BTW Company Limited
Oeo Landfarm
Monitoring Programme
Annual Report
2013-2014

Technical Report 2014-39

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Executive summary

BTW Company Limited (BTW) operates a drilling waste disposal site located on South Road at Manaia. The site was primarily operational during the previous monitoring period, when synthetic and water-based muds and rock cuttings were disposed of to land via the process of landfarming. Activity at the site ceased at the beginning of the 2013-2014 monitoring period, as available spreading area capacity was reached in the main area of the site, and the decision was made not to farm the smaller area east of the Rawa Stream. This report for the period July 2013 – June 2014 describes the monitoring programme implemented by the Taranaki Regional Council to assess the Company's environmental performance during the period under review, and the results and environmental effects of the Company's activities.

The Company holds one resource consent, which includes a total of 23 conditions setting out the requirements that the Company must satisfy.

The Council's monitoring programme for the year under review included six inspections, six surface water samples, 16 groundwater samples and six soil samples collected for physicochemical analysis, in addition to a review of monitoring data received from the Company.

The monitoring showed there were no adverse environmental effects caused by the operation of the site during the monitoring period. Soil sampling indicated levels of contaminants in the receiving soils were rapidly degrading towards background concentrations and were generally already within consent surrender criteria. Surface water in the Rawa Stream was unaffected by site operations, however, there remains trace levels of hydrocarbons in one of the monitoring bores, and salinity is still elevated (but reducing) in the same bore. By comparison with the previous year, the monitoring indicated an improvement in site management and administration. There were no Unauthorised Incident/s (UI/s) recording non-compliance in respect of this consent holder during the period under review. There was an additional investigation conducted at the site to confirm that there was no significant environmental or health risk from naturally occurring radioactivity relating to wastes disposed of at the site. This investigation indicated environmental/health effects were negligible, as concentrations of radioactivity were less than encountered in 'normal' (background) environmental conditions elsewhere.

During the year, the Company demonstrated a good level of environmental performance and compliance with the resource consents. Site management and data supply and reporting were all to a high standard, but there were some ongoing (but reducing) minor environmental effects including difficulties with establishing pasture in isolated areas, which the Company are working well to address.

This report includes recommendations for the 2014-2015 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is the annual report for the period July 2013 - June 2014 by the Taranaki Regional Council (the Council) describing the monitoring programme associated with resource consents held by BTW Company Limited (BTW). BTW operates a drilling waste landfarm situated on South Road at Manaia (Oeo Landfarm).

The Oeo landfarm site became operational in the previous (2012-2013) monitoring year. During that period, there were eight disposals of approximately 4,278 m^3 of water/synthetic based cuttings and fluids over an area of approximately 61,047 m^2. No hydraulic fracturing wastes have been disposed of at this site. During the current monitoring period operations at the site have ceased, with the remaining available spreading area having been utilised and the decision made to not use the smaller area to the east of the Rawa Stream. The Company and the Council will continue to monitor this site until surrender criteria is met and the resource consent can be surrendered or allowed to expire.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by BTW Company Limited, to discharge drilling waste onto and into land via landfarming. This is the second Annual Report to be prepared by the Council to cover the Company's discharges and their effects at this site.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by BTW, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in the Company's Oeo Landfarm site.

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

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

Section 4 presents recommendations to be implemented in the 2014-2015 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

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

(a) the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (eg, recreational, cultural, or aesthetic);
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder/s during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- A **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential non-compliance with conditions.

- A **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or minor at most, or, the Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and any inconsequential non compliances with conditions were resolved positively, co-operatively, and quickly.

- **Improvement required (environmental)** or **improvement required (administrative compliance)** (as appropriate) indicates that the Council may have been obliged to record a verified unauthorised incident involving measurable environmental impacts, and/or, there were measurable environmental effects

arising from activities and intervention by Council staff was required and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.

- **Poor performance (environmental)** or **poor performance (administrative compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or an infringement notice.

For reference, in the 2013-2014 year, 60% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process descriptions

1.2.1 Drilling waste

Waste drilling material is produced during well drilling for hydrocarbon exploration. The primary components of this waste are drilling fluids (muds) and rock cuttings. Drilling fluids are engineered to perform several crucial tasks in the drilling of a hydrocarbon well. These include: transporting cuttings from the drill bit to the well surface for disposal; controlling hydrostatic pressure in the well; supporting the sides of the hole and preventing the ingress of formation fluids; and lubricating and cooling the drill bit and drill pipe in the hole.

Drilling fluids

Oil and gas wells may be drilled with either synthetic based mud (SBM) or water based mud (WBM). As the names suggest, these are fluids with either water (fresh or saline) or synthetic oil as a base material, to which further compounds are added to modify the physical characteristics of the mud (for example mud weight or viscosity). More than one type of fluid may be used to drill an individual well. In the past, oil based muds (diesel/crude oil based) have also been used. Their use has declined since the 1980s due to their ecotoxicity; they have been replaced by SBM. SBM use olefins, paraffins or esters as a base material. While this is technically still a form of oil based fluid, these fluids have been engineered to remove polycyclic aromatic hydrocarbons, reduce the potential for bioaccumulation, and accelerate biodegradation compared with OBM.

Common constituents of WBM and SBM include weighting agents, viscosifiers, thinners, lost circulation materials (LCM), pH control additives, dispersants, corrosion inhibitors, bactericides, filtrate reducers, flocculants and lubricants. Of these, the naturally occurring clay mineral barite (barium sulphate) is generally the most common additive. It is added to most drilling muds as a wetting and weighting agent.

Drilling fluids may be intentionally discharged in bulk for changes to the drilling fluid programme or at the completion of drilling. Depending on operational requirements and fluid type and properties, fluids may be re-used in multiple wells.

Cuttings

Cuttings are produced as the drill bit penetrates the underlying geological formations. They are brought to the surface in the drilling fluid where they pass over a shaker screen that separates the cuttings and drilling fluids. The drilling fluids are recycled for reuse within the drilling process, but small quantities of drilling fluids remain adhered to the cuttings. The cuttings and smaller particle material from the drill fluid treatment units drain into sumps. If sumps cannot be constructed corrals or special bins are used. During drilling this material is the only continuous discharge.

1.2.2 Landfarming

The landfarming process has typically been used in the Taranaki region to assist the conversion of sandy coastal sites prone to erosion into productive pasture. Results of an independent research project conducted by AgKnowledge Ltd (2013) have indicated that the re-contoured sand dunes, after the inclusion of the drilling wastes (as per the consents), and with the addition of appropriate fertilisers and water (irrigation) are capable of producing high quality clover-based pastures and thus increasing the value of the land from about $3-4,000/ha to $30-40,000/ha (2013).

Landfarming uses natural and assisted bioremediation to reduce the concentration of petroleum compounds through degradation. The basic steps in the landfarming process are:

1. Drilling waste is transported from wellsites by truck (cuttings) or tanker (liquids). It may be discharged directly to land or placed in a dedicated storage pit.
2. The required area is prepared by scraping back and stockpiling existing pasture/topsoil and leveling out uneven ground.
3. Waste is transferred to the prepared area by excavator and truck and spread out with a bulldozer. Liquids may be discharged by tanker or a spray system.
4. Waste is allowed to dry sufficiently before being tilled into the soil to the required depth with a tractor and discs.
5. The disposal area is leveled with chains or harrows.
6. Stockpiled or brought in topsoil/clay is applied to aid stability and assist in grass establishment.
7. Fertiliser may be applied and the area is sown in crop or pasture at a suitable time of year.

The landfarming process utilised at the Oeo site is on a single application basis. This means dedicated spreading areas receive only single applications of waste. When disposal is complete, the area will be reinstated and monitored until consent surrender criteria have been met.

1.3 Site location and description

BTW operates Oeo landfarm off South Road, Manaia, identified in Figure 1. The consented site consists of two land parcels totalling 13.8 ha of available spreading area. The site is located on privately owned marginal coastal land situated on reworked dune fields. The predominant soil type has been identified as black loamy sand, and vegetation growth is primarily a mixture of pasture and dune grasses. Average annual rainfall for the site is 1,122 mm (taken from the nearby Glenn Road monitoring station). Two significant surface water bodies run adjacent to the spreading areas. The Waimate Stream flanks the north-western side of the main western site, whilst the Rawa Stream runs adjacent to the north-western side of the smaller eastern site. The Waimate Stream in the immediate vicinity of the site is essentially ephemeral and only flows during periods of prolonged wet weather. Prior to landfarming, the site had suffered from extensive dune ablation, visible in Figure 1 and Photo 1. Basic subsurface soil stratigraphy is provided in Table 1.

Site data

Location

Word descriptor:	South Road, Manaia, Taranaki
Map reference:	E 1684821
(NZTM)	N 5621560
Mean annual rainfall:	1,122 mm
Mean annual soil temperature:	~26.2°C
Mean annual soil moisture:	~15.88%
Elevation:	~25 m asl
Geomorphic position:	Cliff / dune backslope
Erosion / deposition:	Erosion
Vegetation:	Pasture, dune grasses
Parent material:	Aeolian deposit
Drainage class:	Free / well draining
Previous Land use:	Dry stock grazing

Table 1 Bore construction data

Bore	Depth (m)	Drilling Formation
GND2286	0.00 – 0.50 0.50 – 2.00 2.00 – 10.00	Sandy topsoil Soft sandy clay Soft tephra
GND2287	0.00 – 0.50 0.50 – 3.00 3.00 – 10.50	Sandy topsoil Soft sandy clay Tephra
GND2288	0.00 – 0.50 0.50 – 2.50 2.50 – 10.00	Sandy topsoil Sandy soft clay Tephra
GND2350	0.00 – 0.50 0.50 – 3.50 3.50 – 5.00 5.00 – 7.50 7.50 – 8.50 8.50 – 9.00 9.00 – 10.50	Sandy topsoil Sandy clay Conglomerated sand, small gravels, hard Sandy clay Sandy clay, firm Solid rock Conglomerated sand, small gravels, firm

Figure 1 Aerial photograph showing the location and extent of the Oeo Landfarm and approximate regional location (inset)

Photo 1 Oeo Landfarm, western side prior to landfarming operations

1.4 Resource consent

1.4.1 Discharges of wastes to land

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

BTW holds discharge consent 7613-1, to discharge drilling wastes (consisting of drilling cuttings and fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds, onto and into land via landfarming. This consent was issued by the Council on 23 March 2010 as a resource consent under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2024.

Condition 1 sets out definitions.

Condition 2 requires the consent holder to adopt the best practicable option to minimise any environmental effects.

Conditions 3 and 4 require notification and the provision of information and analytical data prior to receipt of wastes on site for stockpiling, and prior to discharge.

Condition 5 and 6 require the notification and the provision of information and analytical data, of which will be made available to the Council via report annually.

Conditions 7 to 9 stipulate the manner and dispersal of wastes, while condition 10 requires a buffer zone between areas of disposal and surface water bodies and site boundaries.

Conditions 11 to 13 specify further site management requirements.

Conditions 14 to 20 specify receiving environment limits for both soil and water.

Condition 21 concerns archaeological remains.

Conditions 22 and 23 concern lapse provisions and consent reviews.

The permit is attached to this report in Appendix I.

1.5 Monitoring programme

1.5.1 Introduction

Section 35 of the RMA sets out obligations upon the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

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

The monitoring programme for the BTW Oeo site consisted of four primary components.

1.5.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans and;
- consultation on associated matters.

1.5.3 Site inspections

A total of six scheduled inspections were made of the site during the monitoring period, with regard to the consents for the discharge of drilling waste. Six further inspections were conducted at the site during chemical sampling runs. Inspections focussed on the following aspects:

- observable and/or ongoing effects upon soil and groundwater quality associated with the land disposal process
- effective incorporation of material, application rates and associated earthworks
- integrity and management of storage facilities
- dust and odour effects in proximity of the site boundaries
- housekeeping and site management
- the neighbourhood was surveyed for environmental effects.

1.5.4 Chemical sampling

During the monitoring period the Council collected six composite soil samples from the Oeo site. The samples were analysed for chloride, conductivity, hydrocarbons, pH, sodium absorption ratio (SAR) and total soluble salts.

During the monitoring period, four monitoring wells were each sampled four times. Samples were analysed for pH, temperature, conductivity, chloride, total dissolved solids, sodium, barium, TPH and BTEX.

The Rawa Stream was sampled twice at two sites (upstream and downstream) for standard surface water quality parameters and hydrocarbons.

1.5.5 Review of analytical results

The Council reviewed soil and surface water sampling results and the annual report provided by the Company on 17 July 2014. The Company collected representative pre-disposal samples from individual waste streams prior to disposal, and receiving

environment soil samples from all spreading areas post waste application. These samples were sent to an independent IANZ accredited laboratory for analysis for a wider range of contaminants. Chemical parameters tested were (all solid/sludge samples):

- pH
- chlorides
- potassium
- sodium
- total nitrogen
- barium
- heavy metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg)
- BTEX
- PAHs
- TPH (and individual hydrocarbon fractions C7-C9, C10-C14, C15-C36)

Receiving environment soil samples were also tested for electrical conductivity and sodium absorption ratio (SAR).

2. Results

2.1 Water

2.1.1 Inspections

5 July 2013

The following was found to be occurring: wind was from the northwest and no objectionable odour or visible emissions were observed. The site was locked and un-manned. There were two lined pits currently at the site, liner integrity appeared satisfactory and there was plenty of space available in both pits. The most recently spread area had been re-contoured and seeded. There was no pasture strike as of the time of inspection, but the area looked very well completed. Another area had been excavated to the southwest of the current storage pits. The stockpiled topsoil appeared stable and there was no evidence of muds within the soil profile and no hydrocarbon odour found. Small quantities of mud had been spilled on the southwest run-in to the storage area and would need to be recovered/spread during the next spreading operations. Historical application areas showed patchy pasture growth and would need to be re-worked and sown when conditions allowed.

23 September 2013

The following was found to be occurring: no recent storage activities had occurred. All pits had been emptied and the storage area had been levelled. The contouring looked good throughout the entire landfarm area. The stockpiled topsoil was stable. Some ponded rainwater water was present in places but there was no evidence of run-off found anywhere and no hydrocarbons were observed in the ponded water. In some parts of the historical spreading areas, small clumps of muds were found to be migrating to the surface as sandy topsoil had been eroded in areas where pasture cover remained patchy. These mud clumps were weathering well.

