrocarbon exploration waste. While the potential for adverse environmental effects does exist, it is the Council's experience and the advice of experts that, providing best practice is implemented, land farming is a safe and efficient method of disposing waste associated with the oil and gas industry.

Discussed in Section 3.1.9 were investigations commissioned by the Council to review the Council's approach to managing environmental effects associated with landfarms. In addition to these investigations, the Council reviews its regulatory practices, including resource consent conditions, used to manage environmental effects associated with land farms.

The majority of waste disposed of at landfarms is comprised of water and synthetic based drilling muds and rock cuttings. The landfarming of drilling muds, solids, and sludges is considered environmentally viable. The disposal of hydraulic fracturing return fluids, produced water and other liquid wastes is best suited to deepwell injection.

Council monitoring and investigations have not found any evidence of adverse effects associated with mix-bury-cover, and recognises that in some circumstances it may

be acceptable to dispose of waste by mix-bury-cover. Mix-bury-cover still remains recognised overseas as good practice.

Rule 42 in the Freshwater Plan provides for land farming and mix-bury-cover to be undertaken as a controlled activity providing the relevant standards, terms and conditions are met. However, applications to dispose of waste under this rule generally fail to meet the relevant conditions and are processed as discretionary activities under Rule 43.

As part of the on-going assessment of regulatory practices the Council has reviewed the resource consent conditions used to manage environmental effects associated with land farms.

It is considered appropriate to amend Rule 42 to limit waste disposed of at landfarms to drilling muds as a controlled activity. Associated conditions managing potential environmental effects under Rule 42 require amendment to reflect best practice. Definitions for landfarming, water based muds and synthetic based muds are proposed for inclusion to provide certainty and clarity when interpreting the Plan.

A key consideration in formulating an effective regulatory regime for the disposal of waste associated with hydrocarbon exploration is to maintain records about the type of waste and how it has been disposed of. Such waste tracking allows all wastes to be accounted for and provides a high level of public assurance.

Iwi have expressed cultural concerns about waste coming into the region from other regions. The practice of moving wastes across rohe boundaries is not new and is a common modern practice so little can be done to address this concern.

5. Future directions for the management of oil and gas operations - informing the drafting of Freshwater Plan provisions

The review of the Freshwater Plan provides an opportunity to integrate knowledge acquired throughout the Freshwater Plan's implementation.

This section outlines areas in which the Freshwater Plan could be amended to better manage environmental effects associated with the petroleum industry.

Included in Appendix II are proposed draft rules for inclusion into the draft Plan. Proposed amendments aim to reflect developments that have been made in industry best practice.

5.1 Definitions

It is recommended that the draft Plan defines; bore, well, hydraulic fracturing, deepwell injection, landfarming, water based muds, synthetic based muds, gas injection, water flooding, produced water and the freshwater/saltwater interface. Proposed definitions are outlined below.

Bore means a hole drilled for the purpose of exploring for, appraising or extracting water.

Well means a hole drilled for the purpose of exploring for, appraising or extracting hydrocarbons and includes;
(i) any hole for injection or reinjection purposes; and
(ii) any down-hole pressure containing equipment; and
(iii) any pressure-containing equipment on top of the well.

Hydraulic fracturing is a well stimulation technique used to increase the flow of hydrocarbon fluids to the surface by pumping fluids from the surface at pressures sufficient to fracture the reservoir rock, propping open that fracture by emplacement of permeable

material and then flowing back to the surface the produced fluids.

Water flooding is a well stimulation technique used to increase the flow of hydrocarbon fluids to the surface by pumping water into the reservoir formation to displace residual hydrocarbon fluids

Saltwater/ freshwater interface is located at the point at which groundwater transitions from below 1,000 mg/l TDS to above 1,000 mg/l TDS.

Deepwell injection involves injecting liquid waste down a well into an underground formation for its permanent disposal.

Land farming involves spreading waste on land to allow for waste constituents to be naturally broken down through bioremediation.

Water based muds is a form of drilling mud where the base fluid is comprised of fresh or saline water, to which further compounds are added to achieve required performance during the drilling process.

Synthetic based muds is a form of drilling mud where the base fluid is comprised of synthesized mineral oils, to which further compounds are added to achieve required performance during the drilling process.

Gas injection is the process by which gas and condensates are injected into a producing hydrocarbon reservoir, raising formation pressure to stimulate its production.

