BTW Company Limited
Oeo Landfarm
Monitoring Programme
Annual Report
2012-2013

Technical Report 2013-54

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Taranaki Regional Council
Private Bag 713
STRATFORD

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Executive summary

BTW Company Limited (BTW) operates a drilling waste landfarm located on South Road at Manaia (Oeo Landfarm) in the Waimate and Rawa catchments. Disposal activities commenced at this site during the 2012-2013 monitoring year. This report for the period July 2012 – June 2013 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 nine inspections, and collection of three soil samples, four surface water and ten groundwater samples, in addition to a review of monitoring data received from the Company.

The monitoring showed that during the early part of the year there were temporary and insignificant impacts on localised groundwater in proximity to the stockpiling facilities, due to the initial storage setup. Subsequent sampling has shown water quality has returned to background. In addition, housekeeping and site management was observed to be sub-par at times during the initial phase of site activity, but improved greatly during the monitoring period to be of high standard for the second half of the period under review. Pasture establishment over the more exposed areas of the site remained an issue. Levels of contaminants in the Council's soil results showed compliance with waste application criteria, and in most cases already with future surrender criteria (with the exception of some of the hydrocarbon limits for some of the areas). There were some initial salinity limit breaches in the supplied results, but subsequent sampling has shown compliance with consent conditions.

During the year, the Company demonstrated an overall 'improvement desirable' level of environmental performance and compliance with the resource consent, based primarily on some issues identified during the first part of the period and subsequently resolved. There was one incident recorded by the Council that was associated with consented activities at the site, resulting in the issuing of an abatement notice and an infringement notice. The environmental effects of this incident were negligible, but the occurrence of the incident highlighted some operational short-comings at the time, which the Company worked well to address during the rest of the monitoring year. The Company's management of the site improved significantly over the second part of the monitoring period, and there was compliance with all consent conditions. The Company's annual report was a large improvement on previous annual reports in terms of clarity and presentation of data.

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents.

This report includes recommendations for the 2013-2014 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 2012 - June 2013 by the Taranaki Regional 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 discharge consent for the Oeo site was granted in 2010. However, the site only became operational in the 2012-2013 monitoring year. The Company began stockpiling material at the site in September 2012. In October 2012 the Council determined to require storage pits at landfarming sites to be lined with impervious materials, and the Company were directed to farm the initial waste being held in pits, re-contour the pits, and line them with high grade synthetic HDPE liners. They were also required, along with other landfarm operators elsewhere, to install monitoring wells in close proximity to the storage facilities to assess liner integrity and detect any possible impacts on shallow groundwater at the site.

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 first Annual Report to be prepared by the Taranaki Regional 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 Resource Management Act and the Council's obligations and general approach to monitoring sites though 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 2013-2014 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 primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and 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 Taranaki Regional Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each discharge source. Monitoring programmes are not only based on exiting permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, (covering both activity and impact) monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management. Ultimately, through the refinement of methods, and considered responsible resource utilisation to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and consent performance

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

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions.

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

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

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

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process 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 $3-4000/ha to $30-40,000/ha (2013). The full report is attached in Appendix III.

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 utilized 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 to be used for grazing following stabilisation and re-grassing.

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 1122 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.

Site data

Location

Word descriptor:	South Road, Manaia, Taranaki
Map reference:	E 1684821
(NZTM)	N 5621560
Mean annual rainfall:	1122 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
Land use:	Remediation farming livestock / grazing cattle

Table 1 Bore construction data

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

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 Taranaki Regional 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 Resource Management Act sets out obligation/s upon the Taranaki Regional 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 Taranaki Regional 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 Taranaki Regional 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 five scheduled inspections were made of the site during the monitoring period, with regard to the consents for the discharge of drilling waste. Further inspections were conducted at the site during sampling and incident follow up inspections were also conducted. 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 three composite soil samples from the Oeo site, as the other spread areas required final contouring and sowing at the time of sampling. 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 constructed and each sampled three times. Samples were analysed for pH, temperature, conductivity, chloride, TPH and BTEX.

The Rawa Stream was sampled twice at two sites for standard surface water quality parameters, hydrocarbons, and (on one occasion) heavy metals.

1.5.5 Review of analytical results

The Council reviewed soil sampling results and the annual reports provided by the Company in respect of both sites. 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 Inspections

23 August 2012
A light breeze was present from the south east at the time of inspection and only localised hydrocarbon/mud odours were detected downwind of the pits. One of the pits was found to be full and no receding tide line was apparent. The level of the adjacent pit was lower yet no material appeared to be moving through the pit wall into the lower pit (ie no signs of leakage from the pits). Materials were being delivered to site in bins, the bins were then washed when emptied and the washings were being discharged into the pit. No spreading had yet occurred and the surrounding vegetation appeared healthy. The ponded water around the turning area appeared free of hydrocarbon sheen. The site appeared well managed.

6 November 2012
At the time of inspection it was noted that the central storage pit was almost at capacity. The pit area looked good, but there was still liquid contained within the unlined pit. The site was generally tidy and structured and spreading area F1 was well contoured, but the pasture appeared to be having great difficulty establishing. The groundwater samples obtained were fairly clear. The sample from bore 2287 had a hydrocarbon odour. Discussion regarding the pasture establishment with members of staff from BTW on site occurred, during which they advised that they would have a second attempt to sow the area in March.

26 November 2012
At the time of inspection a light breeze from the west was present and strong hydrocarbon odours were detected around the storage area and downwind of the landfarm area where muds had previously been applied. All pit liners appeared to be in good condition with plenty of freeboard still available. Drilling muds had been applied to the land, however the material was visible on the surface and no incorporation activities were noted to have occurred. It was observed that ponded liquid had drained to the cliff side of the site and a bund wall had been installed utilizing the scraped topsoil. Evidence showed some of the mud had discharged over the cliff and onto the beach below and vegetation up to the cliff was also coated in the drilling mud. It was advised to BTW that they incorporate all applied muds into the soil as soon as practical to ensure the consent conditions are complied with at all times. An incident was registered against the consent for this event. Further detail is provided in Section 2.5.

7 January 2013
At the time of inspection initial concern was presented upon arrival as the site was extremely dusty, potentially resultant from landfarming activities/operations. However, further inspection indicated that background dust levels were very high through the wider area due to high winds and the on-going dry weather. During the inspection material was being farmed at the site in area F3. Earthworks were also being undertaken around the site, with topsoil being taken from a borrow pit next to the spreading area. Aside from the additional dust being generated, the spreading area looked good. The unlined pit had been reinstated and the other pits had been emptied for farming. The side of one of the liners must have been torn during operations and had been patched. In the future it would be advisable to leave some material in the bottom during emptying to avoid damaging the liners until the pits are ready for reinstatement.

16 January 2013
A light breeze was present from the west at the time of inspection and no objectionable odours were detected beyond the site boundary, but strong localised hydrocarbon / mud odours were noted directly downwind of the pits. Two pits were on site, of which both liners appeared to be intact and the pits were less than half full. No recent mud spreading had occurred prior to the inspection, but a large area had been levelled in preparation for receiving muds. Another area had been re-sown after having muds applied/incorporated and a bund had been created upwind to reduce destabilisation of the area. The area adjacent to the pits which received muds initially had drilling mud present at the surface and the pasture growth was poor, it was suggested that this area may need to be disked and re-sown when the weather conditions were more favourable. A fence had been erected along the cliff top and the buffer zones were being adhered to.

27 March 2013
At the time of inspection no objectionable odours were detected beyond the site boundary. An inspection of the earthworks found that the area receiving the muds was well contoured with good bunding in place and no spreading had occurred within the buffer zones. It was observed that the muds were being applied and incorporated well with very little ponding around the area of application. Previous areas where muds had been spread were planned to be re-sown when the weather permitted. The washing of containers at the site was on an area of metal which has a plastic liner underneath and drains into one of the pits. The two lined pits at the site were noted to have plenty of capacity and the liners appeared to be in good shape.

22 April 2013
At the time of inspection no objectionable odours were detected, although localised hydrocarbon / mud odours were noted around pits and areas where muds had been spread. The two lined pits on site had varying capacities, with the fullest pit draining to the lesser pit. Ponded storm water around the site was observed to be essentially free of hydrocarbons. No disposal or spreading was occurring upon inspection, just minor earthworks were underway using a forklift. The area where muds had been applied looked good and approximately 80% had been well incorporated. The bund integrity looked good with grey/turbid ponded rainwater contained within it. Good contouring works have helped to reduce the risk of overland flow/ponding. The area where muds were previously applied showed limited pasture regrowth, partly due to traffic movements.

22 May 2013
At the time of inspection no objectionable odours or visible emissions were observed. Two lined pits were at the site, both containing drilling waste materials. Pit one had little freeboard (approximately 15cm) and very little oil was present on the surface of both pits. The area where muds had been applied and incorporated looked good, the top soil was yet to be re-applied and bunding was complete around the spreading area. The area to the west of the spreading area had been contoured up to the Waimate Stream (of which the stream channel was dry upon inspection), but no muds appeared to have been discharged within this zone. Pasture growth around the spread areas of the site were considered poor, featuring very few areas which had been sown (mainly sparsely populated coastal weeds were present). Machinery was being delivered to the site. It was advised to BTW that they establish pasture across areas where muds have been applied as soon as practical.

8 May 2013
Routine soil sampling was conducted upon inspection at this site from spreading area F3. Areas F4-6 were also going to be sampled, but it was unclear whether activity at these sites had been completed. Spreading was taking place in area F7, however, at the time of inspection there were no personnel on site and activity appeared to have temporarily ceased. The site was generally looking good with no ponding observed in the current spreading area and no additional issues were observed. A follow up query for BTW will be made regarding areas F4-6 to establish when they will be completed and ready to sample.

2.2 Results of discharge monitoring

Activities at the site commenced in September 2012, with the stockpiling of SBM from Mangahewa D. Material was sourced from Mangahewa D & C, Cheal A, B & C, Sidewinder and KA 20 wellsites and Maui B.

There were eight disposals during the monitoring period of approximately 4278 m^3 of water/synthetic based cuttings and fluids. The waste was spread over an area of approximately 61,047 m^2 (areas F1 through to F8, Figure 2). No hydraulic fracturing wastes have been disposed of at this site.

Spreading areas F1 and F3 were spread at a thickness of 50 mm as average TPH concentrations were greater than 50,000 mg/kg dry weight. The remaining areas were spread at the 100 mm rate as TPH concentrations were less than 50,000 mg/kg dry weight.

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.

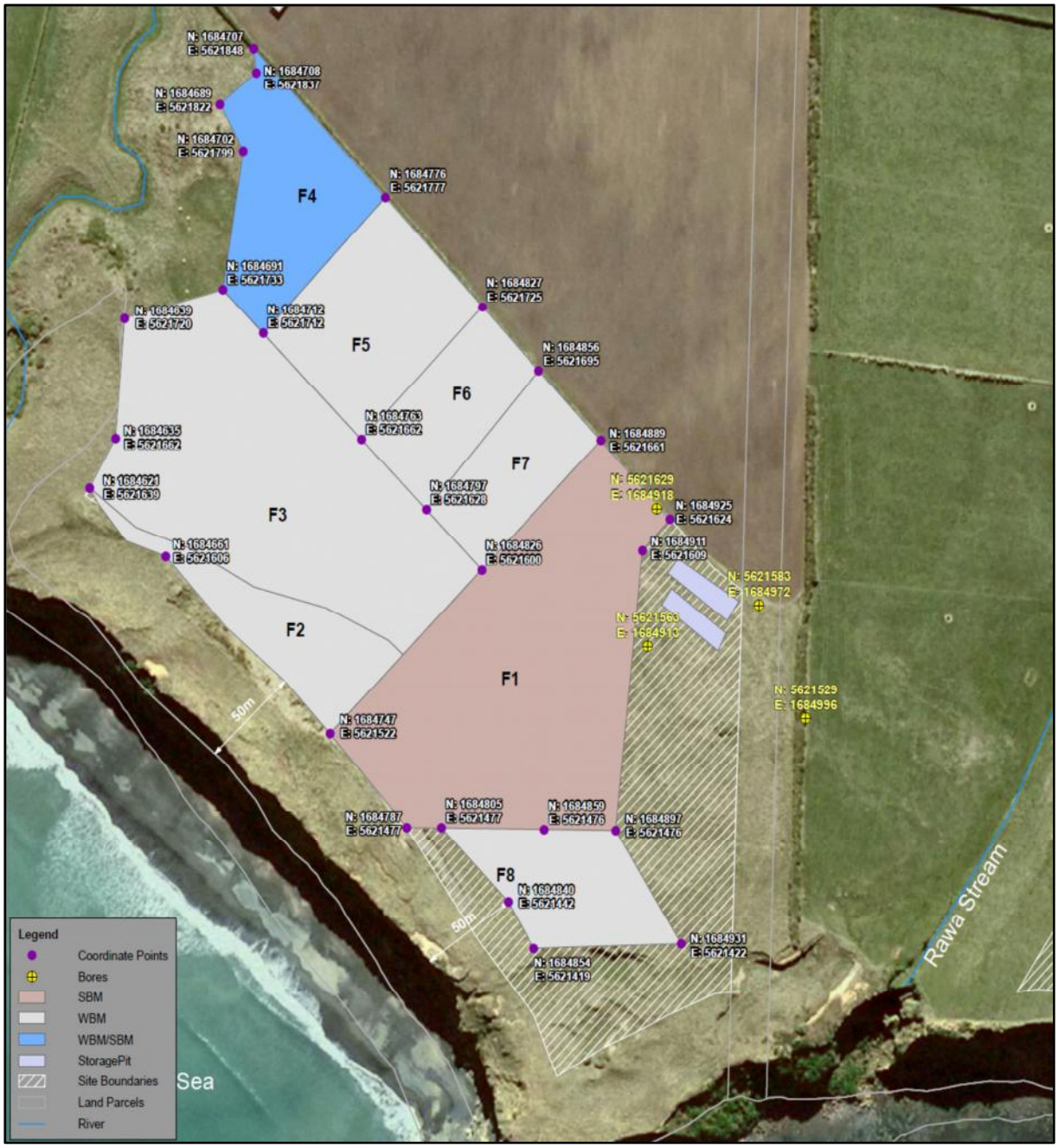

Figure 2 Oeo Landfarm site plan June 2013 showing spreading areas F1-F8

2.3 Results of receiving environment monitoring

2.3.1 Council soil results

During the monitoring year, three composite soil samples were collected by sub-sampling to a depth of 250mm in completed spreading areas F1 and F3. Area F3 was resampled on 27 June 2013 as reviewing of BTW's supplied results indicated a potential non-compliance for the SAR limit. The results are presented below in Table 1, along with supplied baseline results and consent limits.

Table 2 TRC soil sample results, Oeo Landfarm 2012-2013

Parameter	Unit	F1	F3	F3	Baseline*	Consent limit
		6-Nov-12	8-May-13	27-June-13		
Calcium	mg/kg	109	73.4	156	-	-
Chloride	mg/kg DW	539	410	486	40	700
Conductivity	mS/m@20C	254	239	286	-	290
Hydrocarbons	mg/kg DW	7900	9200	12500	<70	50,000 (at application)
Moisture Factor	nil	1.144	1.208	1.201	-	-
Magnesium	mg/kg	15	7.7	14.4	-	-
Sodium	mg/kg	196	286	275	490	460
pH	pH	7.7	8.0	8.1	-	-
Sodium Absorption Ratio	None	4.7	8.5	5.6	-	18
Total Soluble Salts	mg/kg	1988	1870	2238	-	2500

*Baseline figures taken from BTW supplied results

Total hydrocarbon concentrations in area F3 were relatively high, but still well within application limits and can be expected to reduce further through bioremediation. Total soluble salts were also relatively elevated within this area. The first SAR results for area F3 were elevated, but were still within the consent limit, and the subsequent June sampling confirmed consent compliance.

2.3.2 Council groundwater results

Initially, three monitoring wells (GND2286, 2287 and 2288) were constructed at the site to assess for any impacts on localized groundwater from the stockpiling facilities, which present the highest risk as waste is stored in concentrated form. A fourth well (GND2350) was installed at the request of Ngati Haua Hapu representatives who were concerned about the potential for subsurface migration of contaminants towards the Rawa Stream. Monitoring well schematics are included in Appendix V. The locations of all water sampling sites are given in Figure 3, below.

During the monitoring period, the three initial wells were sampled three times, and the fourth monitoring well was sampled once. Samples were analyzed for chloride, pH, conductivity, BTEX and TPH. The results are presented in Tables 3 and 4.

Table 3 Groundwater results, Oeo landfarm, for general water quality and salinity parameters

Site	Date	SWL* (m)	temperature (°C)	pH	Chloride (g/m³)	Conductivity (mS/m @20 °C)	Barium (g/m³)
GND2286	04 Sep 2012	3.78	14.3	6.7	149	74.9	-
	06 Nov 2012	4.27	14.7	6.6	259	74.0	0.10
	05 Apr 2013	4.95	-	-	-	-	-

Site	Date	SWL* (m)	temperature (°C)	pH	Chloride (g/m³)	Conductivity (mS/m @20 °C)	Barium (g/m³)
GND2287	04 Sep 2012	3.97	14.0	6.4	**400**	**228**	-
	06 Nov 2012	4.47	14.7	7.0	**1480**	**560**	**0.76**
	05 Apr 2013	5.53	-	-	-	-	-
GND2288	04 Sep 2012	3.10	14.5	6.6	123	61.2	-
	06 Nov 2012	3.50	14.4	6.5	146	67.3	0.17
	05 Apr 2013	4.25	-	-	-	-	-
GND2350	24 May 2013	5.66	14.9	6.6	261	107	0.06

*Standing water level, measured from top of monitoring well

Groundwater monitoring conducted during the monitoring period showed reasonably typical results for coastal groundwater in the region, with naturally elevated chloride and conductivity indicative of the influence of the nearby Tasman Sea. Monitoring well GND2287, however, showed elevated salinity parameters in excess of background. This would suggest that the initial setup of the stockpiling area was having a localized effect on groundwater. Elevated salinity in non-consumable coastal groundwater presents no significant environmental risk. Barium appeared slightly elevated in well GND2287; however, as observed at some of the other disposal sites, the methodology used to measure barium (acid soluble) is inconsistent with that used by RJ Hill Laboratories and subject to elevation from suspended material in a sample. It is recommended that future barium testing uses the dissolved barium through filtration method in assessing barium levels in groundwater.

Table 4 presents the hydrocarbon results from the four sampling occasions.

Table 4 Groundwater results, Oeo landfarm, for TPH and BTEX

Site	Date	Benzene (g/m³)	Toluene (g/m³)	Ethylbenzene (g/m³)	O-Xylene (g/m³)	M & P-Xylene (g/m³)	C7-C9 (g/m³)	C10-C14 (g/m³)	C15-C36 (g/m³)	TPH (g/m³)
GND2286	04 Sep 2012	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
	06 Nov 2012	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
	05 Apr 2013	<0.0010	0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
GND2287	04 Sep 2012	0.0020	0.0020	<0.0010	<0.0010	<0.002	**0.31**	**0.5**	**3.6**	**4.5**
	06 Nov 2012	**0.0041**	**0.0056**	<0.0010	**0.0012**	**0.002**	**0.22**	**0.8**	**4.9**	**6**
	05 Apr 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
GND2288	04 Sep 2012	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
	06 Nov 2012	**0.0042**	**0.0061**	<0.0010	**0.0011**	**0.002**	<0.10	<0.2	<0.4	<0.7
	05 Apr 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
GND2350	24 May 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7

Monitoring well GND2287 in particular showed concentrations of total hydrocarbons very slightly elevated above the limit of detection, and traces of benzene, toluene and xylene in the September and November sampling runs. Monitoring well GND2288 showed trace levels of benzene, toluene and xylene during the November sampling run. Concentrations were very low, but the resource consent stipulates that contaminants must not be present in surface or groundwater above baseline levels. To put the concentrations that were detected into perspective, they were far below New Zealand's drinking water criteria (Drinking-Water Standards for New Zealand, 2000).

