CD Boyd Drilling Waste Stockpiling Landfarm/ Landspreading Monitoring Programme Annual Report 2015-2016

Technical Report 2016-85

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Executive summary

Colin Boyd (the consent holder), in conjunction with operator MI SWACO, operates two drilling waste stockpiling facilities and a landspreading operation on his property, near Inglewood, within the Waitara catchment, Taranaki. These sites are located on adjoining properties off Derby Road North and Surrey Road respectively. Analytically quantified drilling waste, consisting of water based and synthetic based muds are stockpiled at each facility prior to application across defined paddocks at specific, concentrations below the limits specified within the relevant consents.

This report for the period July 2015 to June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the consent holder's environmental performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the Consent holder's activities.

The consent holder holds four resource consents, one of which is through a subsidiary company which is owned by the consent holder; Surrey Road landfarms. These consents include a total of 64 conditions which set out the requirements that the consent holder must satisfy. The consent holder holds one consent to discharge stormwater into the Managamawhete Stream, and three consents to stockpile and discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading/landfarming.

During the monitoring period, the consent holder demonstrated an overall good level of environmental performance.

The Council's monitoring programme for the year under review included 18 inspections, 50 water samples collected for physicochemical analysis, six composite soil samples and four biomonitoring surveys of receiving waters.

The monitoring indicated that the now closed Derby Road facility did not have any significant adverse effect on the environment; it also indicated that the landspreading operation was for the most part in accordance with the consent for the Derby Road facility. However, at certain times; the Derby Road facility was found to be non-compliant with an abatement notice for the second part of the year. The landspreading had required prompting from Council to regard application distances and buffers.

The Surrey Road facility did not affect the stream species abundance of the Mangatengehu Stream which had been affected in the previous monitoring period. Improved engineering control in line with best practicable option appears to have mitigated the detrimental effects. The operator must be mindful to keep pro-active with management of the Surrey Road stockpiling facility which still contains a residual amount of drilling material; 150 m^3 will require management in the up coming period.

During the year, the consent holder demonstrated a **good** level of environmental performance, but with operational issues evident at each site, the administrative performance with the resource consents was poor. Three infringement notices and two abatement notices had to be issued with compliance with one of the abatement notices still to be established at the years end.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

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 an unacceptable level in the year under review.

This report includes recommendations for the 2016-2017 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 2015-June 2016 by the Taranaki Regional Council (hereafter the Council), describing the monitoring programme associated with resource consents held by Colin Boyd (hereafter the consent holder) and his subsidiary company, Surrey Road Landfarms Limited. The consent holder operates two stockpiling facilities, Derby Road stockpiling facility and Surrey Road stockpiling facility respectively; while Surrey Road Landfarms holds consent for the application of the material to land.

MI SWACO Company operates the Surrey Road stockpiling facility on behalf of the consent holder. In the previous monitoring period MI SWACO moved to relinquish its management responsibilities from the closed Derby Road stockpiling facility, which was handed over for direct control to the consent holder. The stockpiling facilities are located in two locations; one on Surrey Road and the other in close proximity to Derby Road North, respectively. The application areas, in terms of where material are landfarmed/landspread is located between these two stockpiling facilities (indicated as the red area in Figure 1). These locations are detailed in Figure 1.

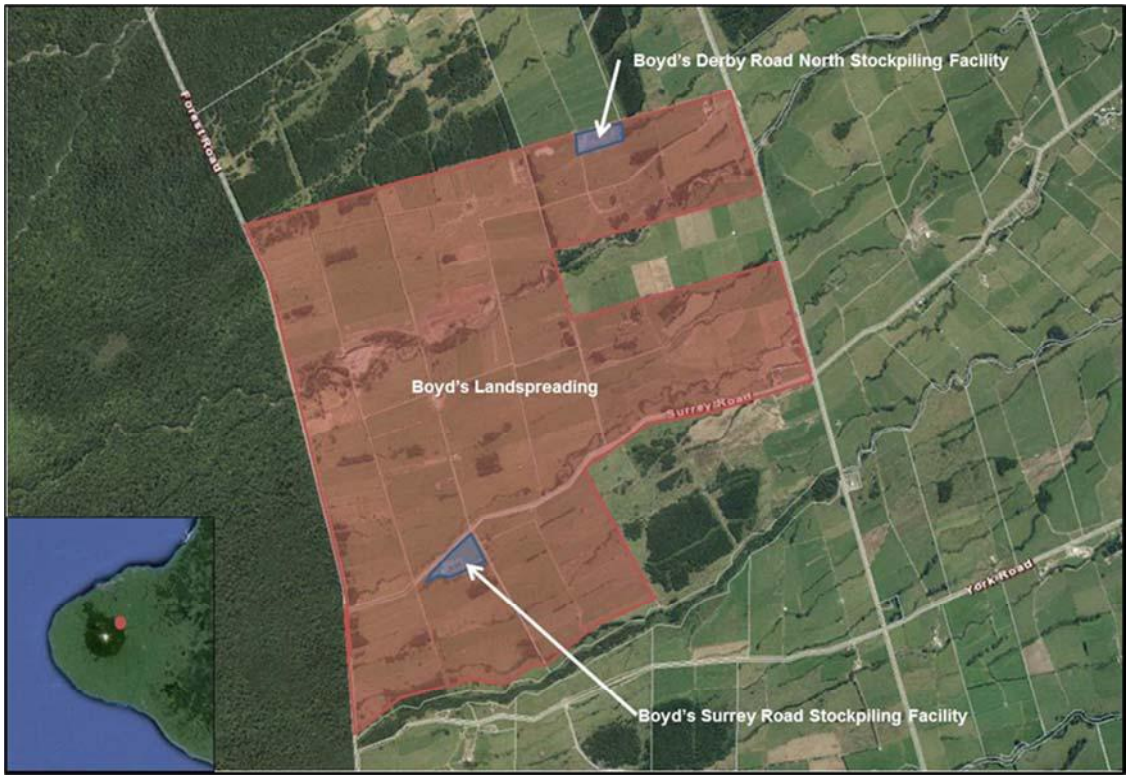

Figure 1 Derby and Surrey Road Stockpiling facilities with associated landspreading area

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the consent holder that relate to the discharges of material in the Waitara catchment. This is the seventh annual report to be prepared by the Council to cover the consent holder's discharges and their effects.

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 the consent holder in the Mangamawhete, Manatenghu and Waipuku catchments;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted in the consent holder's site/catchment.

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 2016-2017 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 the consent holder, 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 the consent holders 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 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents

1.2 Process description

1.2.1 Hydrocarbon exploration and production wastes

For the purposes of disposal to land, waste from the petroleum industry can be divided into two broad categories; exploration (drilling) wastes, and production wastes. The wastes disposed of through the consent holder's operations are primarily drilling waste. Fracture return fluids are not disposed of at these sites.

1.2.2 Drilling wastes

Waste drilling material is produced during well drilling for hydrocarbon exploration. The primary components of this waste are drilling fluids (muds) and rock cuttings.

1.2.3 Drilling fluids

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. 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 polynuclear 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.

1.2.4 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.

1.2.5 Landfarming process description

Basic steps in the landfarming process include:

1. Drilling waste is transported from a specific wellsite by truck (cuttings) or tanker (liquids). It is placed in a dedicated, fit for purpose, lined storage cell. At the consent holder's facilities cuttings arrive from site in metal 'D' bins directly collected from the wellsite. Material is subjected to an analytical screen undertaken in a registered laboratory. The analysis is dictated by specific consent conditions.

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.

Consents 6900-2 and 7559-1 allow for the disposal of drilling waste from hydrocarbon exploration activities with WBM and SBM via the landfarming process outlined above.

Of note 6900-2 is directly concerned with stockpiling of material prior to application to land. Initial landfarming at the site revealed difficulties working with soils with higher baseline moisture content. As a result, consent 7591-1 was issued to allow for disposal via the process of landspreading.

1.2.6 Landspreading process description

The preferred method for the treatment and disposal of drilling material at the consent holder's property is via landspreading (under consent 7591-1). A large muck spreader, detailed in Photo 1, is used for this purpose.

Photo 1 The landspreading unit utilised by the consent holder

An auger in the base of the spreader conveys material back and through an opening (where the size is controlled by a sliding plate) where it contacts two rapidly rotating augers and is applied up to 10 m on either side. The deposition rate is controlled by the size of the opening at the rear of the unit and the speed of forward travel by the tractor.

The waste is deposited onto existing pasture in small fragments, which are allowed some time to dry out before chain harrows and roman discs are used to till and break-up the waste which is dispersed back into the soil, as shown in Photo 2.

Photo 2 Tilling of soil post landspreading

1.3 Resource consents

1.3.1 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.

Colin Boyd holds discharge permit **6900-2** (supersedes expired consent 6900-1), to discharge drilling wastes (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), onto and into land for the purpose of temporary stockpiling prior to disposal. This permit was issued by the Council on 16 February 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027. Site location Derby Road North.

Condition 1 requires adoption of the best practicable option.

Conditions 2 to 4 detail notification, record keeping, and reporting requirements.

Conditions 5 and 6 are operational requirements.

Conditions 7 and 8 set limits on contaminants in groundwater and surface water.

Conditions 9 and 10 set limits on certain parameters in the soil of the previously landfarmed areas, to be met prior to surrender.

Condition 11 is a review condition.

Colin Boyd holds discharge permit **7559-1.3,** to discharge drilling wastes (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming, landspreading, injection spreading and irrigation. This permit was originally issued by the Taranaki Regional Council on 20 November 2009 under Section 87(e) of the Resource Management Act and was amended, 20 February 2016. It is due to expire on 1 June 2027. Site Location Surrey Road.

Condition 1 sets out definitions of stockpiling, landfarming and landspreading.

Condition 2 requires adoption of the best practicable option.

Conditions 3 and 4 require the installation of groundwater monitoring wells and fit for purpose synthetic liners in relation to drilling mud storage cells.

Conditions 5 requires the consent holder to provide a management plan.

Conditions 6 and 7 detail notification and sampling/ screening requirements prior to discharge.

Conditions 8 to 16 detail discharge limits and loading rates.

Conditions 17 to 21 are operational requirements in relation to the receiving environment soil.

Condition 22 and 23 are operational requirements in relation to the receiving environment water.

Condition 24 and 25 detail the monitoring and reporting requirements.

Condition 26 and 27 are lapse and review conditions.

Surrey Road Landfarms Limited holds discharge permit **7591-1.1**, to discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading. This permit was issued by the Taranaki Regional Council on 21 January 2010 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027. Site location Surrey Road.

Condition 1 and 2 concern adoption of the best practicable option and notifications.

Conditions 3 to 9 detail the specific discharge limits.

Conditions 10 to 14 detail the receiving environmental limits for the soil, including the surrender criteria.

Conditions 15 and 16 detail the receiving environment for water.

Conditions 17 and 18 detail the monitoring and reporting requirements for the consent holder.

Conditions 19 and 20 relate to lapse and review of the consent.

These permits are attached to this report in Appendix I.

1.3.2 Water discharge permit

Colin Boyd holds discharge permit **7911-1**, to discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River. This permit was issued by the Council on 27 September 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027. Site location Derby Road North.

Condition 1 concerns adoption of the best practicable option.

Conditions 2 through to 4 specify discharge limits and operational requirements.

Condition 5 relates to effects on surface water.

Condition 6 relates to the implementation and maintenance of a contingency plan.

Condition 7 relates to the lapse and review of the consent.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 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 Derby and Surrey Road stockpiling and associated landspreading sites consisted of five primary components.

1.4.2 Programme liaison and management

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

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

1.4.3 Site inspections

The two stockpiling facilities and the landspread areas were inspected a combined total of eighteen times during the monitoring period. With regard to consents, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Sources of data being collected by the consent holder 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.

1.4.4 Chemical sampling

The Council collected samples of soil and water (groundwater and surface water) through out the monitoring period. This is to check the compliance of the consent holder with the consented conditions and to assess for any adverse effects arising from the facilities as an exercise of their consents.

1.4.4.1 Soil

In total, six composite soil samples from specific disposal areas were collected by Council staff. The sampling methodology utilised is adapted from the Guidelines for the Safe Application of Biosolids to Land in New Zealand (2003). This is undertaken through the compositing of 10 soil cores (Photo 3) (400 mm+/- depth to encompass the zone of application) taken at 10 m intervals along transects through an application area.

Photo 3 An example of a soil core

The analysis undertaken by the Council is provided in Table 1. Each transect is GPS referenced to allow for areas to be characterized and to allow for hotspots to be identified if required.

Of note, the metal analysis and speciation of petroleum hydrocarbons as required by the consent is provided by the consent holder. This is discussed in the following section.

1.4.4.2 Water

Compliance water analysis was undertaken across the following sources in this monitoring period

- Surface water ;
- Stormwater discharge; and
- Groundwater

Surface water samples were collected on three separate occasions along the unnamed tributary of the Mangamawhete Stream (Figure 2) in close proximity to the Derby Road North stockpiling facilities.

Surface water samples were also obtained on three separate occasions along the unnamed tributary of the Mangatengehu Stream (Figure 3) in relation to stormwater discharges from the Surrey Road stockpiling facilities.

Surface water and discharge analytes are provided in Table 1 below.

Table 1 Chemical analytes

Surface / Discharge Water Analytes	
Barium (acid soluble) Benzene Toluene Ethylene Xylene M/O Biological Oxygen Demand (BOD) Biochemical Oxygen Demand (BCOD)	Calcium Chloride Conductivity Total Petroleum Hydrocarbons Suspended Solids Total Dissolved Salts (TDS) Temperature pH
Groundwater Analytes	
Barium (acid soluble) Barium (dissolved) Benzene Toluene Ethylene Xylene M/O Chloride Conductivity	Sodium Level Nitrite-Nitrate Nitrogen Total Dissolved Salts Temperature Level Total Petroleum Hydrocarbon Biochemical Oxygen Demand (BCOD)
Soil Analytes	
Calcium Chloride Conductivity Total Petroleum Hydrocarbons Potassium Moisture factor Sodium Absorption Ratio (SAR)	Magnesium Sodium Ammoniacal Nitrogen Nitrite-Nitrate Nitrogen pH Total Soluble Salts

Groundwater analysis results were obtained through the purpose built groundwater monitoring bore network. Derby and Surrey Road facilities each have three

groundwater monitoring bores. These bore were installed to quantify the quality of the groundwater and specifically to understand if any adverse effects were permeating from either facility.

The Council utilises a peristaltic low flow pump to collect the water samples, which are only collected post stabilization of field parameters, which are obtained through a Yellow Springs Instrument (YSI) multi parameter probe and a flow through cell.

1.4.5 Biomonitoring surveys

Four biological surveys were performed during the monitoring period under review. These four were split evenly across the two stockpiling facilities at Derby and Surrey Roads respective unnamed tributaries.

The Surrey Road stockpiling facility is located in close proximity to the unnamed tributary of the Mangatengehu Stream. A Council Officer undertook a spring and a late summer survey of four specific monitoring sites on this tributary.

The Derby Road stockpiling facility is also located in close proximity to an unnamed tributary of the Mangamawhete Stream. In similarity to the Surrey Road assessment, the Derby Road facility is assessed across four specific monitoring sites on the unnamed tributary of the Mangamawhete Stream.

The analysis results of the biomonitoring surveys are discussed in more detail in Sections 2.4.3 and 3.3.1.3.

1.4.6 Review of analytical data

In accordance with the consent conditions the consent holder or subsidiary must supply the Council with an annual report. The annual report is to contain information pertaining to the records kept by the consent holder and shall include but not be limited to:

- The locations from which the drilling waste originated;
- The composition of the waste, including analytical analysis of a specified range of analytes;
- The stockpiling locations if utilised;
- Volume of material;
- The areas landfarmed, including a map;
- Volumes of wastes landfarmed; and
- Details of monitoring undertaken.

MI SWACO undertook pre screening analysis of the material which they received on site.
They collected representative samples of the material and had it analysed by an independent laboratory (Hill laboratory in Hamilton). This was undertaken for all drilling material brought to the primary stockpiling site of Surrey Road.

MI SWACO also undertook sampling of the final consolidated drilling material, (of which there is over 150m^3 of material still to be landfarmed) which is contained in the non-active Derby Road stockpiling facility. This material which has been storage for a

prolonged period of time (greater than 2 years) is required to be landfarmed. The analysis is provided in the MI SWACO annual report. This report is attached in Appendix II.

MI SWACO also undertook post spreading soil sampling of the paddocks to which material was applied to through the practice of landfarming or landspreading. The chemical parameters for which they analyse are provided below:

- Dry matter;
- Density;
- Total recoverable barium;
- Total recoverable sodium ;
- Arsenic;
- Cadmium;
- Chromium;
- Copper;
- Lead;
- Mercury;
- Nickel ;
- Zinc;
- Phosphorus;
- Potassium;
- Calcium;
- Chloride;
- Magnesium;
- Sodium absorption ratio;
- Electrical conductivity;
- Benzene;
- Toluene;
- Ethylbenzene;
- M&p xylene;
- 0-xylene;
- Polycyclic aromatic hydrocarbons; and
- Total petroleum hydrocarbon speciation.

The analysis of the paddocks which were utilised for the practice of landfarming/spreading is provided in the consent holder supplied annual report in Appendix III.

2. Derby Road North stockpiling facility

2.1 Site description

Derby Road North stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood (Figure 2). In previous monitoring years this was the primary stockpiling site for muds and cuttings. At the beginning of the 2011-2012 monitoring year activity slowed at the site. During the 2012-2013 monitoring year the Surrey Road site became the primary site while the Derby Road site remained unused and on standby to receive waste as a contingency or secondary site if required. While the site remained unused in the previous monitoring period (2014-2015) it still contained 150 m^3 +/- of residual drilling material which would be required to be landfarmed before the Council considered the site for surrender.

The consent holder undertook a cleaning out operation towards the end of the monitoring period, whereby the remaining drilling muds were consolidated into one cell. These consolidated materials were then sampled by the consent holder and analsyed. The site is now to be utilised by the consent holder for the storage of water treatment sludge.

The unnamed tributary of the Mangamawhete Stream flows adjacent to the Derby Road North stockpiling facility. The proximity of the site to this surface water body had been taken into account in the setting of buffer distances and location of the stockpiling facilities.

The predominant soil type has been identified as gravelly sand and the vegetation cover is pasture, recently converted from native bush. Average annual rainfall for the site is 1,942 mm (taken from the nearby 'Stratford' monitoring station).

No consents were initially held to discharge stormwater from this stockpiling site, as it was expected to comply with the permitted activity criteria in Rule 23 of the Regional Freshwater Plan. However, a stormwater discharge consent was issued for the Derby Road North site (7911-1, 27 September 2011). The Derby Road facility also holds a discharge permit (6900-2) which permits the temporary stockpiling of blended waste prior to landfarm deployment.

Figure 2 Derby Road stockpiling facility and sample locations

Site data

Location	
Word descriptor:	Derby Road North, Inglewood, Taranaki
Map reference:	E 1702545
(NZTM)	N 5653650
Mean annual rainfall:	1,942 mm
Mean annual soil temperature:	-
Mean annual soil moisture:	-
Elevation:	~500 MASL
Geomorphic position:	Ring plain
Erosion / deposition:	Negligible
Vegetation:	Transitional – native bush to pasture
Parent material:	Tephra / volcaniclastic
Drainage class:	Free / well draining

2.2 Inspections

06 June 2015

At the time of inspection the wind was from the west, speed 4-5 knots. No objectionable odours or visible emissions were found during the inspection. Water treatment sludge deliveries were occurring during the inspection as the consent holder planned to increase his storage capacity for the water treatment sludge. Cells 8 and 9 were full of sludge. The liquid on the top of the cells was clear. Cells 2 and 3 were also full of sludge, and cell 3 was observed to be filled to capacity during the inspection. During the inspection, Cell 7 was observed to have been emptied of storm water. A small volume of residual mud remained at the southern end, while the sludge was discharged into the cell during the inspection.

The final storm water pond at the eastern side of the site had been emptied. No discharges to the unnamed tributary were occurring during the inspection and the water was flowing clear without any visible foaming effects. A new cell had also been dug adjacent to cell 8 and the last of the muds and cutting had been discharged into it.

A new cell has also been dug adjacent to the final two storm water ponds at the eastern end of the site and the liquid from cell 7 had been pumped across into it. The adjacent drain was flowing clear; some iron oxide surface sheen was present on the surface in places and the bed was stained orange.

The following action was to be taken: Undertake works to land farm the residual drilling muds remaining at the site in accordance with resource consent conditions when the weather permits.

17 July 2015
A discussion was held with the consent holder to discuss the rationale for why he would be receiving an abatement notice to spread the muds stored at the Derby Road site. The muds had been on site for longer than a year. The consent holder outlined the material would need to be removed via a loader and bull-dozed out and finally power harrowed due to the volume of rock in the material from scraping through to the bottom of the cells. Agreed the abatement notice would extend to the end of March 2016.

27 August 2015
The inspection was conducted in fine and calm conditions, in conjunction with groundwater and surface water sampling. All storage cells contained stormwater, with satisfactory freeboard visible. No discharge from any cells had occurred at the time of inspection.

The final stormwater cell was not observed to be discharging. The discharge from the final cell, which had been covered over in the previous monitoring period while the consent holder was undertaking site management, had since been unearthed and no evidence of muds was visible in the stormwater cells. Surface water samples were clear and uncoloured, with no odour, sheen or foaming observed.

Groundwater samples were also clear and uncoloured, with no sheen, odour or foaming. Two new cells had been constructed onsite; these were related to water treatment sludge storage.

27 October 2015
The residual muds at the Derby Road storage facility were observed to have still remained on-site and no land farming works had occurred at the time of inspection. The water treatment sludge cells were all found to contain clear surface liquids and the sludge had settled to the bottom. None of the storage cells were discharging during the inspection and the storm water ponds were below the outlet level. The adjacent tributary was running clear and iron oxide was prevalent throughout the area.

The following action was to be undertaken: Undertake works to land-farm the remaining drilling muds at the Derby Road storage facility in accordance with resource consent conditions by 1 March 2016, as required by abatement notice EAC20834.

07 March 2016
At the time of inspection the wind was from the west and variable, speed 3 knots. No objectionable odours or visible emissions were found during the inspection. Inspection of Derby Road storage site found abatement notice EAC 20834 had not been complied with. No works had been undertaken to land-farm the drilling muds which have remained on-site for more than 1 year.

The site owner outlined that due to staff shortages and a lack of other resources the works have not been undertaken. Four cells at the site contained aged drilling muds. The others contained water treatment sludge. A discussion was held with the consent holder whereby it was agreed that the works will be undertaken by 1 May 2016. This was to allow for the activity to occur during finer weather prior to winter rain. No discharge from skimmer pipes or final treatment ponds were occurring and the receiving waters were running clear and in low flow.

10 May 2016
No works had occurred to spread the residual muds which remained in the Derby Road storage area. A two month extension to abatement notice EAC 20834 was agreed upon; a re-inspection will occur after 1 July 2016. At the time of the inspection no storm water discharges were occurring and the receiving waters were in low flow, with iron oxide prevalent throughout the stream.

2.3 Results of abstraction and discharge monitoring

2.3.1 Drilling mud deliveries/ stockpiled

No deliveries of drilling muds or cuttings were received by the stockpiling facility at Derby Road during this monitoring period. As in the previous monitoring period, the site is now closed with the Surrey Road facility presently serving as the primary site.

However, residual drilling muds estimated to be 150 m^3 +/- are now consolidated to one storage cell and as outlined by the inspecting officer, are required to be landfarmed, by abatement notice.

The analysis provided by MI SWACO in the supplied annual report is presented in Appendix III. This analysis demonstrated that the consolidated drilling material held in the stockpiling facility of Derby Road requires remediation, with a total TPH concentration of 90,000 mg/kg TPH.

2.3.2 Council stormwater results

The Council undertook stormwater discharge sampling on one occasion during the monitoring year. The sample was collected from the location IND001064 (Figure 2). The results are presented in Table 2. The rationale for the collection of stormwater discharge samples is to confirm compliance with the stormwater discharge consent 7911-1; the limits of which are detailed in the table below.

Table 2 Derby Road stormwater sample

Parameter	Unit	Consent 7911-1	Date
			12 May 2016
Benzene	g/m³	-	<0.0010
Toluene	g/m³	-	<0.0010
Ethylbenzene	g/m³	-	<0.0010
meta-Xylene	g/m³	-	<0.0010
ortha-Xylene	g/m³	-	<0.002
Hydrocarbons	g/m³	15	<0.7
C7-C9	g/m³	-	<0.10
C10-C14	g/m³	-	<0.2
C15-C36	g/m³	-	<0.4
Barium (acid soluble)	g/m³	-	0.208
Biochemical oxygen demand	g/m³	2	<0.5
Chloride	g/m³	50	15.9
Conductivity	mS/m@20°C	-	8.4
pH	pH	6.0-9.0	7.1
Suspended solids	g/m³	100	5
Temperature	°C	-	15.2
Total dissolved solids	g/m³	-	65.0

The analysis of the compliance sample collected during this period detailed no exceedance with the consent conditions.

2.4 Results of receiving environment monitoring Derby Road

The Council routinely collects samples of soil and water (both groundwater and surface water) throughout the monitoring period. The rationale for collection of samples is to ascertain the compliance with the consent conditions in the first instance; and secondly, to monitor for potential adverse effects which may arise as a result of the ratification of the consent.

2.4.1 Council groundwater results

Three groundwater monitoring wells were installed in late 2008, prior to the first delivery of drilling material to the site. The wells are located up-gradient (GND2060), adjacent to the cells (GND2061) and down gradient of the storage cells (GND2062), the locations of these wells are detailed in Figure 2. The analysis of the three groundwater monitoring wells located around the site are tabulated in the following Tables 3-5 inclusive.

Table 3 GND 2060 Derby Road Groundwater 2015-2016

Groundwater	Well ID	GND2060	GND2060	GND2060	GND2060
Parameter	Date	27 Aug 2015	24 Nov 2015	11 Feb 2016	26 Jun 2015
	Time	13:00	12:00	09:00	09:20
Barium (acid soluble)	g/m³	0.018	0.023	0.022	0.018
Barium (dissolved)	g/m³	0.018	0.023	0.022	0.018
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Groundwater	Well ID	GND2060	GND2060	GND2060	GND2060
Parameter	Date	27 Aug 2015	24 Nov 2015	11 Feb 2016	26 Jun 2015
	Time	13:00	12:00	09:00	09:20
Chloride	g/m³	6.4	8.5	9.0	7.1
Conductivity	mS/m@20°C	6.6	6.2	6.4	6.3
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.2	<0.2
HC C10-C14	g/m³	<0.2	<0.2	<0.4	<0.4
HC C15-C36	g/m³	<0.4	<0.4	<0.10	<0.10
HC C7-C9	g/m³	<0.10	<0.10	<0.7	<0.7
Water level	m	2.45	2.583	2.809	2.530
Sodium	g/m³	4.6	5.8	6.5	4.6
Nitrate/nitrite nitrogen	g/m³ N	0.12	0.02	<0.01	0.15
pH	pH	6.3	6.0	6.0	6.1
Total dissolved salts	g/m³	51.1	48.0	49.5	48.7
Temperature	°C	10.7	12.2	14.5	11.5
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ortha-Xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Meta-Xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Table 4 GND 2061 Derby Road Groundwater 2015-2016

Groundwater	Well ID	GND2061	GND2061	GND2061	GND2061
Parameter	Date	27 Aug 2015	24 Nov 2015	11 Feb 2016	26 Jun 2015
	Time	12:10	11:10	09:40	11:15
Barium (acid soluble)	g/m³	0.044	0.053	0.13	0.060
Barium (dissolved)	g/m³	0.044	0.047	0.13	0.058
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	35.4	39.3	133	43.3
Conductivity	mS/m@20°C	21.0	24.5	66.2	26.1
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7	<0.2
HC C10-C14	g/m³	<0.2	<0.2	<0.4	<0.4
HC C15-C36	g/m³	<0.4	<0.4	<0.2	<0.10
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.7
Water level	m	1.122	1.418	1.857	1.323
Sodium	g/m³	6.8	8.2	21.6	8.7
Nitrate/nitrite nitrogen	g/m³ N	0.07	0.05	<0.01	0.03
pH	pH	6.3	6.0	6.1	6.0
Total dissolved salts	g/m³	162.5	189.6	512.2	201.9
Temperature	°C	11.5	12.8	15.2	12.5
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ortha-Xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Meta-Xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Table 5 GND 2062 Derby Road Groundwater 2015-2016

Groundwater	Well ID	GND2062	GND2062	GND2062	GND2062
Parameter	Date	27 Aug 2015	24 Nov 2015	11 Feb 2016	26 Jun 2015
	Time	11:00	10:20	10:15	10:15
Barium (acid soluble)	g/m³	0.028	0.040	0.042	0.044
Barium (dissolved)	g/m³	0.028	0.040	0.040	0.039
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	4.5	8.0	8.6	13.9
Conductivity	mS/m@20°C	5.0	7.7	7.7	7.2
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.2	<0.2
HC C10-C14	g/m³	<0.2	<0.2	<0.4	<0.4
HC C15-C36	g/m³	<0.4	<0.4	<0.10	<0.10
HC C7-C9	g/m³	<0.10	<0.10	<0.7	<0.7
Water level	m	0.626	0.791	1.505	0.671
Sodium	g/m³	4.3	4.1	4.3	4.8
Nitrate/nitrite nitrogen	g/m³ N	0.01	<0.01	0.28	<0.01
pH	pH	5.8	5.6	5.5	5.7
Total dissolved salts	g/m³	38.7	59.6	59.6	55.7
Temperature	°C	11.1	13.4	16.2	11.8
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ortha-Xylene	g/m³	<0.002	<0.002	<0.002	<0.0010
Meta-Xylene	g/m³	0.028	0.040	0.042	0.044

The annual analysis of the groundwater monitoring network at the Derby Road stockpiling facility is provided in the above Tables 3-5 respectively. The network was monitored four times in this monitoring year; to encapsulate seasonal variation across the facility.

The results do not detail anything of an adverse nature; the site has been closed for two full years now with no new delivers of landfarmable drilling related material.

Of note was the elevation in Total Dissolved Salts (TDS) concentrations in well GND2061 during the February sampling round, whereby a concentration of 512 g/m^3 was analysed. Whilst this was below the consent conditions which allow for a maximum concentration of 2,500 g/m^3, it constituted the highest TDS reading analyzed in this well to date. This was most likely due to site movements whereby the consent holder began to consolidate aged drilling material to one specific storage cell.

Note that in this period the consent holder collected a representative sample of the residual drilling mud whereby upon receipt of the analysis it can be discerned that remediation is still required for this material, with a value of 90,000 mg/kg TPH. This analysis is provided in the MiSwaco supplied annual report, presented in Appendix III..

2.4.2 Council surface water results

An unnamed tributary of the Mangamawhete Stream flows adjacent to the southern boundary of the site (Figure 1). The Council has three established monitoring sites located on this stretch of the unnamed tributary:

- MMW000161 Upstream
- MMW000162 Midstream
- MMW000163 Downstream
- IND001064 Discharge location

These three sites were monitored three times throughout the monitoring period, the results are provided in the following tables (Tables 6, 7, 8, 9 and 10). Note that the data is presented per sample run to ascertain any effect from the facility.

Table 6 Derby Road surface water sample 27 August 2015

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	27 Aug 2015	27 Aug 2015	27 Aug 2015
Parameter	Unit	11:55	11:45	11:30
Barium (acid soluble)	g/m³	0.028	0.026	0.026
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical oxygen	g/m³		<0.5	<0.5
Chloride	g/m³	7.1	7.2	7.3
Conductivity	mS/m@20 °C	11.0	11.0	10.9
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
HC C7-C9	g/m³	<0.10	<0.10	<0.10
pH	pH	7.1	6.9	7.1
Total dissolved salts	g/m³	85.1	85.1	84.3
Temperature	°C	10.4	9.9	10.0
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 7 Derby Road surface water sample 24 November 2015

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	24 Nov 2015	24 Nov 2015	24 Nov 2015
Parameter	Unit	12:15	11:20	10:30
Barium (acid soluble)	g/m³	0.017	0.020	0.020
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical oxygen	g/m³		<0.5	<0.5
Chloride	g/m³	6.4	6.6	7.0
Conductivity	mS/m@20°C	10.7	10.7	10.9
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	24 Nov 2015	24 Nov 2015	24 Nov 2015
Parameter	Unit	12:15	11:20	10:30
HC C7-C9	g/m³	<0.10	<0.10	<0.10
pH	pH	7.3	7.1	7.4
Total dissolved salts	g/m³	82.8	82.8	84.3
Temperature	°C	17.4	16.2	15.5
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 8 Derby Road surface water sampling 11 February 2016

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	11 Feb 2016	11 Feb 2016	11 Feb 2016
Parameter	Unit	11:10	10:45	10:30
Barium (acid soluble)	g/m³	0.016	0.016	0.015
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical oxygen	g/m³		<0.5	<0.5
Chloride	g/m³	6.7	6.6	7.7
Conductivity	mS/m@20°C	10.3	10.4	10.5
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
HC C7-C9	g/m³	<0.10	<0.10	<0.10
pH	pH	7.2	7.0	7.3
Total dissolved salts	g/m³	79.7	80.5	81.2
Temperature	°C	17.0	18.0	18.9
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 9 Derby Road surface water sampling 12 May 2016

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	12 May 2016	12 May 2016	12 May 2016
Parameter	Unit	14:00	13:45	13:15
Barium (acid soluble)	g/m³	0.030	0.032	0.037
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical oxygen	g/m³		<0.5	<0.5
Chloride	g/m³	6.0	6.0	6.5
Conductivity	mS/m@20°C	9.2	9.1	9.1
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total petroleum hydrocarbon	g/m³	<0.2	<0.2	<0.2
HC C10-C14	g/m³	<0.4	<0.4	<0.4
HC C15-C36	g/m³	<0.10	<0.10	<0.10
HC C7-C9	g/m³	0.7	<0.7	<0.7
pH	pH	7.0	7.0	7.1

Surface Water	Site ID	MMW000161	MMW000162	MMW000163
	Date	12 May 2016	12 May 2016	12 May 2016
Parameter	Unit	14:00	13:45	13:15
Total dissolved salts	g/m^3	71.2	70.4	70.4
Temperature	°C	13.9	14.2	14.4
Toluene	g/m^3	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m^3	<0.002	<0.002	<0.002
Meta-xylene	g/m^3	<0.0010	<0.0010	<0.0010

Table 10 Industrial discharge sample location compared to consent conditions

Parameter	Unit	Consent 7911-1	IND001064
			12 May 2016
			13:25
Barium (acid soluble)	g/m^3	-	0.208
Benzene	g/m^3	-	<0.0010
Biochemical oxygen demand	g/m^3	2	<0.5
Chloride	g/m^3	50	15.9
Conductivity	mS/m@20°C	-	8.4
Ethylbenzene	g/m^3	-	<0.0010
Total petroleum hydrocarbons	g/m^3	15	<0.2
HC C10-C14	g/m^3	-	<0.4
HC C15-C36	g/m^3	-	<0.10
HC C7-C9	g/m^3	-	<0.7
pH	pH	6-9	7.1
Total dissolved salts	g/m^3	-	65.0
Suspended solids	g/m^3	100	5
Temperature	°C	-	15.2
Toluene	g/m^3	-	<0.0010
Ortha-xylene	g/m^3	-	<0.002
Meta-xylene	g/m^3	-	<0.0010

The Council collected surface water samples from the unnamed tributary of the Managamawhete Stream on four occasions throughout the 2015-2016 monitoring year, Tables 6-9, the main rationale was to encapsulate seasonal variation. The Council also collected one waste water sample from the final discharge pipe, Table 10.

The analysis of the surface water samples did not indicate anything of an adverse nature, with minimal variation observed in the samples down the measured length of the unnamed tributary.

No exceedance was found in the singular sample collected (Table 10) in relation to the final discharge location IND001064. The consent limits for the discharge are provided in the table. No hydrocarbons were detected in the discharge.

2.4.3 Council biomonitoring results

The Council undertook the biological monitoring of the unnamed tributary of Mangamawhete Stream on two occasions during the 2015-2016 monitoring year, early spring and later summer. A short synopsis of each survey is provided below.

Spring 2015

Background

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in March 2015 (Sutherland, 2015) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey (Table 11 and Photo 4). The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Photo 4 and Figure 1.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 21 October 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit

less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totaling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

Photo 4 Bio-monitoring sites in relation to the Derby Road stockpiling facility

Table 11 Biological monitoring locations

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Overall, the results of this spring survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

Summary spring 2015 bio-monitoring Derby Road Mangamawhete Stream

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land at the Derby Road landfarm.

- In the current survey there were no significant differences in MCI score between the control site and three downstream sites. Site 3 and 4 both had substantially higher $SQMCI_s$ scores than site 1, which had the lowest $SQMCI_s$ score of the four sites. Taxa richnesses were similar among sites.

- Compared to the March 2015 survey $SQMCI_s$ scores had decreased significantly at site 1, indicating some deterioration in water quality or the state of the habitat at this site. The $SQMCI_s$ scores at sites 2, 3 and 4 had increased significantly from previous survey results and historical medians. MCI scores were similar to the March 2015 survey results.

- There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had had any significant effects on the health of the macroinvertebrate communities present in an unnamed tributary of the Mangamawhete Stream.

Summary late summer 2016 bio-monitoring Derby Road Mangamawhete Stream

- Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

3. Surrey Road stockpiling facility

3.1 Site description

The Surrey Road stockpiling facility (Figure 3) is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. The Mangatengehu Stream flows adjacent to the facility. The proximity of the site to this recognised ecosystem 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 gravelly sand and vegetation growth consists of native bush which transitions into pasture. Average annual rainfall for the site is 1,942 mm (taken from the nearby 'Stratford' monitoring station).

The stockpiling facility located at Surrey Road is operated under one consent (7559-1.3). This consent directs the consent holder to discharge detailed quantities of drilling related material (consisting of drilling cuttings, drilling fluids and muds, both water based and synthetic based) onto land for landfarming. No consents are held to discharge stormwater from this stockpiling site; it is expected to comply with the permitted activity criteria detailed by Rule 23 of the RFWP.

Figure 3 Aerial photograph of the Surrey Road stockpiling facility

3.2 Site data

Location	
Word descriptor:	Surrey Road, Inglewood, Taranaki
Map reference:	E 1701847
(NZTM)	N 5651476
Mean annual rainfall:	1,942 mm
Mean annual soil temperature:	-
Mean annual soil moisture:	-
Elevation:	~500 MASL
Geomorphic position:	Ring plain
Erosion / deposition:	Negligible
Vegetation:	Transitional – native bush to pasture
Parent material:	Tephra / volcaniclastic
Drainage class:	Free / well draining

3.2.1 Inspections

16 July 2015
At the time of inspection the following was found: Wind west, speed 3, no objectionable odours or visible emissions were found during the inspection. However, noticeable hydrocarbon/mud odours were found when standing directly down wind of the storage pits.

Cell one at the site contained approximately 1,399 m^3 of synthetic based muds from the Maari field which is considered outside of the Taranaki region. Special condition 3 of 7591-1 and special condition 7 of 7559-1 require that the muds to be spread have to originated within the Taranaki region. The resource consent holder was made aware of this requirement and was advised to apply for a variation to both resource consents to allow the activity to occur, it was also suggested that the application of drilling muds through the use of an injection spreader should also be included in the 7591-1 variation application. The relevant variation forms were sent to the resource consent holder.

The cell one liner appeared in good repair. Discussions held with site operator regarding spreading activities. It was outlined that the consent holder intends on spreading the material through the use of an injection method and has plans for the operations to occur in September 2015.

Cell two was full of turbid storm water but was reportedly free of muds except the residual materials which cannot be removed due to the need to protect liner integrity. The wash pad was being used to clean IBC's which were being cut open, emptied into cell one, and cleaned prior to being disposed of off-site. The liquid in the wash-pad pond was grey/turbid. The liquid in cell 3 was quite turbid and some surface emulsified oils were present. No irrigation was occurring and approximately 250 mm free-board was available within the storage pit. A measuring stick had been installed below the outlet pipe.

The irrigation area was inspected, all pasture appeared healthy and the irrigator was approximately 28 m from the nearest drain. The nova-flow drain, situated beneath the cells was inspected and found to be discharging a rainbow sheen. The first receiving pond had a minor hydrocarbon sheen. The final pond was essentially clear

of hydrocarbons. The discharge into the receiving waters was inspected and found to be clear. No environmental effects were observed at the time.

Two large cells were being dug on the eastern side of the site below all the drilling mud storage pits. The cells are to be used to contain water treatment sludge authorised by resource consent 5821-2. One digger was operating and a bull dozer was on-site. No water treatment sludge had as yet been delivered. Discussions held with site operator regarding lining of cell 3. No time-frames have been finalised and no works are planned to occur at present. The operator was of the opinion that the cell would be lined once the material currently on-site has been spread/land-farmed. It was outlined to the operator that during a meeting between TRC staff and MI SWACO representatives held on 5 May 2015 at TRC it was agreed by all parties that cell three needed to be lined in accordance with best practicable option (condition 2 of 7559-1 and condition 1 of 7591-1). The view of the site operator was to be conveyed to the job manager and Science Services manager for consideration. No incidents were reported. No recent spreading activities were reported to have occurred.

26 August 2015
The inspection was conducted in fine and calm conditions, in conjunction with surface water and discharge sampling. All surface water samples were clear, with no odour, sheen or foaming. The discharge and downstream samples had a slight yellow tinge. The discharge sample had a slight odour. The novaflow pipe adjacent to cell three was discharging at a low/trickle flow into the stormwater system. Cell three was also discharging via the overflow pipe into the stormwater system. All runoff was contained and directed to the stormwater ponds.

Two new cells have been constructed onsite in relation to water treatment sludge storage activities

1 October 2015
Phone discussion with Ross Henry (MI SWACO site manager) with regard to the then proposed spreading operation of Surrey Road Storage Cell one contents. The consent holder currently has their consent under change of conditions review. The consent holder would like to spread the contents of cell one which is allowed under the newly changed consent. This was not allowed under the previous consent as it prohibited spreading material which originated from outside the Taranaki Region, (such as the offshore fields from outside the 12 nautical mile limit). As the Officer's Report was in its final stages which included the condition to allow the applicant to receive material from the offshore Taranaki Basin, the go ahead was given to allow for the spreading of the material from cell one, retrospectively. Analysis of Cell one contents were to be sent by Ross Henry. Spreading will occur under consent 7559-1.3.

27 October 2015
Wind south variable, speed four. No objectionable odours or visible emissions were found during the inspection. Cell one at the Surrey Road site was found to be full of drilling mud. Cell two contained storm water and residual muds; some surface hydrocarbons were present. Cell three was being irrigated during the inspection. It was suggested to the site operator that the buffer distance should be increased to ensure the adjacent drain remains free of over-spray. The pasture appeared healthy and was coping with the application. No ponding or run-off was observed.

