CD Boyd Drilling Waste Stockpiling Landfarm/Landspreading Monitoring Programme Annual Report 2016-2017

Technical Report 2017-10

ISSN: 1178-1467 (Online)
Document: 1847086 (Word)
Document: 1972430 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

March 2018

Executive summary

Colin Boyd (the consent holder), in conjunction with MI SWACO, operates two drilling waste stockpiling facilities and a landspreading operation on his property, near Inglewood, within the Waitara catchment. The sites are located on adjoining properties off Derby Road North and Surrey Road. Drilling waste, consisting of water based and synthetic based drilling muds are stockpilied at the Surrey Road facility, while the now retired stockpiling facility of Derby Road has recently been turned into a landfarmed area. Material from both sites (when Derby Road was actively stockpiling) were then landfarmed across the consent holder's property.

This activity to date has encompassed 65 paddocks. In the 2016-2017 monitoring period no new material was received at Surrey Road. The only landfarming to be undertaken this period was the re-working of a previous landfarmed paddock and the farming of the residual drilling mud which had been in storage for longer than four years at the now retired, Derby Road stockpiling facility.

This report for the period July 2016 to June 2017 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the consent holder's environmental and consent compliance performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of 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 Ltd. These four consents include a total of 64 conditions. The conditions set out the requirements that the consent holder must satisfy. The consent holder holds one consent to discharge stormwater into the Mangamawhete Stream, and three consents to stockpile and landfarm drilling waste to land.

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 16 inspections, 39 water samples and six soil samples collected for physicochemical analysis. In addition, four biomonitoring surveys of receiving waters of the unnamed tributaries of the Mangatengehu Stream and Mangamawhete Stream were also undertaken.

The monitoring indicated that the activities at the Derby Road facility had no significant environmental effect. Revegetation of the now landfarmed Derby Road site is yet to be undertaken and will be monitored in the upcoming period.

Surrey Road stockpiling facility appears to have had a detrimental effect on the in-stream communities below the discharge location in the unnamed tributary of the Mangatengehu Stream. This may be in part attributed to the removal of an engineering control installed two periods before by the site management. Groundwater monitoring did not identify any contaminants of concern; however, pH monitoring has indicated a potential reducing environment in the down gradient monitoring wells. The addition of a pipe sampling location this period indicated total petroleum hydrocarbons (TPH) within the sample on all four occasions. Note the corresponding discharge sample did not identify any measurable TPH, above the limit of detection.

One paddock was re-worked this period, as the initial landfarming exercise required additional augmentation. Soils samples were collected by the Council, with no exceedance in consent conditions observed in the results. However one paddock, which was sampled had not been recorded by the consent holder. This will require additional investigation in the upcoming monitoring period. To date 65 paddocks have been utilised by the consent holder since inception in 2006. Surrender sampling of these paddocks is proposed in the upcoming monitoring period to assess how close these areas are to being surrendered.

There was one recorded non-compliance in respect of this consent holder during the period under review, where by the consent holder was under abatement notice to undertake farming of residual material which had been in storage at the Derby Road stockpiling facility for longer than the consented one year. The material has now been landfarmed.

During the year, the consent holder demonstrated a good level of environmental performance, however an improvement is required for administrative performance with the resource consents.

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

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

This report includes recommendations for the 2017-2018 year.

Table of contents

List of tables

List of figures

List of photos

1. Introduction

1.1. Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1. Introduction

This report is for the period July 2016 to June 2017 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Colin Boyd (hereafter the consent holder) and his subsidiary company, Surrey Road landfarms Ltd. The consent holder operates two stockpiling facilities, Derby Road stockpiling facility and Surrey Road stockpiling facility; while Surrey Road Landfarms hold consent for the application of the material to land.

MI SWACO Company operates the Surrey Road stockpiling facility and associated landspreading on behalf of the consent holder, where as the Derby Road stockpiling facility, which has been closed to the receipt of new landfarmable material for the last four years, is managed by 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. The application areas, in terms of where material is landfarmed/landspread are located between these two stockpiling facilities (indicated as the red area in Figure 1).

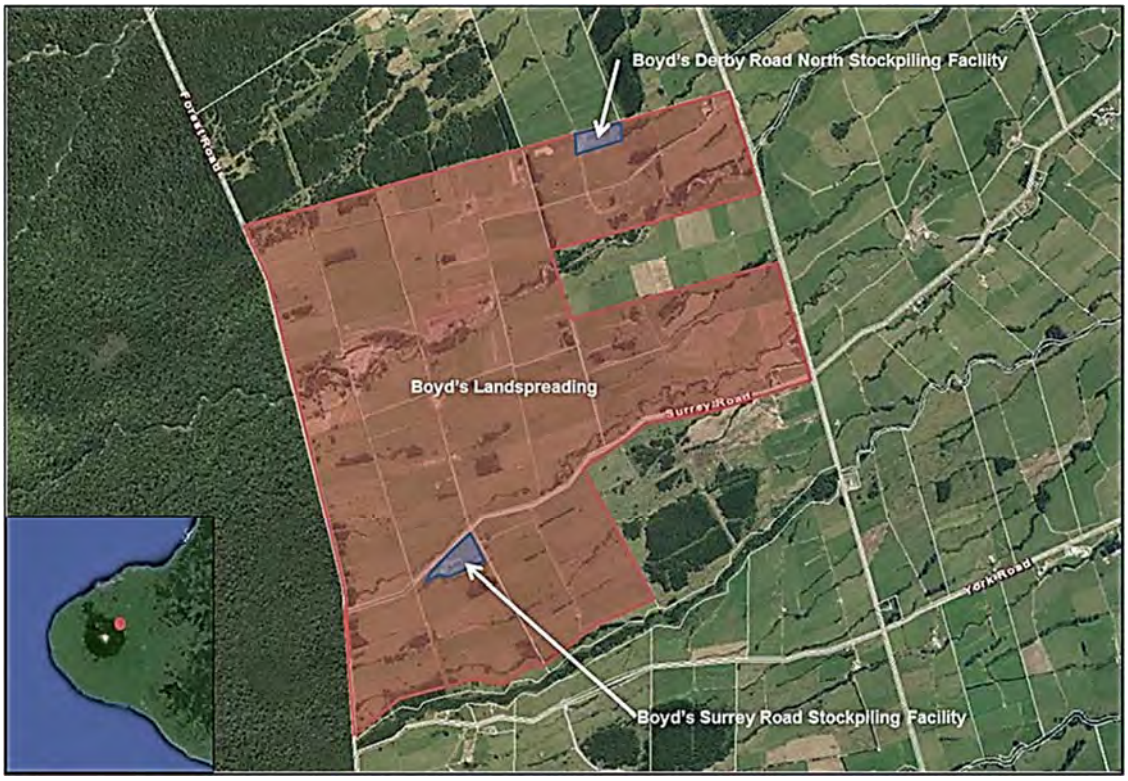


Figure 1 Derby and Surrey Road stockpiling facilities with associated landspreading area

The report includes 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 drilling material within the Waitara catchment.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This

report discusses the environmental effects of the consent holder's use of water and land, and is the eighth combined annual report by the Council for the consent holder.

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 Waitara catchment;
- 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 catchment.

Section 2, 3 and 4 presents the results of monitoring during the period under review, including scientific and technical data.

Section 5 discusses the results, their interpretations, and their significance for the environment.

Section 6 presents recommendations to be implemented in the 2017-2018 monitoring year.

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

1.1.3. The Resource Management Act 1991 and monitoring

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

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

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

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

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

e. risks to the neighbourhood or environment.

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

1.1.4. Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by 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 holder's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

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

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

Environmental Performance

High: No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

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

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

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

Administrative performance

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

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

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

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

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

1.2. Process description

1.2.1. 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 levelled 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.

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 the soil post landspreading

1.3. Resource consents

1.3.1. Water discharge permit

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

The consent holder holds water 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.

1.3.2. 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.

The consent holder 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.

The consent holder 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 Ltd 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 RMA. 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.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consent(s) which are appended 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 stockpiling facilities of Derby and Surrey Roads and the associated landspreading areas 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 consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3. Site inspections

The consent holder's stockpiling facilities and associated landspreading area were visited a combined 16 times this monitoring period. Additional inspections were also undertaken during sampling rounds for groundwater, surface water and soil sampling. 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) throughout the monitoring period. This is to assess 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 an extracted soil core

The analysis undertaken by the Council is provided in Table 1. Each transect is GPS referenced to allow for areas to be characterised 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, groundwater, discharge and soil 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 bores 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 stabilisation 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 location 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.

In an active stockpiling year, MI SWACO would undertake pre-screening analysis of the material which they received on site.

This includes the collection of representative samples of the material which are then analysed by an independent laboratory for specific analytes (RJ Hill laboratory in Hamilton in this case). This is undertaken for all drilling material brought to the primary stockpiling site of Surrey Road.

In the previous monitoring year, MI SWACO undertook sampling of the final consolidated drilling material, (of which there is over 150 m^3 of material still to be landfarmed) contained in the non-active Derby Road stockpiling facility. This material which has been storage for a prolonged period of time (greater than two years) is required to be landfarmed. The analysis is provided in the MI SWACO annual report. This report is attached in Appendix III.

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:

Table 2 MI SWACO soil analytes

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.