12 November 2013

A site inspection was conducted in conjunction with groundwater sampling. The site appeared largely abandoned with poor vegetation establishment at the seaward side of the site. Bore GND2288 could not be sampled as no water was present and the bore required maintenance. Bore GND2287 appeared to have been hit / knocked (potentially by earthworks machinery) and was at an angle. This bore could not be sampled as the bailer was getting stuck halfway down the bore. These bores would need to be sampled at a later date after repairs had taken place.

20 November 2013

The following was found to be occurring: a moderate wind was from the west and no objectionable odours or visible emissions were detected. No recent disposal activity had occurred at the site and no storage pits were present. One of the groundwater monitoring bores had been damaged during re-levelling and was sitting at a slanted angle. Pasture strike across previous spreading areas was very patchy in places and large areas were showing essentially no pasture growth. There were mud clumps present at the surface in some areas where topsoil had mobilised through aeolian processes. These clumps were dry and stable and no evidence of run-off was found. A pile (approximately 3 x 3 x 6 m) of stones and rock mixed with soil had been scraped to the area around where the pits where previously located. No hydrocarbon odours were found in the soil and no muds were identified.

The following action was advised to the consent holder: the operator was required to reinstate the monitoring bore to allow for groundwater sampling. The consent holder was to monitor pasture strike and potentially rework some of the areas to re-incorporate the muds.

14 January 2014
An inspection was conducted in conjunction with sampling of surface water in the Rawa Stream. The stream appeared clear, no foaming or sheens were observed. No recent activity was apparent at the site and the spreading areas were observed to have good pasture growth.

29 January 2014
An inspection of the site was conducted in conjunction with groundwater sampling. Bore GND2287 had since been straightened and was able to be sampled. Pasture growth was good for the majority of the site, however barren patches were observed in places.

30 January 2014
The following was found to be occurring: no objectionable odours or visible emissions were found during the inspection. No recent disposal activities had occurred at the site. All soil around the site was stable. Pasture cover appeared healthy and had gone to seed, and the small areas with limited pasture strike had been populated by weeds in some places. Small surface clumps of mud remained present some areas; this material was weathering well.

7 February 2014
An inspection was conducted in conjunction with groundwater and surface water sampling. No recent activity had occurred on site. Pasture cover looked good (approximately thigh high), with only a few barren patches.

7 March 2014
A site inspection was conducted in conjunction with scheduled groundwater sampling. There was again no evidence of recent activity at site. Pasture establishment was good with few barren/wind-blown areas.

1 April 2014
The following was found to be occurring: no recent disposal activities had occurred at the site. Pasture cover was generally good across the site, with some small bare patches noted. The patches of exposed soil appeared stable, and the cuttings and muds present at surface were becoming very difficult to identify and were weathering well. It was outlined by the consent holder that the paddock would be re-sown into pasture when the weather conditions improved.

10 April 2014
An inspection was conducted in conjunction with routine groundwater and surface water sampling. The site remained inactive. Pasture had been recently cut back and some barren patches had become more noticeable.

16 June 2014
The following was found to be occurring: a moderate wind was blowing from the north and no objectionable odours or visible emissions were detected. Bare patches of soil

were stable. Pasture cover was essentially good throughout the historical spreading areas but it appeared wind has affected pasture growth on some of the smaller ridges. Stockpiled material (possibly cuttings, but likely soil and gravel fill) was present at the site entrance. Test pitting was conducted as part of the inspection. Muds and cuttings were well dispersed within the soil profile throughout all test pits and no hydrocarbon odours were noted.

The following action was advised to the consent holder: The consent holder was to advise The Council of planned disposal activities for stockpiled gravel. Subsequent liaison with the consent holder confirmed this material was fill and metal from the site stockpiling pad, and that the landowner wished to keep this material for future use.

Photo 2 Spreading area F1 during 14 February sampling inspection showing good pasture establishment

2.2 Results of discharge monitoring

There was a single disposal during the monitoring period of approximately 394.1 m^3 of predominantly water based cuttings and fluids from Mangahewa C12, Sidewinder 7A and KA 19/20, that were still in storage from the previous monitoring period. The waste was spread at the 100 mm rate over an area of approximately 4,572 m^2 (Area F8, Figure 2). This disposal started in June 2013, but was completed in August/September 2013. The decision was made to not farm the smaller area east of the Rawa Stream as it was uneconomic being such a small area. The pits were decommissioned during the monitoring period.

The Company is required to track and record all discharges under the resource consent and provide this data as part of their annual report for Council review.

Further details regarding discharges at the site are provided in the supplied report, attached in Appendix II.

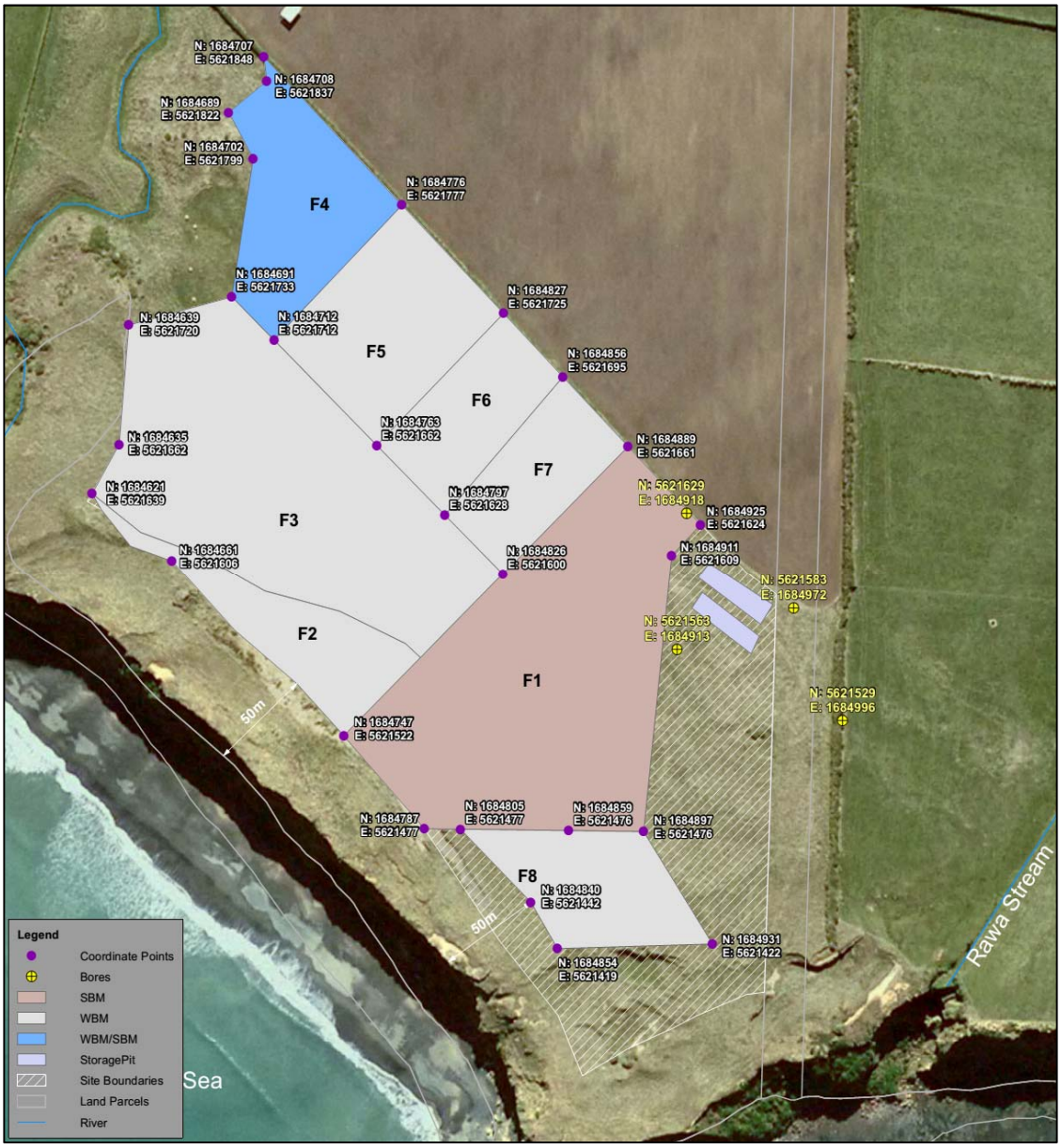


Figure 2 BTW supplied final site map showing spreading areas 1-8 and pits A and B which have since been decommissioned

2.3 Results of receiving environment monitoring

2.3.1 Council soil results

During the monitoring year, six composite soil samples were collected by sub-sampling along transects at 10 m intervals to a depth of 250mm in completed spreading areas F2 to F8 (Figure 3) . The results are presented below in Table 2.

Figure 3 Council soil sampling transect locations, areas F1 to F8

Table 2 Council soil sample results, Oeo Landfarm 29 October 2013

Parameter	Unit	F4	F5	F6	F7	F2	F8
Calcium	mg/kg	211	197	90.0	126	22.9	117
Chloride	mg/kg DW	124	132	75.6	112	68.7	297
Conductivity	mS/m@20C	159	162	86.4	122	67.0	194
Total Hydrocarbons	mg/kg DW	10500	2900	2100	6400	3700	7500
Moisture factor	-	1.010	1.010	1.008	1.008	1.018	1.014
Magnesium	mg/kg	24.8	19.6	12.2	12.2	4.5	12.8
Sodium	mg/kg	89.6	92.1	44.6	71.8	94.6	148
pH	pH	7.5	7.3	6.8	7.6	7.2	7.9
SAR	-	1.5	1.7	1.2	1.6	4.7	3.5
TSS	mg/kg	1244	1267	676	955	524	1518

The Council soil sample results show compliance with all consent limits for all areas sampled. There are reasonably high hydrocarbon concentrations in areas F4, F7 and F8, but all are well within the application limit (50,000 mg/kg) and these levels are expected to reduce rapidly to within surrender criteria. Chloride and sodium levels are relatively low, as are the sodium adsorption ratios and total soluble salt concentrations.

2.3.2 Council groundwater results

During the monitoring quarterly groundwater sampling was conducted from four monitoring bores at the Oeo site, located as shown in Figure 4, below. The results for each of the bores are presented in Tables 3 to 6 respectively.

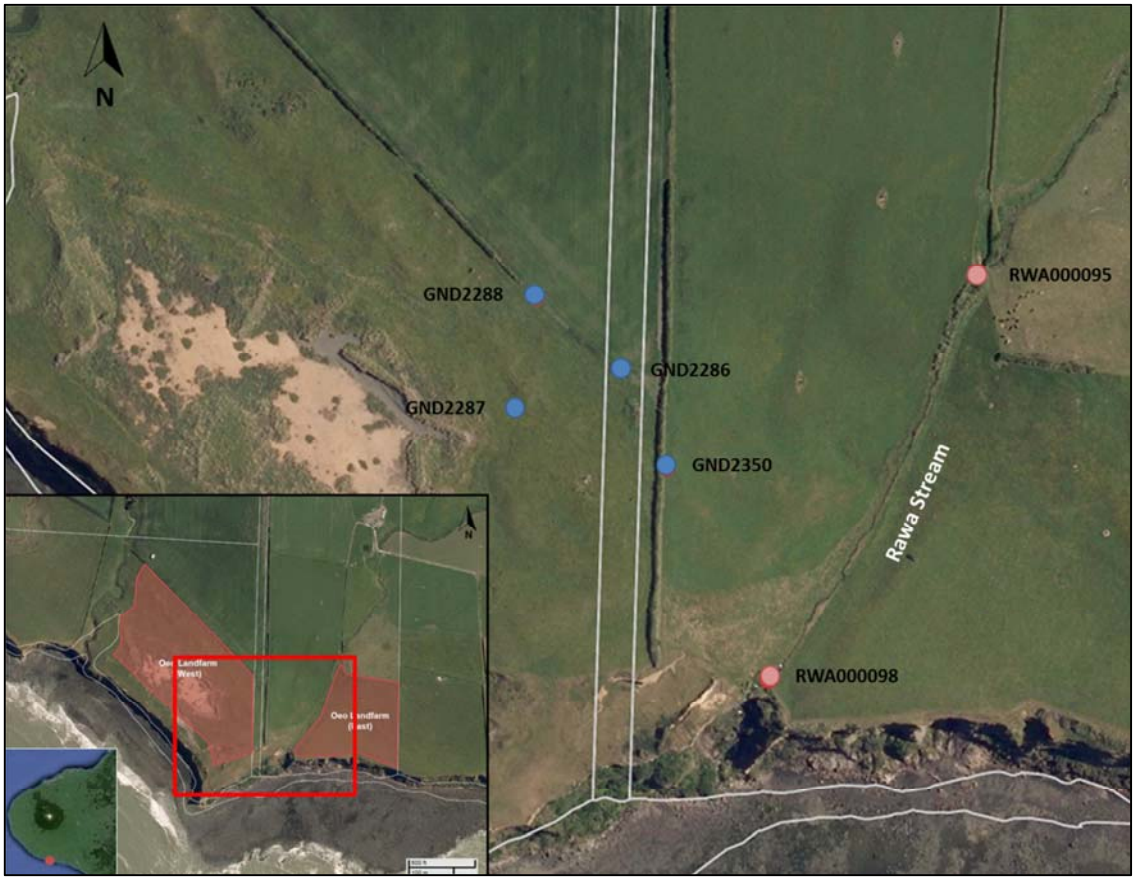


Figure 4 Groundwater and surface water sampling sites, Oeo landfarm

Table 3 Groundwater monitoring results from bore GND2286, Oeo landfarm during 2013-2014 monitoring period

Parameter	Unit	12 Nov 2013	07 Feb 2014	07 Mar 2014	10 Apr 2014
Static water level	m	3.812	4.302	4.468	4.635
Temperature	Deg.C	15.8	15.2	15.7	15.4
pH	pH	6.7	6.8	6.7	6.8
Conductivity	mS/m@20C	71.9	78.5	76.8	78.7
Total dissolved solids	g/m³	556.3	607.4	594.2	608.9
Chloride	g/m³	139	184	158	164
Sodium	g/m³	-	-	-	100
Total barium	g/m³	0.17	0.18	0.10	0.24
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Meta – xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Ortho – xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Parameter	Unit	12 Nov 2013	07 Feb 2014	07 Mar 2014	10 Apr 2014
Hydrocarbon (TPH)	g/m³	<0.7	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4

Bold text indicates results of interest

Table 4 Groundwater monitoring results from bore GND2287, Oeo landfarm during 2013-2014 monitoring period

