Waste Remediation Services Ltd
Symes Manawapou Landfarm
Monitoring Programme
Annual Report
2016-2017

Technical Report 2017-74

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Executive summary

Waste Remediation Services Ltd (WRS) operates a landfarm, Symes Manawapou, which is located on Manawapou Road near Manutahi, in the Manawapou catchment, South Taranaki. The consent held by WRS was originally granted in May 2012 to Remediation Services NZ and was then transferred to WRS in June 2014. This report marks the third full year WRS has been in charge of the Symes Manawapou Landfarm. This is the fifth report by the Council for this facility.

This report for the period July 2016 to June 2017 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to WRS's environmental and consent compliance performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of WRS's activities.

WRS hold one resource consent, which includes a total of 27 conditions setting out the requirements that WRS must satisfy. WRS hold one consent to discharge drilling wastes (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, onto and into land via landfarming.

During the monitoring period, Waste Remediation Services (WRS) demonstrated an overall Good level of environmental performance.

The Council's monitoring programme for the year under review included eight inspections, 17 water samples collected for physicochemical analysis, and six composite soil samples.

The monitoring indicated that the saline impacted groundwater monitoring well, GND2301, which had been impacted with elevated total dissolved salts since 2013 had reduced to below the consented limit of 2,500 g/m^3. WRS removed from service an older damaged storage liner which had been adversely affect by wind erosion. A new lined pit was constructed to replace it.

Composite soil sampling undertaken by the Council indicated compliance with consent conditions. Surrender soil sampling is proposed for the upcoming monitoring period to assess previously landfarmed areas. Revegetation of previously landfarmed areas had been undertaken to a good standard.

During the year, WRS demonstrated a Good level of environmental and a High level for administrative performance with their resource consent.

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance remains at a good level in the year under review.

This report includes recommendations for the 2017-2018 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 for the period July 2016 to June 2017 by the Council describing the monitoring programme associated with resource consents held by the Waste Remediation Services Ltd (WRS). WRS operates a landfarm situated on Manawapou Road, near Manutahi, South Taranaki. In this report it is referred to as Symes Manawapou Landfarm.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by WRS that relate to discharges of drilling wastes from hydrocarbon exploration and production activities, onto and into land, via landfarming, within the Manawapou catchment. This is the third annual report to be prepared by the Council to cover WRS's discharges and their effects and is the fifth annual report for the Symes Manawapou Landfarm.

Disposal activities undertaken by WRS commenced at this site during the 2013-2014 monitoring year. The original consent was granted 1 May 2012 to Remediation NZ Ltd, and the site became operational in September 2012. The present owners took control of the site in June 2014.

During the 2014-2015 monitoring period, there were disposals of approximately 1,170 m^3 of water-based and synthetic-based cuttings and fluids from the TAG OIL (NZ) Ltd Cheal E wellsite. These disposals commenced on 12 December 2014 through to 20 December 2014, across the consented area. Stormwater from the storage pits was also spread onto this area on two occasions prior to the disposal of solid wastes.

During the 2015-2016 monitoring period, the site was relatively inactive and only received three deliveries in this period; of these three deliveries, two originated from TAG Oil (NZ) and constituted a combined maximum of 448 m^3 from two sources, Supplejack and Cheal A, while the third was contaminated soil (1,147 m^3) from the former storage pit area of Origins' former Spence Road landfarm.

During the current monitoring period 2016-2017, the facility received material from three sources which originated from TAG OIL (NZ) operations at the sites of Cheal A, A2X and E-8. These three locations provided a combined 910 m^3 of landfarmable material.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by WRS in the Manawapou catchment;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted at the WRS 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 2017-2018 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 RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;

b. physical effects on the locality, including landscape, amenity and visual effects;

c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and

e. risks to the neighbourhood or environment.

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

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by WRS, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. Administrative performance is concerned with WRS's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

High: No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. 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 in relation to such impacts.

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly.

The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

Improvement required: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

Poor: Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

High: The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

Good: Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

Improvement required: Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

Poor: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

1.2.1 Drilling waste

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

Drilling fluids

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

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

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

Cuttings

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

1.2.2 Landfarming

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

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

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

7. Fertiliser may be applied and the area is sown in crop or pasture at a suitable time of year.

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

Photo 1 Symes Manawapou landfarm post discharge and reinstatement pre-seeding

1.3 Site location and description

The site is located on Manawapou Road at Manutahi, South Taranaki. This site is positioned on marginal coastal farm land situated on reworked dune fields. An extensive (100-250 m) foredune is located seaward of the consented site, and will remain undisturbed by site activities. The foredune provides a considerable natural buffer from prevailing onshore winds. A natural gas pipeline runs adjacent to the length of the site on the seaward side, marking the seaward extent of the disposal site. In addition, a QE II covenant is located in the north western end of the site, and Lake Taumaha (which is a QE II covenant and a Key Native Ecosystem) is located east of the site. The proximity of the site to these recognised ecosystems has been taken into account in the setting of buffer distances and location of the stockpiling facilities.

The predominant soil type has been identified as black loamy sand and vegetation growth is primarily a mixture of pasture and dune grasses. Test pitting and the logging of boreholes on site indicated a relatively shallow water table. Test bores were augured to 10 m in the pit area, revealing extensive compacted, low permeable clays underlying coastal dune sands. Pit construction revealed mostly tightly packed sand at the pit bases (approximately 4-5 m below surface). Average annual rainfall for the site is 1,023 mm (taken from the nearby 'Duffy' monitoring station). As with the other South Taranaki coastal sites, this site is subject to strong winds.

Figure 1 Aerial image of the Symes Manawapou Landfarm with regional location

Site data

Location	
Word descriptor:	Manawapou Road, Manutahi, Taranaki
Map reference:	E 1717244
(NZTM)	N 5608736
Mean annual rainfall:	1,023 mm
Mean annual soil temperature:	~15.1°C
Mean annual soil moisture:	~32.9%
Elevation:	~40 m
Geomorphic position:	Dune backslope
Erosion / deposition:	Erosion
Vegetation:	Pasture, dune grasses
Parent material:	Aeolian deposit
Drainage class:	Free / well draining

1.4 Resource consents

1.4.1 Discharges of wastes to land

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

WRS holds discharge permit **7795-1** to cover the discharge of drilling wastes (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, onto and into land via landfarming. This permit was issued by the Council on 1 May 2012 under Section 87(e) of the RMA. It was transferred to the current consent holder (WRS) in June 2014. It is due to expire on 1 June 2028.

A brief summary of the resource consent conditions is provided below.

- Condition 1 sets out definitions;
- Condition 2 requires the consent holder to adopt the best practicable option to prevent or minimise any environmental effects;
- Condition 3 sets out the requirements for a management plan;
- Condition 4 sets out the requirements for the installation of groundwater monitoring bores prior to the exercise of the consent;
- Conditions 5 to 9 set out the requirements for a management plan, notifications, monitoring and reporting;
- Conditions 10, 12, 13, 14 and 15 specify discharge limits, locations and loading rates;
- Condition 11 requires a buffer zone between areas of disposal and surface water bodies, property boundaries, and QEII Key Native Ecosystems;
- Conditions 16 and 17 regard operational requirements;
- conditions 18 to 24 specify receiving environment limits for both soil and water;
- Condition 25 concerns archaeological remains; and
- Conditions 26 and 27 concern lapse provisions and consent reviews.

The permit is attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consent which is appended to this report.

2 Monitoring programme

2.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

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

The monitoring programme for the Symes Manawapou landfarm consisted of four primary components.

2.1.1 Programme liaison and management

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

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

2.1.2 Site inspections

The Symes Manawapou site was visited eight times during the monitoring period. With regard to consent the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. Sources of data being collected by WRS were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

2.1.3 Chemical sampling

During the monitoring period the Council will assess the mediums of soil and groundwater in relation to compliance at the Symes Manawapou facility. The facility as a consented obligation contains an active groundwater monitoring network which is comprised of four active groundwater monitoring wells.

These wells are sampled four times per annum to ascertain for seasonal fluctuation and to assess for any potential adverse effects permeating from the exercise of the consent. The sampling was conducted through a peristaltic pump and field parameters were captured via a YSi multi parameter probe; the samples were collected once field parameters had been stable within 10% for three consecutive readings. The Council also collected soil samples to assess the quality of the landfarming operation.

The methodology utilised by the Council for the collecting of soil samples across the land farmed area was adapted from the Guidelines for the Safe Application of Biosolids to land in New Zealand (2003). Whereby a soil corer was inserted to a depth of 400 mm +/- to encompass the zone of application. Ten soil cores are collected, these are spaced 10 meters apart. These ten soil cores are then composited to gain one representative soil sample of an application area. An example of a soil core is provided in Figure 2.

In this monitoring period six soil samples were collected. The soil samples were subjected to the following analysis.

Soil analysis parameters

- Total Heavy Metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc);
- Calcium, chloride, conductivity, magnesium, potassium, sodium , total soluble salts and sodium adsorption ratio (SAR);
- Total petroleum hydrocarbons; and
- Moisture factor, ammoniacal nitrogen and nitrate/nitrite nitrogen.