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 1,000 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 analysed. 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 (RFWP). 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 with sample locations and regional inset

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

26 August 2016

At the time of the inspection. The wind was from the west, approximately 3 m/s. No objectionable odours or visible emissions were found during the inspection of the Derby Road storage site. No recent site activities had occurred. No works had been undertaken to landfarm the muds which have been on-site for longer than a year. The staff outlined to the Council that due to poor weather the landfarming had been delayed until early spring. An extension to EAC 20834 had been granted until 1 November 2016.

The storage cells which contained the muds had their cell walls cut through to drain all stormwater out in preparation for the spreading. The receiving stormwater ponds were clear and free of any observable hydrocarbon sheen. The final pond was observed to be discharging a clear liquid at the time of inspection. No adverse effects were observed in the receiving waters.

04 October 2016

At the time of the inspection. The wind was from the west; approximately 4 m/s. No objectionable odours or visible emissions were found during the inspection. The Derby Road storage site was inspected. The discharge into the receiving waters from the final stormwater pond was observed and defined as clear. No deleterious effects were observed in the receiving waters. No works had occurred to spread any of the drilling mud stored at the site. Areas where drilling muds had been previously spread were found to have good pasture cover which appeared healthy. On inspection very little mud was identified within the soil profile within the test pits.

The following action was required be undertaken: Undertake works to spread all drilling muds stored for longer than one year in a manner compliant with resource consent conditions.

16 November 2016

At the time of inspection. The wind was from the north west, approximately 5 m/s. No objectionable odours or visible emissions were found during the inspection. Historic drilling muds remained stockpiled across four

pits at the site upon observation. Localised mud type, hydrocarbon odours were noticeable immediately downwind of the storage pits.

At the time all skimmer pipes had been dug out. No hydrocarbon sheens were observed on any of the observed ponded water or stormwater treatment ponds. The discharge from the final treatment pond was described as clear. No adverse effects were observed within the receiving waters. The water treatment sludge also remained stored at the site. At the time of inspection no works had been undertaken to spread any materials stored at the site.

22 February 2017

At the time of inspection. The wind was from the west, approximately 2 m/s. No objectionable odours or visible emissions were found during the inspection. The inspection was undertaken with the consent holder. Discussions were held with consent holder around the spreading of the residual muds and the associated timeframes in which to undertake the proposed works.

The consent holder outlined that it had been far too wet this summer to prepare paddocks or spread anything. At the time, three original pits contained muds and a smaller pit in the north west corner of the site also contained muds. All other pits contained water treatment sludge.

Discussions were held regarding removing/stockpiling the muds and sludge, levelling out the pits and spreading the materials across the storage area prior to incorporation. The activity would negate the need to prepare any paddocks and will result in the storage area being returned to pasture.

Approximately 1,000 m^3 of muds remained within the pits and the spreading area will be approximately 1.4 hectares. This should suffice when considering required buffer distances.

The consent holder outlined his intention to keep the perimeter drain and treatment ponds to capture any run-off from the spreading area. If the space available is not sufficient, the area below the ponds may also be used.

The cut-off drain at the western end of the storage area will also be kept to prevent groundwater flow through the site. More water treatment sludge is available at other storage areas to help improve soil structure if required and topsoil can also be sourced from other areas of the farm.

The pH of the soil will need to be kept above 5.5 (pH) to prevent mobilisation/toxicity effects from the aluminium within the water treatment sludge. It was suggested that ample lime be incorporated at the same time as the water treatment sludge.

The activity was expected to last for five days and was to occur during fine weather. No discharge from the stormwater treatment ponds was occurring at the time of inspection. No adverse effects were observed within the receiving waters.

31 March 2017

The wind direction was northerly at the time of inspection, approximately 2 m/s. No objectionable odours or visible emissions were found during the inspection.

Paddock 84 had recently been re-worked and sown into pasture which had a good strike response. In comparison to the observed paddock 84 in the November 2016 inspection, no drilling mud was observed at the surface of the reworked paddock.

The run-off into the farm drain was observed and determined to be clear. No adverse effects were observed in the receiving waters. All other historic spreading areas (other than around the northern side of the quarry) had good pasture cover which appeared healthy.

At the Derby Road facility, works had commenced on excavating the muds and sludges from the storage pits. The material was at the time being stockpiled on the northern side of the site prior to contouring works occurring.

The perimeter drain was noted which conveyed run-off into the treatment ponds. The discharge from the stormwater treatment pond was observed and found to be clear. The receiving waters had observable prevalent iron oxide staining on the bed material. No hydrocarbon sheen or other adverse effects were observed to be occurring at the time of inspection and the waterbody was running clear. The proposed work was expected to last approximately one week.

11 April 2017

At the time of inspection the wind was from the north, 2 m/s. No objectionable odours or visible emissions were found during the inspection. No works were occurring at the Derby Road storage area at the time of inspection. Two pits were observed to contain mud. The excavated materials had been stockpiled along the northern perimeter. The bund was effectively containing the muds and sludge. The spreading areas at the top of the site had been levelled out. A perimeter drain was conveying minor run-off into the treatment ponds which were clear, no discharges into the receiving waters were occurring.

12 May 2017

The wind was from the south at approximately 4 m/s with recent heavy rain at the time of inspection. The Derby Road site was too wet to continue working. All pits had been excavated and spread. A small amount of sludge was left to be incorporated in the area adjacent to the stormwater ponds. Ring drains were present around the spreading area, with all run-off directed into the pond system. Both ponds were observed and found to be clear. The discharge into the receiving waters found to have no adverse effects. At the time the receiving waters were in high flow and slightly turbid, though no foaming was observed. At the time a bull-dozer and power harrow were on-site.

26 May 2017

At the time of inspection the wind was from the north, approximately 1 m/s. No objectionable odours or visible emissions were found during the inspection. The storage pits were observed and found to have filled with stormwater to varying levels, though no discharges were occurring. No works had occurred to spread the material stored at the sites.

All adjacent drains and streams were observed to be running clear. All storage pits have been excavated, the muds and sludge had been spread out and bunded. The perimeter drain on the southern side was observed to be directing all run-off into the stormwater ponds. No hydrocarbon sheen was found on observation. The discharge into receiving water was described as clear and no adverse effects were observed.

Power harrows were on-site at the time of inspection though the proposed material was to be incorporated when it dried out further.

2.3. Results of receiving environment monitoring

2.3.1. Drilling mud deliveries/ stockpiled

The Derby Road stockpiling facility is closed to the receipt of drilling material. In this period the consent holder manoeuvred to landfarm the residual drilling material, estimated to be in the region of approximately 1,000 m^3+/-, (which had been in storage for longer than two years) to land. This material was farmed inside the Derby Road stockpiling facility site boundaries. It also included water treatment sludge which the consent holder had been dewatering under the practice of lagooning.

For future monitoring programme this area will be treated as a landfarmed area and will be monitored until consent surrender conditions are achieved as defined in consent 6900-2.

2.3.2. Stormwater

The facility holds stormwater discharge consent 7911-1; to discharge stormwater from drilling waste storage into the unnamed tributary of the Mangamawhete Stream. In this monitoring period a discharge sample was attempted, though no sample was obtainable.

2.3.3. Council groundwater monitoring

Three groundwater monitoring wells remain active on the Derby Road site. These wells were sampled on four occasions this monitoring period. The analysis is provided in the following Tables 3-5.

Table 3 Derby Road monitoring well GND2060 2016-2017

Groundwater	Site	GND2060	GND2060	GND2060	GND2060
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.025	0.023	0.022	0.022
Barium (dissolved)	g/m³	0.024	NR	0.019	0.021
Chloride	g/m³	7.8	7.8	6.5	3.7
Conductivity	mS/m@20°C	6	5.7	5.6	4.3
Sodium	g/m³	5.3	6	5.2	3.5
Nitrate/nitrite nitrogen	g/m³ N	0.02	0.02	<0.01	<0.01
pH	pH	5.7	5.9	5.9	5.6
Level	m	2.649	2.754	2.661	2.652
Temperature	°C	14.2	14.6	13.8	12
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.10	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	46.4	44.1	43.3	33.3

Table 4 Derby Road monitoring well GND2061 2016-2017

Groundwater	Site	GND2061	GND2061	GND2061	GND2061
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.066	0.19	0.1	0.052

Groundwater	Site	GND2061	GND2061	GND2061	GND2061
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Barium (dissolved)	g/m³	0.066	0.19	0.08	0.052
Chloride	g/m³	67.5	171	83.7	44.7
Conductivity	mS/m@20°C	36.2	63.5	38.5	27.2
Sodium	g/m³	12.2	28.7	15.4	9.2
Nitrate/nitrite nitrogen	g/m³ N	0.01	<0.01	0.01	<0.01
pH	pH	6	6.2	6.3	6.1
Level	m	1.709	1.948	1.722	1.624
Temperature	°C	14.6	14.6	14.4	13.1
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.10	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	280.1	491.3	297.9	210.4

Table 5 Derby Road monitoring well GND2062 2016-2017

Groundwater	Site	GND2062	GND2062	GND2062	GND2062
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.057	0.057	0.11	0.058
Barium (dissolved)	g/m³	0.054	NR	0.07	0.055
Chloride	g/m³	9	18.8	28	31.7
Conductivity	mS/m@20°C	8.9	9.9	17	17.4
Sodium	g/m³	4.8	5.5	5.7	6.8
Nitrate/nitrite nitrogen	g/m³ N	0.02	0.04	0.01	0.54
pH	pH	5.6	5.7	6	5.8
Level	m	1.234	1.49	1.224	0.888

Groundwater	Site	GND2062	GND2062	GND2062	GND2062
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Temperature	°C	15.8	16.1	15.3	13.6
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.10	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	68.9	76.6	131.5	134.6

Groundwater monitoring of Derby Road stockpiling facility in the 2016-2017 period indicated negligible impacts as process of the exercise of this consent.