Parameter	Unit	29 Jan 2014	07 Feb 2014	07 Mar 2014	10 Apr 2014
Static water level	m	4.695	4.736	4.994	5.154
Temperature	Deg.C	16.8	15.4	16.1	16.3
pH	pH	6.6	6.4	6.4	6.6
Conductivity	mS/m@20C	**447**	**405**	**403**	**384**
Total dissolved solids	g/m³	**3458.5**	**3133.5**	**3118.1**	**2971.0**
Chloride	g/m³	**1350**	**1260**	**1200**	**1160**
Sodium	g/m³	-	-	-	**348**
Total barium	g/m³	0.74	0.82	0.61	0.72
Benzene	g/m³	<0.0010	<0.0010	**0.0020**	**0.0035**
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Meta – xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Ortho – xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Hydrocarbon (TPH)	g/m³	**1.7**	**1.9**	**1.9**	**1.8**
HC C7-C9	g/m³	<0.10	<0.10	0.10	0.13
HC C10-C14	g/m³	0.2	0.2	0.3	0.3
HC C15-C36	g/m³	**1.5**	**1.7**	**1.5**	**1.4**

Bold text indicates results of interest

Table 5 Groundwater monitoring results from bore GND2288, Oeo landfarm during 2013-2014 monitoring period

Parameter	Unit	29 Jan 2014	07 Feb 2014	07 Mar 2014	10 Apr 2014
Static water level	m	3.548	3.607	3.762	3.916
Temperature	Deg.C	15.5	15.3	15.8	15.3
pH	pH	6.6	6.6	6.5	6.6
Conductivity	mS/m@20C	62.8	63.7	67.0	74.3
Total dissolved solids	g/m³	485.9	492.9	518.4	574.9
Chloride	g/m³	144	146	149	171
Sodium	g/m³	-	-	-	93.2
Total barium	g/m³	0.40	0.31	0.20	0.17
Benzene	g/m³	<0.0010	0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Parameter	Unit	29 Jan 2014	07 Feb 2014	07 Mar 2014	10 Apr 2014
Meta – xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Ortho – xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Hydrocarbon (TPH)	g/m³	<0.7	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4

Bold text indicates results of interest

Table 6 Groundwater monitoring results from bore GND2350, Oeo landfarm during 2013-2014 monitoring period

Parameter	Unit	12 Nov 2013	07 Feb 2014	07 Mar 2014	10 Apr 2014
Static water level	m	4.782	5.320	5.171	5.333
Temperature	Deg.C	14.8	14.8	15.2	15.0
pH	pH	6.6	6.6	6.5	6.6
Conductivity	mS/m@20C	234	228	240	221
Total dissolved solids	g/m³	1810.5	1764.1	1856.9	1709.9
Chloride	g/m³	**680**	**662**	**676**	**648**
Sodium	g/m³	**-**	**-**	**-**	**367**
Total barium	g/m³	0.19	0.21	0.16	0.18
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Meta – xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Ortho – xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Hydrocarbon (TPH)	g/m³	<0.7	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4

Bold text indicates results of interest

Monitoring wells GND2286 and 2288 show no impact on groundwater from storage or spreading activities, no hydrocarbons have been detected in these bores, and salinity parameters (chloride, sodium and total dissolved solids) are within typical coastal groundwater concentrations, as are related standard water quality parameters (conductivity and pH).

Bore GND2287 shows similar results to the previous monitoring period, with trace hydrocarbons and elevated salinity. Bore 2287 is located immediately seaward of the former pits. The initial storage pit arrangement at the site consisted of three unlined pits, which were modified and lined in 2012. In the current monitoring period the site closed and pits have been reinstated. The hydrocarbon concentrations have reduced since the initial sampling towards background, but appear to have stabilised at approximately 1.5 g/m³, which presents no significant environmental risk.

It is expected these concentrations will reduce further to below detection limits within a reasonably short timeframe through dilution and biodegradation. Benzene was detected in bore 2287 in the second two sampling runs, but concentrations were only just above detection limits and well within all applicable guideline values (for comparison, the concentrations are well below the human drinking water standard in New Zealand. No other BTEX compounds were detected. The total dissolved solids limit has been exceeded in all four samples; however, this appears to be reducing with time and is related to the initial pit system rather than ongoing discharges. It will be necessary for the Council to continue to monitor these wells closely to ensure contaminant concentrations continue to reduce to background levels.

Bore GND2350 shows very slightly elevated chloride and sodium concentrations, just above the typical range. Total dissolved solids are elevated in all four samples, but are within the limit of 2,500 g/m³. It is possible that this is unrelated to the landfarming and stockpiling activities, given the location of the bore in respect to the coast. It will be necessary to continue to monitor these parameters to determine whether these slightly elevated results are related to disposal activities or naturally occurring.

2.3.3 Council surface water results

The Rawa Stream was sampled three times during the monitoring period at two sampling sites, one upstream and one downstream of the stockpiling and spreading areas. Sampling sites are identified in Figure 4. Samples were analysed for similar parameters to the groundwater samples. Results are presented in Table 7, below.

Table 7 Surface water samples, Rawa Stream, Oeo landfarm 2013-2014 monitoring period

Parameter	Unit	RWA000095			RWA000098		
		14 Jan 2014	07 Feb 2014	10 Apr 2014	14 Jan 2014	07 Feb 2014	10 Apr 2014
Temperature	Deg.C	16.0	14.8	15.7	17.1	15.1	15.7
pH	pH	7.7	7.7	7.4	7.8	7.7	7.4
Conductivity	mS/m@20C	28.2	28.9	47.3	28.2	28.7	47.8
Total dissolved solids	g/m³	218.2	223.6	366.0	218.2	222.1	369.8
Chloride	g/m³	47.3	50.4	94.8	47.5	51.0	96.3
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Meta – xylene	g/m³	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ortho – xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Hydrocarbon (TPH)	g/m³	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4

The surface water results for the Rawa Stream indicate there have been no adverse environmental effects on this body of water from activities conducted at the adjacent Oeo landfarm site. No hydrocarbons have been detected in any of the samples, and the other water quality parameters measured are within typical ranges for coastal streams in Taranaki. On all three sampling occasions upstream and downstream samples have been shown very similar results for salinity and other water quality parameters.

2.4 Review of analytical results

The Company supplied receiving environment soil results throughout the monitoring year, and as a summary table in their supplied annual report (Appendix II).

BTW collected a total of 22 composite samples from all areas F1-F8 during the monitoring period. Areas F1 and F3-F8 were each sampled three times, area F2 was sampled once. BTW's soil results are included in Table 4.1, Section 4 of the BTW supplied Annual report, Appendix II.

Their results are compliant with all application limits for all areas. During the previous monitoring period, areas F1-F3 were showing elevated concentrations of sodium and chloride, and were outside of the limits for total soluble salts, SAR (there was one non-compliant result for area F3, but the Council results showed compliance for this area), and electrical conductivity. These areas were resampled in July and November 2013 and April 2014 and now show compliance with all salinity consent limits.

Hydrocarbon concentrations in the supplied results also already show compliance with surrender criteria, with the exception of the C10-C14 hydrocarbon fraction in area F3. No significant polycyclic or monocyclic aromatic hydrocarbons or heavy metals have been detected in any of the samples in the current or previous monitoring period.

The Company also sampled the Rawa Stream on two occasions, 31 July 2013 and 10 Dec 2013. These results are presented in Appendix C of the BTW supplied report, included in Appendix II. The results are similar to the Council surface water results. No hydrocarbons or significant metals have been detected in either sample; all other measured parameters are typical of the coastal reaches of a small stream in a Taranaki dairy catchment.

2.5 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

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

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2013-2014 period, no incidents were recorded against the site, however, the Council was required to undertake an additional investigation, detailed in Section 2.5.1.

2.5.1 Alpha/beta radioactivity investigation

In 2013 the Council (with input from GNS and the National Centre for Radiation Science) prepared a technical report addressing potential radioactivity associated with hydrocarbon exploration (Taranaki Regional Council, 2013). This report included assessments undertaken from a range of petrochemical industry sites, including disposal sites.

The assessments included in the technical report found no evidence of any health or environmental issue arising from the use of radioactive tracers, the use of radioactive materials within well logging activities, disposal of drilling wastes potentially containing radioactive materials, or the release of naturally occurring radioactive materials (NORMs) during exploration or production.

More detail can be found in the full technical report available on the Council website: http://www.trc.govt.nz/Publications/ContentSearchForm?Search=radioactivity&Category=437

No production fluids (including fracturing return fluids) were taken to the Oeo site, therefore no tracers should have been present at the site. However, radioactive contamination could potentially occur from elements such as uranium, radium, and radon (which are present in varying concentrations in some geological formations encountered during drilling operations elsewhere). These elements are dissolved in very low concentrations during normal reactions between water and rock or soil, if present in the parent rock. Formation water that coexists with hydrocarbon reservoirs can have higher concentrations of dissolved constituents that build up during prolonged periods of water/rock contact. Water brought to surface during production, or rock cuttings from drilling operations therefore may be a potential source of radiation.

During the previous monitoring period, Ngati Haua Hapu representatives contacted the Company and the Council regarding concerns they held about potential environmental effects relating to operations at the Oeo landfarm. Ngati Haua Hapu engaged an independent scientist to assess the site, who raised concerns about potentially high concentrations of naturally occurring radioactive materials (NORM) at the site.

Ngati Haua Hapu representatives took two samples from storage pits A and B, which were heterogeneous mixes of solid and liquid material and sent these samples to the National Centre for Radiation Science (NCRS) to be analysed as liquids and compared to the drinking water standards for alpha/beta radioactivity. Their results are presented in Table 8.

Table 8 Supplied alpha/beta radioactivity results, Oeo landfarm

Parameter	Unit	Pit A	Pit B
Total alpha concentration	(Bq/L)	25.3 $\pm$ 1.7	25.8 $\pm$ 1.7
Total beta concentration	(Bq/L)	114 $\pm$ 29	121 $\pm$ 31

Ngati Haua presented these findings to the Company without written interpretation. The Company approached the Council to determine the validity and comparability of the results and assess for any potential environmental risk.

The Council contacted the NCRS directly regarding the supplied results. NCRS advised the Council that the physical nature of the samples made the samples difficult to process using the analytical methods designed for liquid samples. NCRS suggested that their preference would have been to filter out the sample and treat the liquid and solid fractions independently. This would make them comparable with drinking water standards (liquid fraction) and background soil samples.

The Council conducted a follow-up investigation on 11 July 2013. A total of 10 samples were taken from the following areas:

- Oeo landfarm storage pit A (liquids and solids – mud/sludge);
- Oeo landfarm storage pit B (liquids and solids – mud sludge);
- Oeo landfarm spreading area F7 (solids - soil);
- Oeo landfarm groundwater bore GND2287 (liquid – groundwater);
- Control paddock (solids – soil);
- Opunake beach (solids – sand);
- Pukeiti (solids – soil), and
- Okato quarry (liquid - groundwater).

Photo 3 Sampling liquid portion of pit A mud/sludge

These samples were sent to the NCRS for analysis using liquid scintillation counting and gamma spectrometry. Water samples were analysed for gross radioactivity as indicated by total alpha and beta particle emissions per litre, as well as naturally occurring potassium-40. All samples were analysed for naturally occurring radium

isotopes associated with the uranium and thorium decay series, as well as lead-210 as these are the radioactive species normally associated with soil and rock.

The two sludge samples taken from pit A were greatly varied in consistency, with equal parts liquid and solid. The NCRS separated the samples and analysed as solids and liquids respectively. The results from pit A are presented in Table 9.

Table 9 NCRS radioactivity results for sludge samples, Oeo landfarm pit A solid and liquid components

Site	Lead-210 (Bq/kg)	Radium-226 (Bq/kg)	Radium-228 (Bq/kg)
Oeo pit A (1) solid portion	<2.0	<2.4	1.20 ± 0.28
Oeo pit A (2) solid portion	1.28 ± 0.72	<2.8	1.55 ± 0.26
Site	**Lead-210 (Bq/L)**	**Radium-226 (Bq/L)**	**Radium-228 (Bq/L)**
Oeo pit A (1) filtered liquid	0.154 ± 0.060	0.042 ± 0.027	0.122 ± 0.055
Oeo pit A (2) filtered liquid	0.109 ± 0.067	0.031 ± 0.025	0.047 ± 0.041

The first point of interest is that processing the sludge samples as individual components yields significantly lower results than processing the mixed samples using the water sample methodology (as per the Ngati Haua supplied sample).

The mud/sludge samples from pit B were mostly solid in nature, so were analysed only as solids. These results are presented in Table 10, along with the soil samples from the spreading area F7, the off-site 'control' paddock, and the wider-regional control sites at Opunake Beach and Pukeiti.

Table 10 NCRS radioactivity results for solid samples, Oeo landfarm and control sites

Site	Lead-210 (Bq/kg)	Radium-226 (Bq/kg)	Radium-228 (Bq/kg)
Oeo pit B (1)	11.3 ± 4.0	11.41 ± 0.97	13.4 ± 1.2
Oeo pit B (2)	12.3 ± 3.4	13.6 ± 1.1	15.2 ± 1.1
Oeo spreading area F7	11.1 ± 2.4	12.12 ± 0.96	11.0 ± 1.1
Oeo control paddock	15.4 ± 3.4	22.4 ± 1.7	22.9 ± 2.0
Opunake Beach	14.1 ± 2.8	13.8 ± 1.1	14.0 ± 1.3
Pukeiti	12.0 ± 2.9	18.2 ± 1.5	23.1 ± 2.3

The solid samples from the landfarm site had lower concentrations of lead-210, radium-226 and radium-228 than the samples taken from the control sites. The soil sample taken from the neighbouring paddock where no waste was applied was higher in radioactivity than area F7 and the solid waste directly from the storage pits (which had relatively low concentrations of the measured isotopes). The wider-regional control samples taken from Opunake Beach and the hillside towards Pukeiti returned higher results than the landfarm site for all three measured isotopes. There are currently no regulatory guideline levels for the release of naturally occurring radioactivity into the environment. As such, the NCRS have provided an average New Zealand soil concentration of approximately 30 Bq/kg for the radium isotopes provided. The NCRS have confirmed that the sludge taken from the pits and analysed as solid material has levels of radioactivity consistent with 'normal' New Zealand soil concentrations.

As part of the investigation groundwater samples were taken from the site and a control site to compare radioactivity levels against the New Zealand drinking water standard. These are presented in Table 11.