The drain adjacent to the storage pits was free of rainbow sheen and no foaming effect was observed. The receiving ponds were both turbid orange due to iron oxide. The discharge was clear and no effects were observed in the receiving waters.

5 January 2016
Wind north, speed three, no objectionable odours or visible emissions were found during the inspection. Localised mud odours were detectable directly down wind of the cells. Cell one had been emptied of OMV muds and was full of turbid storm water with some TKN-1 WBM muds at the load-in end. Approximately 30 cm free-board was available. Cell two was having TKN-1 WBM discharged into it during the inspection. Truck tray-washings were also being discharged into the cell. A small digger was being used to move the mud further into the cell to allow for more deliveries. Cell three has had a liner installed. The cell had a minimal volume of water in it and irrigation from the cell was stopped at the time of inspection. The liner had ballooned in places and was above the liquid level in several places. Staff outlined that microbial gases were possibly causing the issue and to rectify the situation metal will be place in the bottom of the liner to keep it weighted down.

No discharges from the storm water cells were occurring and the receiving waters were clear. The silos at the site still contained unused muds which are periodically circulated. The liquid in the bunds was clear. OMV muds from cell one were recently spread in paddock 73 using the Meyer spreader and harrowed in. The muds were visible in small clumps on the vegetation and rocks in and around the dry farm drain on the northern side of the paddock. Muds were also present on the rocks above a newly dug drain on the southern side of the paddock which had liquid flowing in it. It was considered highly likely that synthetic based mud would have discharged into surface water during the spreading and will likely discharge further during rain. Required buffer distances were clearly not observed during spreading activities.

The following action is to be taken:

- Undertake works to remove muds from in and around the farm drains in paddock 73. Ensure required buffer distances are observed at all times.

This resulted in the generation of incident (in/326990) See incident section 4.5.

7 March 2016
At the time of inspection the following was occurring: Wind west variable, speed three, no objectionable odours or visible emissions were found during the inspection. The Surrey Road storage site was inspected. The two lined cells at the site were extremely full, and virtually no free-board was available in cell one. The liner within the third pond was inflated above the liquid level in several places; capacity was available in case of rain. No irrigation from the cell was occurring. Discharge from the final pond was clear and approximately 0.5 L/s. No effects were occurring in the receiving waters.

The nova-flow drain from under the storage cells was not discharging. The receiving drain was flowing clear. Iron oxide was prevalent throughout its length and the first receiving pond was discoloured. Paddock 84 had works undertaken to fill in a wet patch. Nova-flow had been installed at a depth of approximately 2 m and backfilled with gravel and soil. The site owner outlined that TKN-1 muds will be spread in the paddock in the near future.

Discussions were held regarding the infiltration of drilling fluids into the nova-flow. The site owner was confident that the muds will not enter the buried drain. The adjacent paddock will also be used for land-farming. Both the injection spreader and Myer spreader will be used, each paddock is reportedly ten acres (about four hectares).

Paddock 39 was inspected. The drilling muds no longer remained on the surface in thick lines and the pasture appeared healthy. It is likely the muds were removed from the surface rather than incorporating it in. Abatement notice EAC 21056 had been complied with. The paddock adjacent to the quarry on the northern side was inspected. Residual muds remained on the vegetation and rocks on both the northern and southern sides of the paddock. The northern drain was dry, while the southern drain had a small quantity of water flowing which was clear. The site owner outlined that a spring fed pond will be built at the site for stock watering purposes. All inspected pasture throughout the site where drilling muds have previously been spread appeared healthy.

23 April 2016
At the time of inspection the wind was gusty from the south west with showers. No objectionable odours or visible emissions were found during the inspection. Spreading activities from Surrey Road storage facility were occurring. Cell two was being stirred and emptied at the time of inspection. Spreading occurred by use of the injection spreader.

The mud was not injecting well and was remaining on the surface. After each application the muds were being incorporated using harrows and bull dozers which were on-site. The fringes of the paddock had been spread and harrowed to prevent overland flow from the spreading areas during heavy rain which was forecast. Works were to cease over the long weekend and would resume in the finer weather next week. Cell one at Surrey Road had material already spread in the adjacent paddock. The paddock had been harrowed and the muds were very well incorporated. More muds were to be spread in the paddock from cell one. The liquid from cell three was pumped into cell two to make it easier to pump. The un-used muds stored in the vertical storage containers had also been pumped into cell two and were being spread.

A representative sample of the muds was taken from cell two after mixing. No irrigation from cell three was occurring. A minor storm water discharge from final pond clear and no effects observed within the receiving waters.

10 May 2016
At the time of inspection the wind was from the north, speed three, no objectionable odours or visible emissions were found during the inspection. Noticeable hydrocarbon and drilling mud odours were found down wind of the paddocks 83 and 84 where muds were recently spread.

Works were occurring to harrow the area prior to seed being sown. In paddock 83 seed was recently sown and pasture strike looked good across the entire spreading area. The area adjacent to the quarry on the northern side had also been worked and had seed sown. Topsoil had been brought into other historical spreading areas which had failed to strike. The areas had been worked and seed had been sown.

The Surrey Road storage cells were essentially empty of muds. Turbid storm water remained in all three cells, and the third cell had plenty of storage capacity prior to reaching discharge level. The final storm water treatment pond discharge was clear, with a flow of approximately 1/2 L/s, and no effects were observed within the receiving waters.

3.3 Results of abstraction and discharge monitoring

The Surrey Road facility stockpiled material from two separate drilling campaigns in this period. The campaigns were OMV's 107 Maari MR7A5 drilling programme and Todd's TKN-1 well (Table 12).

OMV's drilling material was received at the end of the previous monitoring year, whilst Todd's material was received during December 2015.

Table 12 2015-2016 Surrey Road deliveries

Source	Quantity
OMV 107 Maari MR7A5	1,399 m^3
Todd TKN-1	1,929.59 m^3
Total	**3,328.59m^3**

Prescreening analysis as required by the consent is provided in the MI SWACO annual report which is provided in Appendix I.

3.3.1 Results of receiving environment monitoring Surrey Road

During the monitoring year the Council collects water samples (both groundwater and surface water) in relation to this facility. These water samples are collected either via the operational groundwater monitoring well network, of which the Surrey Road site contains three active wells or, via surface water samples of the unnamed tributary of the Mangatengehu Stream. This stream is also monitored by Council's fresh water biologists, for species richness. Sample collection locations are detailed in Figure 3.

3.3.1.1 Groundwater monitoring

As previously discussed, the site at Surrey Road contains an active groundwater monitoring well network that comprises three wells (Figure 3). The wells were installed in 2009, prior to the first delivery of landfarmable material.

Of the three monitoring wells; GND2165 is located up gradient from the facility to encapsulate preceding groundwater conditions, while the other two wells, GND 2166 and 2167 are located down gradient to encapsulate any potential effects permeating from the stockpiling facility. The monitoring wells are monitored quarterly to allow for seasonal variation. The results of the annual groundwater monitoring are presented in the following Tables 13-15.

Table 13 GND2165 groundwater monitoring results 2015-2016

Groundwater	Well ID	GND2165	GND2165	GND2165
	Date	23 Jun 2015	14 Sep 2015	28 Jun 2016
Parameter	Unit	10:15	13:15	10:15
Barium (Acid soluble)	g/m³	0.009	0.019	0.010
Barium (Dissolved)	g/m³	0.009	0.019	0.010
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Chloride	g/m³	8.1	6.9	6.3
Conductivity	mS/m@20 °C	6.7	5.3	7.6
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.7	<0.2	<0.7
HC C15-C36	g/m³	<0.2	<0.4	<0.2
HC C7-C9	g/m³	<0.4	<0.10	<0.4
Total petroleum hydrocarbon	g/m³	<0.10	<0.7	<0.10
Water level	m	2.173	2.562	2.22
Sodium	g/m³	4.7	4.1	4.9
Nitrate/ nitrite nitrogen	g/m³ N	0.51	0.51	0.40
pH	pH	6.3	6.4	6.6
Total dissolved salts	g/m³	51.8	41.0	58.8
Temperature	°C	10.5	10.0	11.8
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010
No sample collected in February due to the well running dry.				

Table 14 GND 2166 groundwater monitoring data 2015-2016

Groundwater	Well ID	GND2166	GND2166	GND2166	GND2166
	Date	14 Sep 2015	17 Nov 2015	25 Feb 2016	28 Jun 2016
Parameter	Unit	12:00	10:30	08:30	10:40
Barium (Acid soluble)	g/m³	0.018	0.029	0.022	0.018
Barium (Dissolved)	g/m³	0.018	0.024	0.022	0.018
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	5.5	7.5	8.2	7.2
Conductivity	mS/m@20 °C	4.1	5.7	5.5	5.6
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.2	<0.2	<0.7	<0.7
HC C15-C36	g/m³	<0.4	<0.4	<0.2	<0.2
HC C7-C9	g/m³	<0.10	<0.10	<0.4	<0.4
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.10	<0.10
Water level	m	1.304	1.685	1.725	1.02
Sodium	g/m³	3.2	4.6	4.9	4.1
Nitrate/ nitrite nitrogen	g/m³ N	1.43	1.69	1.33	2.01
pH	pH	5.6	5.6	5.2	5.5
Total dissolved salts	g/m³	31.7	44.1	42.6	43.3
Temperature	°C	9.9	11.9	16.0	11.5
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002	<0.002

Groundwater	Well ID	GND2166	GND2166	GND2166	GND2166
	Date	14 Sep 2015	17 Nov 2015	25 Feb 2016	28 Jun 2016
Parameter	Unit	12:00	10:30	08:30	10:40
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Table 15 GND 2167 groundwater monitoring data 2015-2016

Groundwater	Well ID	GND2167	GND2167	GND2167	GND2167
	Date	14 Sep 2015	17 Nov 2015	25 Feb 2016	28 Jun 2016
Parameter	Unit	12:30	11:10	09:00	11:10
Barium (Acid soluble)	g/m³	0.047	0.045	0.032	0.036
Barium (Dissolved)	g/m³	0.047	0.044	0.032	0.034
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	8.4	12.1	7.6	9.2
Conductivity	mS/m@20 °C	8.6	9.9	8.4	8.5
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.2	<0.2	<0.7	<0.7
HC C15-C36	g/m³	<0.4	<0.4	<0.2	<0.2
HC C7-C9	g/m³	<0.10	<0.10	<0.4	<0.4
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.10	<0.10
Water level	m	1.915	2.197	2.255	1.73
Sodium	g/m³	5.7	7.0	6.0	6.1
Nitrate/ nitrite nitrogen	g/m³ N	1.17	0.70	0.59	1.20
pH	pH	5.8	6.1	5.2	5.6
Total dissolved salts	g/m³	66.5	76.6	65.0	65.8
Temperature	°C	11.2	12.0	14.7	12.8
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Ortha-xylene	g/m³	<0.002	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

The 2015-2016 groundwater monitoring data collected from the operational monitoring bore network of the Surrey Road stockpiling facility is presented in the preceding Tables 13-15 respectively. The Council undertook the collection of samples from each well on four occasions throughout the monitoring year, the aim, to encapsulate seasonal variation across the facility, with a view to detect any potential adverse effects permeating from the exercise of this consent.

On one occasion, GND2165 was unable to be sampled as there was insufficient water with which to sample, thus the sample from February 2016 was omitted from this analysis.

Analysis of the network throughout the monitoring year did not reveal anything adverse from the groundwater samples collected.

3.3.1.2 Council surface water samples

An unnamed tributary of the Managatenghu Stream runs along the southern boundary of the Surrey Road stockpiling facility. On four occasions throughout the monitoring year the Council collected surface water samples from three specific tributary locations (Figure 3).

The locations are as follows:

- MTH000060 (Upstream)
- MTH000062 (Midstream)
- MTH000064 (Downstream)

On three occasions of the four, the Council collected samples from the pond discharge location:

- IND001067

Note: These sample locations are displayed in Figure 3.

The analysis of the surface water and discharge samples are detailed in the following Tables 16-20.

Table 16 Surface water sampling 28 August 2015

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	26 Aug 2015	26 Aug 2015	26 Aug 2015
Parameter	Unit			
Barium (acid soluble)	g/m³	0.016	0.016	0.028
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical oxygen demand	g/m³	-	<0.5	<0.5
Chlorine	g/m³	5.4	5.5	6.5
Conductivity	mS/m@20 °C	6.6	6.7	7.2
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
HC C7-C9	g/m³	<0.10	<0.10	<0.10
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7
pH	m	7.2	7.2	7.2
Suspended solids	g/m³	<2	<2	<2
Total dissolved salts	g/m³ N	51.1	51.8	55.7
Temperature	pH	9.4	9.7	10.0
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	°C	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 17 Surface water sampling 17 November 2015

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	17 Nov 2015	17 Nov 2015	17 Nov 2015
Parameter	Unit			
Barium (acid soluble)	g/m³	0.012	0.013	0.017
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical oxygen demand	g/m³	-	<0.5	<0.5
Chlorine	g/m³	6.8	5.9	7.6
Conductivity	mS/m@20 °C	7.4	7.5	8.4
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	17 Nov 2015	17 Nov 2015	17 Nov 2015
Parameter	Unit			
HC C7-C9	g/m³	<0.10	<0.10	<0.10
Total petroleum hydrocarbon	g/m³	<0.7	<0.7	<0.7
pH	m	7.2	7.3	7.2
Suspended solids	g/m³	2	3	2
Total dissolved salts	g/m³ N	57.3	58.0	65.0
Temperature	pH	13.8	13.0	11.0
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	°C	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 18 Surface water sampling 10 February 2016

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	10 Feb 2016	10 Feb 2016	10 Feb 2016
Parameter	Unit			
Barium (acid soluble)	g/m³	0.048	0.027	0.018
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical oxygen demand	g/m³		<0.5	<0.5
Chlorine	g/m³	5.8	6.0	8.1
Conductivity	mS/m@20 °C	8.7	8.7	9.6
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.7	<0.7	<0.7
HC C15-C36	g/m³	<0.2	<0.2	<0.2
HC C7-C9	g/m³	<0.4	<0.4	<0.4
Total petroleum hydrocarbon	g/m³	<0.10	<0.10	<0.10
pH	m	7.2	7.2	7.1
Suspended solids	g/m³	<2	4	3
Total dissolved salts	g/m³ N	67.3	67.3	74.3
Temperature	pH	15.5	14.9	14.7
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	°C	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 19 Surface water sampling 12 May 2016

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	12 May 2016	12 May 2016	12 May 2016
Parameter	Unit			
Barium (acid soluble)	g/m³	0.018	0.018	0.049
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical oxygen demand	g/m³		<0.5	<0.5
Chlorine	g/m³	5.2	5.2	14.6
Conductivity	mS/m@20 °C	5.4	5.4	8.7
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	<0.7	<0.7	<0.7
HC C15-C36	g/m³	<0.2	<0.2	<0.2

Surface Water	Site ID	MTH000060	MTH000062	MTH000064
	Date	12 May 2016	12 May 2016	12 May 2016
Parameter	Unit			
HC C7-C9	g/m³	<0.4	<0.4	<0.4
Total petroleum hydrocarbon	g/m³	<0.10	<0.10	<0.10
pH	m	6.9	6.9	6.8
Suspended solids	g/m³	2	3	3
Total dissolved salts	g/m³ N	41.8	41.8	67.3
Temperature	pH	12.7	12.8	13.0
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ortha-xylene	°C	<0.002	<0.002	<0.002
Meta-xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 20 Final pond discharge throughout the 2015-2016 year

		Rule 23 RFWP	TRC152551	TRC160503	TRC161609
			IND001067	IND001067	IND001067
Parameter	Unit		26 Aug 2015	10 Feb 2016	12 May 2016
Barium (acid soluble)	g/m³	-	0.171	0.011	0.353
Benzene	g/m³	-	<0.0010	<0.0010	<0.0010
Bio-chemical oxygen demand	g/m³	5	1.7	0.6	3.6
Chlorine	g/m³	-	12.2	7.6	110
Conductivity	mS/m@20 °C	-	10.3	9.2	45.7
Ethylbenzene	g/m³	-	<0.0010	<0.0010	<0.0010
HC C10-C14	g/m³	-	<0.2	<0.7	<0.7
HC C15-C36	g/m³	-	<0.4	<0.2	<0.2
HC C7-C9	g/m³	-	<0.10	<0.4	<0.4
Total petroleum hydrocarbon	g/m³	15	<0.7	<0.10	<0.10
pH	m	6-9	7.0	7.0	6.8
Suspended solids	g/m³	100	7	6	8
Total dissolved salts	g/m³ N	-	79.7	71.2	353.6
Temperature	pH	-	11.7	14.8	15.0
Toluene	g/m³	-	<0.0010	<0.0010	<0.0010
Ortha-xylene	°C	-	<0.002	<0.002	<0.002
Meta-xylene	g/m³	-	<0.0010	<0.0010	<0.0010

Tables 16-20 detail the analysis of the surface water and the final discharge location in relation to the Surrey Road stockpiling facility in the 2015-2016 monitoring year. The surface water samples were collected from the unnamed tributary of the Mangatengehu Stream (Figure 3).

Throughout the monitoring year the level of impact across the length of the stream analyzed by the Council was minimal. A slight increase in the concentration of TDS was observed at the lower sample location when compared with the upper location, however the increase was minimal, and this is similarly echoed in conductivity and a slight increase in chloride.

The Surrey Road facility does not hold a discharge permit, whereby in comparison the Derby facility does. Instead, the Surrey Road facility must comply with the Regional Freshwater Plan Rule (RFWP) 23 which contains parameters which must not be

exceeded in stormwater discharges relating to an industrial location, if the discharge is to be deemed permitted. These are detailed in Table 18 above. No exceedance was observed when compared to the RFWP Rule 23.

3.3.1.2.1 MI SWACO provided stormwater data

Of note, this site purportedly no longer directly discharges to the stream. Stormwater collected in the site specific mud storage cells which once passed through the stormwater ponds into the stream is now irrigated to a specific paddock location. The remaining discharge from the stormwater pond system is a function of what has fallen directly into ponds.

However, in this period MI SWACO provided stormwater analysis which indicated an exceedance in terms of the concentration of oil and grease with a value of 29 g/m^3 analysed on 31 March 2016. This concentration was above the limit set by the region freshwater plan (RFWP) rule 23 (15 g/m^3). MI SWACO will be reminded of their duty to irrigate this to land.

Upon re-analysis by MI SWACO in July of 2016, this value had decrease suitably to below the consented value, with a value of 6 g/m^3.

Table 21 MI SWACO provided stormwater analysis Surrey Road

Analytes	Unit	RFWP Rule 23	SW 31-03-2016	SW 25-07-2016
Free ammonia	g/m^3	-	<0.010	<0.010
pH	pH	6-9	6.9	7.5
Suspended Solids	g/m^3	100	10	5
Temperature	°C	-	20	20
Total Ammoniacal Nitrogen	g/m^3	-	0.139	0.31
Carbonaceous Biochemical Oxygen Demand (cBOD5)	gO_2/m^3	5	-	<2
Oil and grease	g/m^3	15	**29**	6
Free chlorine	g/m^3	-	0.06	<0.05
Combined chlorine	g/m^3	-	<0.08	<0.08

The remaining analytes were all below the specific criteria set by Rule 23.

3.3.1.3 Council biomonitoring results Surrey Road

Background

A macroinvertebrate survey was performed on 21 October 2015 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site, located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary (Table 22 and Figure 4).

No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

However, results from the most recent survey prior to the period under review in March 2015 (Sutherland, 2015b), indicated that there was no significant effect on macroinvertebrate communities from the activities.

Table 22 Surrey Road bio-monitoring location data

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

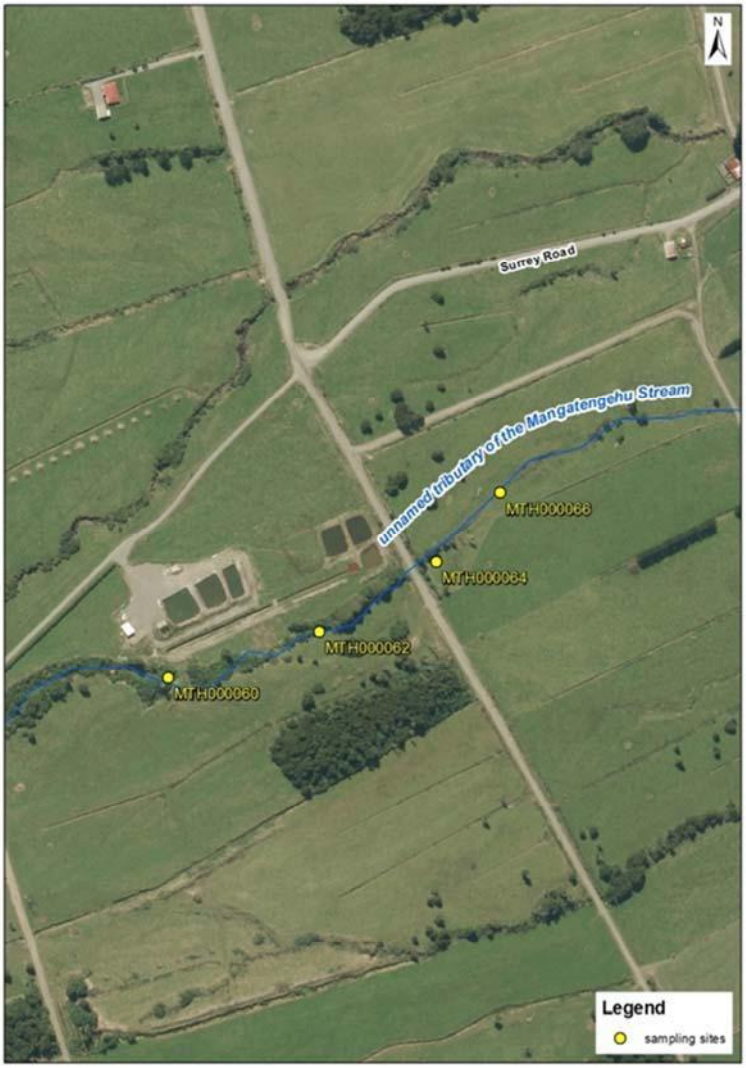

Figure 4 Surrey Road bio-monitoring locations

3.3.1.4 Summary of Spring 2015 bio-monitoring

Overall, the two potentially 'impacted' sites showed significant differences in the macroinvertebrate indices examined compared with the 'control' sites at the time of the survey. Differences in periphyton cover and amount of iron oxide deposits would largely explain the differences observed.

Stockpiling activities may also have contributed to the low macroinvertebrate taxa richnesses and taxa abundances but as to what extent was not possible to determine. Investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream.

3.3.1.5 Summary of the late summer 2016 bio-monitoring survey

In relation to the previous spring (October 2015) survey the 'impacted' sites in the current survey recorded increased MCI scores and taxa richnesses. Taxa richness at site 3 had increased by 12 taxa and the MCI score had increased by a significant (Stark, 1998) 14 units. At site 4, the MCI score had increased by 8 units and taxa richness had increased by 16. This was a vast improvement from the spring survey results and in part can be explained by slight reductions in periphyton cover and iron oxide deposits present during the current survey. However these results may also reflect a recovery from impacts that were occurring as a result of stockpiling activities during the previous survey.

As noted by the previous spring report (Sutherland, 2016) stockpiling activities may have contributed to the low macroinvertebrate taxa richnesses recorded by the spring survey. It was suggested an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites could be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream.

If a return to more unhealthy conditions was to occur, it would again be recommended for such an investigation to take place. However, as this was not the case, as indicated by this late summer survey there are no grounds to consider further investigation.

Comparison of taxa richnesses and MCI values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites and 'impacted sites had results similar to the median values.

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area were no longer resulting in any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

4. Landspreading/ Landfarming activities

4.1 Inspections

05 January 2016
OMV muds from cell one were recently spread in paddocks 1 and 39 using the injection spreader. The muds were not discharging into the soil due to their consistency and were clearly present on the surface of the paddock in thick lines. The paddocks would need to be harrowed to incorporate the muds.

TKN-1 WBM was also applied to land using the injection spreader in paddocks 71 and 72. The muds had incorporated better than the OMV SBM but were still clearly visible in places. The required buffer distances were clearly not observed during spreading activities as the injection lines and surface muds were present immediately adjacent (less than 1 m) to the farm drains on the northern and southern sides of the paddocks.

Due to cell capacity issues the TKN-1 WBM had been applied to land prior to them being analysed and reported to TRC, as required by special condition 2 of resource consent 7591-1.1.

The following action was to be taken:

- Ensure required buffer distances are observed at all times.
- Ensure the use of the injection spreader occurs with drilling muds which are suitable for the machinery otherwise use alternative methods of application.
- Ensure that a representative sample of the mud is analysed and reported to TRC prior to land application.
- Undertake works to incorporate the muds into the soil profile in paddocks 1 and 39.

07 March 2016
Paddock 84 had works undertaken to fill in a wet patch. The Nova-flow had been installed at a depth of approximately 2 m and backfilled with gravel and soil. The site owner outlined that the remaining TKN-1 muds would be spread in the paddock in the near future. Discussions were held regarding the infiltration of drilling fluids into the nova-flow. The site owner was confident that the muds will not enter the buried drain. The adjacent paddock would also be used for land-farming. Both the injection spreader and Myer spreader will be used, each paddock is reportedly ten acres.

Paddock 39 was inspected. The drilling muds were no longer on the surface in thick lines and the pasture appeared healthy. It is likely the muds were removed from the surface rather than incorporated in. Abatement notice EAC 21056 had been complied with.

The paddock adjacent to the quarry on the northern side was inspected. Residual muds remain on the vegetation and rocks on both the northern and southern sides of the paddock, the northern drain was dry, the southern drain had a small quantity of water flowing which was clear. The site owner outlined that a spring fed pond will be built at the site for stock watering purposes. All inspected pasture throughout the site where drilling muds have previously been spread appeared healthy.

23 April 2016
Spreading activities from Surrey Road storage facility were occurring at the time of the inspection. Cell two was being stirred and emptied at the time of inspection, spreading was occurring through the use of an injection spreader, however the mud was not injecting well and remained on the surface.

After each application the muds were being incorporated using harrows and bull dozers which were on-site. The fringes of the paddock had been spread and harrowed to prevent overland flow from the spreading areas during heavy rain which was forecast.

Spreading works were occurring during the rain due to contractor availability. The works were to cease over the long weekend and programmed to resume in the finer weather forecast for the following week. Cell one at Surrey Road had material already spread in the adjacent paddock, the paddock had been harrowed and the muds were very well incorporated. More muds were to be spread in the paddock from cell one. The liquid from cell three was pumped into cell two to make it easier to pump.

The un-used muds stored in the vertical storage containers had also been pumped into cell two and were being spread. A representative sample of the muds was taken from cell two after mixing. At the time, no irrigation from cell three was occurring. There was a minor storm water discharge from final pond which was clear and no effects were observed within the receiving waters.

The area adjacent to the quarry where muds were recently spread was inspected. No pasture had as yet been sown. Soil appeared stable. All other spreading areas inspected appeared healthy with good pasture cover.

10 May 2016
During the inspection a noticeable hydrocarbon and drilling mud odour was found down wind of the paddocks 83 and 84 where muds were recently spread. Works were occurring to harrow the area prior to seed being sown. In paddock 83, seed was recently sown and pasture strike looked good across the entire spreading area. The area adjacent to the quarry on the northern side had also been worked and had seed sown.

Topsoil had been brought into other historic spreading areas which had failed to strike. The areas had been worked and seed had been sown. No works had occurred as yet to spread the residual muds remaining in the Derby Road storage area. A two month extension to abatement notice EAC 20834 was agreed upon, with re-inspection to occur after 1 July 2016. No storm water discharges were occurring and the receiving waters were in low flow. Iron oxide was prevalent throughout the stream.

4.1.1 Results of receiving enviromental monitoring

Applications of material to land undertaken in this period are defined in the following Table 23.

Table 23 Landfarmed/spread paddocks 2015-2016

Paddock	Mud Type	Well name	Application date	Solid m^3	Area
1	SBM	Maari MR7A5	10/12/2015-15/12/2015	546	2.75
39	SBM	Maari MR7A5	10/12/2015-15/12/2015	168	6.80
71	SBM	Todd TKN-1	29/12/2015-05/01/2016	220.50	2.40
72	SBM	Todd TKN-1	29/12/2015-05/01/2016	220	2.84
73	SBM	Maari MR7A5	10/12/2015-15/12/2015	596	2.00
83	SBM	Todd TKN-1	18/03/2016-28/03/2016	430	3.05
84	SBM	Todd TKN-1	18/03/2016-28/03/2016	592	3.45
145	SBM	Todd TKN-1	29/12/2015-05/01/2016	222	1.36
146	SBM	Todd TKN-1	29/12/2015-05/01/2016	187.5	1.80
Total drilling mud sequestered				**3,182 m^3**	

4.1.2 Council soil results

The Council collected six compliance soil samples this monitoring period (Table 24). These soil samples were collected from paddocks which had been landfarmed in this monitoring period. The methodology and the analysis criteria is provided in Section 1.4.4 Chemical sampling. Two paddocks which were spread (P 145 & 146) were not sampled by the Council this term and will be quantified in the following monitoring period. MI SWACO however did sample the paddocks and the analysis is provided in the MI SWACO annual report in Appendix III information.

Of note paddocks 83 and 84 had been reutilised as is allowed under the specific consent conditions. MI SWACO supplied the Council with sufficient analysis of these paddocks prior to re-applying material. This analysis was received and is attached in the MI SWACO supplied annual report which is presented in Appendix III.

Table 24 Council Soil Sampling 2015-2016

Soil Sample	Paddock No	P39	P71	P72	P83	P84	P1
Parameter	Date	24 Feb 2016	25 Feb 2016	25 Feb 2016	16 Aug 2016	16-Aug-16	23 Aug 2016
	Unit						
Calcium	mg/kg	149.3	35.6	63.2	92.2	37.6	213.5
Chloride	mg/kg	276.2	155.9	115.7	246.6	22.2	15
Conductivity	mS/m@20 °C	115	66.7	61.4	117.3	33.9	12.7
Total petroleum hydrocarbon	mg/kg	1017	35	64	1728	873	2634
Potassium	mg/kg	87.3	134.5	121.3	55.9	18.7	14.8
Moisture factor	nil	1.668	1.474	1.592	2.009	1.712	1.302
Magnesium	mg/kg	11.6	2.7	4.2	7.1	4.2	9.9
Sodium	mg/kg	63.1	61.8	105.8	36.3	11.2	17.8
Ammoniacal nitrogen	mgN/kg	0.39	2.66	1.19	8.94	7.58	2.98
Nitrite/nitrate nitrogen	mgN/kg	0.3	2.57	1.69	3.63	5.45	65.1
pH	pH	6.6	6	6.2	5.7	6.5	6.8

Soil Sample	Paddock No	P39	P71	P72	P83	P84	P1
Parameter	Date	24 Feb 2016	25 Feb 2016	25 Feb 2016	16 Aug 2016	16-Aug-16	23 Aug 2016
	Unit						
Sodium absorption ratio	None	1.33898	2.68923	3.47936	0.9807	0.46224	0.32335
Total soluble salts	mg/kg	900	522	480.5	918	265.3	647.2

Composite compliance soil samples were collected from six paddocks in the 2015-2016 monitoring period by the Council. The monitoring indicated that all analytes were below limits specified within consent conditions.

- Calcium ranged from 37-213 mg/kg;
- Potassium ranged from 14.8-134.5 mg/kg;
- Sodium ranged from 11.2–105.8 mg/kg;
- Conductivity readings in the soil ranged from 12.7-117.3 mS/m@20°C, which is below the consented limit which is not to be exceeded, (400 mS/m@20°C);
- Sodium absorption ration (SAR), which has a maximum consented limit of 8 was not exceeded in the 6 paddocks sampled, which ranged from 0.32-3.4 SAR. (Note this condition was recently reduced from 18.)
- Total soluble field salts, though only applicable to the surrender criteria ranged from 265-900 mg/kg. The surrender criterion is set at 2,500 mg/kg.
- Total petroleum hydrocarbon concentration ranged from 35-2,634 mg/kg TPH, well within the consented limit, which was recently amended from 50,000 mg/kg, to 20,000 mg/kg TPH.
- Ammoniacal nitrogen ranged from 0.39-8.94 mg/kg, whilst nitrate/nitrate nitrogen ranged from 0.3-65 mg/kg. A result of 65 mg/kg was from paddock 1 which had recently been spread with fertiliser.
- Heavy metal and speciated hydrocarbon/ BTEX analysis undertaken by MI SWACO is reported in the following section.

Figure 5 Paddock locations and application dates[1]

[1] A larger copy of this map is included in the MI SWACO supplied annual report – Appendix III

4.1.3 Council farm drain sampling

The compliance sampling undertaken by the Council also includes the provision to collect farm drain samples from specific farm drains which are within close proximity to any recently landfarmed area. In this monitoring period, paddocks 83 and 84 had their specific farm drains sampled. The analysis of the farm drain sampling is provided in the following Table 25.

Table 25 Farm drain water sample

Drain sample	Location	Paddock 84	Paddock 83
Parameter	Date	28 Apr 2016	28 Apr 2016
Barium (acid soluble)	g/m³	0.022	0.024
Benzene	g/m³	<0.0010	<0.0010
Chloride	g/m³	5.7	5.7
Conductivity	mS/m@20 °C	13.8	13.8
Ethylbenzene	g/m³	<0.0010	<0.0010
TPH	g/m³	<0.7	<0.7
HC C10-C14	g/m³	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4
HC C7-C9	g/m³	<0.10	<0.10
pH	pH	7.2	7.2
Total dissolved salts	g/m³	106.8	106.8
Temperature	°C	13	12.9
Toluene	g/m³	<0.0010	<0.0010
XYLENE-M	g/m³	<0.002	<0.002
XYLENE-O	g/m³	<0.0010	<0.0010

A slight elevation in the concentration of the TDS was observed although it was minimal. Chloride concentrations were also similarly minimally affected. No adverse effects in respect of this analysis were apparent. TPH concentrations and BTEX were all below the limit of detection for these analytes.

4.2 MI SWACO supplied soil analysis

Individual paddock analyses of the areas of land utilised by the consent holder for landfarming in this monitoring period are provided in the following Tables 26-27. MI SWACO whom collected the samples undertakes a greater variety of analysis than the compliance analysis undertaken by the Council. The reason for this additional analysis is to satisfy the specific consent conditions which dictate the allowed concentrations for landfarming.

Specifically MI SWACO undertake total heavy metal analysis of the soils, total recoverable sodium, benzene, toluene, ethylene and xylenes (BTEX), polycyclic aromatic hydrocarbon (PAH) and total petroleum hydrocarbon speciated analysis. Total recoverable barium is also monitored.

Table 26 MI SWACO provided soil analysis by paddock (a)

	Sample Name:		Paddock 01	Paddock 71	Paddock 72	Paddock 73
		Consent Limit	25/07/2016	25/07/2016	25/07/2016	25/07/2016
	Lab Number:		1628021.1	1628021.2	1628021.3	1628021.4
Dry Matter	**g/100g as rcvd**		55	59	57	67
Density	**g/mL at 20 °C**		0.59 #1	0.90 #2	0.84 #2	0.84 #3
Total recoverable barium	**mg/kg dry wt**	10,000	230	360	230	3,700
Total recoverable sodium	**mg/kg dry wt**	460*	490	550	580	490
Heavy metals with mercury, screen Level						
Total recoverable arsenic	**mg/kg dry wt**	17	< 2	< 2	< 2	3
Total recoverable cadmium	**mg/kg dry wt**	0.8	0.24	0.36	0.31	< 0.10
Total recoverable chromium	**mg/kg dry wt**	600	8	6	6	13
Total recoverable copper	**mg/kg dry wt**	100	41	34	32	83
Total recoverable lead	**mg/kg dry wt**	160	6.4	4.1	3.1	13.5
Total recoverable mercury	**mg/kg dry wt**	1	< 0.10	< 0.10	< 0.10	< 0.10
Total recoverable nickel	**mg/kg dry wt**	60	3	2	2	6
Total recoverable zinc	**mg/kg dry wt**	300	31	36	34	41
BTEX in soil by headspace GC-MS						
Benzene	**mg/kg dry wt**	1.1*	< 0.09	< 0.08	< 0.09	< 0.07
Toluene	**mg/kg dry wt**	82*	< 0.09	< 0.08	< 0.09	0.09
Ethylbenzene	**mg/kg dry wt**	59*	< 0.09	< 0.08	< 0.09	< 0.07
m&p-Xylene	**mg/kg dry wt**	59*	< 0.18	< 0.16	< 0.17	< 0.14
o-Xylene	**mg/kg dry wt**	59*	< 0.09	< 0.08	< 0.09	< 0.07
Polycyclic aromatic hydrocarbons screening in soil						
Acenaphthene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Acenaphthylene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Anthracene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Benzo[a]anthracene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Benzo[a]pyrene (BAP)	**mg/kg dry wt**	0.027*	< 0.09	< 0.04	< 0.08	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Benzo[g,h,i]perylene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Benzo[k]fluoranthene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Chrysene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Dibenzo[a,h]anthracene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Fluoranthene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Fluorene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Indeno(1,2,3-c,d)pyrene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	< 0.04
Naphthalene	**mg/kg dry wt**	7.2*	< 0.5	< 0.19	< 0.4	< 0.16
Phenanthrene	**mg/kg dry wt**	-	< 0.09	< 0.04	< 0.08	0.03
Pyrene	**mg/kg dry wt**	160*	< 0.09	< 0.04	< 0.08	< 0.04
Total petroleum hydrocarbons in soil						
C7 - C9	**mg/kg dry wt**	210*	< 30	< 12	< 30	< 10
C10 - C14	**mg/kg dry wt**	150*	< 50	< 30	< 50	2,100
C15 - C36	**mg/kg dry wt**	1300*	< 100	< 50	< 90	7,000
Total hydrocarbons (C7 - C36)	**mg/kg dry wt**	-	< 170	< 80	< 160	9,100
*relates to surrender criteria, may be above this limit unless considered for surrender.						

Table 27 MI SWACO provided soil analysis by paddock (b)

	Sample Name:		Paddock 39	Paddock 83	Paddock 84	Paddock 145	Paddock 146
		Consent Limit	25/07/2016	25/07/2016	25/07/2016	25/07/2016	25/07/2016
	Lab Number:		1628021.5	1628021.6	1628021.7	1628021.8	1628021.9
Dry Matter	g/100g as rcvd		49	57	61	48	66
Density	g/mL at 20°C	-	0.76 #3	0.77 #4	0.77 #5	0.63 #3	0.90 #3
Total recoverable barium	mg/kg dry wt	10,000	70	1,990	4,600	181	97
Total recoverable sodium	mg/kg dry wt	460*	370	680	610	590	430
Heavy metals with mercury, screen Level							
Total recoverable arsenic	mg/kg dry wt	17	< 2	< 2	3	< 2	< 2
Total recoverable cadmium	mg/kg dry wt	0.8	< 0.10	0.14	< 0.10	0.35	0.11
Total recoverable chromium	mg/kg dry wt	600	4	6	8	5	5
Total recoverable copper	mg/kg dry wt	100	30	43	53	43	43
Total recoverable lead	mg/kg dry wt	160	5	8.6	23	5.8	6.8
Total recoverable mercury	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total recoverable nickel	mg/kg dry wt	60	< 2	3	5	2	< 2
Total recoverable zinc	mg/kg dry wt	300	25	33	36	26	51
BTEX in soil by headspace GC-MS							
Benzene	mg/kg dry wt	1.1*	< 0.10	< 0.09	< 0.08	< 0.11	< 0.07
Toluene	mg/kg dry wt	82*	< 0.10	< 0.09	< 0.08	< 0.11	< 0.07
Ethylbenzene	mg/kg dry wt	59*	< 0.10	< 0.09	< 0.08	< 0.11	< 0.07
m&p-Xylene	mg/kg dry wt	59*	< 0.2	< 0.17	< 0.16	< 0.3	< 0.14
o-Xylene	mg/kg dry wt	59*	< 0.10	< 0.09	< 0.08	< 0.11	< 0.07
Polycyclic aromatic hydrocarbons screening in soil							
Acenaphthene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Acenaphthylene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Anthracene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Benzo[a]anthracene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.027*	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	-	< 0.09	< 0.04	0.04	< 0.09	< 0.04
Benzo[g,h,i]perylene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Benzo[k]fluoranthene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Chrysene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Dibenzo[a,h]anthracene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Fluoranthene	mg/kg dry wt	-	< 0.09	< 0.04	0.12	< 0.09	< 0.04
Fluorene	mg/kg dry wt	-	< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt		< 0.09	< 0.04	< 0.04	< 0.09	< 0.04
Naphthalene	mg/kg dry wt	7.2*	< 0.5	< 0.2	< 0.19	< 0.5	< 0.17
Phenanthrene	mg/kg dry wt	-	< 0.09	< 0.04	0.21	< 0.09	< 0.04
Pyrene	mg/kg dry wt	160*	< 0.09	< 0.04	0.15	< 0.09	< 0.04
Total petroleum hydrocarbons in soil							
C7 - C9	mg/kg dry wt	210*	< 30	< 12	< 12	< 30	< 11
C10 - C14	mg/kg dry wt	150*	< 60	1,500	12,700	< 60	< 30
C15 - C36	mg/kg dry wt	1300*	< 110	5,000	23,000	< 110	< 50

	Sample Name:		Paddock 39	Paddock 83	Paddock 84	Paddock 145	Paddock 146
		Consent Limit	25/07/2016	25/07/2016	25/07/2016	25/07/2016	25/07/2016
	Lab Number:		1628021.5	1628021.6	1628021.7	1628021.8	1628021.9
Total hydrocarbons (C7 - C36)	**mg/kg dry wt**	20,000	< 190	6,500	**36,000**	< 190	< 80
*relates to surrender criteria, may be above this limit unless considered for surrender.							

The MI SWACO soil analysis was provided in the preceding Tables 26 & 27. The analysis indicated that the concentrations of total recoverable heavy metals within the soil samples collected were within the specified criteria as stipulated by the consent conditions. These concentrations have been added to the table to allow the reader to compare the actual analysis with the conditions.

Concentrations of BTEX were similarly below the limit of detection on all but one sample (0.09 mg/kg toluene) from paddock 73, though this concentration was well below the surrender criterion which is set at 82 mg/kg.

Polycyclic aromatic hydrocarbon analysis (PAH) concentrations were also below the limit of detection in all but two samples. These latter concentrations were minimal.

The only exceedance with respect to the consent conditions was the concentration of total petroleum hydrocarbon analysed in paddock 84, whereby a total concentration of 36,000 mg/kg was analysed. The newly consented application rate[2] stipulates a maximum allowable concentration of 2% TPH, which equates to a concentration of 20,000 mg/kg Total TPH. The older consent allowed for an application rate of 50,000 mg/kg Total TPH.