Groundwater analysis parameters

- Barium (dissolved and acid soluble), chloride, conductivity (@ 20°C), sodium, total dissolved salts (TDS), pH;
- Benzene, ethylbenzene, total petroleum hydrocarbons (speciated), toluene, meta-xylene, ortha-xylene, and
- In-situ readings: pH, conductivity, dissolved oxygen (DO), oxidation and reduction potential (ORP) and temperature.

Figure 2 An example of an extracted soil core

2.1.4 Review of consent holder provided data

The consent holder delivers information pertaining to consented obligations which is provided to the Council each year in the form of an annual report. The WRS Symes Manwapou annual report is attached in Appendix II.

In addition to the requirement for an annual report, the consent holder must also notify the Council as to planned landfarming operations, and provide various data on material, including analysis results. In this monitoring period all notifications and associated analysis were supplied.

3 Results

3.1 Inspections

10 October 2016

At the time of inspection the wind was from west, at a speed of approximately 4 m/s. No objectionable odours or visible emissions were found during the inspection. The recent excavation and landfarming works were inspected. The spreading areas had been contoured and sown into pasture, with pasture strike observed across all areas. The ridges had been sown by hand.

Historic application areas were inspected and the pasture appeared healthy across all areas. There were essentially no muds visible at the surface. Five intermediate bulk containers (IBC's) of various liquids were present above pit 1, the labels included waste oil, cleaner and an IBC full of red 'fresh water'.

The walls of storage pit 1 were covered in sand on all four sides. The liquid level in the pond appeared to have dropped slightly when compared to the tideline in the sand. The pit 2 liner was found to have two small holes near the top on the eastern wall and a larger hole below the balance pipe on the southern wall. Pit 3 liner was found to have a tear half way up the northern wall below the 'pit 3' sign. The liquid level in each of the 2 pits was too low for anything to discharge through the holes identified and it is unlikely that stormwater will fill the pits to the discharge levels. The liquid in all three pits was discolored and free of hydrocarbon sheen. No incidents were reported.

15 November 2016

At the time of inspection the wind was from the north, at a speed of approximately 5 m/s. No objectionable odours or visible emissions were found during the inspection. No recent mud deliveries had occurred. The muds and liquids remained in the lined pits. No works had occurred to fix the holes in the liners. The liquid level was much lower than the lowest visible rip.

The IBC's containing liquids previously observed remained adjacent to pit 1. No recent spreading activities had occurred. The historic spreading areas had good pasture cover which appeared healthy, with essentially no muds found at the surface. The mud was very difficult to identify within the soil profile. Recently sown pasture in the area where soil was removed was observed to be developing nicely across the area. (Readers note soil was excavated to back fill the former storage pit area of the former Origin Energy Landfarm, Spence Road, WRS aided in the remediation project).

The site office had been blown over during a recent wind event.

22 February 2017

At the time of inspection the wind direction was west, at a speed of approximately 2 m/s. No objectionable odours or visible emissions were found during the inspection. No recent spreading or storage activities had occurred. The lined pits contained residual muds and stormwater. Pit 3 liner which runs the entire length of the pit was observed to be in a terrible state. The northern face had torn halfway up the pit wall. The liner will need to be replaced if the pit is to be reused.

Pit 2 liner had three small holes which were well above the liquid level. At the time it was not possible to assess the pit 1 liner due to the faces being sand/grass covered, although the tideline in the pit indicated that the level remained stable. The liquid observed within the liner was red coloured, with no surface hydrocarbons present in any of the pits. Two IBC's remained stored adjacent to pit 1 on the southern side.

The spreading areas were inspected and the pasture cover appeared good and healthy. Some muds had migrated to the surface in places and were weathered. The muds broke apart easily, with typical type mud odours. Topsoil had been applied to areas which were sandy and barren of pasture.

26 April 2017

At the time of inspection the wind direction was from the south, at a speed of approximately 3 m/s. No objectionable odours or visible emissions were found during the inspection. Pits 1 and 2 had received drilling muds and were essentially full. The small area of repaired liner in pit 2 was observed above the mud level and looked to be effective. No surface hydrocarbons were present in either pit and the muds appeared quite liquid in character. Pit 3 liner was observed to be in a state of disrepair and had been roped off to prevent discharges into the pit.

No recent spreading activities had occurred and the historic spreading areas had good pasture cover which appeared complete. Essentially no muds were identified at the surface and all pasture appeared healthy. Two IBC's were observed to contain a light red liquid were stored adjacent to pit 1.

28 April 2017

At the time of inspection the wind was from the north, at a speed of approximately 4 m/s. No objectionable odours or visible emissions were found during the inspection. Mud deliveries were occurring at the time of inspection, these were observed to be discharging in to pit 2. Pit 1 was observed to be at capacity.

A new storage pit had been dug on the northern side of pit 3. At the time WRS was awaiting delivery of the new liner which was expected. No recent spreading activities had occurred; pasture across all spreading areas appeared healthy.

Preparation of a new spreading area on the western side of the storage pits to receive drilling muds was likely to occur in the near future. No incidents were reported.

26 May 2017

The wind was from the northeast, at a speed of 2 m/s at the time of inspection. No objectionable odours or visible emissions were found during the inspection. The newly dug pit 4 had been lined with a synthetic liner and a balance pipe installed into pit 2. At the time pit 2 was discharging into pit 4 and capacity of the pit had been essentially reached. Pit 1 was observed to be full. 2 IBC's remain stored adjacent to pit 1.

No surface hydrocarbons were observed in any pits and the liquid contained within was described as turbid grey. At the time of inspection contractors were onsite and preparing the earth for spreading. The topsoil had been stripped back and was in the process of being stockpiled on the spreading area on the western side of storage pits. All historic spreading areas were observed to have good pasture cover which appeared healthy, no muds identified within the soil profile in any of the test pits.

16 June 2017

At the time of inspection the wind was from the west, at a speed of approximately 2 m/s. No objectionable odours or visible emissions were found during the inspection. Contractors were onsite, as works were being undertaken to spread the muds at the time of inspection.

At the time a digger was emptying pit 1 and a tanker was being utilised to empty the liquid from pit 4. Spreading area earthworks were observed to have provided a fairly level surface. The lowest areas had been bunded and observed to be effectively containing any overland flow. A bulldozer was onsite to incorporate the muds. The topsoil was stockpiled adjacent to the spreading area.

The pit liners appeared in good repair. All historic spreading areas were found to have good pasture cover which appeared healthy. No incidents were reported.

20 June 2017

At the time of inspection the wind was from the east, at a speed of approximately 2 m/s. No objectionable odours or visible emissions were found during the inspection. All storage pits had been emptied as far as practicable.

Pit 1 was observed to contain a mound of solid mud which remained in the middle of the pit where the digger was unable to reach. A turbid liquid also remained within the pit. Pit 2 contained what appeared to be slurry in the bottom. Pit 4 contained a small volume of turbid liquid. No surface hydrocarbons were present in any pit. The spreading area were then inspected, the stockpiled topsoil remained stable along the eastern fringe.

The solid mud portion of the material had been spread across two thirds of the northern exposed area. The liquids were also spread mainly along the eastern side adjacent to the topsoil bund.

No contractors were onsite, only a bulldozer was left working to incorporate the muds.

Minor ponding of grey liquid in places was observed, although all discharged materials appeared to of remained within the spreading areas. The southern third of the exposed area appeared to have had very little mud applied. The muds along the northern side of the spreading area were present in piles in places and the area was yet to be worked to incorporate the muds.

Typical, noticeable drilling mud odours were observed around the spreading area. Historic spreading areas had good pasture cover which appeared healthy.

3.2 Results of discharge monitoring

3.2.1 Provision of Company data

In the 2016-2017 monitoring period the site at Symes Manawapou received material from four separate sources shown in Table 1. Kauri C material originated from the retired Spence Road landfarm. WRS aided in the remediation of a former storage pit area at the former Origin Energy Landfarm on Spence Road. This material was received at the Symes Manawapou landfarm just before the beginning of the 2016-2017 monitoring period and was landfarmed within this period. Further information pertaining to the actual remediation project undertaken is provided in the WRS annual report in appendix II.

The remaining three deliveries were from TAG Oil's operations and constituted the material from two new wells, A2X and E-8, and one well work over, Cheal A. Notifications pertaining to deliveries of this material to site, landfarming dates when applicable and associated screening analysis, were provided by the consent holder throughout the year.

Table 1 Drilling mud delivery record Symes Manawapou

Material source	Description	Date	Quantity
Kauri C	Impacted soils from former landfarm storage cell	11/05/2016-13/06/2016	1,147 m^3
Cheal A	Well water	11/08/2016	38 m^3
A2X	Water based muds	04/03/2017-21/03/2017	439 m^3
E-8	Water based muds	20/03/2017-14/05/2017	433 m^3
		Total	**2,057 m^3**

3.2.2 Council Soil Sampling Results:

As proposed in the specific compliance monitoring program associated with this facility, the Council collected six composite soil samples across landfarmed areas this monitoring period. The analysis undertaken was described in Section 1.5.4 Chemical Sampling. The result of the soil sampling is provided in the following Table 2.