Table 11 NCRS alpha/beta radioactivity results for aqueous samples, Oeo landfarm and control site

Site/sample	Total alpha concentration (Bq/L)	Total beta concentration (Bq/L)
Okato quarry groundwater	<0.050	<0.33
Monitoring bore GND2287	<0.050	1.142 ± 0.083
GND2287 corrected for potassium-40	<0.050	<0.50

The initial beta radioactivity result for GND2287 of 1.142 (+/- 0.083) appeared slightly above the drinking water standard of 0.50 Bq/L in the initial analyses, but included potassium-40 radiation. A second analysis was done on the water sample to correct for potassium-40. The second result shows that the sample was within the drinking water standard for beta radioactivity. The drinking water standard for beta-emitting radiation excludes beta radiation emitted from potassium-40, as the body essentially self-regulates its content of potassium-40. In simple terms, the elevated level of total beta radiation found in the sample was accounted for by the concentration of potassium-40 that was present; reducing the effective beta concentration to within drinking water standards and indicating there was no elevated human or animal health risk.

These findings are consistent with the assessments undertaken at the other petrochemical sites during previous monitoring years, and confirm there is no meaningful risk from radioactivity at landfarm sites.

3. Discussion

3.1 Discussion of site performance

During the monitoring period the Company ceased active disposal at the Oeo site, reinstated the storage area, and have accordingly reduced site operations to ongoing monitoring of soil and water resources until such a time as the consent can be surrendered. Site management has improved greatly and sample results indicate successful assimilation and degradation of waste in all areas except F3, where more time may be required to meet surrender criteria. The Company has re-sown the entire area and vegetation establishment has improved throughout the monitoring period.

The record keeping and reporting has been of a very high standard, effectively and concisely demonstrating compliance with consent conditions. The Company has effective monitoring and site management procedures in place and has worked well to address the issues encountered in the previous monitoring year. No incidents have been recorded at the site during the 2013-2014 monitoring period.

3.2 Environmental effects of exercise of consents

The results of the monitoring conducted during the 2013-2014 monitoring period have indicated that there have been no significant adverse environmental effects occurring at the Oeo landfarm site from activities conducted during that monitoring period. One of the groundwater bores shows trace levels of hydrocarbons and elevated salinity related to the original site storage arrangement. These levels are of no environmental significance. It is expected these concentrations will reduce to background within a relatively short time frame. Soil results are generally compliant with surrender consent criteria, with the exception of area F3. No effects have been noted in the Rawa Stream. Alpha/beta radioactivity levels at the site posed no environmental or health risk, and were in most cases lower than at the control sites. No off-site effects have been detected in any sampling or inspections.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 12.

Table 12 Summary of performance for Consent **7613-1** To discharge: drilling wastes (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds, onto and into land via landfarming

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions which apply to the consent	N/A	N/A
2. Best practicable option to be adopted	Inspections and liaison with consent holder	Yes
3. Notify TRC in writing prior to stockpiling	Notifications received	N/A
4. Notify TRC in writing prior to landfarming	Notifications received	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Keep records relating to wastes, areas, compositions, volumes, dates, treatments and monitoring	Company records	Yes
6. Report on records in condition 5 to Council by 31 August each year	Report received 17 July 2014	Yes
7. Discharge depth limited to 100mm for waste with hydrocarbons <5%, or 50mm for waste with hydrocarbons >5%	Company records and inspection	Yes
8. Incorporation into soil as soon as practicable so that top 250mm layer contains less than 5% hydrocarbons	Inspection and sampling	Yes
9. Single application of wastes to each area of land	Company records and inspection	Yes
10. No discharge within 25m of a water body or property boundaries	Inspection	Yes
11. Maximum volume of stockpiling 6000m^3, discharge within twelve months of arrival on site	Company records and inspection	Yes
12. Re-vegetate landfarmed areas as soon as practicable	Company records and inspection	Yes
13. No destabilisation of neighbouring land	Inspection	Yes
14. Total dissolved salts in any fresh water body shall not exceed 2500g/m^3	Sampling	Exceeded in bore GND2287
15. Disposal of waste shall not lead to contaminants entering surface water or ground water exceeding background concentrations	Sampling	Some contaminants still elevated from previous period in bore GND2287
16. Conductivity must be less than 400 mS/m. If background conductivity exceeds 400 mS/m, then increase shall not exceed 100 mS/m	Sampling	Yes
17. Sodium absorption ratio [SAR] must be less than 18.0, if background SAR exceeds 18.0 then increase shall not exceed 1.0	Sampling	Yes
18. Levels of metals in soil shall comply with guidelines	Sampling	Yes
19. Prior to expiry/cancellation of consent these levels must not be exceeded: a. conductivity, 290 mSm^{-1} b. chloride, 700 g/m^3 c. dissolved salts, 2500 g/m^3 d. sodium, 460 g/m^3	Sampling prior to surrender	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
20. If condition 19 not met, consent cannot be surrendered	Sampling	N/A
21. Notification of discovery of archaeological remains	None found	N/A
22. Lapse condition	Inspection for evidence of exercise	N/A
23. Optional review provision re environmental effects	Next optional review June 2018	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**Good**

The overall rating of the site for the monitoring year for environmental performance and consent compliance is 'good'.

During the year under review the Company managed the site well and there were no incidents recorded, administrative consent compliance at the site was at a 'high' level.

Pasture strike at the site has continued to be an issue, but was improving towards the end of the monitoring period, and the groundwater results from bore GND2287 were still showing trace levels of hydrocarbons and had exceeded the TDS limit. These are largely due to activities conducted during the previous monitoring year, but continue to be observed during the 2013-2014 year. For this reason, the overall site rating is 'good'.

3.4 Recommendations from the 2012-2013 Annual Report

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

1. THAT monitoring of consented activities at Oeo landfarm in the 2013-2014 year be amended from that undertaken in 2012-2013, by including a fourth groundwater sampling run.

2. THAT water, sludge, soil and baseline alpha/beta radioactivity samples are taken at the site by the National Radiation Laboratory (NRL) as part of investigations into potential environmental/human health radioactivity risks associated with industry practices.

These recommendations were implemented.

3.5 Alterations to monitoring programmes for 2014-2015

During the 2013-2014 monitoring period there was one additional investigation undertaken at the Oeo site to determine levels of naturally occurring radiation. This study was outside of the scope of the standard monitoring programme and is not required to be repeated in the 2014-2015 monitoring period.

In designing and implementing the monitoring programmes for air/water discharges in the region, the Taranaki Regional Council has taken into account the extent of information made available by previous authorities, its relevance under the RMA the obligations of the Act in terms of monitoring emissions/discharges and effects, and subsequently reporting to the regional community. The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/discharging to the environment.

It is proposed that for 2014-2015 the monitoring programme remains unchanged from that undertaken during the 2013-2014 monitoring period (with the exclusion of the additional investigation described above). A recommendation to this effect is attached to this report.

4. Recommendation

1. THAT monitoring of consented activities at Oeo landfarm in the 2014-2015 year continue at the same level as scheduled in 2013-2014.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Al*	Aluminium.
As*	Arsenic.
Biomonitoring	Assessing the health of the environment using aquatic organisms.
BOD	Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate.
BODF	Biochemical oxygen demand of a filtered sample.
BTEX	MAH's benzene, toluene, ethylbenzene and xylene.
Bund	A wall around a tank to contain its contents in the case of a leak.
CBOD	Carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate .
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cu*	Copper.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1}).
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus
E.coli	*escherichia coli,* an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
l/s	Litres per second.

MAHs	Monocyclic aromatic hydrocarbons, molecules consist of a single six-sided hydrocarbon ring.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
OW	Oily waste.
PAHs	Polycyclic aromatic hydrocarbons, molecules consist of more than two six-sided hydrocarbon rings.
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
PM_{10}	Relatively fine airborne particles (less than 10 micrometre diameter).
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	Resource Management Act 1991 and including all subsequent amendments.
SBM	Synthetic based mud.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
TPH	Total petroleum hydrocarbons
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
WBM	Water based mud.
Zn*	Zinc.

*an abbreviation for a metal or other analyte may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount

of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form.

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

Bibliography and references

Ministry for the Environment (1999): Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in New Zealand, Ministry for the Environment.

Ministry for the Environment (2003): Guidelines for the safe application of biosolids to land in New Zealand, Ministry for the Environment.

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

Taranaki Regional Council (2014): BTW Company Limited Oeo Landfarm Monitoring Programme Annual Report 2012-2013. Technical Report 2013-54

Appendix I

Resource consents held by BTW Company Ltd

Consent 7613-1

TARANAKI REGIONAL COUNCIL

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

Please quote our file number on all correspondence

Discharge Permit

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

Name of Consent Holder:	BTW Company Limited P O Box 551 Taranaki Mail Centre NEW PLYMOUTH 4340
Consent Granted Date:	23 March 2010

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds, onto and into land via landfarming at or about (NZTM) 1684821E-5621560N
Expiry Date:	1 June 2024
Review Date(s):	June 2012, June 2018
Site Location:	South Road, Manaia [Property owner: C & D Putt]
Legal Description:	Sec 2 & 3 Blk III Oeo SD
Catchment:	Rawa Waimate

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

General conditions

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

Special conditions

1. For the purposes of this consent the following definitions shall apply:

   a) stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating the discharged material into the soil within 24 hours; and
   b) landfarming means the discharge of drilling wastes onto land, subsequent spreading and incorporation into the soil, and includes any stripping and relaying of topsoil.

2. The consent holder shall adopt the best practicable option [as defined section 2 of the Resource Management Act 1991] to prevent or minimise any actual or potential effects on the environment arising from the discharge.

Notifications, monitoring and reporting

3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to permitting drilling wastes onto the site for stockpiling, from each well drilled. Notification shall include the following information:

   a) the consent number;
   b) the name of the well[s] from which the waste was generated;
   c) the type of waste to be stockpiled;
   d) the volume of waste to be stockpiled; and

4. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to landfarming stockpiled material. Notification shall include the following information:

   a) the consent number;
   b) the name of the well[s] from which the waste was generated;
   c) the type of waste to be landfarmed;
   d) the volume and weight of the waste to be landfarmed;
   e) the concentration of chlorides, nitrogen and hydrocarbons in the waste; and
   f) the specific location and area over which the waste will be landfarmed.

5. The consent holder shall keep records of the following:

   a) wastes from each individual well;
   b) composition of wastes [including concentrations of chloride, nitrogen and total petroleum hydrocarbons];
   c) stockpiling area[s];

d) volumes of material stockpiled;
e) landfarming area[s], including a map showing individual disposal areas with GPS co-ordinates;
f) volumes and weights of wastes landfarmed;
g) dates of commencement and completion of stockpiling and landfarming events;
h) dates of sowing landfarmed areas;
i) treatments applied;
j) details of monitoring, including sampling locations, sampling methods and the results of analysis;

and shall make the records available to the Chief Executive, Taranaki Regional Council.

6. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 5, for the period of the previous 1 July to 30 June.

Discharge limits

7. For the purposes of landfarming, drilling wastes shall be applied to land in a layer not exceeding:

a) 100 mm thick for wastes with a hydrocarbon concentration less than 50,000 mg/kg dry weight; or
b) 50 mm thick for wastes with a hydrocarbon concentration equal to or greater than 50,000 mg/kg dry weight; and
c) in a rate and manner such that no ponded liquids remain after one hour, for all wastes;

prior to incorporation into the soil.

8. As soon as practicable following the application of drilling wastes to land in accordance with condition 7 of this consent, the consent holder shall incorporate the wastes into the soil to a depth of at least 250 mm, so that the hydrocarbon concentration at any point in the soil/waste mix is less than 50,000 mg/kg dry weight, anywhere in the 250 mm layer below the topsoil layer.

9. An area of land used for the landfarming of drilling wastes in accordance with conditions 7 and 8 of this consent, shall not be used for any subsequent discharges of drilling waste.

10. No discharge shall take place within 25 metres of surface water or property boundaries.

Operational requirements

11. The stockpiling of material authorised by this consent is limited to a maximum volume of 6000 cubic metres at any one time on the property. All stockpiled material must be landfarmed as soon as practicable, but no later than twelve months after being brought onto the site.

12. As soon as practicable following landfarming, areas shall be sown into pasture [or into crop]. The consent holder shall monitor revegetation and if adequate establishment is not achieved within two months of sowing, shall undertake appropriate land stabilisation measures to minimise wind and stormwater erosion.

13. The exercise of this consent shall not result in the destabilisation of neighbouring land.

Receiving environment limits - water

14. The exercise of this consent shall not result in the concentration of total dissolved salts in any fresh water body exceeding 2500 g/m^3.

15. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which after reasonable mixing, exceeds the background concentration for that particular contaminant.

Receiving environment limits - soil

16. The conductivity of the soil/waste layer after landfarming shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the landfarming of waste shall not increase the soil conductivity by more than 100 mS/m.

17. The sodium absorption ratio [SAR] of the soil/waste layer after landfarming shall be less than 18.0, or alternatively if the background soil SAR exceeds 18.0, the landfarming of waste shall not increase the SAR by more than 1.0.

18. The concentration of metals in the soil shall at all times comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the Guidelines for the safe application of biosolids to land in New Zealand [Ministry for the Environment and New Zealand Water & Wastes Assoication, 2003].

19. From 1 March 2024 (three months prior to the consent expiry date), constituents in the soil shall not exceed the standards shown in the following table:

Constituent	Standard
conductivity	290 mS/m
chloride	700 mg/kg
sodium	460 mg/kg
total soluble salts	2500 mg/kg
MAHs PAHs TPH	Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999]. Tables 4.12 and 4.15, for soil type sand.

MAHs - benzene, toluene, ethylbenzene, xylenes
PAHs - napthalene, non-carc. (pyrene), benzo(a)pyrene eq.
TPH - total petroleum hydrocarbons (C_7-C_9, C_{10}-C_{14}, C_{15}-C_{36})

The requirement to meet these standards shall not apply if, before 1 March 2024, the consent holder applies for a new consent to replace this consent when it expires.

20. This consent can not be surrendered until the standards in condition 19 are being met.

Archaeological remains

21. In the event that any archaeological remains are discovered as a result of works authorised by this consent, the works shall cease immediately at the affected site and tangata whenua and the Chief Executive, Taranaki Regional Council, shall be notified within one working day. Works may recommence at the affected area when advised to do so by the Chief Executive, Taranaki Regional Council. Such advice shall be given after the Chief Executive, Taranaki Regional Council, has considered: tangata whenua interest and values, the consent holder's interests, the interest of the public generally, and any archaeological or scientific evidence. The New Zealand Police, Coroner, and Historic Places Trust shall also be contacted as appropriate, and the work shall not recommence in the affected area until any necessary statutory authorisation or consent has been obtained.