Produced water is water brought to surface from below the freshwater -saltwater interface during hydrocarbon exploration and production operations.

5.2 Drilling wells

The HSE Petroleum Regulations use 'well' to describe a hole drilled with the intention of accessing hydrocarbons. The definition of a well should apply to holes drilled to appraise or extract hydrocarbons. The definition of a bore should be amended to include all holes drilled to appraise or extract water. When referring to drilling that does not intercept the water table, the result of drilling would be considered a hole.

Some amendments are proposed to the framework of definitions and rules through which well and bore drilling is regulated in the draft Plan.

Currently drilling a well or bore is a permitted activity under Rule 46 providing the relevant standards, terms and conditions can be met.

The drilling and/or construction of a well to appraise or extract hydrocarbons should remain a permitted activity with standards, terms and conditions to ensure environmental effects are less than minor. Conditions should be included to require the use of water based muds when drilling above the fresh water/salt water interface.

Proposed drilling that does not meet the relevant standards, terms and conditions would require consent as a discretionary activity, providing the Council with full discretion to evaluate environmental effects in more detail.

The drilling and/or construction of a bore to access or explore for water should be regulated as a separate controlled activity.

5.3 Seismic testing

It is proposed that a seismic testing remains a permitted activity providing the environmental effects associated with the activity are both minor and temporary. Permitted activity conditions should be used

to control the drilling, detonation and abandonment of seismic shot holes.

Where permitted activity conditions are not met, resource consent would be required as a discretionary activity.

5.4 Taking of groundwater during drilling

As noted in section 4.1.1, a lack of provision in the Freshwater Plan for the taking of produced water means the Council has required consents for this activity, despite the associated environment effects being less than minor.

It is proposed that the taking of produced water during hydrocarbon exploration and production is provided for in its own permitted activity rule with relevant conditions to ensure adverse environmental effects are less than minor.

5.5 Hydraulic fracturing

It is considered appropriate to introduce a restricted discretionary activity rule to specifically address hydraulic fracturing and allow the Council to require best practice measures be undertaken to avoid adverse environmental effects.

5.6 Gas injection

It is considered appropriate to introduce a permitted activity rule for the injection of gas and condensates into subsurface reservoirs to stimulate hydrocarbon production. Permitted activity conditions will control the depth and pressure at which gas is injected.

5.7 Discharge of stormwater and drilling surplus water

Currently Rule 41 provides for the discharge of drilling surplus water and produced water to water as a controlled activity. Failure to meet the standards, terms and conditions associated with Rule 41 requires resource

consent as a discretionary activity under Rule 43.

Industry best practice promotes deepwell injection as the most appropriate method of disposing produced water and fracturing fluids.

Given stormwater and drilling surplus water are commonly mixed prior to their discharge to water, it is considered appropriate to regulate the combined discharge under a single rule.

It is proposed that Rule 41 be amended to exclude the discharge of produced water to surface water and provide for the combined discharge of stormwater and drilling surplus water to land as a controlled activity, with appropriate standards, terms and conditions to limit adverse environmental effects. The discharge of stormwater and drilling surplus water to water would be processed under a discretionary activity rule.

5.8 Landfarming and mix-bury-cover

As noted in Section 4.1.6 the disposal of drilling muds by landfarming and mix-bury-cover is environmentally viable. It is proposed that Rule 42 is amended to provide for the discharge of drilling muds to land, while excluding other wastes associated with hydrocarbon exploration that are more appropriately disposed of by deepwell injection.

If proposed landfarming activities do not meet the standards, terms and conditions associated with the controlled activity rule, resource consent would be required under a 'catch all' discretionary activity rule.

It is recommended that as a component of future well completion logs, operators are required to record and provide information

regarding the volume, contents and disposal site of waste produced.

5.9 Deepwell injection and water flooding

It is proposed that deepwell injection and water flooding continue to be regulated under the same rule, however be reclassified as a restricted discretionary activity. Definitions are proposed for both activities.

5.10 Pipelines

Amendments to the Freshwater Plan are proposed to recognise the varying effects associated with the transportation of different substances in pipelines e.g. hydrocarbons compared to water.

The use of pipelines should remain a permitted activity, with conditions to control the contents of the pipeline and the scale of acceptable disturbance.³¹ Failure to meet these conditions, which would include requiring a contingency plan where the pipeline is being used to transport contaminants, would require resource consent as a discretionary activity.