While this is a slight exceedance it will not result in adverse effects due to the concentration exceedance. It will result in a longer time for the paddocks to bio-remediate in comparison to areas which are below 20,000 mg/kg. The remaining eight paddocks are below this specific concentration for TPH.

The Council will continue to monitor these paddocks in the upcoming monitoring period.

[2] The previous consent 7591-1 allowed for a maximum application rate of 50,000mg/kg TPH, this was augmented last year through expert opinion to a lower limit of 20,000 mg/kg TPH.

5. Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A pro-active 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 (IR) includes events where the Company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

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

In the 2015-2016 period, the Council was required to undertake significant additional investigations and interventions, or record incidents, in association with the Consent holder's conditions in resource consents or provisions in Regional Plans.

Derby Road stockpiling facility

Incident/32072

An abatement notice was issued as it was noted that drilling muds had been stored at the site of Derby Road for longer than one year. This was in breech of condition 6 of consent 6900-2. The consent holder had until 01 July 2016 to comply with abatement notice EAC 20834.

Surrey Road Stockpiling and landfarming/spreading

07 December 2016 Incident/32621

During routine compliance monitoring of information supplied within the annual report regarding drilling mud spreading activities at Surrey Road, Tariki, it was found that the information supplied was incorrect.

A letter requesting an explanation for the inconsistencies was sent and the reply was reviewed.

An infringement notice was issued (EAC-21074).

The report information was rectified upon issuance of this infringement.

05 January 2016 Incident 32699:

During a routine compliance monitoring inspection it was found that land-farming activities had likely discharged synthetic based drilling mud into two unnamed tributaries at Surrey Road, Tariki.

An infringement notice was issued: (EAC-21077).

The issue was rectified upon issuance of this infringement.

05 January 2016 Incident/ 32718:
During a routine compliance monitoring inspection it was discovered that synthetic based drilling mud had been discharged onto land using an injection spreader, but had not been incorporated into the soil due to the high viscosity of the material, in contravention of resource consent conditions.

An abatement notice was issued (EAC-21056) which required the consent holder undertake works to incorporate the synthetic based muds into the soil profile.

Upon follow up inspection the abatement notice was complied with.

05 January 2016 Incident/32704:
During a routine monitoring inspection it was found that a site used for land-farming drilling wastes was not operating within resource consent conditions, with regards to application buffer distances from surface water.

An infringement notice EAC-21076 was issued.

6. Discussion

6.1 Discussion of site performance

The discussion will focus on each individual facility.

Derby Road Stockpiling facility

The facility at Derby Road, in similarity to last year, remained closed during this monitoring year. The only site work which went ahead was the slow consolidation of residual drilling muds to one main cell on site undertaken by the consent holder. It was estimated to be in the region of 150 m^3 of residual drilling mud, which has to be farmed as soon as practicable.

It is noted that analysis undertaken of this aged drilling material revealed that it still contains components that will require bioremediation. This analysis is provided in the attached MI SWACO supplied annual report under Derby Road (20 May 2016) (refer to Appendix III).

The residual muds have been in-situ at the Derby Road facility for over two years now. The Council has repeatedly discussed this with the consent holder as it contravenes a specific consent condition which states:

Consent 6900-2 Condition 6.
'*All material must be spread onto land in accordance with consent 7591-1 as soon as practicable, but no later than twelve months after being brought onto the site.*'

With this in mind, the Council issued an abatement notice; this was discussed in more detail in section 5.

Once this material has been landfarmed to the satisfaction of the Council, the Council will inspect the Derby Road facility. This will mark the final application of landfarmable mud material from the Derby Road stockpiling facility.

Surrey Road stockpiling facility

As in previous monitoring year, the Surrey Road stockpiling facility was the primary facility in relation to the consent holder's landfarming operations. The site received wastes from two large drilling campaigns; OMV's Maari Field and TODD's Te Kiri North. This accounted for the majority of material applied to land in this monitoring period.

In terms of site developments, the original third storage pit which was historically unlined was re-developed by the site operators after discussions with the Council, and was fitted with a fit for purpose synthetic liner[3]; this occurred on the 3 November 2015.

The site historically would discharge stormwater through the specific storage cells, on to the multi ponded storm water system prior to discharging to the unnamed tributary. This was augmented to prevent the potential for dilute factions of material from egress into the unnamed tributary as historically, the biology of the stream had been

[3] All landfarm storage cells in Taranaki are now fitted with fit for purpose synthetic liners.

adversely affected. Thus a pump and an irrigator were fitted to cell three and fluid from this cell, which contains the fluid fraction from both cells one and two, flows into it during and post rainfall, would be pumped and irrigated to the specific paddock 46. This paddock would then be treated as a spread area moving forward.

At the end of the previous monitoring period MI SWACO were requested to undertake additional analysis of the pre-spread material. This analysis included the requirement to undertake total heavy metal analysis (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), polycyclic aromatic hydrocarbons, BTEX and speciated petroleum hydrocarbons.

They were also requested to analyse for the same constituents in the soil sampling which they undertake. These additional analyses were all undertaken by MI SWACO in this monitoring period, which is inline with what was requested.

The site received wastes from two large drilling campaigns this period, as already stated, OMV and Todd Oils material were processed through the facility, the landfarming of said material will be discussed in the following section.

This marked a proactive approach from MI SWACO, which was well received, as in the beginning of the monitoring period it was realised that MI SWACO had supplied the incorrect paddock listing information. This practice has since been rectified; however it led to the issuance of an infringement notice.

Post the landfarming of those two drilling campaigns the site at Surrey Road has been emptied as far as practicable and deemed to be empty by the site management, (although discussion with the management detailed that a residual of 150 m^3 of material remains in the cells which will require management). This includes the farming of silo held mud.

MI SWACO has accepted that notwithstanding they do not hold any significant volumes of landfarmable material they are required to be monitored by the Council moving forward as wastes remain on site. Groundwater analysis as well as stream assessment (bio-monitoring) will continue into the following year.

MI SWACO will also undertake discharge sampling to ascertain the quality of the storm water, which along with the irrigation of rainwater from the storage cells infers management of the facility even in periods of low activity.

Landfarming

In comparison to the previous monitoring period, where the landfarming undertaken was limited to two paddocks of STOS's operations from their KA-20 wellsite (550 m^3 of material applied to land). This period dealt with the application of 3,300 m^3 of drilling material from two separate sources. The first was related to OMV's offshore operations in the Maari Field. This was delivered to the site on the cusp of this monitoring period, These muds were farmed during December 2015 prior to the arrival of the material from Todd's operations at the Te Kiri North wellsite. These muds were spread from late December through to March 2016.

In total nine paddocks were utilised for the application of drilling mud to land under the practice of landfarming in this period, which was a greater undertaking than in the previous monitoring period which was limited to two paddocks.

While the majority of the paddocks which were landfarmed were completed to a high standard, the Council's investigating officer did have to point out a few discrepancies with the job which was undertaken. In a couple of cases an infringement notice was issued where it had been discovered that some muds had made their way into a surface drain. Though a minimal amount, it should not have ended up there. The consent holder was also abated in regard to failure to observe the consented buffer distances with respect to water courses and to re-work a specific paddock when disposal was deemed to not have been undertaken to a standard which was expected. Note that upon these issuances the issues were rectified quite swiftly.

This monitoring period marked the first time the consent holder had re-used a paddock, as is allowed under the recently amended consent. They did so by providing the Council with analysis which stated the analytes of concern were within the specific concentration to allow for a re-application of material. The also undertook additional analyte analysis of the spread paddocks.

Overall, the 2015-2016 period was a busy period for the consent holder. However the consent holder still failed to farm material from Derby Road, which has been in-situ now for longer than two years and recent analysis dictates that this material still requires to be landfarmed.

The development of the Surrey Road facility with its three lined storage cells remains dormant until required. It is noteworthy to mention that although the Surrey Road facility is deemed to be empty by site management, it still contains a residual amount of drilling material within its specific storage cells and this material must be managed. The amount of material is close to 150 m^3.

At certain times the landfarming aspect of the process had required prompting when the standard which is expected of this land farmer was less than so. That said, the final end product was accomplished to the required standard. The Council will continue to monitor these specific paddocks until they reach their consent requirement for surrender.

6.2 Environmental effects of exercise of consents

In order for the Council to assess whether a site is in compliance with its consent conditions, specific analysis is undertaken to quantify chemical constituents. This analysis couple with experienced inspectors allows the Council to make informed decisions as to the scale of compliance with respect to a consent holder as well as assessing potential effects or actual effects which may have occurred, or may occur. In doing so they safe guard the life supporting capacities of both soil and water, as in this instance, these media are the main resources which are being utilised by this consent holder.

The environmental effects associated with the two stock piling facilities of Derby and Surrey Road and their associated landfarming area will be discussed on a facility basis below.

Derby Road

Assessment of the media of groundwater, surface water, stormwater discharge and biological monitoring of the stream health were undertaken this monitoring period, as established by the specific monitoring program. This program will remain in effect until the consent holder has satisfied to the approval of Council, their final requirement to landfarm the consolidated material which has been in-situ for over two years now. While the Council has been waiting for this material to be expedited the consent holder has utilised the free storage cells to dewater water treatment sludge in the cost efficient manner which is known as lagooning.

Groundwater analysis was undertaken as proposed, on four occasions. On one monitoring round a slight elevation in the concentration of TDS was observed. The environmental effects on the groundwater, as determined by the site specific monitoring wells, indicated negligible effects.

Surface water analysis, inline with the groundwater, also indicated negligible effects, which is similar to the previous monitoring period and was summed up by the Council biologist who concluded:

- Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

Surrey Road

As in the previous monitoring period, the site at Surrey Road remains the primary landfarming facility with respect to the consent holder's two stockpiling facilities. In the previous monitoring period the main issues in terms of environmental effects were centered on a decline in species population within the unnamed tributary, which was inferred to be a function of the stormwater system. This instream effect was mitigated through the use of an irrigator and pump to discharge to land instead.

In this monitoring period the bio-monitoring indicated the following:

- Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not resulted in any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

While this is an improvement on the previous year's assessment, it did not exclude the possibility that effects did or might occur. Management of the facility in fallow years when they are not stockpiling will still be required and the Council will continue to monitor the stream communities. As already discussed in the previous section, the storage cells still contain residual material which if unmanaged contains the potential to adversely affect the in-stream biology as has occurred in the past.

One sampling round does stand out from the rest and it was provided by MI SWACO. It was the analysis of 29 g/m^3 of oil and grease from a storm water sample, which was above the RFWP rule 23. This result, while not hugely environmentally significant, it does indicate that the stormwater system and the associated fluid component of the cells still has the potential to egress in to the unnamed tributary. It was appreciated that MI SWACO were transparent in providing this sample.

This underlines the rationale for comprehensive site management in times of fallow. The instream communities will serve as a constant bio-indicator as to the quality of the stormwater ejected from the facility.

Other than the slightly elevated oil and grease result, there were no other measured effects from the exercise of this consent shown by the chemical analysis of water quality.

Landfarming/ Landspreading

In comparison to the previous monitoring period which was relatively quiet in terms of landfarming, this monitoring period, 2015-2016, marked two large landfarming campaigns with the application of OMV's and Todd's material. These two campaigns which encompassed a total of 3,300 m^3 of drilling mud were landfarmed/ landspread across nine paddocks.

Environmental effects as a result of the exercise of this consent were limited; however, there existed the potential for effects in this period as previously discussed in Section 5. Specific matters noted included the application of material, whereby the operator must be mindful to respect buffer distance from water ways, not to over apply material when landfarming, and to supply correct paddock spreading information.

Buffer distances are required as they protect waterways from run off drilling material, and to project material into waterways or farm drains is not good practice and more care needs to be given in future. While analysis of the drain did not indicate anything of an adverse nature, the purpose of the application is to apply it to ground, not to water.

The over application of material will result in a longer remediation time for that specific area when compared to normal application areas. Note while one paddock was over the newly adjusted, consented maximum loading rate of 20,000 mg/kg TPH or 2% TPH, it was still below the older consent value of 50,000 mg/kg or 5% TPH.

The supply of correct paddock information is vital for the transparency of the industry and considering a duty of care to the customers, the correct supply of information is required.

Overall, there were three infringement notices and two abatement notices that had to be issued to the consent holder for non-performance; while environmental effects of these non-compliances were minor, an improvement in the consent holder's performance is required.

6.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 28-31.

Table 28 Summary of performance with respect to consent 6900-2

Purpose: ***To discharge drilling waste [consisting of drill9ing cuttings and drilling fluids from water based muds and synthetic based muds], onto and into land for the purpose of temporary stockpiling prior to disposal***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Mostly
2. Notify TRC 48 hours prior receiving waste onto site for stockpiling	No material received in relation to this consent	N/A
3. Records to be kept by consent holder and made available to the Council	Records received	Not applicable in this period
4. Consent holder to report to Council by 31 August each year on records specified in SC3	Report received late	Yes
5. No discharge within 25 m of surface water or property boundaries	Inspection	Yes
6. Stockpiled material to be landspread under consent 7591-1 within 12 months of arrival on site	Inspection and consent holders records	No Residual material still in-situ. Stockpiles left in paddocks.
7. Total dissolved solids in any fresh water body not to exceed 2500 g/m^3	Sampling	Yes
8. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
9. Concentrations in soil to be met prior to expiry	Not applicable in this monitoring period	N/A
10. Consent may not be surrendered until compliance with SC9	Not applicable	N/A
11. Optional review provision re environmental effects	Not to be undertaken	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **Poor**

The environmental performance in relation to consent 6900-2 of the Derby Road facility was rated as **high**, as no issues environmentally were observed during this monitoring period. However administrative performance was poor as the site has contained aged drilling mud which according to recent analysis still contains contaminates of concern. The specific consent condition must be met. This states that material brought to the site must be farmed within 12 months upon arrival at the site. This has not occurred despite continual prompting and infringements.

Table 29 Summary of performance for consent 7911-1

Purpose: ***To discharge storm water from a drilling waste storage site into an unnamed tributary of the Mangawhete Stream in the Waitara River.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Stormwater discharged shall be from a catchment area not exceeding 1.5 hectares	Inspection and liaison with consent holder	Yes
3. Discharges shall meet the following: a. pH 6.0 – 9.0 b. Suspended solids <100 gm^{-3} c. Total recoverable hydrocarbons <15 gm^{-3}	Sampling	Yes
4. 25m downstream of the initial discharge point, discharges shall not exceed: a. BOD_5 <2 gm^{-3} b. Chloride <50 gm^{-3}	Sampling, no annual report for the storm water supplied by consent holder	Yes
5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all of the following effects in the receiving water: a. the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; b. any conspicuous change in the colour or visual clarity; c. any emission of objectionable odour; d. the rendering of fresh water unsuitable for consumption by farm animals; e. any significant adverse effects on aquatic life.	Inspection and sampling	Yes
6. Consent holder shall maintain a contingency plan	Inspection and liaison with consent holder	Yes
7. Optional review provision re environmental effects	Next option for review in June 2015	Yes
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative compliance in respect of this consent		**High** **Good**

The environmental performance in relation to stormwater discharge consent 7911-1 of the Derby Road facility was rated as **high**, as no issues environmentally were observed during this monitoring period. However administrative performance is rated as **good**,

the site still contains aged drilling mud which according to recent analysis holds significant concentrations of contaminates of concern with regard to possible stormwater discharge from this facility. Thus the consent holder must collect and supply stormwater discharge data while the site still contains material.

Table 30 Summary of performance with respect to consent 7559-1.3

Purpose: ***To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Definitions of stockpiling and landfarming	N/A	N/A
2. Adoption of the best practicable option	Inspection	For the most part
3. Install groundwater monitoring wells prior to exercise of consent	Inspection	Yes
4. Install fit for purpose high grade synthetic liners for storage cells	Cell 3 now lined	Yes
5. Approved management plan to be reviewed annually		N/A
6. Notify Council 48 hours prior to stockpiling wastes	Informed	Yes
7. Notify Council 48 hours prior to landfarming wastes	Informed	Yes
8. Limited to wastes generated in Taranaki	Including offshore region	Yes
9. Maximum stockpiling volume of 4,000 m^3 to be landfarmed/spread within nine months	Records	Yes
10. Maximum application thickness for wastes: a) 100 mm TPH < 5% b) 50 mm TPH > 5% c) no ponded liquids 1 hr after application	Sampling and inspection	Yes, though after being re-ploughed
11. Landfarmed areas to be used once only unless surrender criteria satisfied	Surrender criteria satisfied for paddock 83 and 84	N/A
12. Incorporate wastes into the soil so that the surface 250mm contains less than 2% hydrocarbons	Sampling, eight of nine paddocks within criteria, one paddock over the 2% limit	For the most part
13. Maximum chloride loading 800 kg/ha	Sampling	N/A
14. Maximum nitrogen loading 1,000 kg/5yrs	Sampling	N/A
15. Discharge area shall be resown to pasture/crop as soon as practicable	Inspection	Yes

Purpose: ***To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
16. No discharge within 6m of a water body (includes farm drains) 12 m from stream No liquid discharged within 25m of any water body	Inspection, some material found in farm drain	No
17. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
18. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling	Yes
19. Sodium absorption ratio [SAR] must be less than 8. If background soil SAR is greater than 8, then waste application shall not increase SAR by more than 1	Sampling	Yes
20. At time of expiry/cancellation/ surrender, soil hydrocarbon concentrations must comply with MfE guidelines Prior to expiry/cancellation/surrender, soil parameters shall not exceed: a) conductivity 290 mS/m b) dissolved salts 2,500 g/m^3 c) sodium 460 g/m^3 d) chloride 700 g/m^3	Paddocks 83 and 84 were not surrdered, they were reutilised as allowed under condition 11.	Yes
21. Consent may not be surrendered unless condition 20 is met	Sampling	Yes
22. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m^3	Sampling	Yes
23. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
24. Records to be kept by consent holder and made available to the Council	Provided	Yes
25. Consent holder to report to Council by 31 August each year on records specified in SC23	Provided	Late
26. Consent shall lapse on 31 Dec 2014 unless exercised		Exercised
27. Optional review provision re environmental effects	Undertaken just after the monitoring period of this report	Exercised

Purpose: *To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
Overall assessment of environmental performance and compliance in respect of this consent		**Good**
Overall assessment of administrative performance in respect of this consent		**Poor**

The environmental performance in relation to discharge consent 7559-1.3 of the Surrey Road stockpiling facility was rated as **Good**, no issues environmentally were observed during this monitoring period. Administrative performance is rated as **poor**.

The reasons for the poor rating were down to the supply of incorrect information, the supply of the annual report three months later than required and the evident high concentration of oil and grease analysed from the stormwater system, which is supposedly to be put to land via irrigator.

Table 31 Summary of performance in respect of consent 7591-1.1

Purpose: *To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Mostly
2. Notify Council 48 hours prior to landspreading	Notifications received	Yes
3. Limited to wastes generated in Taranaki including the Taranaki basin	Consent holder's records	Yes
4. Discharge rate shall not exceed 100 m^3/ha/yr and no ponded liquids shall remain after 1 hr	Inspection and consent holder's records	Yes
5. Maximum chloride loading 800 kg/ha	Not calculated during period under review	N/A
6. Maximum nitrogen loading 1,000 kg/5yrs	Consent holders records	Yes
7. Landspreading of liquid fraction of the material must be undertaken with pasture cover	Inspection	Yes
8. No waste shall be applied within: a) 12 m of boundaries b) 12 m of named streams c) 6 m of other water courses	Inspection	Some material was found in a farm drain, infringement issued
9. Liquid wastes which may flow overland shall not be discharged within 25 m of boundaries or water courses	Inspection	Yes
10. Post application the material must be incorporated to a depth of 100mm and the TPH concentration must be below 2% TPH	Inspection and sampling, one paddock of nine was over the new 2% TPH concentration	Mostly

Purpose: ***To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Soil hydrocarbon concentrations must comply with MfE guidelines: a) prior to areas being reused for landspreading b) at the time of expiry/cancellation/surrender	Sampling, paddocks 83 and 84 reused, analysis provided and accepted for paddock reuse.	Yes
12. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling	Yes
13. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
14. Sodium absorption ratio [SAR] must be less than 8. If background soil SAR is greater than 8, then waste application shall not increase SAR by more than 1	Sampling	Yes
15. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m^3	Sampling	Yes
16. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
17. Records to be kept by consent holder and made available to the Council	Report provided	Yes, later than planned and required updating due to inconsistent paddock listing
18. Consent holder to report to Council by 31 August each year on records specified in SC17	Provided	Yes later than specified
19. Consent shall lapse on 1 June 2027 unless exercised	-	N/A
20. Optional review provision re environmental effects	Undertaken in the following period	Exercised
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Good** **Improvement Required**

The environmental performance in relation to discharge consent 7591-1.1 of the Surrey Road stockpiling facility was rated as **Good**, no issues environmentally were observed during this monitoring period. Administrative performance is also rated as **improvement required**.

The consent holder must regard buffer distances and supply correct information.

Ratings are as defined in Section 1.1.4

6.4 Recommendations from the 2014-2015 Annual Report

In the 2014-2015 Annual Report, it was recommended:

1. THAT monitoring of consented activities at the Derby Road stockpiling facility in the 2015-2016 year continues at the same level as in 2014-2015.

2. THAT monitoring of consented activities at Surrey Road stockpiling facility in the 2015-2016 year continues at the same level as in 2014-2015.

3. That the monitoring programme for landspreading activities in the2015-16 year continue at the same level as in 2014-15.

4. THAT the option for a review of resource consent(s) in June 2015, as set out in condition 26 of consent 7559-1 and condition 20 of consent 7591-1, be exercised, on the grounds of the following:

    - Modified application concentrations for specific parameters within the receiving environment soils, inline with international best practice and expert opinion;

    - Allowance to include material from outside the 12 nautical mile maritime limit, within the Taranaki basin;

    - A reduction in allowable sodium absorption ratio within the receiving environmental soils;

    - Condition requiring the lining of all waste storage cells/pits with fit for purpose liners;

    - An expansion to the initial screen of pre-landfarmable material;

    - Adjustment to the method utilised by the consent holder to apply the landspreadble fluid component of the storage cells;

    - The inclusion of an injection spreader to the method of application to soil;

    - An increase to allow for more material to be stockpiled; and

    - An adjustment to the specific hydrocarbon speciation with regard to surrender criteria.

The above recommendations were implemented by the Council in 2015-16 year.

6.5 Alterations to monitoring programmes for 2016-2017

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 for 2016-2017 that the monitoring of the activities at Derby Road stockpiling facility be scaled back if the consent holder landfarms the final material held within the facility. Until this occurs groundwater analysis, surface water analysis and bio-monitoring will continue.

It is proposed that for 2016-2017 that the monitoring of the activities at Surrey Road facility be slightly augmented by limiting the surface water sampling of the facility, as the site has been cleaned out as far as practicable, though the site still contains 150 m^3 of residual material and this will require management. Once storage re-commences surface water sampling will be included. Discharge samples will continue to be collected and biological monitoring will also continue, as will groundwater analysis and inspections.

It is proposed that for the 2016-2017 that the monitoring activities of the landspreading aspect continue at the same level as in 2015-2016.

7. Recommendations

1. It is proposed that for 2016-2017 that the monitoring of the storage activities at Derby Road stockpiling facility be scaled back if the consent holder landfarms the final material held within the facility. Until this occurs, groundwater analysis, surface water analysis and bio-monitoring will continue.

2. It is proposed that for 2016-2017 that the monitoring of the storage activities at Surrey Road facility be slightly augmented by limiting the surface water sampling of the facility. Once storage re-commences surface water sampling will be included. Discharge samples will continue to be collected, and biological monitoring will also continue, as will groundwater analysis and inspections.

3. It is proposed that for 2016-2017 the monitoring activities of the landspreading aspect continue at the same level as in 2015-2016.

Glossary of common terms and abbreviations

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

Al*	Aluminium.
As*	Arsenic.
Biomonitoring	Assessing the health of the environment using aquatic organisms.
BOD	Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate.
BODF	Biochemical oxygen demand of a filtered sample.
Bund	A wall around a tank to contain its contents in the case of a leak.
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
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.
IR	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.

Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
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.

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Taranaki Regional Council, 2010: Boyd Landfarm Monitoring Programme Annual Report 2008-2009. Technical Report 2009-53.

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Taranaki Regional Council, 2001: Regional Fresh Water Plan for Taranaki.

Appendix I

Resource consents held by CD Boyd

(For a copy of the signed resource consent please contact the TRC consent 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:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	16 February 2011
Commencement Date:	16 February 2011

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds], onto and into land for the purpose of temporary stockpiling prior to disposal at or about (NZTM) 1702545E-5653650N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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 [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

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

Notifications, monitoring and reporting

2. 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.

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

    a) wastes from each individual well;
    b) composition of wastes [including concentrations of chloride, nitrogen and total petroleum hydrocarbons];
    c) stockpiling area[s];
    d) volumes and weights of material stockpiled;
    e) dates of commencement and completion of stockpiling events;
    f) the results of analysis;

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

4. 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 3, for the period of the previous 12 months, 1 July to 30 June.

Operational requirements

5. There shall be no discharge of drilling waste to land, within 25 metres of surface water or of property boundaries.

6. All material must be spread on to land in accordance with consent 7591-1 as soon as practicable, but no later than twelve months after being brought onto the site.

Receiving environment limits - water

7. 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.

8. Other than as provided for in condition 7, 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

9. From 1 March 2027 [three months prior to the consent expiry date], constituents in the soil of previously landfarmed areas 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 2027, the consent holder applies for a new consent to replace this consent when it expires.

10. This consent may not be surrendered at any time until the standards in condition 9 have been met.

Review

11. 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 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 16 February 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	27 September 2011
Commencement Date:	27 September 2011

Conditions of Consent

Consent Granted:	To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River at or about (NZTM) 1702717E-5653665N
Expiry Date:	1 June 2027
Review Date(s):	June 2013, June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge source & site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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 to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The stormwater discharged shall be from a catchment area not exceeding 1.5 hectares.

3. Constituents of the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm^{-3}
total recoverable hydrocarbons	Concentration not greater than 15 gm^{-3}

This condition shall apply before entry of the treated stormwater into the receiving waters at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

4. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point to the unnamed tributary of the Mangamawhete Stream, the discharge shall not, either by itself or in combination with other discharges, cause the following:

   a) the carbonaceous filtered biochemical oxygen demand [BOD_5] to exceed 2 gm^{-3}, or
   b) the chloride concentration to exceed 50 gm^{-3}.

5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all of the following effects in the receiving water:

   a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effects on aquatic life.

6. The consent holder shall maintain a contingency plan. The contingency plan shall be adhered to in the event of a spill or emergency and shall, to the satisfaction of the Chief Executive, Taranaki Regional Council, detail measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

7. 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 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 27 September 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Surrey Road Landfarms Limited CD Boyd PO Box 44 Inglewood 4347
Decision Date (Change):	29 October 2015
Commencement Date (Change):	29 October 2015 (Granted Date: 21 January 2010)

Conditions of Consent

Consent Granted:	To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landspreading, injection spreading and irrigation
Expiry Date:	1 June 2027
Review Date(s):	June 2016, June 2017, June 2018, June 2019, June 2025
Site Location:	Surrey Road, Inglewood
Legal Description:	Lot 2 DP 344156, Secs 9, 10 & Pt Sec 13 Blk XII Egmont SD, Secs 17 & 18 Blk XVI Egmont SD (Discharge site)
Grid Reference (NZTM)	1701750E-5652370N
Catchment:	Waitara
Tributary:	Manganui Waipuku Mangatengehu

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. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landspreading/ injection spreading of drilling waste during extended periods of dry weather.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to landspreading/ injection spreading waste from each separate storage cell. 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 applied;
    d) the volume and weight of the waste to be applied;
    e) the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land;
    f) the specific location and area over which the waste will be applied; and
    g) the method of application.

    In order to demonstrate compliance with conditions 5, 6, 7, 10, 12, 13 and 14 of this consent.

3. The exercise of this consent is limited to waste generated in the Taranaki Region, and from outside the 12 nautical mile maritime limit, within the Taranaki Basin.

Discharge limits

4. Drilling waste shall be applied to land at a rate not exceeding 100 m^3/ha/yr, and in a rate and manner such that no ponded liquids remain after one hour.

5. The exercise of this consent shall not result in a chloride loading in the soil exceeding 800 kg/ha.

6. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

7. Landspreading of liquid fraction of drilling wastes and or stormwater component of the storage cells shall be undertaken through the use of a landspreader or injection spreader or irrigator. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times

8. No drilling waste shall be discharged within:

   a) 12 metres of property boundaries; or
   b) 12 metres of the Mangamawhete, Mangatengehu and Waipuku Streams; or
   c) 6 metres of any other surface water course (including farm drains).

9. Any liquid drilling waste which may flow overland, shall not be discharged within 25 metres of property boundaries or surface water courses (including farm drains).

Receiving environment limits for soil

10. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 100 mm so that the hydrocarbon concentration at any point in the soil/ waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point.

11. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	
Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt	
MAHs	
Benzene	1.1
Toluene	82
Ethylbenzene	59
Xylene	59
PAHs	
Naphthalene	7.2
Non-carc (Pyrene)	160
Benzo(a)pyrene	0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn. These conditions also apply:

   a) prior to drilling wastes being discharged onto an area that has previously been used for the disposal of drilling wastes; and
   b) at the time of expiry, cancellation, or surrender of this consent.

12. The concentration of metals and salts in the soil layer containing the discharge shall comply with the following criteria:

Metal/ Salt	Maximum value (mg/kg)
Arsenic [1]	17
Barium – Barite [2]	10,000
Extractable Barium [2]	250
Cadmium [1]	0.8
Chromium [3]	600
Copper [3]	100
Lead [1]	160
Nickel [3]	60
Mercury	1
Zinc [3]	300
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land)	

13. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

14. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

Receiving environment limits for water

15. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

16. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

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

    a) wastes from each individual well;
    b) composition of wastes, as analysed in condition 2 e);
    c) application areas, including a map showing individual disposal areas with GPS co-ordinates;
    d) volumes and weights of wastes applied;
    e) dates of commencement and completion of application events;
    f) 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.

18. 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 17, for the period of the previous 1 July to 30 June.

Lapse and review

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

20. 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 2017 and/or June 2018 and/or June 2019 and/ or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent

Signed at Stratford on 29 October 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Advice Note
The consent holder's attention is drawn to MPI's "New Zealand Code of Practice for the Design and Operation of Farm Dairies (NZCP1) which restricts:

- *the discharge of specified wastes to land used for grazing of milking animals; and*
- *the use of feed from land which has had specified wastes applied to it.*

Should you require further information, please contact a Dairy Industry Technical Advisory Group (DITAG) representative ***or*** *visit http://www.foodsafety.govt.nz/elibrary/industry/dairy-nzcp1-design-code-of practice/amdt-2.pdf (specifically section 6.4 Disposal of effluent and other wastes and section 7.8 Purchased Stock Food)* ***or*** *contact an operating dairy processing company regarding conditions of supply.*

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd PO Box 44 Inglewood 4347
Decision Date (Change):	25 February 2016
Commencement Date (Change):	25 February 2016 (Granted Date: 20 November 2009)

Conditions of Consent

Consent Granted:	To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming, landspreading, injection spreading and irrigation
Expiry Date:	1 June 2027
Review Date(s):	June 2016, June 2017, June 2018, June 2019, June 2025
Site Location:	Surrey Road, Inglewood
Legal Description:	Secs 17 & 18 Blk XIV Egmont SD (Discharge site)
Grid Reference (NZTM)	1701847E-5651476N
Catchment:	Waitara
Tributary:	Manganui Waipuku Mangamawhete Mangatengehu

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

General conditions

a. On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b. Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c. The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i. the administration, monitoring and supervision of this consent; and
   ii. charges authorised by regulations.

Special conditions

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

   a. stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating into the soil within 24 hours of such discharge; and
   b. landfarming means the discharge of drilling waste onto land, subsequent spreading, incorporation into the soil and re-sowing into pasture or crop.
   c. landspreading means the discharge to land of the liquid fraction of drilling wastes. This includes the stormwater component of the storage cells through the use of a landspreader and/or irrigator and/or injection spreader. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times.

2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landfarming of drilling waste during extended periods of dry weather.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall install a minimum of three groundwater monitoring wells. The wells shall be at locations and to depths, that enable the collection of groundwater samples (to assess any changes in groundwater quality) to the satisfaction of the Chief Executive, Taranaki Regional Council. The wells shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.

4. Any pits used for stockpiling solid or liquid waste shall be lined with 'fit for purpose' high-grade synthetic liner or equivalent and the consent holder shall demonstrate, that the lined pits are suitable for storing liquid without leakage through the base or side walls. The Consent holder shall monitor the integrity of the pit liners and repair or replace liners as required.

5. Prior to the exercise of this consent, the consent holder shall provide, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a landfarming and stockpiling management plan to demonstrate the activity will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually and shall include as a minimum:

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

Notification and sampling requirements prior to discharge

6. 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.

7. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to the application of stockpiled material. Notification shall include the following information:

   a. the consent number;
   b. the name of the well(s) from which the waste was generated;
   c. the type of waste to be applied to land;
   d. the volume and weight of the waste to be applied to land;
   e. the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land; and
   f. the specific location and area over which the waste will be applied.

   in order to demonstrate compliance with conditions 10, 12, 13 and 14 of this consent.

Discharge limits

8. The exercise of this consent is limited to waste generated in the Taranaki region, including from outside the 12 nautical mile maritime limit within the Taranaki Basin.

9. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 4,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.

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

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

    prior to incorporation into the soil.

11. The areas which are irrigated, injection spread, landspread or landfarmed may receive future applications of material if they are below the consented criteria outlined by conditions 18, 19 and 20 of this consent.

12. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250 mm for landfarming and 100 mm for the injection spreader, so that the hydrocarbon concentration at any point in the soil/waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point'.

13. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.

14. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

15. As soon as practicable following the landfarming of drilling wastes the discharge area shall be re-sown into pasture (or into crop). If revegetation cannot be established within two months of the discharge, the consent holder shall undertake appropriate land stabilisation measures to minimise wind and/or stormwater erosion.

16. No drilling waste shall be discharged within:

    a) 12 metre(s) of property boundaries; or
    b) 12 metre(s) of the Mangamawhete, Mangatengehu and Waipuku Streams; or
    c) 6 metre(s) of any other surface water course (including farm drains).

    Any liquid drilling waste which may flow overland, shall not be discharged within 25 metre(s) of property boundaries or surface water courses (including farm drains).

Receiving environment limits for soil

17. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

18. The concentration of metals and salts in the soil layer containing the discharge shall comply with the following criteria:

Metal/ Salt	**Maximum value (mg/kg)**
Arsenic [1]	**17**
Barium – Barite [2]	**10,000**
Extractable Barium [2]	**250**
Cadmium [1]	**0.8**
Chromium [3]	**600**
Copper [3]	**100**
Lead [1]	**160**
Nickel [3]	**60**
Mercury	**1**
Zinc [3]	**300**
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land)	

19. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

20. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	
Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt MAHs Benzene Toluene Ethylbenzene Xylene PAHs Naphthalene Non-carc (Pyrene) Benzo(a)pyrene	 1.1 82 59 59 7.2 160 0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn.

21. This consent may not be surrendered unless the standards specified in condition 20 have been met.

Receiving environment limits for water

22. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

23. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

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

    a) wastes from each individual well (including records of all additives used at the wellsite during the drilling process);
    b) composition of wastes, including concentrations of chloride, nitrogen and total hydrocarbons;
    c) stockpiling area(s);
    d) volumes of material stockpiled;
    e) landfarming area(s), including a map showing each individual disposal area and GPS co-ordinates;
    f) volumes and weights of wastes landfarmed;
    g) dates of commencement and completion of stockpiling and landfarming events;
    h) treatments applied;
    i) details of monitoring, including sampling locations, sampling methods and the results of analysis;

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

25. 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 23, for the period of the previous 1 July to 30 June.

Lapse and review

26. This consent shall lapse on the 31 December 2014, 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 2017 and/or June 2018 and/or June 2019 and/or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent.

Signed at Stratford on 25 February 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Advice Note
The consent holder's attention is drawn to MPI's "New Zealand Code of Practice for the Design and Operation of Farm Dairies (NZCP1) which restricts:

- *the discharge of specified wastes to land used for grazing of milking animals; and*
- *the use of feed from land which has had specified wastes applied to it.*

Should you require further information, please contact a Dairy Industry Technical Advisory Group (DITAG) representative ***or*** *visit http://www.foodsafety.govt.nz/elibrary/industry/dairy-nzcp1-design-code-of practice/amdt-2.pdf (specifically section 6.4 Disposal of effluent and other wastes and section 7.8 Purchased Stock Food)* ***or*** *contact an operating dairy processing company regarding conditions of supply.*

Appendix II

Biomonitoring reports

To	Job Manager, Nathan Crook
From	Scientific Officers; Darin Sutherland and Brooke Thomas
Document	1625931
Report No	BT046
Date	January 2016

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, October 2015

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in spring and was one of two scheduled surveys for the site in the 2015-16 year. The site receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits where it is either pumped out for removal, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in March 2015 (Sutherland, 2015) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 1 and Figure 1.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 21 October 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

Results

Site habitat characteristics and hydrology

This October 2015 survey followed a period of 17 days since a fresh in excess of three times median flow, and 18 days since a fresh in excess of seven times median flow.

The water temperature ranged between 11.5 ºC and 15.1 ºC. Water levels were low and water speeds steady. Water was uncoloured and clear and sites 1 and 2 and uncoloured and cloudy at sites 3 and 4 (Table 2). Substrate composition for site 1 was mostly composed of a mixture of silt, gravel and cobble. For site 2, substrate was predominately silt, cobble and boulder with some gravels and sand. For site 3, substrate comprised mainly of cobble and gravel with some silt and boulder. For site 4, substrate was predominantly cobble and coarse gravel with some boulder and silt.

There were patchy periphyton mats and filaments at site 1, patchy mats and widespread filaments at site 2, while sites 3 and 4 had slippery mats only. Macrophytes were absent from all sites. Leaves and wood were patchy at all sites but site 2, which had patchy moss only. Sites 1 and 4 were partially shaded by overhanging vegetation, site 3 had complete shading, while site 2 had no shading.

Table 2 Summary of time of sampling and some water variables collected at four sites in the unnamed tributary of the Mangamawhete Stream sampled in relation to the Derby Rd landfarm on 21 October 2015.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1200	14.6	Uncoloured	Clear	Low	Steady
2	1150	14.7	Uncoloured	Clear	Low	Steady
3	1130	15.1	Uncoloured	Cloudy	Low	Steady
4	1111	11.5	Uncoloured	Cloudy	Low	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Derby Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site on 21 October 2015 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Oct 2015	Median	Range	Oct 2015	Median	Range	Oct 2015
1	12	23	12-33	19	105	87-114	100	5.1	3.2-7.4	4.5
2	12	15	6-30	17	100	80-109	92	3.3	2.0-7.4	4.8
3	12	16	5-19	15	100	88-109	100	4.2	2.5-5.9	6.7
4	12	18	6-24	12	96	73-110	110	4.3	2.1-6.8	5.1

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 21 October 2015 in relation to the Derby Rd Landfarm.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB15331	FWB15332	FWB15333	FWB15334
NEMATODA	Nematoda	3	-	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	C	C	C
	Lumbricidae	5	R	-	-	R
MOLLUSCA	*Potamopyrgus*	4	A	R	R	C
CRUSTACEA	Ostracoda	1	R	R	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	R	-
	Deleatidium	8	C	A	VA	A
	Neozephlebia	7	-	-	R	C
	Nesameletus	9	-	R	-	-
	Zephlebia group	7	A	R	R	R
COLEOPTERA (BEETLES)	Elmidae	6	R	R	-	-
	Dytiscidae	5	R	-	-	-
	Ptilodactylidae	8	R	-	C	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	R	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosella*	9	-	-	-	R
	Polyplectropus	6	C	-	-	R
	Psilochorema	6	R	R	R	R
	Oxyethira	2	-	R	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A	-	-
	Eriopterini	5	R	-	R	-
	Hexatomini	5	-	-	R	-
	Harrisius	6	R	-	-	-
	Maoridiamesa	3	-	R	-	-
	Orthocladiinae	2	C	A	A	A
	Tanypodinae	5	R	R	R	-
	Ephydridae	4	-	R	-	-
	Muscidae	3	-	-	-	R
	Austrosimulium	3	R	-	-	-
ACARINA (MITES)	Acarina	5	C	R	-	-
		No of taxa	19	17	15	12
		MCI	100	92	100	110
		SQMCIs	4.5	4.8	6.7	5.1
		EPT (taxa)	5	5	5	6
		%EPT (taxa)	26	29	33	50

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A moderate macroinvertebrate community richness of 19 taxa was found at site 1, which was four taxa less than the median number recorded for the site and six less than the previous sample (median taxa richness 23; Table 3).

The MCI score of 100 units indicated a community of 'good' biological health which similar to the median value calculated from previous surveys at the same site (median MCI score 105; Table 3). The $SQMCI_s$ score of 4.5 was a substantial 0.6 unit less than the median value calculated from previous surveys at the same site and 0.6 unit less than that recorded in the March 2015 survey (Table 3).

The community was characterised by two 'tolerant' taxa; [snail (*Potamopyrgus*) and oligochaete worms] and one 'sensitive' taxon [mayfly (*Zephlebia* group)] (Table 5).

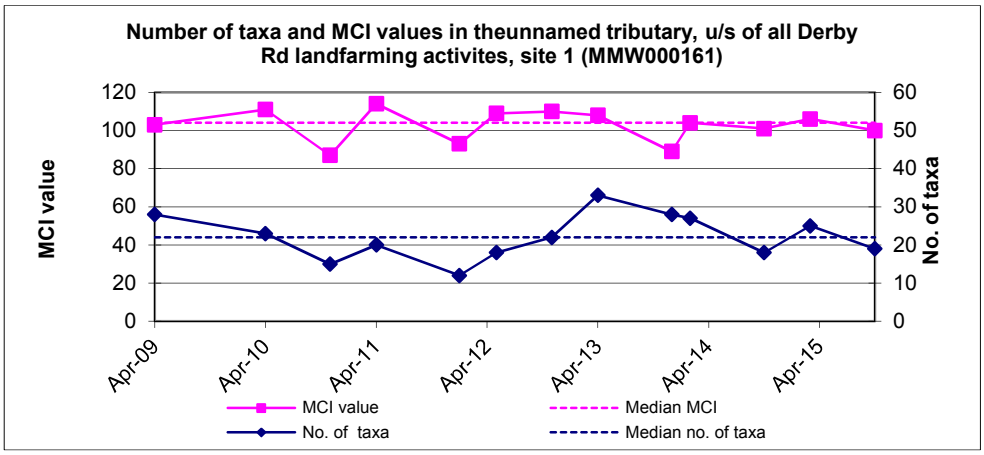

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 17 taxa was found at site 2, which was two taxa more that the median number recorded for the site and four taxa less than the previous sample (median taxa richness 15; Table 3).