Table 2 Council collected soil analysis Symes Manawapou 2016-2017

Soil analysis	Site	Consent limit 7795-1	SOL000188	SOL000188	SOL000188	SOL000188	SOL000188	SOL000188
	Collected		03 Feb 2017	03 Feb 2017	28 Mar 2017	28 Mar 2017	19 Jun 2017	19 Jun 2017
Parameter	Time		11:00	12:00	10:00	11:40	10:00	11:05
Conductivity	mS/m@20°C	400/290*	107.1	98.1	162.1	35.4	85.2	104.2
Moisture Factor	nil	-	1.04	1.01	1.01	1.01	1.00	1.00
pH	pH	-	8	8.1	8	6.8	7.4	7.9
TR Arsenic	mg/kg dry wt	20	< 2	< 2	< 2	< 2	< 2	< 2
TR Cadmium	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
TR Chromium	mg/kg dry wt	600	16	16	14	14	23	21
TR Copper	mg/kg dry wt	100	9	9	10	10	14	15
TR Mercury	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
TR Nickel	mg/kg dry wt	60	7	7	7	7	12	12
TR Lead	mg/kg dry wt	300	1.5	1.5	1.7	1.7	2.1	3.1
TR Zinc	mg/kg dry wt	300	55	52	56	52	82	74
Calcium	mg/kg	-	186.5	368.5	236.3	29.8	97.8	134.4
Chloride	mg/kg	700*	70.5	23.8	154.5	31.3	88.7	90.1
TPH	mg/kg	20,000	45	75	512	62	426	648
Potassium	mg/kg	-	115.5	79.9	311.6	43	118.4	200.4
Magnesium	mg/kg	-	21.9	18.2	33.3	8.1	10.1	7.6
Sodium	mg/kg	460*	22.5	23.3	40.4	22.7	28.7	28.2
Ammonia Nitrogen	mgN/kg	-	0.91	0.1	0.64	1.41	1.08	1.74
Nitrite/Nitrate Nitrogen	mgN/kg	-	1.88	0.15	0.4	0.71	0.91	0.86
Sodium absorption ratio (SAR)	None	18	0.41	0.32	0.65	0.95	0.73	0.64
Total soluble salts	mg/kg	2,500*	838.2	767.7	1268.6	277	666.8	815.5
Area Location			Area A1	Area A2	Area A1	Area A2	A East	B West
TR= Total recoverable TPH= Total Petroleum Hydrocarbon AAR=additional analysis required *=pertains to surrender								

Soil analysis undertaken by the Council at the Symes Manawapou Landfarm is presented above in Table 2. Specific consent limits with respect to analytes are also presented in the table to compare with the actual results when applicable. A brief synopsis per analyte is provided below:

- Soil conductivity ranged from 35.4-162 mS/m@20°C, note the consent limit is limited to 400 mS/m@20°C in the first instance (in terms of initial application and landfarming);

- Moisture within the soil in terms of moisture factor remained pretty consistent across all samples, ranging from 1.00-1.04;
- Soil pH analysis ranged from 6.8-8.1 pH;
- Total recoverable (TR) Arsenic, Cadmium and Mercury concentrations were found to be below the limit of reporting with respect to these heavy metals, with the limit of reporting set at <2 (Ar), <0.10 (Cd) and <0.10 (Hg) all mg/kg;
- TR Chromium ranged from 14-23 mg/kg, note the limit is 600 mg/kg;
- TR Copper ranged from 9-15 mg/kg, with a limit set at 100 mg/kg;
- TR Nickel ranged from 7-12 mg/kg, with a limit of 60 mg/kg;
- TR Lead ranged from 1.5-3.1 mg/kg, with a limit set at 300 mg/kg;
- TR Zinc ranged from 52-82 mg/kg, with a limit of 300 mg/kg;
- Calcium concentrations ranged from 29.8-368.5 mg/kg;
- Chloride concentrations ranged from 23.8-154 mg/kg;
- Total Petroleum Hydrocarbons ranged from 45-648 mg/kg TPH;
- Potassium ranged from 43-311mg/kg;
- Magnesium ranged from 7.6-33 mg/kg;
- Sodium concentrations ranged from 22-40 mg/kg;
- Ammonia nitrogen and nitrite/nitrate nitrogen ranged from 0.1-1.74 mg/kg (NH_4) and 0.15-1.88 mg/kg (NNN) respectively;
- Sodium absorption ratio (SAR) ranged from 0.32-0.95, and
- Total soluble salts ranged from 277-1,268 mg/kg, the final surrender limit s set at 2,500 mg/kg.

Council collected soils samples were within consent limits when compared to the conditions. Surrender sampling analysis has been proposed by WRS and the previously landfarmed areas will be assessed in the upcoming monitoring period.

3.2.3 Council groundwater analysis

As previously stated in Section 1.5.4 Chemical sampling, groundwater monitoring of the site specific monitoring wells is undertaken at the Symes Manawapou landfarm. The facility, inline with its consented obligation, contains four groundwater monitoring wells. These wells are sampled by the Council four times per annum to account for seasonal variation. The aim is to assess the quality of the groundwater in the first instance and to assess for any potential adverse effects arising in the groundwater as an exercise of this consent. The locations of the monitoring wells are provided in the following Figure 3. The analysis per round, per well, is provided in Tables 3 to 6.

Figure 3 Groundwater monitoring well locations Symes Manawapou Landfarm

Table 3 GND2300 Symes Manawapou 2016-2017

Site		GND2300	GND2300	GND2300	GND2300
	Collected	11/10/2016	03/02/2017	28/03/2017	19/06/2017
Parameter	Time	11:30	11:51	11:25	12:30
Barium (acid soluble)	g/m^3	0.11	0.12	0.14	0.034
Barium (dissolved)	g/m^3	0.09	0.07	0.06	0.023
Chloride	g/m^3	782	989	720	154
Conductivity	mS/m@20°C	252	293	221	61.1
Sodium	g/m^3	126	155	126	76.5
pH	pH	6.1	5.9	5.9	6.2
Temperature	°C	15.4	16	NR	14.8
Benzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
TPH C_7-C_9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.06
TPH C_{10}-C_{14}	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2
TPH C_{15}-C_{36}	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4
TPH C_7-C_{36}	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7
Ethylbenzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
XYLENE-M	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Total dissolved salts	g/m^3	1,949.7	2267	1,709.9	472.7

Table 4 GND2301 Symes Manawapou 2016-2017

Site		GND2301	GND2301	GND2301	GND2301
	Collected	11/10/2016	03/02/2017	28/03/2017	19/06/2017
Parameter	Time	10:50	12:25	Well dry	12:00
Barium (acid soluble)	g/m^3	3.72	1.65		0.494
Barium (dissolved)	g/m^3	3.65	1.43		0.353
Chloride	g/m^3	**2,560**	1,560		314
Conductivity	mS/m@20°C	747	465		130
Sodium	g/m^3	488	339		154
pH	pH	6.4	6.3		6.2
Temperature	°C	16.4	17.5		15.9
Benzene	g/m^3	< 0.001	< 0.001		< 0.001
TPH C_7-C_9	g/m^3	< 0.10	< 0.10		< 0.06
TPH C_{10}-C_{14}	g/m^3	< 0.2	< 0.2		< 0.2
TPH C_{15}-C_{36}	g/m^3	< 0.4	< 0.4		< 0.4
TPH C_7-C_{36}	g/m^3	< 0.7	< 0.7		< 0.7
Ethylbenzene	g/m^3	< 0.001	< 0.001		< 0.001
Toluene	g/m^3	< 0.001	< 0.001		< 0.001
XYLENE-M	g/m^3	< 0.002	< 0.002		< 0.002
XYLENE-O	g/m^3	< 0.001	< 0.001		< 0.001
Total dissolved salts	g/m^3	**5,779.6**	**3,597.8**		1,005.8

Table 5 GND2302 Symes Manawapou 2016-2017

Site		GND2302	GND2302	GND2302	GND2302
	Collected	11/10/2016	03/02/2017	28/03/2017	19/06/2017
Parameter	Time	09:45	10:20	09:30	10:30
Barium (acid soluble)	g/m^3	0.03	0.03	0.02	0.03
Barium (dissolved)	g/m^3	0.03	0.02	0.02	0.03
Chloride	g/m^3	78.2	81.6	76.6	87.8
Conductivity	mS/m@20°C	46.7	47.9	47.8	52.2
Sodium	g/m^3	48.5	52.5	52.6	56.8
pH	pH	6.5	6.6	6.4	6.4
Temperature	°C	15.1	16.3	16	14.7
Benzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
TPH C_7-C_9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.06
TPH C_{10}-C_{14}	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2
TPH C_{15}-C_{36}	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4
TPH C_7-C_{36}	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7
Ethylbenzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001

Site		GND2302	GND2302	GND2302	GND2302
	Collected	11/10/2016	03/02/2017	28/03/2017	19/06/2017
Parameter	Time	09:45	10:20	09:30	10:30
XYLENE-M	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Total dissolved salts	g/m^3	361.3	370.6	369.8	403.9

Table 6 GND2303 Symes Manawapou 2016-2017

Site		GND2303	GND2303	GND2303	GND2303
	Collected	11/10/2016	03/02/2017	28/03/2017	19/06/2017
Parameter	Time	10:15	10:55	10:10	11:00
Barium (acid soluble)	g/m^3	0.36	0.37	0.32	0.27
Barium (dissolved)	g/m^3	0.36	0.27	0.32	0.26
Chloride	g/m^3	1,070	1,100	998	717
Conductivity	mS/m@20°C	313	311	308	225
Sodium	g/m^3	207	194	188	175
pH	pH	6	6	5.9	6
Temperature	°C	14.6	16.1	16	14.5
Benzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
TPH C_7-C_9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.06
TPH C_{10}-C_{14}	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2
TPH C_{15}-C_{36}	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4
TPH C_7-C_{36}	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7
Ethylbenzene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
XYLENE-M	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m^3	< 0.001	< 0.001	< 0.001	< 0.001
Total dissolved salts	g/m^3	2,421.7	2,406.2	2,383	1,740.8

Groundwater analysis of the Symes Manawapou Landfarm in the 2016-2017 monitoring year is provided in the above Tables 3, 4, 5 and 6. A brief synopsis per analyte is provided below.