³¹ The Council's functions in regulating the installation, use and maintenance of pipelines are generally limited to where they intersect a river or stream bed.

6. Summary and conclusion

Since the Freshwater Plan became operative the oil and gas industry has undergone significant growth in Taranaki. This working paper has reviewed the environmental effects associated with methods used to explore for, access, extract, transport and process hydrocarbons and recommended amendments to reflect developments in best practice and technology applied within the petroleum industry.

Concerns have been raised in regard to the impacts of oil and gas operations on the environment, particularly in relation to the increased application of hydraulic fracturing to stimulate reservoirs.

Based on investigations carried out by international, national and local organisations, this working paper largely confirms the appropriateness of the current regulatory framework for the oil and gas industry in Taranaki.

However, changes to the Freshwater Plan are warranted to take into account developments in the industry over the life of the Freshwater Plan and account for the Council's experiences in regulating the environmental effects associated with oil and gas operations in Taranaki.

Proposed amendments to the Freshwater Plan include:

- Amending the definition of a well and bore and include definitions of hydraulic fracturing, deepwell injection, land farming, water based muds, synthetic based muds, gas injection, produced water, water flooding and the freshwater/saltwater interface.
- Including dedicated permitted activity rules for undertaking a seismic survey, gas

injection and the taking of saline produced water

- Where a well structure is established, compliance with the well integrity provisions of the HSE Petroleum Regulations must be established and proof provided upon request from the Council.
- Requiring a contingency plan for the use of pipelines carrying hydrocarbons under, on or over the bed of a river or stream
- A new dedicated restricted discretionary activity rule for hydraulic fracturing
- Amending the standards, terms and conditions of rules 41 and 42 (addressing the discharge of surplus drilling water and produced water and discharges associated with landfarming) to better reflect industry best practice.

Activities that do not meet the standards/terms/conditions of a specific rule will be addressed by a catch all rule, and these have not been provided in this working paper.

These changes are minor. It has not been necessary to make major changes based on the results of comprehensive compliance and state of the environment monitoring that have been publically reported to the community. The changes also look to avoid duplication, particularly on the regulation of well integrity.

It is recommended that the draft working paper be used for targeted consultation with key industry stakeholders, relevant regulatory authorities, including district councils and MOBIE, and members of the Freshwater Plan focus group. Stakeholder feedback will be considered and will contribute to the compilation of the draft Plan.

Appendix I: Existing rules in the Freshwater Plan for the Hydrocarbon industry

Discharges from hydrocarbon exploration

Activity	Rule	Standards/Terms/Conditions	Classification	Notification	Control/Discretion	Policy Reference
Discharge of surplus drill water and production water from hydrocarbon exploration activities to surface water (excluding the wetlands listed in Appendix II)	41	<ul style="list-style-type: none"> • The discharger must at all times adopt the best practicable option to prevent or minimise any adverse effects of the discharge or discharges to any surface water body. • The discharge shall have a pH range of 6.5-8.5; • The discharge shall contain less than 15 gm-3 of oil and grease; • The discharge shall contain less than 100 gm-3 suspended solids; • The discharge shall not cause the temperature of the receiving water to increase by more than 2 oC or the level of biochemical oxygen demand to increase by more than 2.00 gm-3 after reasonable mixing; • The discharge shall not give rise to any or all of the following effects in the receiving water after reasonable mixing: <ul style="list-style-type: none"> (a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; (b) any conspicuous change in the colour or visual clarity; (c) any emission of objectionable odour; (d) the rendering of Freshwater unsuitable for consumption by farm animals; (e) any significant adverse effects on aquatic life; • The applicant must provide with an application, a contingency plan for avoiding, remedying or mitigating unauthorised discharges. 	Controlled	May be non-notified without written approval	<ul style="list-style-type: none"> • Definition and delineation of mixing zone; • Approval of contingency plan and all matters contained therein; • Setting of conditions relating to adverse effects on aquatic life and the environment; • Monitoring and information requirements; • Duration of consent; • Review of conditions of consent and the timing and purpose of the review; • Payment of administrative charges and financial contributions. 	3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.2.1, 3.2.2, 3.2.3, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 5.1.1, 5A.1.1, 5A.1.2, 5A.1.3, 6.2.1, 6.2.2, 6.2.3, 6.2.4, 6.2.7