The MCI score of 92 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 100; Table 3). The $SQMCI_s$ score of 4.8 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 3.3 units; Table 3).

The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)], one 'moderately sensitive' taxon, [cranefly *Aphrophila*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)](Table 5)].

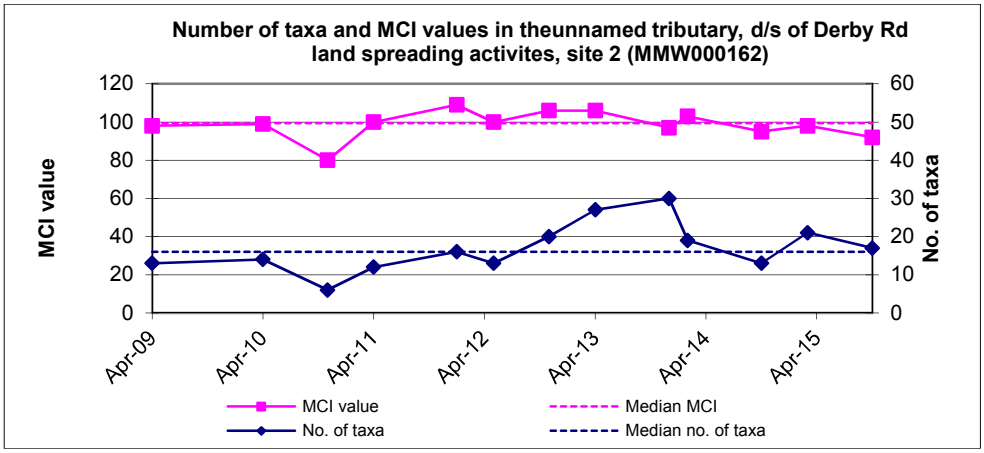

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 15 taxa was found at site 3, which was one taxon less than the median number recorded for the site and three taxa less than the previous sample (median taxa richness 16; Table 3).

The MCI score of 100 units indicated a community of 'good' biological health which was the same as the median value calculated from previous surveys at the same site (Table 3). The $SQMCI_s$ score of 6.7 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.2 units; Table 3) and significantly higher (by 4.2 units) than the March 2015 result.

The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)] and one 'highly sensitive' taxon; [mayfly (*Deleatidium*) (Table 5)].

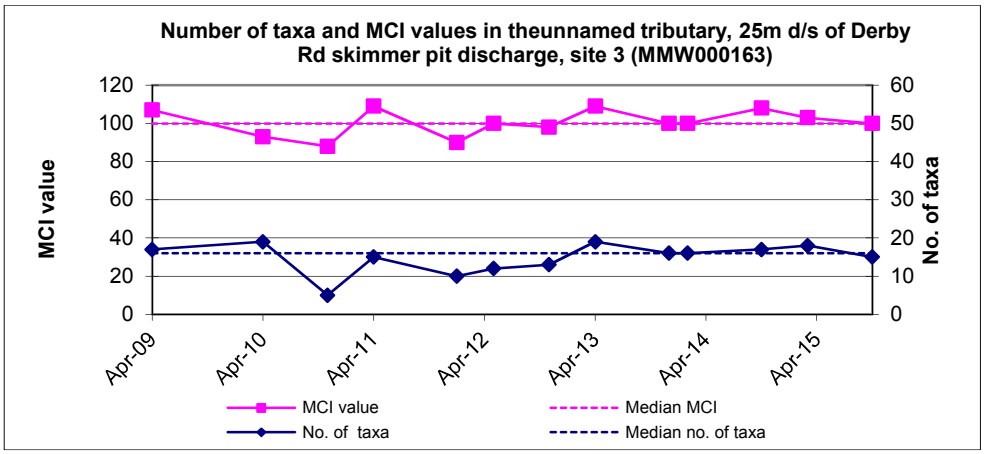

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderately low macroinvertebrate community richness of 12 taxa was found at site 4, which was six taxa less than the median number recorded for the site and five taxa less than the previous sample (median taxa richness 18; Table 3).

The MCI score of 110 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 96; Table 3). The $SQMCI_s$ score of 5.1 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.3 units; Table 3).

The community was characterised by one 'tolerant' taxon [midge (Orthocladiinae) and one 'highly sensitive' taxon; [mayfly (*Deleatidium*)] (Table 5).

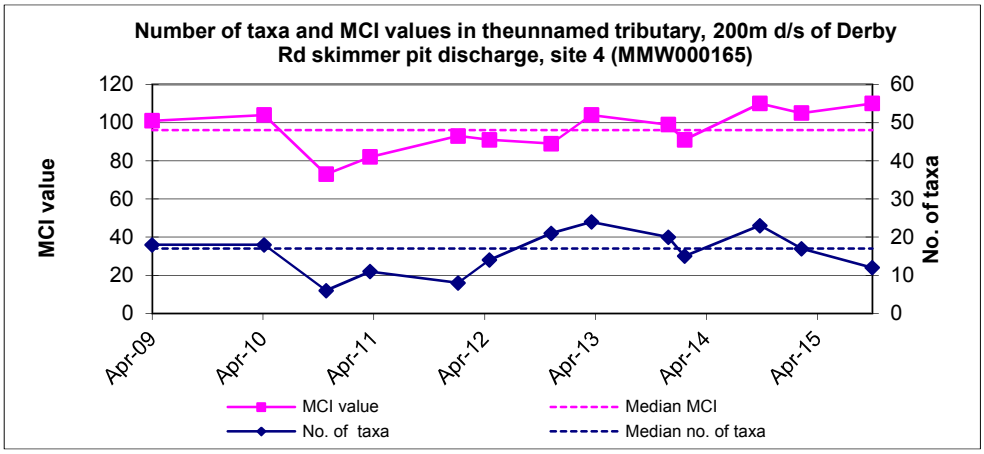

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

Discussion and Conclusions

The Council's 'kick-sampling' technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence / absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_s$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In the current survey, the $SQMCI_s$ score recorded at the upstream 'control' site was significantly lower than the median score recorded at this site in previous surveys. This score was also significantly (Stark, 1998) lower than that recorded by the March 2015 survey, indicating upstream activities had possibly caused a deterioration in preceding water quality at this site. Substantial iron oxide deposits, long green filamentous algae and organic foaming recorded at the site also indicated deterioration at this site. Taxa richness

was also below the historical median; however the MCI score was only slightly below the historical median.

The results of this survey indicated that there was no significant deterioration in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. There was a slight increase in $SQMCI_s$ score (by 0.3 units) between site 1 and site 2, but a slight decrease in MCI score (by 8 units). The $SQMCI_s$ score of 4.8 units was significantly higher (by 2.3 units) than the March 2015 score and significantly higher (by 1.4 units) than the median score previously recorded, indicating some improvement at this site.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by reduced (when compared to the upstream 'control' site) taxa richnesses at both sites. The MCI score recorded at site 3 was the same as that recorded at site 1 and slightly more than that recorded at site 2. The $SQMCI_s$ score recorded at site 3 was significantly (Stark, 1998) higher than that recorded at all other sites and was significantly higher than the median recorded by previous surveys at this site. The MCI score recorded at site 4 was the highest of all sites and was significantly (Stark, 1998) higher than that recorded at site 2 and significantly higher than the median recorded by previous surveys. The $SQMCI_s$ score recorded at site 4 was also significantly (Stark, 1998) higher than the median recorded by previous surveys and significantly higher than that recorded by the March 2015 survey.

Overall, the results of this spring survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

Summary

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land at the Derby Rd landfarm.

- In the current survey there were no significant differences in MCI score between the control site and three downstream sites. Site 3 and 4 both had substantially higher $SQMCI_s$ scores than site 1, which had the lowest SQMCIs score of the four sites. Taxa richnesses were similar among sites.

- Compared to the March 2015 survey SQMCIs scores had decreased significantly at site 1, indicating some deterioration in water quality at this site. The SQMCIs scores at sites 2, 3 and 4 had increased significantly from previous survey results and historical medians. MCI scores were similar to the March 2015 survey results.

- There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had had any significant effects on the health of the macroinvertebrate communities present in an unnamed tributary of the Mangamawhete Stream.

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To	Job Manager, Nathan Crook
From	Scientific Officers, Darin Sutherland and Katie Blakemore
Document	1623587
Report No	DS037
Date	February 2016

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility, October 2015

Introduction

A macroinvertebrate survey was performed on 21 October 2015 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. However, results from the latest previous survey in March 2015 (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 21 October 2015 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at all the sites (Table 1). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road drilling waste stockpiling activities

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

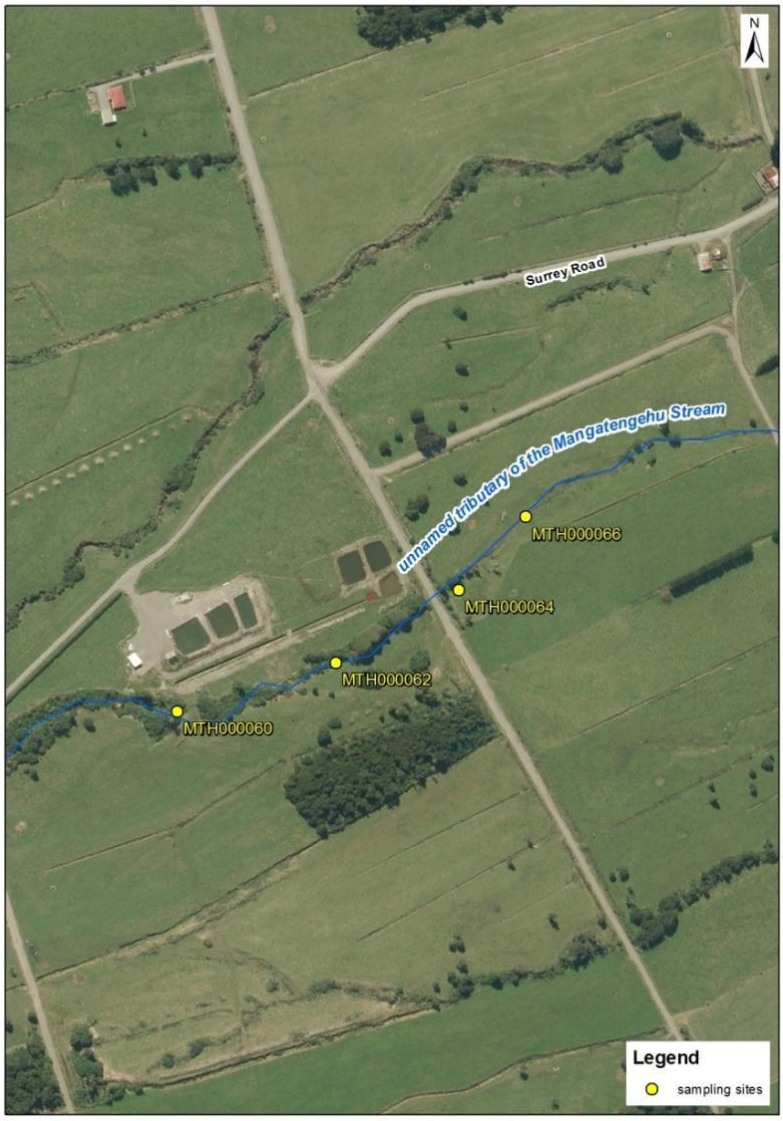

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark *et al*, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 19 98 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and Discussion

Site habitat characteristics and hydrology

This October 2015 survey followed a period of 17 days since a fresh in excess of three times median flow, and 18 days since a fresh in excess of seven times median flow based on the nearest flow gauging site on the Manganui river at SH3 Midhurst. The flow at the time of the survey was at approximately half of the median flow but flows during the last month were close to the median flow.

The water temperatures were relatively cool (11.8-13.0 °C). Water levels were low and water speeds either steady or swift. Water was uncoloured and clear for all sites during the survey All sites had a predominately cobble substrate.

Periphyton mats were patchy at sites 1 and 2 and widespread at sites 3 and 4. Periphyton filaments were widespread at sites 1, 3 and 4 and absent at site 2. Moss was only present at site 2 and leaves were present at sites 2 and 3 but not sites 1 and 4. There was wood and macrophytes at any of the sites.

Sites 1, 2 and 3 had partial shading while site 4 had no shading. Only site 2 had overhanging vegetation. Iron oxide deposits were evident at all four sites but were most prevalent at sites 3 and 4. Cyanobacteria mats and long green filamentous algae were also more prevalent at sites 3 and 4 compared with the two upstream sites.

Macroinvertebrate communities

Table 2 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 2 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 21 October 2015 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Oct 2015	Median	Range	Oct 2015	Median	Range	Oct 2015
1	12	20	15-36	19	112	89-127	109	5.0	2.0-5.6	6.2
2	12	20	5-30	18	118	80-128	124	5.8	1.6-6.9	5.8
3	12	12	6-19	7	101	77-121	97	2.3	1.4-3.9	3.1
4	8	13	7-24	9	94	77-109	98	2.5	1.4-4.3	4.7

Table 3 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 3 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 4.

Table 4 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 21 October 2015.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB15335	FWB15336	FWB15337	FWB15338
ANNELIDA (WORMS)	Oligochaeta	1	R	A	C	C
	Lumbricidae	5	-	-	-	R
CRUSTACEA	Ostracoda	1	R	-	-	-
	Paranephrops	5	R	R	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C	-	R
	Deleatidium	8	C	A	R	C
	Nesameletus	9	C	C	-	-
	Zephlebia group	7	A	A	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	C	R	R
	Austroperla	9	-	R	-	-
	Megaleptoperla	9	R	-	-	-
	Stenoperla	10	R	R	-	-
	Zelandobius	5	-	R	-	-
	Zelandoperla	8	-	C	-	-
COLEOPTERA (BEETLES)	Ptilodactylidae	8	-	C	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	-	-	-
	Hydrobiosis	5	R	-	-	-
	Hydrochorema	9	-	R	-	-
	Plectrocnemia	8	R	-	-	-
	Psilochorema	6	R	R	-	-
	Oxyethira	2	R	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-	-	-
	Eriopterini	5	R	R	-	R
	Hexatomini	5	R	R	-	-
	Paralimnophila	6	-	-	-	R
	Orthocladiinae	2	C	C	C	R
	Polypedilum	3	-	R	-	-
	Muscidae	3	-	-	R	-
	No of taxa		19	18	7	9
	MCI		109	124	97	98
	SQMCIs		6.2	5.8	3.1	4.7
	EPT (taxa)		11	11	3	3
	%EPT (taxa)		58	61	43	33

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A moderate macroinvertebrate community richness of 19 taxa was found at site 1 ('control' site) which was similar to the previous sample (Figure 2) and to the median calculated from historical data for the site (Table 2). Taxa richness was also similar to the median from similar sites (Table 3).

The MCI score of 109 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the previous survey score (Figure 2) but not significantly different to the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_s$ score of 6.2 units was higher than the previous survey score ($SQMCI_s$ score of 5.1 units) and to the median value calculated from previous surveys at the same site (Table 2).

The community had low taxa abundances. Only one abundant taxon was recorded, a 'moderately sensitive' mayfly (*Zephlebia* group) (Table 4).

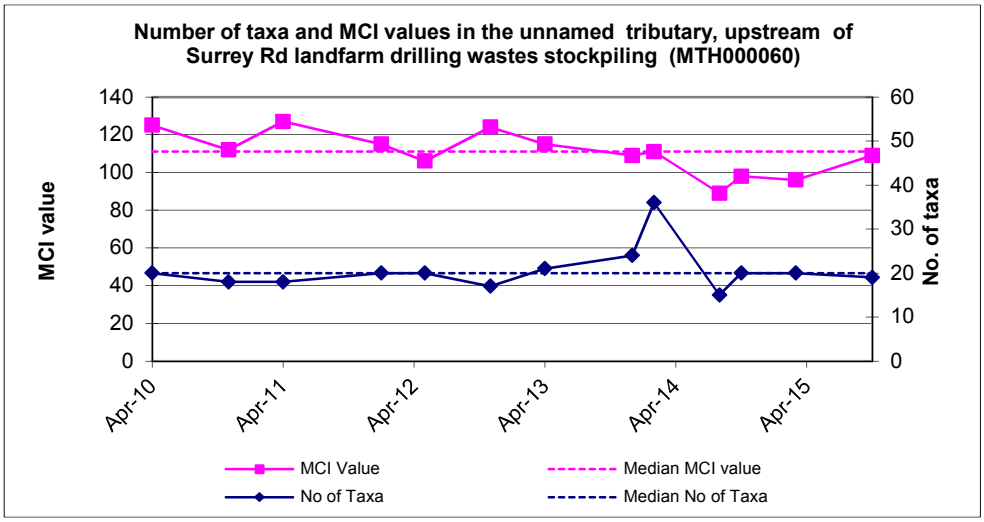

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 18 taxa was found at site 2 which was similar to the previous sample (Figure 3) and to the median calculated from historical data for the site (Table 2). Taxa richness was also similar to the median from similar sites (Table 3).

The MCI score of 124 units indicated a community of 'very good' biological health which was significantly higher (Stark, 1998) the previous survey score (Figure 4) but not significantly different to the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_s$ score of 5.8 units was higher than the previous survey score ($SQMCI_s$ score of 4.1 units) and to the median value calculated from previous surveys at the same site (Table 2).

The community had low taxa abundances. Only three abundant taxa were recorded, 'tolerant' oligochaete worms, a 'moderately sensitive' mayfly (*Zephlebia* group) and a 'highly sensitive' mayfly (*Deleatidium*) (Table 4).

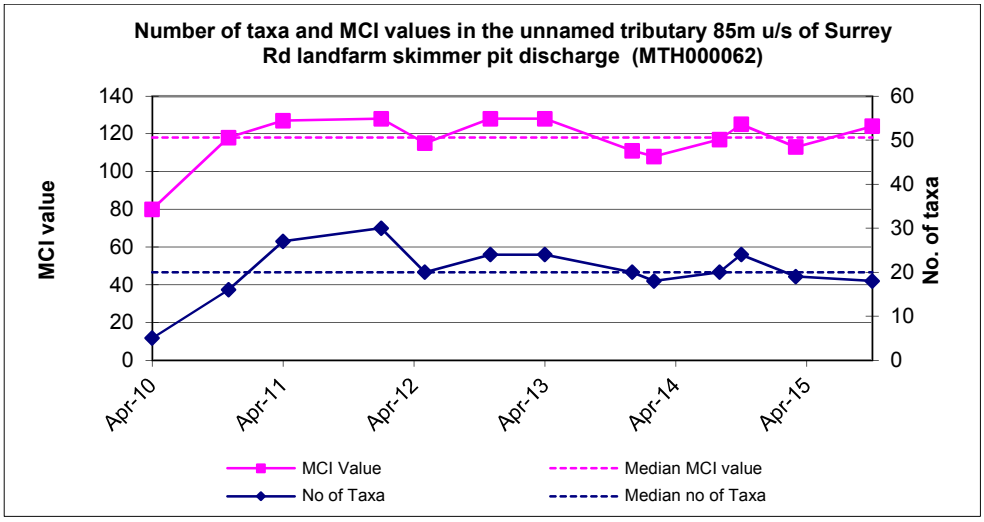

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A low macroinvertebrate community richness of only seven taxa was found at site 3 which was substantially less than that found for the previous survey (Figure 4). Furthermore, the sample contained five taxa fewer than the median number recorded for the site (Table 2) and 13 taxa fewer than the median calculated from similar sites (Table 3). This result was also only one taxon above the lowest number ever recorded at the site (Table 3) and represented the second lowest number of taxa ever recorded at the site (Figure 4). Low taxa richness may be an indicator of discharges though other factors such as poor habitat quality may also cause low taxa richness.

The MCI score of 97 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the previous survey (Figure 4) or to the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_s$ score of 3.1 units was similar to the previous survey score ($SQMCI_s$ score of 3.5 units) and was slightly higher than the median value calculated from previous surveys at the same site (Table 2).

The community had very low taxa abundances with no abundant taxa and only two taxa recorded as being 'common' (Table 4). Low taxa abundances, especially when associated with low taxa richness, may also indicate a macroinvertebrate community affected by discharges. The low taxa abundances could be due to the majority or all individuals from a particular taxon either dying or activity migrating downstream to avoid discharges. Individuals collected at the time of the survey may naturally be more tolerant to contaminants or more likely represent recolonisation of the reach since any discharges occurred.

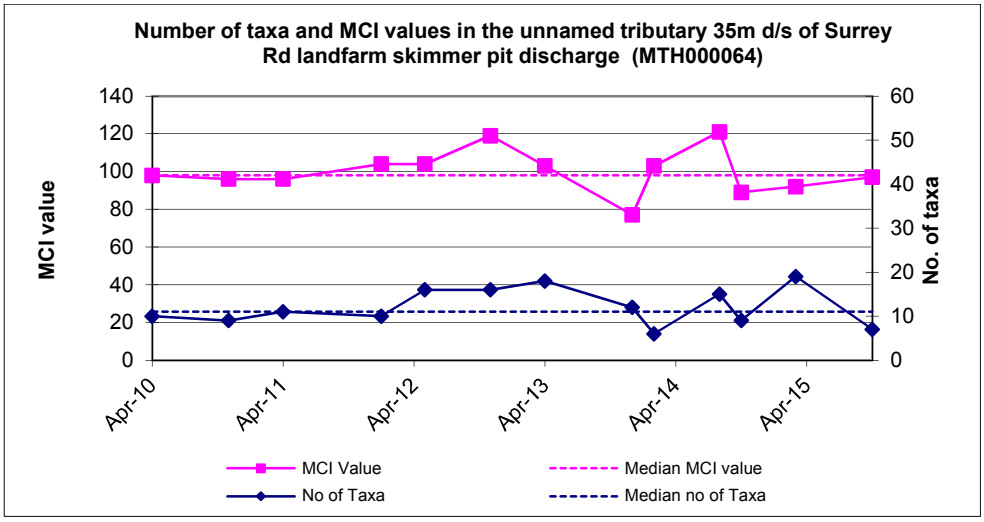

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of only nine taxa was found at site 4 which was substantially less than that found for the previous survey (Figure 5). Furthermore, the sample contained four taxa fewer than the median number recorded for the site (Table 2) and 11 taxa fewer than the median calculated from similar sites (Table 3). This result was also only two taxa above the lowest number ever recorded at the site (Table 3) and represented the second lowest number of taxa recorded at the site (Figure 4). The site is located further downstream of any discharges and hence may not be affected by any discharges to the same extent as site 3.

The MCI score of 98 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the previous survey (Figure 4) or to the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_s$ score of 4.7 units was similar to the previous survey score ($SQMCI_s$ score of 4.2 units) and was higher than the median value calculated from previous surveys at the same site (Table 2).

The community had very low taxa abundances with no abundant taxa and only two taxa recorded as being 'common' (Table 4). Surprisingly, the 'highly sensitive' mayfly *Deleatidium* was recorded as 'common' in the sample but as the genus was recorded as 'abundant' at site 2, recolonisation from that source population could easily occur.

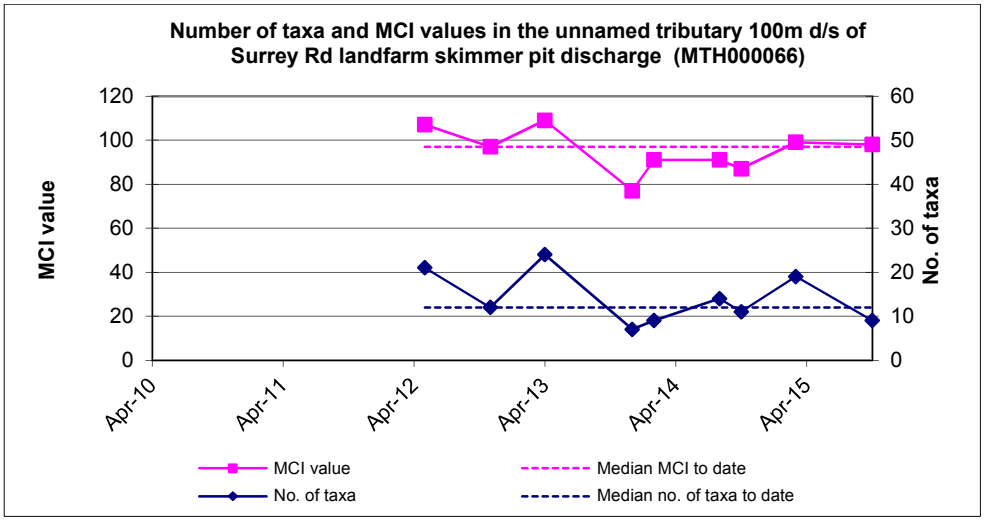

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Summary and Conclusions

The Council's 'kick-sampling' technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangatengehu Stream in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to harmful discharges. Macroinvertebrates when exposed to harmful chemicals may die or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence / absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_s$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

The macroinvertebrate communities present at the two 'control' sites were of good to very good quality. In general there was little difference in macroinvertebrate indices between sites 1 and 2 for the current survey apart from site 2 having a higher MCI score, which would possibly be due to better habitat quality at the site as the riparian cover at site 2 was superior to that of site 1.

In contrast, the macroinvertebrate communities present at the two 'impacted' sites were of 'fair' quality and had low taxa richnesses and taxa abundances. Sites 3 and 4 had similar macroinvertebrate indices to each other and these indicated that the macroinvertebrate communities present were of substantially lower quality compared with the two 'control' sites. In particular, taxa richnesses at the 'impacted' sites were between 9-12 taxa fewer than at the 'control' sites.

However, there is variation among sites which would account for some of the differences

between the 'control' and 'impacted' sites. In particular, sites 3 and 4 had higher levels of periphyton which is normally associated with high levels of nutrients (e.g. effluent and fertilizer discharges), sunlight, warm temperatures and stable flows. Long filamentous periphyton often provides habitat for lower scoring taxa and would partially explain the differences in MCI scores. However, the presence of periphyton would not negatively affect taxa richness. The iron oxide deposits which were found at all four sites may reduce macroinvertebrate habitat quantity and quality by infilling spaces in the benthos and potentially creating a hard impregnable pan. This could potentially reduce both taxa richness and taxa abundances. Sites 3 and 4 did have considerably more iron oxide deposits than sites 1 and 2 at the time of the survey which could explain the low taxa richnesses and abundances found.

In relation to the previous survey the two 'control' sites showed improvements in their MCI scores and little change in their taxa richnesses. The 'impacted' sites had little change in their MCI scores but had large decreases in taxa richness (12 taxa decrease for site 3 and 10 taxa decrease for site 4). The 'impacted' sites at the time of the survey had high levels of periphyton with abundant cyanobacteria (*Phormidium* sp) mats which were largely absent in the previous survey. Iron oxide deposits were also more substantial during the present survey than the previous survey. Interestingly, periphyton and iron oxide deposits at the 'impacted' sites were very similar to the previous spring survey in October 2014 and the taxa richnesses and taxa abundances were also very similar suggesting that they were responsible for structuring macroinvertebrate community composition.

Comparison of the macroinvertebrate indices of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites had similar taxa richnesses to similar sites but the 'impacted' sites had substantially lower taxa richnesses. MCI scores for sites 1 and 2 were similar to the median value at similar sites in the same altitudinal band. Sites 3 and 4 had significantly lower MCI scores than similar sites in the same altitudinal band.

Overall, the two potentially 'impacted' sites showed significant differences in the macroinvertebrate indices examined compared with the 'control' sites at the time of the survey. Differences in periphyton cover and amount of iron oxide deposits would largely explain the differences observed. Stockpiling activities may also have contributed to the low macroinvertebrate taxa richnesses and taxa abundances but as to what extent was not possible to determine. Investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream.

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To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1656255
Report No	BT052
Date	March 2016

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, February 2015

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in summer and was one of two scheduled surveys for the site in the 2015-16 year.

The site historically received drilling waste, which were stored on site, and then spread over land under specific consent conditions. However, this site has been closed for the past two years, with the Company moving to consolidate the remaining residual drilling material with a view to submit this facility for surrender in the near future.

Drainage of water from the storage pits flows through at least two skimmer pits where it is either discharged across specific paddocks, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in October 2015 (Sutherland & Thomas, 2015) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established

just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 1 and Figure 1.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 02 February 2016. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

Results

Site habitat characteristics and hydrology

This February 2016 survey followed a period of 14 days since a fresh in excess seven times median flow.

The water temperature ranged between 16.4 ºC and 20.2 ºC. Water levels were low to moderate and water speeds steady. Water was uncoloured and cloudy at all four sites (Table 2). Substrate composition for site 1 comprised mainly of sand, silt and fine gravels with some cobbles and coarse gravels. For site 2 and site 3 substrate was predominately cobbles and boulders with some gravels, sand and silt. For site 4, substrate was predominantly cobble and gravels with some boulder, sand and silt.

Periphyton mats were slippery at site 1, patchy at sites 2 and 3 and absent at site 4. Periphyton filaments were widespread at sites 2 and 3 but absent at sites 1 and 4. Macrophytes were present at the edges of the stream at sites 1 and 3 while they were recorded growing at the edges of the stream and on the bed of the stream at site 2. Macrophytes were absent at site 4. All sites recorded either patchy or widespread wood or leaves on the stream bed. Sites 1 and 3 were partially shaded by overhanging vegetation whereas site 3 had complete shading and site 2 had no shading.

Table 2 Summary of time of sampling and water variables collected at four sites in the unnamed tributary of the Mangamawhete Stream sampled in relation to the Derby Rd landfarm on 02 February 2016.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1145	17.5	Uncoloured	Cloudy	Moderate	Steady
2	1130	18.5	Uncoloured	Cloudy	Moderate	Steady
3	1105	20.2	Uncoloured	Cloudy	Low	Steady
4	1050	16.4	Uncoloured	Cloudy	Moderate	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Derby Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site on 02 February 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2016	Median	Range	Feb 2016	Median	Range	Feb 2016
1	13	22	12-33	12	104	87-114	83	5.0	3.2-7.4	4.7
2	13	16	6-30	20	99	80-109	96	3.4	2.0-7.4	4.9
3	13	16	5-19	24	100	88-109	92	4.4	2.5-6.7	3.5
4	13	17	6-24	16	99	73-110	106	4.6	2.1-6.8	4.6

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 02 February 2016 in relation to the Derby Rd Landfarm.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB16022	FWB16023	FWB16024	FWB16025
ANNELIDA (WORMS)	Oligochaeta	1	R	R	C	-
	Lumbricidae	5	-	-	R	R
MOLLUSCA	*Potamopyrgus*	4	R	C	R	C
CRUSTACEA	Ostracoda	1	R	R	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	-	R
	Deleatidium	8	C	A	C	C
	Nesameletus	9	-	-	R	-
	Zephlebia group	7	-	R	-	R
HEMIPTERA (BUGS)	*Saldula*	5	-	-	R	-
	Sigara	3	-	-	C	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R	R	-
	Dytiscidae	5	-	C	R	-
	Hydraenidae	8	-	R	-	-
	Hydrophilidae	5	-	-	R	-
	Scirtidae	8	-	-	C	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	C	R	-
	Hydrochorema	9	-	-	-	R
	Hydropsyche (Orthopsyche)	9	-	-	-	C
	Polyplectropus	6	-	C	R	R
	Psilochorema	6	-	R	R	R
	Oeconesidae	5	-	-	-	R
	Oxyethira	2	-	R	C	-
	Paroxyethira	2	-	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R	-	-
	Eriopterini	5	R	-	R	-
	Hexatomini	5	R	-	-	R
	Limonia	6	-	-	R	-
	Zelandotipula	6	-	R	-	-
	Orthocladiinae	2	R	A	A	C
	Polypedilum	3	-	-	-	R
	Tanypodinae	5	R	R	C	R
	Paradixa	4	-	R	-	-
	Empididae	3	-	-	R	-
	Austrosimulium	3	C	C	A	A
ACARINA (MITES)	Acarina	5	-	C	R	-
		No of taxa	12	20	24	16
		MCI	83	96	92	106
		SQMCIs	4.7	4.9	3.5	4.6
		EPT (taxa)	2	6	5	8
		%EPT (taxa)	17	30	21	50

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A low macroinvertebrate community richness of 12 taxa was found at site 1, which was ten taxa less than the median number recorded for the site and equal to the lowest number of taxa recorded to date (Table 3). This number was also seven less than that recorded by the previous spring survey.

The MCI score of 83 units indicated a community of 'fair' biological health which was significantly (Stark, 1998) lower than the median value calculated from previous surveys at the same site (median MCI score 104; Table 3). This MCI score was also the lowest recorded to date for this site. The $SQMCI_s$ score of 4.7 was similar to the historical median for the site (5.0) and slightly above that recorded by the previous spring survey (by 0.2 unit).

There were no taxa recorded in abundance at this site. Two taxa were recorded as 'common' (5-19 individuals) including the 'highly sensitive' mayfly (*Deleatidium*) and black fly larvae (*Austrosimulium*) (Table 5).

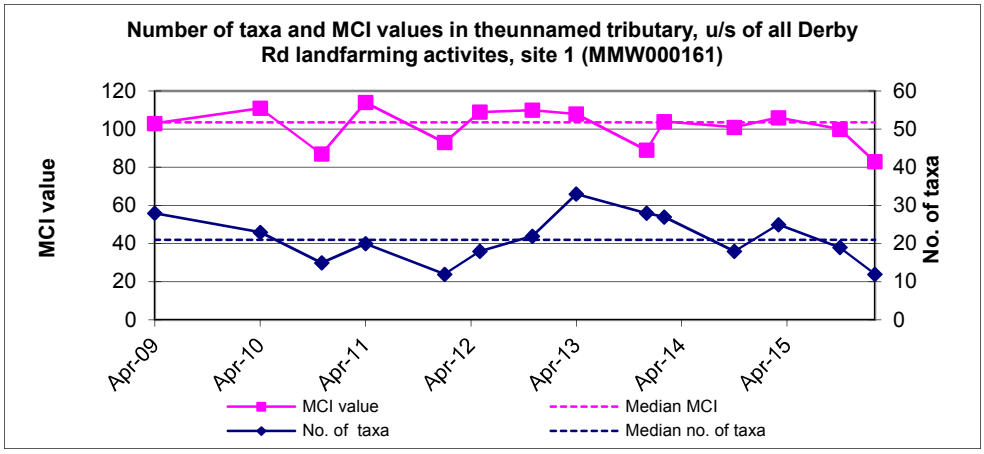

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 20 taxa was found at site 2, which was four taxa more that the median number recorded for the site and three taxa more than that recorded by the previous spring survey (median taxa richness 16; Table 3).

The MCI score of 96 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). The $SQMCI_s$ score of 4.9 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 3.4 units; Table 3).

The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5)].

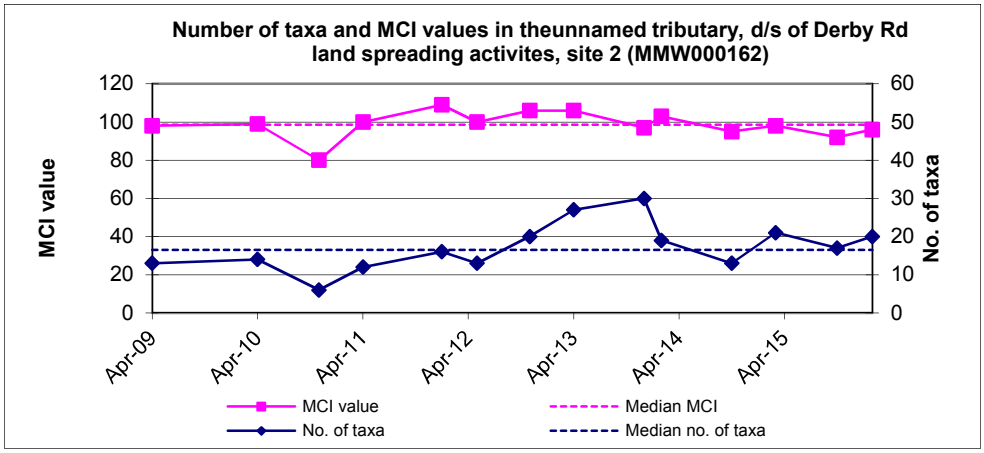

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 24 taxa was found at site 3, which was eight taxa more than the median number recorded for the site and nine taxa more than that recorded by the previous sample (median taxa richness 16; Table 3).

The MCI score of 92 units indicated a community of 'fair' biological health which was slightly below the median value calculated from previous surveys at the same site (Table 3). The $SQMCI_s$ score of 3.5 units was substantially lower than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.4 units; Table 3) and significantly lower (by 3.2 units) than the October 2015 result.

The community was characterised by two 'tolerant' taxa; [midge (Orthocladiinae) and black fly larvae (*Austrosimulium*)]) (Table 5)].

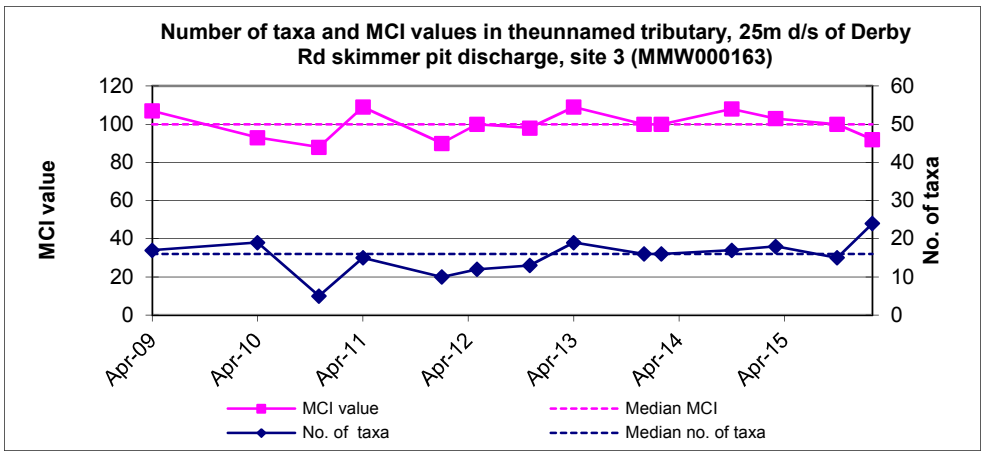

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 16 taxa was found at site 4, which was similar to the median number recorded for the site and four taxa more than that recorded by the previous spring survey (Table 3).

The MCI score of 106 units indicated a community of 'good' biological health which was higher than the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). The $SQMCI_s$ score of 4.6 units was equal to the median value calculated from previous surveys at the same site (Table 3).

The community was characterised by one 'tolerant' taxon [black fly larvae (*Austrosimulium*)] (Table 5).

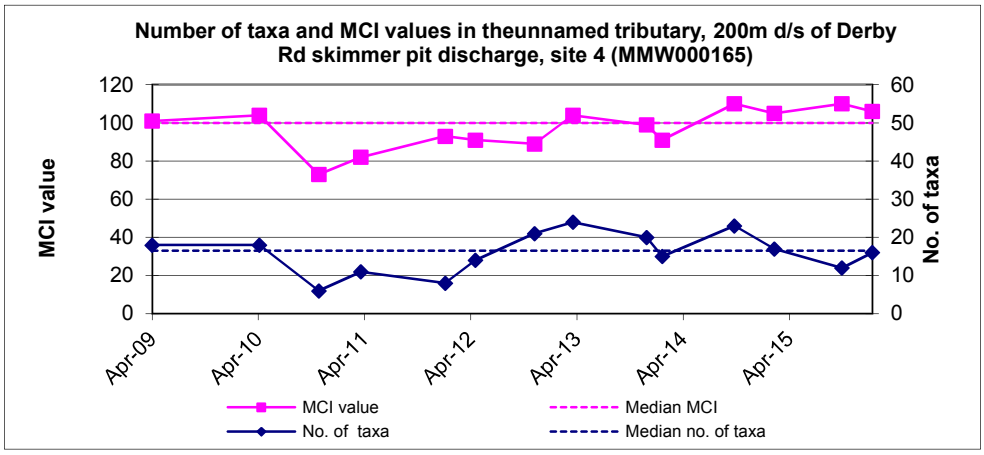

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

Discussion and Conclusions

The Council's 'kick-sampling' technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence / absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_s$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In the current survey, taxa richness at the upstream 'control' site was substantially lower than that recorded by the previous spring survey and was equal to the lowest score recorded at this site to date. The MCI score was also lower than that recorded by the previous spring survey and was significantly (Stark, 1998) lower than the median MCI score for the site (by 21 units). It is likely that the habitat available at the time of the survey has contributed to these results. In comparison to the previous spring survey the habitat available was restricted by lower flows and reduced periphyton growth. In addition, a high proportion of fine gravel, silt and sand substrate was sampled; a less favourable habitat for many macroinvertebrate taxa. Iron oxide deposits were present at the time of survey which may

have also contributed to a reduction in habitat quality at this site. It is also possible that upstream activities have caused a reduction in preceding water quality at this site. Despite a reduced taxa richness and MCI score the upstream 'control' site recorded a $SQMCI_s$ score similar to the historical median.

The results of this survey indicated that there was an improvement in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. There was a slight increase in $SQMCI_s$ score (by 0.2 unit) between site 1 and site 2 and a significant (Stark, 1998) increase in MCI score (by 13 units). The $SQMCI_s$ score of 4.9 units was similar to the October 2015 score (4.8 units) and significantly higher (by 1.5 units) than the median score previously recorded, indicating some improvement at this site.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by increased (when compared to the upstream 'control' site) taxa richnesses at both sites. The MCI score recorded at site 3 was higher than that recorded at site 1 but slightly less than that recorded at site 2. The $SQMCI_s$ score recorded at site 3 was significantly (Stark, 1998) lower than that recorded at all other sites and was substantially lower than the median recorded by previous surveys at this site. The substrate was particularly firm at this site which made collection of a sample difficult. The MCI score recorded at site 4 was the highest of all sites and was significantly (Stark, 1998) higher than that recorded at sites 1 and 3 and was substantially higher than the median recorded by previous surveys. The $SQMCI_s$ score recorded at site 4 was the same as the median recorded by previous surveys but was slightly lower than that recorded by the October 2015 survey.

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

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To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1656819
Report No	BT053
Date	March 2016

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility, February 2016

Introduction

A macroinvertebrate survey was performed on 02 February 2016 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. However, results from the previous summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The more recent spring (October 2015) survey again indicated some impact on macroinvertebrate communities from stockpiling activities, however the extent to which could not be determined due habitat variables such as periphyton growth and iron oxide deposits. It was recommended an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream.