- No hydrocarbon impacts were noted in any of the four rounds undertaken.
- All petroleum hydrocarbon analysis, including associated benzene, toluene, ethylbenzene and xylenes (BTEX) were found below the limit of detection in all three wells, across the four rounds undertaken.
- Total dissolved salt (TDS) concentrations were similarly low, though a slight increase was observed in GND2061 (491 g/m³ TDS) in the March 2017 sample. A similar increase was also seen in chloride concentrations within the same sample.
- pH monitoring indicated that the up gradient monitoring well, GND2060 and the lower monitoring bore, GND2062 were reducing in pH concentration. GND2060 was noted to range between 5.6-5.9 pH in the four monitoring rounds undertaken. While GND2062 ranged from 5.6-6.0 pH. GND2061 ranged 6.0-6.3 pH.

2.3.4. Derby Road surface water

An unnamed tributary of the Mangamawhete Stream flows adjacent to the southern boundary of the facility (Figure 2). The Council undertook one surface water sampling round this period. The results are provided in the following Table 6. No discharge to the tributary was occurring at the time of the surface water sampling, thus no discharge sample was collected.

Table 6 Derby Road surface water sampling 2016-2017

Surface water	Site	MMW000161	MMW000162	MMW000163
Parameter	Collected	09 Jun 2017	09 Jun 2017	09 Jun 2017
Barium (acid soluble)	g/m³	0.022	0.024	0.025
Bio-chemical oxygen demand	g/m³	NR	<0.5	<0.5
Chloride	g/m³	5.8	6	6.6

Surface water	Site	MMW000161	MMW000162	MMW000163
Parameter	Collected	09 Jun 2017	09 Jun 2017	09 Jun 2017
Conductivity	mS/m@20°C	10.1	10.3	10.2
pH	pH	7.3	7	7.3
Temperature	°C	8.7	9.1	9.3
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	78.1	79.7	78.9

A singular monitoring round of the unnamed tributary of the Mangamawhete Stream was undertaken in the 2016-2017 monitoring period. Three locations were sampled on one occasion.

The results are presented above in Table 6.

- The results indicate negligible impacts as a result of the exercise of the consent.
- Specifically, all petroleum hydrocarbon analysis, including associated benzene, toluene, ethylbenzene and xylenes (BTEX) were found below the limit of detection.

2.3.5. Biological monitoring

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. Two surveys were conducted, one in late spring, December 2016 and the follow up, in summer, February 2017. A brief synopsis of both surveys is provided below the methods section. The reports in full are attached in Appendix II.

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 7 and Figure 3.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Figure 3) to collect streambed macroinvertebrates on 22 December 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 7 Biomonitoring locations in relation to the unnamed tributary of the Mangamawhete Stream

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 3 Biomonitoring sites in the unnamed tributary of the Mangamawhete Stream

Summary of the late spring biomonitoring 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 of the Mangamawhete Stream surveyed. MCI values were similar to or better than the median values recorded by each site and indicated 'fair' to 'good' biological health in the Mangamawhete Stream.

Summary of the late summer 2017 biomonitoring 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 of the

Mangamawhete Stream surveyed. MCI values were similar to or better than the median values recorded by each site and indicated ‘fair’ to ‘very good’ biological health in the Mangamawhete Stream.

3. Surrey Road stockpiling facility

3.1. Site description

The Surrey Road stockpiling facility (Figure 4) is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. An unnamed tributary of 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 WBM and SBM) 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 4 Surrey Road stockpiling facility with associated sample locations and regional inset

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. Inspections

26 August 2016

At the time of inspection no site activity was observed to have occurred. The mud tanks adjacent to the entrance remained empty. It was observed that the fibreglass roof had blown off one tank and was found within the adjacent lined bund. Both bunds were free of muds and surface hydrocarbons and the liners appeared in good repair.

All mud storage cell liners appeared in good repair, and all pits cells were full of stormwater with a minor surface hydrocarbon sheen. At the time the skimmer pipes were discharging into the third lined cell. No irrigation was occurring at the time due to the recent weather. The discharge from the cell into the ring drain was clear and free of any observable hydrocarbon sheen, though some minor foaming was observed to be occurring below the outlet pipe. This was observed to clear before the first stormwater pond.

The drainage pipe from under the lined cells was discharging clear liquid and no hydrocarbon sheen or foaming was present in the receiving drain. Both the receiving ponds had an observable hydrocarbon surface sheen. No adverse effects were noted in the receiving waters which were in high flow.

Approximately 1,800 litres of skimmed hydrocarbons remained onsite in the bulk storage tank.

04 October 2016

During the inspection the wind was from the west approximately 7 m/s. No objectionable odours or visible emissions were found during the inspection. The Surrey Road storage area was inspected. At the time no recent storage activities had occurred at the site. All lined pits were full of stormwater, and essentially no surface hydrocarbons were noted to be present.

The irrigation equipment was not in use due to bad weather. The discharge into the drain from the third lined storage pit was approximately 1 L/Min. The final stormwater pond was at the time discharging clear liquid into the receiving waters which were in high flow, no adverse effects were observed.

22 February 2017

At the time of inspection. No recent storage activities had occurred. All storage pits contained stormwater only. The liner of pit three was observed to be inflated in places above the water line, although bar this, all liners appeared in good repair and the stormwater was observably free of any hydrocarbon sheen.

A vertical silo lid had blown off into the bund but the tanks had been emptied. The skimmed oil remained stored onsite in the bulk fuel cell. The discharge from the buried pipe under the pits was free of hydrocarbon sheen. The final stormwater treatment pond was discharging clear, no adverse effects were observed within the receiving waters.

31 March 2017

The following was noted: No recent storage activities had occurred and all lined pits remained empty except for stormwater and residual muds on the liner. Very little surface hydrocarbons were observed present in the pits. No discharges onto land or into surface water were occurring from any of the storage pits at the time.

The pipe under the pits was noted again to be discharging hydrocarbons into the receiving drain and the first receiving pond had minor hydrocarbon sheen. The discharge from the final pond however was clear and no adverse effects were noted to be occurring in the receiving waters at the time of inspection.

The bulk fuel tank remained onsite and contained previously skimmed hydrocarbons, vertical storage tanks remained empty.

3.3. Results of receiving environment monitoring

3.3.1. Surrey Road groundwater monitoring

Surrey Road stockpiling facility contains a groundwater monitoring well network comprised of three monitoring wells. These three wells were a consented obligation and were installed in 2009 prior to the delivery of landfarmable material, as defined by the consent. A pipe sample was also obtained from a pipe which flowed from under the lined storage pit area. The groundwater monitoring locations are defined in Figure 4.

The wells were sampled on four occasions this period. The results of the quarterly monitoring are provided in the following Tables 8 – 11.

Table 8 Surrey Road monitoring well GND2165 2016-2017

Groundwater	Site	GND2165	GND2165	GND2165	GND2165
Parameter	Collected	06 Dec 2016	Dry	27 Apr 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.017		0.012	0.02
Barium (dissolved)	g/m³	0.017		0.012	0.02
Chloride	g/m³	5.9		4.4	5.2
Conductivity	mS/m@20°C	4.8		5.1	6.1
Sodium	g/m³	3.7		3.5	4.4
Nitrate/nitrite nitrogen	g/m³ N	0.22		0.24	0.98
pH	pH	5.7		6.1	5.9
Level	m	3.143		3.135	3.295
Temperature	°C	12.9		14.1	12.6
Benzene	g/m³	< 0.0010		< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7		< 0.7	< 0.7
C15-C36	g/m³	< 0.4		< 0.4	< 0.4
C10-C14	g/m³	< 0.2		< 0.2	< 0.2
C7-C9	g/m³	< 0.10		< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010		< 0.0010	< 0.0010

Groundwater	Site	GND2165	GND2165	GND2165	GND2165
Parameter	Collected	06 Dec 2016	Dry	27 Apr 2017	21 Jun 2017
Toluene	g/m³	< 0.0010		< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002		< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010		< 0.0010	< 0.0010
Total dissolved salts	g/m³	37.1		39.5	47.2

Table 9 Surrey Road monitoring well GND2166 2016-2017

Groundwater	Site	GND2166	GND2166	GND2166	GND2166
Parameter	Collected	06 Dec 2016	27 Apr 2017	10 Mar 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.028	0.022	0.032	0.018
Barium (dissolved)	g/m³	0.026	0.021	NR	0.016
Chloride	g/m³	9.2	6.5	9.7	5.3
Conductivity	mS/m@20°C	6.6	4.7	6.7	4.4
Sodium	g/m³	5.6	4.4	6.2	4.3
Nitrate/nitrite nitrogen	g/m³ N	1.61	0.91	1.34	0.63
pH	pH	5.3	5.4	5.6	5.4
Level	m	3.71	1.684	2.051	1.623
Temperature	°C	13.6	14.5	14.7	11.7
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.06	< 0.10	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	51.1	36.4	51.8	34