The concentrations of BTEX in the bores have been compared with the drinking water standards, as exact limits were not set in the consent conditions. In the absence of consent limits, the conventional approach is to compare results to the most stringent guideline values. In reality, the drinking water standards are arguably not applicable at this site, as there is no actual or likely abstraction of water intended for consumption by humans or animals. The Tier 1 groundwater acceptance criteria for benzene are 0.8 g/m^3 for irrigation, 4 g/m^3 for stock water, and 0.3 g/m^3 for protection of aquatic ecosystems (MfE, 1999). The levels detected in the samples from the Oeo landfarming facilities are well within these guideline values (by orders of magnitude).

Following the lining of the stockpiling pits there was a relatively rapid reduction of hydrocarbon concentrations to back to below detection levels (5 April 2013 samples). This justifies the Council's initiative to ensure high grade synthetic liners be installed at all current disposal sites. Sampling of these wells will continue, to ensure ongoing consent compliance.

It is noted there was no evidence of hydrocarbons emerging into surface water (next section).

No hydrocarbons have been detected in wells GND2286 or GND2350.

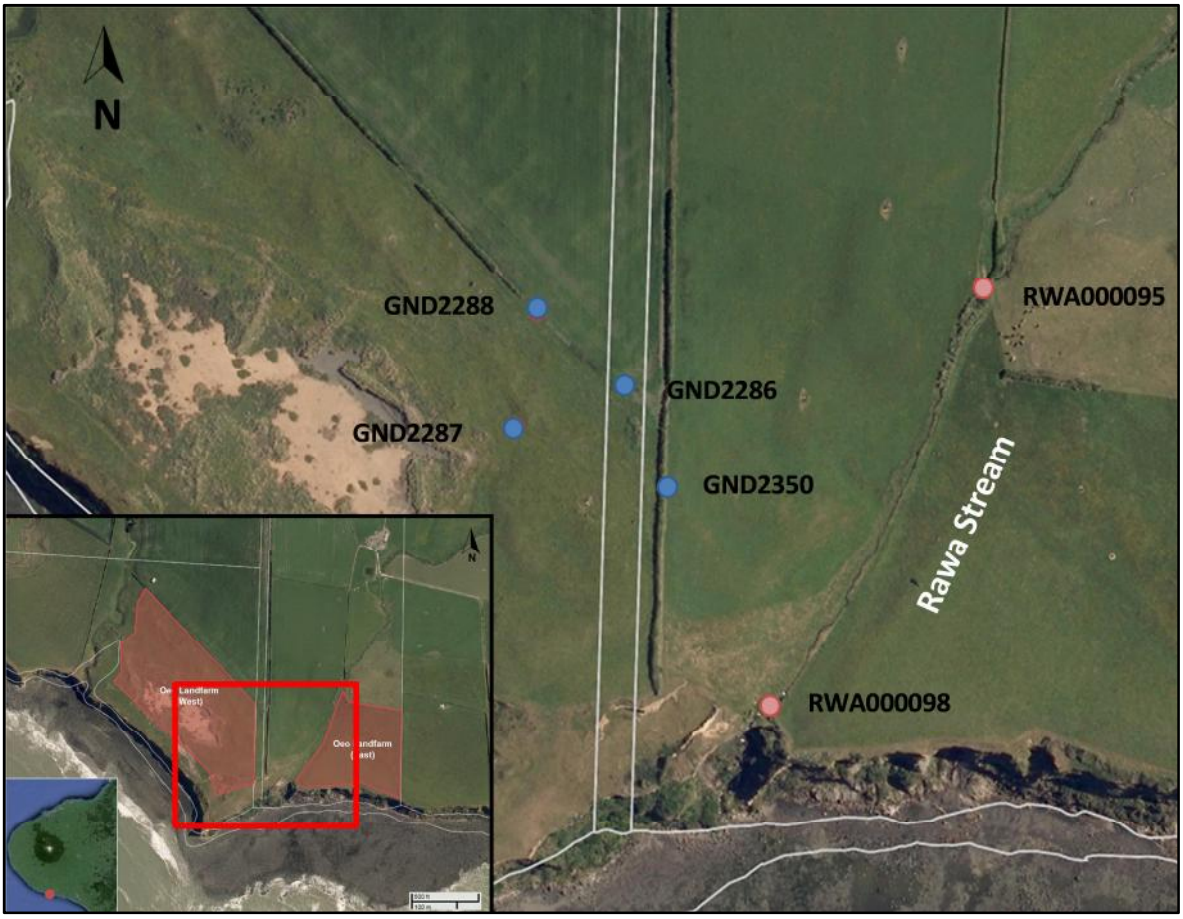

Figure 3 Site map showing groundwater and surface water sampling sites and overall site map (inset)

2.3.3 TRC surface water results

The Rawa Stream was sampled twice 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 3. On two occasions the sites were sampled for hydrocarbons, these results are presented in Table 5.

Table 5 Surface water results for BTEX and TPH, Rawa Stream

Site	Date	Benzene (g/m³)	Toluene (g/m³)	Ethylbenzene (g/m³)	O-Xylene (g/m³)	M & P Xylene (g/m³)	C7-C9 (g/m³)	C10-C14 (g/m³)	C15-C36 (g/m³)	TPH (g/m³)
RWA000095 (Upstream)	05 Apr 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
	24 May 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
RWA000098 (Downstream)	05 Apr 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7
	24 May 2013	<0.0010	<0.0010	<0.0010	<0.0010	<0.002	<0.10	<0.2	<0.4	<0.7

No hydrocarbons were detected in any of the samples. During the May sampling run, the samples were analysed for further water quality parameters and potential changes in salinity parameters. These results are presented in Table 6.

Table 6 Rawa Stream surface water results 24 May 2013

Site	Barium (g/m³)	Total dissolved solids (g/m³)	Chloride (g/m³)	Conductivity (lab)	Conductivity (field)	pH	Temperature (°C)
RWA000095	0.024	284.7	60.6	36.8	41.6	7.4	12.4
RWA000098	0.024	284.7	61.0	36.8	41.5	7.4	12.5

During the May sampling run the downstream site (RWA000098) was also sampled for heavy metals. These results are presented in Table 7.

Table 7 Rawa Stream downstream water results for heavy metals

Site	Arsenic (g/m³)	Barium (g/m³)	Cadmium (g/m³)	Chromium (g/m³)	Copper (g/m³)	Nickel (g/m³)	Lead (g/m³)	Zinc (g/m³)
RWA000098	<0.02	0.022	<0.0010	<0.010	<0.010	<0.010	<0.002	<0.02

No heavy metals were detected in the downstream sample. The surface water results show no impact of site activities on the Rawa Stream. Testing will continue in the following monitoring period to confirm ongoing consent compliance.

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).

Areas F1-F3 were sampled twice during the monitoring period, and once just after the end of the monitoring period, when areas F4-F7 were also sampled. Their results are presented in Section 4 of Appendix II.

The sampling conducted during the monitoring period indicated initial non compliance for salinity parameters chloride, sodium, total soluble salts, conductivity and SAR for areas F1 and F3, and conductivity, sodium and total soluble salts for area F2. Subsequent sampling has shown that these parameters have or are reducing rapidly to within consent criteria. Hydrocarbon concentrations are within application limits, but surrender criteria (which do not yet apply, as the site is still in use) are not yet met for certain hydrocarbon fractions in certain areas.

No significant PAHs or MAHs have been detected in the soil samples taken by the Company. Concentrations of heavy metals were well below the MfE guidelines and close to background concentrations.

The Company also supplies predisposal results for review by Council staff prior to landfarming. The predisposal results are included in Appendix II.

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 eg

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 2012-2013 period, it was necessary for the Council to undertake significant additional investigations and interventions, and record an incident, in association with BTW's conditions in resource consent in relation to the Company's activities during the monitoring period.

One incident was recorded against the site during the monitoring period, and there were additional investigations conducted regarding potential impacts on localised groundwater and general site operations.

The initial stockpiling of material at the site utilised three unlined drilling waste pits (Photo 2). The Council advised BTW, along with other landfarming operators, that all storage pits required high grade synthetic liners that were fit for the purpose of storing solids and liquids on site for several months. The Company were cooperative on this matter and lined two of the pits immediately, following the spreading of material into area F1 (Photo 3). The Company were also advised that the Council expected monitoring wells to be installed at the site in proximity of the storage facilities.

Three bores were installed at the site (locations identified in Figure 3, Section 2.3.2). The initial sampling of these bores revealed measurable but very low levels of petroleum hydrocarbons in bores GND2287 and GND2288, which were located near pit C. Subsequent sampling has shown that hydrocarbon concentrations have returned to background, verifying that pit liners have been working effectively at this site, and that the impacts on groundwater were localised, short-lived, of negligible consequence, and related to the absence of adequate pit liners in the initial site setup. The contents of the third pit was farmed and the pit reinstated shortly after the completion of the groundwater monitoring wells.

Photo 2 Oeo landfarm initial storage pit arrangement

Photo 3 Oeo landfarm pits showing HDPE synthetic liners

Incident 23149 – 26 November 2012

During a routine monitoring inspection it was observed that drilling mud had ponded at the seaward side of area F2, breached the makeshift bund, run across the grass beyond the site boundary, and had discharged over the cliff face onto the beach 30-40 m below the cliff. The earthworks contractors had scraped back some topsoil from outside of the consented area to create a bund to prevent any further runoff.

Special condition 7 of consent 7613-1 stipulates that for the purposes of landfarming, drilling wastes shall be applied to land *"in a rate and manner such that no ponded liquids remain after one hour, for all wastes"*.

Special condition 10 states that *"no discharge shall take place within 25 metres of surface water or property boundaries"*.

Unauthorised Incident 23149 was non compliant with these two consent conditions. The following enforcement action was undertaken by the Council:

An abatement notice was issued requiring that the ponded liquid around the site be incorporated into the soil and that the conditions of the resource consent are complied with for all future operations.

An infringement notice was also issued to the Company for the unauthorised discharge of drilling mud onto land in such a manner that the material may have entered the Tasman Sea.

Re-inspection found that the abatement notice was being complied with. A letter of explanation was received from the Company. An infringement notice was issued to the Company. A letter of explanation was received from the contractor and accepted.

Figure 4 Oeo landfarm photos showing (clockwise from top left) ponding liquid in area F2, makeshift bunding in buffer zone, mud on beach below cliff, and mud staining of grass

The Company conducted their own investigation into the incident and supplied results of the material taken from the beach. These results are presented in Table 8.

Table 8 BTW supplied results for beach sample UI23149

Parameter	Unit	Result	Parameter	Unit	Result
Dry Matter	g/100g as rcvd	93	Acenaphthene	mg/kg dry wt	<0.03
Density*	g/mL at 20°C	2.40	Acenaphthylene	mg/kg dry wt	<0.03
Total Recoverable Barium	mg/kg dry wt	30	Anthracene	mg/kg dry wt	<0.03
Total Recoverable Potassium*	mg/kg dry wt	102	Benzo[a]anthracene	mg/kg dry wt	<0.03
Total Recoverable Sodium	mg/kg dry wt	280	Benzo[a]pyrene (BAP)	mg/kg dry wt	<0.03
Chloride*	mg/kg dry wt	97	Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	<0.03
pH*	pH Units	8.7	Benzo[g,h,i]perylene	mg/kg dry wt	<0.03
Total Nitrogen*	g/100g dry wt	<0.05	Benzo[k]fluoranthene	mg/kg dry wt	<0.03
Total Recoverable Arsenic	mg/kg dry wt	< 2	Chrysene	mg/kg dry wt	<0.03
Total Recoverable Cadmium	mg/kg dry wt	<0.1	Dibenzo[a,h]anthracene	mg/kg dry wt	<0.03
Total Recoverable Chromium	mg/kg dry wt	15	Fluoranthene	mg/kg dry wt	<0.03
Total Recoverable Copper	mg/kg dry wt	9	Fluorene	mg/kg dry wt	<0.03
Total Recoverable Lead	mg/kg dry wt	1.4	Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03
Total Recoverable Mercury	mg/kg dry wt	<0.1	Naphthalene	mg/kg dry wt	< 0.12
Total Recoverable Nickel	mg/kg dry wt	5	Phenanthrene	mg/kg dry wt	< 0.03
Total Recoverable Zinc	mg/kg dry wt	62	Pyrene	mg/kg dry wt	< 0.03
Benzene	mg/kg dry wt	<0.05	C7 - C9	mg/kg dry wt	< 8
Toluene	mg/kg dry wt	<0.05	C10 - C14	mg/kg dry wt	< 20
Ethylbenzene	mg/kg dry wt	<0.05	C15 - C36	mg/kg dry wt	< 40
m&p-Xylene	mg/kg dry wt	<0.1	Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70

The results from the beach sample show the absence of any hydrocarbon content, slightly elevated salts, and inconsequential metals (although well within MfE heavy metal guidelines) (MfE, 2003). Arguably they indicate an absence of drilling wastes. The temporary nature of the incident, the relatively small quantity of material involved, and the contaminant concentrations in the material make it unlikely that any significant adverse environmental impacts would be associated with such an incident, but it could have been avoided with the implementation of better operational practices.

Investigations conducted by the Council and the Company suggested there were several contributing factors to the UI. The three primary contributors were poor weather conditions, the presence of a shallow iron pan (impeding drainage in the subsoil), and lack of contractor awareness.

3. Discussion

3.1 Discussion of site performance

During the monitoring period there were several operational matters encountered at the Oeo landfarm site, which required additional attention from Council scientific and managerial staff. The Company were very cooperative with all matters raised during the monitoring year, and actively sought to improve all aspects of their operation at the site.

The incident described in Section 2.5 demonstrated that some of the contractor's operations could be improved. The establishment of pasture following the completion of areas F1 and F2 was an issue due to inclement dry weather and wind exposure. These areas have since been re-sown, but ongoing monitoring of pasture cover by the Company will be required.

There were several matters raised by a group representing Ngati Haua Hapu relating to perceived inconsistencies between the site operations and proposed measures outlined in the consent application process in 2010. The Company worked to resolve some of these matters through measures including installing an additional monitoring well between the pits and the Rawa Stream, and completing riparian planting of the seaward buffer zone. The Company also constructed a lined wash down area to reduce ponding of water around the driving pad.

At the conclusion of the monitoring year, the Company made the decision to farm the remaining stockpiled material as per the consent conditions, reinstate the site, and receive no further material. At this stage available space was almost at capacity, and the decision was also made to not spread in the smaller area to the east of the Rawa Stream.

3.2 Environmental effects of exercise of consents

Monitoring indicates that there appears to be no ongoing adverse environmental effects due to activities at the site. Levels of contaminants in the surface soil meet the required consent conditions in the Council samples. The Company soil samples showed compliance with all heavy metal, MAH and PAH limits, and total hydrocarbon concentrations were within the application limit (50,000 mg/kg). Initial results of the earlier areas showed elevated conductivity, soluble salts and SAR. Ongoing monitoring of groundwater results has indicated that there were low-level temporary impacts on groundwater resources from stockpiling activities conducted at this site. Following pit lining, the levels of contaminants have returned to background levels (ie hydrocarbons are no longer detectable). Further monitoring of the site will ensure that compliance with all consent limits is demonstrated prior to surrender. Due to the location of the sites and the significant distance to any neighbours no air monitoring was undertaken as effects are known to be minimal.

During the monitoring year there were discussions concerning the potential risk from naturally occurring radioactive material (NORM) at disposal sites. Samples taken from exploration, production and disposal sites in the region have shown no sign of elevated radioactivity levels (Taranaki Regional Council, 2013). To further confirm there is no risk at the Oeo site it is recommended that samples be taken during the next monitoring year. A recommendation to this effect is given in Section 4.

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 9.

Table 9 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	**No**
3. Notify TRC in writing prior to stockpiling	Notifications received	Yes
4. Notify TRC in writing prior to landfarming	Notifications received	Yes
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 28 August 2013	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	**No**
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	**Attempted**
13. No destabilisation of neighbouring land	Inspection	Yes
14. Total dissolved salts in any fresh water body shall not exceed 2500g/m^3	Sampling	Yes
15. Disposal of waste shall not lead to contaminants entering surface water or ground water exceeding background concentrations	Sampling	**No**

Condition requirement	Means of monitoring during period under review	Compliance achieved?
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	**No***
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
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		**Improvement desirable**

*1 breach in BTW supplied results

The overall rating of the site for the monitoring year for environmental performance and consent compliance is 'improvement desirable'. During the year under review there was one UI which resulted in the issuing of an abatement notice and an infringement notice. The environmental impacts of this incident were negligible, but it highlighted areas for improvement within the Company and their contractors' practices. Additionally, there were matters that required significant Council intervention and investigation. During the second part of the year the Company complied with all consent conditions. BTW were very cooperative in all matters raised and took appropriate action to improve operations at this site significantly during the monitoring period.

3.4 Alterations to monitoring programmes for 2013-2014

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 Resource Management Act, 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 2013-2014 the monitoring programme is modified to increase groundwater sampling frequency to quarterly, in addition to conducting an investigation into potential radioactivity risks associated with industry practices. Recommendations to such effects are attached to this report.

4. Recommendations

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.

Glossary of common terms and abbreviations

The following abbreviations and terms are 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

Department of Health 1992: Public health guidelines for the safe use of sewage effluent and sewage sludge on land, Department of Health.

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.

Ministry of Health 2000: Drinking-Water Standards for New Zealand, Ministry of Health.

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

Appendix I

Resource consent 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

Supplied annual report

Annual Report

Special Condition 6 - Monitoring and Reporting

Oeo Landfarm Annual Report - Consent 7613

by BTW Company





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

Oeo Landfarm Annual Report - Consent 7613
09389

	Reviewed	
Report Author	Dave Bolger	28/8/13 Date
Reviewed by	Kathryn Hooper	28/8/13 Date

09389
28/08/2013

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 2012 to 30 June 2013 as well as monitoring required under SC 14-20.

1.2 July 2012 to June 2013 - Summary

During the reporting year eight specific areas have been landfarmed, which are shown on the plan attached in Appendix B as F1 through to F8. These eight areas complete the landfarming of this consented area. The F8 area was levelled in June 2013, however the spreading of the material did not take place until August, therefore no receiving environment results are provided with this report.

A total area of 6.6 hectares was landfarmed during the reporting year and the material landfarmed was either Water based cuttings and fluids or Synthetic based cuttings and fluids.

1.3 Records required under Special Condition 5

The consent holder shall keep records of the following:

a) wastes from each individual well;
b) composition of waste (including concentrations of chloride, nitrogen and total petroleum hydrocarbons);
c) stockpiling area(s);
d) volume of material stored;
e) landfarming areas, including a map showing individual disposal area with GPS co-ordinates;
f) volumes and weight of wastes landfarmed;
g) dates of commencement and completion of storage and landfarming events;
h) dates of sowing landfarming areas;
i) treatment 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.

1.4 Report Overview

The following information has been collated for the purpose of demonstrating compliance with Special Condition (SC)6 of the 7613-1. Information will be 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 or well work over fluids and are 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 which disposal is 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 also 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

The approximate volume of material farmed during the reporting year is 4278m³, however due to the conservative way BTW calculates spreading areas, the actual volume is likely to be considerably less as the volumes presented in this report are based on landfarming areas, for simplicity, and because this allows 100% accuracy.

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. Both F1 and F3 areas (as shown on the Plan in Appendix B) have been spread at a 50mm thickness due to the TPH being greater than 50,000 mg/kg.

In what we consider best practice, BTW always increase the spreading areas to absolutely ensure compliance with consent conditions.

For an example, the F5 area has a total area of 6500m², the material calculated to be landfarmed in this area was 625m³. This volume was 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.

The material had a TPH of less than 5%, therefore the required area to meet consent conditions is 6250m², however as stated above BTW increase the spreading area, in this case to 6500m², to ensure the spreading area is more than adequate for the volume of material. BTW believe this approach is important in the promotion of the natural bio-remedial process of the material, and to ensure consent compliance is in no doubt.