The results of previous surveys performed in relation to this site are discussed in the references at the end of this report.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 02 February 2016 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at sites 2, 3 and 4, and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques was used at site 1 (Table 1). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road drilling waste stockpiling activities

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

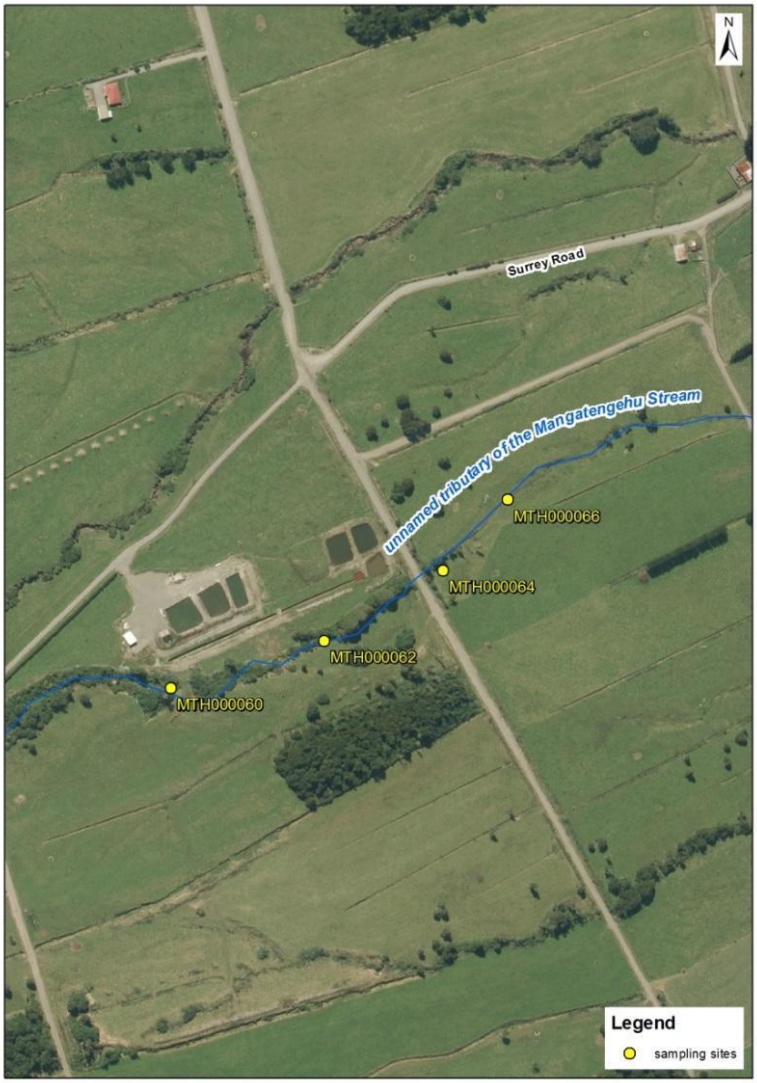

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark *et al*, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The

MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 19 98 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and Discussion

Site habitat characteristics and hydrology

This February 2016 survey followed a period of 14 days since a fresh in excess of seven times median flow based on the nearest flow gauging site on the Manganui river at SH3 Midhurst.

Water temperature ranged between 14.0-15.1 °C. There was an uncoloured, clear, moderate and steady flow at sites 2, 3 and 4 and a cloudy, steady flow at site 1.At site 1 the substrate comprised predominantly of fine and coarse gravels with some sand, silt and cobbles. At site 2 the substrate comprised mainly of coarse gravels and cobbles while sites 3 and 4 had predominately cobble substrates.

No periphyton was recorded at sites 1 or 2 while patchy mats were recorded at site 3 and patchy mats and filaments were recorded growing at site 4. Macrophytes were recorded growing at the edges and on the bed of the stream at site 1 but were not recorded growing at any of the downstream sites.

Site 2 had complete shading while sites 1, 3 and 4 had no shading. Iron oxide deposits were evident at sites 1, 3 and 4 but were most prevalent at sites 3 and 4. Cyanobacteria mats and long green filamentous algae were prevalent at site 4 whereas at site 3 only patchy mats were recorded. No extensive periphyton mats or filaments were recorded growing at either site 1 or site 2.

Macroinvertebrate communities

Table 2 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 2 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 02 February 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2016	Median	Range	Feb 2016	Median	Range	Feb 2016
1	13	20	15-36	26	111	89-127	107	5.0	2.0-6.2	4.9
2	13	20	5-30	23	118	80-128	123	5.5	1.6-6.9	5.0
3	13	11	6-19	19	98	77-121	111	2.5	1.4-3.9	3.6
4	9	12	7-24	25	97	77-109	106	2.8	1.4-4.7	4.5

Table 3 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 3 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	37	37	35
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 4.

Table 4 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 02 February 2016.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB16018	FWB16019	FWB16020	FWB16021
NEMATODA	Nematoda	3	-	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A	A	A
	Lumbricidae	5	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	C	-	-	C
CRUSTACEA	Ostracoda	1	R	-	-	-
	Paranephrops	5	C	R	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	C	R
	Deleatidium	8	A	A	C	A
	Nesameletus	9	R	R	R	-
	Zephlebia group	7	A	A	C	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R	R	R
	Stenoperla	10	R	R	-	R
	Zelandobius	5	R	-	-	-
	Zelandoperla	8	-	R	-	R
COLEOPTERA (BEETLES)	Elmidae	6	C	R	-	R
	Dytiscidae	5	-	-	R	-
	Hydraenidae	8	-	R	-	-
	Hydrophilidae	5	R	-	-	-
	Ptilodactylidae	8	R	R	-	-
	Scirtidae	8	-	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	-	-	C
	Hydropsyche (Orthopsyche)	9	R	R	R	-
	Polyplectropus	6	-	R	R	C
	Psilochorema	6	C	C	C	C
	Oxyethira	2	-	-	-	R
	Triplectides	5	R	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	-	R	-
	Eriopterini	5	C	R	-	-
	Hexatomini	5	R	R	R	R
	Limonia	6	-	-	R	R
	Paralimnophila	6	R	-	-	-
	Zelandotipula	6	R	-	-	R
	Orthocladiinae	2	C	C	A	A
	Polypedilum	3	C	C	A	R
	Tanypodinae	5	-	-	R	R
	Paradixa	4	-	-	-	R
	Empididae	3	R	-	-	-
	Muscidae	3	-	-	R	R
	Austrosimulium	3	A	A	-	-
	Tanyderidae	4	-	-	R	-
ACARINA (MITES)	Acarina	5	A	R	R	C
		No of taxa	26	23	19	25
		MCI	107	123	111	106
		SQMCIs	4.9	5.0	3.6	4.5
		EPT (taxa)	10	10	8	10
		%EPT (taxa)	38	43	42	40

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A moderate richness of 26 taxa was recorded at site 1 upstream of the storage area, which was six taxa higher than the median recorded to date (Figure 2 and Table 2). Taxa richness was above the median from similar sites (20) (Table 3).

There were five taxa recorded in abundance; two 'tolerant' taxa [oligochaete worms and black fly larvae (*Austrosimulium*)], two 'moderately sensitive' taxa [mayfly (*Zephlebia* group) and mites (Acarina)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).The community was comprised of a high proportion (73%) of 'sensitive' taxa which included five 'highly sensitive' taxa (two mayflies, one stonefly, one beetle, and one caddisfly). This high proportion of 'sensitive' taxa contributed to the MCI score of 107 units which was an insignificant (Stark, 1998) four units less than the historical median and two units less than the score recorded by the previous spring survey.

A moderate $SQMCI_s$ score of 4.9 units was recorded, an insignificant (0.1 unit) lower than the median for the site recorded by previous surveys (Stark, 1998). This score reflected the two 'tolerant' and three 'sensitive' taxa that were recorded as abundant.

The MCI score recorded was reflective of 'good' macroinvertebrate health. This coupled with a moderate $SQMCI_S$ score and a number of 'sensitive' taxa in the community, indicated that water quality in the weeks prior to this survey had been relatively good.

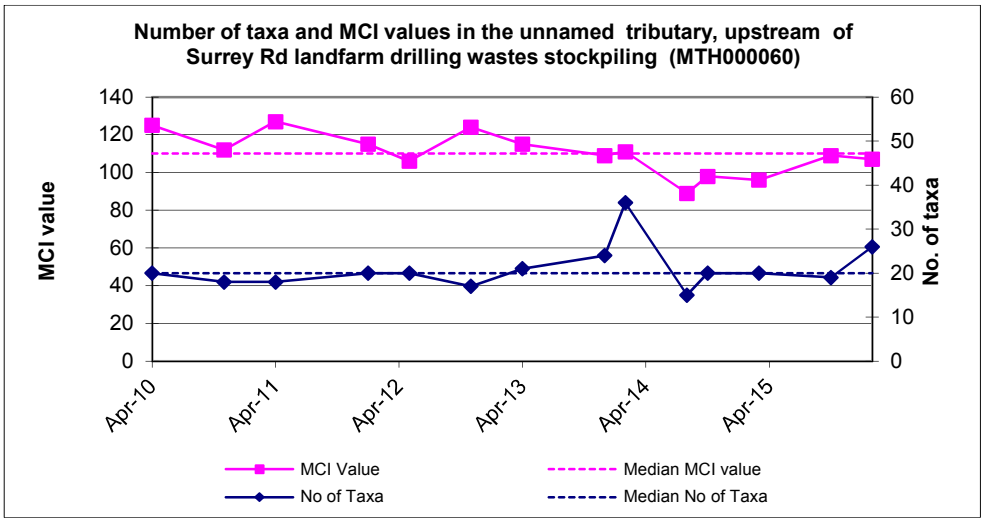

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 23 taxa was found at site 2 which was slightly higher than the previous sample (Figure 3) and slightly above the median calculated from historical data for the site (Table 2). Taxa richness was also slightly above the median from similar sites (Table 3). Although this result was seven taxa less than the maximum recorded at this site previously, it represented a marked improvement in the community from the initial survey in which only five taxa were recorded. This marked improvement has

been directly related to the change in location of the discharge point (to further downstream) which occurred in mid-2010 and also to additional skimmer pit/spring drainage provided at the stockpiling site (see Figure 1). This taxa richness was an insignificant three taxa less than that recorded at site 1 in the current survey.

The community was comprised of a high proportion of 'sensitive' taxa (78%).The MCI score of 123 units indicated a community of 'very good' biological health which was similar to the previous survey score (Figure 4) and not significantly different to the median value calculated from previous surveys at the same site (Table 2). This score was a significant (Stark, 1998) 16 units higher than that recorded at the upstream 'control' site, however there was only one significant change in individual taxon abundance, between sites 1 and 2. The $SQMCI_s$ score of 5.0 units was lower than the previous survey score ($SQMCI_s$ score of 5.8 units) and lower than the median value calculated from previous surveys at the same site, although was similar to that recorded at the upstream 'control' site (Table 2).

The community was characterised by two 'tolerant' taxa [oligochaete worms and black fly larvae (*Austrosimulium*)], one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

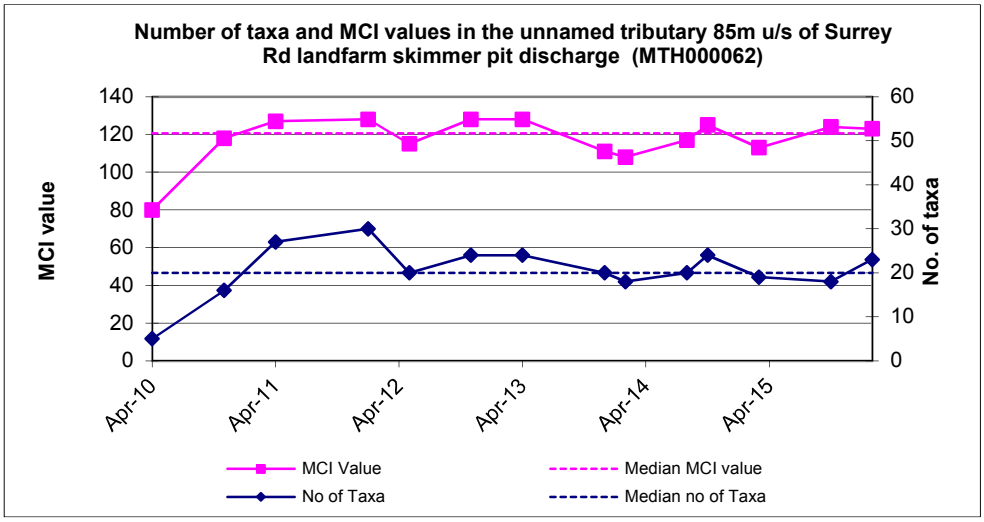

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A moderate macroinvertebrate community richness of 19 taxa was found at site 3 which was substantially more than that found by the previous survey (Figure 4). Furthermore, the sample contained eight taxa more than the median number recorded for the site (Table 2) and one taxon fewer than the median calculated from similar sites (Table 3). This community richness was seven taxa lower than that recorded at site 1 and four taxa less than that recorded at site 2.

The community was characterised by three 'tolerant' taxa [oligochaete worms, orthoclad midges and chironomid midge (*Polypedilum*)]. 'Sensitive' taxa comprised 74% of the macroinvertebrate community which contributed to the 'good' MCI score of 111 units. This score was significantly (1998) higher than the median for this site (Table 2) and significantly (Stark, 1998) higher than the previous MCI score (Figure 4). It was similar to that recorded at the upstream 'control' site score but significantly lower than that recorded at site 2.

The $SQMCI_s$ score of 3.6 units was higher than the previous survey score ($SQMCI_s$ score of 3.1 units) and was significantly higher than the median value calculated from previous surveys at the same site ($SQMCI_s$ score of 2.5) (Table 2).The current $SQMCI_s$ score of 3.6 units represented a significant downstream decrease of 1.4 units in $SQMCI_s$ score between sites 2 and 3. However, there was only one significant change in individual taxon abundance between site 2 and 3, including the decrease of one 'tolerant' taxon, black fly larvae (*Austrosimulium*). There was a decrease in one 'highly sensitive' taxon, mayfly (*Deleatidium*), which was 'common' to site 3 but 'abundant' at all other sites. The proliferation of algal mats, together with increased iron oxide sedimentation, impacted on the macroinvertebrate community at this site and can, to some extent, explain the reduction in $SQMCI_s$ and MCI scores at this site compared to site 2.

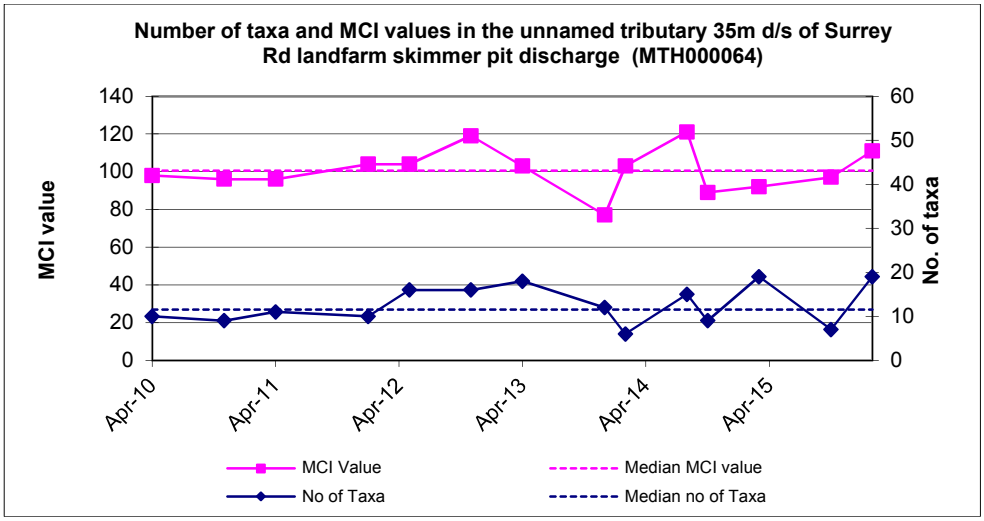

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A moderate macroinvertebrate community richness of 25 taxa was found at site 4 which was substantially more than that recorded by the previous survey and only one taxon less than that recorded by the upstream 'control' site (Figure 5). Furthermore, the sample contained 13 taxa more than the median number recorded for the site (Table 2) and five taxa more than the median calculated from similar sites (Table 3).

The MCI score of 106 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the previous survey (Figure 4) or to the median value calculated from previous surveys at the same site or to the upstream control site (Table 2). This score was significantly lower than that recorded at site 2, which can be attributed to habitat differences between the sites. The $SQMCI_s$ score of 4.5 units was similar to the previous survey score ($SQMCI_s$ score of 4.7 units) and was higher than the median value calculated from previous surveys at the same site (Table 2). This $SQMCI_s$ score was not significantly different to that recorded at site 1 or site 2.

The community was characterised by two 'tolerant' taxa [oligochaete worms and orthoclad midges] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

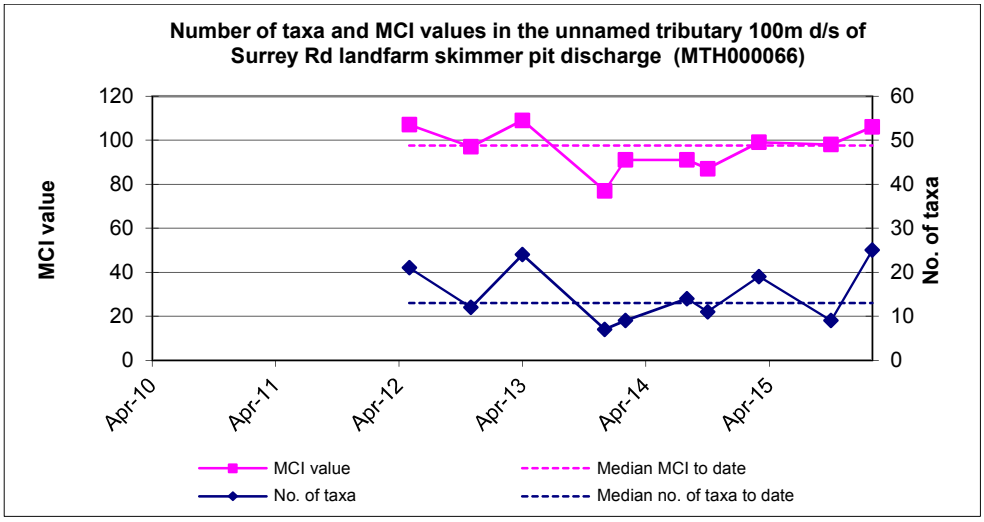

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Summary and Conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 02 February 2016, to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_S$ score for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to harmful discharges. Macroinvertebrates when exposed to harmful chemicals may die or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence / absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_s$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In the current survey, the MCI and $SQMCI_S$ scores recorded at the upstream 'control' site were similar to the median scores recorded at the site in previous surveys. The MCI score was indicative of 'good' macroinvertebrate health and together with the presence of many 'sensitive' taxa in this community was indicative of good preceding water quality.

The results of this survey indicated an increase in MCI score at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall.In general there was little difference in macroinvertebrate indices between sites 1 and 2 apart from site 2 having a significantly (Stark, 1998) higher MCI score, which would possibly be due to better habitat quality at the site. In comparison to the 'control' site 1, site 2 had greater riparian cover, no iron oxide deposits and a greater proportion of cobble substrate. The MCI score was reflective of 'very good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were both of 'good' quality and had similar taxa richnesses to the control site. In addition sites 3 and 4 also had MCI scores similar to the upstream 'control' site. In comparison to site 2, site 3 and 4 had

significantly lower MCI scores which can be attributed to habitat differences rather than from any impacts caused by stockpiling activities.

In relation to the previous spring (October 2015) survey the 'impacted' sites in the current survey recorded increased MCI scores and taxa richnesses. Taxa richness at site 3 had increased by 12 taxa and the MCI score had increased by a significant (Stark, 1998) 14 units. At site 4, the MCI score had increased by 8 units and taxa richness had increased by 16. This was a vast improvement from the spring survey results and in part can be explained by slight reductions in periphyton cover and iron oxide deposits present during the current survey. However these results may also reflect a recovery from impacts that were occurring as a result of stockpiling activities during the previous survey.

As noted by the previous spring report (Sutherland, 2016) stockpiling activities may have contributed to the low macroinvertebrate taxa richnesses recorded by the spring survey. It was suggested an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites could be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream. If a return to more unhealthy conditions was to occur, it would again be recommended for such an investigation to take place. However, as this was not the case, as indicated by this late summer survey there are no grounds to consider further investigation.

Comparison of taxa richnesses and MCI values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites and 'impacted sites had results similar to the median values. Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not resulted in any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

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Appendix III

Company supplied annual report

MI SWACO

A Schlumberger Company

ANNUAL REPORT FOR

CONSENT# 6900-2

CONSENT# 7591-1.1

CONSENT# 7911-1

CONSENT# 7559-1.3

COLIN BOYD LAND FARMS

SURREY ROAD & DERBY ROAD

INGLEWOOD

TARANAKI

31 JULY 2016

Status of Derby Rd and Surrey Rd Land Farm Facilities:

Derby Rd.

The Derby Rd Land Farm is still unused, and we consider that it will not be required as a drilling waste facility in the future. A small quantity of residual material (less than 100 cubic metres) has been stockpiled on site which will be spread when the weather allows in the spring of 2016. Pre-spread samples have been analysed by Hill Laboratories.

Surrey Rd.

There was 1,399.6 cubic metres of drilling waste stored in cell 1 at the Surrey Rd land farm from the OMV 107 Maari MR7A5 drilling program. This product was awaiting suitable weather for land farming, which was completed in December 2015 as shown in included GPS maps and charts.

In December 2015, drilling waste began arriving from Todd TKN-1 well. This was initially stored in cell 2, however further material was also stored in cell 1 after the previous OMV material was emptied. There was a total of 1,929.59 cubic metres received from Todd TKN-1. This material was spread over several months to allow adequate storage space over the entire drilling program, and was completed in April 2016 as shown in the GPS maps and charts.

Consequently, there is no longer any drilling waste stored in the Surrey Rd land farm. The site is deemed to be empty, although samples of water from the storm water 3 outlet will be tested to ensure levels remain below Taranaki Regional Council requirements. TRC will also continue with ground water sampling and monitoring.

The nitrate spike detected in the May 2015 ground water sampling by TRC has now been deemed to relate to the use of Urea fertiliser by the farmer adjacent to the piezometer below the site. Further TRC sampling in June/ September/ December 2015 showed a resumption to normal levels.

All paddocks used to spread drilling waste during the 2016 period have been soil sampled and the results are included within this report.

In September 2015, a meeting was held between MI SWACO management and Taranaki Regional Council. Topics discussed were

- The requirement by TRC that all pre-land farming samples are now to include heavy metal analysis.
- The requirement to fit a permathene liner to cell 3 which is not directly used to store drilling waste yet is used as a storm water overflow for cells 1 and 2. This cell is then pumped onto paddock 46 as noted in our 2015 annual report.
- Surrender criteria of paddocks.
- Stock assess to affected pasture.
- Consent variation relating to proximity to waterways.
- Changes to criteria for accepting offshore drilling waste.

A copy of these issues is included within this report, and includes details of the consent variations.

The permathene liner was fitted to cell 3 in November 2015.

The issue of decreased Macroinvertebrates numbers within the stream adjacent to the storm water pond outlet has shown considerable improvement as a result of the changes to the non-discharge status in 2015. We expect to see further improvements in the future as populations increase, monitored by TRC. Copies of the March 2016 TRC findings are included within this report.

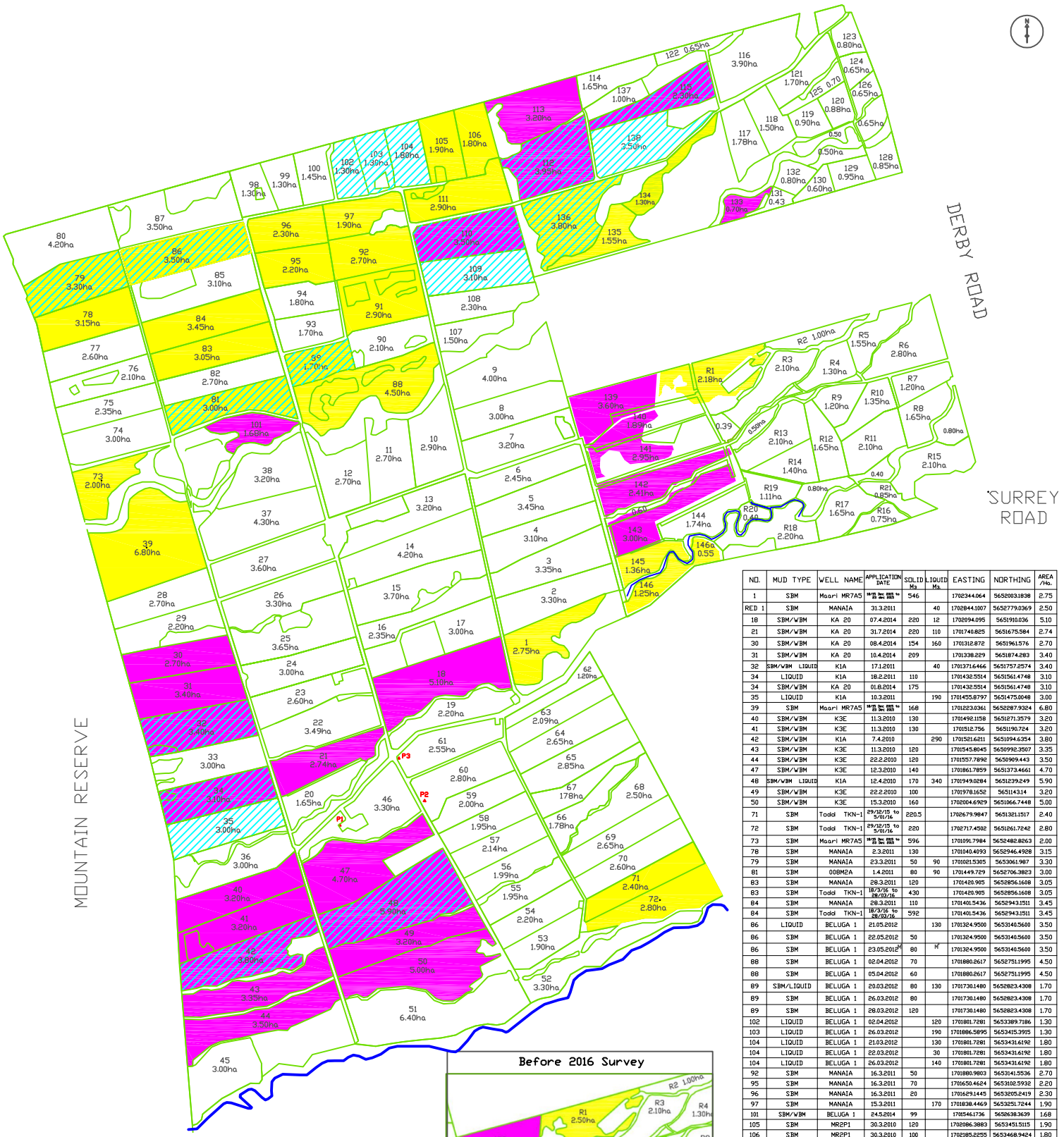
The remaining 500 barrels of unused SBM/WBM drilling mud stored in the three bunded vertical silo's were incorporated into the TKN-1 drilling waste. This new product was transferred prior to the pre-land farm samples being taken. The silo's were subsequently professionally cleaned and are now completely empty. The Selwood pump used to circulate the silo's has been removed from the site.

Scrap steel left over from the demolition of the 80 IBC's during 2013/2014 has been removed from the site.

The Portacom office has been returned to the supplier.

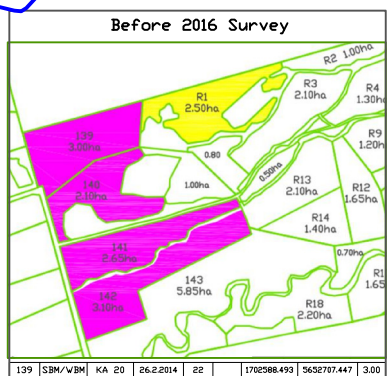
The access gate to the land farm remains locked.

In May 2016, all land farm management and staff successfully underwent Spill Response Training at the New Plymouth Schlumberger office, through Spill Control NZ.



NO.	MUD TYPE	WELL NAME	APPLICATION DATE	SOLID M3	LIQUID M3	EASTING	NORTHING	AREA /Ha.
1	SBM	Maari MR7A5	18/21 Dec 2015 to 21 Dec 2015	546		1702344.064	5652003.1838	2.75
RED 1	SBM	MANAIA	31.3.2011		40	1702844.1007	5652779.0369	2.50
18	SBM/WBM	KA 20	07.4.2014	220	12	1702994.095	5651910.036	5.10
21	SBM/WBM	KA 20	31.7.2014	220	110	1701740.825	5651675.584	2.74
30	SBM/WBM	KA 20	08.4.2014	154	160	1701312.872	5651961.576	2.70
31	SBM/WBM	KA 20	10.4.2014	209		1701338.229	5651874.283	3.40
32	SBM/WBM LIQUID	K1A	17.1.2011		40	1701371.6466	5651757.2574	3.40
34	LIQUID	K1A	18.2.2011	110		1701432.5514	5651561.4748	3.10
34	SBM/WBM	KA 20	01.8.2014	175		1701432.5514	5651561.4748	3.10
35	LIQUID	K1A	10.3.2011		190	1701455.8797	5651475.0048	3.00
39	SBM	Maari MR7A5	18/21 Dec 2015 to 21 Dec 2015	168		1701223.0361	5652287.9324	6.80
40	SBM/WBM	K3E	11.3.2010	130		1701492.1158	5651271.3579	3.20
41	SBM/WBM	K3E	11.3.2010	130		1701512.756	5651190.724	3.20
42	SBM/WBM	K1A	7.4.2010		290	1701521.6211	5651094.6354	3.80
43	SBM/WBM	K3E	11.3.2010	120		1701545.8045	5650992.3507	3.35
44	SBM/WBM	K3E	22.2.2010	120		1701557.7892	5650909.443	3.50
47	SBM/WBM	K3E	12.3.2010	140		1701861.7859	5651373.4661	4.70
48	SBM/WBM LIQUID	K1A	12.4.2010	170	340	1701949.0284	5651239.249	5.90
49	SBM/WBM	K3E	22.2.2010	100		17019781652	565114.314	3.20
50	SBM/WBM	K3E	15.3.2010	160		1702004.6929	5651066.7448	5.00
71	SBM	Todd TKN-1	29/12/15 to 5/01/16	220.5		1702679.9847	5651321.1517	2.40
72	SBM	Todd TKN-1	29/12/15 to 5/01/16	220		1702717.4502	5651261.7242	2.80
73	SBM	Maari MR7A5	18/21 Dec 2015 to 21 Dec 2015	596		1701091.7984	5652482.8263	2.00
78	SBM	MANAIA	2.3.2011	130		1701040.4093	5652946.4928	3.15
79	SBM	MANAIA	23.3.2011	50	90	1701021.5305	5653061.987	3.30
81	SBM	008M2A	1.4.2011	80	90	1701449.729	5652706.3823	3.00
83	SBM	MANAIA	28.3.2011	120		1701420.905	5652856.1608	3.05
83	SBM	Todd TKN-1	18/3/16 to 28/03/16	430		1701420.905	5652856.1608	3.05
84	SBM	MANAIA	28.3.2011	110		1701401.5436	5652943.1511	3.45
84	SBM	Todd TKN-1	18/3/16 to 28/03/16	592		1701401.5436	5652943.1511	3.45
86	LIQUID	BELUGA 1	21.05.2012		130	1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	22.05.2012	50		1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	23.05.2012	80	M	1701324.9500	5653140.5600	3.50
88	SBM	BELUGA 1	02.04.2012	70		1701880.2617	5652751.1995	4.50
88	SBM	BELUGA 1	05.04.2012	60		1701880.2617	5652751.1995	4.50
89	SBM/LIQUID	BELUGA 1	20.03.2012	80	130	1701730.1480	5652823.4308	1.70
89	SBM	BELUGA 1	26.03.2012	80		1701730.1480	5652823.4308	1.70
89	SBM	BELUGA 1	28.03.2012	120		1701730.1480	5652823.4308	1.70
102	LIQUID	BELUGA 1	02.04.2012		120	1701801.7281	5653389.7186	1.30
103	LIQUID	BELUGA 1	26.03.2012		190	1701886.5895	5653415.3915	1.30
104	LIQUID	BELUGA 1	21.03.2012		130	1701801.7281	5653431.6192	1.80
104	LIQUID	BELUGA 1	22.03.2012		30	1701801.7281	5653431.6192	1.80
104	LIQUID	BELUGA 1	26.03.2012		140	1701801.7281	5653431.6192	1.80
92	SBM	MANAIA	16.3.2011	50		1701880.9803	5653141.5536	2.70
95	SBM	MANAIA	16.3.2011	70		1701650.4624	5653102.5932	2.20
96	SBM	MANAIA	16.3.2011	20		1701629.1445	5653205.2419	2.30
97	SBM	MANAIA	15.3.2011		170	1701838.4469	5653251.7244	1.90
101	SBM/WBM	BELUGA 1	24.5.2014	99		1701546.1736	5652638.3639	1.68
105	SBM	MR2P1	30.3.2010	120		1702086.3883	5653451.5115	1.90
106	SBM	MR2P1	30.3.2010	100		1702185.2255	5653468.9424	1.80
109	LIQUID	MANAIA	9.9.2010		20	1702181.9172	5653079.0521	3.10
110	SBM/WBM	MANAIA	2.6.2010		380	1702151.6533	5653186.6314	3.50
111	SBM	MANAIA	28.3.2011	120		1702129.2835	5653302.9184	2.90
112	SBM/WBM	BELUGA 1	17.6.2010		430	1702400.5903	5653403.0924	3.95
113	SBM/WBM	MANGAHEWA 'A' MR3P2/MR4P3/MR5P12	23.4.2009	600		1702366.1241	5653556.1796	3.20
115	SBM/WBM	BELUGA 1	1.12.2010		190	1702713.8302	5653586.2504	2.30
133	SBM/WBM	BELUGA 1	1.12.2010			1702947.5999	5653281.2916	0.70
134	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702679.6848	5653306.816	1.30
135	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702585.4113	5653198.2808	1.55
136	SBM	MR1P7 / MR2P1	8.9.2010	90	120	1702442.6169	5653242.1715	3.80
138	LIQUID	BELUGA 1	18.6.2010		370	1702646.6426	5653461.9277	3.50
139	SBM/WBM	KA 20	26.2.2014	22		1702588.493	5652707.447	3.00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.522	5652609.159	2.10
141						1702692.770	5652472.580	2.65
142						1702742.882	5652416.2866	3.10
143						1702742.882	5652416.2866	3.10
144	NOT IN USE					1702858.0299	5652378.5946	1.74
145	SBM	Todd TKN-1	29/12/15 to 5/01/16	222		1702670.0203	5652245.8655	1.36
146	SBM	Todd TKN-1	29/12/15 to 5/01/16	187.5		1702703.446	5652173.1761	1.80

Before 2016 Survey



139	SBM/WBM	KA 20	26.2.2014	22		1702588.493	5652707.447	3.00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.522	5652609.159	2.10
141	SBM/WBM	KA 19	03.3.2014	296	265	1702692.770	5652472.580	2.65
142	SBM	MANAIA	28.3.2011	150	150	1702742.882	5652416.2866	3.10
142	SBM/WBM	KA 19	20.3.2014	180	159	1702742.882	5652416.2866	3.10

LEGEND

- LIQUID ONLY
- MIX
- SBM
- WBM
- FENCE
- ROAD

NOTES

1. CO ORDINATE SYSTEM : NZTM2000
2. HEIGHTS ABOVE SEA LEVEL

DERBY AND SURREY ROAD LANDSPREAD DISPOSAL SITE PLAN SHOWING AREAS OF DISPOSAL

NO.	DATE	BY	CHD	DESCRIPTION
1	25-8-11	BP	CW	ADD PADDOCKS & LANDSPREAD INFO
2	01-11-12	BP	CW	ADD NEW LANDSPREAD INFO
3	18-08-14	BP	CW	ADD 2014 LANDSPREAD INFO
4	06-01-16	BP	CW	ADD 2015 LANDSPREAD INFO
5	14-09-16	BP	CW	ADD 2016 LANDSPREAD INFO
6	25-09-16	BP	CW	ADD 2016 SPREAD INFO & RIVISE MAP
7	10-12-16	BP	CW	ADD Dec 2016 SPREAD INFO

DRAWN BY	BP	10-12-2016
PROJECT No.	107	
LOCATION	SURREY ROAD	
SCALE	1 : 1500	

0 50 100 200 300 400 500

GPS SOLUTIONS FREEPHONE 0800 752 705
MAPS DESIGNS DATA AGENTS CELLPHONE 027 477 6271

DRAWING No. MI SWACO 101 REV 7

NO.	MUD TYPE	WELL NAME	APPLICATION DATE	SOLID M3	LIQUID M3.	EASTING	NORTHING	AREA /Ha.
1	SBM	Maari MR7A5	18/15 Dec 2015 to 23 dec 2015	546		1702344.064	5652003.1838	2.75
RED 1	SBM	MANAIA	31.3.2011		40	1702844.1007	5652779.0369	2.50
18	SBM/WBM	KA 20	07.4.2014	220	12	1702094.095	5651910.036	5.10
21	SBM/WBM	KA 20	31.7.2014	220	110	1701740.825	5651675.584	2.74
30	SBM/WBM	KA 20	08.4.2014	154	160	1701312.872	5651961.576	2.70
31	SBM/WBM	KA 20	10.4.2014	209		1701338.229	5651874.283	3.40
32	SBM/WBM LIQUID	K1A	17.1.2011		40	1701371.6466	5651757.2574	3.40
34	LIQUID	K1A	18.2.2011	110		1701432.5514	5651561.4748	3.10
34	SBM/WBM	KA 20	01.8.2014	175		1701432.5514	5651561.4748	3.10
35	LIQUID	K1A	10.3.2011		190	1701455.8797	5651475.0048	3.00
39	SBM	Maari MR7A5	18/15 Dec 2015 to 23 Dec 2015	168		1701223.0361	5652287.9324	6.80
40	SBM/WBM	K3E	11.3.2010	130		1701492.1158	5651271.3579	3.20
41	SBM/WBM	K3E	11.3.2010	130		1701512.756	5651190.724	3.20
42	SBM/WBM	K1A	7.4.2010		290	1701521.6211	5651094.6354	3.80
43	SBM/WBM	K3E	11.3.2010	120		1701545.8045	5650992.3507	3.35
44	SBM/WBM	K3E	22.2.2010	120		1701557.7892	5650909.443	3.50
47	SBM/WBM	K3E	12.3.2010	140		1701861.7859	5651373.4661	4.70
48	SBM/WBM LIQUID	K1A	12.4.2010	170	340	1701949.0284	5651239.249	5.90
49	SBM/WBM	K3E	22.2.2010	100		1701978.1652	5651143.14	3.20
50	SBM/WBM	K3E	15.3.2010	160		1702004.6929	5651066.7448	5.00
71	SBM	Todd TKN-1	29/12/15 to 5/01/16	220.5		1702679.9847	5651321.1517	2.40
72	SBM	Todd TKN-1	29/12/15 to 5/01/16	220		1702717.4502	5651261.7242	2.80
73	SBM	Maari MR7A5	18/15 Dec 2015 to 23 Dec 2015	596		1701091.7984	5652482.8263	2.00
78	SBM	MANAIA	2.3.2011	130		1701040.4093	5652946.4928	3.15
79	SBM	MANAIA	23.3.2011	50	90	1701021.5305	5653061.987	3.30
81	SBM	008M2A	1.4.2011	80	90	1701449.729	5652706.3823	3.00
83	SBM	MANAIA	28.3.2011	120		1701420.905	5652856.1608	3.05
83	SBM	Todd TKN-1	18/3/16 to 28/03/16	430		1701420.905	5652856.1608	3.05
84	SBM	MANAIA	28.3.2011	110		1701401.5436	5652943.1511	3.45
84	SBM	Todd TKN-1	18/3/16 to 28/03/16	592		1701401.5436	5652943.1511	3.45
86	LIQUID	BELUGA 1	21.05.2012		130	1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	22.05.2012	50		1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	23.05.2012 M	80	M	1701324.9500	5653140.5600	3.50
88	SBM	BELUGA 1	02.04.2012	70		1701880.2617	5652751.1995	4.50
88	SBM	BELUGA 1	05.04.2012	60		1701880.2617	5652751.1995	4.50
89	SBM/LIQUID	BELUGA 1	20.03.2012	80	130	1701730.1480	5652823.4308	1.70
89	SBM	BELUGA 1	26.03.2012	80		1701730.1480	5652823.4308	1.70
89	SBM	BELUGA 1	28.03.2012	120		1701730.1480	5652823.4308	1.70
102	LIQUID	BELUGA 1	02.04.2012		120	1701801.7281	5653389.7186	1.30
103	LIQUID	BELUGA 1	26.03.2012		190	1701886.5895	5653415.3915	1.30
104	LIQUID	BELUGA 1	21.03.2012		130	1701801.7281	5653431.6192	1.80
104	LIQUID	BELUGA 1	22.03.2012		30	1701801.7281	5653431.6192	1.80
104	LIQUID	BELUGA 1	26.03.2012		140	1701801.7281	5653431.6192	1.80
92	SBM	MANAIA	16.3.2011	50		1701880.9803	5653141.5536	2.70
95	SBM	MANAIA	16.3.2011	70		1701650.4624	5653102.5932	2.20
96	SBM	MANAIA	16.3.2011	20		1701629.1445	5653205.2419	2.30
97	SBM	MANAIA	15.3.2011		170	1701838.4469	5653251.7244	1.90
101	SBM/WBM	BELUGA 1	24.5.2014	99		1701546.1736	5652638.3639	1.68
105	SBM	MR2P1	30.3.2010	120		1702086.3883	5653451.5115	1.90
106	SBM	MR2P1	30.3.2010	100		1702185.2255	5653468.9424	1.80
109	LIQUID	MANAIA	9.9.2010		20	1702181.9172	5653079.0521	3.10
110	SBM/WBM	MANAIA	2.6.2010		380	1702151.6533	5653186.6314	3.50
111	SBM	MANAIA	28.3.2011	120		1702129.2835	5653302.9184	2.90
112	SBM/WBM	BELUGA 1	17.6.2010		430	1702400.5903	5653403.0924	3.95
113	SBM/WBM	MANGAHEWA A/ MR3P8/MR4P9/M R5P12	23.4.2009	600		1702366.1241	5653556.1796	3.20
115	SBM/WBM	BELUGA 1	1.12.2010		190	1702713.8302	5653586.2504	2.30
133	SBM/WBM	BELUGA 1	1.12.2010			1702947.5999	5653281.2916	0.70
134	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702679.6848	5653306.816	1.30
135	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702585.4113	5653198.2808	1.55
136	SBM	MR1P7 / MR2P1	8.9.2010	90	120	1702442.6169	5653242.1715	3.80
138	LIQUID	BELUGA 1	18.6.2010		370	1702646.6426	5653461.9277	3.50
139	SBM/WBM	KA 20	26.2.2014	22		1702588.493	5652707.447	3.00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.522	5652609.159	2.10
141						1702692.770	5652472.580	2.65
142						1702742.882	5652416.2866	3.10
143						1702742.882	5652416.2866	3.10
144	NOT IN USE					1702858.0299	5652378.5946	1.74
145	SBM	Todd TKN-1	29/12/15 to 5/01/16	222		1702670.0203	5652245.8655	1.36
146	SBM	Todd TKN-1	29/12/15 to 5/01/16	187.5		1702703.446	5652173.1761	1.80

Consent Variation Meeting 7559-1/7591-1

10:45am Friday 4 September

Committee Room, TRC, Stratford

Minutes

John Cooper

Attendees

Nathan Crook, John Cooper (Both TRC), Ross Henry (Mi Swaco Surrey Road Manager)

Apologies: Ruka Te Moana (Mi Swaco)

Items	Responsibility
Discussion of the variation of the consent conditions Ross Henry provided application to change conditions of the consents7591-1 and 7559-1. The proposed changes are as such: • Variation to include an irrigator, to allow for spreading the liquid fraction of the drilling waste; • Variation to include the use of an injection spreader, as per utilised during the trials; • Variation to include deliveries from Taranaki and the offshore region, outside of the 12 mile limit (Which will encapsulate deliveries from the Maari Field, as currently stored at the Surrey Road Facility). • Limits to the sodium absorption ratio • Limits to the total petroleum hydrocarbon concentration in the soil • The requirement for lining un lined storage cells; and • Provisions to review the conditions of the consent. • Pre-screening of pre landfarmable material, to include, heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), salts (Calcium, Magnesium, Sodium and Potassium) and hydrocarbon differentiation (TPH, MAH, PAH). • Amendment to the current surrender criteria with respect to metal and hydrocarbon concentrations inline with expert advice. Accepted that these changes will be reflected in both consents 7591-1 and 7559-1 respectively	**NC**
Pit lining of Surrey Road Storage Cell 3 - To occur when the conditions allow, primarily when the area dries out sufficiently. - Cell 3 may be made smaller The use of the irrigator to spread potentially contaminated stormwater from the throughflow associated with Cells 1, 2 and 3. Irrigation is pumped from Cell 3. - Working well especially from a health and safety stand point, more cost effective than utilizing the land spreader for application of liquid waste.	**RH**

- Areas of paddock which receive the application of liquid fraction from the Cells will be treated as a spread paddock. - Operator to be mindful of the volumes which are irrigated to the paddock.	
Pre-screening of received material to encompass heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), salts (Calcium, Magnesium, Sodium and Potassium) and hydrocarbon differentiation (TPH, MAH, PAH). - Analysis pending, at Hills laboratory, no spreading to occur until this analysis has been received.	**RH**
Amendment to the surrender criteria of paddocks associated with the application of drilling muds and liquid fraction. - Hydrocarbon breakdown analysis as stipulated by Jo Cavangh of Landcare research Table 4. RH provided with Landcare report (Land application of waste from oil and gas) and NC discussed the TPH speciation. - Alteration to the metal concentration as per Landcare report, Table 6.	**RH**
Stock access to sites - Young stock only graze on spread areas after a period of time (RH) - No stock should be allowed on the site for grazing, or should the site used for cropping until the areas has reached surrender criteria, i.e. it's agricultural land use compliance limit. (NC) - Discussed the possibility of the paddocks which have received application of drilling mud to be utilised to grow hay for winter fodder, however no direction was given to put this into effect. Ministry of Primary Industries should be contacted to discuss whether this route is possible.	**RH**
Consent variation - e-mail #1545924 attached to variation of consent form, initialed by Ross Henry and Colin Boyd	**RH**
Other Business relating to non- notifications • The incident 14th July 2013 involved MI SWACO staff emptying the bunded area around the three storage silo's containing WBM at the Surrey Road landfarm. ONLY rainwater was contained within the bunded area, hence why our staff considered it appropriate to pump this into nearby paddock 46. There has never been any drilling waste spilled within the bunded area, which was initially installed to contain the stored WBM in the event of a silo rupturing. John Cooper commented at the time he still does not want this rainwater pumped into the paddock. - *After being shown photographic evidence taken on 15 July 2013 it was acknowledged by Ross Henry that the run-off from paddock 46 had originated from liquid mud material pumped out of cell 1 or 2 to increase storage capacity and did contain drilling mud based on the colour of the run-off into the receiving waters. Photographs taken on the 15 July 2013 show that the silo infrastructure referred to in the response had not as yet been built at the site; an email from Ruka Te Moana to TRC dated 23 July 2013 outlined MI Swaco's intention to build the Silo infrastructure (including building and lining the bunds) during the week commencing 22 July 2013. It was also acknowledged by Ross Henry that land spreading activities had occurred on 15 July 2013 and was observed by Ross Henry and John Cooper, the paddock was thought to be 49, no mention of the land spreading activities had been disclosed in the site activity report for 2013-2014.*	**RH**

- The incident where stormwater was spread across paddock 141 in October 2013 was the result of the attempting to control the foam-forming discharge from Stormwater 3 (SW3) into the nearby creek. At this point, our staff were still treating this discharge as stormwater only, as a result of heavy rainfall at that time across the entire landfarm facility. Paddock 141 was still in pasture at that time, and was mechanically cultivated later in February/ March 2014. This action prevented further foam forming downstream of the SW3 discharge point. Subsequent meetings between TRC and MI SWACO have determined that the contents of the SW ponds are still deemed to contain some drilling waste residues and should be treated appropriately. Hence we have now made the Surrey Road landfarm into a non-discharge facility, which is reflected in our latest Hill Laboratories results from SW3 outfall reflecting predominantly rainfall over the entire site. Paddock 141 was later used in February/ March 2014 where the actual drilling waste from cell 1 was landfarmed.