- Barium (Acid soluble) ranged from 0.024-3.72 g/m^3, with the highest reading found in GND2301 in October 2016;
- Barium (dissolved) ranged from 0.023-3.65 g/m^3, in similarity to the acid soluble, the highest concentration was found in GND2301 in October 2016;
- Chloride concentrations ranged from 76-2560 g/m^3, the elevated concentration was above the conditional limit set by the consent of 2,500 Total dissolved salts of 2,500 g/m^3. This concentration was observed in GND2301, again in October 2016;
- Groundwater conductivity readings ranged from 46-747 mS/m@20°C, the elevated conductivity was found in GND2301 in October 2016;
- Sodium ranged from 48-488 g/m^3;

- Groundwater pH ranged from 5.9-6.6 pH;
- Groundwater temperature ranged from 14.6-17.5 °C;
- Benzene, Toluene, Ethylene and Xylene m/o (BTEX) were below the limit of detection for these parameters and were not detected in any well, in any of the four monitoring rounds;
- Total petroleum hydrocarbons, C_7-C_9, C_{10}-C_{14}, C_{15}-C_{36} and C_7-C_{36} concentrations were all below the limit of detection for these parameters and were not detected in any well in all four rounds of monitoring;
- Total dissolved salt (TDS) concentrations ranged from 361-5,779 g/m^3. The elevated concentration was found in well GND2301, in October 2016. Note this concentration exceeded the consented maximum (condition 18 of consent 7785-1) with regard to salts within groundwater, which is set at 2,500 g/m^3.

Groundwater analysis in the 2016-2017 monitoring year of the Symes Landfarm indicated one impacted well, GND2301. Analysis of monitoring well GND 2301 detailed an exceedance this monitoring year with respect to elevated salts, chloride and TDS, primarily in the initial monitoring round in October 2016.

It is noteworthy to mention that by the end of the monitoring period the elevated salt concentrations were below their consented limit of 2,500 g/m^3. TDS concentrations had been elevated in this monitoring well over the past few monitoring periods and the recent analysis denoted a reduction in this analyte (Figure 4).

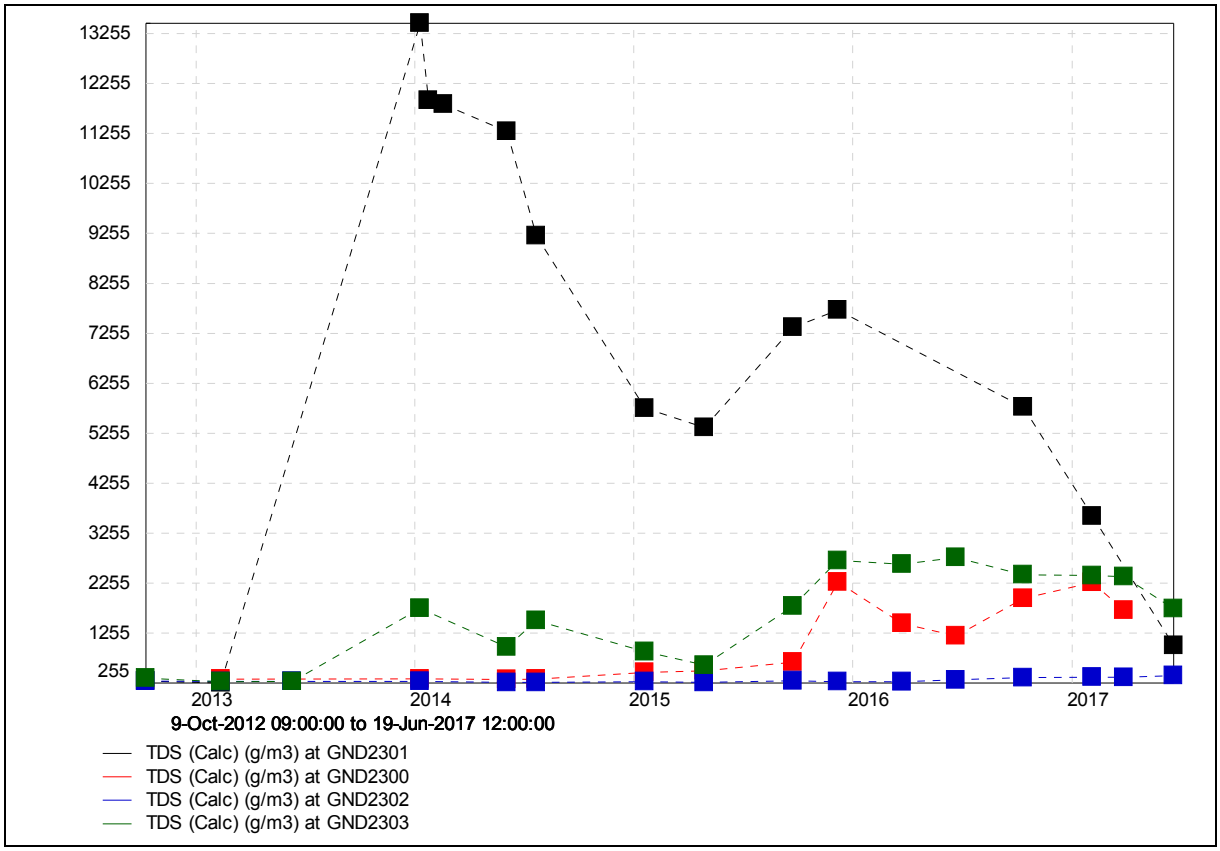


Figure 4 Long term record for total dissolved salt (TDS) concentrations in groundwater wells Symes Manawapou 2013-2017

3.3 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 WRS. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A proactive approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The incident register includes events where WRS 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 WRS is indeed the source of the incident (or that the allegation cannot be proven).

In the 2016-2017 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with WRS's conditions in resource consents or provisions in Regional Plans.

4 Discussion

4.1 Discussion of site performance

The site was landfarmed twice by the consent holder during this monitoring period. The first landfarming operation was undertaken between July and September 2016. This encompassed older stored drilling mud material with the Kauri C impacted soils. The older stored material had been cited in the previous period as being in storage for longer than the consented one year. The second round of landfarming was undertaken between May and June 2017. The work involved the preparation of the ground to take the current material stored within the cells and also for the expected material in the upcoming monitoring period 2017-2018.

Inspections in relation to the quality of the farming indicated that the standard of finishing with respect to the first farming exercise (Jul-Sept 2016) had been undertaken to a good standard. Minimal amounts of material were observed at the surface. The surface vegetation coverage had been established as required by the consent.

Liner integrity had been cited as an issue during this monitoring period, as it had been in the previous monitoring period. The older pit 3 was adversely affected by wind erosion which compromised the liner integrity. This eventuated in a long tear across the length of the storage pit. While the operator indicated that this pit was free from landfarmable material, the investigating officer did observe the pit to be containing liquid (presumed stormwater) in October 2016. This pit was removed from service in April 2017. A new storage pit had since been developed and lined with a new synthetic, fit for purpose line. This pit is now in service.

Soil sampling undertaken in this monitoring period indicated compliance with the consent conditions (not including surrender parameters) and WRS had proposed to submit previously landfarmed areas for surrender analysis. This will occur in the upcoming monitoring period to determine if the soil meets the criteria determined in the surrender related consent condition.

4.2 Environmental effects of exercise of consents

The main environmental effect associated with the exercise of this consent is centred on localised saline impacts in the groundwater in the direct vicinity of GND 2301. Note this well is positioned between two storage pits on site. This monitoring location had detailed impacts since January 2014 where elevated total dissolved salts and BTEX were observed in the water sample.

In the previous monitoring period (2015-2016) only two rounds of sampling were possible due to a lower than normal water table (when compared to previous monitoring years). These two rounds indicated elevated saline impacts and low concentrations of petroleum hydrocarbons (C_7-C_9 and C_{10}-C_{15}) in the groundwater.

In this monitoring year, three rounds of sampling were possible with the well GND2301, although the mid summer round was not possible as the well ran dry. The monitoring indicated that the saline impacts, while still elevated above the conditional concentration of 2,500 g/m^3 TDS at the beginning of the monitoring period, were decreasing.