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

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

Table 2.1: Volumes of Material Landfarmed – July 2012 to June 1013

Location	Material Type	Date Landfarmed	Area of cover (m^2)	Thickness of material (mm)	Volume landfarmed (m^3)
F1	SBM	September 2012	18500	50	925
F2	WBM	November 2012	4200	100	420
F3	WBM	December 2012	18000	50	900
F4	WBM / SBM	March 2013	6000	100	600
F5	WBM	April 2013	6500	100	650
F6	WBM	April 2013	4000	100	400
F7	WBM	April 2013	3847	100	384.7

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.

Sowing has occurred on areas F1 to F5, however very wet conditions in early winter hindered sowing of areas F6 to F7 and this is yet to occur.

F1, F2 and F3 areas had a poor strike due to a number of reasons, including a dry, windy summer.

BTW intend to re sow these areas in spring (September 2013) during the completion of this landfarming site. Photo's contained in Appendix D show an early strike in the F4 and F5 areas.

3 MONITORING INFORMATION

The following section provides the details of monitoring, including sampling locations, sampling methods and the results of analysis;

3.1 Monitoring

All material stockpiled on site is tested prior to arrival on site to assess its exact composition. Testing takes place prior to its arrival because on occasions it is added to other material already stored and therefore unable to be sampled separately once on-site.

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. 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). A number of areas identified during the monitoring year now meet the surrender limits criteria as stipulated on the consent. Areas that have meet surrendering criteria are discussed in Section 4. Sampling of these areas will now cease until one last sampling composite of the site is completed as part of surrender this consent. BTW Company will continue to sample the remaining areas until surrender criteria limits have been met.

All receiving environment samples are tested by an independent laboratory (Hill Laboratory) and methodology is in accordance with their requirement and the TRC.

3.2 Sampling Locations

Specific landfarmed 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. In the future, each composite sample position will be marked with a GPS and included on a GIS overlay of the site.

3.3 Methods

Sampling involves collecting a composite of 15 sub-samples which are GPS along a transect line running from the central point of a landfarmed area. Typically, samples are retrieved from approximately 250mm but this can vary depending on the location of the drilling mud layer.

Once the 15 sub samples have been collected the soil is mixed together and the appropriate sampling containers are filled and sent to Hill Laboratory for testing for specific constituents as required by the consent.

3.4 Inspection Notices

All but one routine inspection by TRC compliance Officers have found activities on the site complying with the conditions of consent 7942-1. The one routine inspection of concern found the consent holder was breaching the consent conditions and an abatement notice was accordingly issued. Refer to section 3.6 regarding the abatement notice issued, BTW was regretful this breach had occurred, however extreme weather conditions were a major cause of this incident.

3.5 Infringement Notices

No infringement notices were issued during the reporting year.

3.6 Abatement Notices

An abatement notice was issued on the 4th of December 2012. The abatement notice was for not incorporating drilling mud into soil, excesses ponding and evidence some fluids had been blown outside the consented area towards the coastal cliff buffer zone. A letter was provided to TRC addressing the incident and non-compliance. Essentially weather conditions were a major contributing factor plus there was a lack of contractor awareness which resulted in unnecessary ponding. The ponding was a result of a hard iron pan in the sub-strata as normal spreading practices were adhered too. The ponding became an issue when strong winds close to the sea cliff edge created a vortex and blew small amounts of fluid beyond the consented boundary towards the cliff edge. Contractors and BTW Company acted quickly once this issue had been identified by increasing the bund height and bringing in extra soil to absorb the fluid. BTW undertook testing along the beach to ensure no drilling fluid had reached the beach. The results showed no presence of hydrocarbons or BTEX. A full incident investigation was undertaken by BTW in accordance with company procedures, and the result has been that contractors and BTW Company have now put in place practices to ensure an incident like this would never happen again.

An abatement notice had been issued by the South Taranaki District Council during the annual reporting year; this abatement notice was mainly due to procedural errors, alleged earthworks outside the consented area and planting along the coastal buffer zone. This abatement notice was withdrawn.

3.7 Site Improvements

A collaborative approach has been taken to improve best practice of the landfarming operation at Oeo, and landfarming in general throughout the region. All pits on the site are now lined to ensure no uncontrolled discharge or leaching from the pits is taking place. The lining of pits is not a consent requirement, however is now deemed best practice which BTW Company endorse.

BTW Company have installed and paid for three ground water monitoring bores as requested by the TRC and have also installed a fourth groundwater monitoring bore at the request of Ngati Haua Hapu. Essentially these groundwater monitoring bores provide data on the potentially movement and or contamination of groundwater from drilling material stored on the site. These groundwater monitoring bores are likely to provide useful data going forward with the surrendering of the consent in the future.

Spreading areas have been increased to ensure the soil is not over loaded and the bio-remedial process can breakdown the material in an appropriate time frame.

Improved sampling techniques have been adopted to ensure best practice and to align with industry practices.

A wash down area was constructed. This wash down area was lined and all wash down fluid flowed back into one of the lined pits. This wash down areas had been a problem in the past, especially during winter months where the driving pad can become very ponded with fluid (generally stormwater). Having a specific wash down area reduced the amount of stormwater runoff from the turnaround pad area.

A section of the coastal protection buffer zone was planted in native species, as well as an area on the natural headland and the lower reaches of the Waimate Stream. Species were mainly toetoe, flax, pittosporum and broadleaf species. This project was intended to take place at the end of landfarming at the site, however the South Taranaki District Council requested we undertake the planting immediately. This area of coastline line is extremely windy, therefore with the assistance of the TRC we have chosen very hardy species, which we hope survive the winter.

4 ANALYSIS OF RESULTS

The following Table 4.1 provides a summary of the monitoring results undertaken over the Oeo Landfarm during the reporting period. 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.

Where compliant with consent conditions for the surrendering of the consent, the fields are coloured green, where the sampling indicates the sampled constituent has not yet reached consent surrender limits the field is coloured red.

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	Benozene <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	[illegible]	[illegible]	[illegible]	[illegible]	<0.05	<0.05	<0.05	<0.1	<0.14	0.04	<0.03	2	<0.1	7	13	[illegible]	<0.1	5	43	12	[illegible]	[illegible]	0.08	[illegible]	[illegible]	
	3/04/2013	[illegible]	10.5	[illegible]	<0.05	<0.05	<0.05	<0.1	<0.12	<0.03	<0.03	<2	<0.1	9	13	[illegible]	<0.1	6	45	8	[illegible]	[illegible]	0.14	660	[illegible]	SBM
	4/07/2013	10	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	[illegible]	2800	0.11	280	227	
F2	15/01/2013	[illegible]	11.7	[illegible]	<0.05	0.05	<0.05	<0.1	[illegible]	[illegible]	[illegible]	2	0.1	8	24	3.6	<0.1	4	49	8	20	<40	0.17	230	[illegible]	
	3/04/2013	[illegible]	12.4	[illegible]	<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	[illegible]	WBM
	[illegible]	50	4	357	<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	82	66	
F3	15/01/2013	[illegible]	9.9	[illegible]																					[illegible]	
	3/04/2013	[illegible]	[illegible]	[illegible]	<0.05	<0.05	<0.05	<0.1	<0.13	0.15	<0.03	<2	<0.1	11	19	4.5	<0.1	7	47	8	[illegible]	[illegible]	0.12	[illegible]	[illegible]	WBM
	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	[illegible]	2800	0.17	220	166	
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	WBM/SBM
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	[illegible]	1010	0.2	165	195	WBM
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	WBM
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	[illegible]	370	0.13	39	58	WBM

*Indicates sample was "<" result provided

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

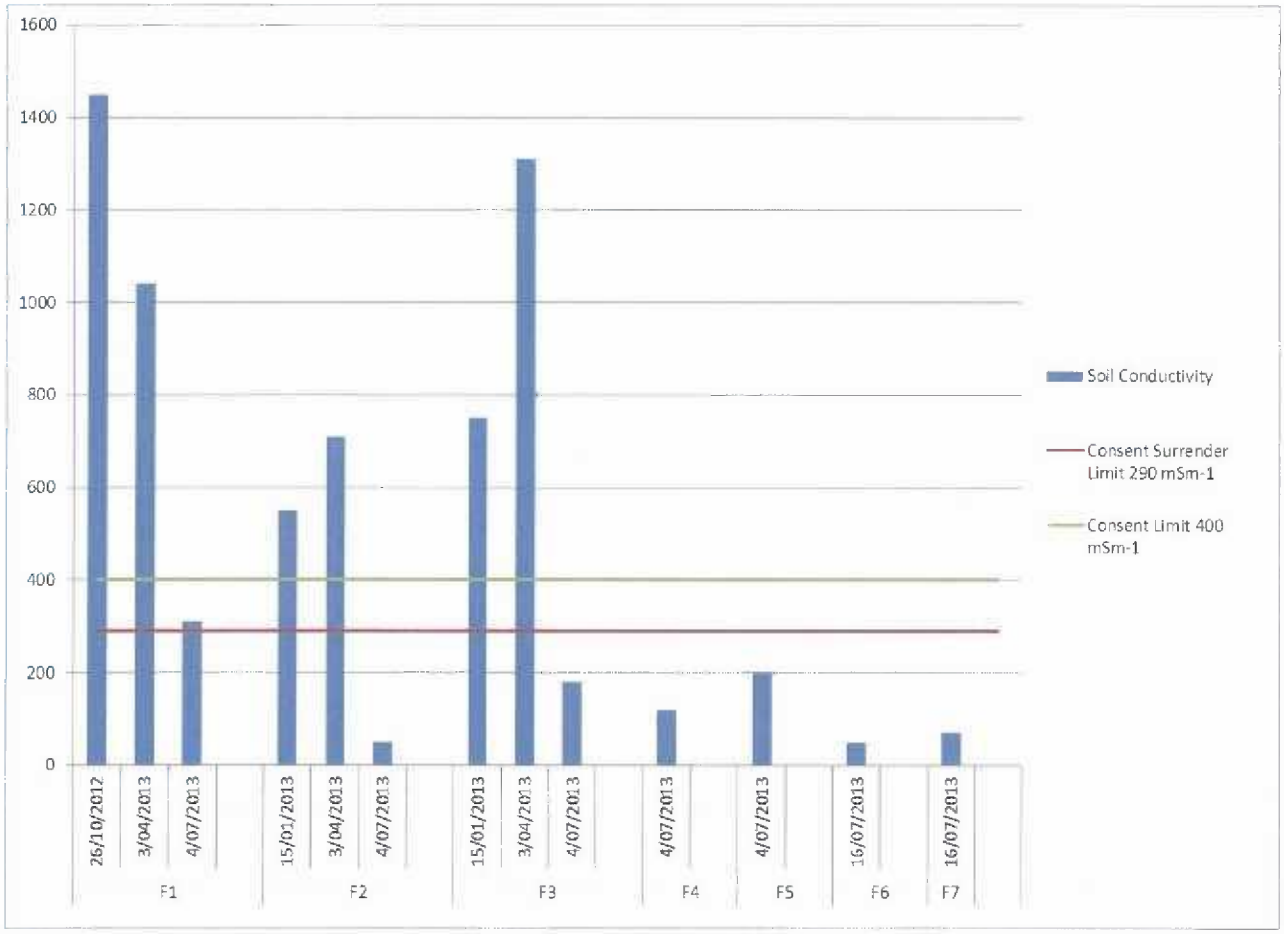

Figure 1 Soil Conductivity analysis – Oeo Landfarm

While initial monitoring of soil conductivity at the site F1 to F3, showed exceedance of the consent limit, follow up results have shown decrease in soil conductivity to consent limits, with F2 and F3 being with consent surrender limits. Locations F4 to F7 are also within consent surrender limits.

Area/s not within surrender limits: F1.

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 2 below, all the landfarmed area are currently within the surrender criteria for the consent.

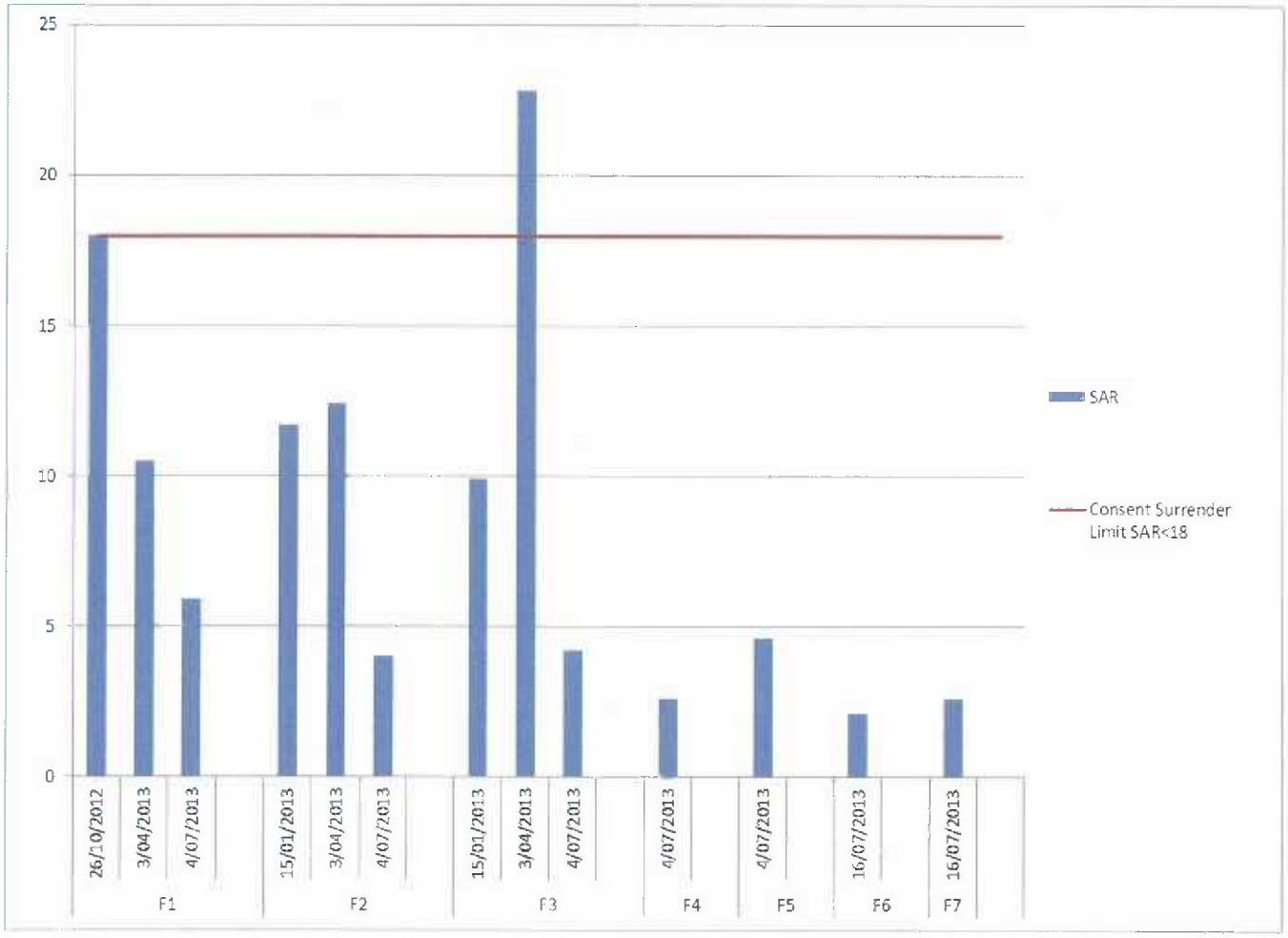

Figure 2 SAR analysis – Oeo Landfarm

4.2.3 Condition 18 – Heavy Metals

Condition 18 requires:

18. The concentration of metals in the soil shall as 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 complaint 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 following presents series of figures detailing results from the landfarm monitoring in respect of closure criteria.

4.2.5 Chloride

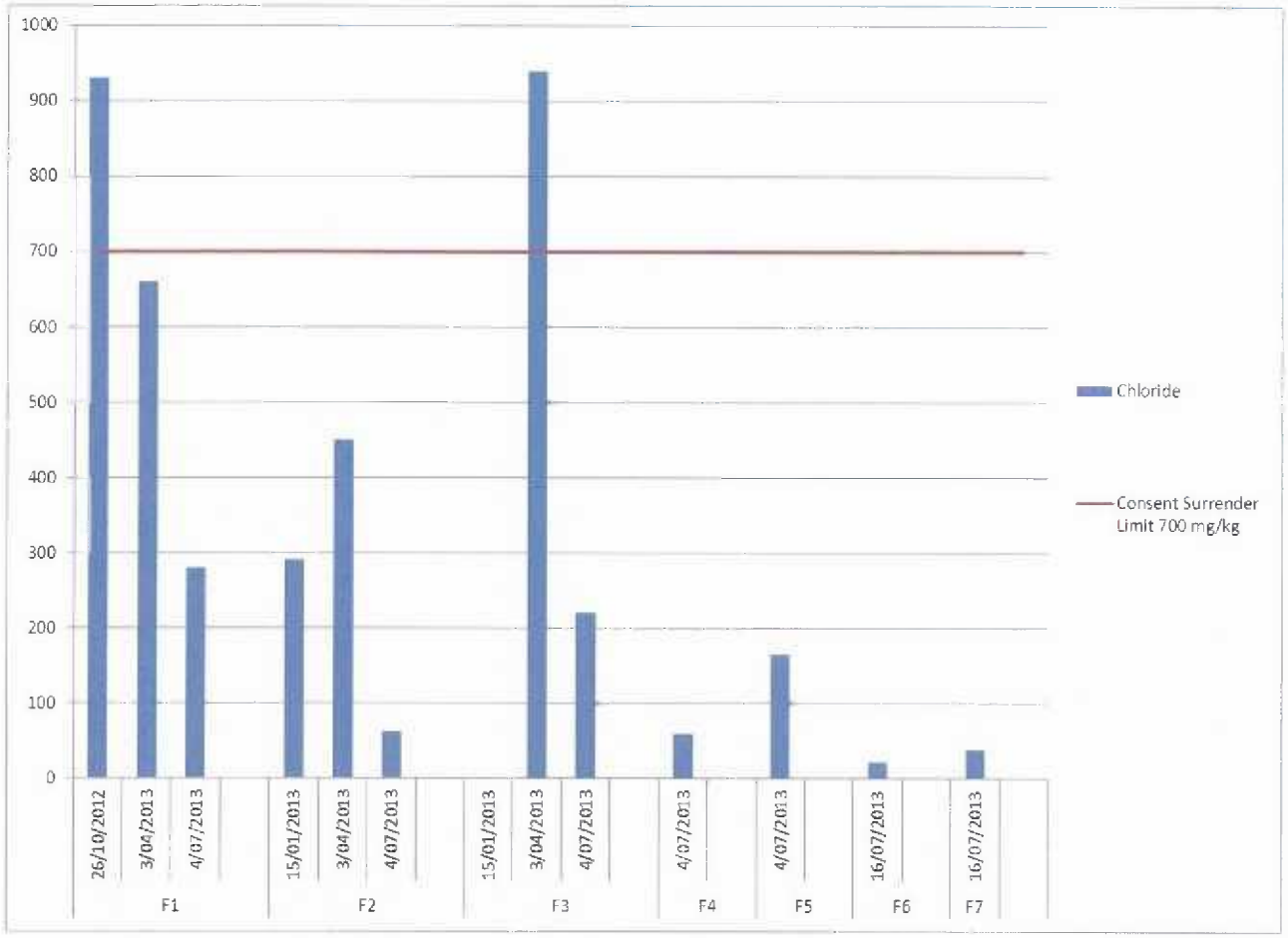

Figure 3 Chloride analysis – Oeo Landfarm

As shown in Figure 3, while initial monitoring results at sites F1 and F3 were elevated, consent surrender requirements for Chloride have now been met for all monitored areas of the landfarm.