  - *After being shown photographic evidence taken on 2 October 2013 and 18 November 2013 it was acknowledged by Ross Henry that paddock 141 was not in pasture during October 2013, and that drilling mud appeared to of been applied to paddock 141 prior to 2 October 2013, Ross was not aware how much mud had been applied or where it originated from; he agreed that Colin Boyd had likely taken it upon himself to spread drilling mud over the area of land he was developing at the time (around paddock 141) to increase storage capacity at the Surrey Road storage facility. No mention of drilling mud being applied to paddock 141 prior to October 2013 had been disclosed in the site activity report for 2013-2014; the report stated that drilling muds had been applied to paddock 141 in March 2014. It was suggested by Ross Henry that the fact that muds were likely applied to paddock 141 prior to 2 October 2013 and again during March 2014 could account for the significant increase in Chloride levels found during soil sampling activities undertaken on 30 June 2014, whereby Paddock 141 returned a value of 231 mg/kg, whereas the Chloride level in paddock 18 was 12 mg/kg, paddock 30 was <10 mg/kg, paddock 31 was <10 mg/kg, paddock 140 was 13 mg/kg, and paddock 142 was <10 mg/kg.*

- The reported incident involving paddock 101 adjacent the quarry was independent of MI SWACO. We understand that Colin Boyd staff had excavated an old cell at the Derby Road facility, and had spread this material in paddock 101.

  - *After being shown photographic evidence taken on 27 May 2014 and 16 June 2014 it was agreed that a significant quantity of drilling mud had been applied to paddock 101 from cell 3 of the Derby Road storage facility; the fact that Colin Boyd did not inform MI Sawco staff of his intention to undertake the works did not remove the responsibility of MI Sawco staff who wrote the Derby and Surrey Road activity report to include the information, MI Swaco staff had observed that the material had been spread in paddock 101 in the presence of John Cooper on 23 June 2014.*

  - **Route forward - Make sure that site work pertaining to the spreading of drilling muds and associated fluid fraction is conveyed to the council in both an e-mailed work notification and in the annual report as stipulated by the consented conditions.**

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	16 February 2011
Commencement Date:	16 February 2011

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds], onto and into land for the purpose of temporary stockpiling prior to disposal at or about (NZTM) 1702545E-5653650N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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 [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

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

Notifications, monitoring and reporting

2. 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.

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

    a) wastes from each individual well;
    b) composition of wastes [including concentrations of chloride, nitrogen and total petroleum hydrocarbons];
    c) stockpiling area[s];
    d) volumes and weights of material stockpiled;
    e) dates of commencement and completion of stockpiling events;
    f) the results of analysis;

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

4. 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 3, for the period of the previous 12 months, 1 July to 30 June.

Operational requirements

5. There shall be no discharge of drilling waste to land, within 25 metres of surface water or of property boundaries.

6. All material must be spread on to land in accordance with consent 7591-1 as soon as practicable, but no later than twelve months after being brought onto the site.

Receiving environment limits - water

7. 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.

8. Other than as provided for in condition 7, 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

9. From 1 March 2027 [three months prior to the consent expiry date], constituents in the soil of previously landfarmed areas 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 2027, the consent holder applies for a new consent to replace this consent when it expires.

10. This consent may not be surrendered at any time until the standards in condition 9 have been met.

Review

11. 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 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 16 February 2011

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	27 September 2011
Commencement Date:	27 September 2011

Conditions of Consent

Consent Granted:	To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River at or about (NZTM) 1702717E-5653665N
Expiry Date:	1 June 2027
Review Date(s):	June 2013, June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge source & site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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 to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The stormwater discharged shall be from a catchment area not exceeding 1.5 hectares.

3. Constituents of the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm^{-3}
total recoverable hydrocarbons	Concentration not greater than 15 gm^{-3}

This condition shall apply before entry of the treated stormwater into the receiving waters at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

4. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point to the unnamed tributary of the Mangamawhete Stream, the discharge shall not, either by itself or in combination with other discharges, cause the following:

   a) the carbonaceous filtered biochemical oxygen demand [BOD_5] to exceed 2 gm^{-3}, or
   b) the chloride concentration to exceed 50 gm^{-3}.

5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all of the following effects in the receiving water:

   a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effects on aquatic life.

6. The consent holder shall maintain a contingency plan. The contingency plan shall be adhered to in the event of a spill or emergency and shall, to the satisfaction of the Chief Executive, Taranaki Regional Council, detail measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

7. 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 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 27 September 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Surrey Road Landfarms Limited CD Boyd PO Box 44 Inglewood 4347
Decision Date (Change):	29 October 2015
Commencement Date (Change):	29 October 2015 (Granted Date: 21 January 2010)

Conditions of Consent

Consent Granted:	To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landspreading, injection spreading and irrigation
Expiry Date:	1 June 2027
Review Date(s):	June 2016, June 2017, June 2018, June 2019, June 2025
Site Location:	Surrey Road, Inglewood
Legal Description:	Lot 2 DP 344156, Secs 9, 10 & Pt Sec 13 Blk XII Egmont SD, Secs 17 & 18 Blk XVI Egmont SD (Discharge site)
Grid Reference (NZTM)	1701750E-5652370N
Catchment:	Waitara
Tributary:	Manganui Waipuku Mangatengehu

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. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landspreading/ injection spreading of drilling waste during extended periods of dry weather.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to landspreading/ injection spreading waste from each separate storage cell. 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 applied;
    d) the volume and weight of the waste to be applied;
    e) the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land;
    f) the specific location and area over which the waste will be applied; and
    g) the method of application.

    In order to demonstrate compliance with conditions 5, 6, 7, 10, 12, 13 and 14 of this consent.

3. The exercise of this consent is limited to waste generated in the Taranaki Region, and from outside the 12 nautical mile maritime limit, within the Taranaki Basin.

Discharge limits

4. Drilling waste shall be applied to land at a rate not exceeding 100 m^3/ha/yr, and in a rate and manner such that no ponded liquids remain after one hour.

5. The exercise of this consent shall not result in a chloride loading in the soil exceeding 800 kg/ha.

6. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

7. Landspreading of liquid fraction of drilling wastes and or stormwater component of the storage cells shall be undertaken through the use of a landspreader or injection spreader or irrigator. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times

8. No drilling waste shall be discharged within:

   a) 12 metres of property boundaries; or
   b) 12 metres of the Mangamawhete, Mangatengehu and Waipuku Streams; or
   c) 6 metres of any other surface water course (including farm drains).

9. Any liquid drilling waste which may flow overland, shall not be discharged within 25 metres of property boundaries or surface water courses (including farm drains).

Receiving environment limits for soil

10. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 100 mm so that the hydrocarbon concentration at any point in the soil/ waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point.

11. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	
Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt MAHs Benzene Toluene Ethylbenzene Xylene PAHs Naphthalene Non-carc (Pyrene) Benzo(a)pyrene	 1.1 82 59 59 7.2 160 0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn. These conditions also apply:

   a) prior to drilling wastes being discharged onto an area that has previously been used for the disposal of drilling wastes; and
   b) at the time of expiry, cancellation, or surrender of this consent.

12. The concentration of metals and salts in the soil layer containing the discharge shall comply with the following criteria:

Metal/ Salt	Maximum value (mg/kg)
Arsenic [1]	17
Barium – Barite [2]	10,000
Extractable Barium [2]	250
Cadmium [1]	0.8
Chromium [3]	600
Copper [3]	100
Lead [1]	160
Nickel [3]	60
Mercury	1
Zinc [3]	300
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land)	

13. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

14. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

Receiving environment limits for water

15. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

16. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

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

    a) wastes from each individual well;
    b) composition of wastes, as analysed in condition 2 e);
    c) application areas, including a map showing individual disposal areas with GPS co-ordinates;
    d) volumes and weights of wastes applied;
    e) dates of commencement and completion of application events;
    f) 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.

18. 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 17, for the period of the previous 1 July to 30 June.

Lapse and review

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

20. 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 2017 and/or June 2018 and/or June 2019 and/ or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent

Signed at Stratford on 29 October 2015

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Advice Note
The consent holder's attention is drawn to MPI's "New Zealand Code of Practice for the Design and Operation of Farm Dairies (NZCP1) which restricts:

- *the discharge of specified wastes to land used for grazing of milking animals; and*
- *the use of feed from land which has had specified wastes applied to it.*

Should you require further information, please contact a Dairy Industry Technical Advisory Group (DITAG) representative ***or*** *visit http://www.foodsafety.govt.nz/elibrary/industry/dairy-nzcp1-design-code-of practice/amdt-2.pdf (specifically section 6.4 Disposal of effluent and other wastes and section 7.8 Purchased Stock Food)* ***or*** *contact an operating dairy processing company regarding conditions of supply.*

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd PO Box 44 Inglewood 4347
Decision Date (Change):	25 February 2016
Commencement Date (Change):	25 February 2016 (Granted Date: 20 November 2009)

Conditions of Consent

Consent Granted:	To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming, landspreading, injection spreading and irrigation
Expiry Date:	1 June 2027
Review Date(s):	June 2016, June 2017, June 2018, June 2019, June 2025
Site Location:	Surrey Road, Inglewood
Legal Description:	Secs 17 & 18 Blk XIV Egmont SD (Discharge site)
Grid Reference (NZTM)	1701847E-5651476N
Catchment:	Waitara
Tributary:	Manganui Waipuku Mangamawhete Mangatengehu

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

General conditions

a. On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b. Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c. The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i. the administration, monitoring and supervision of this consent; and
   ii. charges authorised by regulations.

Special conditions

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

   a. stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating into the soil within 24 hours of such discharge; and
   b. landfarming means the discharge of drilling waste onto land, subsequent spreading, incorporation into the soil and re-sowing into pasture or crop.
   c. landspreading means the discharge to land of the liquid fraction of drilling wastes. This includes the stormwater component of the storage cells through the use of a landspreader and/or irrigator and/or injection spreader. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times.

2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landfarming of drilling waste during extended periods of dry weather.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall install a minimum of three groundwater monitoring wells. The wells shall be at locations and to depths, that enable the collection of groundwater samples (to assess any changes in groundwater quality) to the satisfaction of the Chief Executive, Taranaki Regional Council. The wells shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.

4. Any pits used for stockpiling solid or liquid waste shall be lined with 'fit for purpose' high-grade synthetic liner or equivalent and the consent holder shall demonstrate, that the lined pits are suitable for storing liquid without leakage through the base or side walls. The Consent holder shall monitor the integrity of the pit liners and repair or replace liners as required.

5. Prior to the exercise of this consent, the consent holder shall provide, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a landfarming and stockpiling management plan to demonstrate the activity will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually and shall include as a minimum:

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

Notification and sampling requirements prior to discharge

6. 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.

7. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to the application of stockpiled material. Notification shall include the following information:

   a. the consent number;
   b. the name of the well(s) from which the waste was generated;
   c. the type of waste to be applied to land;
   d. the volume and weight of the waste to be applied to land;
   e. the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land; and
   f. the specific location and area over which the waste will be applied.

   in order to demonstrate compliance with conditions 10, 12, 13 and 14 of this consent.

Discharge limits

8. The exercise of this consent is limited to waste generated in the Taranaki region, including from outside the 12 nautical mile maritime limit within the Taranaki Basin.

9. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 4,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.

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

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

    prior to incorporation into the soil.

11. The areas which are irrigated, injection spread, landspread or landfarmed may receive future applications of material if they are below the consented criteria outlined by conditions 18, 19 and 20 of this consent.

12. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250 mm for landfarming and 100 mm for the injection spreader, so that the hydrocarbon concentration at any point in the soil/waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point'.

13. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.

14. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

15. As soon as practicable following the landfarming of drilling wastes the discharge area shall be re-sown into pasture (or into crop). If revegetation cannot be established within two months of the discharge, the consent holder shall undertake appropriate land stabilisation measures to minimise wind and/or stormwater erosion.

16. No drilling waste shall be discharged within:

    a) 12 metre(s) of property boundaries; or
    b) 12 metre(s) of the Mangamawhete, Mangatengehu and Waipuku Streams; or
    c) 6 metre(s) of any other surface water course (including farm drains).

    Any liquid drilling waste which may flow overland, shall not be discharged within 25 metre(s) of property boundaries or surface water courses (including farm drains).

Receiving environment limits for soil

17. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

18. The concentration of metals and salts in the soil layer containing the discharge shall comply with the following criteria:

Metal/ Salt	**Maximum value (mg/kg)**
Arsenic [1]	**17**
Barium – Barite [2]	**10,000**
Extractable Barium [2]	**250**
Cadmium [1]	**0.8**
Chromium [3]	**600**
Copper [3]	**100**
Lead [1]	**160**
Nickel [3]	**60**
Mercury	**1**
Zinc [3]	**300**
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land)	

19. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

20. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	
Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt MAHs Benzene Toluene Ethylbenzene Xylene PAHs Naphthalene Non-carc (Pyrene) Benzo(a)pyrene	 1.1 82 59 59 7.2 160 0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn.

21. This consent may not be surrendered unless the standards specified in condition 20 have been met.

Receiving environment limits for water

22. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

23. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

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

    a) wastes from each individual well (including records of all additives used at the wellsite during the drilling process);
    b) composition of wastes, including concentrations of chloride, nitrogen and total hydrocarbons;
    c) stockpiling area(s);
    d) volumes of material stockpiled;
    e) landfarming area(s), including a map showing each individual disposal area and GPS co-ordinates;
    f) volumes and weights of wastes landfarmed;
    g) dates of commencement and completion of stockpiling and landfarming events;
    h) treatments applied;
    i) details of monitoring, including sampling locations, sampling methods and the results of analysis;

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

25. 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 23, for the period of the previous 1 July to 30 June.

Lapse and review

26. This consent shall lapse on the 31 December 2014, 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 2017 and/or June 2018 and/or June 2019 and/or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent.

Signed at Stratford on 25 February 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Advice Note
The consent holder's attention is drawn to MPI's "New Zealand Code of Practice for the Design and Operation of Farm Dairies (NZCP1) which restricts:

- *the discharge of specified wastes to land used for grazing of milking animals; and*
- *the use of feed from land which has had specified wastes applied to it.*

Should you require further information, please contact a Dairy Industry Technical Advisory Group (DITAG) representative ***or*** *visit http://www.foodsafety.govt.nz/elibrary/industry/dairy-nzcp1-design-code-of practice/amdt-2.pdf (specifically section 6.4 Disposal of effluent and other wastes and section 7.8 Purchased Stock Food)* ***or*** *contact an operating dairy processing company regarding conditions of supply.*

To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1656819
Report No	BT053
Date	March 2016

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility, February 2016

Introduction

A macroinvertebrate survey was performed on 02 February 2016 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. However, results from the previous summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The more recent spring (October 2015) survey again indicated some impact on macroinvertebrate communities from stockpiling activities, however the extent to which could not be determined due habitat variables such as periphyton growth and iron oxide deposits. It was recommended an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream.

The results of previous surveys performed in relation to this site are discussed in the references at the end of this report.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 02 February 2016 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at sites 2, 3 and 4, and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques was used at site 1 (Table 1). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road drilling waste stockpiling activities

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark *et al*, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The

MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 19 98 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and Discussion

Site habitat characteristics and hydrology

This February 2016 survey followed a period of 14 days since a fresh in excess of seven times median flow based on the nearest flow gauging site on the Manganui river at SH3 Midhurst.

Water temperature ranged between 14.0-15.1 °C. There was an uncoloured, clear, moderate and steady flow at sites 2, 3 and 4 and a cloudy, steady flow at site 1.At site 1 the substrate comprised predominantly of fine and coarse gravels with some sand, silt and cobbles. At site 2 the substrate comprised mainly of coarse gravels and cobbles while sites 3 and 4 had predominately cobble substrates.

No periphyton was recorded at sites 1 or 2 while patchy mats were recorded at site 3 and patchy mats and filaments were recorded growing at site 4. Macrophytes were recorded growing at the edges and on the bed of the stream at site 1 but were not recorded growing at any of the downstream sites.

Site 2 had complete shading while sites 1, 3 and 4 had no shading. Iron oxide deposits were evident at sites 1, 3 and 4 but were most prevalent at sites 3 and 4. Cyanobacteria mats and long green filamentous algae were prevalent at site 4 whereas at site 3 only patchy mats were recorded. No extensive periphyton mats or filaments were recorded growing at either site 1 or site 2.

Macroinvertebrate communities

Table 2 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 2 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 02 February 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2016	Median	Range	Feb 2016	Median	Range	Feb 2016
1	13	20	15-36	26	111	89-127	107	5.0	2.0-6.2	4.9
2	13	20	5-30	23	118	80-128	123	5.5	1.6-6.9	5.0
3	13	11	6-19	19	98	77-121	111	2.5	1.4-3.9	3.6
4	9	12	7-24	25	97	77-109	106	2.8	1.4-4.7	4.5

Table 3 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 3 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	37	37	35
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 4.

Table 4 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 02 February 2016.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB16018	FWB16019	FWB16020	FWB16021
NEMATODA	Nematoda	3	-	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A	A	A
	Lumbricidae	5	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	C	-	-	C
CRUSTACEA	Ostracoda	1	R	-	-	-
	Paranephrops	5	C	R	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	C	R
	Deleatidium	8	A	A	C	A
	Nesameletus	9	R	R	R	-
	Zephlebia group	7	A	A	C	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R	R	R
	Stenoperla	10	R	R	-	R
	Zelandobius	5	R	-	-	-
	Zelandoperla	8	-	R	-	R
COLEOPTERA (BEETLES)	Elmidae	6	C	R	-	R
	Dytiscidae	5	-	-	R	-
	Hydraenidae	8	-	R	-	-
	Hydrophilidae	5	R	-	-	-
	Ptilodactylidae	8	R	R	-	-
	Scirtidae	8	-	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	-	-	C
	Hydropsyche (Orthopsyche)	9	R	R	R	-
	Polyplectropus	6	-	R	R	C
	Psilochorema	6	C	C	C	C
	Oxyethira	2	-	-	-	R
	Triplectides	5	R	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	-	R	-
	Eriopterini	5	C	R	-	-
	Hexatomini	5	R	R	R	R
	Limonia	6	-	-	R	R
	Paralimnophila	6	R	-	-	-
	Zelandotipula	6	R	-	-	R
	Orthocladiinae	2	C	C	A	A
	Polypedilum	3	C	C	A	R
	Tanypodinae	5	-	-	R	R
	Paradixa	4	-	-	-	R
	Empididae	3	R	-	-	-
	Muscidae	3	-	-	R	R
	Austrosimulium	3	A	A	-	-
	Tanyderidae	4	-	-	R	-
ACARINA (MITES)	Acarina	5	A	R	R	C
		No of taxa	26	23	19	25
		MCI	107	123	111	106
		SQMCIs	4.9	5.0	3.6	4.5
		EPT (taxa)	10	10	8	10
		%EPT (taxa)	38	43	42	40

'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A moderate richness of 26 taxa was recorded at site 1 upstream of the storage area, which was six taxa higher than the median recorded to date (Figure 2 and Table 2). Taxa richness was above the median from similar sites (20) (Table 3).

There were five taxa recorded in abundance; two 'tolerant' taxa [oligochaete worms and black fly larvae (*Austrosimulium*)], two 'moderately sensitive' taxa [mayfly (*Zephlebia* group) and mites (Acarina)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).The community was comprised of a high proportion (73%) of 'sensitive' taxa which included five 'highly sensitive' taxa (two mayflies, one stonefly, one beetle, and one caddisfly). This high proportion of 'sensitive' taxa contributed to the MCI score of 107 units which was an insignificant (Stark, 1998) four units less than the historical median and two units less than the score recorded by the previous spring survey.

A moderate $SQMCI_s$ score of 4.9 units was recorded, an insignificant (0.1 unit) lower than the median for the site recorded by previous surveys (Stark, 1998). This score reflected the two 'tolerant' and three 'sensitive' taxa that were recorded as abundant.

The MCI score recorded was reflective of 'good' macroinvertebrate health. This coupled with a moderate $SQMCI_S$ score and a number of 'sensitive' taxa in the community, indicated that water quality in the weeks prior to this survey had been relatively good.

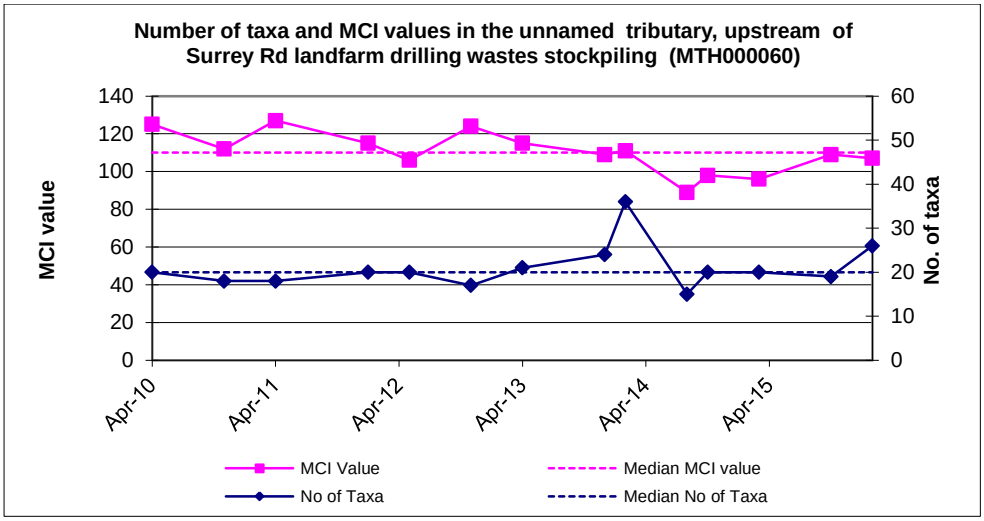

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 23 taxa was found at site 2 which was slightly higher than the previous sample (Figure 3) and slightly above the median calculated from historical data for the site (Table 2). Taxa richness was also slightly above the median from similar sites (Table 3). Although this result was seven taxa less than the maximum recorded at this site previously, it represented a marked improvement in the community from the initial survey in which only five taxa were recorded. This marked improvement has

been directly related to the change in location of the discharge point (to further downstream) which occurred in mid-2010 and also to additional skimmer pit/spring drainage provided at the stockpiling site (see Figure 1). This taxa richness was an insignificant three taxa less than that recorded at site 1 in the current survey.

The community was comprised of a high proportion of 'sensitive' taxa (78%).The MCI score of 123 units indicated a community of 'very good' biological health which was similar to the previous survey score (Figure 4) and not significantly different to the median value calculated from previous surveys at the same site (Table 2). This score was a significant (Stark, 1998) 16 units higher than that recorded at the upstream 'control' site, however there was only one significant change in individual taxon abundance, between sites 1 and 2. The $SQMCI_S$ score of 5.0 units was lower than the previous survey score ($SQMCI_S$ score of 5.8 units) and lower than the median value calculated from previous surveys at the same site, although was similar to that recorded at the upstream 'control' site (Table 2).

The community was characterised by two 'tolerant' taxa [oligochaete worms and black fly larvae (*Austrosimulium*)], one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

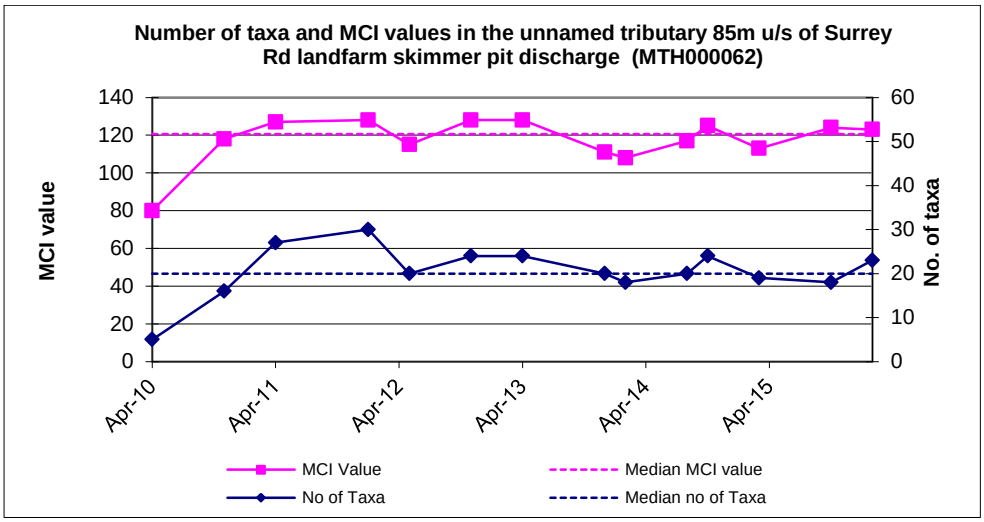

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A moderate macroinvertebrate community richness of 19 taxa was found at site 3 which was substantially more than that found by the previous survey (Figure 4). Furthermore, the sample contained eight taxa more than the median number recorded for the site (Table 2) and one taxon fewer than the median calculated from similar sites (Table 3). This community richness was seven taxa lower than that recorded at site 1 and four taxa less than that recorded at site 2.

The community was characterised by three 'tolerant' taxa [oligochaete worms, orthoclad midges and chironomid midge (*Polypedilum*)]. 'Sensitive' taxa comprised 74% of the macroinvertebrate community which contributed to the 'good' MCI score of 111 units. This score was significantly (1998) higher than the median for this site (Table 2) and significantly (Stark, 1998) higher than the previous MCI score (Figure 4). It was similar to that recorded at the upstream 'control' site score but significantly lower than that recorded at site 2.

The $SQMCI_S$ score of 3.6 units was higher than the previous survey score ($SQMCI_S$ score of 3.1 units) and was significantly higher than the median value calculated from previous surveys at the same site ($SQMCI_s$ score of 2.5) (Table 2).The current $SQMCI_s$ score of 3.6 units represented a significant downstream decrease of 1.4 units in $SQMCI_s$ score between sites 2 and 3. However, there was only one significant change in individual taxon abundance between site 2 and 3, including the decrease of one 'tolerant' taxon, black fly larvae (*Austrosimulium*). There was a decrease in one 'highly sensitive' taxon, mayfly (*Deleatidium*), which was 'common' to site 3 but 'abundant' at all other sites. The proliferation of algal mats, together with increased iron oxide sedimentation, impacted on the macroinvertebrate community at this site and can, to some extent, explain the reduction in $SQMCI_S$ and MCI scores at this site compared to site 2.

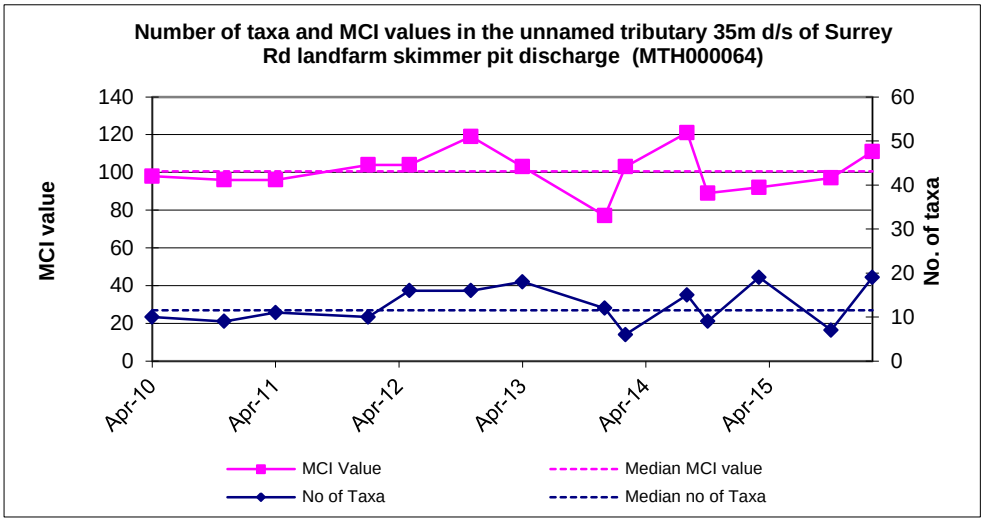

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A moderate macroinvertebrate community richness of 25 taxa was found at site 4 which was substantially more than that recorded by the previous survey and only one taxon less than that recorded by the upstream 'control' site (Figure 5). Furthermore, the sample contained 13 taxa more than the median number recorded for the site (Table 2) and five taxa more than the median calculated from similar sites (Table 3).

The MCI score of 106 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the previous survey (Figure 4) or to the median value calculated from previous surveys at the same site or to the upstream control site (Table 2). This score was significantly lower than that recorded at site 2, which can be attributed to habitat differences between the sites. The $SQMCI_S$ score of 4.5 units was similar to the previous survey score ($SQMCI_S$ score of 4.7 units) and was higher than the median value calculated from previous surveys at the same site (Table 2). This $SQMCI_S$ score was not significantly different to that recorded at site 1 or site 2.

The community was characterised by two 'tolerant' taxa [oligochaete worms and orthoclad midges] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

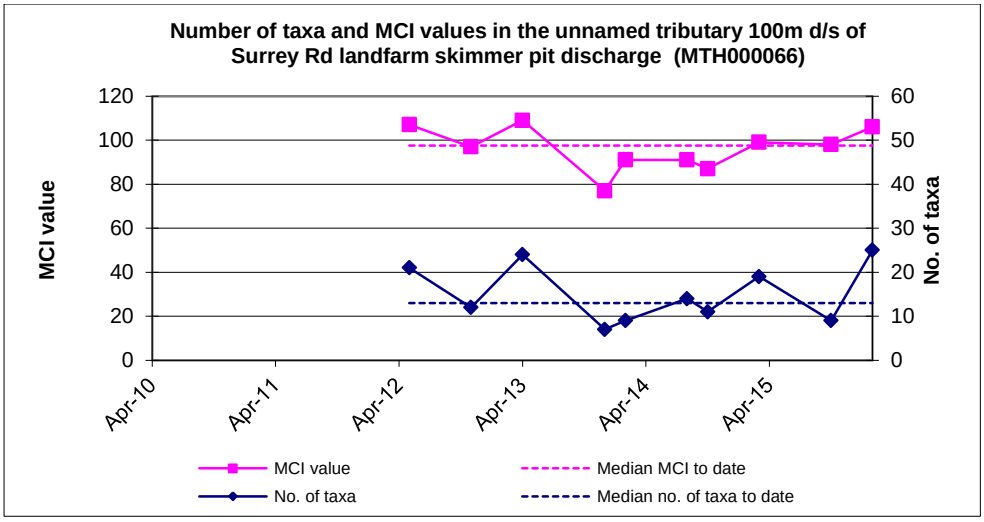

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Summary and Conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 02 February 2016, to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_S$ score for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to harmful discharges. Macroinvertebrates when exposed to harmful chemicals may die or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In the current survey, the MCI and $SQMCI_S$ scores recorded at the upstream 'control' site were similar to the median scores recorded at the site in previous surveys. The MCI score was indicative of 'good' macroinvertebrate health and together with the presence of many 'sensitive' taxa in this community was indicative of good preceding water quality.

The results of this survey indicated an increase in MCI score at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall.In general there was little difference in macroinvertebrate indices between sites 1 and 2 apart from site 2 having a significantly (Stark, 1998) higher MCI score, which would possibly be due to better habitat quality at the site. In comparison to the 'control' site 1, site 2 had greater riparian cover, no iron oxide deposits and a greater proportion of cobble substrate. The MCI score was reflective of 'very good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were both of 'good' quality and had similar taxa richnesses to the control site. In addition sites 3 and 4 also had MCI scores similar to the upstream 'control' site. In comparison to site 2, site 3 and 4 had

significantly lower MCI scores which can be attributed to habitat differences rather than from any impacts caused by stockpiling activities.

In relation to the previous spring (October 2015) survey the 'impacted' sites in the current survey recorded increased MCI scores and taxa richnesses. Taxa richness at site 3 had increased by 12 taxa and the MCI score had increased by a significant (Stark, 1998) 14 units. At site 4, the MCI score had increased by 8 units and taxa richness had increased by 16. This was a vast improvement from the spring survey results and in part can be explained by slight reductions in periphyton cover and iron oxide deposits present during the current survey. However these results may also reflect a recovery from impacts that were occurring as a result of stockpiling activities during the previous survey.

As noted by the previous spring report (Sutherland, 2016) stockpiling activities may have contributed to the low macroinvertebrate taxa richnesses recorded by the spring survey. It was suggested an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites could be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream. If a return to more unhealthy conditions was to occur, it would again be recommended for such an investigation to take place. However, as this was not the case, as indicated by this late summer survey there are no grounds to consider further investigation.

Comparison of taxa richnesses and MCI values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites and 'impacted sites had results similar to the median values. Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not resulted in any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

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To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1656255
Report No	BT052
Date	March 2016

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, February 2015

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in summer and was one of two scheduled surveys for the site in the 2015-16 year.

The site historically received drilling waste, which were stored on site, and then spread over land under specific consent conditions. However, this site has been closed for the past two years, with the Company moving to consolidate the remaining residual drilling material with a view to submit this facility for surrender in the near future.

Drainage of water from the storage pits flows through at least two skimmer pits where it is either discharged across specific paddocks, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in October 2015 (Sutherland & Thomas, 2015) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established

just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 1 and Figure 1.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 02 February 2016. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

Results

Site habitat characteristics and hydrology

This February 2016 survey followed a period of 14 days since a fresh in excess seven times median flow.

The water temperature ranged between 16.4 ºC and 20.2 ºC. Water levels were low to moderate and water speeds steady. Water was uncoloured and cloudy at all four sites (Table 2). Substrate composition for site 1 comprised mainly of sand, silt and fine gravels with some cobbles and coarse gravels. For site 2 and site 3 substrate was predominately cobbles and boulders with some gravels, sand and silt. For site 4, substrate was predominantly cobble and gravels with some boulder, sand and silt.

Periphyton mats were slippery at site 1, patchy at sites 2 and 3 and absent at site 4. Periphyton filaments were widespread at sites 2 and 3 but absent at sites 1 and 4. Macrophytes were present at the edges of the stream at sites 1 and 3 while they were recorded growing at the edges of the stream and on the bed of the stream at site 2. Macrophytes were absent at site 4. All sites recorded either patchy or widespread wood or leaves on the stream bed. Sites 1 and 3

were partially shaded by overhanging vegetation whereas site 3 had complete shading and site 2 had no shading.

Table 2 Summary of time of sampling and water variables collected at four sites in the unnamed tributary of the Mangamawhete Stream sampled in relation to the Derby Rd landfarm on 02 February 2016.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1145	17.5	Uncoloured	Cloudy	Moderate	Steady
2	1130	18.5	Uncoloured	Cloudy	Moderate	Steady
3	1105	20.2	Uncoloured	Cloudy	Low	Steady
4	1050	16.4	Uncoloured	Cloudy	Moderate	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Derby Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_S$ values for an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site on 02 February 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_S$ value		
		Median	Range	Feb 2016	Median	Range	Feb 2016	Median	Range	Feb 2016
1	13	22	12-33	12	104	87-114	83	5.0	3.2-7.4	4.7
2	13	16	6-30	20	99	80-109	96	3.4	2.0-7.4	4.9
3	13	16	5-19	24	100	88-109	92	4.4	2.5-6.7	3.5
4	13	17	6-24	16	99	73-110	106	4.6	2.1-6.8	4.6

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 02 February 2016 in relation to the Derby Rd Landfarm.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB16022	FWB16023	FWB16024	FWB16025
ANNELIDA (WORMS)	Oligochaeta	1	R	R	C	-
	Lumbricidae	5	-	-	R	R
MOLLUSCA	*Potamopyrgus*	4	R	C	R	C
CRUSTACEA	Ostracoda	1	R	R	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	-	R
	Deleatidium	8	C	A	C	C
	Nesameletus	9	-	-	R	-
	Zephlebia group	7	-	R	-	R
HEMIPTERA (BUGS)	*Saldula*	5	-	-	R	-
	Sigara	3	-	-	C	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R	R	-
	Dytiscidae	5	-	C	R	-
	Hydraenidae	8	-	R	-	-
	Hydrophilidae	5	-	-	R	-
	Scirtidae	8	-	-	C	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	C	R	-
	Hydrochorema	9	-	-	-	R
	Hydropsyche (Orthopsyche)	9	-	-	-	C
	Polyplectropus	6	-	C	R	R
	Psilochorema	6	-	R	R	R
	Oeconesidae	5	-	-	-	R
	Oxyethira	2	-	R	C	-
	Paroxyethira	2	-	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R	-	-
	Eriopterini	5	R	-	R	-
	Hexatomini	5	R	-	-	R
	Limonia	6	-	-	R	-
	Zelandotipula	6	-	R	-	-
	Orthocladiinae	2	R	A	A	C
	Polypedilum	3	-	-	-	R
	Tanypodinae	5	R	R	C	R
	Paradixa	4	-	R	-	-
	Empididae	3	-	-	R	-
	Austrosimulium	3	C	C	A	A
ACARINA (MITES)	Acarina	5	-	C	R	-
		No of taxa	12	20	24	16
		MCI	83	96	92	106
		SQMCIs	4.7	4.9	3.5	4.6
		EPT (taxa)	2	6	5	8
		%EPT (taxa)	17	30	21	50

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1

A low macroinvertebrate community richness of 12 taxa was found at site 1, which was ten taxa less than the median number recorded for the site and equal to the lowest number of taxa recorded to date (Table 3). This number was also seven less than that recorded by the previous spring survey.