Lapse and review

22. This consent shall lapse on 31 March 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

23. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2012 and/or June 2018, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 23 March 2010

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

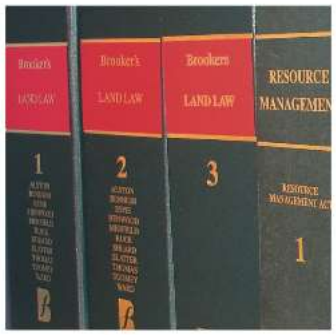
BTW supplied annual report

Annual Report

Special Condition 6 - Monitoring and Reporting

Oeo Land Farm Annual Report - Consent 7613

by BTW Company



btw company
surveyors . planners . engineers . land & g·i·s services

Oeo Land Farm Annual Report - Consent 7613
09389

Reviewed

Report Author		
	Dave Bolger	Date
Reviewed by		
	Cameron Twigley	Date

09389
1/10/2014

btw company

CONTENTS

1 INTRODUCTION

1.1 Special Condition 6

In accordance with Special Condition 6 (SC6) of resource consent 7613-1 it is a requirement that:

The consent holder provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with Special Condition 5 (SC5), for the period of the previous 1 July to 30 June.

This report therefore includes all information related to activities provided for under consent 7613-1 from 1 July 2013 to 30 June 2014 as well as monitoring required under SC 14-20.

1.2 July 2013 to June 2014 - Summary

During the reporting year one area was land farmed, which was the completion of the F8 area during August and September. Also the decommissioning of the stock piling pits has taken place during the reporting year. The F8 area was 4572m² in area and includes 394.1m³ of drill cuttings. No new material was disposed of during the reporting year.

For the majority of the reporting year the site has been inactive, apart from the ongoing monitoring requirements.

Pasture establishment has continued during the last year. Firstly the whole site was re-sown in oaks, and then in April the site was completely re-sown in permanent pasture. Generally pasture strike has been excellent, except some patchy areas in the F3 area.

At the end of the monitoring year soil sampling results have demonstrated all but one area (F3) met surrendering criteria for the consent. The site has responded well to the land farming process, and the bio remediation process of breaking down any elevated constituents in the drilling muds has seen positive results. If land farming is managed appropriately with tight management and appropriate application rates of material, the actual process of microbes breaking down the material is sustainable as shown in the soil sample results for the site.

One operational change during monitoring year was to have a 50 meter setback from the coastal cliff edge not the actual legal boundary. This was discussed with Ngati Haua Hapu members who advised this was always the intention during initial consultation, however for some reason was not included in the South Taranaki District Council consent conditions for the site. BTW acknowledged Ngati Haua concerns and the last area land farmed (F8) was set back a minimum of 50 meters from the cliff edge. This operational change was adhered to during the completion of the F8 landfarmed area.

Many of the planted native species that were planted along the coastal buffer zone and on the coastal edge of the Waimate stream have survived. The establishment of these native plants can be seen in a photo in appendix D of this report. This is a positive outcome, and we hope these native species continue to prosper in this harsh location and provide some natural habitat.

1.3 Records required under Special Condition 5

The consent holder shall keep records of the following:

a) wastes from each individual well;

composition of waste (including concentrations of chloride, nitrogen and total petroleum hydrocarbons)

b) stockpiling area(s);
c) volume of material stored;
d) landfarming areas, including a map showing individual disposal area with GPS co-ordinates;
e) volumes and weight of wastes landfarmed;
f) dates of commencement and completion of storage and landfarming events;
g) dates of sowing landfarming areas;
h) treatment applied;
i) details of monitoring, including sampling locations, sampling methods and the results of analysis;

and shall make the records available to the Chief Executive, Taranaki Regional Council.

1.4 Report Overview

The following information has been collated for the purpose of demonstrating compliance with Special Condition (SC)6 of consent 7613-1. Information is supplied generally in the order as requested within SC5 a-j.

- Records required under SC 5 condition a) Wastes from each individual well and b) Composition of waste, is provided in Appendix A of the Report. Appendix A provides a list of all chemical products and lists of possible constituents which may be added to alter the consistency of drilling mud stored on well sites.

  Condition b) is also addressed in Section 4 of the report.

- A map of the site showing individual disposal areas, GPS co-ordinates and stockpiling areas is located in Appendix B displaying compliance with SC5 c), e) & g). This includes:
  - *stockpiling Area's;*
  - *landfarming areas, including a map showing individual disposal area with GPS co-ordinates;*
  - *dates and commencement and completion of storage and landfarming events.*

- Section 2 provides the information related to the recording of details required within conditions d), f), h), and i) of SC5 which are listed below;

  - *volumes of material stored;*
  - *volumes and weights of wastes landfarmed;*
  - *dates of sowing landfarmed areas;*
  - *treatments applied.*

  Material volumes have been calculated based on the area of disposal and the thickness of disposal which has been undertaken. This information is available on the site map provided in Appendix B.

- Section 3 provides details of monitoring, including sampling locations and sampling methods as required by SC5, condition j.

- Section 4 provides the results of analysis as required by SC5, condition j. Special Conditions 14-20 of Consent 7613-1 are also addressed in this section.

2 MATERIAL STORAGE AND TREATMENT

The following section provides the information related to recording of details required within conditions d), f), h), and i) of SC5 which are listed below;

- *volumes of material stored;*
- *volumes and weights of wastes landfarmed;*
- *dates of sowing landfarmed areas;*
- *treatments applied.*

2.1 Material Volumes

No new material was disposed of or stockpiled during the monitoring year.

The approximate volume of material farmed during the reporting year was 394.1m³, which was for the completion of the F8 area.

The volume of incoming material is accurately measured by either trucks being weighted or determination of trailer capacity. i.e., a tube tanker will hold a maximum of 22m³. In addition to trucking records the volume can also be calculated based on the size of the storage pit, the shape of the pit and the depth of material in the pit, however given there is always variation in pit walls and pit construction, results of the calculation could be +/- 5-10m^3 of the actual material volume.

Spreading areas relate to the hydrocarbon percentage per dry weight of material to be spread, as specified in SC7 of consent 7613-1. For material with less than 50,000mg/kg dry weight (<5%) the material can be applied at 100mm thickness, greater than 50,000mg/Kg dry weight (>5%) a thickness of 50mm is required. The F8 area (as shown on the Plan in Appendix B) has been spread at a 100mm thickness due to the TPH being less than 50,000 mg/kg.

In what we consider best practice, BTW always increase the spreading areas to absolutely ensure compliance with consent conditions and to ensure no overloading of material. This would also account for any variation in pit calculation and trucking record calculation. For an example, the F8 area has a total area of 4572m², the material calculated to be landfarmed in this area was 394.1m³. To comply with the application rate condition for TPH concentration of less than 5%, an area of 3941m² would be required to meet this condition. However best practice which is applied by BTW is to ensure sufficient area is available for the material to be spread at the appropriate rate, and hence ensure bio remediation breakdown can actually take place in a timely manner. Therefore the F8 has been increased to 4572m².

Table 2.1 provides the information required relating to the volumes of material land farmed. Material volumes have been calculated based on the area of disposal and the thickness of disposal undertaken.

This information is available on the site map provided in Appendix B

Table 2.1: Volumes of Material Landfarmed – July 2013 to June 2014

Location	Material Type	Date Landfarmed	Area of cover (m^2)	Thickness of material (mm)	Volume landfarmed (m^3)
F8	WBM	June 2013	4572	100	394.1

2.2 Sowing and treatments

No treatments (e.g. fertiliser/lime) have been applied to materials landfarmed at the Oeo Landfarm during the year under review.

The whole site from F1 to F8 was re sown in oaks for initial vegetation establishment. The whole site has now been sown in permanent pasture. The F3 area still has a patchy pasture strike; however the rest of the site now has excellent pasture strike as shown in Figure 2.1 below

Figure 2.1: Pasture Establishment Oeo Landfarm 1-6-14

3 MONITORING INFORMATION

The following section provides the details of monitoring, including sampling locations and sampling methodology.

3.1 Monitoring

A pre-disposal sample of all material is analysed for a variety of constituents before the material is stockpiled on site in lined pits. Testing takes place prior to stockpiling because on occasions it is added to other material already stored and therefore unable to be sampled separately once on-site. The material is tested by an independent accredited laboratory (Hill Laboratories), the analysis includes testing for hydrocarbons, including Total Petroleum Hydrocarbons, Polycyclic Aromatic Hydrocarbons, BTEX, Heavy Metals and individual tests such as for Barium, Potassium, Sodium, Chloride, Nitrogen and pH.

When an appropriate volume of material has been stockpiled which justifies mobilising equipment for a landfarming operation, an assessment is made of all predisposal results to determine whether a composite sample needs to be taken. If hydrocarbon levels can be determined without the need for a composite sample, the landfarm area is designated and landfarming commences.

Monitoring of the landfarmed area begins within the first month of topsoil being re-applied to the landfarmed area. At this point, an entire suite of tests is undertaken to assess the receiving environment against consent conditions. For WBM material, monitoring is undertaken every six months for the first year following application, and then 6-monthly sampling continues until compliance with consent conditions is achieved. For SBM material, monitoring is undertaken every three months for the first year following application, and then 6-monthly until compliance is achieved. Within the first year, if results are compliant with surrender conditions, monitoring ceases.

Monitoring results have been provided in a spread sheet form to assist with compliance and consent requirements for surrender (See Section 4).

The results demonstrate that only one area does not meet surrender criteria. This one area identified is F3 and will be continually monitored until surrender criteria is met. Surrender criteria data and analysis is discussed in section 4. Areas that have met surrender criteria will not be further sampled until a sampling methodology plan has been approved by the TRC to complete the surrendering of the whole site.

All receiving environment samples are tested by Hill Laboratories and sampling methodology is in accordance with the TRC.

As part of the monitoring programme BTW has also sampled the Rawa Stream on two occasions during the monitoring year. The Rawa stream has been tested for a wide range of contaminates that can be associated with drilling material. The results of the sampling are contained in Appendix C and demonstrate compliance with special condition 14 and 15.

3.2 Sampling Locations

Specific land farmed areas are located through the use of a GPS navigational system. These co-ordinates are contained within the “Oeo Landfarm Area and Track Access” plan (Appendix B) which shows areas of disposal and is updated following landfarming events. A central point is located within each area and a composite sample retrieved in a transect line from the central point. The line direction is dependent on the underlying orientation of the landfarmed material.

3.3 Methods

Sampling involves collecting a composite of 10 sub-samples along a transect line from the central GPS point on the specific landfarmed area. Typically, samples are retrieved from an approximate depth of 250mm but this can vary depending on the location of the drilling mud layer.

Once the 10 sub samples have been collected the soil is mixed together and the appropriate sampling containers are filled and sent to Hill Laboratories for testing for specific constituents as required by the consent.

The sampling methodology is consistent with the TRC methodology. The goal is to achieve a representative sample of each specific landfarmed area. As the actual levels of constituents is known in the materials to be landfarmed via the pre disposal sampling, it is considered this methodology provides a representative sample of the material once mixed (power harrowed into the soil) on the land farming area, and also gives data on constituent levels within the top 250mm of the soil profile, which in essence is for the protection of human and livestock health.

3.4 Inspection Notices

All routine site inspections by TRC compliance officers have found activities on the site complying with the conditions of consent 7942-1 for the annual monitoring year.

3.5 Infringement Notices

No infringement notices were issued during the reporting year.

3.6 Abatement Notices

No abatement notices were issued during the reporting year.

4 ANALYSIS OF RESULTS

The following Table 4.1 provides a summary of the monitoring results undertaken for the Oeo Landfarm during the reporting period. Please note we have provided the complete sampling results from the initial soil sampling at the site, we believe this is useful to observe trends of constituent breakdowns over time at the site. Analysis of the results of monitoring are required by SC5, condition j. Special Conditions 14-20 of Consent 7613-1 are also addressed in this section.

We have colour coded table 4.1 for ease of quick interpretation. Green indicates that the level of a specific constituent meets consent surrender criteria, and red indicates that surrender criteria has not been met yet.

Analysis of the monitoring results is undertaken over the following Sections 4.1 and 4.2, with a summary proved in Section 4.3