4.2.6 Sodium

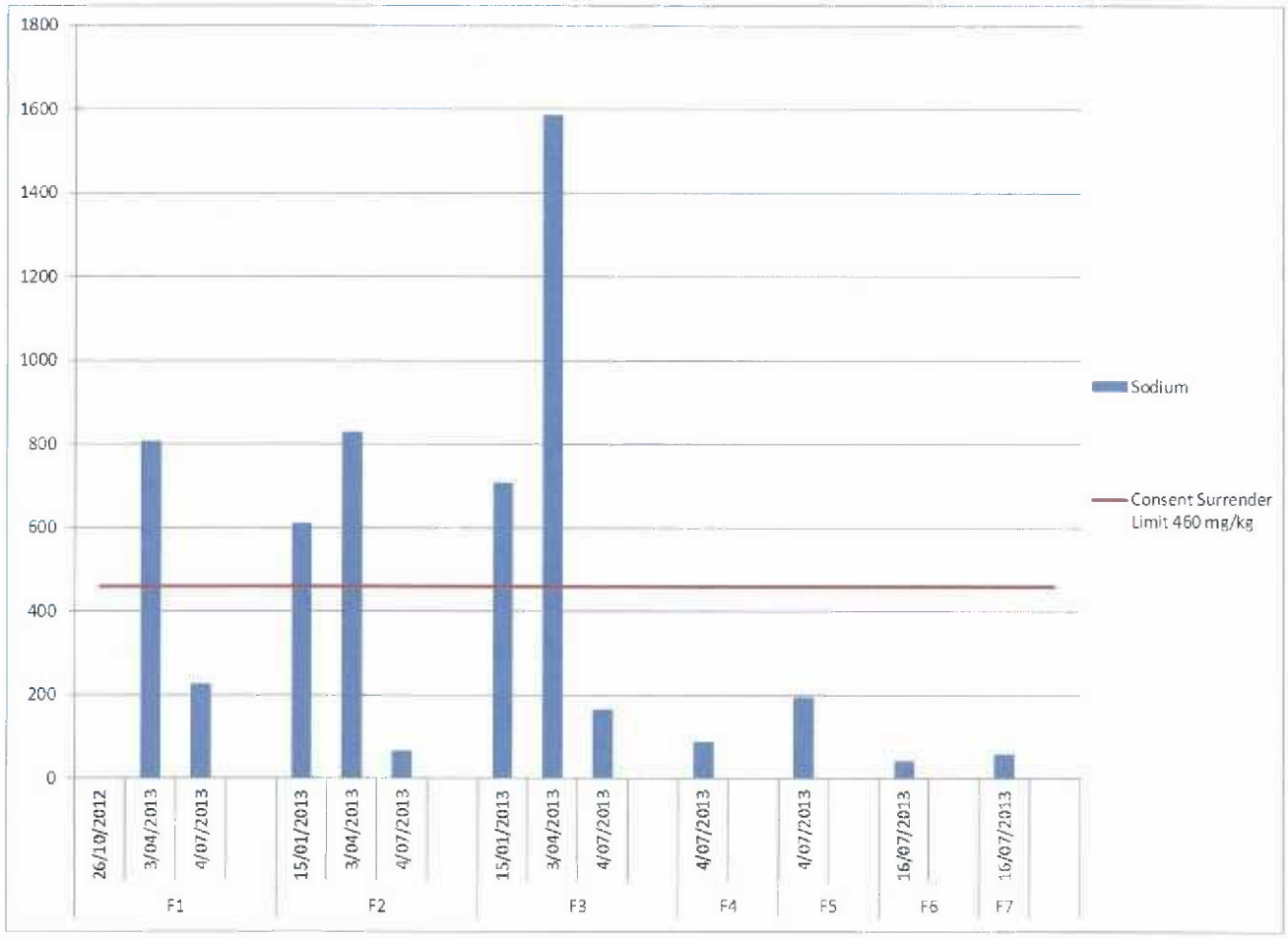

Figure 4 Sodium analysis – Oeo Landfarm

As shown in Figure 4, consent surrender requirements for Sodium have been reached for all monitored areas of the landfarm.

4.2.7 Dissolved Salts

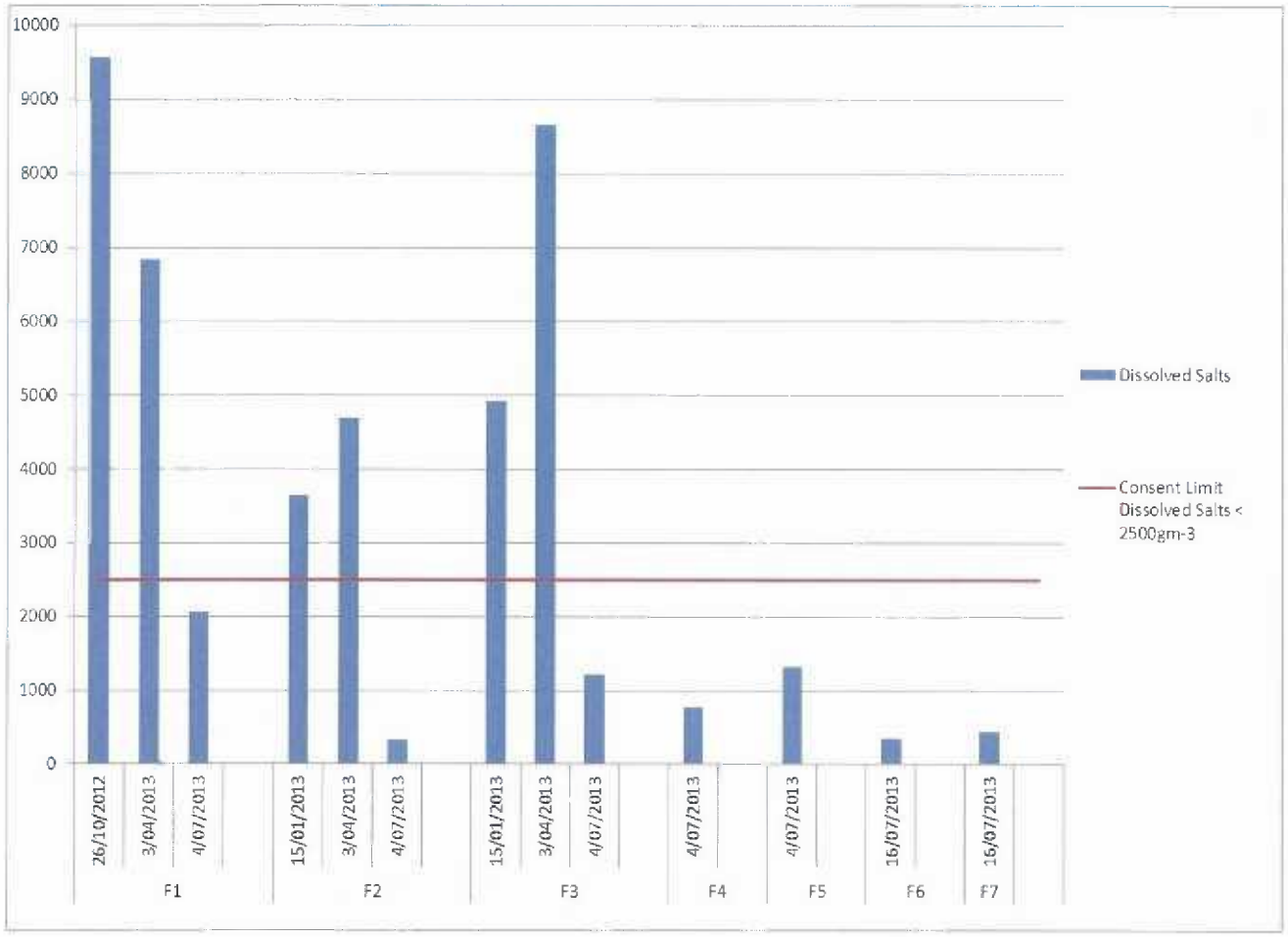

Figure 5 Dissolved Salts analysis – Oeo Landfarm

While initial monitoring results at sites F1, F2 and F3 were elevated, consent surrender requirements for dissolved salts have now been met for all monitored areas of the landfarm, as shown in Figure 5.

4.2.8 TPH C7 – C9

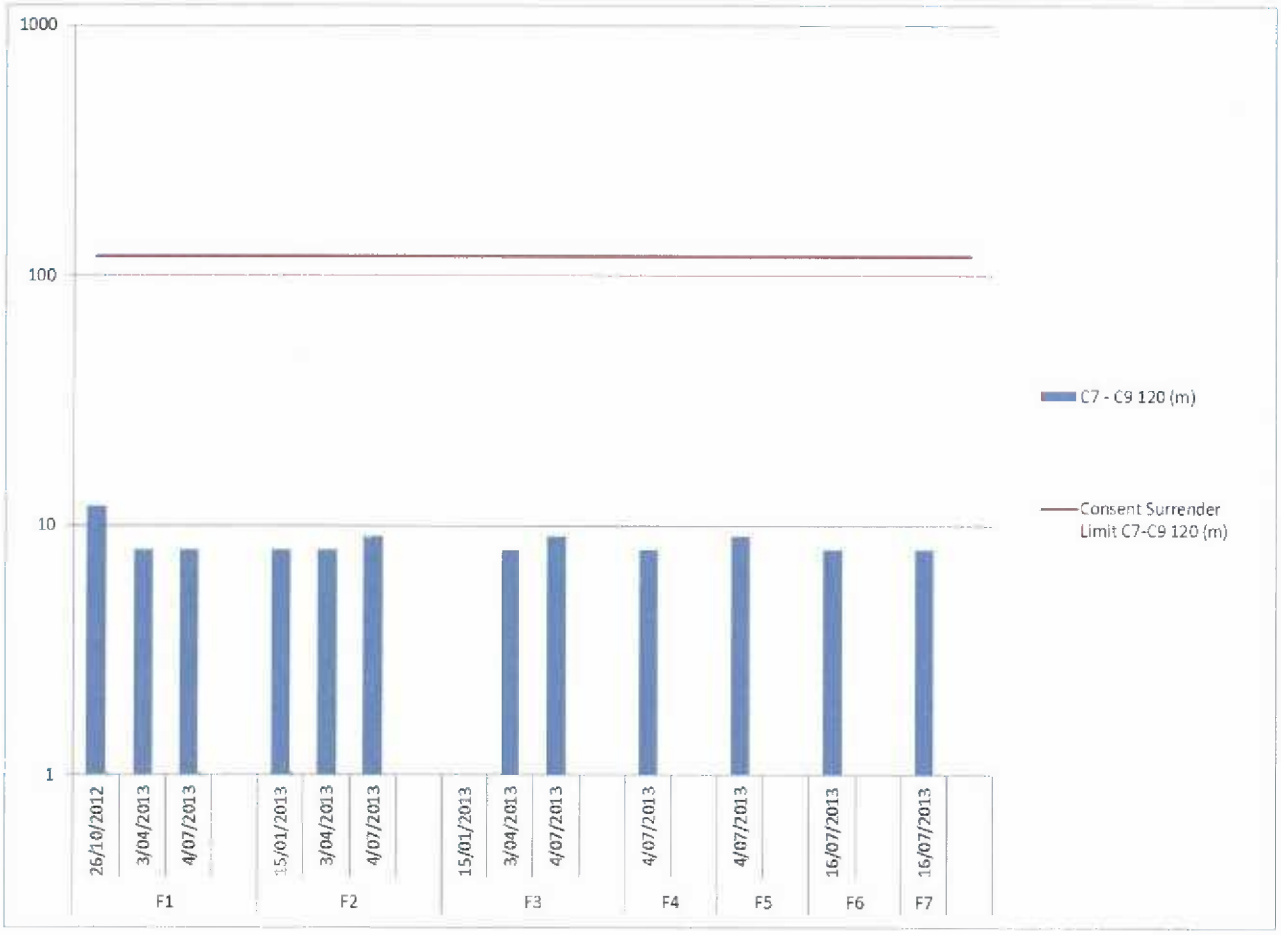

Figure 6 TPH C7-C9 – Oeo Landfarm

As shown in Figure 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

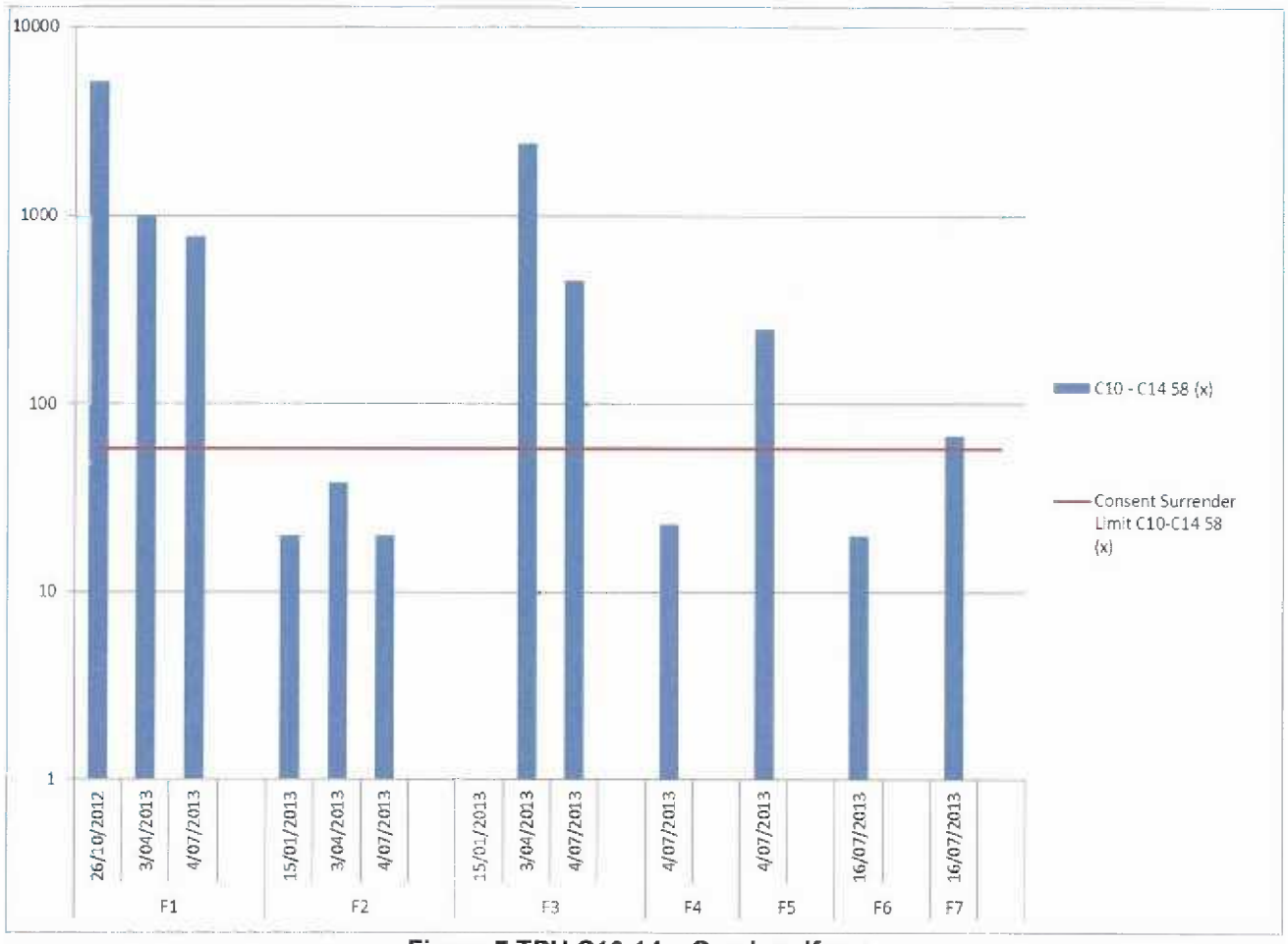

Figure 7 TPH C10-14 – Oeo Landfarm

Results above the consent surrender limits for TPH C10 to C14 58 (x) were encountered for sites F1, F3, F5 and F7 and will require further monitoring.

Area/s not within surrender limits F1, F3, F5 and F7

4.2.10 TPH C15 – C36

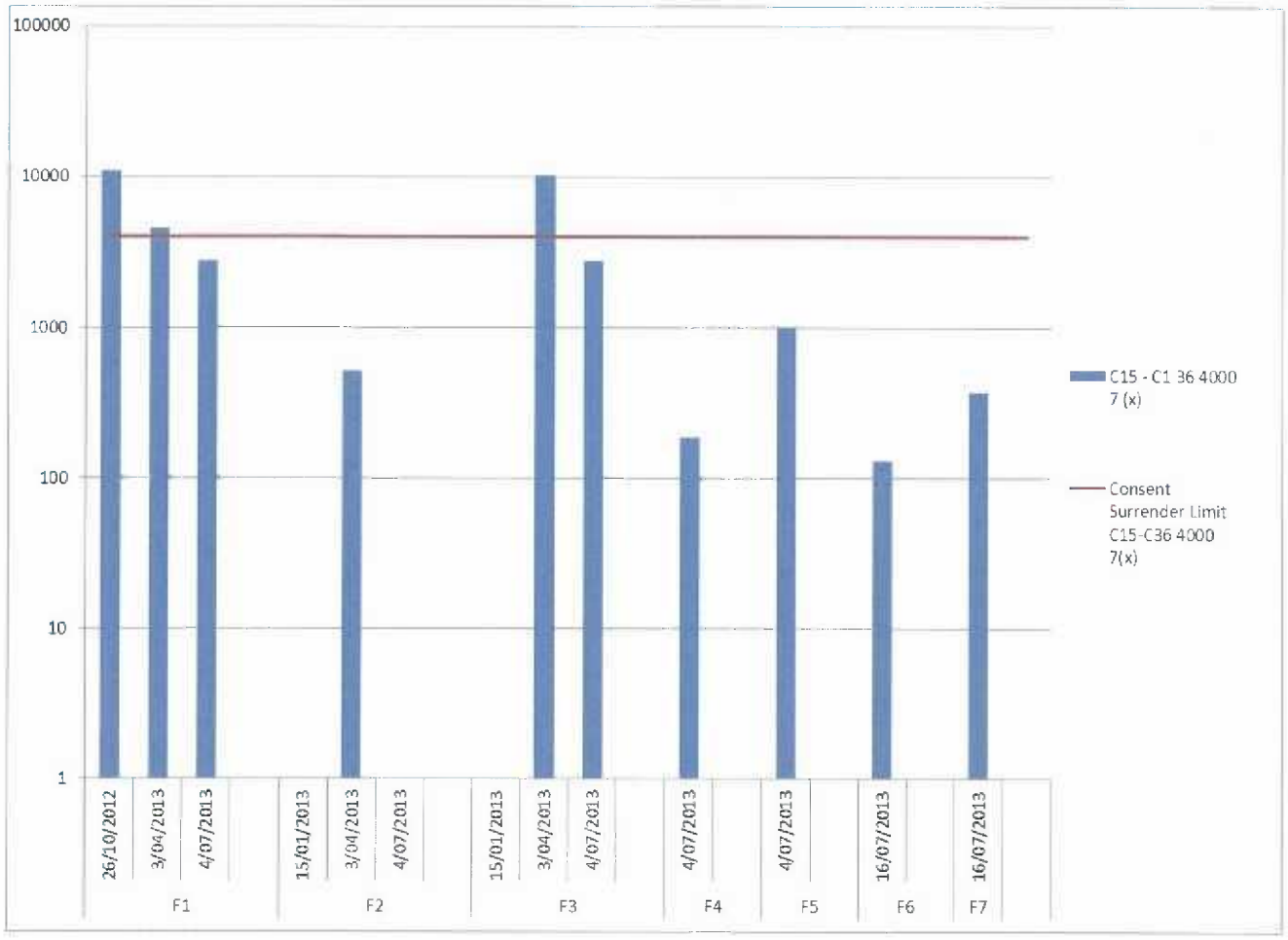

Figure 8 TPH C15-36 – Oeo Landfarm

Figure 8 shows results for TPH C15-C36 for all sites. All areas are now within the surrender criteria for the consent.

4.2.11 Summary

Further monitoring will be undertaken at sites F1, F3, F5 and F7 until surrender criteria limits are meet for the consent. These areas have shown a significant reduction in constituent levels. It is pleasing to see that the F4 and F7 areas have meet the surrender criteria for the consent within the first round of sampling (3 months).