The MCI score of 83 units indicated a community of 'fair' biological health which was significantly (Stark, 1998) lower than the median value calculated from previous surveys at the same site (median MCI score 104; Table 3). This MCI score was also the lowest recorded to date for this site. The SQMCI$_S$ score of 4.7 was similar to the historical median for the site (5.0) and slightly above that recorded by the previous spring survey (by 0.2 unit).

There were no taxa recorded in abundance at this site. Two taxa were recorded as 'common' (5-19 individuals) including the 'highly sensitive' mayfly (*Deleatidium*) and black fly larvae (*Austrosimulium*) (Table 5).

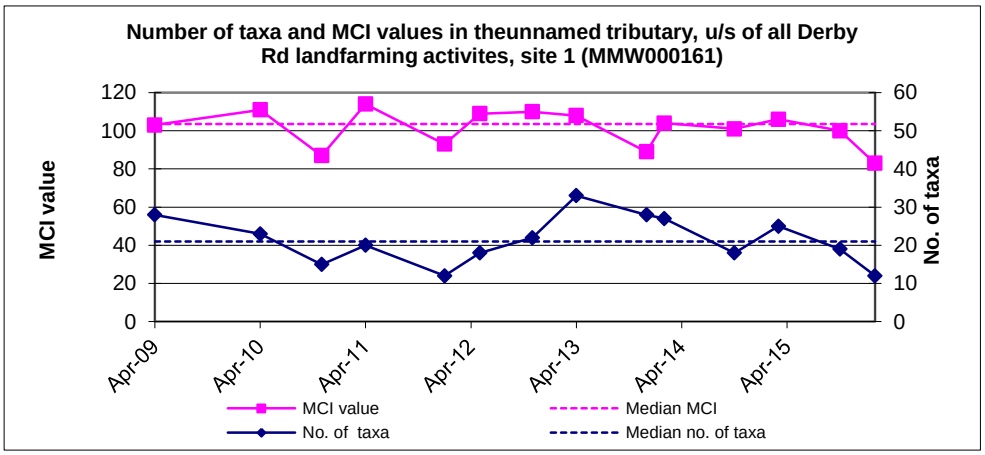

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 20 taxa was found at site 2, which was four taxa more that the median number recorded for the site and three taxa more than that recorded by the previous spring survey (median taxa richness 16; Table 3).

The MCI score of 96 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). The SQMCI$_S$ score of 4.9 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI$_S$ score of 3.4 units; Table 3).

The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5)].

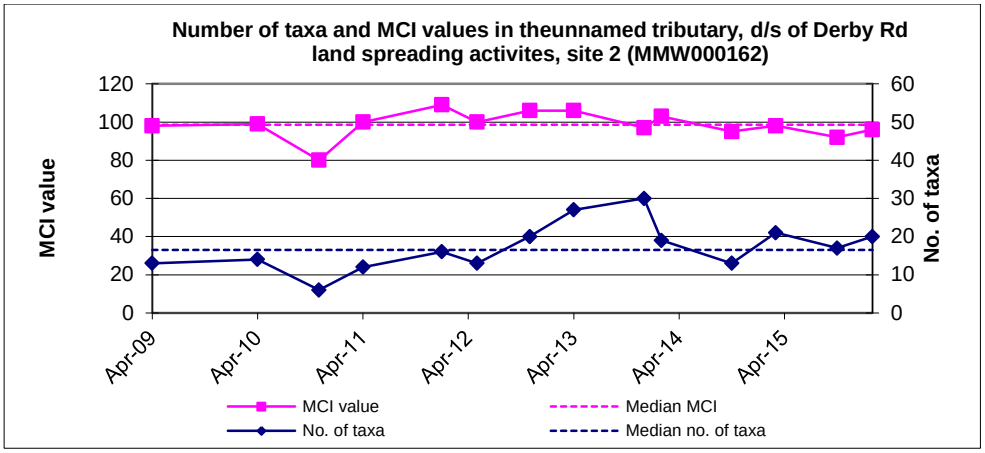

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 24 taxa was found at site 3, which was eight taxa more than the median number recorded for the site and nine taxa more than that recorded by the previous sample (median taxa richness 16; Table 3).

The MCI score of 92 units indicated a community of 'fair' biological health which was slightly below the median value calculated from previous surveys at the same site (Table 3). The $SQMCI_S$ score of 3.5 units was substantially lower than the median value calculated from previous surveys at the same site (median $SQMCI_S$ score of 4.4 units; Table 3) and significantly lower (by 3.2 units) than the October 2015 result.

The community was characterised by two 'tolerant' taxa; [midge (Orthocladiinae) and black fly larvae (*Austrosimulium*)]) (Table 5)].

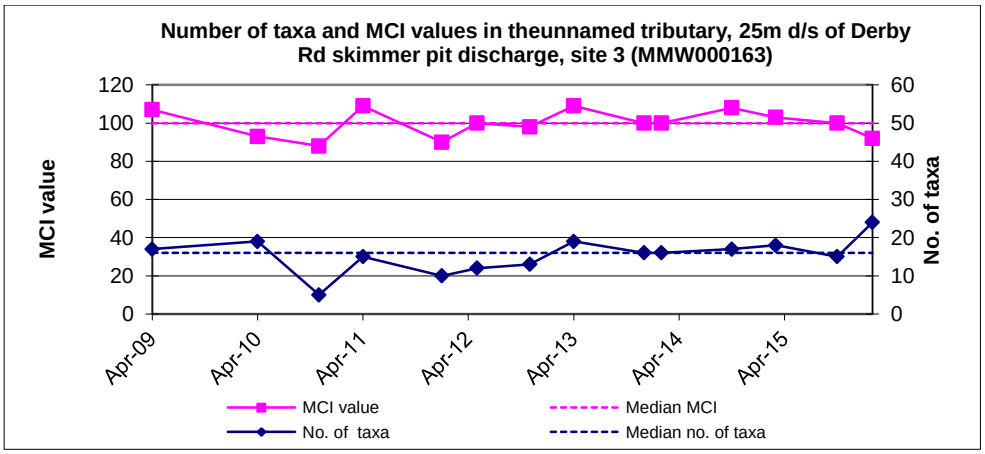

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 16 taxa was found at site 4, which was similar to the median number recorded for the site and four taxa more than that recorded by the previous spring survey (Table 3).

The MCI score of 106 units indicated a community of 'good' biological health which was higher than the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). The $SQMCI_S$ score of 4.6 units was equal to the median value calculated from previous surveys at the same site (Table 3).

The community was characterised by one 'tolerant' taxon [black fly larvae (*Austrosimulium*)] (Table 5).

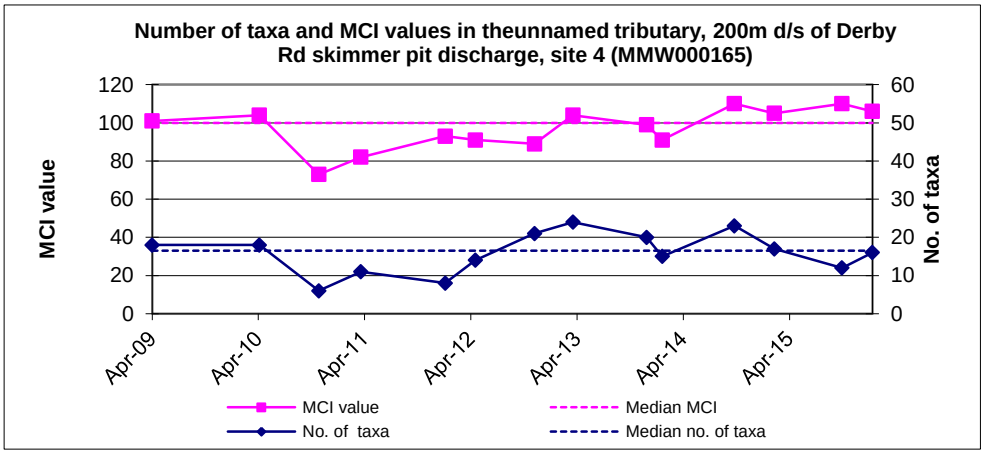

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

Discussion and Conclusions

The Council's 'kick-sampling' technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_S$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In the current survey, taxa richness at the upstream 'control' site was substantially lower than that recorded by the previous spring survey and was equal to the lowest score recorded at this site to date. The MCI score was also lower than that recorded by the previous spring survey and was significantly (Stark, 1998) lower than the median MCI score for the site (by 21 units). It is likely that the habitat available at the time of the survey has contributed to these results. In comparison to the previous spring survey the habitat available was restricted by lower flows and reduced periphyton growth. In addition, a high proportion of fine gravel, silt and sand substrate was sampled; a less favourable habitat for many

macroinvertebrate taxa. Iron oxide deposits were present at the time of survey which may have also contributed to a reduction in habitat quality at this site. It is also possible that upstream activities have caused a reduction in preceding water quality at this site. Despite a reduced taxa richness and MCI score the upstream 'control' site recorded a $SQMCI_s$ score similar to the historical median.

The results of this survey indicated that there was an improvement in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. There was a slight increase in $SQMCI_s$ score (by 0.2 unit) between site 1 and site 2 and a significant (Stark, 1998) increase in MCI score (by 13 units). The $SQMCI_s$ score of 4.9 units was similar to the October 2015 score (4.8 units) and significantly higher (by 1.5 units) than the median score previously recorded, indicating some improvement at this site.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by increased (when compared to the upstream 'control' site) taxa richnesses at both sites. The MCI score recorded at site 3 was higher than that recorded at site 1 but slightly less than that recorded at site 2. The $SQMCI_s$ score recorded at site 3 was significantly (Stark, 1998) lower than that recorded at all other sites and was substantially lower than the median recorded by previous surveys at this site. The substrate was particularly firm at this site which made collection of a sample difficult. The MCI score recorded at site 4 was the highest of all sites and was significantly (Stark, 1998) higher than that recorded at sites 1 and 3 and was substantially higher than the median recorded by previous surveys. The $SQMCI_s$ score recorded at site 4 was the same as the median recorded by previous surveys but was slightly lower than that recorded by the October 2015 survey.

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed.

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1472485
Contact:	R Henry	**Date Registered:**	08-Sep-2015
	C/- Schlumberger New Zealand Limited	**Date Reported:**	24-Sep-2015
	PO Box 7100	**Quote No:**	71417
	Fitzroy	**Order No:**	M16600105A
	NEW PLYMOUTH 4341	**Client Reference:**	
		Submitted By:	R Henry

Interim Report

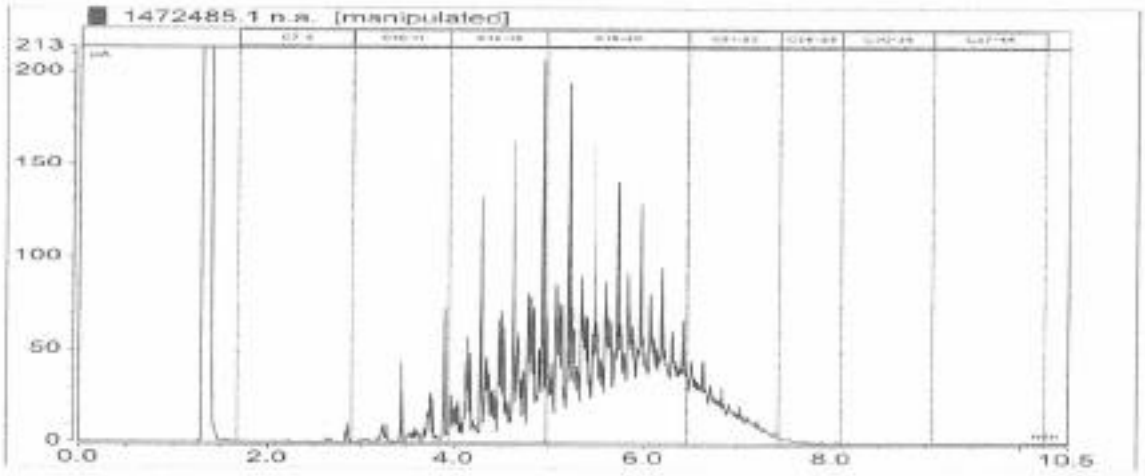
This is an interim report, prepared before all test results are completed. As all final Q.C. checks may not have been possible, it is not regarded as an official laboratory report. The final, official report will be issued upon completion of all tests.

Sample Type: Sludge

		Sample Name:	Surrey Road Cell 1	Surrey Road Cell 1 [Oily]			
		Lab Number:	1472485.1	1472485.2			
Individual Tests							
Dry Matter	g/100g as rcvd		70	-	-	-	-
Density	g/mL at 20°C		1.75	-	-	-	-
Total Arsenic	mg/kg as rcvd		-	3.1	-	-	-
Total Barium	mg/kg as rcvd		-	330	-	-	-
Total Cadmium	mg/kg as rcvd		-	0.11	-	-	-
Total Calcium	mg/kg as rcvd		-	58,000	-	-	-
Total Chromium	mg/kg as rcvd		-	21	-	-	-
Total Copper	mg/kg as rcvd		-	25	-	-	-
Total Lead	mg/kg as rcvd		-	10.9	-	-	-
Total Mercury	µg/kg as rcvd		-	In Progress	-	-	-
Total Nickel	mg/kg as rcvd		-	20	-	-	-
Total Potassium	mg/kg as rcvd		-	1,220	-	-	-
Total Sodium	mg/kg as rcvd		-	710	-	-	-
Total Zinc	mg/kg as rcvd		-	39	-	-	-
Chloride	mg/kg as rcvd		-	8,100	-	-	-
Total Nitrogen	g/100g as rcvd		-	< 0.12	-	-	-
BTEX in Soil by Headspace GC-MS							
Benzene	mg/kg dry wt		< 0.07	-	-	-	-
Toluene	mg/kg dry wt		0.33	-	-	-	-
Ethylbenzene	mg/kg dry wt		0.22	-	-	-	-
m&p-Xylene	mg/kg dry wt		0.86	-	-	-	-
o-Xylene	mg/kg dry wt		0.34	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil							
Acenaphthene	mg/kg dry wt		14	-	-	-	-
Acenaphthylene	mg/kg dry wt		< 7	-	-	-	-
Anthracene	mg/kg dry wt		< 0.7	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt		< 0.7	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt		< 0.7	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt		< 0.7	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt		< 0.7	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt		< 0.7	-	-	-	-
Chrysene	mg/kg dry wt		< 0.7	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt		< 0.7	-	-	-	-
Fluoranthene	mg/kg dry wt		< 0.7	-	-	-	-
Fluorene	mg/kg dry wt		< 7	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt		< 0.7	-	-	-	-
Naphthalene	mg/kg dry wt		< 40	-	-	-	-

Sample Type: Sludge						
Sample Name:		Surrey Road Cell 1	Surrey Road Cell 1 [Oily]			
Lab Number:		1472485.1	1472485.2			
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Phenanthrene	mg/kg dry wt	1.3	-	-	-	-
Pyrene	mg/kg dry wt	< 0.7	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	1,030	-	-	-	-
C10 - C14	mg/kg dry wt	85,000	-	-	-	-
C15 - C36	mg/kg dry wt	175,000	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	260,000	-	-	-	-

1472485.1
Surrey Road Cell 1
Client Chromatogram for TPH by FID



Analyst's Comments

It was observed that the container for sample 1472485/1 was not completely filled. Volatile loss may have occurred due to the headspace in the container

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
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:5785,2805,10734]	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
Ashing and Aqua Regia digest	Ashing in Muffle furnace, Aqua Regia (HNO_3/HCl) digestion.	-	2
Density	Calculation: weight of sample / volume of sample at 20°C Gravimetric determination.	0.02 g/mL at 20°C	1
Total Arsenic	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	2
Total Barium	Aqua Regia Digestion, ICP-MS.	0.2 mg/kg as rcvd	2
Total Cadmium	Aqua Regia Digestion, ICP-MS.	0.05 mg/kg as rcvd	2

Sample Type: Sludge			
Test	Method Description	Default Detection Limit	Sample No
Total Calcium	Aqua Regia Digestion, ICP-MS.	50 mg/kg as rcvd	2
Total Chromium	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	2
Total Copper	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	2
Total Lead	Aqua Regia Digestion, ICP-MS.	0.2 mg/kg as rcvd	2
Total Mercury	Aqua Regia Digestion, reduction with Tin Chloride, analysis by Atomic Fluorescence (PSA Millenium Merlin). Subcontracted to IPL Ltd. ANC 010 - Method for the Determination of Ultra Trace Mercury in Hydrocarbon by Millenium Merlin.	20 µg/kg as rcvd	2
Total Nickel	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	2
Total Potassium	Aqua Regia Digestion, ICP-MS.	50 mg/kg as rcvd	2
Total Sodium	Aqua Regia Digestion, ICP-MS.	20 mg/kg as rcvd	2
Total Zinc	Aqua Regia Digestion, ICP-MS.	2 mg/kg as rcvd	2
Total Chloride in Oil	Determination using Titrachlor-c, used oil quantification kit.	50 mg/kg as rcvd	2
Total Nitrogen	Catalytic Combustion (900°C, C2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g as rcvd	2

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.

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

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ANALYSIS REPORT

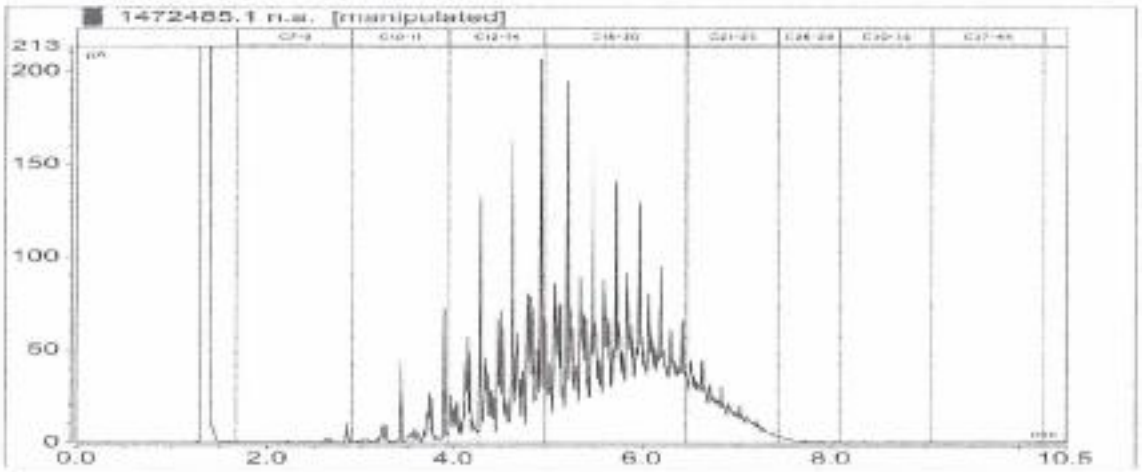
Client:	Schlumberger New Zealand Limited	**Lab No:**	1472485 SPv2
Contact:	R Henry	**Date Registered:**	08-Sep-2015
	C/- Schlumberger New Zealand Limited	**Date Reported:**	25-Sep-2015
	PO Box 7100	**Quote No:**	71417
	Fitzroy	**Order No:**	M16600105A
	NEW PLYMOUTH 4341	**Client Reference:**	
		Submitted By:	R Henry

Sample Type: Sludge

Sample Name:		Surrey Road Cell 1	Surrey Road Cell 1 [Oily]			
Lab Number:		1472485.1	1472485.2			
Individual Tests						
Dry Matter	g/100g as rcvd	70	-	-	-	-
Density*	g/mL at 20°C	1.75	-	-	-	-
Total Arsenic*	mg/kg as rcvd	-	3.1	-	-	-
Total Barium*	mg/kg as rcvd	-	330	-	-	-
Total Cadmium*	mg/kg as rcvd	-	0.11	-	-	-
Total Calcium*	mg/kg as rcvd	-	58,000	-	-	-
Total Chromium*	mg/kg as rcvd	-	21	-	-	-
Total Copper*	mg/kg as rcvd	-	25	-	-	-
Total Lead*	mg/kg as rcvd	-	10.9	-	-	-
Total Mercury*	µg/kg as rcvd	-	49	-	-	-
Total Nickel*	mg/kg as rcvd	-	20	-	-	-
Total Potassium*	mg/kg as rcvd	-	1,220	-	-	-
Total Sodium*	mg/kg as rcvd	-	710	-	-	-
Total Zinc*	mg/kg as rcvd	-	39	-	-	-
Chloride*	mg/kg as rcvd	-	8,100	-	-	-
Total Nitrogen*	g/100g as rcvd	-	< 0.12	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.07	-	-	-	-
Toluene	mg/kg dry wt	0.33	-	-	-	-
Ethylbenzene	mg/kg dry wt	0.22	-	-	-	-
m&p-Xylene	mg/kg dry wt	0.86	-	-	-	-
o-Xylene	mg/kg dry wt	0.34	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	14	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 7	-	-	-	-
Anthracene	mg/kg dry wt	< 0.7	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.7	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.7	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.7	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.7	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.7	-	-	-	-
Chrysene	mg/kg dry wt	< 0.7	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.7	-	-	-	-
Fluoranthene	mg/kg dry wt	< 0.7	-	-	-	-
Fluorene	mg/kg dry wt	< 7	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.7	-	-	-	-
Naphthalene	mg/kg dry wt	< 40	-	-	-	-

Sample Type: Sludge						
Sample Name:		Surrey Road Cell 1	Surrey Road Cell 1 [Oily]			
Lab Number:		1472485.1	1472485.2			
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Phenanthrene	mg/kg dry wt	1.3	-	-	-	-
Pyrene	mg/kg dry wt	< 0.7	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	1,030	-	-	-	-
C10 - C14	mg/kg dry wt	86,000	-	-	-	-
C15 - C36	mg/kg dry wt	175,000	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	260,000	-	-	-	-

1472485.1
Surrey Road Cell 1
Client Chromatogram for TPH by FID



Analyst's Comments

It was observed that the container for sample 1472485/1 was not completely filled. Volatile loss may have occurred due to the headspace in the container

Appendix No.1 - Mercury Report - 1472485

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**
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]	9 - 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
Ashing and Aqua Regia digest	Ashing in Muffle furnace, Aqua Regia (HNO_3/HCl) digestion.	-	2
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1
Total Arsenic*	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	2

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ANALYSIS REPORT

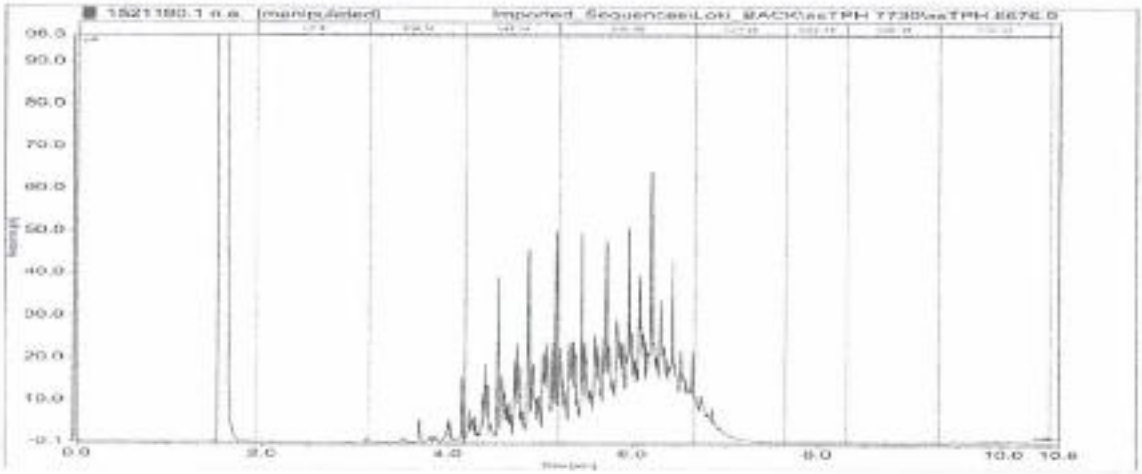
Client:	Schlumberger New Zealand Limited	**Lab No:**	1521190 SPnt
Contact:	R Henry	**Date Registered:**	06-Jan-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	18-Jan-2016
	PO Box 7100	**Quote No:**	71417
	Fitzroy	**Order No:**	M16600171A
	NEW PLYMOUTH 4341	**Client Reference:**	
		Submitted By:	R Henry

Sample Type: Sludge

	Sample Name:	Surrey Road Cell 2 26-Dec-2015				
	Lab Number:	1521190.1				
Individual Tests						
Dry Matter	g/100g as rcvd	29	-	-	-	-
Density*	g/mL at 20°C	1.32 #	-	-	-	-
Total Recoverable Barium	mg/kg dry wt	1,620	-	-	-	-
Total Recoverable Calcium	mg/kg dry wt	22,000	-	-	-	-
Total Recoverable Magnesium	mg/kg dry wt	5,100	-	-	-	-
Total Recoverable Potassium	mg/kg dry wt	15,000	-	-	-	-
Total Recoverable Sodium	mg/kg dry wt	1,990	-	-	-	-
Chloride*	mg/kg dry wt	14,800	-	-	-	-
pH*	pH Units	9.3	-	-	-	-
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	9	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.11	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	21	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	47	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	60	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	20	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	68	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.3	-	-	-	-
Toluene	mg/kg dry wt	< 0.3	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.3	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.5	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.3	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.16	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.16	-	-	-	-
Anthracene	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.18	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.24	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.16	-	-	-	-
Chrysene	mg/kg dry wt	0.21	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.16	-	-	-	-

Sample Type: Sludge						
Sample Name:	Surrey Road Cell 2 26-Dec-2015					
Lab Number:	1521190.1					
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Fluoranthene	mg/kg dry wt	0.45	-	-	-	-
Fluorene	mg/kg dry wt	< 0.16	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.16	-	-	-	-
Naphthalene	mg/kg dry wt	1.0	-	-	-	-
Phenanthrene	mg/kg dry wt	1.36	-	-	-	-
Pyrene	mg/kg dry wt	0.97	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 50	-	-	-	-
C10 - C14	mg/kg dry wt	7,200	-	-	-	-
C15 - C36	mg/kg dry wt	15,800	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	23,000	-	-	-	-

1521190.1
Surrey Road Cell 2 26-Dec-2015
Client Chromatogram for TPH by FID



Analyst's Comments

#1 Relative Density. Free water decanted off before testing.

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 clear 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 3270). Tested on as received sample. [KBIs:5786,2805,2696]	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/ME 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

Sample Type: Sludge			
Test	Method Description	Default Detection Limit	Sample No
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-6% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1
eslCextn*	(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
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	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
Chloride*	Ion Chromatography determination of es potassium phosphate extraction.	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 [Elemental 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.

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Client Services Manager - Environmental Division

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ANALYSIS REPORT

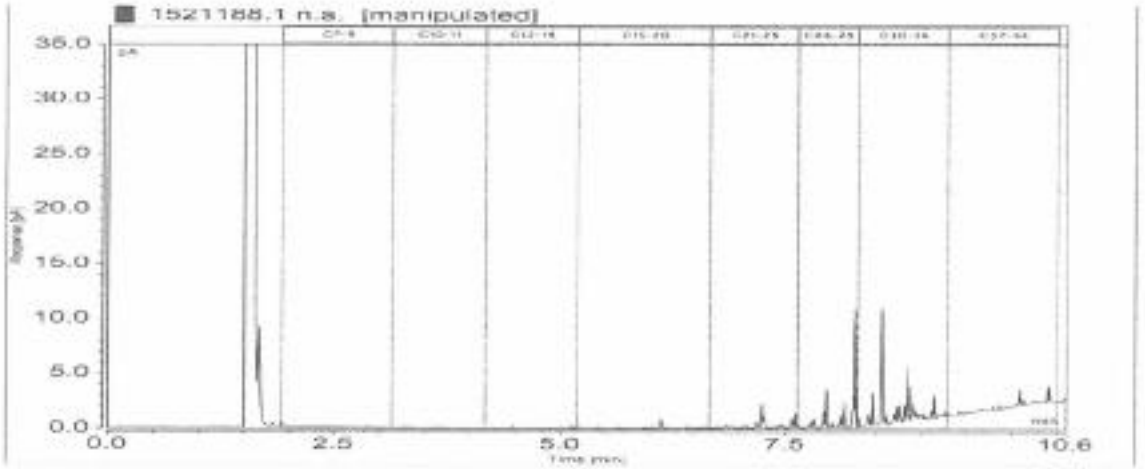
Client:	Schlumberger New Zealand Limited	**Lab No:**	1521188
Contact:	R Henry	**Date Registered:**	06-Jan-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	18-Jan-2016
	PO Box 7100	**Quote No:**	34979
	Fitzroy	**Order No:**	M16600073A
	NEW PLYMOUTH 4341	**Client Reference:**	Soil
		Submitted By:	R Henry

Sample Type: Soil

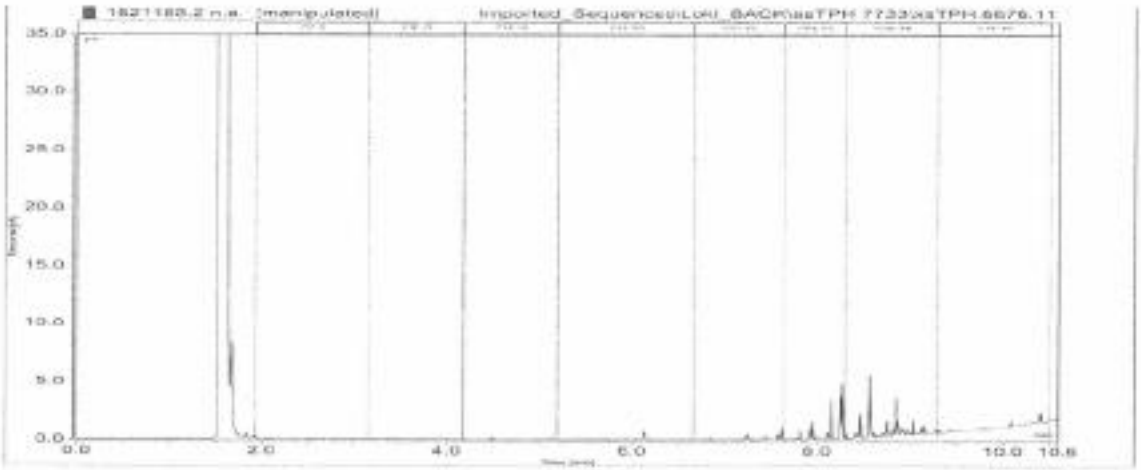
Sample Name:		Paddock 83 28-Dec-2015	Paddock 64 28-Dec-2015			
Lab Number:		1521188.1	1521188.2			
Individual Tests						
Dry Matter	g/100g as rcvd	65	60	-	-	-
Density*	g/mL at 20°C	0.73 #2	0.71 #2	-	-	-
Total Recoverable Barium	mg/kg dry wt	54	48	-	-	-
Total Recoverable Sodium	mg/kg dry wt	590	650	-	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.44 #1	-	-	-
Total Recoverable Chromium	mg/kg dry wt	6	6	-	-	-
Total Recoverable Copper	mg/kg dry wt	61	47	-	-	-
Total Recoverable Lead	mg/kg dry wt	5.0	5.8	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	-	-	-
Total Recoverable Nickel	mg/kg dry wt	3	3	-	-	-
Total Recoverable Zinc	mg/kg dry wt	38	32	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.08	< 0.14	-	-	-
Toluene	mg/kg dry wt	< 0.08	< 0.14	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.08	< 0.14	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.16	< 0.3	-	-	-
o-Xylene	mg/kg dry wt	< 0.08	< 0.14	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Anthracene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Chrysene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Fluoranthene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Fluorene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Naphthalene	mg/kg dry wt	< 0.17	< 0.4	-	-	-
Phenanthrene	mg/kg dry wt	< 0.04	< 0.08	-	-	-
Pyrene	mg/kg dry wt	< 0.04	< 0.08	-	-	-

Sample Type: Soil						
Sample Name:		Paddock 83 28-Dec-2015	Paddock 84 28-Dec-2015			
Lab Number:		1521188.1	1521188.2			
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 10	< 30	-	-	-
C10 - C14	mg/kg dry wt	< 20	< 60	-	-	-
C15 - C36	mg/kg dry wt	141	170	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	141	170	-	-	-

1521188.1
Paddock 83 28-Dec-2015
Client Chromatogram for TPH by FID



1521188.2
Paddock 84 28-Dec-2015
Client Chromatogram for TPH by FID



Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample. The average of the results of the replicate analyses has been reported.

#2 Bulk Density.

SUMMARY OF METHODS

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

Sample Type: Soil			
Test	Method Description	Default Detection Limit	Sample No

Sample Type: Soil			
Test	Method Description	Default Detection Limit	Sample No
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required	0.10 - 4 mg/kg dry wt	1-2
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,26667,3629]	0.05 - 0.10 mg/kg dry wt	1-2
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 - 0.35 mg/kg dry wt	1-2
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	1-2
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1-2
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	1-2
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination	0.02 g/mL at 20°C	1-2
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	1-2
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	1-2

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

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

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

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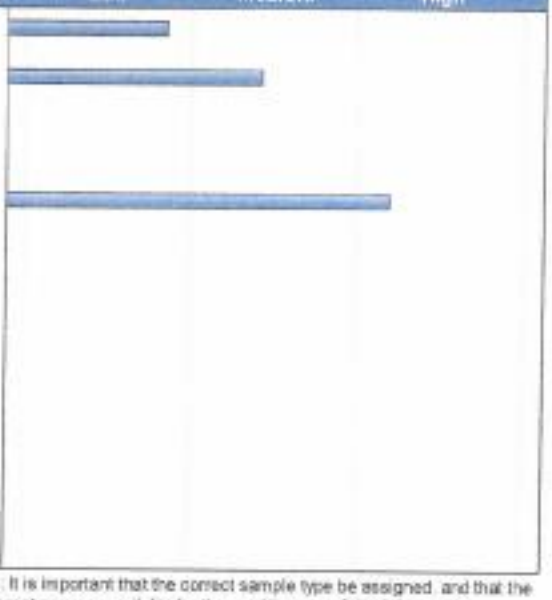
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1521189
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	06-Jan-2016
		Date Reported:	14-Jan-2016
		Quote No:	34979
		Order No:	M16600073A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 83 — **Lab Number:** 1521189.1
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	5.7	5.8 - 6.2
Volume Weight	g/mL	0.77	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	< 10	
Total Nitrogen	%	0.88	0.30 - 0.60
Total Soluble Salts*	mg/L	125.4	
Electrical Conductivity (Sat Paste)*	mS/cm	0.2	
Nitrate-N (Sat Paste)*	mg/L	16	
Ammonium-N (Sat Paste)*	mg/L	2	
Phosphorus (Sat Paste)*	mg/L	2	
Potassium (Sat Paste)*	mg/L	7	
Calcium (Sat Paste)*	mg/L	21	
Magnesium (Sat Paste)*	mg/L	2	
Sodium (Sat Paste)*	mg/L	4	
Sodium Absorption Ratio*		0.2	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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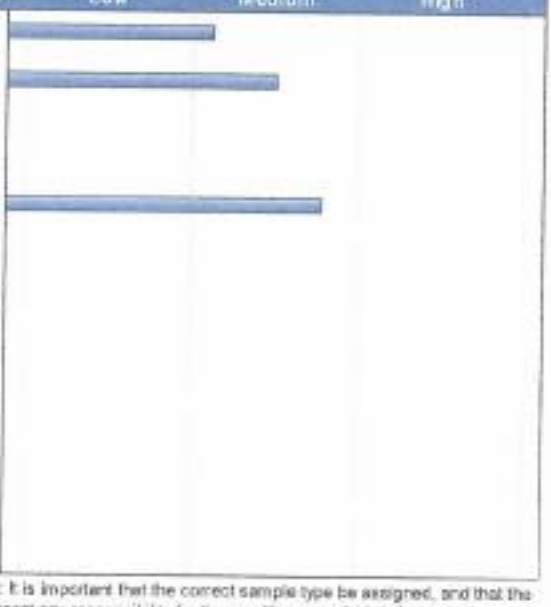
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1521189
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	06-Jan-2016
		Date Reported:	14-Jan-2016
		Quote No:	34979
		Order No:	M16600073A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 84
Sample Type: SOIL Mixed Pasture (S1)

Lab Number: 1521189.2

Analysis		Level Found	Medium Range
pH	pH Units	5.8	5.8 - 6.2
Volume Weight	g/mL	0.80	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	< 10	
Total Nitrogen	%	0.54	0.30 - 0.60
Total Soluble Salts*	mg/L	92.4	
Electrical Conductivity (Sat Paste)*	mS/cm	0.1	
Nitrate-N (Sat Paste)*	mg/L	3	
Ammonium-N (Sat Paste)*	mg/L	2	
Phosphorus (Sat Paste)*	mg/L	1	
Potassium (Sat Paste)*	mg/L	4	
Calcium (Sat Paste)*	mg/L	7	
Magnesium (Sat Paste)*	mg/L	< 1	
Sodium (Sat Paste)*	mg/L	4	
Sodium Absorption Ratio*		0.4	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1521189
Address:	PO Box 7100	**Date Registered:**	06-Jan-2016
	Fitzroy	**Date Reported:**	14-Jan-2016
	NEW PLYMOUTH 4341	**Quote No:**	34979
		Order No:	M16600073A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-2
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-2
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-2
Total Nitrogen	Dumas combustion.	0.04 %	1-2
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35.	0.05 %	1-2
Chloride	Saturated Calcium Sulphate extraction followed by Potentiometric Titration.	10 mg/kg	1-2
Total Soluble Salts*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	1.0 mg/L	1-2
Electrical Conductivity (Sat Paste)*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	0.1 mS/cm	1-2
Nitrate-N (Sat Paste)*	Saturated Paste extraction followed by Salicylate colorimetry.	1 mg/L	1-2
Ammonium-N (Sat Paste)*	Saturated Paste extraction followed by Berthelot colorimetry.	1 mg/L	1-2
Phosphorus (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-2
Potassium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-2
Calcium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-2
Magnesium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-2
Sodium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-2
Sodium Absorption Ratio (SAR)*	Calculation from the sodium, calcium and magnesium determined on a Saturated Paste extract.	0.2	1-2
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-2

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Shelley Edhouse
Quality Assurance Coordinator - Agriculture Division

Hill Laboratories
BETTER TESTING BETTER RESULTS

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Hamilton 3240, New Zealand

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1561410 SPV1
Contact:	Ruka Te Moana	**Date Registered:**	02-Apr-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	14-Apr-2016
	PO Box 7100	**Quote No:**	31151
	Fitzroy	**Order No:**	M16600203A
	New Plymouth 4341	**Client Reference:**	Stormwater Analysis
		Submitted By:	R Henry

Sample Type: Aqueous

Sample Name:	Surrey Rd SW3 Outlet 31-Mar-2016	Surrey Rd SW3 Downstream 31-Mar-2016	Surrey Rd SW3 Upstream 31-Mar-2016		
Lab Number:	1561410.1	1561410.2	1561410.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	-	-	-	-
pH pH Units	6.9	-	-	-	-
Total Suspended Solids g/m³	10	-	-	-	-
Sample Temperature* °C	20	-	-	-	-
Total Ammoniacal-N g/m³	0.139	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	-	< 2	< 2	-	-
Oil and Grease g/m³	29	-	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	0.06	-	-	-	-
Combined Chlorine g/m³	< 0.05	-	-	-	-

SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Free Ammonia*	Calculation from NH4N, pH, Temperature (Calculations based on data for distilled water). APHA Table 4010:VI 22nd ed. 2012.	0.010 g/m³ at Client Temperature	1
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
pH	pH meter. APHA 4500-H+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m³	1
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.10 °C	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology: 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	2-3
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1

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Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1591561
Contact:	R Henry	**Date Registered:**	28-May-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	24-Jun-2016
	PO Box 7100	**Quote No:**	71417
	Fitzroy	**Order No:**	M16600223A
	New Plymouth 4341	**Client Reference:**	
		Submitted By:	R Henry

Sample Type: Oil

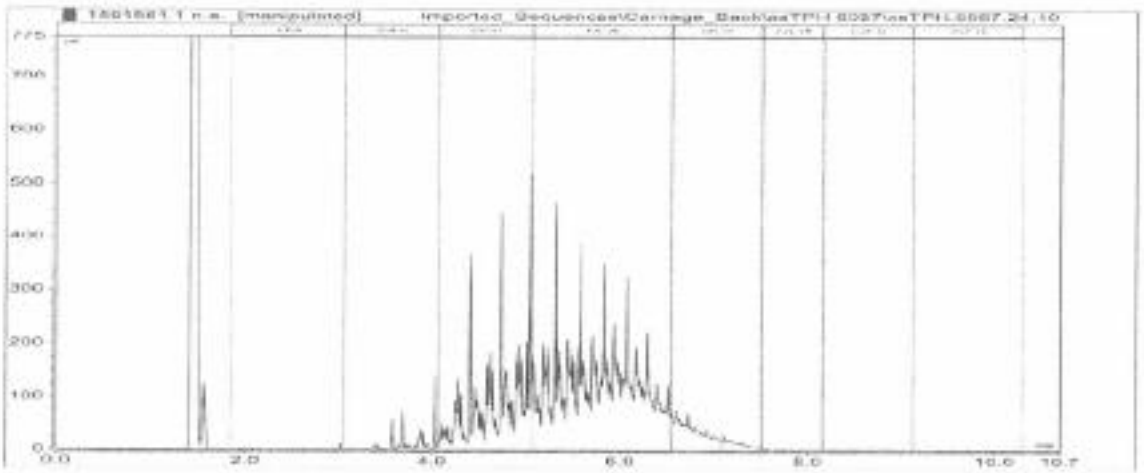
Sample Name:		Surrey Road Cell 1 [sub-sample for inorganics]]	Surrey Road Cell 2 [sub-sample for inorganics]			
Lab Number:		1591561.4	1591561.5			
Individual Tests						
Total Arsenic*	mg/kg as rcvd	6.6	3.4	-	-	-
Total Barium*	mg/kg as rcvd	290	440	-	-	-
Total Cadmium*	mg/kg as rcvd	0.11	0.06	-	-	-
Total Calcium*	mg/kg as rcvd	32,000	25,000	-	-	-
Total Chromium*	mg/kg as rcvd	16.0	7.8	-	-	-
Total Copper*	mg/kg as rcvd	31	16.8	-	-	-
Total Lead*	mg/kg as rcvd	61	25	-	-	-
Total Mercury*	µg/kg as rcvd	102	53	-	-	-
Total Nickel*	mg/kg as rcvd	9.4	6.6	-	-	-
Total Potassium*	mg/kg as rcvd	1,410	2,400	-	-	-
Total Zinc*	mg/kg as rcvd	45	26	-	-	-
Chloride*	mg/kg as rcvd	3,400	4,200	-	-	-
Total Nitrogen*	g/100g as rcvd	< 0.12	0.35	-	-	-