Discharges from hydrocarbon exploration (continued)

Activity	Rule	Standards/Terms/Conditions	Classification	Notification	Control/Discretion	Policy Reference
Discharge of drilling muds, drilling cuttings and drilling wastes onto or into land from hydrocarbon exploration	42	<ul style="list-style-type: none"> • The discharge shall not result or be liable to result in any contaminant entering surface water; • The discharger must at all times adopt the best practicable option to prevent or minimise any adverse effects of the discharge or discharges to any water body or soil; • The discharge shall contain less than 15 mg/kg oil and grease; • There shall be no adverse chemical effects on groundwater beyond the site. 	Controlled	May be non-notified without written approval	<ul style="list-style-type: none"> • Approval of contingency plan and matters contained therein; • Setting of conditions relating to adverse effects on soil, groundwater and the environment, site closure and rehabilitation; • Monitoring and information requirements; • Duration of consent; • Review of conditions of consent and the timing and purpose of the review; • Payment of administrative charges and financial contributions. 	3.2.1, 3.2.2, 3.2.3, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 5.1.1, 5A.1.1, 5A.1.2, 5A.1.3, 6.2.1, 6.2.2, 6.2.3, 6.2.4, 6.2.7

Deepwell injection

Activity	Rule	Standards/Terms/Conditions	Classification	Notification	Control/Discretion	Policy Reference
The discharge of contaminants to groundwater by deepwell injection or water flooding	51		Discretionary	May be non-notified		4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 5.1.1, 5A.1.1, 5A.1.2, 5A.1.3, 6.5.3, 6.5.4

Appendix II: Proposed rules in the Freshwater Plan for the Hydrocarbon industry

Rule	Activity	Classification	Conditions/standards/terms	Discretion/notification	Policy reference
1.	<p>Seismic surveys</p> <p>The use of land to drill a hole to undertake a seismic survey and any associated subsurface discharge of water or contaminants into water or onto land.</p>	Permitted	<ul style="list-style-type: none"> a) Holes must be abandoned³² on the same day that drilling occurs. b) Holes must be managed and abandoned to prevent aquifer cross contamination or leakage to or from the ground surface. c) Holes must be no more than 50m deep. d) All drilled holes must comply with the following separation distances: <ul style="list-style-type: none"> (i) 25 m from surface water bodies (ii) 50 m from any effluent treatment system, holding pond or septic tank (iii) 100 m from adjacent bores. e) Any drilling muds used must be water based. f) Products, including cement and bentonite, necessary to drill, construct and/or abandon the hole must not be a hazardous substance³³. g) Drilling cuttings deposited on land must be removed prior to abandonment. h) The Taranaki Regional Council must be informed that the activity is to occur at least 15 working days prior to the commencement of works i) Any person who undertakes the activity must within 30 working days of the completion of the activity submit to the Council information detailing: <ul style="list-style-type: none"> (iv) Total area of the survey (v) The location and depth of shot holes (vi) Depth that groundwater was encountered (vii) Abandonment method applied. 		
2.	<p>Hydrocarbon well drilling</p> <p>The use of land to drill a well, and any associated minor subsurface discharges of water or contaminants into water or onto land and any minor takes of water or geothermal energy incidental</p>	Permitted	<ul style="list-style-type: none"> a) Water-based drilling muds must be used when drilling above the freshwater - saltwater interface b) Products, including cement and bentonite, necessary to drill and construct the well may be used providing they are not a hazardous substance³⁴. c) All drilled wells must comply with the following separation distances: <ul style="list-style-type: none"> (i) 500m from adjacent bores (ii) 25m from surface water bodies. d) The Taranaki Regional Council must be informed that the activity is to occur at least 15 working days prior to the commencement of works. e) Any person who undertakes the activity must, within 30 working days of 		

³² Abandonment for the purpose of this rule is defined as the use of washed gravel, bentonite and/or cement grout as necessary to prevent any discharge down the hole or to surface.

³³ Hazardous substances are defined according to the Hazardous Substances and New Organisms Act 1996.

³⁴ Hazardous substances are defined according to the Hazardous Substances and New Organisms Act 1996.