APPENDIX A COMPOSITION OF WASTE

BTW COMPANY		Section of Regulations		Test Certificates					Emergency Management														Sched 4
		Sub-section		Location & Transfer	Manufacture and Use	Approved Handler	Hazardous atmosphere zone	Tracking	EM Level 1	EM Level 2	EM Level 3	Fire Extinguisher	Fire Extinguisher	Documentation	Signage	Signage	Separation	Separation	Separation	Incompatibility	Disposal		Bunding
		Reference		4.2	4.2	4.3	4.4	4.5	5.2.1	5.2.2	5.2.3	5.2.5	5.2.6	5.3.1	5.3.2	5.3.2	5.4.2	5.4.1	5.4.2	5.4.1	5.5		
		Schedule Table reference from Regulations		Table 1	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 9	Table 9	Table 10	Table 10	Table 11	Table 11	Table 12	Table 12	Table 13	Table 14	Sched 4
		Description of what the numbers relate to in table below		Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Number of Extinguishers	Threshold level	Emergency Regulations	Identification Requirements	Low Intensity Land Use Threshold VOLUME	Low Intensity Land Use Separation Distance	Separation required from	Incompatible substances	Information Requirements	Decontamination Requirements	Threshold
Asphasol (4-5% Crystal Ice Flake)	Solid/ Powder	6.7A Substances that are carcinogenic	0	-	-	10L	-	-	-	0.1L	100OL	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	1000L
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.1L	1000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	1000L
Calcium Carbonate (Uniflocal 16/100, 15 & 25)	Solid	6.4A Irritating to the eye	42500kg	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
Caustic Soda	Solid	6.1D (Oral) Acutely toxic	125kg	-	-	-	-	-	0.1kg	3.0kg	1000kg	-	-	30.0kg	10000kg	10000kg	-	-	-	-	0.1kg	3.0kg	1000kg
		8.1A Metallic corrosive		-	-	-	-	-	Any	1.0kg	-	-	-	2.0kg	1000kg	1000kg	-	-	-	-	-	2.0kg	-
		8.2B Skin corrosive		-	-	-	-	-	Any	1.0kg	1000kg	-	-	1.0kg	250kg	250kg	-	-	-	-	Any	1.0kg	1000kg
		8.3A Corrosive to eyes		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	0.1kg	2.0kg	10000kg
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0kg	5.0kg	-	-	-	5.0kg	10000kg	10000kg	-	-	-	-	1.0kg	5.0kg	-
Ecotrol RD	Solid	3.2C Flammable (Medium hazard)	1225kg	-	-	-	-	-	-	-	-	-	-	-	1000kg	1000kg	-	-	-	Class 1 Class 2 Class 4.2 Class 4 Class 5	-	-	-
		6.1C Acutely toxic (Inhalation)		-	-	Any	-	Required	ANY	0.5kg	100kg	-	-	0.5kg	2500kg	100kg	-	-	-	-	Any	0.5kg	100kg
		6.1E Acutely toxic (Oral)		-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.3B Skin Irritant		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.4A Eye Irritant		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.6B Suspected human mutagen		-	-	-	-	-	-	3.0kg	-	-	-	30kg	-	-	-	-	-	-	0.1kg	3.0kg	-
		6.8B Suspected human reproductive or developmental toxicant		-	-	-	-	-	-	3.0kg	-	-	-	30kg	-	-	-	-	-	-	-	3.0kg	-
		6.9B Harmful to human target organs or systems (inhalation)		-	-	-	-	-	-	3.0kg	-	-	-	30kg	-	-	-	-	-	-	0.1kg	3.0kg	-
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
Fine Attack	Powder	T&C	5000kg																				
G-cide 25	Liquid	6.1D (Oral) Acutely toxic	25L	-	-	-	-	-	0.1L	1.0L	100OL	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	100L
		6.5B Contact sensitiser		-	-	-	-	-	1.0L	1.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	100L
		8.2C Corrosive to dermal tissue		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1kg	1.0L	10000L
		8.3A Corrosive to eyes		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L
Glydril CC	Liquid	6.1D (Oral) Acutely toxic	0	-	-	-	-	-	0.1L	1.0L	2000L	-	-	1.0L	10000l	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
Glydril MC	Liquid	6.1D (Oral) Acutely toxic	0	-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	25000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
G-Seal	Solid/ Powder	6.1E Acutely toxic	4000kg	-	-	-	-	-	1.0L	50L	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.3B Mildly irritating to the skin		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
		6.4A Irritating to the eye		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
HRP	Liquid	6.3A Skin Irritant	835L	-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
Kleen Up	Liquid	6.3A Skin Irritant	1875L	-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		8.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
Lime	Powder/ Dust	8.2C Corrosive to dermal tissue	2000kg	-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	2000kg	-	-	-	-	-	2.0kg	10000kg
		8.3A Corrosive to eyes		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	0.1kg	2.0kg	10000kg
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
M-I Barite	Powder	6.1D (Oral) Acutely toxic	40000kg	-	-	-	-	-	0.1kg	3.0kg	1000kg	-	-	30.kg	10000kg	10000kg	-	-	-	-	0.1kg	3.0kg	1000kg
		6.7A Substances that are carcinogenic		-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0kg	5.0kg	-	-	-	5.0kg	10000kg	10000kg	-	-	-	-	1.0kg	5.0kg	-
M-I Gel Supreme (Bentonite)	Powder	6.7A Substances that are carcinogenic	281Kg	-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
MIX II (Coarse & Fine)	Powder	6.7A Substances that are carcinogenic	4000kg	-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
Novamul	Liquid	3.1D Flammable liquids: low hazard	970GL	-	-	-	-	-	5.0L	50L	10000L	500L	2	50L	10000L	10000L	-	-	-	Class 1 Class 2 Class 4.2 Class 4 Class 5	5.0L	50L	10000L
Novatec F	Liquid	6.1D (Oral) Acutely toxic	4095L	-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.5A Respiratory sensitiser		-	-	-	-	-	1.0L	1.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	1000L
		6.5B Contact sensitiser		-	-	-	-	-	1.0L	1.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	1000L
		8.2C Corrosive to dermal tissue		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1kg	1.0L	10000L
		8.3A Corrosive to eyes		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	1.0L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
XCI	Powder	6.1E Acutely toxic	24075kg	-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.3B Mildly irritating to the skin		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		9.3B Ecotoxic to terrestrial vertebrates.		-	-	-	-	-	0.2kg	5.0kg	-	-	-	5.0kg	1000kg	1000kg	-	-	-	-	0.2kg	5.0kg	-

BTW COMPANY		Section of Regulations		Test Certificates					Emergency Management															Sched 4
		Sub-section		Location & Transfer	Manufacture & End Use	Approved Handler	Hazardous atmosphere zone	Tracking	EM Level 1	EM Level 2	EM Level 3	Fire Extinguisher	Fire Extinguisher	Documentation	Signage	Signage	Separation	Separation	Separation	Incompatibility	Dispersal		Bunding
		Reference																						
		Schedule Table reference from Regulations		4.2	4.2	4.3	4.4	4.5	5.2.1	5.2.2	5.2.3	5.2.5	5.2.5	5.3.1	5.3.2	5.3.2	5.4.1	5.4.1	5.4.1	5.4.1	5.5			
		Description of what the numbers relate to in table below		Table 3	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 8	Table 9	Table 10	Table 10	Table 11	Table 11	Table 12	Table 13	Table 14	Sched 4
				Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Number of fire extinguishers	Threshold level	Emergency Regulations	Identification Requirements	Low Intensity Land Use Threshold VOLUME	Low Intensity Land Use Separation Distance	Separation required from	Incompatible substances	Information Requirements	Documentation Requirements	Threshold
Safe Cide	Liquid	6.1D (Oral) Acutely toxic		-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.5B Contact sensitiser		-	-	-	-	-	1.0L	1.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	1000L
		9.3C Harmful to terrestrial vertebrates	0	-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
Safe Solv E	Liquid	6.1E Acutely toxic		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.5A Respiratory Sensitiser		-	-	-	-	-	1.0L	1.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	1000L
		6.5B Contact sensitiser		-	-	-	-	-	1.0L	2.0L	1000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	1000L
		8.2C Corrosive to dermal tissue	435L	-	-	-	-	-	0.1L	1.0L	10000L	-	-	2.0L	1000L	1000L	-	-	-	-	Any	1.0L	1000L
		8.3A Corrosive to eyes		-	-	-	-	-	0.1L	1.0L	10000L	-	-	2.0L	1000L	1000L	-	-	-	-	0.1kg	1.0L	10000L
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	1.0L	50L	20000L	-	-	50L	10000L	10000L	-	-	-	-	0.1L	1.0L	30000L
Safe Surf O	Liquid	6.1D (Oral) Acutely toxic		-	-	-	-	-	0.1L	1.0L	1000L	-	-	2.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.3A Skin Irritant		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	1.0L	1000L
		8.3A Corrosive to eyes	835L	-	-	-	-	-	0.1L	1.0L	10000L	-	-	2.0L	1000L	1000L	-	-	-	-	0.1L	50L	-
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	50L	10000L
Salt PVD	Solid	6.1E Acutely toxic		-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.4A Irritating to the eye	4200kg	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
Seraline 185V	Liquid			50L	-	-	1.0L	-	1.0L	1.0L	1000L	250L	2	1.0L	250L	250L	-	-	-	Class 1 Class 2 Class 3.2 Class 4 Class 5	1.0L	1.0L	1000L
		3.1B Flammable Liquids: high hazard	8																				
		6.1E Acutely toxic																					
		6.2B Mildly Irritating to the skin		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
Soda Ash	Solid	6.1B Acutely toxic		-	-	-	-	-	1.0L	50L	1000L	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.3A Skin Irritant		-	-	Any	-	REQUIRED	ANY	any	100kg	-	-	any	250kg	250kg	-	-	-	-	any	any	100kg
		6.4A Irritating to the eye	450KG	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.15g	50kg	-
		6.9B Toxic to human target organ or systems		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	2.1kg	50kg	-
Sodium Formate	Liquid	6.1E Acutely toxic,		-	-	-	-	-	-	3.0kg	-	-	-	10kg	-	-	-	-	-	-	0.1kg	3.0kg	-
	Solid	6.1E Acutely toxic.	80000L	-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
Sodium Formate																							
Versawet	Liquid	6.9B Toxic to human target organs or systems	1500kg	-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	2.0kg	50kg	-
		8.3A Corrosive to eyes		-	-	-	-	-	-	1.0L	-	-	-	1.0L	-	-	-	-	-	-	0.1L	1.0L	-
		9.1D Slightly harmful to the aquatic environment or otherwise designed for biocidal action.		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	1.0L	10000L
		9.2B Ecotoxic in the soil environment	1892L	-	-	-	-	-	1.0L	50L	10000L	-	-	50L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L
		9.2B Ecotoxic to terrestrial vertebrates		-	-	-	-	-	0.2L	5.0L	-	-	-	5.0L	1000L	1000L	-	-	-	-	0.2L	5.0L	-
HALLIBURTON CHEMICALS																							
A3-L	Liquid	6.1D Acutely Toxic		-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L
		8.2C Corrosive to skin		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	1.0L	10000L
		8.3A Corrosive to eyes	1000L	-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	2.1kg	1.0L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	0.1L	1.0L	10000L	-	-	5.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L
AS-S	Liquid	6.1D (oral) Acutely toxic		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
		3.1B Flammable Liquids: high hazard		50L	-	-	1.0L	-	1.0L	1.3L	1000L	250L	2	1.0L	250L	250L	-	-	-	Class 1 Class 2 Class 3.2 Class 4 Class 5	1.0L	1.0L	1000L
		6.1F (oral) Acutely toxic																					
		6.3A Irritating to the skin	1000L	-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.3B Mildly Irritating to the skin		-	-	-	-	-	0.1L	50L	1000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.4A Irritating to the eye		-	-	-	-	-	1.0L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		8.3A Corrosive to ocular tissue		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		9.1D (fish, crustacea, algae) Slightly harmful in the aquatic environment or are otherwise designed for biocidal action		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	50L	-
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	2.0L	50L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	1.0L	10000L
Calcium Chloride	Solid	6.1D (oral) Acutely toxic		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.9L	50L	10000L
		6.3A Irritating to the skin		-	-	-	-	-	0.1kg	2.0kg	1000kg	-	-	20.0kg	10000kg	10000kg	-	-	-	-	1.0L	5.0L	-
		6.4A Irritating to the eye	1000kg	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	3.0kg	1000kg
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
CFR-3	Solid	6.1E Acutely toxic (oral)		-	-	-	-	-	1.0kg	5.0kg	-	-	-	5.0kg	10000kg	10000kg	-	-	-	-	0.1kg	50kg	-
CFR-3L	Liquid	6.3A Irritating to the skin	1000kg	-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	1.0kg	5.0kg	-
		6.4A Irritating to the eye	1000L	-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
Class G Cement	Solid	6.1(oral) Acutely toxic		-	-	-	-	-	0.2L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.5A Respiratory sensitisers.		-	-	-	-	-	0.1kg	2.0kg	1000kg	-	-	20kg	10000kg	10000kg	-	-	-	-	2.1kg	3.0kg	1000kg
		6.5B Contact sensitisers.		-	-	-	-	-	2.5kg	3.0kg	1000kg	-	-	30kg	-	-	-	-	-	-	Any	3.0kg	1000kg
		8.2C Corrosive to dermal tissue	1000kg	-	-	-	-	-	1.0kg	3.0kg	1000kg	-	-	40kg	-	-	-	-	-	-	0.1kg	3.0kg	1000kg
		8.3A Corrosive to eyes		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	Any	3.0kg	1000kg
Cleanbore_B	Liquid	6.1D (oral) Acutely toxic		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	2000kg	-	-	-	-	-	2.0kg	10000kg
		6.3A Irritating to the skin		-	-	-	-	-	0.1L	2.0L	1000L	-	-	2.0L	10000L	10000L	-	-	-	-	0.1kg	2.0kg	10000kg
		8.3A Corrosive to ocular tissue	1000L	-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	1.0L	1000L
		9.1D (fish, crustacea, algae) Slightly harmful in the aquatic environment or are otherwise designed for biocidal action		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	50L	-
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	1.0L	10000L
D-Air 3000	Liquid	6.3B Mildly Irritating to the skin	1000L	-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	50L	10000L
		6.4A Irritating to the eye		-	-	-	-	-	1.0L	50L	10000L	-	-	50L	-	-	-	-	-	-	1.0L	5.0L	-
Econolite Liquid	Liquid	6.1D (oral) Acutely toxic		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		8.2C Corrosive to dermal tissue		-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	50L	-
		8.3A Corrosive to ocular tissue	1000L	-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	1000L	1000L	-	-	-	-	0.1L	1.0L	1000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	10000L	10000L	-	-	-	-	2.1kg	1.0L	10000L
				-	-	-	-	-	2.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	10000L

BTW COMPANY		Section of Regulations		Test Certificates					Emergency Management															Sched 4
		Sub-section		Location & Transit	manufacture and Use	Approved Handler	Hazardous Atmosphere zone	Tracking	Ehl Level 1	Ehl Level 2	Ehl Level 3	Fire Extinguisher	Fire Extinguisher	Documentation	Signage	Signage	Separation	Separation	Separation	Incompatibility	Disposal		Bunding
		Reference		4.2	4.2	4.3	4.4	4.5	5.2.1	5.2.2	5.2.3	5.2.5	5.2.5	5.3.1	5.3.2	5.3.2	5.4.1	5.4.1	5.4.1	5.4.1	5.5		
		Schedule Table reference from Regulations		Table 1	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 8	Table 9	Table 10	Table 10	Table 11	Table 11	Table 11	Table 12	Table 13	Table 14	Sched 4
		Description of what the numbers relate to in table below		Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Number of Extinguishers	Threshold level	Emergency Regulations	Identification Requirements	Low Intensity Land Use Threshold VOLUME	Low Intensity Land Use Separation Distance	Separation outside fence	Incompatible substances	Information Requirements	Documentation Requirements	Threshold
Fly Ash	Solid	6.1E Acutely toxic (oral)		-	-	-	-	-	1.0kg	50kg	-	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.7A Substances that are carcinogenic	1000kg	-	-	10kg	-	-	-	0.5kg	5000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	20000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		8.2C Corrosive to dermal tissue		-	-	-	-	-	0.1kg	1.0kg	20000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	-	2.0kg	10000kg
		9.1D (fish, crustacea, algae) Slightly harmful in the aquatic environment or are otherwise designed for biocidal action		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
Gascon 469	Liquid	6.1E (oral) Acutely toxic		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.3A Irritating to the skin		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.4A Irritating to the eye	1000L	-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.7A Substances that are carcinogenic		-	-	10L	-	-	-	0.1L	1000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	1000L
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.1L	10000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	10000L
Goldseal Bentonite	Liquid	6.7A Substances that are carcinogenic	1000L	-	-	10L	-	-	-	0.1L	1000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	1000L
		6.9B Toxic to human target organs or systems		-	-	-	-	-	-	1.0L	-	-	-	1.0L	-	-	-	-	-	-	0.1L	1.0L	-
HAI 404	Liquid	3.1B Flammable Liquids: high hazard		50L	-	-	1.0L	-	1.0L	1.0L	1000L	250L	2	1.0L	250L	250L	-	-	-	Class 1 Class 2 Class 3.2 Class 4 Class 5	1.0L	1.0L	1000L
		6.1D (oral) Acutely toxic	1000L	-	-	-	-	-	0.1L	1.0L	10000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.3B Mildly irritating to the skin		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.8B Suspected human reproductive or developmental toxicants		-	-	-	-	-	-	1.0L	-	-	-	1.0L	-	-	-	-	-	-	-	1.0L	-
		6.9A (Inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.1L	10000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000l	10000L	-	-	-	-	1.0L	5.0L	-
Halad 344	Solid	6.1C (oral) Acutely toxic		-	-	Any	-	Recipes	ANY	0.5kg	100kg	-	-	0.5kg	1000kg	1000kg	-	-	-	-	Any	0.5kg	100kg
		6.1D (dermal & inhalation) Acutely toxic		-	-	-	-	-	0.1kg	3.0kg	1000kg	-	-	30kg	10000kg	10000kg	-	-	-	-	0.1kg	3.0kg	1000kg
		6.3A Irritating to the skin		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.5B (contact) Contact sensitisers	1000kg	-	-	-	-	-	1.0kg	1.0kg	1000kg	-	-	30kg	-	-	-	-	-	-	Any	3.0kg	5000kg
		6.6A Known or presumed human mutagens		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		6.7A Known or presumed human carcinogens		-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.8B Suspected human reproductive or developmental toxicants		-	-	-	-	-	-	3.0kg	-	-	-	30kg	-	-	-	-	-	-	-	3.0kg	-
		6.9A Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		9.3B Ecotoxic to terrestrial vertebrates		-	-	-	-	-	0.2kg	5.0kg	-	-	-	5.0kg	1000kg	1000kg	-	-	-	-	0.2kg	5.0kg	-
Halad 688	Solid	6.1D (oral) Acutely toxic		-	-	-	-	-	0.1kg	3.0kg	1000kg	-	-	30kg	10000kg	10000kg	-	-	-	-	0.1kg	3.0kg	1000kg
		6.7A Known or presumed human carcinogens		-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A (inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		8.1A Corrosive to metals	1000kg	-	-	-	-	-	Any	1.0kg	-	-	-	2.0kg	1000kg	1000kg	-	-	-	-	-	2.0kg	-
		8.2C Corrosive to dermal tissue		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	-	2.0kg	10000kg
		8.3A Corrosive to ocular tissue		-	-	-	-	-	0.1kg	1.0kg	10000kg	-	-	2.0kg	1000kg	1000kg	-	-	-	-	0.1kg	2.0kg	10000kg
		9.1C Harmful to the aquatic environment		-	-	-	-	-	1.0kg	5.0kg	-	-	-	5.0kg	1000kg	1000kg	-	-	-	-	1.0kg	5.0kg	1000kg
		9.3B Ecotoxic to terrestrial vertebrates		-	-	-	-	-	0.2kg	5.0kg	-	-	-	5.0kg	1000kg	1000kg	-	-	-	-	0.2kg	5.0kg	-
HI1500kk	Liquid	6.1E (oral) Acutely toxic		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.4A Irritating to the eye	1000L	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.9A (oral) Toxic to human target organs or systems		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
Microsilica 690	Solid	6.7A Carcinogenic	1000kg	-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A Target Organ Toxicant		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	20000kg
SSA-1 Silica Flour	Powder	6.7A Carcinogenic	1000kg	-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A Target Organ Toxicant		-	-	-	-	-	-	0.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
Super CLB	Solid	4.3B Flammable Solids - Dangerous when wet	1000kg	25kg	-	100kg	-	-	0.5kg	0.5L	1000L	250kg	2	0.5kg	250kg	250kg	<1000 1000-10000kg 10000-100000kg 100000-1000000kg 1000000L+	1m 1m 1m Toxic Assay	-	Low Intensity Land Use	Class 1 Class 2 Class 3 Class 4 Class 4.2.1, 4.2.2, 4.2.3 & 4.2 Class 5 Class 8 Water	0.5kg	0.5kg	1000kg
		6.9B Toxic to human target organs or systems		-	-	-	-	-	-	3.0kg	-	-	-	30.kg	-	-	-	-	-	-	0.1kg	3.0kg	-
		9.1D (fish, crustacea, algae) Slightly harmful in the aquatic environment or are otherwise designed for biocidal action		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	10000kg	10000kg	-	-	-	-	1.0kg	50kg	10000kg
Tuned Spacer III	Powder	6.7A Carcinogenic	1000L	-	-	10kg	-	-	-	0.5kg	1000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	1000kg
		6.9A Target Organ Toxicant		-	-	-	-	-	-	3.5kg	10000kg	-	-	0.5kg	-	-	-	-	-	-	Any	0.5kg	10000kg
Versatet	Solid	6.3A Irritating to the skin	1000kg	-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	0.1kg	50kg	-
Weltlife 684	Solid	4.2C Flammable Solids - spontaneously combustible (self heating)	1000kg	25kg	-	-	-	-	1.0kg	3.5kg	10000kg	500kg	2	3.0kg	1000kg	1000kg	<1000 1000-10000kg 10000-100000kg 100000-1000000kg 1000000L+	1m 1m 1m Toxic Assay	-	Low Intensity Land Use	Class 2 Class 3 Class 4 Class 4.1, 4.2, 4.3 & 4.1 Class 5 Class 8 Oxidizing	1.0kg	-	10000kg
Zonesealant 2000	Liquid	3.1B Flammable Liquids: high hazard	1000L	50L	-	-	1.0L	-	1.0L	1.0L	1000L	250L	2	1.0L	250L	250L	-	-	-	Class 1 Class 3 Class 3.2 Class 4 Class 5	1.0L	1.0L	1000L
		6.1E Acutely toxic		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.3B Mildly irritating to the skin		-	-	-	-	-	1.0L	50L	10000L	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-