The concentration at the start of the monitoring year indicated a concentration of 5,779 g/m^3 TDS, October 2016. This concentration continued to decrease throughout the year to a lower concentration of 1,005 g/m^3 TDS in June 2017. It is noted that this concentration is the lowest recorded for TDS at this location since 2013. Also of note, there were no results above the limit of detection for any hydrocarbon related parameter in the groundwater this period.

WRS is aware of the potential for torn/damaged storage cell liners and the subsequent leaching of cell constituents to groundwater if they are damaged. In this monitoring period two pits were observed by the

investigating officer to require additional repair work, of which, one was dually repaired throughout the year. The other was the severely damaged pit 3, this was retired from service and a new storage cell constructed and lined with a fit for purpose liner.

The site is affected by strong winds, which can adversely affect the storage cells/pits when they are not storing significant amounts of material. It was noted during one inspection that the site office had been blown over

The scale of revegetation was cited by the investigating officer as being undertaken to a good standard and hand planted in certain locations. This details how committed WRS is to gaining and maintaining vegetative cover to prevent the potential for elemental erosion which has affected other landfarms in the area.

4.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 7.

Table 7 Summary of performance for consent 7795-1

Purpose: ***To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, 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	Inspection and liaison with consent holder. Frequent liner inspections and repairs, suggested	Yes
3. The consent holder shall provide a stockpiling and landfarming management plan prior to the exercise of the consent	Management plan received and approved	Yes
4. Install groundwater monitoring wells prior to exercise of consent	Inspections and site records	Yes
5. Notify TRC 48 hrs prior to stockpiling	Notifications received	Yes
6. Notify TRC 48 hrs prior to landfarming	Notifications received	Yes
7. The consent holder shall sample for the following: a. Total petroleum hydrocarbons b. Benzene, toluene, ethylbenzene, xylenes c. Polycyclic aromatic hydrocarbons d. Chloride, nitrogen, pH, potassium, sodium	Predisposal samples analysis supplied by consent holder as requested	Yes
8. Keep records relating to wastes, areas, compositions, volumes, dates, treatments and monitoring	Company records	Yes

Purpose: *To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, onto and into land via landfarming*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
9. Report on records in condition 6 to Council by 31 August each year	Report received	Yes
10. Discharges made only within area as specified by submitted application	Inspection	Yes
11. No discharge within 25 m of a water body, 10 m from any property boundary and 50 m from the QEII covenant Key Native Ecosystems	Inspection	Yes
12. Maximum application thickness for wastes: a. 100 mm TPH <5% b. 50 mm TPH >5% c. No ponded liquids 1 hr after application	Company records and inspection	Yes
13. Incorporation into soil as soon as practicable to a depth of at least 250 mm	Inspection and sampling	Yes
14. Hydrocarbon concentrations in soil shall not exceed 50,000 mg/kg dry weight	Sampling	Yes
15. Landfarming areas to be used in accordance with conditions 10 and 11 and shall not be used for any subsequent discharges of drilling wastes	Inspection	Yes
16. All material to be landfarmed as soon as practicable and no later than 12 months	Company records and inspections. Older stored material finally farmed	No
17. Re-vegetate landfarmed areas as soon as practicable	Company records and inspections	Yes
18. Total dissolved salts in any fresh water body shall not exceed 2500 g/m^3	Sampling indicated one well above this concentration at inception of monitoring year, now reduced to below concentration	No
19. Disposal of waste shall not lead to contaminants entering surface water or ground water exceeding background concentrations	Sampling, see above note	No

Purpose: *To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, onto and into land via landfarming*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
20. 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
21. Sodium absorption ratio [SAR] must be less than 18.02, if background SAR exceeds 18.0 then increase shall not exceed 1.0	Sampling	Yes
22. Concentrations of heavy metals in the soil shall at all times comply with MfE guidelines	Sampling	Yes
23. 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 to occur in the following monitoring period, thus not assed in this current period	N/A
24. If condition 23 is not met, consent cannot be surrendered	Not applicable , see above	N/A
25. Notification of discovery of archaeological remains	Not applicable – none discovered in this monitoring period	N/A
26. Consent shall lapse on 30 June 2017	Not applicable – consent exercised	N/A
27. Optional review provision re environmental effects	Next optional review June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Good** **High**

N/A = not applicable

Table 8 Evaluation of environmental performance over time

Year	Consent no	High	Good	Improvement req	Poor
2012-2013	7795-1				1
2013-2014	7795-1		1		
2014-2015	7795-1		1		
2015-2016	7795-1		1		
Totals	-	0	3	0	1
WRS gained consent of the Symes Manawapou facility at the end of the 2013-2014 monitoring period					

During the year, WRS demonstrated a Good level of environmental and High level of administrative performance with the resource consents as defined in Section 1.1.4.

4.4 Recommendations from the 2015-2016 Annual Report

In the 2015-2016 Annual Report, it was recommended:

1. That monitoring of consented activities at Symes Manawapou landfarm in the 2016-2017 year continues at the same level as in 2015-2016. This was undertaken.

4.5 Alterations to monitoring programmes for 2017-2018

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/discharges and effects under the RMA; and
- to report 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 monitoring of consented activities at Symes Manawapou landfarm in the 2017-2018 year continue at the same level as in 2016-2017.

5 Recommendations

1. THAT monitoring of consented activities at Symes Manwapou landfarm in the 2017-2018 year continues at the same level as in 2016-2017.

Glossary of common terms and abbreviations

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

As*	Arsenic.
Biomonitoring	Assessing the health of the environment using aquatic organisms.
BOD	Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate.
BODF	Biochemical oxygen demand of a filtered sample.
Bund	A wall around a tank to contain its contents in the case of a leak.
Conductivity	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.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
$g/m^2/day$	grams/$metre^2$/day.
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.
Incident Register	The 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.
L/s	Litres per second.
m^2	Square Metres.
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.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.

O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
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.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
Zn*	Zinc.

*an abbreviation for a metal or other analyte may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form.

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

Bibliography and references

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

Taranaki Regional Council 2016: Waste Remediation Services Ltd (WRS) Symes Manawapou Landfarm Monitoring Programme Annual Report 2015-2016. Technical Report 2016-92.

Taranaki Regional Council 2015: Waste Remediation Services Ltd (WRS) Symes Manawapou Landfarm Monitoring Programme Annual Report 2014-2015. Technical Report 2015-77.

Taranaki Regional Council 2014: Waste Remediation Services (WRS) Limited Symes Manawapou Landfarm Monitoring Programme Annual Report 2013-2014. Technical Report 2014-118.

Taranaki Regional Council 2013: Remediation NZ Limited Drilling Waste Disposal Monitoring Programme Annual Report 2012-2013. Technical report 2013-67.

Waste Remediation Services (WRS) Manawapou (Symes) Disposal Site Annual Report 2015.

Waste Remediation Services (WRS) Manawapou (Symes) Disposal Site Annual Report 2016.

Waste Remediation Services (WRS) Manawapou (Symes) Disposal Site Annual Report 2017

Waste Remediation Services Ltd (WRS), Waikaikai (Wards) & Manawapou (Symes) Landfarm Management Plan 2017-2018.

Appendix I

Resource consents held by WRS

(For a copy of the signed resource consent
please contact the TRC Consents department)

Discharge Permit

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

Name of Consent Holder:	Waste Remediation Services Limited PO Box 7150 New Plymouth 4341
Decision Date:	01 May 2012
Commencement Date:	01 May 2012

Conditions of Consent

Consent Granted:	To discharge drilling wastes (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), from hydrocarbon exploration and production activities, onto and into land via landfarming
Expiry Date:	01 June 2028
Review Date(s):	June 2016, June 2022
Site Location:	156 Manawapou Road, Manutahi
Legal Description:	Lot 1 DP 7324 (Discharge site)
Grid Reference (NZTM)	1717244E-5608736N
Catchment:	Manawapou

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

General condition

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

Special conditions

1. 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 for the purpose of interim storage prior to landfarming, but without subsequently spreading onto, or incorporating the discharged material into the soil within 48 hours; and
    b) landfarming means the discharge of drilling wastes onto land, subsequent spreading and incorporation into the soil, for the purpose of attenuation of hydrocarbon and/or other contaminants, 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.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall provide a stockpiling and landfarming management plan that, to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council, demonstrates the activity can and will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually (on or about the anniversary of the date of issue of this consent) and shall include as a minimum:

    a) procedures for notification to Council of disposal activities;
    b) procedures for the receipt and stockpiling of drilling wastes onto the site;
    c) methods used for the mixing and testing of different waste types;
    d) procedures for site preparation;
    e) procedures for landfarming drilling wastes (including means of transfer from stockpiling area, means of spreading, and incorporation into the soil);
    f) procedures for sowing landfarmed areas, post-landfarming management, monitoring and site reinstatement;
    g) contingency procedures;
    h) sampling regime and methodology;
    i) control of site access; and
    j) documentation for all the procedures and methods listed above.

4. Prior to the exercise of this consent, the consent holder shall after consultation with the Chief Executive, Taranaki Regional Council, install a minimum of three groundwater monitoring bores. The bores shall be at locations and to depths, that enable monitoring to determine any change in groundwater quality resulting from the exercise of this consent. The bores shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.