Rule	Activity	Classification	Conditions/standards/terms	Discretion/notification	Policy reference
	to the activity.		completing the activity, submit to the Taranaki Regional Council a well completion diagram and a geological log of the well.		
3.	<p>Hydrocarbon well construction and use</p> <p>The use of land for hydrocarbon well construction and use to ensure appropriate standards of well integrity are achieved</p>	Permitted	<p>a) Any person who undertakes the activity must comply with the Well Operations (Part 6) provisions of the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013 to ensure there are no unplanned discharges of contaminates from the well.</p> <p>b) Any person who undertakes the activity must, provide upon request from the Taranaki Regional Council, proof of compliance with condition (a)</p> <p>c) Any person who undertakes the activity must notify the Taranaki Regional Council, as soon as practicable, in the event of an unplanned discharge from the well.</p>		
4.	<p>Taking produced water</p> <p>Taking and use of saline water obtained during hydrocarbon production which is incidental to the activity</p>	Permitted			
5.	<p>Deepwell injection</p> <p>The subsurface discharge of contaminants to land and saline water by deepwell injection or water flooding</p>	Restricted Discretionary		<p>Control is reserved over:</p> <p>a) Location, depth, timing and rate of discharge</p> <p>b) Discharge location relative to any potable water, other relevant features such as other hydrocarbon wells, water bores, and geological features, including faults</p> <p>c) Volume of discharge</p> <p>d) Details of the hydrogeological integrity of receiving formation</p> <p>e) Injection pressure</p> <p>f) Composition of material discharged</p> <p>g) Source of material discharged</p> <p>h) Effects on water quality and land</p> <p>i) Monitoring of the discharge activity</p> <p>j) Monitoring of water quality and land</p> <p>k) Monitoring of compliance with consent conditions</p> <p>l) Notification to the Council about matters over which it has</p>	

Rule	Activity	Classification	Conditions/standards/terms	Discretion/notification	Policy reference
				<p>retained discretion</p> <p>m) Provision of information relating to matters over which discretion is restricted</p> <p>n) Duration of consent</p> <p>o) Review of the conditions of consent and the timing and purpose of the review</p> <p>p) Payment of administrative charges and financial contributions.</p>	
6.	<p>Hydraulic fracturing and water flooding</p> <p>The subsurface discharge of contaminants to land and saline water associated with hydraulic fracturing</p>	Restricted Discretionary		<p>Control is reserved over:</p> <p>a) Location, depth, timing and rate of discharge</p> <p>b) Discharge location relative to any potable water, other relevant features such as other hydrocarbon wells, water bores, and geological features, including faults</p> <p>c) Volume of discharge and return fluids</p> <p>d) Details of the hydrogeological integrity of the receiving formation</p> <p>e) Discharge pressure</p> <p>f) Composition of material discharged</p> <p>g) Effects on water quality and land</p> <p>h) Monitoring of the discharge activity</p> <p>i) Monitoring of water quality and land</p> <p>j) Monitoring of compliance with consent conditions</p> <p>k) Notification to the Council about matters over which it has retained discretion</p> <p>l) Provision of information relating to matters over which discretion is restricted</p> <p>m) Duration of consent</p> <p>n) Review of the conditions of consent and the timing and purpose of the review</p> <p>o) Payment of administrative charges and financial contributions.</p>	
7.	<p>Gas injection</p> <p>The subsurface discharge of contaminants into land and into saline water associated with gas storage or</p>	Permitted	<p>a) The discharge must not result in the target reservoir formation exceeding the pressure of the reservoir prior to hydrocarbon production activities commencing.</p> <p>b) Any person who undertakes the activity must, provide upon request from the Taranaki Regional Council, proof of compliance with</p>		