		Consent Surrender limit meet			Consent Surrender limit not meet																TPH						
	Date	Soil conductivity <290mSm-1 (see Consent if PD is greater than 400)	SAR <18	Total Soluble salts 2500 mg/kg	Benzene <1.1(v)	Toulene <68(4m)	Ethylbenzene (53)(4.v)	Xylenes (48) (4,m)	Naphthalene (7.2) (p)	Non-carc. (Pyrene) (160) (4p)	Benzo(a)pyrene eq.(5) (0.027)(p)	Arsenic (20mg/kg)	Cadmium (1mg/kg)	Chromium (600mg/kg)	Copper (100mg/kg)	Lead (300mg/kg)	Mercury (1mg/kg)	Nickel (60mg/kg)	Zinc (300mg/kg)	C7-C9 (120) (m)	C10-C14 (58) (x)	C15-C36 (4000) (7,x)	nitrogen mg/kg	Chloride 700 mg/kg	Sodium 460 mg/kg	Material
F1	26/10/2012	1450	18	9560	<0.05	<0.05	<0.05	<0.1	<0.14	0.04	<0.03	2	<0.1	7	13	6.7	<0.1	5	43	12	5100	11000	0.08	930		
	3/04/2013	1040	10.5	6840	<0.05	<0.05	<0.05	<0.1	<0.12	<0.03	<0.03	<2	<0.1	9	13	5.5	<0.1	6	45	8	1000	4600	0.14	660	808	
	4/07/2013	310	5.9	2060	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	<0.10	8	14	3.8	<0.10	6	37	8	770	2800	0.11	280	227	SBM
	15/11/2013	130	4.3	851	<0.05	<0.05	<0.05	<0.10	<0.13	<0.03	<0.03	<2	0.12	9	14	3.2	<0.10	6	44	8	61	470	2	82	111	
	11/04/2014				<0.05	<0.05	<0.05	<0.10	<0.13	<0.03	<0.03									8	20	210				
F2	15/01/2013	550	11.7	3640	<0.05	0.05	<0.05	<0.1	<0.14	<0.03	<0.03	2	0.1	8	24	3.6	<0.1	4	49	8	20	<40	0.17	290	612	
	3/04/2013	710	12.4	4690	<0.05	<0.05	<0.05	<0.1	<0.12	<0.03	<0.03	<2	<0.1	7	17	2.6	<0.1	4	39	8	38	520	0.15	450	829	
	4/07/2013	50	4	337	<0.05	<0.05	<0.05	<0.05	<0.14	<0.03	<0.03	<2	0.11	11	16	2.5	<0.10	6	39	9	20	<40	15	62	66	WBM
F3	15/01/2013	750	9.9	4920																					708	
	3/04/2013	1310	22.8	8660	<0.05	<0.05	<0.05	<0.1	<0.13	0.15	<0.03	<2	<0.1	11	19	4.6	<0.1	7	47	8	2400	10200	0.12	940	1587	
	4/07/2013	180	4.2	1221	<0.05	<0.05	<0.05	<0.05	<0.14	0.06	<0.03	2	0.14	12	23	4	<0.10	8	42	9	450	2800	0.17	220	166	SBM
	15/11/2013	360	7.8	2380	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.03	<2	0.14	10	19	4.6	<0.10	7	49	<8	900	6100	1	360	363	
	11/04/2014				<0.05	<0.05	<0.05	<0.05	<0.14	<0.03	<0.03									9	620	2800				
F4	4/07/2013	120	2.6	779	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	0.16	8	13	2.5	<0.10	6	46	8	23	189	0.23	59	88	
	17/01/2014	150	2.6	970	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	0.15	9	14	2.9	<0.10	5	46	8	270	1390	1	72	112	WBM/SBM
	11/04/2014				<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03									8	20	40				
F5	4/07/2013	200	4.6	1320	<0.06	<0.06	<0.06	<0.11	<0.14	<0.03	<0.03	<2	0.13	9	14	3.1	<0.10	6	46	9	250	1010	0.2	165	195	
	15/11/2013	130	5.4	858	<0.05	<0.05	<0.05	<0.10	<0.13	<0.03	<0.03	<2	0.2	10	15	2.4	<0.10	5	54	<8	97	510	6	117	151	WBM
	11/04/2014				<0.05	<0.05	<0.05	<0.10	<0.13	<0.03	<0.03									8	20	86				
F6	16/07/2013	50	2.1	343	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	0.12	7	11	1.8	<0.10	4	38	8	20	131	22	22	42	
	17/01/2014	20	1	138	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	0.13	9	14	2	<0.10	5	49	8	153	650	1	8	17	WBM
	2/05/2014				<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03									8	20	40				
F7	16/07/2013	70	2.6	436	<0.05	<0.05	<0.05	<0.05	<0.13	<0.03	<0.03	<2	0.11	7	12	1.7	<0.10	4	40	8	68	370	0.13	39	58	
	17/01/2014	80	3.8	521	<0.05	<0.05	<0.05	<0.05	<0.12	<0.03	<0.03	<2	<0.10	8	13	1.8	<0.01	5	50	8	83	610	1	51	83	WBM
	2/05/2014				<0.05	<0.05	<0.05	<0.05	<0.12	<0.03	<0.03									8	20	40				
F8	25/09/2013	70	3.2	462	<0.05	<0.05	<0.05	<0.05	<0.14	<0.03	<0.03	<2	0.17	10	16	2.9	<0.10	6	52	<9	420	1470		79	71	
	17/01/2014	70	2.9	449	<0.05	<0.05	<0.05	<0.05	<0.12	<0.03	<0.03	2	0.17	9	16	2.6	<0.10	5	50	8	20	119	9	34	67	WBM
	2/05/2014				<0.05	<0.05	<0.05	<0.05	<0.12	<0.03	<0.03									9	20	40				

Table 4.1: Monitoring Results from Oeo Landfarm

4.1 Compliance with SC's 14 and 15

Conditions 14-15 require:

> *14. The exercise of this consent shall not result in the concentration of total dissolved salts in any fresh water body exceeding 2500 g/m3*
>
> *15. Other than as provided for in condition 15, the exercise of this consent shall not result in any containment concentration, within surface water or groundwater, which after reasonable mixing, exceeds the background concentration for that particular contaminant.*

Compliance with SC's 14-15 is contained in Appendix C with the results of the Rawa Stream.

4.2 Compliance with SC's 16 - 20

4.2.1 Condition 16 – Soil Conductivity

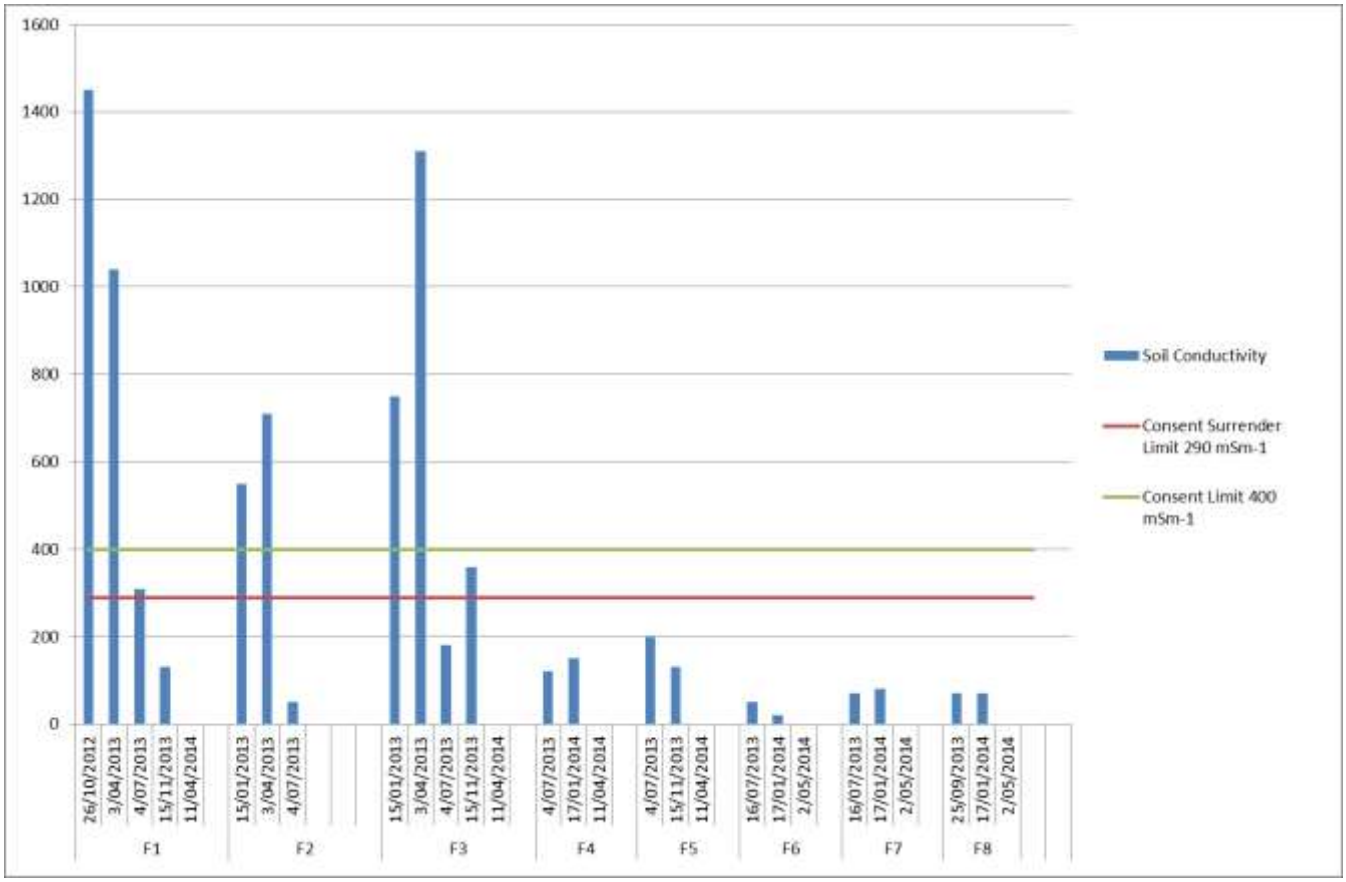


Figure 4.1: Soil Conductivity Analysis – Oeo Landfarm

For the monitoring period all landfarmed area's demonstrated compliance with consent conditions and meet surrender criteria, as show in Figure 4.1 above.

Area/s not within consent surrender limits: **None**

4.2.2 Condition 17 – SAR

Condition 17 requires:

> *17. The sodium absorption ratio (SAR) of the soil / waste layer after landfarming shall be less than 18.0, or alternatively if the background SAR exceeds 18.0, the landfarming of waste shall not increase the SAR by more than 1.0.*

As shown in Figure 4.2 below, all the landfarmed areas are within the surrender criteria for the consent.

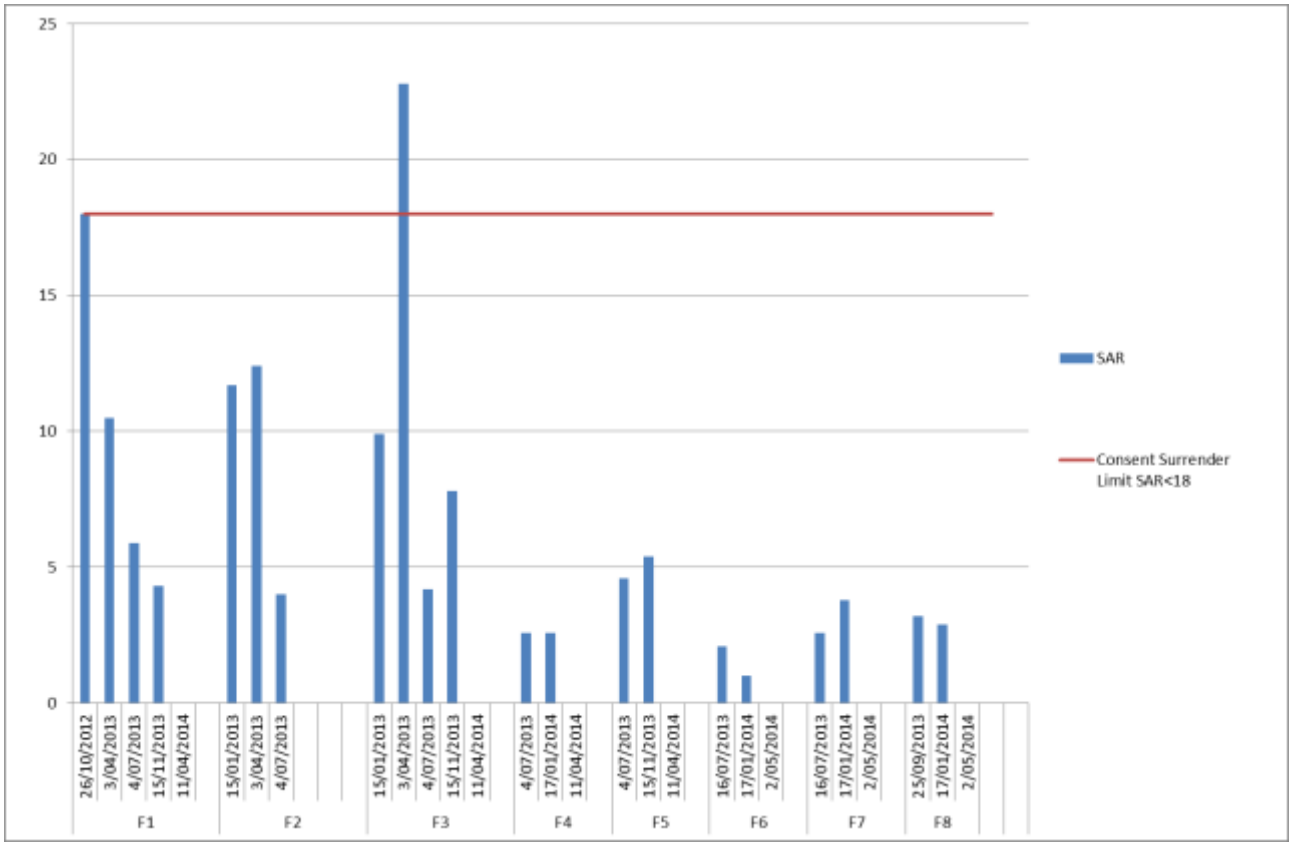


Figure 4.2: SAR Analysis – Oeo Landfarm

Area/s not within consent surrender limits: **None**

4.2.3 Condition 18 – Heavy Metals

Condition 18 requires:

18. The concentration of metals in the soil shall at all times comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the Ministry of the Environment and New Zealand Water and Wastes Association's Guidelines for the safe application of biosolids to land in New Zealand (2003)

As shown in Table 4.1, all metal concentrations are compliant with Table 7.1, Section 7 of the Ministry of the Environment and New Zealand Water and Wastes Association's Guidelines for the safe application of biosolids to land in New Zealand (2003).

4.2.4 Condition 19 and 20 – Constituent Closure Criteria

Condition 19 requires:

19. From 1 March 2024 (Three months prior to the consent expiry date), constituents in the soil shall not exceed the standards shown in the following table:

Table 4.2: Consent Surrender Limits

Constituent	Standard
Conductivity	290 mS/m
Chloride	700 mg / kg
Sodium	460 mg /kg
Total soluble salts	2500 mg / kg
MAHs PAHs TPH	Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (Ministry for the Environment, 1999). Tables 4.12 and 4.15, for soil type sand.

MAHs – benzene, toluene, ethylbenzene, xylenes
PAHs – naphthalene, non coarc. (Pyrene) benzo(a)pyrene eq.
TPH – Total petroleum hydrocarbons (C_7-C_9, C_{10}-C_{14}, and C15-C_{36}).

The requirement to meet these standards shall not apply if, before 1 March 2028, the consent holder applies for a new consent to replace this consent when it expires.

20. This consent may not be surrendered at any time until the standards in condition 19 are being met.

The monitoring and data of these constituent levels follows in this report. However currently all areas meet consent surrender limits except for F3 which is only above the surrender criteria for the TPH C10 – C14 criteria. It is expected this hydrocarbon chain will bio remediate over time and the consent can be surrendered in the near future.