Notifications, monitoring and reporting

5. 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; and
   d) the volume of waste to be stockpiled.

6. 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, or material brought onto the site for landfarming within 48 hours. 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 (or density) 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.

7. The consent holder shall take a representative sample of each type of waste, from each individual source, and have it analysed for the following:

   a) total petroleum hydrocarbons (C_6-C_9, C_{10}-C_{14}, C_{15}-C_{36});
   b) benzene, toluene, ethylbenzene, and xylenes;
   c) polycyclic aromatic hydrocarbons screening; and
   d) chloride, nitrogen, pH, potassium, and sodium.

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

   a) wastes from each individual well;
   b) composition of wastes (in accordance with condition 5);
   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; and
   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.

9. 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 6, for the period of the previous 12 months, 1 July to 30 June.

Discharge limits

10. The discharge shall only occur on the disposal sites shown in the Drawing entitled 'Remediation NZ Ltd Proposed Disposal Site' submitted with the application and attached to this consent.

11. There shall be no discharge within buffer zone, being:

    - 25 metres of the Manawapou River;
    - 25 metres of the unnamed tributary;
    - 10 metres from any property boundary; and
    - 50 metres from the QE II covenant Key Native Ecosystem areas.

12. 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;
    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.

13. As soon as practicable following the application of solid drilling wastes to land, the consent holder shall incorporate the wastes into the soil to a depth of at least 250 mm.

14. The hydrocarbon concentration in the soil over the landfarming area shall not exceed 50,000 mg/kg dry weight at any point where:

    a) liquid waste has been discharged; or
    b) solid waste has been discharged and incorporated into the soil.

15. An area of land used for the landfarming of drilling wastes in accordance with conditions 10 and 11 of this consent, shall not be used for any subsequent discharges of drilling waste.

Operational requirements

16. All material must be landfarmed as soon as practicable, but no later than twelve months after being brought onto the site.

17. 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.

Receiving environment limits - water

18. 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.

19. Other than as provided for in condition 18, 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

20. 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 S/m, the landfarming of waste shall not increase the soil conductivity by more than 100 mS/m.

21. The sodium adsorption 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.

22. The concentration of heavy metals in the soil over the disposal area shall at all times comply with the Ministry for the Environment and New Zealand Water & Wastes Assoication's Guidelines for the safe application of biosolids to land in New Zealand (2003), as shown in the following table:

Constituent	Standard (mg/kg dry weight)
Arsenic	20
Cadmium	1
Chromium	600
Copper	100
Lead	300
Mercury	1
Nickel	60
Zinc	300

23. From 1 March 2028 (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 2028, the consent holder applies for a new consent to replace this consent when it expires, and that application is not subsequently withdrawn.

24. This consent may not be surrendered at any time until the standards in condition 23 have been met.

Archaeological remains

25. 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 has considered: tangata whenua interest and values, the consent holder's interests, the interests 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 authorisations or consents have been obtained.

Lapse and review

26. This consent shall lapse on 30 June 2017, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

27. 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 2016 and/or June 2022, 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.

Transferred at Stratford on 3 June 2014

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Appendix II

WRS Landfarm Annual Report

30 June 2017

Chief Executive
Taranaki Regional Council
Private Bag 713
47 Cloten Road
Stratford
Attention Nathan Crook

Dear Nathan

RE: Resource Consent 7795-1 - Manawapou (Symes) - 156 Manawapou Road, RD 2, Patea

As required under special condition 9 of resource consent 7795-1, please find information that WRS, in its second year of operation of the site, have recorded from the 1 July 2016 to the 30th June 2017. WRS took over operation of the site from 30 May 2014.

At the beginning of the reporting period on 1 July 2016 Pit 1 and 2 had approx.. 433 m3 of mud in storage from the TAG Supplejack and Cheal A Water Well. Pit 3 was empty as the liner was failing and no longer useable.

In spite of the sustained depression of world oil prices from the spring of 2014 showing no signs of persistent recovery, WRS has received a quantity of drilling mud and produced water in the Q1 and Q2 2017. At the close of the 2017 monitoring and reporting year all three pit had been cleaned out and the waste products spread onto to recently prepared ground awaiting the next phases of final disposal.

Wastes Received for Disposal

Three wells of drilling mud and produced water were delivered to Manawapou as follows;

A) Drilling Muds

During Q3 2016 there was two IBCs (< 2 m3) of drilling waste delivered, Q4 2016 there was no new mud deliveries to site, however Q1 and Q2 were quite active periods at Manawapou. The drilling of two new wells and a workover of another by TAG resulted in the delivery of the following

1. Cheal A Water Well 38 m3 of drill water on 11 August 2016

2. A2X 439 m3 of WBM and cuttings from 04 – 21 March 2017
3. E -8 433 m3 of WBM and cuttings from 20 March – 14 May 2017

Total for 2016-17 910 m3.

All of this waste was placed into storage at Manawapou until early June 2017 at which time removal and spreading commenced.

B) Contaminated Soils

Kauri C Wellsite Remediation Project

In Late April 2016 WRS was awarded the contract to remediate Origin Energy NZ's (OENZ) Kauri C Wellsite. Kauri C site has not been drilled however some years ago three unlined pits were excavated within the surficial sands with the intention of storing drilling muds prior to land farming these on the adjacent sand dune country. It is understood no significant volumes of mud was ever received at the site, but an unknown quantity mud was discharged into pits 1 and 2 in error by a truck driver. This was later removed (pers comm.) Unfortunately the sandy material removed to form the pits was discarded and nothing remained on site with which to backfill the pits and return these to pasture. All backfill during the April to July 2016 restoration had to be imported from offsite, namely Manawapou where large volumes of dune sand was available.

WRS/Symons provided a cradle to grave approach for the remediation project with the backfill sand sourced from Symes property where the Manawapou land farm is located. Once sufficient volume was excavated and stockpiled, both at Symes and Kauri C, contaminated soil from the walls and floor of the three pits at Kauri C were transported and

placed in temporary stockpile at Manwapou until all the required backfill sand had been won. From time to time back loading of contaminated soil occurred when feasible, but often this was not possible due to a number of constraints, viz available working space, PID testing, sampling, waiting upon analytical results and particularly weather.

Initially the three pits were cleaned up using a digger to excavate all four walls and floor, with up to one meter being removed from the walls and 0.5 m from the floor. Over the years of disuse, the pit walls had collapsed and significant sand blow had buried both walls and pit floor. WRS engaged OPUS to undertake the photoionisation detection (PID) and sampling of the cleaned out pits. Samples were dispatched to Hills Labs. Upon receipt of results OPUS produced a factual report for OENZ, this was then submitted to the TRC to seek approval that the pits were suitable for backfilling. Contaminated sand had been well characterised by Origin's initial investigations and subsequent PID directed pit floor and wall in situ sampling as the excavation progressed.

The project kicked off with ground preparation and forming of all- weather facilities at Symes on 19 May 2016 and some minor movement of backfill sand from Symes to Kauri C followed. Movement of contaminated soil to Manawapou started on the 11 May 2016 and continued on an intermittent basis as excavated and access and logistics allowed. Movement of contaminated soil was completed on 13 June 2106 with a total of 1,147 m3 of material stored in a short term temporary stockpile within the area it was later spread upon. This material remained in stockpile until the end of the monitoring year until works were completed at Kauri C and the earthmoving machinery relocated to Manawapou to undertake reinstatement work. Spreading of the contaminated soil was subsequently undertaken in this reporting period, viz July, August 2016. Reinstatement involved relocation of the sand backfill stockpile and contouring mostly by digger and tractor and trailer. Final contouring and levelling was completed by wheeled tractor. The contaminated soils were then removed from stockpile and spread at nominally 100 mm thick as would be the process for drilling mud. Once this was complete the 471 m3 in Pit 1 and 2 was removed and landfarmed on the area adjacent to that used for stockpiling and spreading Kauri C contaminated soil. The combined this area is labelled M1610 (Manawapou completed in year 2016,month 10)

Information pertaining to resource consent 7795-1 is provided under the following headings

1. Delivery Record - attached 'Mud Register'

The mud register contains the record of deliveries for storage, for each well/delivery campaign as notified by email to the TRC; as required by Condition 12.

2. Spread Areas, Records and Events during 2016/17

There has been two episodes of spreading and final disposal, subsequent rehabilition and return to pasture at Manawapou during 2016-17

A) July- September 2016
Spread area M1610 a 1.42 Ha block with considerable dune relief was utilised for final disposal of the mud in storage in Q4 2016 together with the contaminated soil removed from Kauri C. See fig 14037_03 Manawapou Consented Area attached.
Preparation of the area commenced 25 July and was completed on 5 August 2016. Spreading of mud in storage and contaminated sand commenced on the 5 August and was completed on 15 August. Deep ripping, tilling the waste into the subsoil and final levelling followed by re-sowing in pasture species was completed on 24 August. Fencing of the area followed in September. At 30 June 2017 the area has 100% ground cover and strong growth, however part of the western edge of the area has more recently been used to stockpile topsoil from the current area M1709 until this is complete in Q3/4 2017.