Table 10 Surrey Road monitoring well GND2167 2016-2017

Groundwater	Site	GND2167	GND2167	GND2167	GND2167
Parameter	Collected	06 Dec 2016	27 Apr 2017	10 Mar 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.037	0.029	0.04	0.032
Barium (dissolved)	g/m³	0.036	0.029	NR	0.029
Chloride	g/m³	7.1	7	9.8	8
Conductivity	mS/m@20°C	7.7	7.6	9.5	7.9
Sodium	g/m³	5.2	5.4	7.2	5.9
Nitrate/nitrite nitrogen	g/m³ N	0.2	0.21	0.11	0.15
pH	pH	5.4	4.6	5.7	5.4
Level	m	2.285	2.321	2.478	2.116
Temperature	°C	13.5	14.6	15	13.4
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.06	< 0.10	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	59.6	58.8	73.5	61.1

Table 11 Surrey Road pipe monitoring location GND2517 2016-2017

Groundwater	Site	GND2517	GND2517	GND2517	GND2517
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Barium (acid soluble)	g/m³	0.19	0.39	0.28	0.19
Barium (dissolved	g/m³	0.19	0.39	0.21	0.17
Chloride	g/m³	86	101	66.6	51.7
Conductivity	mS/m@20°C	39.4	46.3	35.4	29.4
Sodium	g/m³	12.6	14.6	11.5	9.7
Nitrate/nitrite nitrogen	g/m³ N	0.01	<0.01	0.01	<0.01
pH	pH	6.5	6.4	6.5	6.2

Groundwater	Site	GND2517	GND2517	GND2517	GND2517
Parameter	Collected	06 Dec 2016	10 Mar 2017	27 Apr 2017	21 Jun 2017
Temperature	°C	15.7	17.1	14.8	12
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	33	1.6	15.9	45
C15-C36	g/m³	25	1.2	12.2	33
C10-C14	g/m³	8.4	0.3	3.7	12.2
C7-C9	g/m³	< 0.10	< 0.10	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	304.8	358.2	273.9	227.5

The analysis of the Surrey Road groundwater monitoring network of three monitoring wells and one pipe sample were provided above in Tables 8-11 inclusive. The results provide an insight into the groundwater conditions of the site on the day they were sampled:

- Total petroleum hydrocarbon analysis (C7-C9, C10-C14, C15-C36 and C7-C36) in the three groundwater monitoring wells (GND2165, 2166 and 2167) were all below the laboratory limit of detection, which are set at <0.10, <0.2, <0.4 and <0.7 g/m^3 respectively.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) analysis of the three monitoring wells (GND2165, 2166 and 2167) were also below the limit of detection for these analytes, which are set at <0.001, <0.001, <0.001 and <0.002 and <0.001 respectively.
- Total petroleum hydrocarbon analysis (C7-C9, C10-C14, C15-C36 and C7-C36) in the pipe sampling location (GND2517) indicated results this period, which were as follows:
    - C7-C9 results were below the limit of detection for this analyte.
    - C10-C14 was observed in the four sampling rounds undertaken by the Council this period, ranging from 0.3-12.2 g/m^3.
    - C15-C36 was also observed in the four sampling rounds undertaken by the Council, ranging from 1.2-33 g/m^3.
    - C7-C36, which is the combined total of the previous three carbon chains, ranged across the four samples collected this period, 1.6-45 g/m^3.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) of the pipe sample location (GND2517) were below the limit of detection for these analytes, which is set at <0.001, <0.001, <0.001 and <0.002 and <0.001 g/m^3 respectively.
- Total dissolved salt concentrations were higher in the pipe sample (ranging 273-358 g/m^3 TDS) than in the groundwater monitoring well samples (ranging 34-73 g/m^3 TDS). This may reflect the pipe sample location which is in close proximity to the storage area, situated under storage cell 3.

- Groundwater pH in all three monitoring wells were observed (bar one round in GND 2060) to remain below pH 6 in all four monitoring rounds. GND 2167 recorded a pH of 4.6 this period in the April 2017 monitoring round.

Caution must be exercised by the consent holder, as within the site boundary is lagooned water treatment sludge which contains poly-aluminium chloride which will mobilise if the pH of the solution reaches 4.2 pH.

Note the groundwater monitoring bore within 150m of this lagoon was observed to range between 5.7-4.6 pH (GND2167), while the nearest monitoring well (GND2166) indicated a pH of 5.3-5.6.

3.3.2. Surrey Road surface water

Surface water sampling of the unnamed tributary of the Mangatengehu Stream and discharge sampling of the stormwater discharge from the Surrey Road facility was undertaken this monitoring period on three occasions. The facility does not hold a stormwater discharge consent, as such the facility discharge will be accounted for under the regional fresh water plan (RFWP) rule 23.

Specifically under this rule the following must be observed for any discharge:

- pH: 6.0-9.0
- Oil and grease: 15 g/m^3
- Biochemical oxygen demand: 5 g/m^3
- Suspended solids: 100 g/m^3
- Unionised ammonia: 0.025 g/m^3
- And free chlorine: 0.2g/m^3

The results of the surface water and discharge sampling are provided in the following Tables 12 – 14. Each table represents the upstream surface water preceding the discharge (MTH000062) and post discharge (MTH000064) to ascertain for the effect of the discharge (IND001067) on the day of sampling.

Table 12 Surrey Road surface water monitoring 16 August 2016

Surface water	Site	MTH000062	IND001067	MTH000064
Parameter	Collected	16 Aug 2016	16 Aug 2016	16 Aug 2016
Barium (acid soluble)	g/m^3	0.017	0.12	0.022
Bio-chemical oxygen demand	g/m^3	1.1	0.8	0.9
Chloride	g/m^3	6.1	52.6	12.1
Conductivity	mS/m@20°C	7.7	24.6	9.9
pH	pH	7.1	6.5	6.9
Suspended solids	g/m^3	2	6	<2
Temperature	°C	8.5	8.9	8.5
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m^3	< 0.7	< 0.7	< 0.7

Surface water	Site	MTH000062	IND001067	MTH000064
Parameter	Collected	16 Aug 2016	16 Aug 2016	16 Aug 2016
C15-C36	g/m³	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.10	< 0.10	< 0.10
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	59.6	190.3	76.6

Table 13 Surrey Road surface water monitoring 26 April 2017

Surface water	Site	MTH000062	IND001067	MTH000064
Parameter	Collected	26 Apr 2017	26 Apr 2017	26 Apr 2017
Barium (acid soluble)	g/m³	0.018	0.025	0.023
Bio-chemical oxygen demand	g/m³	<0.5	<0.5	<0.5
Chloride	g/m³	5.5	7.4	7.9
Conductivity	mS/m@20°C	7.9	8.4	8.7
pH	pH	7.2	7.2	7.1
Suspended solids	g/m³	3	3	4
Temperature	°C	11.7	11.5	11.7
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m³	< 0.7	< 0.7	< 0.7
C15-C36	g/m³	< 0.4	< 0.4	< 0.4
C10-C14	g/m³	< 0.2	< 0.2	< 0.2
C7-C9	g/m³	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m³	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m³	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m³	61.1	65	67.3

Table 14 Surrey Road surface water monitoring 09 June 2017

Surface water	Site	MTH000062	IND001067	MTH000064
Parameter	Collected	09 Jun 2017	09 Jun 2017	09 Jun 2017
Barium (acid soluble)	g/m^3	0.018	0.096	0.026
Bio-chemical oxygen demand	g/m^3	<0.5	0.7	<0.5
Chloride	g/m^3	5.4	24.8	7.8
Conductivity	mS/m@20°C	7.6	16.8	8.9
pH	pH	7.1	6.7	7
Suspended solids	g/m^3	2	5	2
Temperature	°C	8.6	8.6	8.3
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010
C7-C36	g/m^3	< 0.7	< 0.7	< 0.7
C15-C36	g/m^3	< 0.4	< 0.4	< 0.4
C10-C14	g/m^3	< 0.2	< 0.2	< 0.2
C7-C9	g/m^3	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010
XYLENE-M	g/m^3	< 0.002	< 0.002	< 0.002
XYLENE-O	g/m^3	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m^3	58.8	130	68.9

Specifically, the results of the surface water and discharge sampling indicated the following:

- Total petroleum hydrocarbon (TPH) analysis (C7-C9, C10-C14, C15-C36 and C7-C36) of the three sample locations, across the three occurrences this period, resulted in no values above the limit of detection for these analytes. The limits of detection (LOD) are <0.10, <0.2, <0.4 and <0.7 g/m^3 respectively for these carbon chains.
- No oil and grease analysis was undertaken this period. However the resultant TPH and BTEX analysis indicated results below the LOD, thus negating the requirement.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) analysis of the three sampling rounds were also below the limit of detection for these analytes, which are <0.001, <0.001, <0.001 and <0.002 and <0.001 g/m^3 respectively.
- pH of the discharge ranged from 6.5-7.2 pH this period which was within the RFWP rule 22.
- Suspended solid analysis of the discharge indicated compliance with the RFWP, all three results were sub 10 g/m^3, with the rule set at 100 g/m^3.
- Bio-chemical oxygen demand was similarly compliant with all results below the requisite 5 g/m^3.
- No free chlorine analysis was undertaken on the discharge this period.