4.2.5 Chloride

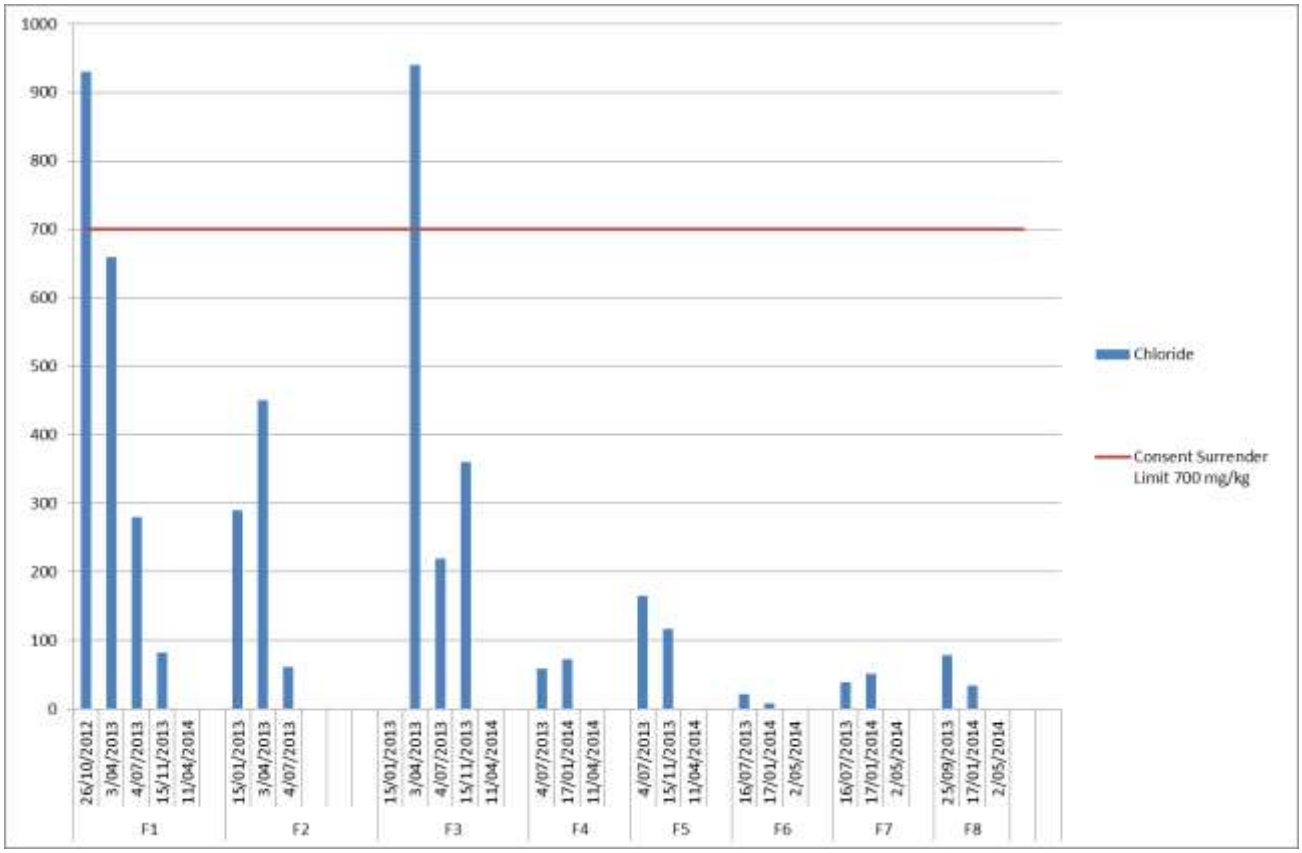


Figure 4.3: Chloride Analysis – Oeo Landfarm

As shown in Figure 4.3, all landfarmed areas meet consent surrender criteria.

4.2.6 Sodium

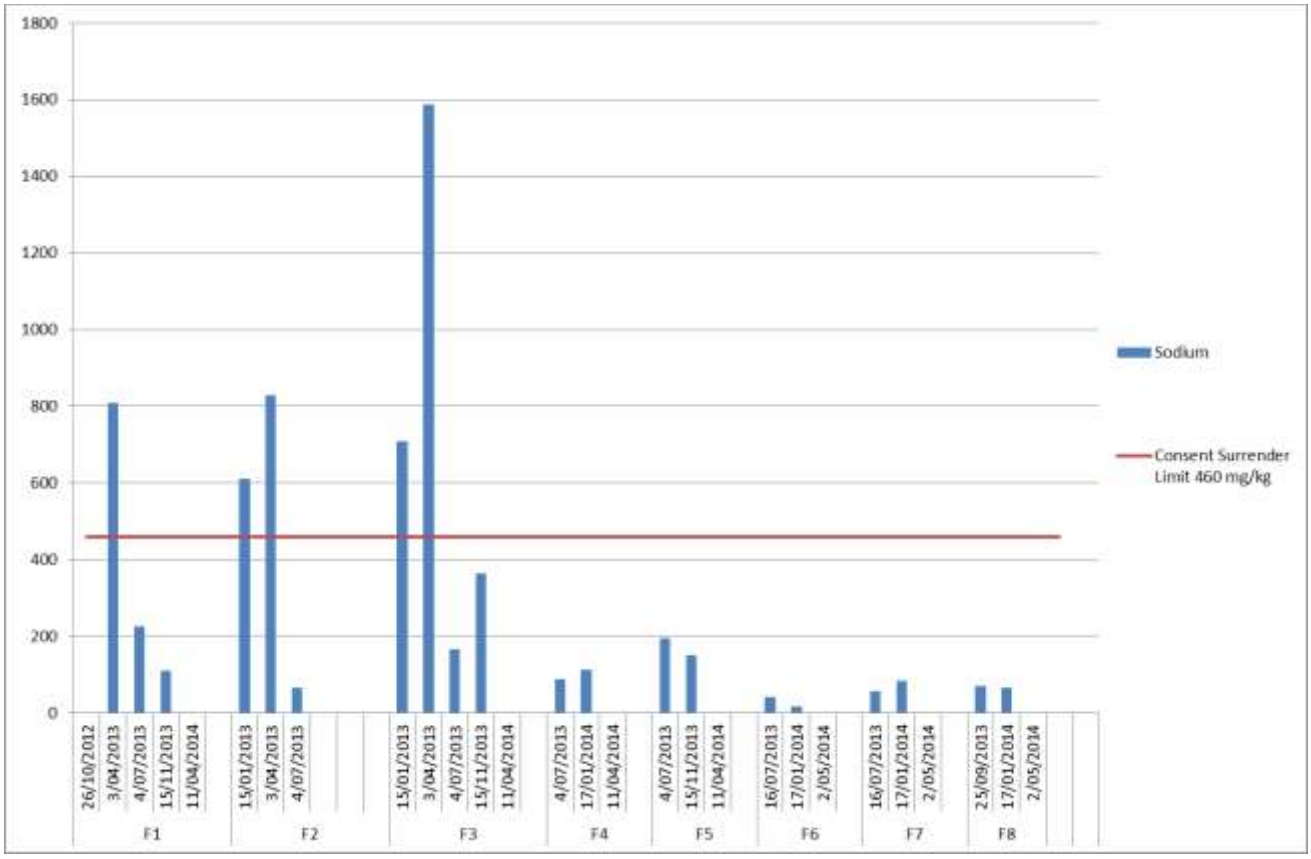


Figure 4.4: Sodium Analysis – Oeo Landfarm

As shown in Figure 4.4, consent surrender requirements for Sodium have been reached for all monitored areas of the landfarm.

4.2.7 Dissolved Salts

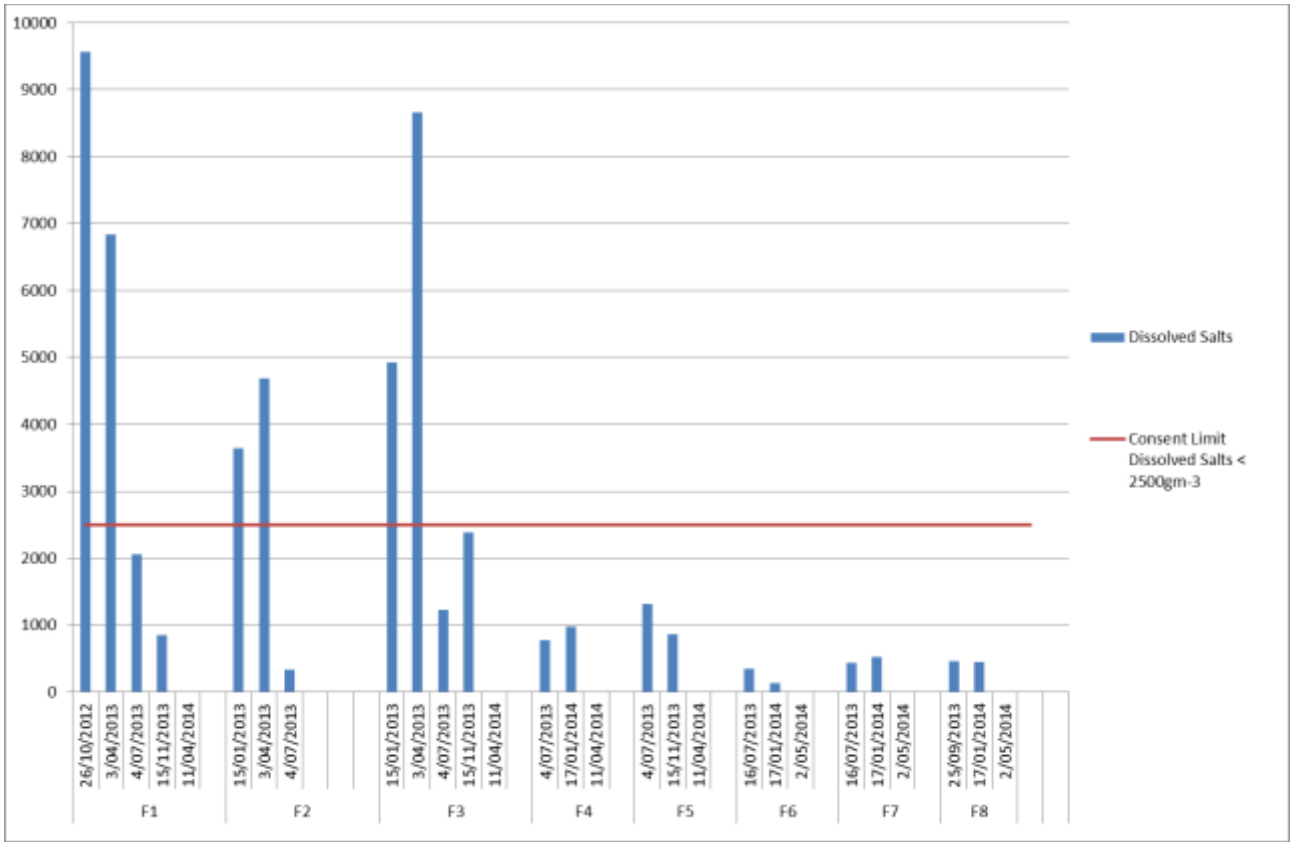


Figure 4.5: Dissolved Salts Analysis – Oeo Landfarm

As shown in Figure 4.5, consent surrender requirements for Dissolved Salts have been reached for all monitored areas of the landfarm

4.2.8 TPH C7 – C9

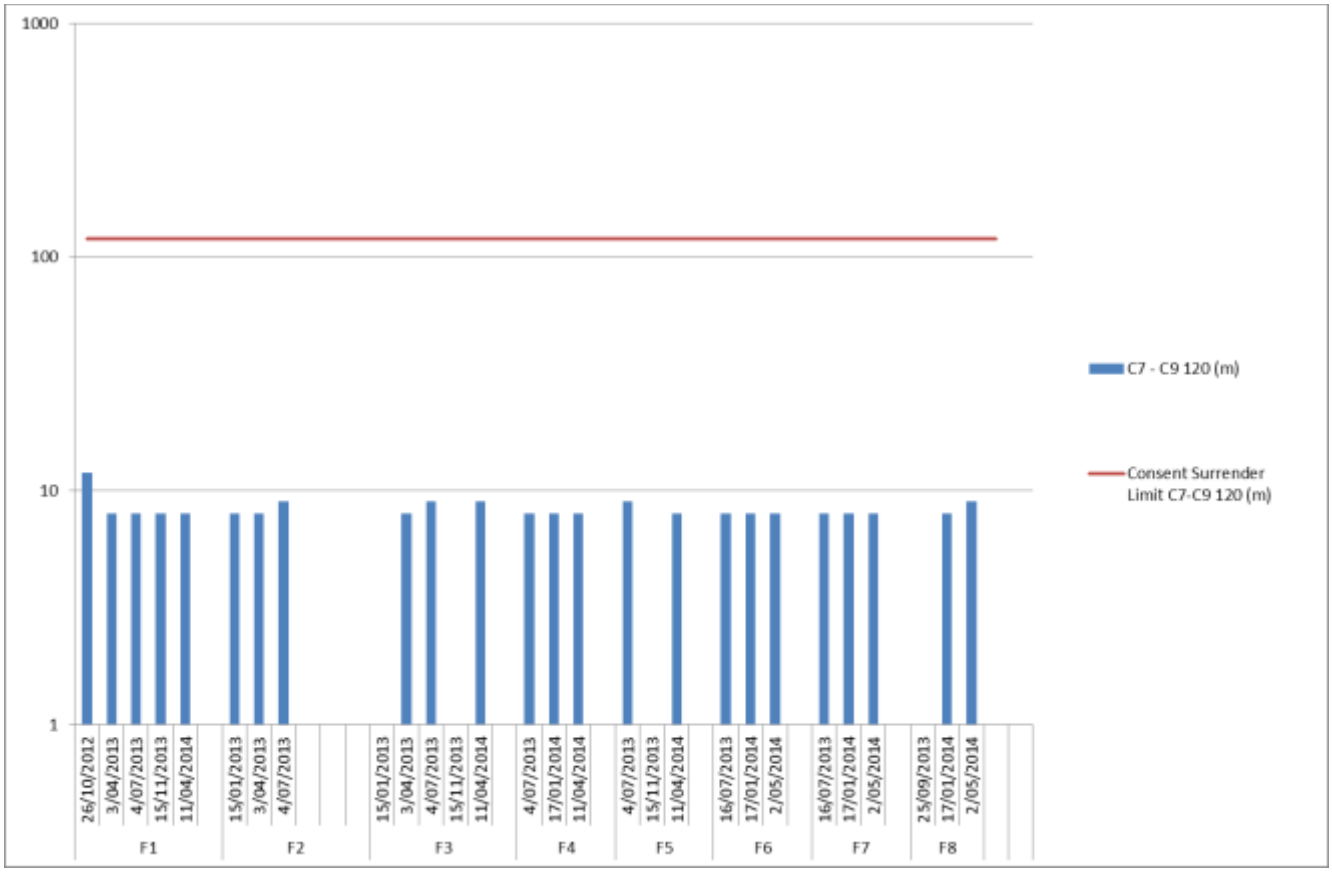


Figure 4.6: TPH C7-C9 – Oeo Landfarm

As shown in Figure 4.6, results for TPH C7-C9 at the Oeo landfarm were within the consent surrender limits for all areas.