Sample Type: Sludge

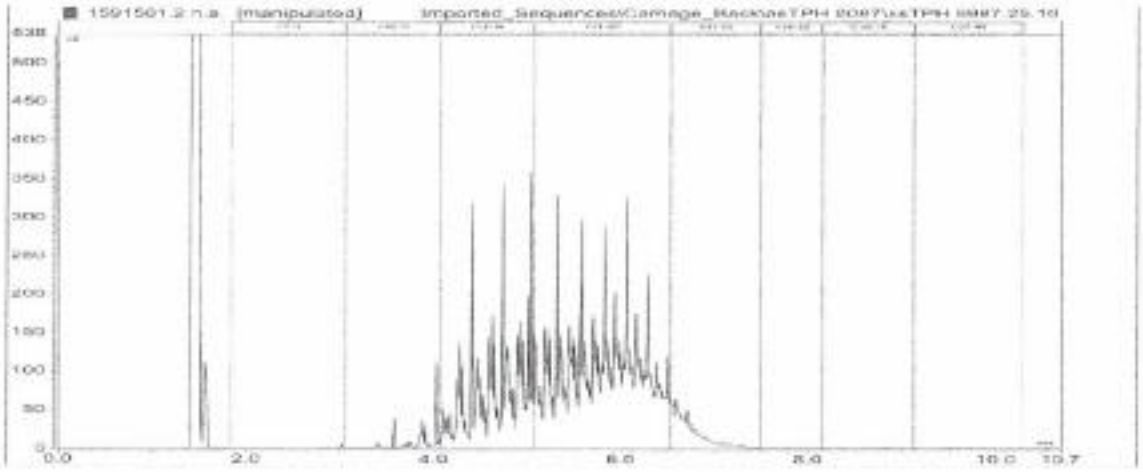
Sample Name:		Surrey Road Cell 1 19-Apr-2016 1:00 pm	Surrey Road Cell 2 20-Apr-2016 1:00 pm	Derby Road 20-May-2016 2:00 pm		
Lab Number:		1591561.1	1591561.2	1591561.3		
Individual Tests						
Dry Matter	g/100g as rcvd	52	40	65	-	-
Density*	g/mL at 20°C	1.19 #1	1.29 #1	1.48 #1	-	-
Total Recoverable Barium	mg/kg dry wt	-	-	2,200	-	-
Total Recoverable Calcium	mg/kg dry wt	-	-	120,000	-	-
Total Recoverable Magnesium	mg/kg dry wt	-	-	6,900	-	-
Total Recoverable Potassium	mg/kg dry wt	-	-	1,340	-	-
Total Recoverable Sodium	mg/kg dry wt	-	-	240	-	-
Chloride*	mg/kg dry wt	-	-	480	-	-
pH*	pH Units	-	-	9.9	-	-
Total Nitrogen*	g/100g dry wt	-	-	0.06	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	-	-	15	-	-
Total Recoverable Cadmium	mg/kg dry wt	-	-	0.13	-	-
Total Recoverable Chromium	mg/kg dry wt	-	-	87	-	-
Total Recoverable Copper	mg/kg dry wt	-	-	37	-	-
Total Recoverable Lead	mg/kg dry wt	-	-	10.8	-	-
Total Recoverable Mercury	mg/kg dry wt	-	-	< 0.10	-	-
Total Recoverable Nickel	mg/kg dry wt	-	-	35	-	-

Sample Type: Sludge						
Sample Name:		Surrey Road Cell 1 19-Apr-2016 1:00 pm	Surrey Road Cell 2 20-Apr-2016 1:00 pm	Derby Road 20-May-2016 2:00 pm		
Lab Number:		1591561.1	1591561.2	1591561.3		
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Zinc	mg/kg dry wt	-	-	91	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	0.14	< 0.3	< 0.12	-	-
Toluene	mg/kg dry wt	0.35	0.2	< 0.12	-	-
Ethylbenzene	mg/kg dry wt	0.29	< 0.3	< 0.12	-	-
m&p-Xylene	mg/kg dry wt	1.0	0.5	< 0.3	-	-
o-Xylene	mg/kg dry wt	0.37	0.2	< 0.12	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Acenaphthylene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Anthracene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Chrysene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Fluoranthene	mg/kg dry wt	< 0.5	0.8	< 0.4	-	-
Fluorene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.5	< 0.6	< 0.4	-	-
Naphthalene	mg/kg dry wt	5	6	< 1.6	-	-
Phenanthrene	mg/kg dry wt	2.6	4.4	0.5	-	-
Pyrene	mg/kg dry wt	< 0.5	1.8	< 0.4	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	660	490	< 110	-	-
C10 - C14	mg/kg dry wt	157,000	174,000	3,900	-	-
C15 - C36	mg/kg dry wt	310,000	330,000	86,000	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	470,000	510,000	90,000	-	-

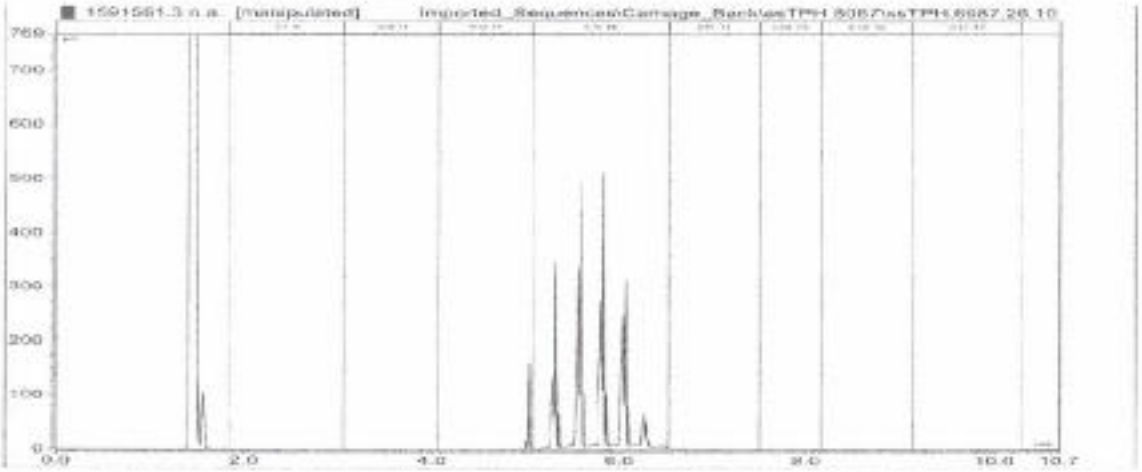
1591561.1
Surrey Road Cell 1 19-Apr-2016 1:00 pm
Client Chromatogram for TPH by FID



1591561.2
Surrey Road Cell 2 20-Apr-2016 1:00 pm
Client Chromatogram for TPH by FID



1591561.3
Derby Road 20-May-2016 2:00 pm
Client Chromatogram for TPH by FID



Analyst's Comments

It was observed that the container for sample 1591561/3 was not completely filled. Volatile loss may have occurred due to the headspace created in the container.

#1 Relative Density, Water.

Appendix No.1 - IPL mercury results

Appendix No.2 - IPL mercury results

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: Oil

Test	Method Description	Default Detection Limit	Sample No
Ashing and Aqua Regia digest	Ashing in Muffle furnace, Aqua Regia (HNO_3/HCl) digestion.	-	4-5
Total Arsenic*	Aqua Regia Digestion, ICP-MS	1.0 mg/kg as rcvd	4-5
Total Barium*	Aqua Regia Digestion, ICP-MS	0.2 mg/kg as rcvd	4-5
Total Cadmium*	Aqua Regia Digestion, ICP-MS	0.05 mg/kg as rcvd	4-5
Total Calcium*	Aqua Regia Digestion, ICP-MS	50 mg/kg as rcvd	4-5
Total Chromium*	Aqua Regia Digestion, ICP-MS	1.0 mg/kg as rcvd	4-5

Sample Type: Oil			
Test	Method Description	Default Detection Limit	Sample No
Total Copper*	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	4-5
Total Lead*	Aqua Regia Digestion, ICP-MS.	0.2 mg/kg as rcvd	4-5
Total Mercury*	Aqua Regia Digestion, reduction with Tin Chloride, analysis by Atomic Fluorescence (PSA Millenium Merlin). Subcontracted to IPL Ltd. ANC 010 - Method for the Determination of Ultra Trace Mercury in Hydrocarbon by Millenium Merlin.	20 µg/kg as rcvd	4-5
Total Nickel*	Aqua Regia Digestion, ICP-MS.	1.0 mg/kg as rcvd	4-5
Total Potassium*	Aqua Regia Digestion, ICP-MS.	50 mg/kg as rcvd	4-5
Total Zinc*	Aqua Regia Digestion, ICP-MS.	2 mg/kg as rcvd	4-5
Chloride in Oil / Water Emulsion*	Extraction of chloride using acid / alcohol mix. Back titration of silver nitrate against potassium thiocyanate. In-House method based on Vogel's Inorganic Analysis.	70 mg/kg as rcvd	4-5
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser]	0.05 g/100g as rcvd	4-5

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%.	-	1-3
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-3
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	3
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	1-3
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	1-3
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	1-3
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1-3
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	1-3
esICextn*	(1:5) ratio of sample (g) 0.02M potassium dihydrogen ortho-phosphate extractant (mL). analysis by Ion Chromatography. In House.	-	3
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	3
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-3
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	3
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	3
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	3
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	3
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	3
Chloride*	Ion Chromatography determination of es potassium phosphate extraction.	3 mg/kg dry wt	3
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	3
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	3

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

IPL
The best at all we test

Laboratory Test Report

Customer:	Graham Corban	**Copy to:**	
Address:	Hill Laboratories 1 Clyde Street Private Bag 3205 Hamilton East Hamilton	**Purchase Order:**	146972
		Customer Ref:	1591561/4
E-Mail:	EnvJobEnquiry@hill-labs.co.nz	**Product:**	Sludge

SAMPLES RECEIVED / WORK COMPLETED

One vial of sludge was received on 15th of June 2016, in a container supplied by Hill Labs.

The sample was homogenised and digested by closed vial aqua regia digestion (ANC-010) on 15th of June followed by combustion and quantification by hollow cathode absorption spectroscopic analysis (ANC-011) on 16th of June.

The sample was analysed in duplicate and the averaged result is quoted below.

Estimated limit of quantification for this sample is 3 ppb w/w.

RESULTS

Customer Reference	**1591561/4**
IPL Sequence No	**519998**
Mercury Content	**102 µg/kg (ppb w/w)**

Work completed and Reported by: (Steven Fawcett, *Analytical Technician*) Date: 16/06/2016

Checked by: (Tony Hockings, *Development Manager*) Date: 16/06/2016

IPL
The best at all we test

Laboratory Test Report

Customer:	Graham Corban	**Copy to:**	
Address:	Hill Laboratories 1 Clyde Street Private Bag 3205 Hamilton East Hamilton	**Purchase Order:**	146972
		Customer Ref:	1591561/5
E-Mail:	EnvJobEnquiry@hill-labs.co.nz	**Product:**	Sludge

SAMPLES RECEIVED / WORK COMPLETED

One vial of sludge was received on 15th of June 2016, in a container supplied by Hill Labs.

The sample was homogenised and digested by closed vial aqua regia digestion (ANC-010) on 15th of June followed by combustion and quantification by hollow cathode absorption spectroscopic analysis (ANC-011) on 16th of June.

The sample was analysed in duplicate and the averaged result is quoted below.

Estimated limit of quantification for this sample is 3 ppb w/w.

RESULTS

Customer Reference	1591561/5
IPL Sequence No	519999
Mercury Content	53 µg/kg (ppb w/w)

Work completed and Reported by: (Steven Fawcett, *Analytical Technician*) Date: 16/06/2016

Checked by: (Tony Hockings, *Development Manager*) Date: 16/06/2016

DISCLAIMERS

This report relates specifically to the samples as received.
The latest issue of the relevant test methods was used unless otherwise stated.
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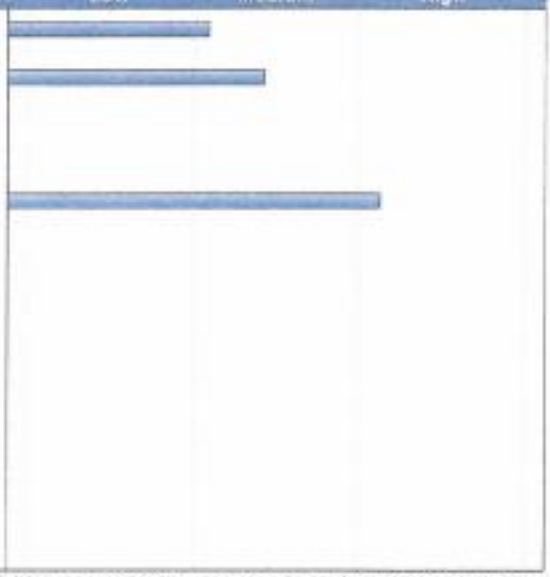
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 01 **Lab Number:** 1628206.1
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	5.8	5.8 - 6.2
Volume Weight	g/mL	0.77	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	16	
Total Nitrogen	%	0.78	0.30 - 0.60
Total Soluble Salts*	mg/L	65.8	
Electrical Conductivity (Sat Paste)*	mS/cm	0.1	
Nitrate-N (Sat Paste)*	mg/L	< 1	
Ammonium-N (Sat Paste)*	mg/L	2	
Phosphorus (Sat Paste)*	mg/L	2	
Potassium (Sat Paste)*	mg/L	15	
Calcium (Sat Paste)*	mg/L	7	
Magnesium (Sat Paste)*	mg/L	1	
Sodium (Sat Paste)*	mg/L	8	
Sodium Absorption Ratio*		0.7	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information.
IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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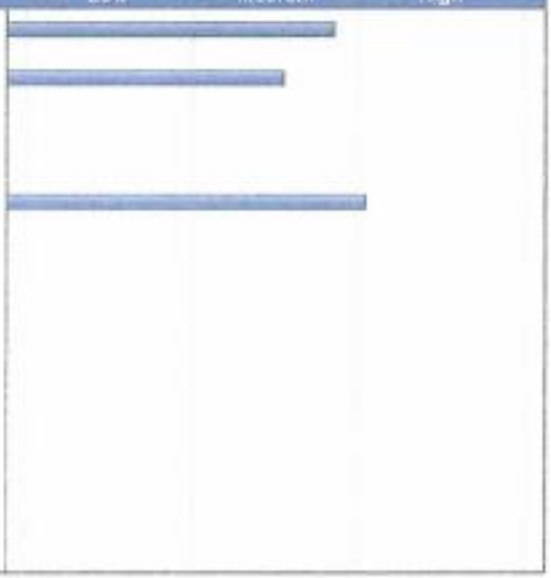
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 71 **Lab Number:** 1628206.2
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.1	5.9 - 6.2
Volume Weight	g/mL	0.82	0.83 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	45	
Total Nitrogen	%	0.66	0.30 - 0.60
Total Soluble Salts*	mg/L	165.0	
Electrical Conductivity (Sat Paste)*	mS/cm	0.2	
Nitrate-N (Sat Paste)*	mg/L	5	
Ammonium-N (Sat Paste)*	mg/L	4	
Phosphorus (Sat Paste)*	mg/L	6	
Potassium (Sat Paste)*	mg/L	27	
Calcium (Sat Paste)*	mg/L	22	
Magnesium (Sat Paste)*	mg/L	3	
Sodium (Sat Paste)*	mg/L	8	
Sodium Absorption Ratio*		0.4	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information.
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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 72 **Lab Number:** 1628206.3
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.1	5.8 - 6.2
Volume Weight	g/mL	0.72	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	65	
Total Nitrogen*	%	0.84	0.30 - 0.60
Total Soluble Salts*	mg/L	211	
Electrical Conductivity (Sat Paste)*	mS/cm	0.3	
Nitrate-N (Sat Paste)*	mg/L	19	
Ammonium-N (Sat Paste)*	mg/L	3	
Phosphorus (Sat Paste)*	mg/L	3	
Potassium (Sat Paste)*	mg/L	20	
Calcium (Sat Paste)*	mg/L	33	
Magnesium (Sat Paste)*	mg/L	4	
Sodium (Sat Paste)*	mg/L	8	
Sodium Absorption Ratio*		0.4	

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information.
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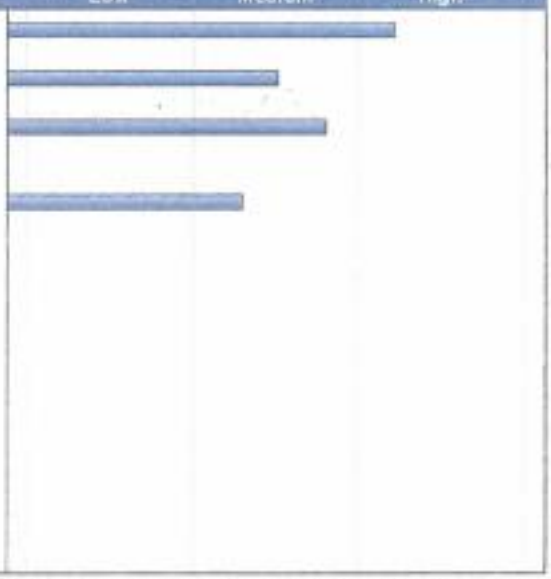
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600245A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 73 **Lab Number:** 1628206.4
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.4	5.9 - 6.2
Volume Weight	g/mL	0.81	0.80 - 1.00
Soluble Salts (Field)	%	0.25	0.05 - 0.30
Chloride	mg/kg	983	
Total Nitrogen	%	0.39	0.30 - 0.60
Total Soluble Salts*	mg/L	2,720	
Electrical Conductivity (Sat Paste)*	mS/cm	4.1	
Nitrate-N (Sat Paste)*	mg/L	1	
Ammonium-N (Sat Paste)*	mg/L	6	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	78	
Calcium (Sat Paste)*	mg/L	563	
Magnesium (Sat Paste)*	mg/L	42	
Sodium (Sat Paste)*	mg/L	94	
Sodium Absorption Ratio*		1.0	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information.
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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 39 **Lab Number:** 1628206.5
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	5.7	5.3 - 6.2
Volume Weight	g/mL	0.62	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	23	
Total Nitrogen	%	0.53	0.30 - 0.60
Total Soluble Salts*	mg/L	112.2	
Electrical Conductivity (Sat Paste)*	mS/cm	0.2	
Nitrate-N (Sat Paste)*	mg/L	5	
Ammonium-N (Sat Paste)*	mg/L	2	
Phosphorus (Sat Paste)*	mg/L	1	
Potassium (Sat Paste)*	mg/L	13	
Calcium (Sat Paste)*	mg/L	18	
Magnesium (Sat Paste)*	mg/L	2	
Sodium (Sat Paste)*	mg/L	7	
Sodium Absorption Ratio*		0.4	

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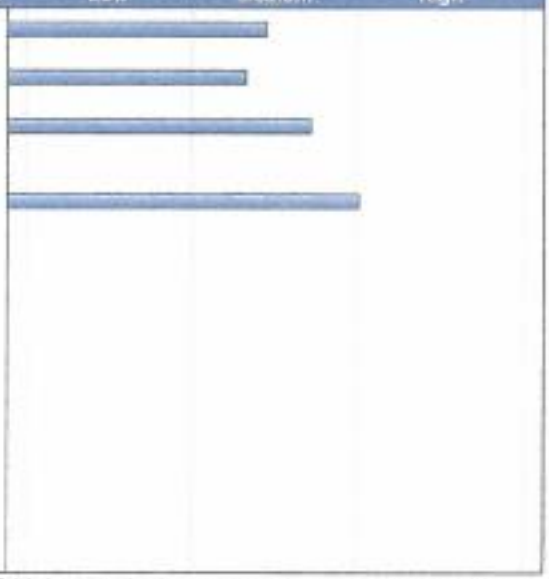
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 83 **Lab Number:** 1628206.6
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.0	5.8 - 6.2
Volume Weight	g/mL	0.73	0.63 - 1.00
Soluble Salts (Field)	%	0.23	0.05 - 0.30
Chloride	mg/kg	1,148	
Total Nitrogen	%	0.62	0.33 - 0.60
Total Soluble Salts*	mg/L	2,130	
Electrical Conductivity (Sat Paste)*	mS/cm	3.2	
Nitrate-N (Sat Paste)*	mg/L	1	
Ammonium-N (Sat Paste)*	mg/L	3	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	142	
Calcium (Sat Paste)*	mg/L	348	
Magnesium (Sat Paste)*	mg/L	31	
Sodium (Sat Paste)*	mg/L	88	
Sodium Absorption Ratio*		1.2	



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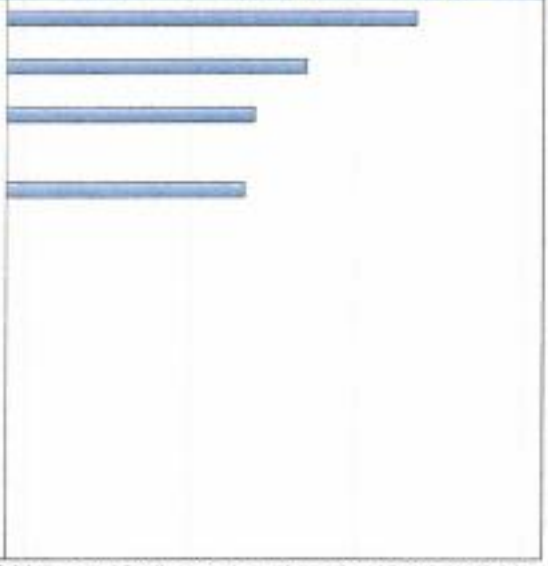
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 84 **Lab Number:** 1628206.7
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.6	5.8 - 6.2
Volume Weight	g/mL	0.88	0.60 - 1.00
Soluble Salts (Field)	%	0.15	0.05 - 0.30
Chloride	mg/kg	617	
Total Nitrogen	%	0.40	0.30 - 0.60
Total Soluble Salts*	mg/L	1,762	
Electrical Conductivity (Sat Paste)*	mS/cm	2.7	
Nitrate-N (Sat Paste)*	mg/L	< 1	
Ammonium-N (Sat Paste)*	mg/L	2	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	245	
Calcium (Sat Paste)*	mg/L	229	
Magnesium (Sat Paste)*	mg/L	12	
Sodium (Sat Paste)*	mg/L	98	
Sodium Absorption Ratio*		1.7	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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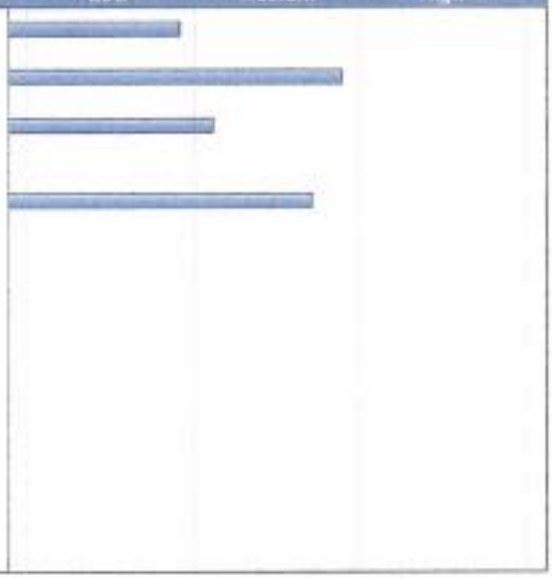
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 145 **Lab Number:** 1628206.8
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	5.7	5.8 - 6.2
Volume Weight	g/mL	0.96	0.80 - 1.00
Soluble Salts (Field)	%	0.06	0.05 - 0.30
Chloride	mg/kg	27	
Total Nitrogen	%	0.51	0.30 - 0.60
Total Soluble Salts*	mg/L	931	
Electrical Conductivity (Sat Paste)*	mS/cm	1.4	
Nitrate-N (Sat Paste)*	mg/L	108	
Ammonium-N (Sat Paste)*	mg/L	13	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	153	
Calcium (Sat Paste)*	mg/L	75	
Magnesium (Sat Paste)*	mg/L	10	
Sodium (Sat Paste)*	mg/L	41	
Sodium Absorption Ratio*		1.2	



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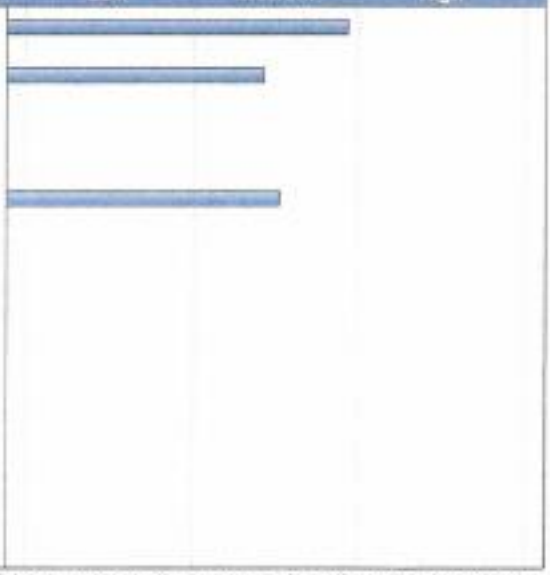
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100 Fitzroy New Plymouth 4341	**Date Received:**	09-Aug-2016
		Date Reported:	26-Aug-2016
		Quote No:	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

Sample Name: Paddock 146 **Lab Number:** 1628206.9
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.2	5.8 - 6.2
Volume Weight	g/mL	0.77	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	14	
Total Nitrogen	%	0.46	0.30 - 0.60
Total Soluble Salts*	mg/L	79.2	
Electrical Conductivity (Sat Paste)*	mS/cm	0.1	
Nitrate-N (Sat Paste)*	mg/L	3	
Ammonium-N (Sat Paste)*	mg/L	< 1	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	20	
Calcium (Sat Paste)*	mg/L	5	
Magnesium (Sat Paste)*	mg/L	< 1	
Sodium (Sat Paste)*	mg/L	5	
Sodium Absorption Ratio*		0.6	



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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628206
Address:	PO Box 7100	**Date Received:**	09-Aug-2016
	Fitzroy	**Date Reported:**	26-Aug-2016
	New Plymouth 4341	**Quote No:**	34979
		Order No:	M16600246A
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	R Henry

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-9
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-9
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-8
Total Nitrogen	Dumas combustion.	0.04 %	1-2, 4-9
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35.	0.05 %	1-9
Chloride	1:5 Soil:Saturated Calcium Sulphate extraction followed by Potentiometric Titration.	10 mg/kg	1-9
Total Nitrogen*	Determined by NIR, calibration based on Total N by Dumas combustion.	0.04 %	3
Total Soluble Salts*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	1.0 mg/L	1-9
Electrical Conductivity (Sat Paste)*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	0.1 mS/cm	1-9
Nitrate-N (Sat Paste)*	Saturated Paste extraction followed by Salicylate colorimetry.	1 mg/L	1-9
Ammonium-N (Sat Paste)*	Saturated Paste extraction followed by Berthelot colorimetry.	1 mg/L	1-9
Phosphorus (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-9
Potassium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-9
Calcium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-9
Magnesium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-9
Sodium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-9
Sodium Absorption Ratio (SAR)*	Calculation from the sodium, calcium and magnesium determined on a Saturated Paste extract.	0.2	1-9
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-9

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.

Andrew Whitmore BSc (Tech)
Client Services Manager - Agriculture

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628020 SPv1
Contact:	R Henry	**Date Received:**	09-Aug-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	26-Aug-2016
	PO Box 7100	**Quote No:**	31151
	Fitzroy	**Order No:**	M16600246A
	New Plymouth 4341	**Client Reference:**	
		Submitted By:	R Henry

Sample Type: Aqueous

Sample Name:	Surrey Road SW3 25-Jul-2016 11:00 am	Surrey Road SW3 Outlet 25-Jul-2016 11:00 am	Surrey Road SW3 Upstream 25-Jul-2016 11:00 am		
Lab Number:	1628020.1	1628020.2	1628020.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	-	-	-	-
pH pH Units	7.5	-	-	-	-
Total Suspended Solids g/m³	5	-	-	-	-
Sample Temperature* °C	20.0	-	-	-	-
Total Ammoniacal-N g/m³	0.31	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	< 2	< 2	< 2	-	-
Oil and Grease g/m³	6	-	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	< 0.05	-	-	-	-
Combined Chlorine g/m³	< 0.08	-	-	-	-

SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Free Ammonia*	Calculation from NH4N, pH, Temperature (Calculations based on data for distilled water). APHA Table 8010:VI 22nd ed. 2012.	0.010 g/m³ at Client Temperature	1
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
pH	pH meter. APHA 4500-H+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m³	1
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.1 °C	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at HE Laboratories - Microbiology: 1 Cow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-3
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1628021 SPv1
Contact:	R Henry	**Date Received:**	09-Aug-2016
	C/- Schlumberger New Zealand Limited	**Date Reported:**	26-Aug-2016
	PO Box 7100	**Quote No:**	34979
	Fitzroy	**Order No:**	M16600246A
	New Plymouth 4341	**Client Reference:**	
		Submitted By:	R Henry

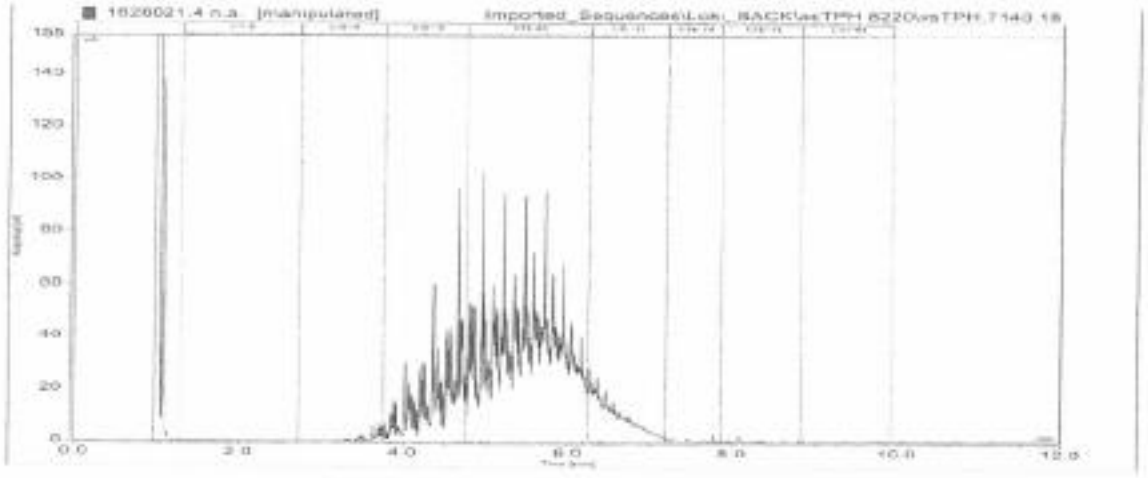
Sample Type: Soil

Sample Name:		Paddock 01 25-Jul-2016	Paddock 71 25-Jul-2016	Paddock 72 25-Jul-2016	Paddock 73 25-Jul-2016	Paddock 39 25-Jul-2016
Lab Number:		1628021.1	1628021.2	1628021.3	1628021.4	1628021.5
Individual Tests						
Dry Matter	g/100g as rcvd	55	59	57	67	49
Density*	g/mL at 20°C	0.59 [#1]	0.90 [#2]	0.84 [#2]	0.84 [#3]	0.76 [#3]
Total Recoverable Barium	mg/kg dry wt	230	360	230	3,700	70
Total Recoverable Sodium	mg/kg dry wt	490	550	560	490	370
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	< 2	3	< 2
Total Recoverable Cadmium	mg/kg dry wt	0.24	0.36	0.31	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	8	6	6	13	4
Total Recoverable Copper	mg/kg dry wt	41	34	32	83	30
Total Recoverable Lead	mg/kg dry wt	6.4	4.1	3.1	13.5	5.0
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	3	2	2	6	< 2
Total Recoverable Zinc	mg/kg dry wt	31	36	34	41	25
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.09	< 0.08	< 0.09	< 0.07	< 0.10
Toluene	mg/kg dry wt	< 0.09	< 0.08	< 0.09	0.09	< 0.10
Ethylbenzene	mg/kg dry wt	< 0.09	< 0.08	< 0.09	< 0.07	< 0.10
m&p-Xylene	mg/kg dry wt	< 0.18	< 0.16	< 0.17	< 0.14	< 0.2
o-Xylene	mg/kg dry wt	< 0.09	< 0.08	< 0.09	< 0.07	< 0.10
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Acenaphthylene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Anthracene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Benzo[a]anthracene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Benzo[k]fluoranthene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Chrysene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Fluoranthene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Fluorene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09
Naphthalene	mg/kg dry wt	< 0.5	< 0.19	< 0.4	< 0.16	< 0.5
Phenanthrene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	0.03	< 0.09
Pyrene	mg/kg dry wt	< 0.09	< 0.04	< 0.08	< 0.04	< 0.09

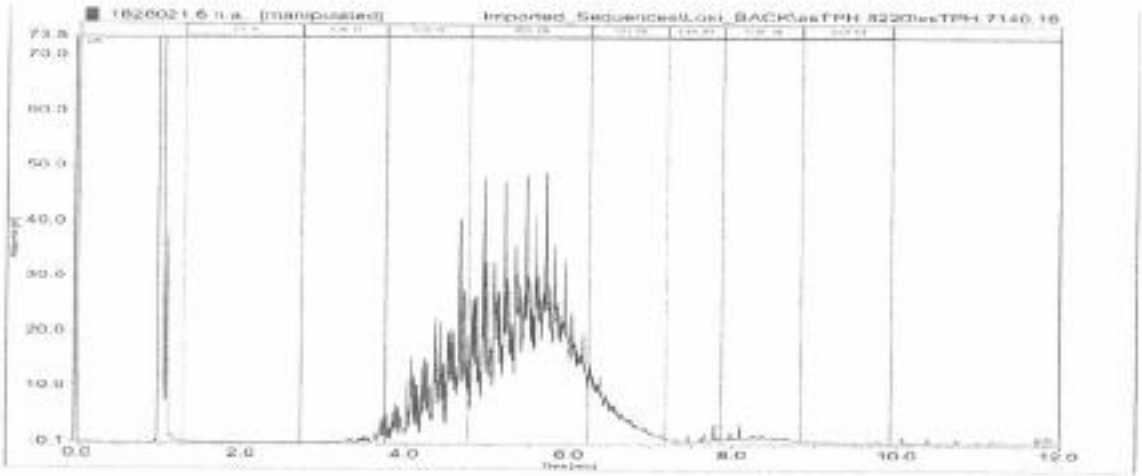
Sample Type: Soil						
Sample Name:		Paddock 01 25-Jul-2016	Paddock 71 25-Jul-2016	Paddock 72 25-Jul-2016	Paddock 73 25-Jul-2016	Paddock 39 25-Jul-2016
Lab Number:		1628021.1	1628021.2	1628021.3	1628021.4	1628021.5
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 30	< 12	< 30	< 10	< 30
C10 - C14	mg/kg dry wt	< 50	< 20	< 50	2,100	< 60
C15 - C36	mg/kg dry wt	< 100	< 50	< 90	7,000	< 110
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 170	< 80	< 160	9,100	< 190

Sample Name:		Paddock 83 25-Jul-2016	Paddock 84 25-Jul-2016	Paddock 145 25-Jul-2016	Paddock 146 25-Jul-2016	
Lab Number:		1628021.6	1628021.7	1628021.8	1628021.9	
Individual Tests						
Dry Matter	g/100g as rcvd	57	61	48	66	-
Density*	g/mL at 20°C	0.77 [#4]	0.77 [#5]	0.63 [#3]	0.90 [#3]	-
Total Recoverable Barium	mg/kg dry wt	1,990	4,600	181	97	-
Total Recoverable Sodium	mg/kg dry wt	560	610	590	430	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	< 2	3	< 2	< 2	-
Total Recoverable Cadmium	mg/kg dry wt	0.14	< 0.10	0.35	0.11	-
Total Recoverable Chromium	mg/kg dry wt	6	8	5	5	-
Total Recoverable Copper	mg/kg dry wt	43	53	43	43	-
Total Recoverable Lead	mg/kg dry wt	8.6	23	5.8	6.8	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	3	5	2	< 2	-
Total Recoverable Zinc	mg/kg dry wt	33	36	26	51	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.09	< 0.06	< 0.11	< 0.07	-
Toluene	mg/kg dry wt	< 0.09	< 0.06	< 0.11	< 0.07	-
Ethylbenzene	mg/kg dry wt	< 0.09	< 0.06	< 0.11	< 0.07	-
m&p-Xylene	mg/kg dry wt	< 0.17	< 0.16	< 0.3	< 0.14	-
o-Xylene	mg/kg dry wt	< 0.09	< 0.06	< 0.11	< 0.07	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Benzo[a]anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.04	0.04	< 0.09	< 0.04	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Chrysene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Fluoranthene	mg/kg dry wt	< 0.04	0.12	< 0.09	< 0.04	-
Fluorene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	< 0.04	< 0.09	< 0.04	-
Naphthalene	mg/kg dry wt	< 0.2	< 0.19	< 0.5	< 0.17	-
Phenanthrene	mg/kg dry wt	< 0.04	0.21	< 0.09	< 0.04	-
Pyrene	mg/kg dry wt	< 0.04	0.15	< 0.09	< 0.04	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 12	< 12	< 30	< 11	-
C10 - C14	mg/kg dry wt	1,500	12,700	< 60	< 30	-
C15 - C36	mg/kg dry wt	5,000	23,000	< 110	< 50	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	6,500	36,000	< 190	< 80	-

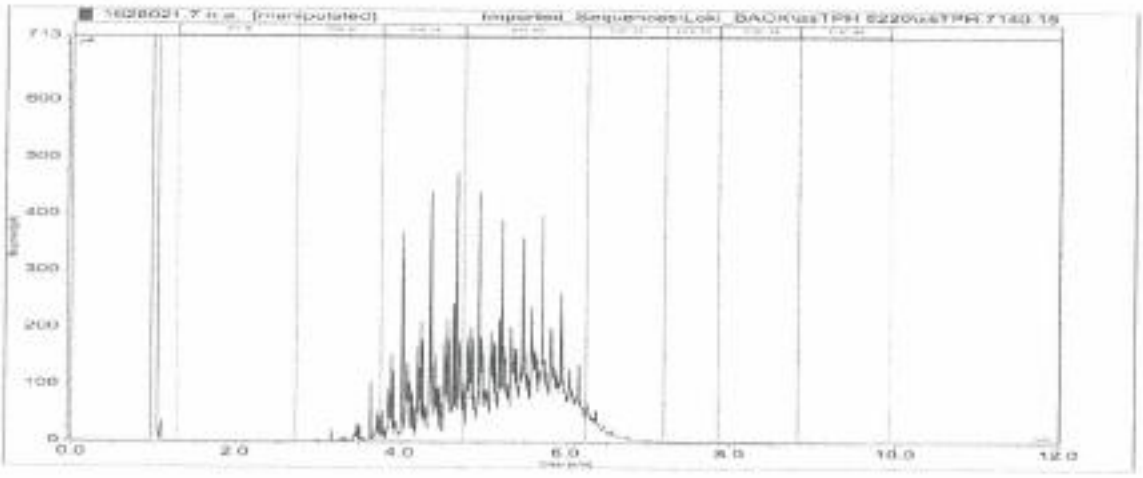
1628021.4
Paddock 73 25-Jul-2016
Client Chromatogram for TPH by FID



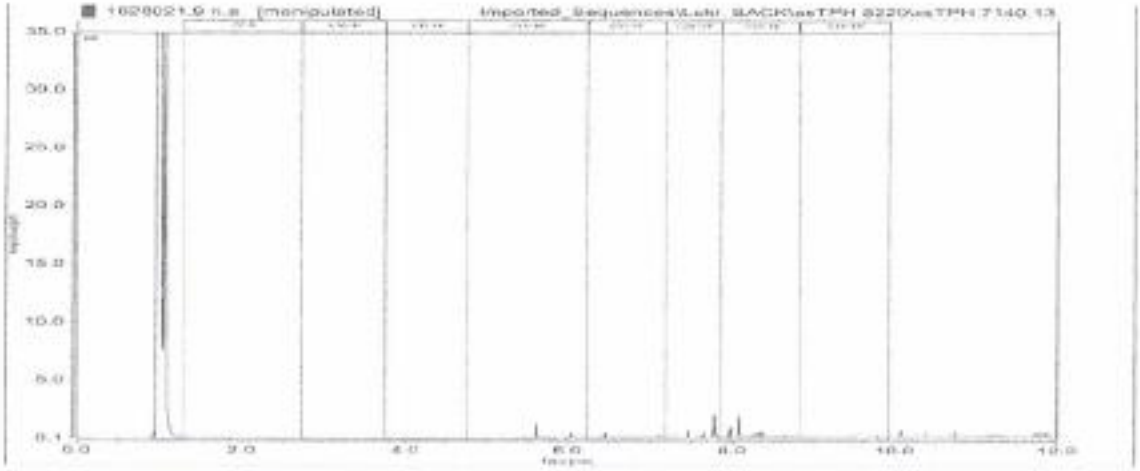
1628021.6
Paddock 83 25-Jul-2016
Client Chromatogram for TPH by FID



1628021.7
Paddock 84 25-Jul-2016
Client Chromatogram for TPH by FID



1628021.9
Paddock 146 25-Jul-2016
Client Chromatogram for TPH by FID



Analyst's Comments

It was observed that the container for sample 1628021.1 was not completely filled. Volatile loss may have occurred due to the headspace created in the container.

The matrix in sample 1628021.4 has affected the System Monitoring Compound Anthracene-d10 in the PAH analysis, whereby the recovery was 126%. Therefore the results may be over-estimated for compounds like Anthracene.

#1 Bulk Density. Minimal Sample.

#2 Bulk Density. Minimal sample.

#3 Bulk Density.

#4 Bulk Density. Large piece of bark not sampled.

#5 Bulk Density. Large stone not sampled.

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-9
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,28687,3629]	0.05 - 0.10 mg/kg dry wt	1-9
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	1-9
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	1-9
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1-9
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	1-9
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-9
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	1-9

Sample Type: Soil			
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	1-9

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