- Un-ionised ammonia was not analysed this period, though the resultant pH analysis indicated the likelihood for un-ionised ammonia to be very low, <7.3 pH.
- A slight increase was observed in total dissolved salt (TDS) concentration in the final surface sampling location (MTH000064), purposed to be a function of the discharge. Note this is a minimal change.

3.3.3. Biological monitoring

A macroinvertebrate survey was performed on two occasions, 22 December 2016 and the 27 February 2017. The aim of these surveys was 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 discharged to 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 RFWP 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. A brief synopsis of the findings of the two bio-monitoring surveys is provided below the methods section, the report in full is attached in Appendix II.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 22 December 2016 (Table 15 and Figure 5). 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 to collect macroinvertebrates at all four sites. 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 15 Biomonitoring sites on the unnamed tributary of the Mangatenghu Stream

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

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

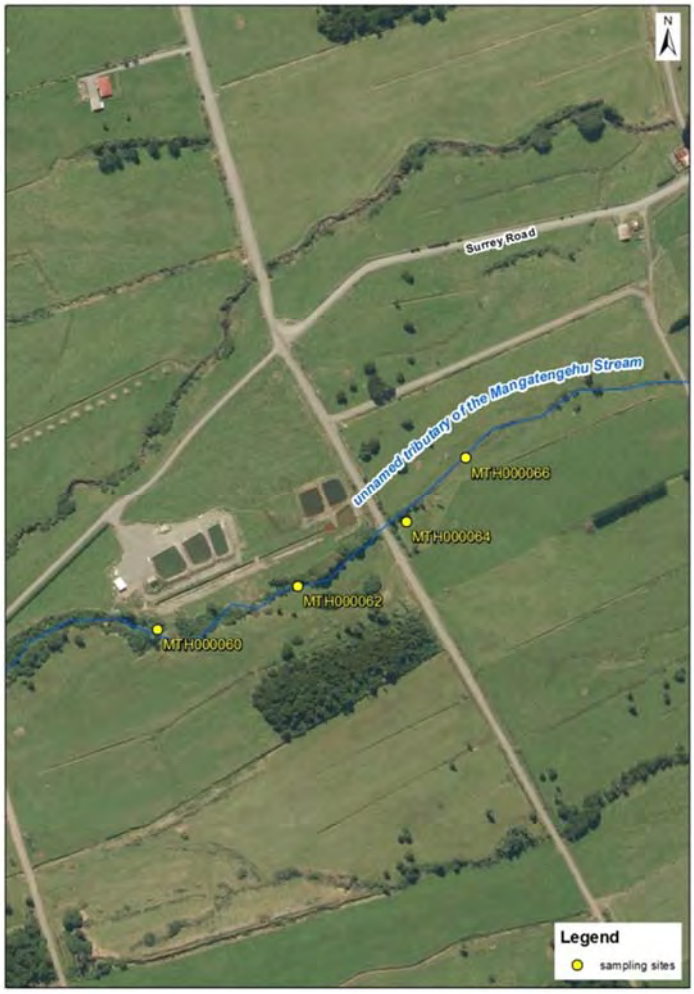


Figure 5 Biomonitoring sites on the unnamed tributary of the Mangatenghu Stream

Summary of the late summer 2017 biomonitoring survey

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses, MCI and $SQMCI_S$ values examined compared with the 'control' sites at the time of the survey. Differences in periphyton cover and amount of iron oxide deposits would explain some of the differences observed. Stockpiling activities are likely to have also contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores. Further investigation into the extent to which stockpiling activities are responsible for the low taxa richnesses, abundances and MCI scores in the lower section of the tributary of the Mangatengehu Stream would be useful, particularly whether or not stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites.

3.3.4. Provision of consent holder data

MI SWACO, whom undertakes management duties of the Surrey Road stockpiling facility, on behalf of the consent holder, provided two sample results of the discharge (IND001067). The two sample results are provided in the following Table 16. The requisite discharge parameter range as defined by RFWP rule 23 are provided where applicable per analyte.

Table 16 MI SWACO discharge sample results 2016-2017 Surrey Road

Surface water	Site	IND001067	IND001067
Parameter	RFWP rule 23	2 February 2017	15 June 2017
Free Ammonia (NH3)	0.025 g/m^3	<0.01	<0.01
pH	6.0-9.0	6.8	7
Total suspended solids	100 g/m^3	15	5
Total ammoniacal nitrogen (NH4)	-	0.24	0.51
Carbonaceous Biochemical Oxygen Demand (cBOD5)	5 g/m^3	3	<2
Oil and grease	15 g/m^3	<4	6
Free chlorine	0.2 g/m^3	0.23	0.11
Combined chlorine	-	<0.08	<0.08

Table 16 details the results of the MI SWACO provided discharge analysis. Specifically, in relation to compliance with the RFWP rule 23, one slight exceedance with respect to free chlorine analysis was observed in the February 2017 sample. The remaining analytes were within RFWP rule 23 range for compliance.

4. Landspreading/ Landfarming activities

4.1. Inspection

26 August 2016

The following was noted. The recently landfarmed paddocks (83 and 84) were inspected. Drilling muds were found to have migrated to the surface through natural processes. The mud was quite wet and described as sticky with a typical hydrocarbon/mud odour upon inspection. The run-off however, from the paddock, was described as clear and free of muds/hydrocarbons. The pasture was observed and the pasture strike looked good across the other spreading areas. The historic application areas around the farm had good pasture cover which appeared healthy.

22 February 2017

The following was observed: No recent spreading had occurred. Several spreading areas were inspected and found to have good pasture cover which appeared healthy. The consent holder outlined his intention to re-disc the last spreading area through the low point in the middle of the paddock as water run-off had prevented pasture strike. The area was to be re-sown after the works had occurred.

The spreading area on the northern side of the quarry also had patches which were barren of pasture cover and muds were visible at the surface. The consent holder outlined that the bare areas were due to machinery accessing the quarry. Works were to occur to sow pasture in the western paddock on the northern side of the quarry. No incidents were reported.

31 March 2017

The following was observed. Paddock 84 (which was identified during the August 2016 inspection) had been recently re-worked and sown in pasture. The pasture appeared to have a good strike response, essentially no drilling mud was observably present at the surface. The run-off into drain was described as clear and no deleterious effects were observed in the receiving waters. All other historic spreading areas (other than around the northern side of the quarry) had good pasture cover which appeared healthy.

26 May 2017

The following was observed. The pasture growth within Paddock 84 was observed and described as in good condition across the majority of the spreading area. Some muds were identified at the surface in the patches which were void of pasture. The material was sticky with a typical drilling mud odour. All other historic spreading areas had good pasture cover which appeared healthy.

4.2. Results of the receiving environmental monitoring

No landfarm operations were undertaken in this monitoring period. The last landfarming operations were undertaken in the previous monitoring period, 2015-2016. In that period 3,182 m^3 of material was landfarmed across nine paddocks. The paddocks which were utilised and the associated material origins are provided in the following Table 17. The paddock locations are provided in Figure 6.

Table 17 Most recent landfarming application dates and locations

Paddock	Mud Type	Well name	Application date	Solid m3	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**	

4.3. Council soil results

Six compliance soil samples were collected from six landfarmed paddocks this period. The analysis of the soil samples is provided in the following Table 18. Five of the six paddocks were farmed in the previous monitoring period.

Table 18 Council soil sampling results 2016-2017

Council soil	Paddock No.	P83	P1	P145	P146	P22	P84
Parameter	Collected	16 Aug 2016	23 Aug 2016	10 Mar 2017	10 Mar 2017	21 Jun 2017	21 Jun 2017
Conductivity	mS/m@20°C	117.3	82.7	78.1	98.6	42.4	108.8
pH	pH	5.7	6.8	6.1	5.8	5.6	7.1
Calcium	mg/kg	92.2	213.5	53.3	66.8	23.8	242.3
Chloride	mg/kg	246.6	15	40.1	76.1	95.8	138.2
TPH Total	mg/kg	1,728	2,634	191	411	300	15,180
Potassium	mg/kg	55.9	14.8	46.5	64.7	46.6	71.1
Magnesium	mg/kg	7.1	9.9	4.5	6.8	3.2	11.3
Sodium	mg/kg	36.3	17.8	22.7	25.6	30.2	22.7
Ammonia Nitrogen	mgN/kg	8.94	2.98	19.32	29.62	19.06	11.39
Nitrate/nitrite nitrogen	mgN/kg	3.63	3.91	0.21	0.26	0.69	1.19
Sodium absorption ratio	None	0.98	0.32	0.80	0.80	1.54	0.39
Total soluble field salts	mg/kg	918	647.2	611.2	771.6	331.8	851.5

Council soil	Paddock No.	P83	P1	P145	P146	P22	P84
Parameter	Collected	16 Aug 2016	23 Aug 2016	10 Mar 2017	10 Mar 2017	21 Jun 2017	21 Jun 2017
TPH= Total petroleum hydrocarbons							