4.2.9 TPH C10 – C14

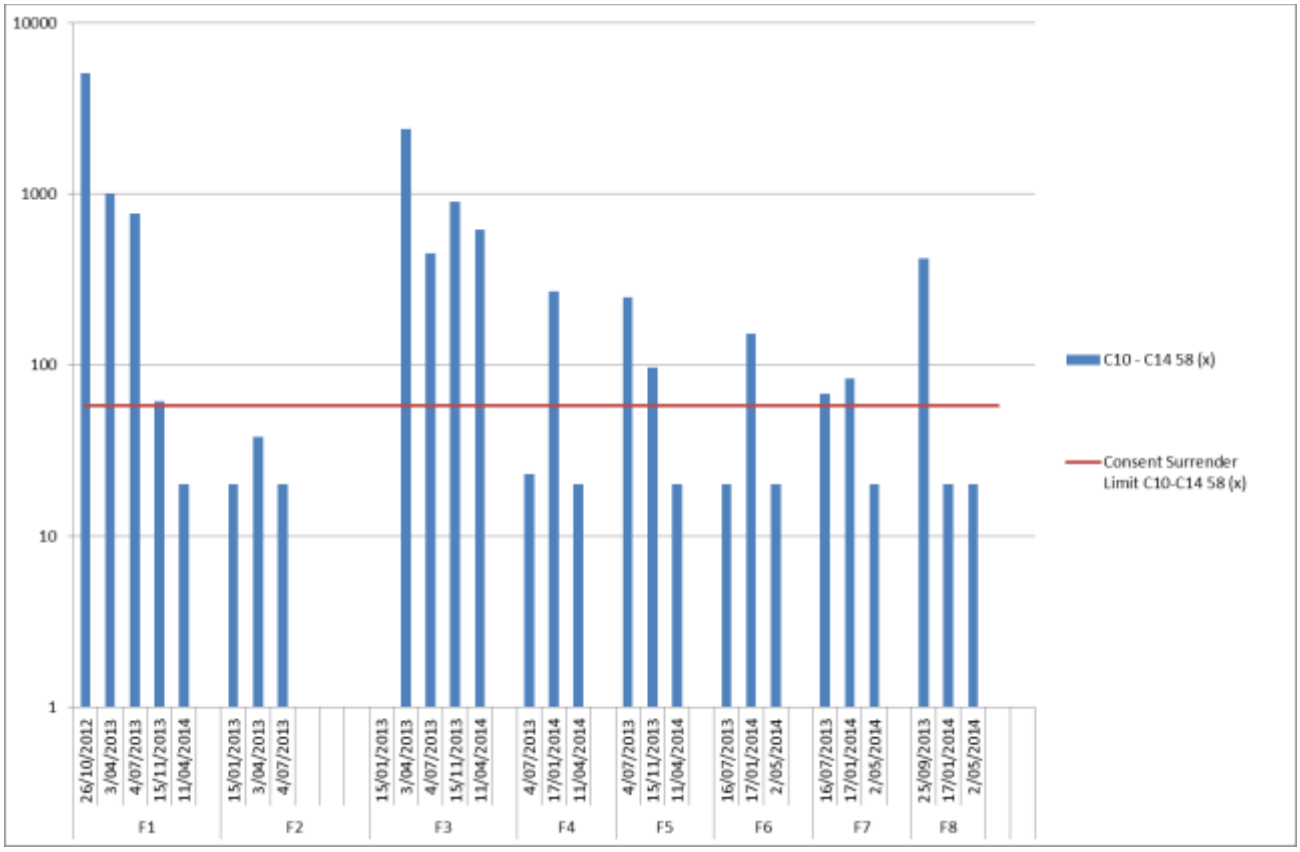


Figure 4.7: TPH C10-14 – Oeo Landfarm

As shown in Figure 4.7, all the land farmed areas except F3 meet surrender criteria for the consent. Monitoring of F3 will continue and possibly additional natural treatment like aeration may be required to assist with the breakdown of this hydrocarbon chain so the consent can be surrendered within this next monitoring year.

4.2.10 TPH C15 – C36

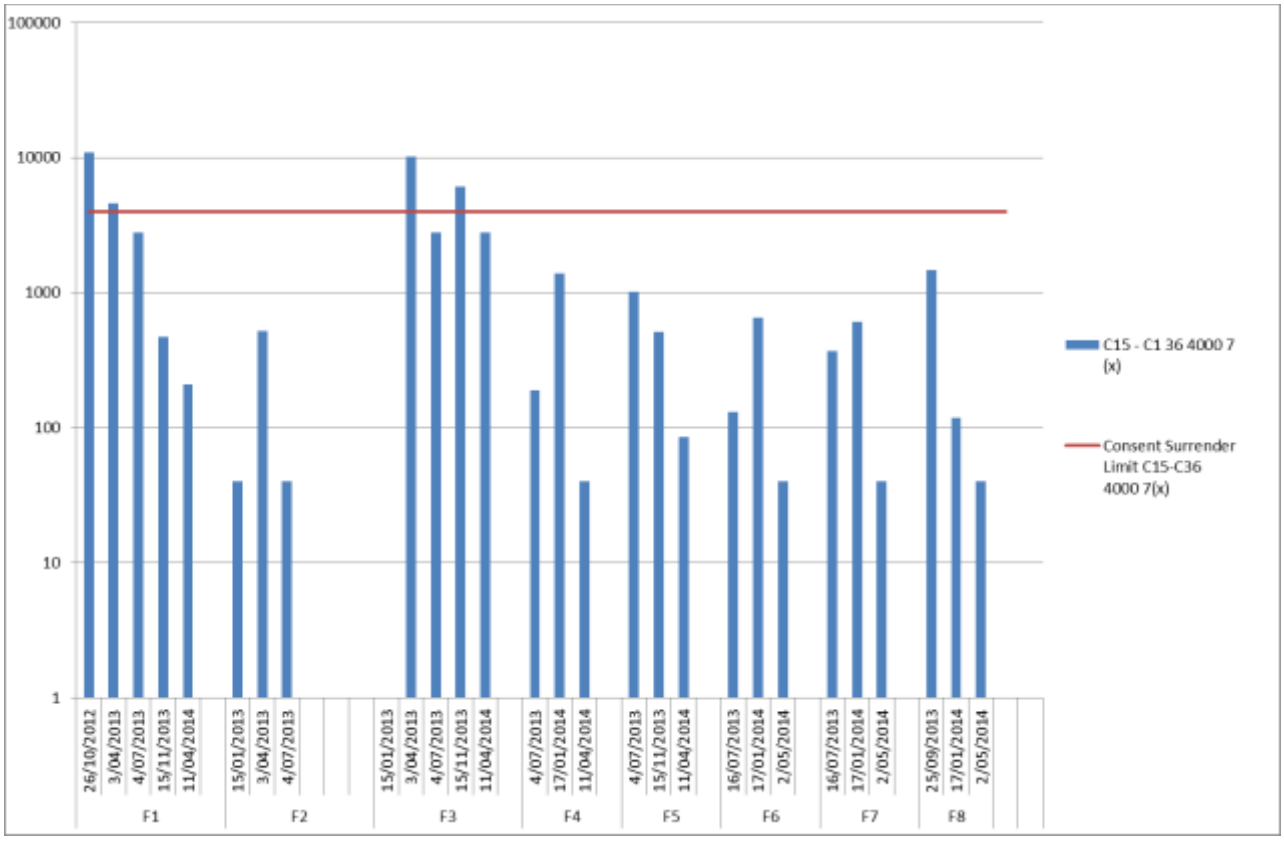


Figure 4.8: TPH C15-36 – Oeo Landfarm

Figure 4.8 shows results for TPH C15-C36 for all sites. All areas are now within the surrender criteria for the consent.

5 SUMMARY

The monitoring of the Oeo landfarm site has shown pleasing results over the last year. All areas except one (F3) meet surrender criteria. This attenuation of drilling mud contaminates over time is demonstrating that the land farming option is sustainable if appropriate management, application rates, waste source and environmental factors are adhered too.

It is likely that some additional treatment may be required to the F3 area to assist with hydrocarbon breakdown. Further aeration during the spring time of the F3 area is likely to stimulate microbe breakdown of hydrocarbon molecules using oxygen.

It is worth noting the surrender criterion on the consent is a stringent standard to meet. These guidelines are set by the Ministry for the Environment to ensure constituents in the soil are at a level that poses negligible risk to agricultural activities, this includes pathways such as ingestion by stock. This standard is more stringent than what is required for soil acceptance criteria for residential activities.

As the results demonstrate, the F3 area has not yet met surrender criteria for the consent, therefore will be continually monitored by BTW, all other areas meet surrender criteria.

APPENDIX A COMPOSITION OF WASTE

WBM – TYPICAL CHEMICALS

Table 1: Typical Chemicals used in Drilling

Chemical Description	Use	Phase
Sodium Sulphite with 2% Cobalt Chloride catalyst	Oxygen scavenger	Solid
Non-ionic Isothiazolin Solid	Biocide	Solid
Cationic Polymer	Shale stabiliser	Liquid
Sodium Hydroxide	PH control	Solid
Sodium Montimorillonite	Viscosifier	Solid
Polyanionic Cellulose	Filtrate control	Solid
Xanthan Gum	Viscosifier	Solid
Calcium Hydroxide	Flocculant	Solid
Ground Peanut Shells (Liquid casing)	Lost circulation material	Solid
Ammonium thiocyanate	Tracer in well	Solid
Potassium Chloride		

Table 2: Drilling Fluid Contingency Items

Chemical Description	Use	Phase
Zinc Oxide	Sulphide scavenger	Solid
Alcohol ethoxylate blend	Defoamer	Liquid
Sodium Bicarbonate	Calcium precipitation	Solid
Sodium Chloride	Clear Brine	Solid
Poly-glycol/Poly-glycotlether Surfactant blend	Well lubricant	Liquid
Calcium Carbonate	Lost circulation material	Solid
Acrylamide acrylate polymer	Shale encapsulator	Solid/Liquid
Polymino Acid	Shale Stabiliser	Liquid
Barioum Sulfate (barite)	Inert weighting agent	Solid
Citric Acid	PH control	Solid
Mica	Lost circulation material	Solid
Ground Walnut Shells	Lost circulation material	Solid
Sodium Carbonate	Calcium precipitation	Solid
Chrome free Lignosulfonate	Dispersant	Solid
Surfactant/Emulsifier blend	Stuck pipe compound	Liquid
Blended filming aminos	Corrosion Inhibitor	Liquid
Phosphate ester salt	Corrosion Inhibitor	Liquid
Sodium Silicate (Cementing)	Lost circulation material	Solid
Calcium Chloride (cementing)	Inhibitor	Solid

APPENDIX B SITE MAPS

APPENDIX C COMPLIANCE WITH SC'S 14 AND 15 - RAWA STREAM

Hill Laboratories
BETTER TESTING BETTER RESULTS
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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	BTW Company Ltd	**Lab No:**	1163003	SPv1
Contact:	Dave Bolger	**Date Registered:**	02-Aug-2013	
	C/- BTW Company Ltd	**Date Reported:**	08-Aug-2013	
	PO Box 551	**Quote No:**	45045	
	NEW PLYMOUTH 4340	**Order No:**		
		Client Reference:	Tank Water	
		Submitted By:	Dave Bolger	

Sample Type: Aqueous						
Sample Name:		RAWA 31-Jul-2013 1:00 pm				
Lab Number:		1163003.1				
Individual Tests						
pH	pH Units	7.3	-	-	-	-
Electrical Conductivity (EC)	mS/m	31.3	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	190	-	-	-	-
Specific Gravity*	20°C/20°C	1.00	-	-	-	-
Total Potassium	g/m³	7.4	-	-	-	-
Total Sodium	g/m³	30	-	-	-	-
Chloride	g/m³	49	-	-	-	-
Total Nitrogen	g/m³	2.1	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	1.64	-	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	0.48	-	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Chromium	g/m³	< 0.00053	-	-	-	-
Total Copper	g/m³	0.00125	-	-	-	-
Total Lead	g/m³	0.00012	-	-	-	-
Total Nickel	g/m³	< 0.00053	-	-	-	-
Total Zinc	g/m³	0.0034	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0010	-	-	-	-
m&p-Xylene	g/m³	< 0.002	-	-	-	-
o-Xylene	g/m³	< 0.0010	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	-	-	-	-
C10 - C14	g/m³	< 0.2	-	-	-	-
C15 - C36	g/m³	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	-	-	-	-

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BETTER TESTING BETTER RESULTS

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	BTW Company Ltd	**Lab No:**	1214882	SPv1
Contact:	Dave Bolger	**Date Registered:**	13-Dec-2013	
	C/- BTW Company Ltd	**Date Reported:**	20-Dec-2013	
	PO Box 551	**Quote No:**	45045	
	NEW PLYMOUTH 4340	**Order No:**	09389	
		Client Reference:	Tank Water	
		Submitted By:	Dave Bolger	

Sample Type: Aqueous

Sample Name:		Rawa 10-Dec-2013 4:00 pm				
Lab Number:		1214882.1				
Individual Tests						
pH	pH Units	7.4	-	-	-	-
Electrical Conductivity (EC)	mS/m	31.8	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	200	-	-	-	-
Specific Gravity*	20°C/20°C	1.01	-	-	-	-
Total Potassium	g/m³	7.8	-	-	-	-
Total Sodium	g/m³	29	-	-	-	-
Chloride	g/m³	51	-	-	-	-
Total Nitrogen	g/m³	1.87	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	1.50	-	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	0.37	-	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Chromium	g/m³	< 0.00053	-	-	-	-
Total Copper	g/m³	0.00145	-	-	-	-
Total Lead	g/m³	0.00017	-	-	-	-
Total Nickel	g/m³	< 0.00053	-	-	-	-
Total Zinc	g/m³	0.0015	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0010	-	-	-	-
m&p-Xylene	g/m³	< 0.002	-	-	-	-
o-Xylene	g/m³	< 0.0010	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	-	-	-	-
C10 - C14	g/m³	< 0.2	-	-	-	-
C15 - C36	g/m³	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	-	-	-	-

APPENDIX D PHOTOGRAPHIC RECORD OF LANDFARMING

October 2013 Whole site re-sown

January 2014 new areas landfarmed

Coastal Planting along buffer zone June 2014