BTW COMPANY	Section of Regulations		Test Certificates					Emergency Management															Sched 4
	Sub-section		location & Transit	manufacture and Use	Approved Handler	Hazardous atmosphere zone	Tracking	EM Level 1	EM Level 2	EM Level 3	Fire Extinguisher	Fire Extinguisher	Decontamination	Signage	Signage	Separation	Separation	Separation	Incompatibility	Disposal			Bunding
	Reference		4.2	4.2	4.3	4.4	4.5	5.2.1	5.2.2	5.2.3	5.2.5	5.2.5	5.3.1	5.3.2	5.3.2	5.4.1	5.4.1	5.4.1	5.4.1	5.5			
	Schedule Table reference from Regulations		Table 2	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 8	Table 9	Table 10	Table 10	Table 11	Table 11	Table 11	Table 12	Table 13	Table 14	Sched 4	
	Description of what the numbers relate to in table below		Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Threshold level	Number of Extinguishers	Threshold level	Emergency Restrictions	Manifestation Requirements	Low Intensity Land Use Threshold VOLUME	Low Intensity Land Use Separation Distance	Separation required from	Incompatible substances	Information Requirements	Document-ation Requirements	Threshold	
GENERAL CHEMICALS																							
Methanol	Liquid	3.1B Flammable Liquids: high hazard		50L	-	-	1.0L	-	1.0L	1.0L	10000	250L	2	1.0L	250L	250L	-	-	-	Class 1 Class 2 Class 3.2 Class 4 Class 5	1.0L	1.0L	1000L
		6.1D (oral) Acutely toxic	3500L	-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000L	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.8B Suspected human reproductive or developmental toxicants		-	-	-	-	-	-	2.0L	-	-	-	1.0L	-	-	-	-	-	-	-	1.0L	-
		6.9A (inhalation) Toxic to human target organs or systems		-	-	-	-	-	-	0.1L	10000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-
LPG	Gas	2.1.1A Flammable Gases : high hazard	188m3	100m3	-	200m3	10m3	-	0.2m3	0.2m3	200m3	38m3	1	0.2m3	100m3	100m3	-	-	-	Class 2	0.2m3	0.2m3	-
Diesel	Liquid	3.1D Flammable liquids: low hazard.	20000L	-	-	-	-	-	5.0L	50L	10000L	500L	2	50L	10000L	10000L	-	-	-	Class 1 Class 2 Class 3.2 Class 4 Class 5	5.0L	50L	10000L
		6.1E Acutely toxic		-	-	-	-	-	1.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.3B Mildly irritating to the skin.		-	-	-	-	-	1.0kg	50kg	10000kg	-	-	50kg	-	-	-	-	-	-	1.0kg	50kg	-
		6.7B Carcinogenic		-	-	-	-	-	-	1.0L	10000L	-	-	1.0L	-	-	-	-	-	-	Any	1.0L	10000L
		9.1B Harmful to aquatic ecosystems		-	-	-	-	-	0.2L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	0.2L	5.0L	10000L
Produced Hydrocarbons	Liquid	3.1B Flammable Liquids: high hazard	15000L	50L	-	-	-	1.0L	1.0L	1000L	500L	2	1.0L	250L	250L	-	-	-	Class 1	1.0L	1.0L	1000L
		6.1E Acutely toxic		-	-	-	-	-	2.0L	50L	-	-	-	50L	-	-	-	-	-	-	1.0L	50L	-
		6.6A Mutagenic properties		-	-	-	-	-	-	0.1L	10000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	10000L
		6.7A Substances that are carcinogenic		-	-	10L	-	-	-	0.1L	1000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	1000L
		6.9B Toxic to human target organs or systems		-	-	-	-	-	-	1.0L	-	-	-	1.0L	-	-	-	-	-	-	0.1L	1.0L	-
		9.1C Harmful to aquatic ecosystems		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	1000L	1000L	-	-	-	-	1.0L	5.0L	1000L
Monoethylene Glycol	Liquid	6.1D Toxic	1500L	-	-	-	-	-	0.1L	1.0L	1000L	-	-	1.0L	10000	10000L	-	-	-	-	0.1L	1.0L	1000L
		6.4A Irritating to the eye		-	-	-	-	-	0.1L	50L	10000L	-	-	50L	-	-	-	-	-	-	0.1L	50L	-
		6.9A Target Organ		-	-	-	-	-	-	0.1L	10000L	-	-	0.1L	-	-	-	-	-	-	Any	0.1L	10000L
		9.3C Harmful to terrestrial vertebrates		-	-	-	-	-	1.0L	5.0L	-	-	-	5.0L	10000L	10000L	-	-	-	-	1.0L	5.0L	-

APPENDIX B SITE MAPS

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

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
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	-	-	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B [KBIs:26687,3629]	-	1
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) 21st ed. 2005.	10 g/m^3	1
Specific Gravity*	Calculation: weight of sample / weight of equivalent volume of water at 20°C. Gravimetric determination.	0.01 20°C/20°C	1
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.053 g/m^3	1
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.021 g/m^3	1
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m^3	1
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N.	0.05 g/m^3	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 21st ed. 2005.	0.002 g/m^3	1
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 21st ed. 2005.	0.10 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

APPENDIX D PHOTOGRAPHIC RECORD OF LANDFARMING

June 2013 F4

June 2013 new areas landfarmed

Coastal Planting along buffer zone April 2013

Appendix III

AgKnowledge landfarm review report

The Taranaki Landfarms

are they

"Fit for Purpose"

A report

Commissioned by Taranaki Regional Council

Undertaken by

Dr D C Edmeades
agKnowledge Ltd
PO Box 9147, Hamilton, 3240.

September 2013

EXECUTIVE SUMMARY

1. Waste products (rock cuttings and drilling muds) from the oil exploration industry in Taranaki are being incorporated into re-contoured formed sand dunes and re-sown back to pasture (a process referred to as Landfarming). This process is controlled by resource consents issued by the Taranaki Regional Council. Three Landfarms have been completed to date and are now being farmed commercially (2 under irrigation).

2. The drilling muds contain potential contaminants: petrochemical residues, barium, heavy metals and salts. The question arises: are these reformed soils 'fit-for-purpose' - in this case pastoral farming and especially dairy farming.

3. As required by the consents regular soil samples were collected and analysed during the disposal process. These results were summarised and examined relative to the permitted limits for the various potential contaminants.

4. The completed sites were visited and the pasture and soils inspected. Soil and pasture samples were collected and analysed for all potential contaminants. These results were compared to the properties of normal New Zealand pastorals soils.

5. It is concluded from this body of evidence that these modified soils are 'fit –for-purpose". The concentrations of: nutrients (macro and micro), heavy metals and soluble salts in these soils and pasture are similar to normal New Zealand soils. The form of barium present is as environmentally benign barite, and there is no evidence of accumulation of petrochemical residues.

6. The process of Landfarming these otherwise very poor soils, together with appropriate management (irrigation, fertiliser and improved pastures) has increased the agronomic value of the land from about $3-5000/ha to $30-40,000/ha.

BRIEF

1. The Taranaki Regional Council (TRC) has consented several oil exploration companies to dispose of 'drilling muds' at several sites on coastal sands around the region.

2. The drilling muds are initially stored at the sites and, after the sand dunes have been levelled, this material is applied to the surface (at < 100mm thick) and then incorporated into the re-contoured sandy soils (at a minimum depth of 250mm depth). Once this process is completed the modified soils are fertilised (not more the 200 kg N/ha) and sown down to clover–based pasture. This whole process is controlled by criteria set out in resource consents.

3. Three sites (referred to as landfarms) have been completed to date and are currently being used for pastoral farming. One site (Browns, commenced 2006, completed 2011) is not irrigated and runs dry stock. The other 2 sites (Schrider, commenced 2004, completed 2010, and Geary, commenced 2001, completed 2006) are under pivot irrigation and used for dairy farming. Note there is a small area at the Geary site, which is not irrigated.

4. The TRC has retained agKnowledge Ltd to determine whether these landfarms are "fit for purpose", in this case fit for pastoral farming and in particular dairying.

5. Specifically this brief excludes any consideration as to the off-site effects of the landfarms (possible movement of contaminants via runoff or leaching) and does not consider whether the compliance criteria set out in the consents were met or otherwise.

METHODOLOGY

6. Drilling muds consist of a) the cuttings (mainly solid) of the underlying strata of rocks from the drill bit b) drilling fluids (bentonite based mud and slurry including proprietary additives used to either lubricate the drilling process or to control the in-well pressure and conditions. This includes barium sulphate which is used as a wetting and weighting agent and c) drilling wastes (liquid) containing well water and petrochemical residues. There are 3 classes of drilling fluids: water-based, (WBM), oil based (OBM) and synthetic (SBM) (Taranaki Regional Council, undated, ref: PCDOCS\FRODO\98943\1).

7. Given the general composition of the drilling muds, this report investigates the following aspects of the completed landfarms:

    a. What is the current soil fertility of the modified soils with respect to growing clover-based pasture for ruminants and in particular dairy cows?

b. What are the heavy metal and barium concentrations in the soils and pastures and are there any implications for soil, pasture and animal health and production?
c. Are there any petrochemical residues in the soils and pasture, which may affect soil, plant and animal health?

8. Two sites, Geary and Schrider, were visited on July 4 2013 and soils samples (0-75mm – the standard depth for determining soil fertility) and mixed-pasture samples were collected for an initial investigation, using the standard sampling protocols.

9. The 3 completed landfarms were visited on 5 August 2013 and on this occasion two sets of soil (0-75mm) and mixed pasture samples were collected from the following sites: Schrider (irrigated), Geary (irrigated and non-irrigated) and Brown (non-irrigated). One set were sealed in clip-tight plastic bags for analysis of petroleum hydrocarbon (PCH) residues and the other set were used to determine the concentrations of the full suit of elements including the macro, micro and heavy metals plus barium.

10. The TRC provided the full records of the soil tests (0-250mm) undertaken as per the consents, during the process of disposal of the drilling muds, at each site. This data was summarized.

11. Throughout this the report the criteria for the safe disposal of heavy metals, barium and petroleum hydrocarbons (as set down by a number of authorities) are used as part (other matters are also considered) of the assessment process. In applying these criteria it is assumed that they have been set at levels to ensure the protection of soil, pasture, animal and human health.

RESULTS

Pasture Assessment

At the time of the second site visit (5 August 2013) the pastures were assessed as follows:

Table 1: Visual assessment of the pastures at the three sites.

Site	Assessment	Rating
Schrider (irrigated)	Ryegrass dominant pasture, vigorous. Very little clover some showing signs of potassium deficiency. Excreta patches obvious. Some flats weeds and poor pasture grasses.	6/10
Geary (irrigated)	Vigorous ryegrass pasture with about 20% clover. Excreta patches not apparent. Very few weeds.	8/10
Geary (non-irrigated)	Assorted weeds abundant, excreta patches prominent, Some low value browntop and Yorkshire fog. Ryegrass and clover only in excreta patches.	2/10
Brown (non-irrigated)	Assorted weeds abundant, excreta patches prominent, Ryegrass and clover only in excreta patches.	2/10

Importantly, there were abundant earthworm casts on all sites indicating considerable soil biological activity. The earthworm can be regarded as the 'canary in the mine' with respect to soil biological activity.

Soil Properties

The general properties of the modified soils (0-75mm, the standard depth for soil fertility assessment) are given in Table 2 and indicate low levels of cation exchange capacity (CEC), anion storage capacity (ASC), organic matter (OM) and organic nitrogen (ON), reflecting their sandy nature and past history (low quality pasture). The amounts of soluble salts (SS) and the exchangeable sodium percentage (referred to in the documentation incorrectly as the sodium absorption, SAR) are low and the soil calcium (Ca) and sodium (Na) levels are consistent with the normal levels found in pastoral soils.

Table 2: Soil chemical properties (0-75mm) at the three landfarms sites.

Site	CEC (me/100 gm)	ASC (%)	OM (%)	ON (%)	SS (%)	Ca (MAF units)	Na (MAF units)	SAR (%)
Schrider	9	11	2.6	0.13	0.01	7	7	1.1
Geary Irrigated	7	11	2.2	0.16	0.02	5	10	2.0
Geary Non irrigated	9	16	3.5	0.21	0.02	6	7	1.2
Brown	9	34	3.4	0.14	0.01	6	4	0.6
Typical	*10-30*	*20-80*	*5-20*	*0.1-0.4*	*0.05-0.30*	*5-20*	*3-10*	*1-2*

As required by the consent agreements, routine soil testing (0-250mm) was undertaken on all three sites during the process of disposal of the drilling muds. The results for each site are summarized in Tables 3 a,b,c:

Table 3a. Chemical characteristics of the soil (0-250mm) at the Schrider site during disposal.

Soil Property	No. samples	Average	Max	Min	Limit[1] & units	No. over limit
Conductivity (disposal)	51	32 <0.02	0.13	<0.02	400 mS/m	0
Conductivity (expiry)	53	44 < 0.02	1.3	<0.02	290 mS/m	0
Soluble salts	53	43 <0.05	0.46	<0.05	0.25 %	2
SAR	47	1.1	3.1	0.3	18	0
Sodium	31	482	790	310	460 g/m3	14
Chloride	50	145	1360	4	700g/m3	3

Note 1) Taranaki Regional Council, undated, ref: PCDOCS\FRODO\98943\1.

Table 3b. Chemical characteristics of the soil (0-250mm) at the Geary site during disposal.

Soil Property	No. samples	Average	Max	Min	Limit[1]& units	No. over limit
Conductivity (disposal)	33	30 <0.02	0.37	<0.02	400 mS/m	0
Conductivity (expiry)	33	29 <0.02	0.37	<0.02	290 mS/m	0
Soluble salts	33	32 <0.05	0.13	<0.05	0.25 %	0
SAR	38	1.0	3.7	0.1	18	0

Sodium	13	481	600	310	460 g/m3	7
Chloride	36	28	356	4	700 g/m3	0

Note 1) Taranaki Regional Council, undated, ref: PCDOCS\FRODO\98943\1.

Table 3c. Chemical characteristics of the soil (0-250mm) at the Brown site during disposal.

Soil Property	No. samples	Average	Max	Min	Limit[1]& units	No. over limit
Conductivity (disposal)		No given			400 mS/m	0
Conductivity (expiry)		No given			290 mS/m	0
Soluble salts	5	all < 0.05	<0.05	-	0.25 %	0
SAR	17	2.4	18	0.3	18	0
Sodium	17	80	530	7	460 g/m3	7?
Chloride	31	98	550	5.9	700 g/m3	0

Note 1) Taranaki Regional Council, undated, ref: PCDOCS\FRODO\98943\1.

The soil property which most frequently exceeded the limit was the soil Na concentrations. The limit of 460 gm/m^3 soil, is (assuming a soil bulk density of about 1) equivalent to a MAF soil Na reading of about 20. Thus, while some elevated soil Na levels were recorded during the disposal process the current levels (0-75 mm) are normal (Table 2). This is also apparent in the SAR levels. The likely reason for this is that Na (and the same applies to chloride) are very mobile and will readily leach out of soils, especially sandy soils with a good rainfall and under irrigation, noting that in the New Zealand situation Na and Cl are environmentally benign.

In any case note that the problems that occur when soil Na levels are elevated (loss of soil structure and impeded drainage together with plant sensitivity to salinity) normally arise on heavy soils in arid climates. Furthermore, higher than normal soil Na levels and hence better than normal pasture Na concentration (see later) can only be beneficial to animal health in the New Zealand setting.

Soil Fertility

Soils

The soil tests (Table 4) indicate that, in terms of optimizing production from clover-based pastures, the sites are deficient with respect to potassium (K) and sulphur (S). The site with the best overall soil fertility is 'Geary irrigated' and this is reflected in the superior pasture on this site (Table 1). The poor pasture on the 2 non-irrigated sites (Brown, Geary non-irrigated) can be explained by the lack of irrigation resulting in moisture stress together with the poor underlying soil fertility.

Table 4: Soil nutrient levels (0-75mm) at the three landfarms sites (units are as used in the standard MAF soil testing protocol)

Site	pH	Olsen P	K	Sulphate S	Organic S	Mg
Schrider	6.0	24	2	4	3	23
Geary Irrigated	6.3	28	5	12	3	37
Geary Non irrigated	6.2	38	7	6	3	22

Brown	6.6	22	2	8	4	13
Optimal[1]	*5.8-6.0*	*35-40*	*7-10*	*10-12*	*10-12*	*8-10*

Notes 1) assuming a high producing dairy farm

Pasture

The concentrations of macro (Table 5a) and micro (Table 5b) nutrients in the mixed-pasture samples from the 4 sites are given below. Mixed-pasture analysis provides information relating to the nutrient value of the pastures for, in this case, ruminants.

Table 5a: Macronutrient concentrations (%) in mixed-pasture from the three sites for samples collected 5 August 2013 (Figures in parenthesis are from samples collected 4 July 2013).

Site	**Pasture macronutrient concentration (%)**						
	N	**P**	**K**	**S**	**Mg**	**Ca**	**Na**
Schrider	4.43 (2.66)	0.44 (0.43)	2.51 (1.69	0.37 (0.40)	0.29 (0.38)	0.57 (0.64)	0.79 (1.11)
Geary Irrigated	4.44	0.47	3.59	0.40	0.33	0.38	0.55
Geary non-irrigated	3.92 (4.11)	0.46 (0.45)	3.62 (2.73)	0.37 (0.41)	0.30 (0.31)	0.39 (0.39)	0.54 (0.45)
Brown	4.15	0.40	3.51	0.36	0.24	0.64	0.47
Typical	*4.5-5.5*	*0.30-0.40*	*2.0-4.00*	*0.25-0.35*	*0.15-0.22*	*0.25-0.50*	*0.1-0.3*

Table 5b: Micronutrient concentrations (ppm) in mixed-pasture from the three sites for samples collected 5 August 2013 (Figures in parenthesis are from samples collected 4 July 2013).