The subsequent soil analysis indicated the following:

- Calcium ranged 23-242 mg/kg;
- Chloride ranged 15-246 mg/kg, the surrender limit is set at 700 mg/kg;
- Potassium ranged 14-71 mg/kg;
- Sodium ranged 17-36 mg/kg;
- Magnesium ranged 3.2-11.3 mg/kg;
- Conductivity readings ranged from 42-117 mS/m @20°C ; the surrender limit is set at <290 mS/m;
- Soil pH ranged 5.6-7.1 pH;
- Total petroleum hydrocarbon (TPH) analysis indicated variation across the six samples collected, ranging 191-15,380 mg/kg total TPH. Note, no speciated hydrocarbon analysis was undertaken by the Council. These results cannot be assessed against surrender concentrations as this requires specific testing of speciated petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes (BTEX) and polycyclic aromatic hydrocarbon. However, this result is indicative to the concentration of this analyte on the day of sampling. Additional paddock analysis was undertaken by MI SWACO and it is presented in the following section.
- Ammonia nitrogen ranged from 3-33 mg/kg;
- Nitrate/nitrite nitrogen ranged from 0.2-3.9 mg/kg;
- Sodium absorption ratio (SAR) results ranged from 0.3-1.5 SAR this period, the absolute limit is set at 8 SAR; and
- Total soluble field salts ranged from 611-918 mg/kg this period, the surrender limit is set at 2,500 mg/kg.

4.3.1. MI SWACO supplied soil analysis

MI SWACO provided additional analysis of three previously landfarmed paddocks. Included in this analysis is a greater variety of parameters, as defined by the consent. The specific consent limits are provided in the associated Table 19 where applicable.

Table 19 MI SWACO provided soil analysis 2016-2017 monitoring period

MI SWACO Soil Results 2016-2017	Sample Name:	Consent limit	Paddock 73	Paddock 83	Paddock 84
Parameter	Unit	7559-1.3	29-Jul-17	29-Jul-17	29-Jul-17
Dry Matter	g/100g as rcvd		63	61	59
Density	g/mL at 20°C	-	0.92	0.9	0.86
Total Recoverable Barium	mg/kg dry wt	10,000	4,000	1,470	3,200
Total Recoverable Sodium	mg/kg dry wt	460*	510	650	510
Heavy Metals with Mercury, Screen Level					
Total Recoverable Arsenic	mg/kg dry wt	17	2	< 2	< 2
Total Recoverable Cadmium	mg/kg dry wt	0.8	< 0.10	0.12	< 0.10
Total Recoverable Chromium	mg/kg dry wt	600	16	6	5
Total Recoverable Copper	mg/kg dry wt	100	66	38	43
Total Recoverable Lead	mg/kg dry wt	160	12.7	5.9	8.9
Total Recoverable Mercury	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	60	7	2	4
Total Recoverable Zinc	mg/kg dry wt	300	55	29	34
BTEX in Soil by Headspace GC-MS					
Benzene	mg/kg dry wt	1.1*	< 0.08	< 0.08	< 0.09
Toluene	mg/kg dry wt	82*	< 0.08	< 0.08	< 0.09
Ethylbenzene	mg/kg dry wt	59*	< 0.08	< 0.08	< 0.09
m&p-Xylene	mg/kg dry wt	59*	< 0.15	< 0.16	< 0.17
o-Xylene	mg/kg dry wt	59*	< 0.08	< 0.08	< 0.09
Polycyclic Aromatic Hydrocarbons Screening in Soil					
1-Methylnaphthalene	mg/kg dry wt	-	0.2	< 0.017	< 0.017
2-Methylnaphthalene	mg/kg dry wt	-	0.127	< 0.017	< 0.017
Perylene	mg/kg dry wt	-	0.016	0.037	< 0.017
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES	mg/kg dry wt	-	< 0.04	< 0.04	< 0.04
Benzo[a]pyrene Toxic Equivalence (TEF)	mg/kg dry wt	-	< 0.04	< 0.05	< 0.05
Acenaphthylene	mg/kg dry wt	-	< 0.016	< 0.017	< 0.017
Acenaphthene	mg/kg dry wt	-	0.46	0.078	0.136
Anthracene	mg/kg dry wt	-	< 0.016	< 0.017	< 0.017

MI SWACO Soil Results 2016-2017	Sample Name:	Consent limit	Paddock 73	Paddock 83	Paddock 84
Parameter	**Unit**	**7559-1.3**	**29-Jul-17**	**29-Jul-17**	**29-Jul-17**
Benzo[a]anthracene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Benzo[a]pyrene (BAP)	**mg/kg dry wt**	0.027*	< 0.016	< 0.017	< 0.017
Benzo[b]fluoranthene + Benzo[j]fluoranthene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Benzo[e]pyrene	**mg/kg dry wt**	-	< 0.016	< 0.017	0.027
Benzo[g,h,i]perylene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Benzo[k]fluoranthene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Chrysene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Dibenzo[a,h]anthracene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Fluoranthene	**mg/kg dry wt**	-	0.022	< 0.017	0.02
Fluorene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Indeno(1,2,3-c,d)pyrene	**mg/kg dry wt**	-	< 0.016	< 0.017	< 0.017
Naphthalene	**mg/kg dry wt**	7.2*	0.15	< 0.09	< 0.09
Phenanthrene	**mg/kg dry wt**	-	0.072	< 0.017	< 0.017
Pyrene	**mg/kg dry wt**	160*	< 0.016	< 0.017	0.034
Total Petroleum Hydrocarbons in Soil					
C7 - C9	**mg/kg dry wt**	210*	< 10	< 10	< 10
C10 - C14	**mg/kg dry wt**	150*	1,510	250	300
C15 - C36	**mg/kg dry wt**	1,300*	9,100	1,730	2,600
Total hydrocarbons (C7 - C36)	**mg/kg dry wt**	20,000	10,600	1,980	2,900
*Relates to the surrender criteria concentrations as defined in consent condition 20 of consent 7559-1.3					

The results of the MI SWACO soil analysis indicate the following:

- No exceedance was observed when compared to the consent conditions.
- Speciated petroleum hydrocarbon analysis indicated that carbon chains C10-C14 and C15-C36 were still elevated above the criteria defined by the consent for surrender.
- Benzene, toluene, ethylbenzene and xylenes (m/O) (BTEX) concentrations were all below the laboratory limit of detection (LOD) for these analytes in all three samples provided.
- Polycyclic aromatic hydrocarbon (PAH) analysis indicated that for the three target parameters of benzo (a) pyrene (BaP), naphthalene and pyrene, as defined by consent, were below the laboratory limit of detection.
- Total recoverable sodium results ranged from 510-650 mg/kg sodium, the surrender limit is set at 460 mg/kg sodium.
- Total recoverable heavy metal analysis indicated the following:

- Total recoverable (TR) arsenic result was found to be at or below the LOD which was set at 2 mg/kg. Note the consented value which must not be exceeded in the soil is set at 17 mg/kg.
- TR cadmium results were similar, with one result marginally above the LOD which is set at >0.1 mg/kg, with a value of 0.12 mg/kg. The value set by the consent which must not be exceeded is 0.8 mg/kg cadmium.
- TR chromium results indicated a range of 6- 16 mg/kg chromium, the limit as defined by the consent is set at 600 mg/kg.
- TR copper results indicated a range of 43-66 mg/kg copper, the limit as defined by the consent is set at 100 mg/kg.
- TR lead results indicated a range of 5-12 mg/kg, the limit as defined by the consent is set at 160 mg/kg.
- TR mercury results were found to all be below the LOD of the laboratory which is set at >0.1 mg/kg, the limit as defined by the consent is set at 1 mg/kg mercury.
- TR nickel results indicated a range of 2-7 mg/kg, with the consent limit set at 60 mg/kg nickel.
- TR zinc results indicated a range of 29-55 mg/kg, the limit as defined by the consent is set at 300 mg/kg zinc.