B) May – 30 June 2017

Preparation of the area designated M1709 of approx. 1.6 Ha commenced on 23 May 17 to accept all the mud and produced water in storage at the completion of wells A2X, E-8, A-2, and provide for sufficient ground to spread forthcoming wells D-1 and Pukatea in Q3 and Q4. This area is the most westerly and south in the first block of consented ground and had substantial dune relief requiring considerable cut and fill quantities to produce a suitably contoured spread area. Original topsoil stripping and stockpiling got underway on 23 May, was followed by cut and fill by digger and tractor and trailer transport to fill the topographic lows. Cut and fill was completed early June and a D-8 bull dozer bought in to complete the final volumetric cut and fill and contouring. Final finishing touches were undertaken by tractor and trailer to establish the mandatory 6m stand off from the Kapuni Gas line running along the western boundary. FirstGas had been called at the outset of stripping to peg out the pipeline corridor and be present whenever earthworks were near the live gas lines. Ground preparation was completed approx.. 14th June and spreading got underway mid-month emptying Pits 1, 2 and 4. The spread material at the end of June has been left to dry out for up to a month to accelerate the disintegration of the mud solids and sludge and will be levelled and tilled- in when the waste is sufficiently fragmented and moisture levels reduced.

3. Liner Integrity

Storage pit synthetic FFP and HDPE liners are fragile and are susceptible to both mechanical damage and failure due to natural degradation; they require continual care and a great deal of operator skill when machines are used to clean out the drilling solids from a pit.

There are 4 pits at Manawapou ; three of these existed when WRs took over the site in 2014 and the fourth was constructed and liner installed in May 2017 to replace the failed Pit 3 liner. A balance pipes exists between Pits 1, 2, and 4, where-by liquids discharge from one to the next as each fills. This enhances the progressive settling out solids from the liquid fraction, minimising the build- up of solids in Pit 2and 4 reducing to a minimum the need to use mechanical means to remove these.

The status of the 4 Pits as at 30 June 2017 are as follows

Pit 1 Installed some time prior to 2014 (no records were available from the previous operator). Pit 1 is the primary discharge point for both solids and liquids from incoming trucks. As the pit fills liquid is displaced through the balance line to Pit 2 and sequentially to new Pit 4. Pit 1 is normally cleaned out by a combination of sucker tank and mechanical digger using a spotter. Protection of the liner is assured by a policy of leaving up to 300-500 mm slab of sludge/solids undisturbed above the liner. To facilitate this a practice of spreading a thin layer of black dune sand over the excavated layer is used to act as a witness marker for the liner. To date there has been no damage to the liner as a result of digger use to clean out the pit – the liner remains in good condition throughout.

Pit 2 As for Pit 1 the date of installation of the liner is unknown, but is likely to be 2013. Mechanical means of cleaning this out has only been used once to WRS's knowledge to remove a slug or material resulting from an early direct discharge? to the pit. In May 2017 four minor holidays and one small 200x200 L shaped tear were repaired in the upper level of the pit using proprietary double and single sided repair tapes and sections of new liner material. The rest of the liner is in good repair with no evidence whatsoever of loss of material from the pit.

Pit 3 Together with Pit 1, this pit was originally the also used for direct discharge of both solids and liquid wastes. It was cleaned out by digger in October 2016 and presumably during this work minor damage was caused to the liner. Before this could be investigated and repaired a 2m long horizontal tear developed in the liner. With no material in the pit and exposure to wind flogging and sun, the liner appeared quite perished and the tear grew very rapidly. Investigation did show the liner material was quite weak and tore very easily. It was decided to rope off and decommission the pit until a new liner could be installed. this was soon realised to be impractical to try and repair the liner so a decision was made to

order a replacement , however the pit still had up to a metre of mud and slurry across the liner base. Upon receipt of the liner and arrival of a digger and still with up to 100 m3 of mud and slurry to remove and nowhere to store this, that it would be most efficacious to construct a new pit, Pit 4 adjacent to Pit 3. Pit 3 remains decommissioned until the need for additional storage is established at which time replacement of the liner will occur.

Pit 4 This was constructed using a new liner between 1 – 5 May 2017 and the Pit 2 to 3 balance pipe installed on 15 May when the Pit 2 level was lowered enough to do this. Pit 4 has resurrected the sites storage capacity to approx. 1,000 m3. Pit 4was in excellent condition at the end of the reporting period.

. Field Photographs – Appendix A

5. Composition of Wastes/Pre Disposal Analysis - attached

All 3 wells drilled and exporting mud/produced water for disposal at both Manawapou and Waikaikai sites were sampled by the drilling company/TAG and provided to WRS for analysis. Results of two of these have been received and forwarded to the TRC as requested upon receipt by WRS. The lab result sheets are attached here, with the exception of the 3rd sample of produced water from A-2. At 30 June results have not yet been received and follow up emails sent to establish what may have happened. The results when received will be immediately forwarded to the TRC

Samples were taken from the following 3 wells as the drilling mud was received by WRS;

A2X, E-8, A-2 .

A pre disposal (spreading) sample was taken during the spreading phase of the mud disposal – results are awaited and as for the other samples results will be forwarded to the TRC upon receipt.

6. TRC Inspection Notices

The consent holder has copies of inspections, however it is not known if this is a complete record of all the inspections undertaken as there are no identifiers that would show this.

7. Operations Management Plan –attached

Operations at the Manawapou land farm are all undertaken generally in accordance with the WRS's Landfarm Management Plan that covers both the Manawapou and Waikaikai sites. The document is a live document and is constantly reviewed and updated as necessary (most recently June 2017) to reflect operational requirements and practices at both sites operated by WRS.

MONITORING

1. **Consent Holder - Soils** - although there is no specific consent requirement for the consent holder to undertake routine, programmed monitoring, there are numeric conditions that must be complied with in respect to conductivity Cond.26, SAR Cond.27 and heavy metals Cond.28**.** WRS undertook an L-shaped transect through the middle of area M1610 on the 15 September 2016 down to a minimum of 400 mm depth using a standard soil sampler and methodology – results are attached. No further soils sampling was undertaken during the reporting year as it was decided to seek surrender of all land farmed areas including the most recently completed in October 2016. WRS has initiated this process by requesting a proposal and costs from the TRC to undertake the sampling. This is in progress at 30 June 2017

2. **Regulator** – a reduced programme of compliance monitoring was completed during the year by the TRC in response to a request from WRS to make the annual monitoring commensurate with site activity and likely effects.

METHODS

Soils

All sampling is undertaken as per standard Hill Laboratories sampling protocols. Representative samples are collected from a number of surveyed points and these are aggregated to produce the representative sample that is sent to the laboratory for analysis. Typically samples are retrieved from approximately 75mm depth with an industry standard plug sampler (exposure pathway sampling – animal welfare/food security) or 250-350 mm depth (environmental sampling) to test the zone of application of hydrocarbon wastes) but sampling depths can vary depending on the location of the waste layer and the depth of waste incorporation into the sub soils during the final disposal phase.

TO SUMMARISE

A year of reasonable activity at the site resulting in very major earthworks and change of final disposal landscape from well developed dune topography to rolling contoured pasture land when spreading and rehab are completed. These changes resulted from 2 episodes of spreading the first in Q4 2016 and the second remains in progress at the end of Q2 2017. A futher two wells are expected in 2017 with capacity to direct spread if that were feasible.

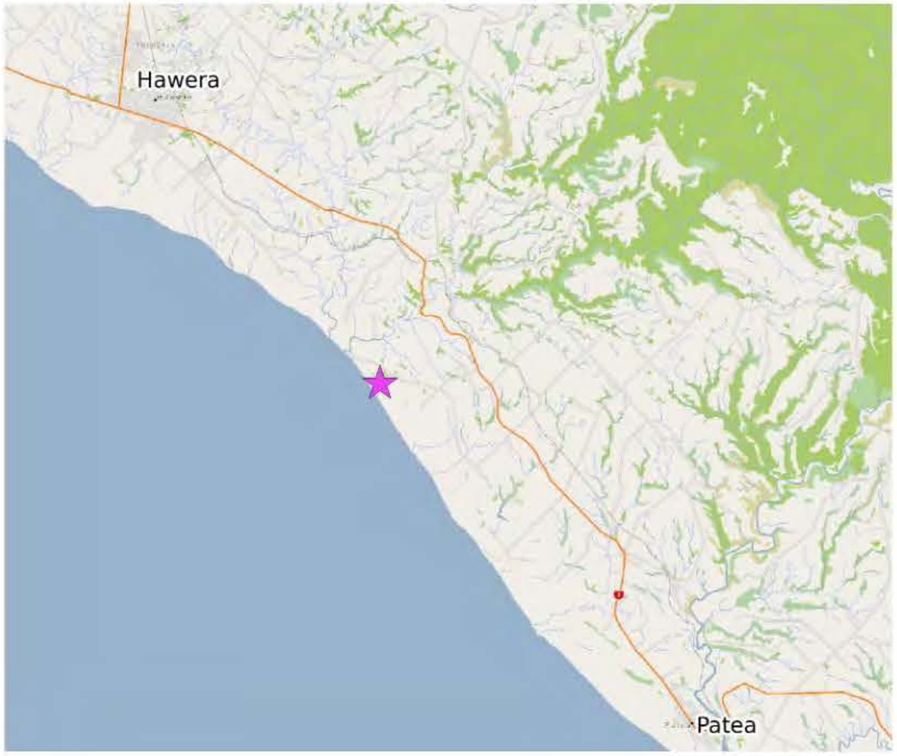
Waste Remediation Services Ltd
w +64 6 751 9221 m + 64 275 996 105 f +64 751 9225
Address 141 – 143 Connett Road East, Bell Block 4312, New Zealand
Post PO Box 7150, New Plymouth 4341, New Zealand
Email: **keith@wrsltd.co.nz**