Site	**Pasture micronutrient concentrations (ppm)**							
	Mn	**Zn**	**Cu**	**Fe**	**Co**	**Mo**	**Se**	**B**
Schrider	54 (58)	31 (33)	6.4 (6.3)	230 (818)	0.16 (0.27)	0.34 (<0.05)	0.31 (0.48)	6.0 (7.3
Geary Irrigated	86	32	7.6	2057	0.87	0.59	0.14	9.7
Geary non-irrigated	79 (84)	28 (34)	9.2 (10.9)	1124 (930)	0.46 (0.23)	0.46 (0.41)	0.02 (0.02)	7.7 (7.5)
Brown	65	31	9.3	351	0.18	2.38	<0.01	6.9
Typical	*20-50*	*10-20*	*5-10*	*45-65*	*0.04-0.10*	*0.1-1.0*	*>0.03*	*13-16*

These results indicate that the nutrient levels in the pastures from these landfarm sites are typical of New Zealand pastures except that:

a) The pasture sodium (Na) levels are elevated due to enrichment from the soils either from sea sprays or from the drilling muds. Either way this is of no consequence and can only be a benefit to animal health.
b) The manganese (Mn) and zinc (Zn) levels appear to the greater than normal but are nevertheless not sufficiently high to give rise to animal health problems.
c) The iron (Fe) levels are elevated. This is most likely due to contamination from the soil as frequently occurs on 'normal' soils and in any case is of little practical consequence.
d) The cobalt (Co) and molybdenum (Mo) are above the minimum levels for optimal health.

e) The selenium (Se) levels on 2 sites are below the minimum level for optimal animal production as is frequently the case for many New Zealand soils. This can be readily corrected with fertiliser Se.

The combined soil and pasture results suggest that there is nothing unusual about the soils and pastures at these landfarms, relative to normal conditions, which occur routinely throughout New Zealand. Furthermore, they indicate that providing the soil fertility is optimised and there is little moisture stress (i.e. they are irrigated), high quality productive and healthy clover-based pastures can be grown on these landfarms.

If the constraints (soil fertility and moisture) were removed it should be possible to grow at least 15 tonnes DM/ha annually, and assuming they are used for dairying, would put the value of the landfarms at about $30-40,000/ha. In their natural state (i.e. before land farming) they were growing low-quality feed and used for dry-stock farming only. There original value would be about $3-4000/ha.

Heavy Metals

Soil (Routine Sampling 0-250mm)

The results from the monitoring of the soils (0-250mm) during the process of disposal of the drilling muds, as required under the consents, are summarized for each site in Table 6 a, b, c:

In all cases the heavy metal concentrations were well below the guideline limits set by the Ministry for the Environment (2003) for the disposal of biosolids.

Table 6a: Summary of heavy metal concentrations (ppm) in the soil (0-250mm) at the Schrider site.

Element	No. samples	Average	Max.	Min.	Limit[1]
As	47	46 < 2[2]	4	< 2	20
Cd	47	all < 0.10[2]	< 0.10	-	1
Cr	50	15	23	8	600
Cu	50	13	25	9	100
Pb	50	3	23	1	300
Ni	50	8	11	5	60
Zn	50	71	100	33	300
Hg	41	all < 0.01[2]	< 0.10	-	1

Note 1) from the Ministry for the Environment 2003
2) for some elements and on some occasions the results were reported at being less than a given limit. It is not realistic in such cases to give an arithmetic mean and hence some indication of the distribution of the results is recorded.

Table 6b: Summary of heavy metal concentrations (ppm) in the soil (0-250mm) at the Geary site.

Element	No. samples	Average	Max.	Min.	Limit[1]
As	33	all < 2[2]	<2	-	20
Cd	33	all < 0.1[2]	<0.10	-	1
Cr	33	15	20	8	600
Cu	33	17	32	7	100
Pb	33	14	48	1	300
Ni	33	7	11	5	60
Zn	33	72	113	33	300
Hg	33	all < 0.1[2]	<0.10	-	1

Note 1) from the Ministry for the Environment 2003
2) for some elements and on some occasions the results were reported at being less than a given limit. It is not realistic in such cases to give an arithmetic mean and hence some indication of the distribution of the results is recorded.

Table 6c: Summary of heavy metal concentrations (ppm) in the soil (0-250mm) at the Brown site.

Element	No. samples	Average	Max.	Min.	Limit[1]
As	24	17 < 2[2]	5	< 2	20
Cd	24	22 < 0.10[2]	0.27	< 0.10	1
Cr	24	11	19	7	600
Cu	24	21	41	15	100
Pb	24	3	8	1	300
Ni	24	6	10	4	60
Zn	24	74	120	49	300
Hg	24	all < 0.01[2]	<0.10	-	1

Note 1) from the Ministry for the Environment 2003
2) for some elements and on some occasions the results were reported at being less than a given limit. It is not realistic in such cases to give an arithmetic mean and hence some indication of the distribution of the results is recorded.

The heavy metal concentrations in the soils (0-250mm), as measured during the process of disposal, were all much less than the set limits, at all three sites.

Soil (normal pastoral soil levels)

The heavy metal concentrations in soils (0-100mm) from surveys conducted from various regions of New Zealand under pasture and non-farmed land uses are summarized in Appendix 1. The Table below (Table 7) compares these typical concentrations (0-100mm) with those found at the three landfarm sites (0-75mm).

Table 7: Comparison of the heavy metal concentrations (ppm) in typical New Zealand pastoral and non-farmed soils (0-100mm) and in the soils (0-75mm) at the three sites; Schrider, Geary and Brown.

Element	Range in mean/median values in NZ farmed or (non-farmed) soils)[1]	Site					
		Schrider		Geary			Brown[2]
				Sample 1[2]	Sample 2[2]		
		Sample 1[2]	Sample 2[2]	Non-irrigated	Non irrigated	Irrigated	Sample 1
Arsenic (As)	3-9 (3-5)	<2	<2	<2	<2	<2	2
Cadmium (Cd)	0.1-0.8 (0.1-0.14)	<0.1	0.11	<0.1	<0.1	<0.1	<0.1
Chromium (Cr)	8-18 (12-18)	nd	11	nd	11	11	8
Copper (Cu)	10-20 (10-16)	nd	11	nd	20	13	21
Lead (Pb)	6-16 (9-16)	1.6	1.8	3.2	3	1.4	3.6
Nickel (Ni)	4-14 (4-14)	nd	5	nd	5	5	4
Zinc (Zn)	7-79 (28-66)	nd	55	nd	53	57	57
Mercury (Hg)	0.07-0.20 (0.11-0.19)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Notes 1) from Appendix 1.
2) samples 1 collected 4 July 2013, samples 2 collected 8 August 2013.

The samples collected on the three landfarms (Schrider, Geary and Brown), were from the depth 0-75mm (the normal depth for testing soil nutrients). The range in the median and mean above, from the surveys, are for soils to a depth of 0-100mm. Data from Waikato survey (Waikato Regional Council 2011) shows that top-soils (0-100mm) are enriched relative to the sub-soils (100-200mm) for Cd, Cr, Cu, Ni but not for the other heavy metals. Thus, the results above for the landfarms (0-75mm) are likely to be elevated to some extend relative to the typical ranges given in Table 7.

These results indicate that the soil heavy metal concentrations are at the low end of the ranges for both farmed (dairying) and non-farmed soils (referred to in the respective reports as either native, indigenous and background).

Pasture (normal levels)

The available information on the heavy metal concentrations in pastures in New Zealand is summarized in Appendix 2.

Table 8: Heavy metal concentrations (ppm) in mixed-pasture from the three sites for samples collected 5 August 2013 (Figures in parenthesis are from samples collected 4 July 2013).

Site	Pasture heavy metal and barium concentrations (ppm)						
	As	**Cd**	**Hg**	**Pb**	**Cr**	**Ni**	**Ba**
Schrider	<0.1 (<0.1)	0.022 (0.033)	0.013 (0.028)	0.039 (0.079)	0.460 (<0.1)	<1 (<1)	42 (33)
Geary Irrigated	<0.1	0.011	<0.01	0.072	0.750	<1	74
Geary non-irrigated	<0.1 (<0.10)	0.025 (0.027)	0.011 (0.029)	0.102 (0.112)	0.600 (0.160)	<1 (<1)	>100 (97)
Brown	<0.1	0.073	0.011	0.104	0.520	<1	71
***Typical*[1]**	*0.07-0.24*	*0.03-0.29*	*na*	*0.10-1.8*	*0.31-0.49*	*0.10-0.20*	*na*

Note 1) see Appendix 2

Consistent with the soil data, these results indicate that there is nothing unusual about the heavy metal concentrations in the pastures from these landfarms relative to normal levels reported for New Zealand pastures.

Barium

Barium sulphate (Barite) is used during the drilling process (Alberta Environment 2009), as noted. This chemical form of barium is practically insoluble and therefore environmentally benign, unlike other barium salts (e.g. barium chloride and nitrate) (Menzies et al 2008). There are currently no guidelines in New Zealand for the disposal of biosolids containing barite. The Canadian Authorities (Alberta Environment 2009) have set remediation guidelines for agricultural land at 10,000 ppm (Barite containing sites) and 750 ppm (non-barite sites).

Table 9 summarizes the soil barium (Ba) data (0-250mm) collected during the disposal phase for the three sites.

Table 9: Total barium (Ba) concentrations (ppm) in the soils (0-250mm) at the three sites during the disposal phase.

Site	No. samples	Average	Max	Min	Limit[1]	No. over limit
Schrider	54	528	5500	17	750 ppm	6
Geary	39	1265	5400	90	750 ppm	11
Brown	15	1860	3200	40	750 ppm	13

Note 1) Taranaki Regional Council, undated, ref: PCDOCS\FRODO\98943\1.

This data suggests that the Ba limit (assuming a non-barite source of Ba) was exceeded at some times, however none of the sites reached levels of 10,000 ppm the guideline for barite sites.

The Alberta Environment (2009) guidelines specify a simple procedure to determine whether barite is present at a specific site. If the extractable Ba (in 0.1M Calcium chloride at a 1:10 ratio) exceeds 250 ppm then it is assumed it is a non-barite site. The results below show that the extractable Ba levels are well below the 250-ppm limit leading to the conclusion that the only source of Ba at these sites is the environmentally benign barite form.

Table 10. The concentrations of extractable and total barium (Ba) in soils and in pastures at the 3 landfarm sites

Site	Extractable Ba (ppm)	Total Ba (ppm)	Pasture Ba (ppm)
Schrider	24	7800	42 (33)
Geary (irrigated)	36	760	74
Geary (non-irrigated)	46	2400	>100 (97)
Brown	31	930	71

This being so, the limit for safe disposal (viz. < 10,000 ppm) applies and this was never exceeded during the disposal process. This is consistent with the measured Ba concentrations in the pastures (Table 8) which indicate levels in the ppm range and not in the percent (%) range as might be expected for a divalent cation such as calcium (Ca) or magnesium (Mg) (c.f. table 5a and 8). This is consistent with the view that barite is not considered bioavailable (Alberta Environment 2009).

Petroleum Hydrocarbons

Soils

The guidelines for the management of petrochemical hydrocarbons (PHC) (Ministry for the Environment 2011) require the monitoring of 3 representative types of PHCs:

a) TPH (Total Petroleum Hydrocarbons) in three classes: C7-C9, C10-C14 and C15-36.
b) BTEX: which includes benzene, toluene, ethyl-benzene and xylene.
c) PAH (Polycyclic aromatic hydrocarbons).

Levels of each PHC are set for screening purposes, meaning that if these levels are exceeded, further investigation is recommended.

The measured concentrations of these classes of PHC in the soil (0-250mm) collected during the disposal process for each site are given in tables 11a,b,c below:

Table 11a. Concentrations of various petroleum hydrocarbons (PHC) in the soils (0-250mm) at the Schrider site.

PHC		No. samples	Average	Max.	Min	Limit[1]	No. over limit
TPH	C7-C9	55	50< 8	12	<8	120	0
	C10-C14	55	44< 20	5020	<10	58	3
	C15-C36	55	21<30	19000	<30	4000	4
BTEX	Benzene	43	13<0.05	0.26	<0.03	1.1	0
	Toluene	43	35<0.06	3.23	<0.03	68	0
	Ethylbenzene	43	35<0.05	1.93	<0.03	53	0
	o-xylene	43	23<0.05	4.68	<0.03	48	0
	m&p-xylene	43	31<0.09	13	<0.05	48	0
PAH	Benzo[a]pyrene	37	12<0.02	0.07	<0.02	0.027	1
	Napthelene	37	13<0.10	7.1	<0.10	7.2	0
	Pyrene	37	30<0.09	0.72	<0.02	160	0

Note 1) screening limit set by Ministry for the Environment 2011

Table 11b. Concentrations of various petroleum hydrocarbons (PHC) in the soils (0-250mm) at the Geary site.

PHC		No. samples	Average	Max.	Min	Limit[1]	No. over limit
TPH	C7-C9	32	all<8	<8	-	120	0
	C10-C14	32	29<20	49	<10	58	0
	C15-C36	32	17<30	1400	<30	4000	0
BTEX	Benzene	28	25<0.05	0.20	<0.05	1.1	0
	Toluene	28	25<0.06	0.20	<0.05	68	0
	Ethylbenzene	28	25<0.05	0.20	<0.05	53	0
	o-xylene	28	21<0.05	0.13	<0.02	48	0
	m&p-xylene	28	25<0.09	<0.20	<0.05	48	0
PAH	Benzo[a]pyrene	19	16<0.02	0.40	<0.02	0.027	1
	Napthelene	19	18<0.10	0.12	<0.02	7.2	1
	Pyrene	19	18<0.09	0.19	<0.02	160	0

Note 1) screening limit set by Ministry for the Environment 2011

Table 11c. Concentrations of various petroleum hydrocarbons (PHC) in the soils (0-250mm) at the Brown site.

PHC		No. samples	Average	Max.	Min	Limit[1]	No. over limit
TPH	C7-C9	57	36<8	16	<8	120	0
	C10-C14	57	28<20	5500	<20	58	23
	C15-C36	57	5<30	13500	<30	4000	14
BTEX	Benzene	26	16<0.05	0.08	<0.05	1.1	0
	Toluene	26	16<0.06	0.08	<0.05	68	0
	Ethylbenzene	26	16<0.05	0.16	<0.05	53	0
	xylene	26	14<0.10	0.24	<0.10	48	0
PAH	Benzo[a]pyrene	26	8<0.025	0.028	<0.025	0.027	2
	Napthelene	26	8<0.12	0.30	<0.12	7.2	0
	Pyrene	26	23<0.09	0.28	<0.09	160	0

Note 1) screening limit set by Ministry for the Environment 2011

During the process of disposal there were some occasions when the limits, particularly of TPHs, and particularly on the Brown site, were exceeded. Despite this the BTEX and PAH screening limits were rarely exceeded.

Petrochemical hydrocarbons are biodegradable (Ministry for the Environment 2011) under aerobic soil conditions (as is the case on these sandy soils) and it is likely that the higher rate of exceedances on the Brown site is because this is the most recently completed site. It is anticipated that with time these levels will decline noting that the numerous earthworm casts at all sites indicated an active biomass. This is confirmed by the fact that the TPH concentrations (0-75mm) measured in August 2013 (Table 12) were below the levels of detection on all sites (Table 12).

Table 12: Concentrations of total petrochemical hydrocarbons (TPH) in the soils (0-75mm) at the three landfarm sites (samples collected 5 Aug 2013).

Site	Total Petrochemical Hydrocarbon[1] (TPH) (ppm)			
	C7-C9	C10-C14	C15-C36	Total (C7-C36)
Schrider	<8	<20	<40	<70
Geary Irrigated	<10	<20	<40	<70
Geary non-irrigated	<8	<20	<40	<70
Brown	<8	<20	<40	<70

Note 1) see Appendix 3 for the full results including BTEX and PAH.

The possibility that the TPH levels in these topsoils (0-75mm) underestimate the concentrations in the full profile (i.e. 0-250mm), either due to uneven placement of the drilling wastes in the profile, or their movement down the profile, can be set aside because of the method of disposal required under the consents (surface applied not more than 100mm and incorporated to a depth > 250 mm) and the fact that TPHs are not water soluble.

Pasture

The measured concentrations of these classes of PHCs in the pasture from each site are given in table 13 below:

Table 13: Concentrations of total petrochemical hydrocarbons (TPH) in the pastures at the three landfarm sites (samples collected 5 Aug 2013).

Site	Total Petrochemical Hydrocarbon[1] (TPH) (ppm)			
	C7-C9	C10-C14	C15-C36	Total (C7-C36)
Schrider	<8	<20	58	58
Geary Irrigated	<8	<20	86	86
Geary non-irrigated	<8	<20	71	71
Brown	<8	<20	81	81

1) see Appendix 3 for the full results including BTEX and PAH.

Once again the levels of C7-C9 and C10-C14 TPHs are below the detection limits, as for the soils, but there are higher order TPHs (C15-C36) in the pasture, which

are not present in the soil. The likely explanation for this is that plants manufacture waxes, which are represented in the C15-C36 group of TPH (*pers. comm*. Jo Cavanagh, Landcare Research Ltd)

The concentrations of individual PAHs in the pasture are given in Appendix 3 and for most, the levels are below the detection limit. Plants do not manufacture these compounds and hence any levels above the limit of detection are likely due to plant uptake. However the levels are so low that it is unlikely they would cause a problem in terms of pasture growth, animal health or food quality.

This is consistent with the results from monitoring the concentrations of these compounds in milk from these farms. None have been found (*pers. com*. Mr Andy Fowler, Fonterra, Hamilton).

CONCLUSIONS

Based on the available evidence it is concluded that the Taranaki 'Landfarms' are 'fit for purpose' in terms of pastoral farming and particular dairy farming. This conclusion is based on considering the concentrations of nutrients (both macro and micro), heavy metals, barium and petrochemical hydrocarbons residues in both the soils and pastures at 3 sites.

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 $3-4000/ha to $30-40,000/ha.

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Appendix 1a: Heavy metal concentrations (ppm) in non-farmed soils (0-100mm).

Heavy metal	Source of data			
	Rural Auckland[1] (indigenous)	Waikato[2] (background)	Wellington[3] (native)	Range in mean/median values
Arsenic (As)	3.3	5.1 (1-25)	3 (<2-10)	3-5
Cadmium (Cd)	0.14	0.11 (0.03-0.30)	0.10 (<0.1-0.30)	0.10-0.14
Chromium (Cr)	12.5	18 (1-50)	12 (6-18)	12-18
Copper (Cu)	10.1	16 (4-55)	12 (6-22)	10-16
Lead (Pb)	15.8	11 (3-32)	9 (3-15)	9-16
Nickel (Ni)	4.8	3.9 (0.56-21)	14 (16-2-22)	4-14
Zinc (Zn)	40.2	28 (11-58)	66 (40-104)	28-66
Mercury (Hg)	0.11	0.19 (0.19-0.5)	ng	0.11-0.19

Notes 1) Concentrations of Selected Trace Elements for Various Land Uses and Soil Orders within Rural Auckland. Auckland Council Technical Report 2012/021

2) Soil Quality and Trace Element Monitoring in the Waikato Region. Waikato Regional Council Technical Report 2011/13

3) Soil quality and stability in the Wellington Region. State and Trends. Great Wellington Regional Council. 2012

Appendix 1b: Heavy metal concentrations (ppm) in dairy or farmed soils (0-100mm).