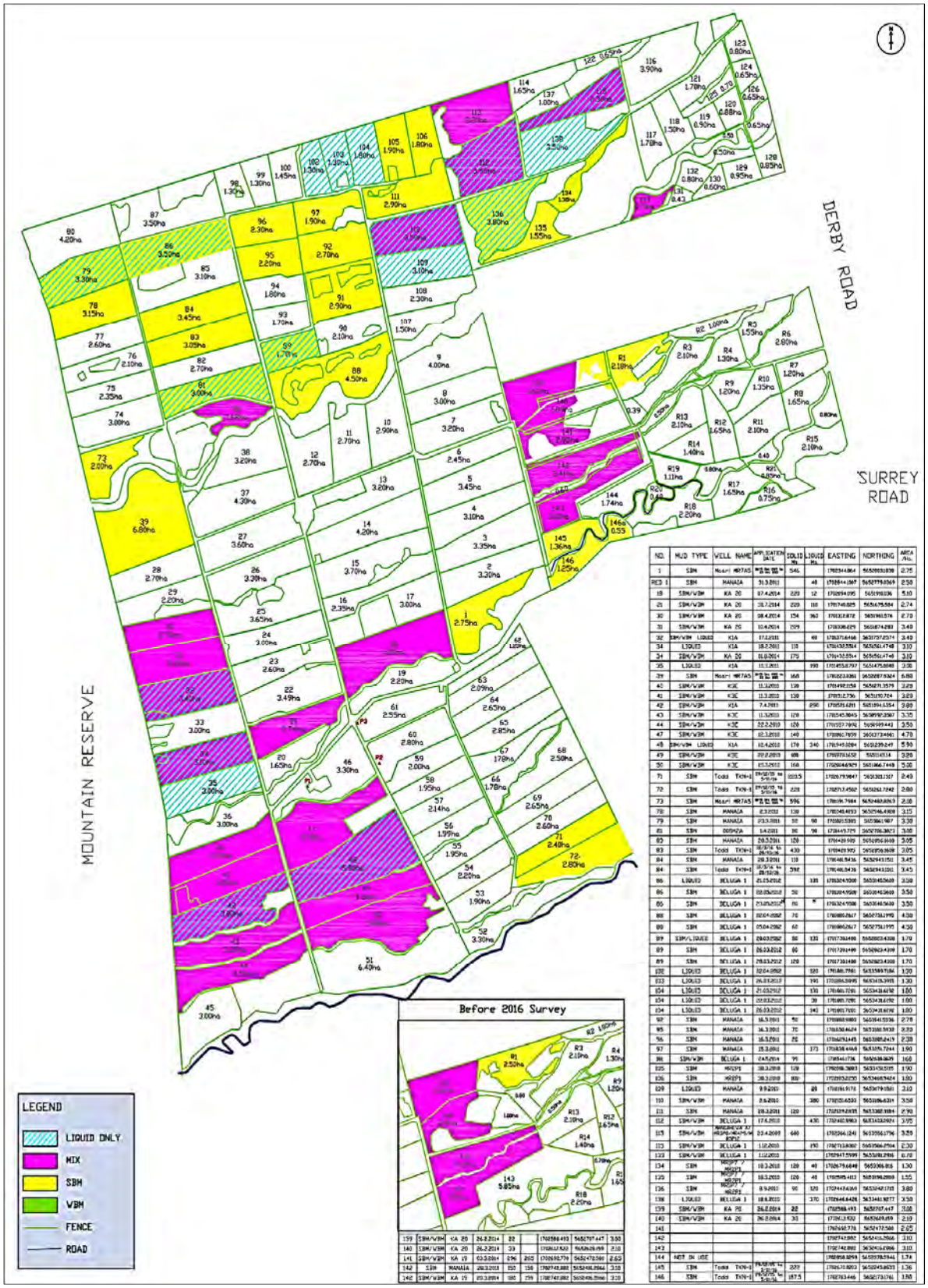


Figure 6 Landfarming/landspreading paddock locations and application dates[1]

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 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 2016-2017 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.

26 August 2016 6900-2 (Derby Road) technical non-compliance

No recent site activities have occurred and no works have been undertaken to land-farm the muds which have been on-site for longer than a year, staff outlined to TRC that due to poor weather the land-farming has been delayed until early spring, an extension to abatement notice EAC 20834 was granted until 1 November 2016.

04 October 2016 (Derby Road) technical non-compliance

No works have occurred to spread any of the drilling mud stored at the site. Areas where drilling muds have been previously spread were found to have good pasture cover which appeared healthy; very little mud was identified within the soil profile within the test pits.

The following action is to be taken: Undertake works to spread all drilling muds stored for longer than one year in a manner compliant with resource consent conditions.

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

6. Discussion

6.1. Discussion of site performance

Derby Road facility

The Derby Road stockpiling facility is closed to the receipt of landfarmable material, this report marks the fourth year the facility ceased stockpiling. In this monitoring period the consent holder removed the final consolidated drilling material from the former storage area of the Derby Road stockpiling facility. The consent holder had been under abatement notice to undertake the landfarming of this material for longer than one year. The material which had been in-situ for at least four years was removed from the former storage pits and landfarmed across the area where the stockpiling facility was originally located.

The drilling material was mixed and blended with the actual storage cells and landfarmed across the Derby Road site.

Included with the drilling mud was lagooned water treatment sludge which the consent holder also held at the Derby Road facility. This area will now be treated as a specific landfarmed area with consent defined surrender criteria to be met before the site is considered for surrender. This area has been bunded with any run off directed to the final stormwater ponds.

Suitable weather conditions were outlined by the consent holder as to why the exercise was not undertaken sooner.

Surrey Road stockpiling

The Surrey Road stockpiling facility, which is the main site for the consent holder in terms of the receipt of drilling muds, did not receive any deliveries of material throughout the 2016-2017 monitoring period. Inspections noted stormwater within the storage cells at varying levels throughout the year. Approximately 1,800 litres of skimmed oil remained on site within a holding tank. This was noted at the beginning of the monitoring period and remains on site.

Minimal site activity was observed during inspection and monitoring rounds this period. The irrigation of cell 3 contents to land has not been undertaken this period as the pump had been removed. This was a management option undertaken two years ago to prevent the stormwater component of the storage cells from egressing into the stormwater system and discharging into the unnamed tributary of the Mangatengehu Stream.

This was undertaken previously when a decline in species was noted during the biomonitoring undertaken of the same water course. See report 2014-2015-86 in reference section. Inspections noted no obvious adverse effect of the discharge to the receiving waters in this period. However, evident iron oxides were observed in the receiving waters, with a greater concentration observed below the discharge. The results of the annual biological monitoring of this water course is discussed in Section 6.2 of this report. The full reports are also appended.

Landspreading/Landfarming

No landfarming of new material was undertaken this period. The main performance undertaken by the consent holder was the re-working of a previous landfarmed paddock, paddock 84. This paddock was identified by the investigating officer to require additional re-working as the landfarmed material was observed at the surface in places.

This was undertaken by the consent holder in March 2017. The other landfarmed areas of the consent holder's property were observed and found to have good pasture cover which appeared healthy. Paddock 84 was again observed in May 2017 and found to have pasture established, though with the odd bare patch

where mud was identifiable. The paddock, after the reworking, was much improved when compared to the original observation in August 2016.

Paddock listing information will require further investigation, as a Council soil sample was collected from paddock 22 this monitoring period. Paddock 22 was not listed as being spread, thus further investigation is to be undertaken in the upcoming monitoring period.

Surrender sampling of previous landfarmed paddocks is also proposed in the upcoming monitoring period. Surrender sampling will attest to the current remediation status of previous landfarmed paddocks. This will allow the consent holder to return areas to the previous status or to reutilise the areas for additional landfarming operations in future if found to be within surrender criteria. Note, the surrender sampling criteria is defined by the consent 7591-1.1 and is appended to this report.

6.2. Environmental effects of exercise of consents

Derby Road

Environmental effects associated with the Derby Road facility are primarily centred on the facility grounds which have now been turned into a landfarmed area. This area was originally a stockpiling area, which contained eight storage cells. The consent holder stockpiled the residual material which was estimated to be in the region of 1,000 m^3 of residual drilling mud and then levelled out the storage cells with heavy machinery. In the previous monitoring period one sample of the residual material was included in the MI SWACO provided annual report. This analysis detailed a total hydrocarbon concentration of 90,000 mg/kg. Included with the residual drilling mud was water treatment sludge which was blended with the residual mud and landfarmed.

As the facility has now been landfarmed within the grounds of the Derby Road site, the specific consent 6900-2 stipulates the requirements with respect to the site surrender criteria. This states the standards of the soil required to be considered for surrender. Additional work is required to revegetate the area, as currently revegetation has not occurred.

Presently no soil samples of the new landfarmed Derby Road area have been undertaken, these are proposed in the upcoming monitoring period. The analysis of the groundwater and surface monitoring did not indicate any effect of an adverse nature this monitoring period.

The associated biological monitoring of the unnamed tributary of the Mangamawhete stream 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 of the Mangamawhete Stream surveyed. MCI values were similar to or better than the median values recorded by each site and indicated 'fair' to 'very good' biological health in the Mangamawhete Stream.

Surrey Road

Environmental effects associated with the Surrey Road stockpiling facility are related to a management option which was undertaken at the beginning of this monitoring period. This resulted in the decline in the species composition and richness at the two biological monitoring locations below the Surrey Road discharge, as identified in the biological monitoring of this water course in this monitoring period.

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses, MCI and $SQMCI_S$ values examined compared with the 'control' sites at the time of the survey. Differences in periphyton cover and amount of iron oxide deposits would explain some of the differences observed.

Stockpiling activities are likely to have also contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores. Further investigation into the extent to which stockpiling activities are responsible for the low taxa richnesses, abundances and MCI scores in the lower section of the tributary of

the Mangatengehu Stream would be useful, particularly whether or not stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites.

By way of background, in the 2014-2015 monitoring period, a decline in biological community richness was observed in the unnamed tributary. Discussions held during that period identified that the stormwater discharge location was responsible for conveying (at certain times) the diluted stormwater of the holding cells into the unnamed tributary of the Mangatengehu Stream. At that time an engineering decision was undertaken by the site management. This was the installation of a pump to the base of the newly lined cell three.