Rule	Activity	Classification	Conditions/standards/terms	Discretion/notification	Policy reference
	hydrocarbon recovery activities.		condition (a)		
8.	<p>Discharge of stormwater and surplus drilling water to land</p> <p>Discharge of stormwater and surplus drilling water from hydrocarbon exploration and production onto and into land in circumstances where contaminants from the discharge may enter water .</p>	Controlled	<p>a) The discharge must not contain more than 50 gm-3 chloride</p> <p>b) No liquid recovered from or returned from a well shall be directed to the discharge or its collection and treatment system.</p> <p>c) The discharge must not directly enter or directly flow to any surface water body.</p> <p>d) The discharge must contain less than 15 gm-3 of total petroleum hydrocarbons.</p> <p>e) The discharge must contain less than 100 gm-3 suspended solids;</p> <p>f) The pH of the discharge shall have a pH range of 6.0-9.0.</p> <p>g) The discharge must not:</p> <p>(i) give rise significant adverse effects on any values listed in Schedules 2A and D for that water body</p> <p>(ii) cause or result in the receiving water exceeding the water quality limits for the Water Management Zone as listed in Schedule 3.</p> <p>h) The applicant must provide with an application, a contingency plan for avoiding, remedying or mitigating unauthorised discharges.</p>	Control is reserved over:	
9.	<p>Discharge of stormwater and surplus drilling water to land or water</p> <p>Discharge of stormwater and surplus drilling water to water from hydrocarbon exploration and production onto and into land or into water.</p>	Discretionary			
10.	<p>Landfarming</p> <p>The discharge of drilling muds and cuttings onto or into land associated with landfarming and mix-bury-cover</p>	Controlled	<p>a) There must be no adverse chemical effects on groundwater beyond the site.</p> <p>b) The discharge must not result or be liable to result in the direct discharge of contaminants to surface water.</p> <p>c) The discharge must contain less than 15 gm-3 of total petroleum hydrocarbons.</p>		

Appendix III: Part 6 Well Operations of the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013

63 Application

- This Part applies to all well operations.

General duties

64 Well operator's primary duty

- A well operator must ensure that a well is designed, constructed, commissioned, equipped, operated, maintained, modified, suspended, and abandoned so that—
 - (a) so far as is reasonably practicable, there can be no unplanned escape of fluids from the well; and
 - (b) risks to the health and safety of persons from the well or anything in it, or from strata to which the well is connected, are as low as is reasonably practicable.

65 Duty holder must ensure persons have adequate knowledge, skills, support, etc

- (1) A duty holder must ensure that every person who is, or is to be, engaged in any capacity in a well operation has the necessary knowledge, skills, experience, and ability to carry out his or her responsibilities and perform his or her job safely and effectively.
- (2) A duty holder must ensure that a well operation is carried out only in circumstances where the petroleum workers carrying out the operation have received sufficient information, instruction, and training and are sufficiently supervised such that the risks to the health and safety of persons from that operation are as low as is reasonably practicable.

Assessment of conditions below ground

66 Well operator must assess conditions below ground before well is designed

- (1) Before the design of a well is commenced, a well operator must assess—
 - (a) the geological strata and formations through which the well may pass; and
 - (b) fluid within those strata and formations; and
 - (c) any hazards that those strata and formations may present.
- (2) The well operator must ensure that the findings from the assessment are taken into account when the well is designed and constructed, in order to comply with regulation 64.

67 Well operator must continue to assess conditions below ground

- (1) While well operations are being carried out, a well operator must continue to assess—
 - (a) the geological strata and formations through which the well may pass; and
 - (b) fluid within those strata and formations; and
 - (c) any hazards that those strata and formations may present.
- (2) If any change to any matter described in subclause (1)(a) to (c) is observed, the well operator must, if necessary, ensure that the following are modified in order to comply with regulation 64:
 - (a) the design and construction of the well:
 - (b) any procedures.

Duties in relation to design and construction

68 Well operator must ensure well designed to allow safe suspension or abandonment

- A well operator must ensure that a well is designed and constructed so that, as far as is reasonably practicable,—
 - (a) the well can be suspended or abandoned in a safe manner; and
 - (b) after its suspension or abandonment, there can be no unplanned escape of fluids from the well or from the reservoir to which it led.

69 Well operator must ensure use of appropriate materials

- A well operator must take all practicable steps to ensure that every part of a well is composed of suitable material, in order to comply with regulation 64.

Well control equipment

70 Well operator to ensure use of suitable well control equipment

- (1) Before any well operation is carried out, the well operator must ensure that suitable well control equipment and associated control systems are provided to protect against the uncontrolled release of petroleum.
- (2) When any well operation is carried out, the duty holder for the installation must take all practicable steps to ensure that suitable well control equipment and associated control systems are deployed when the well and operational conditions so require.