Heavy metal	Source of data					
	Auckland (dairying) [1]	Bay of Plenty (dairying) [2]	Waikato[3] (farmed)	Wellington[4] (dairying)	Malborough [6] (dairying)	Range in mean/ median values
Arsenic (As)	3.3	4.9 (SE 1.2)	8.6 (0.70-94)	4 (<2-30)	5.1	3-9
Cadmium (Cd)	0.59	0.75 (SE 0.09)	0.71 (0.10-2.0)	0.5 (0.23-1.3)	0.42	0.1-0.8
Chromium (Cr)	13.1	7.6 (SE 0.8)	14 (1-220)	17 (9.8 – 50)	27	8-18
Copper (Cu)	16	16.1 (SE 3.7)	24 (3-250)	13 (6.8-35)	20	10-20
Lead (Pb)	14.7	5.6 (SE 0.6)	16 (3-95)	16 (7.3-32)	15	6-16
Nickel (Ni)	5.5	6.1 (SE 1.0)	6 (1-34)	12 (4-24)	13	4-14
Zinc (Zn)	43.1	72 (SE 17.8)	62 (1-258)	79 (33-120)	81	7-79
Mercury (Hg)	0.2	0.07 (SE 0.01)	0.16 (0.03-0.5)	ng	ng	0.07-0.20

Appendix 2: Heavy metal concentrations (ppm) in pasture reported in the literature and the Maximum Permissible Levels (MPL) in complete rations.

Heavy metal	**Longhurst[1]**	**Quin[2]**	**Typical**	**MPL[3]**
As	0.07-0.24	ng[4]	0.07-0.24	2
Cd	0.03-0.29	0.05 – 0.08	0.03-0.29	1
Cr	ng	0.34-0.46	0.31-0.49	ng
Cu	9-14	5.4-11.7	5.4-14	ng
Pb	0.10-0.35	0.76-1.80	0.10-1.8	5
Ni	ng	< 0.10-0.20	0.10-0.20	ng
Zn	6.5-40	22-37	6.5-37	ng
Hg	ng	ng	ng	0.10

Notes
1) Longhurst et. al. 2004. Range in mean concentrations across soil groups and plant species
2) Quin and Syers 1978. Range in values for control treatment
3) Maximum permitted levels in complete rations for ruminants (Suttle N. F. 2010)
4) ng = not given

Appendix 3: Laboratory results showing the concentrations of all petrochemical hydrocarbons in 4 soils samples and 4 pasture samples.

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1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Eurofins NZ Laboratory Services Ltd	**Lab No:**	1168389	SPv2
Contact:	S Stiles-Jones	**Date Registered:**	17-Aug-2013	
	C/- Eurofins NZ Laboratory Services Ltd	**Date Reported:**	29-Aug-2013	
	PO Box 281	**Quote No:**	56330	
	HAMILTON 3240	**Order No:**	168833HM	
		Client Reference:	3256047	
		Submitted By:	S Stiles-Jones	

Amended Report

This report replaces an earlier report issued on the 26 Aug 2013 at 1:33 pm
Sample IDs have been amended at the client's request.

Sample Type: Soil

		Sample Name:	13508240 (Brown) 09-Aug-2013	13508241 (Geary Unirrig) 09-Aug-2013	13508242 (Geary irrig) 09-Aug-2013	13508243 (Schrider) 09-Aug-2013	
		Lab Number:	1168389.1	1168389.2	1168389.3	1168389.4	
Individual Tests							
Dry Matter	g/100g as rcvd		80	84	75	84	-
BTEX in Soil by Headspace GC-MS							
Benzene	mg/kg dry wt		< 0.05	< 0.05	< 0.06	< 0.05	-
Toluene	mg/kg dry wt		< 0.05	< 0.05	< 0.06	< 0.05	-
Ethylbenzene	mg/kg dry wt		< 0.05	< 0.05	< 0.06	< 0.05	-
m&p-Xylene	mg/kg dry wt		< 0.10	< 0.10	< 0.12	< 0.10	-
o-Xylene	mg/kg dry wt		< 0.05	< 0.05	< 0.06	< 0.05	-
Polycyclic Aromatic Hydrocarbons Screening in Soil							
Acenaphthene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Acenaphthylene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Anthracene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Benzo[a]anthracene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Benzo[a]pyrene (BAP)	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Benzo[g,h,i]perylene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Benzo[k]fluoranthene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Chrysene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Dibenzo[a,h]anthracene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Fluoranthene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Fluorene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Naphthalene	mg/kg dry wt		< 0.14	< 0.14	< 0.16	< 0.13	-
Phenanthrene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Pyrene	mg/kg dry wt		< 0.03	< 0.03	< 0.04	< 0.03	-
Total Petroleum Hydrocarbons in Soil							
C7 - C9	mg/kg dry wt		< 8	< 8	< 10	< 8	-
C10 - C14	mg/kg dry wt		< 20	< 20	< 20	< 20	-
C15 - C36	mg/kg dry wt		< 40	< 40	< 40	< 40	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt		< 70	< 70	< 70	< 70	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	-	1-4
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Eurofins NZ Laboratory Services Ltd	**Lab No:**	1165426	SPv1
Contact:	K Rhodes	**Date Registered:**	09-Aug-2013	
	C/- Eurofins NZ Laboratory Services Ltd	**Date Reported:**	23-Aug-2013	
	PO Box 281	**Quote No:**		
	HAMILTON 3240	**Order No:**	168833HM	
		Client Reference:	9640618	
		Submitted By:	K Rhodes	

Sample Type: Plant Material

Sample Name:		13P02588	13P02589	13P02590	13P02591	
Lab Number:		1165426.1	1165426.2	1165426.3	1165426.4	
Polycyclic Aromatic Hydrocarbons in Biomatter						
Acenaphthene	mg/kg	0.0009	0.0007	0.0006	0.0010	-
Acenaphthylene	mg/kg	< 0.0005	< 0.0005	< 0.0005	0.0006	-
Anthracene	mg/kg	0.0009	0.0023	0.0005	0.0014	-
Benzo[a]anthracene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Benzo[a]pyrene (BAP)	mg/kg	0.0003	< 0.0002	0.0003	< 0.0002	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg	0.0004	0.0003	0.0003	0.0002	-
Benzo[g,h,i]perylene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Benzo[k]fluoranthene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Chrysene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Dibenzo[a,h]anthracene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Fluoranthene	mg/kg	0.0008	0.0004	0.0004	0.0004	-
Fluorene	mg/kg	0.0014	0.0013	0.0010	0.0015	-
Indeno(1,2,3-c,d)pyrene	mg/kg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-
Naphthalene	mg/kg	0.006	0.007	0.005	0.011	-
Phenanthrene	mg/kg	0.0028	0.0021	0.0016	0.0018	-
Pyrene	mg/kg	< 0.0005	< 0.0005	< 0.0005	< 0.0005	-
Total Petroleum Hydrocarbons in Biota						
C7 - C9	mg/kg as rcvd	< 8	< 8	< 8	< 8	-
C10 - C14	mg/kg as rcvd	< 20	< 20	< 20	< 20	-
C15 - C36	mg/kg as rcvd	81	71	86	58	-
Total hydrocarbons (C7 - C36)	mg/kg as rcvd	81	71	86	< 60	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Plant Material

Test	Method Description	Default Detection Limit	Samples
Homogenisation of Biological samples for Organics Tests	Mincing, chopping, or blending of sample to form homogenous sample fraction.	-	1-4
Polycyclic Aromatic Hydrocarbons in Biomatter		-	1-4
Total Petroleum Hydrocarbons in Biota	Sonication extraction, Alumina cleanup, GC-FID analysis	-	1-4

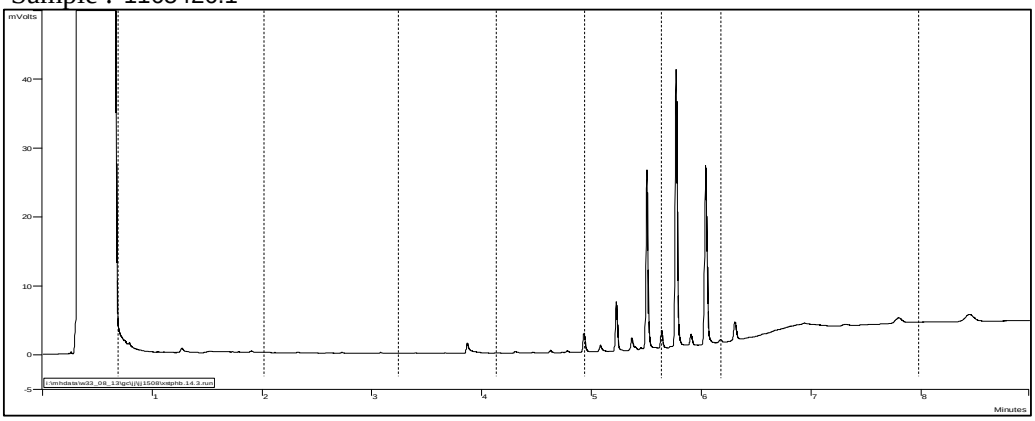
Sample Type: Plant Material			
Test	**Method Description**	**Default Detection Limit**	**Samples**
TPH in Biota extraction by Sonication (Instrument Vial)	Sonication extraction, Silica cleanup, GC-FID analysis.	-	1-4
TPH in Biota extraction by Sonication (Storage Vial)	Sonication extraction, Silica cleanup, GC-FID analysis.	-	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

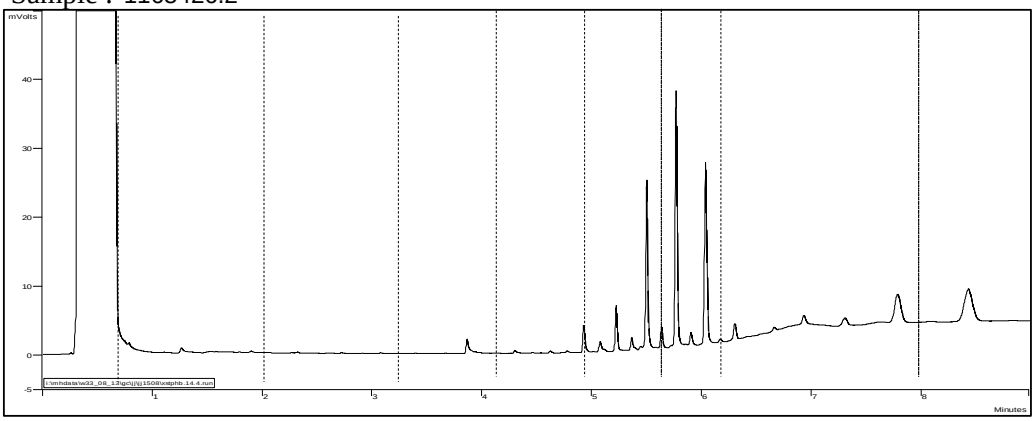
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

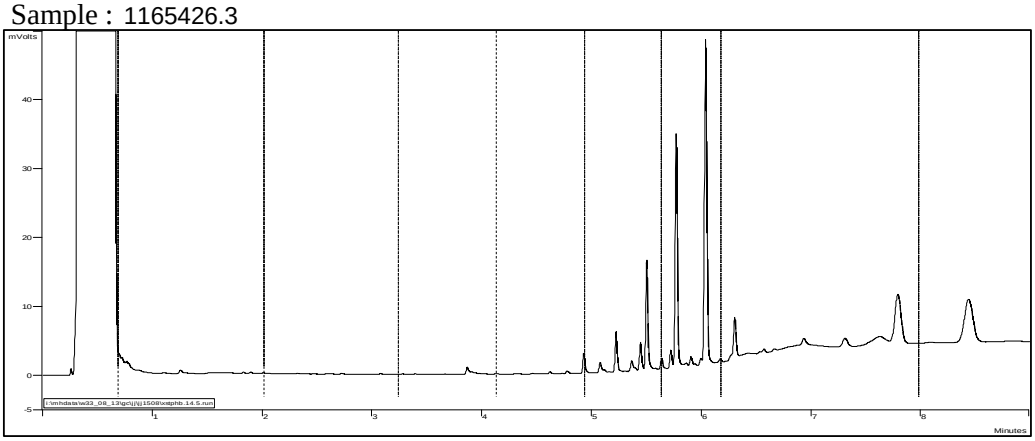
Sample : 1165426.1



Sample : 1165426.2

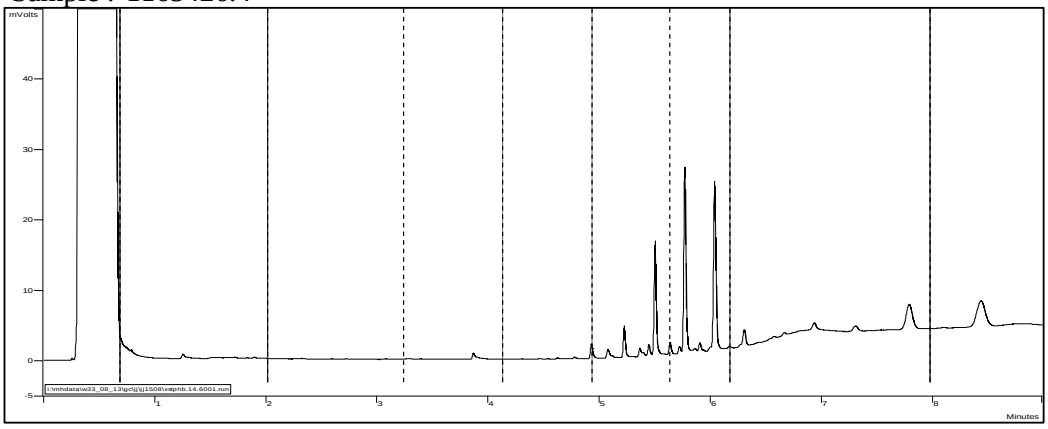


Sample : 1165426.3



C7 C10 C15 C20 C25 C30 C34 C44

Sample : 1165426.4



C7 C10 C15 C20 C25 C30 C34 C44

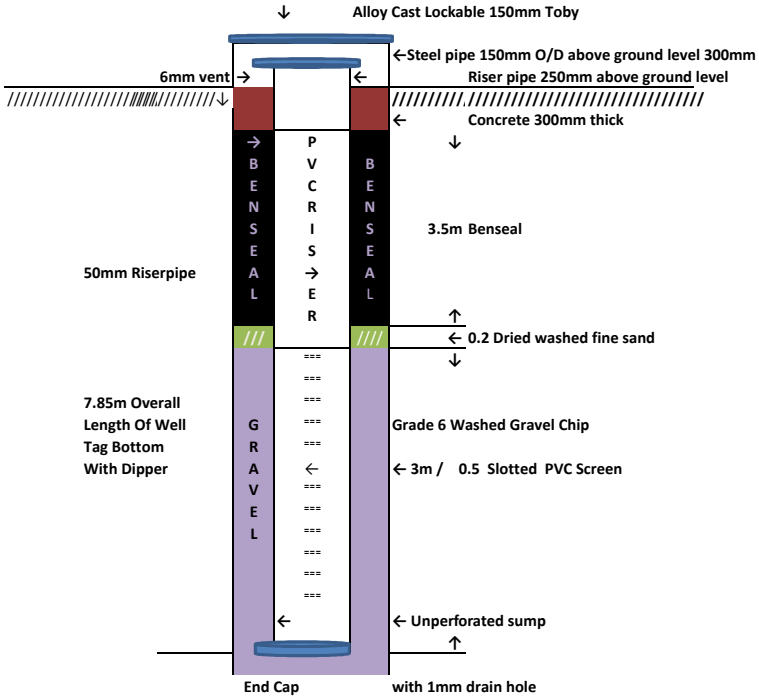
Appendix IV

Monitoring well schematics

Oeo Land Farm

Construction Diagram Of Monitoring Well Installation GND2286

Date: 27-08-2012
Hole Drilled With Tractor Rig From 0 to 10m with 100mm auger
Purged Wells 5 Times
Note: BTW to survey in ground elevations & GPS well locations



Monitoring Wells Installed By Strata Drilling Services Ltd

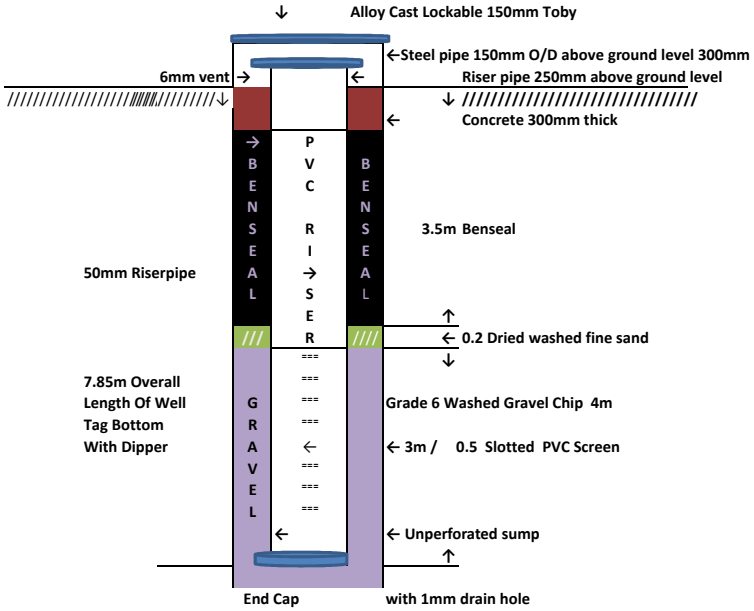
Drilling Formations
0 - 500mm Sandy Topsoil
500mm - 2m Soft Sandy Clay
2m - 10mm Soft Tephra

Water Table @ 3.4m dipped by TRC on 28-08-2012

Oeo Land Farm

Construction Diagram Of Monitoring Well Installation GND2287

Date: 27-08-2012
Hole Drilled With Tractor Rig From 0 to 10.5m with 100mm auger
Purged Wells 5 Times
Note: BTW to survey in ground elevations & GPS well locations



Monitoring Wells Installed By Strata Drilling Services Ltd

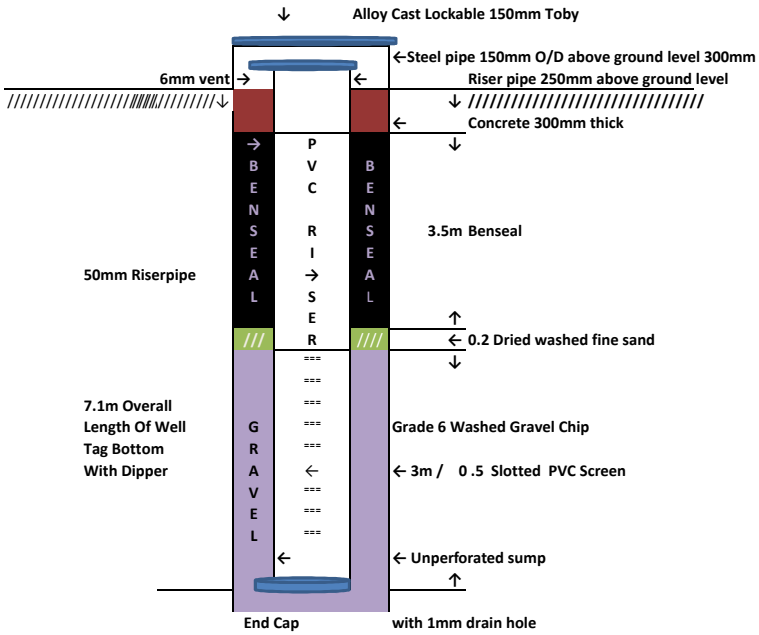
Drilling Formations
0-500mm sandy Topsoil
500mm - 3m Soft Sandy Clay
3m - 10.5m Tephra

Water Table @ 4.2m dipped by TRC on 28-08-2012

Oeo Land Farm

Construction Diagram Of Monitoring Well Installation GND2288

Date: 27-08-2012
Hole Drilled With Tractor Rig From 0 to 10m with 100mm auger
Purged Wells 5 Times
Note: BTW to survey in ground elevations & GPS well locations



Monitoring Wells Installed By Strata Drilling Services Ltd

Drilling Formations
0-500mm Sandy Topsoil
500mm - 2.5m Sandy Soft Clay
2.5m to 10m Tephra

Water Table @ 3.4m dipped by TRC on 28-08-2012