Appendix A Field Photographs

Various photographs showing the progress of stripping, contouring and preparation of spread area **M1709** May –June 2017

Appendix B Manawapou Site Map

To be provided by GeoSync



id	area (ha)	consent no	start date	end date	MUD
RNZ1	0.43	7795-1	2013-08-17	2013-09-19	NA
RNZ2	0.68	7795-1	2013-09-19	2013-10-12	NA
RNZ3	0.86	7795-1	2013-10-12	2014-01-27	NA
M1408	1.38	7795-1	2014-07-01	2014-08-31	DL/S SW
M1610	1.41	7795-1	2016-10-01	2016-10-30	DL/S CS
M1709	1.6	7795-1	2017-06-20	2017-09-30	DL/S

Mud Type Codes
SW = Stormwater
DL/S = Drilling Liquids/Solids
CS = Contaminated Soils
NA = No data available

Rev	Date	Revision Details	By	Ver.	App.
C	09/16	Mud Types inserted into table	BLW	KMB	KMB
B	07/16	Soil transect added	BLW	KMB	KMB
A	06/15	RNZ data added	BLW	KMB	KMB

GeoSync
Land Surveying & Spatial Solutions
PO Box 8268 | New Plymouth 4342 | t 06 2811714
w geosync.co.nz | e info@geosync.co.nz

Datum:
NZGD2000/NZTM 2000 coordinates:ESPG 2193

Notes:
Aerial photography source TRC 2012
Stages 1-3 interpolated from RNZ

Project:
Manawapou Consented Area (7795-1)

Owner:
Symes

WRS Waste Resource Services

Project 1403
Scale: 1:2000
Drawing No. 14037_03

Hill Laboratories
TRIED, TESTED AND TRUSTED

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ANALYSIS REPORT

Client:	Waste Remediation Services Limited (WRS)	**Lab No:**	1751246 SPv1
Contact:	Keith Brodie	**Date Received:**	01-Apr-2017
	PO Box 77	**Date Reported:**	21-Apr-2017
	Oakura 4345	**Quote No:**	80931
	TARANAKI	**Order No:**	KB1911
		Client Reference:	Waste characterisation Sludge
		Submitted By:	Keith Brodie

Sample Type: Sludge

Sample Name:		Supplejack A2 x2 06-07/03/17 15:00				
Lab Number:		1751246.1				
Individual Tests						
Dry Matter	g/100g as rcvd	75	-	-	-	-
Approx Total Dissolved Salts	g/m³	1,900	-	-	-	-
Electrical Conductivity (EC)*	mS/m	283 #1	-	-	-	-
Total Recoverable Barium	mg/kg dry wt	22	-	-	-	-
Total Recoverable Calcium	mg/kg dry wt	8,600	-	-	-	-
Total Recoverable Magnesium	mg/kg dry wt	6,600	-	-	-	-
Total Recoverable Potassium	mg/kg dry wt	8,100	-	-	-	-
Total Recoverable Sodium	mg/kg dry wt	1,080	-	-	-	-
Chloride*	mg/kg dry wt	10,000	-	-	-	-
pH*	pH Units	9.7	-	-	-	-
Total Nitrogen*	g/100g dry wt	< 0.05	-	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	7	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	43	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	12	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	14.1	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	22	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	50	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.06	-	-	-	-
Toluene	mg/kg dry wt	< 0.06	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.06	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.11	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.06	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.03	-	-	-	-
Anthracene	mg/kg dry wt	< 0.03	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	< 0.03	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	-	-	-	-
Chrysene	mg/kg dry wt	< 0.03	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	-	-	-	-

Sample Type: Sludge						
Sample Name:		Supplejack A2 x2 06-07/03/17 15:00				
Lab Number:		1751246.1				
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Fluoranthene	mg/kg dry wt	< 0.03	-	-	-	-
Fluorene	mg/kg dry wt	< 0.03	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.15	-	-	-	-
Phenanthrene	mg/kg dry wt	< 0.03	-	-	-	-
Pyrene	mg/kg dry wt	< 0.03	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	-	-	-	-
C10 - C14	mg/kg dry wt	< 20	-	-	-	-
C15 - C36	mg/kg dry wt	< 40	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	-	-	-	-

Analyst's Comments

#1 Electrical Conductivity: Undertaken using as received sample as requested; used during the extraction.

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: Sludge			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,26687,3629]	0.05 - 0.10 mg/kg dry wt	1
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1
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
esICextn*	(1:5) ratio of sample (g):0.02M potassium dihydrogen ortho-phosphate extractant (mL), analysis by Ion Chromatography. In House.	-	1
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m^3	1
Electrical Conductivity (EC)*	Electrical Conductivity measured in 1:5 Solid:Water extract.	0.1 mS/m	1
Total Recoverable Barium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1
Total Recoverable Calcium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	1
Total Recoverable Magnesium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1
Total Recoverable Potassium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	1
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1

Sample Type: Sludge			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Chloride*	Ion Chromatography determination of a potassium phosphate extract of an environmental solid.	3 mg/kg dry wt	1
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

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ANALYSIS REPORT

Client:	Waste Remediation Services Limited (WRS)	**Lab No:**	1807369	SPv1
Contact:	Keith Brodie	**Date Received:**	12-Jul-2017	
	PO Box 77	**Date Reported:**	27-Jul-2017	
	Oakura 4345	**Quote No:**	80931	
	TARANAKI	**Order No:**	KB 1924	
		Client Reference:	Waste characterisation	
		Submitted By:	Keith Brodie	

Sample Type: Sludge

Sample Name:		E-8 Manawapou 02-May-2017 12:00 pm				
Lab Number:		1807369.1				
Individual Tests						
Dry Matter	g/100g as rcvd	75	-	-	-	-
Approx Total Dissolved Salts	g/m³	2,300	-	-	-	-
Electrical Conductivity (EC)*	mS/m	341	-	-	-	-
Total Recoverable Barium	mg/kg dry wt	21	-	-	-	-
Total Recoverable Calcium	mg/kg dry wt	8,100	-	-	-	-
Total Recoverable Magnesium	mg/kg dry wt	6,600	-	-	-	-
Total Recoverable Potassium	mg/kg dry wt	8,100	-	-	-	-
Total Recoverable Sodium	mg/kg dry wt	1,030	-	-	-	-
Chloride*	mg/kg dry wt	5,400	-	-	-	-
pH	pH Units	9.3	-	-	-	-
Total Nitrogen*	g/100g dry wt	0.07	-	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	6	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	43	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	13	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	14.0	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	24	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	58	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.06	-	-	-	-
Toluene	mg/kg dry wt	< 0.06	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.06	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.12	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.06	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
1-Methylnaphthalene	mg/kg dry wt	< 0.013	-	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.013	-	-	-	-
Perylene	mg/kg dry wt	0.014	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.013	-	-	-	-
Acenaphthene	mg/kg dry wt	< 0.013	-	-	-	-
Anthracene	mg/kg dry wt	< 0.013	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.013	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.013	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	< 0.013	-	-	-	-

Sample Type: Sludge						
Sample Name:		E-8 Manawapou 02-May-2017 12:00 pm				
Lab Number:		1807369.1				
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Benzo[e]pyrene	mg/kg dry wt	< 0.013	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.013	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.013	-	-	-	-
Chrysene	mg/kg dry wt	< 0.013	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.013	-	-	-	-
Fluoranthene	mg/kg dry wt	< 0.013	-	-	-	-
Fluorene	mg/kg dry wt	< 0.013	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.013	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.07	-	-	-	-
Phenanthrene	mg/kg dry wt	< 0.013	-	-	-	-
Pyrene	mg/kg dry wt	< 0.013	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 8	-	-	-	-
C10 - C14	mg/kg dry wt	< 20	-	-	-	-
C15 - C36	mg/kg dry wt	< 40	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 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.

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Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,26687,3629]	0.05 - 0.10 mg/kg dry wt	1
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1
esICextn*	(1:5) ratio of sample (g):0.02M potassium dihydrogen ortho-phosphate extractant (mL), analysis by Ion Chromatography. In House.	-	1
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m^3	1
Electrical Conductivity (EC)*	Electrical Conductivity measured in 1:5 Solid:Water extract.	0.1 mS/m	1
Total Recoverable Barium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1
Total Recoverable Calcium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	1
Total Recoverable Magnesium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1
Total Recoverable Potassium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	1

Sample Type: Sludge			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1
Chloride*	Ion Chromatography determination of a potassium phosphate extract of an environmental solid.	3 mg/kg dry wt	1
pH	1:2 v/v soil:water slurry after 16±2hrs, pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1
1-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1
2-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1
Perylene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1

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