Well examination schemes

71 Well operator must prepare and implement well examination scheme

- (1) Before the design of a well is commenced or adopted, the well operator must prepare and implement a well examination scheme for the well.
- (2) If the well operator has already prepared and implemented a well examination scheme for another well, the well operator may, instead of developing a new well examination scheme, modify the existing scheme to incorporate the new well.
- (3) The well operator must review and revise the well examination scheme as often as is appropriate.
- (4) In this regulation, **well examination scheme** means arrangements for examinations of the well that are—
 - (a) recorded in writing; and
 - (b) suitable for ensuring (together with the assistance of any other measures the well operator may take) that the well is designed, constructed, operated, maintained, modified, suspended, and abandoned so that,—
 - (i) so far as is reasonably practicable, there can be no unplanned escape of fluids from the well; and
 - (ii) risks to the health and safety of persons from the well or anything in it, or from strata to which the well is connected, are as low as is reasonably practicable; and
 - (c) conducted by an independent and competent person.
- (5) The well operator of a well that was completed before the commencement of these regulations must—
 - (a) prepare and implement a well examination scheme for the well by 30 June 2014; or
 - (b) if the well operator has already prepared and implemented a well examination scheme for another well, modify the existing scheme to incorporate the well in accordance with subclause (4)(a) to (c) by 30 June 2014.
- (6) If before the commencement of these regulations, the design of a well has commenced or been adopted but the well has not been completed, the well operator must as soon as practicable, and no later than 30 June 2014,—
 - (a) prepare and implement a well examination scheme for the well; or
 - (b) if the well operator has already prepared and implemented a well examination scheme for another well, modify the existing scheme to incorporate the well in accordance with subclause (4)(a) to (c).
- (7) To avoid doubt, this regulation does not apply to a well that has been abandoned.

72 Well operator must retain records of well examination scheme

- A well operator must make and retain records of the following matters, and store them at an address notified to the Secretary, until the date that is 12 months after the well examination scheme, including any revision, has ceased to be current:

- (a) the well examination scheme:
- (b) any revision of the well examination scheme:
- (c) any examination and testing carried out:
- (d) the findings of any examination and testing carried out:
- (e) any remedial action recommended:
- (f) any remedial action performed.

Notice of well operations

73 Well operator must notify Secretary before well-drilling operations

- (1) This regulation applies to the following well operations only:
 - (a) drilling, completion, suspension, and abandonment of a well; and
 - (b) recommencement of drilling after a well has been completed, suspended, or abandoned.
- (2) A well operator must not commence well operations to which this regulation applies unless the well operator has given the Secretary notice of well operations.
- (3) A notice of well operations—
 - (a) must contain the information required in Schedule 7; and
 - (b) must be given to the Secretary at least 21 days (or any shorter period specified by the Secretary) before commencement of the well operation.
- (4) If there is a material change to any of the information provided in a notice of well operations before completion of the relevant well operation, the well operator must notify the Secretary, in writing, of that change as soon as practicable.

74 Well operator must notify Secretary of certain workover and well intervention operations

- (1) This regulation applies to a workover or well intervention operation that involves—
 - (a) an alteration to the construction of a well; or
 - (b) the insertion of a hollow pipe into a well.
- (2) A well operator must not commence the well operation unless the operator has given the Secretary a notice of well operations.
- (3) A notice of well operations under this regulation—
 - (a) must contain the information required in Schedule 7; and
 - (b) must be given to the Secretary at least 10 days (or any shorter period specified by the Secretary) before commencement of the well operation.

75 Secretary may grant exemptions from notice requirement

- (1) The Secretary may, in writing, exempt a well operator from the notice requirements of either or both of regulations 73 and 74.

- (2) The Secretary may grant an exemption under subclause (1) only if the Secretary is satisfied that the well operation will not—
 - (a) create any significant new risks to the health and safety of persons on or near the installation; or
 - (b) significantly increase existing risks to the health and safety of persons on or near the installation.
- (3) An exemption granted under subclause (1) may be—
 - (a) subject to conditions:
 - (b) for a time specified by the Secretary:
 - (c) revoked by the Secretary by notice in writing at any time.

76 Well operator must make and retain daily well operation reports

- (1) A well operator must make and retain daily reports of any well operation described in subclause (3) and store them at an address notified to the Secretary, until 12 months after the abandonment of the well.
- (2) Copies of daily reports must be made available to an inspector on request.
- (3) The well operations referred to in subclause (1) include the following:
 - (a) a well-drilling operation:
 - (b) a well-completion operation:
 - (c) a workover operation:
 - (d) a suspension or abandonment operation:
 - (e) any other operation involving substantial risk of the unplanned escape of fluids from the well