Cell three received the stormwater from the other two, larger storage cells, one and two respectively. A pump was installed at the base of cell three to transfer the stormwater component to a specific area, termed the irrigation area, whereby stormwater was irrigated across this area, which was then treated as a landfarmed area. This engineering control was primarily aimed at reducing the potentially contaminated stormwater from egressing through the stormwater system, and as a result, into the unnamed tributary. The use of the pump and an associated irrigator to irrigate the fluid stormwater contents to land was also included in a consent variation of consent 7591-1.1 (condition 7) (October 2015).

In the previous monitoring period (2015-2016), the biological monitoring of the unnamed tributary of the Mangatengehu Stream indicated an improvement in species composition and richness after this engineering control. During the first quarter of the 2016-2017 monitoring period the pump was removed from cell three.

Groundwater analysis did not reveal any petroleum related compounds in the four monitoring rounds undertaken of the three monitoring wells onsite, above the limit of detection. An additional monitoring location was included in this monitoring period's program. This was a pipe sample which flowed from under the storage cells into the stormwater drain. This source was sampled in line with the groundwater monitoring regime, quarterly. This sample location denoted total petroleum hydrocarbons in all four monitoring rounds undertaken this monitoring period. The hydrocarbons are most likely a result of the storage of landfarming material in unlined storage cells. The corresponding discharge analysis did not analyse any hydrocarbons above the limit of detection in any of the three monitoring rounds undertaken. The main measurable (discharge) parameter was the slight elevation in the value for chlorides, total dissolved salt and as a result, conductivity concentration in this discharge.

Field measurement parameters from the groundwater monitoring however denoted a potential reducing environment, with pH values found to be lowering, especially in the down gradient monitoring wells of GND2166 and 2167. This would account for the elevated iron oxide deposits discussed in the biological monitoring report and specifically at the two potentially impacted bio-monitoring sites, below the discharge. The formation of a reduced pH environment would be a direct result of the storage of drilling material within an un-lined storage cell. This was lined in the 2015-2016 monitoring period.

Landspreading

No landfarming or landspreading operations of new material were undertaken this period. No new deliveries of material were received. However, paddock 84, which was cited by the Council's investigating officer as requiring additional work, was reworked by the consent holder. The previously landfarmed areas were observed and found to contain good vegetation cover which appeared healthy.

To date, 65 paddocks have been utilised by the consent holder for landfarming across the two facilities of Derby and Surrey Road. The application of material to land began in 2010 and the most recently farmed paddock was undertaken in January 2016. Since this date there have been minimal requirements for the reutilisation of paddocks. Paddocks 83 and 84 which were re-spread, post successful analysis, which stipulated they were within criteria to allow for further application are, to date, the only paddocks to be re-used.

Surrender sampling of the older paddocks is proposed as this will allow the consent holder to return the paddocks to their original purpose, or allow the option for further applications if required. It will also seek to assess the stage of bioremediation over time. Surrender sampling will be proposed in the upcoming monitoring period.

Landfarming was undertaken on the Derby Road site this period. The consent holder farmed the former cell constituents (estimated to be 1,000m^3 of residual drilling material) blended with water treatment sludge across the Derby Road site area. Further revegetation of this landfarmed area is required in the upcoming monitoring period.

Council soil samples indicated results from six paddocks this monitoring period. The resultant analysis indicated that one paddock, paddock 22 contained a measurable concentration of total petroleum hydrocarbons. However the corresponding paddock loading information as defined by the site management of Surrey Road stockpiling facility does not account for this paddock being utilised. As a consequence additional soil sampling will be undertaken in the upcoming monitoring period to confirm whether material had been farmed at this location.

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 20-23.

Table 20 Summary of performance for consent 6900-2 2016-2017

Purpose: ***To discharge drilling waste [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***		
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, though farming operations were undertaken under abatement notice
2. Notify TRC 48 hours prior receiving waste onto site for stockpiling	No material received in relation to this consent, though notification to spread the final consolidated material was given	Yes
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 29 October 2017	Late, but received
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	Residual material finally spread
7. Total dissolved solids in any fresh water body not to exceed 2,500 g/m^3	Sampling of groundwater indicated minimal impacts, GND2061 <500 g/m^3 TDS	Yes
8. No contamination of groundwater or surface water to exceed background concentrations	Sampling of groundwater and surface water indicated negligible impacts, slight elevation in TDS in central monitoring well (GND2061) though sub 500g/m^3 TDS	Yes
9. Concentrations in soil to be met prior to expiry	Not applicable in this monitoring period, though soil sampling has been added to the upcoming monitoring period. No site will be surrendered until surrender compliance criteria has been met.	N/A
10. Consent may not be surrendered until compliance with SC9	Not applicable presently	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** **Good**

Table 21 Summary of performance for consent 7911-1 2016-2017

Purpose: *To discharge stormwater 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: • pH 6.0 – 9.0 • Suspended solids • <100 g/m^3 • Total recoverable hydrocarbons <15 g/m^3	Sampling was not possible as no discharge was occurring during surveys	N/A
4. 25m downstream of the initial discharge point, discharges shall not exceed: • BOD5 <2 g/m^3 • Chloride <50 g/m^3	Surface water sampling indicated minimal impacts as a process of this consent. No discharge occurring at time of surface water sampling	Yes
5. After allowing for reasonable mixing, within a mixing zone extending 25 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: • the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; • any conspicuous change in the colour or visual clarity; • any emission of objectionable odour; • the rendering of fresh water unsuitable for consumption by farm animals; • any significant adverse effects on aquatic life.	Inspection indicated no discharge to be occurring	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	N/A

Purpose: *To discharge stormwater 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?**
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative compliance in respect of this consent		**Good** **Good**

Table 22 Summary of performance for consent 7559-1.3 2016-2017

Purpose: *To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM 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, the removal of the pump from cell 3 appears to have adversely affected the in stream communities below the discharge.	No
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	Not assessed this period, proposed review in upcoming monitoring period	N/A
6. Notify Council 48 hours prior to stockpiling wastes	No material stockpiled this monitoring period	Yes
7. Notify Council 48 hours prior to landfarming wastes	No material landfarmed this period under this consent	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: • 100 mm TPH < 5% • 50 mm TPH > 5% • no ponded liquids 1 hr after application	Sampling and inspection	Yes, though after being re-ploughed in previous period

Purpose: *To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM onto and into land via landfarming.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Landfarmed areas to be used once only unless surrender criteria satisfied	Surrender criteria satisfied for paddock 83 and 84 prior to re-application. Additional surrender sampling proposed in the upcoming monitoring period	N/A
12. Incorporate wastes into the soil so that the surface 250mm contains less than 2% hydrocarbons	Sampling	Yes
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	Inspections denoted that the Derby Road landfarmed area will require additional work to revegetate.	Yes
16. No discharge within 6m of a water body (includes farm drains) 12 m from stream	Inspection	Yes
17. No liquid discharged within 25m of any water body	Inspection	Yes
18. 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
19. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling provided by MI SWACO indicated compliance with metal concentrations in three paddocks sampled, further analysis proposed in line with surrender criteria	Yes
20. 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 indicated low SAR	Yes
21. At time of expiry/cancellation/ surrender, soil hydrocarbon concentrations must comply with MfE guidelines Prior to expiry/cancellation/surrender, soil parameters shall not exceed: • conductivity 290 mS/m • dissolved salts 2,500 g/m^3 • sodium 460 g/m^3 • chloride 700 g/m^3	Surrender sampling to be proposed for 65 paddocks in upcoming monitoring period	Not applicable

Purpose: *To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM onto and into land via landfarming.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
22. Consent may not be surrendered unless condition 20 is met	Sampling	Not applicable at present
23. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m3	Sampling indicated negligible saline impacts	Yes
24. No contamination of groundwater or surface water to exceed background concentrations	Sampling indicated that the pipe sampling location GND2517 returned measurable TPH in all four monitoring rounds undertaken this period. <100 g/m^3 TPH. No trace of hydrocarbons in discharge or surface water or in other three groundwater monitoring wells. pH reducing in down gradient monitoring wells.	No
25. Records to be kept by consent holder and made available to the Council	Records kept and made available. Though investigation into paddock 22 to be undertaken with further sampling planned in upcoming monitoring period. Analysis found hydrocarbons in paddock 22.	Yes
26. Consent holder to report to Council by 31 August each year on records specified in SC23	Provided late	Late
27. Consent shall lapse on 31 Dec 2014 unless exercised		Exercised
28. Optional review provision re environmental effects		Exercised
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Improvement required** **Improvement required**

Table 23 Summary of performance for consent 7591-1.1 2016-2017

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	Yes, paddock 84 re-worked after original job deemed insufficient
2. Notify Council 48 hours prior to landspreading	Notifications received pertaining to farming of Derby Road residual material	Yes

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?**
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: • 12 m of boundaries • 12 m of named streams • 6 m of other water courses	Inspection	Yes
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	Analysis of newly landfarmed Derby Road to be undertaken in upcoming monitoring period. Previous landfarmed area which was above 2% TPH re-worked	Yes
11. Soil hydrocarbon concentrations must comply with MfE guidelines: • prior to areas being reused for landspreading • at the time of expiry/cancellation/surrender	Sampling, paddocks 83 and 84 reused, analysis provided and accepted for paddock reuse. Additional 65 paddocks to be proposed for surrender sampling in upcoming monitoring period	Yes
12. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling proposed to attest these concentrations	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

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?**
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, though inconsistent in one paddock 22. Further investigation purposed in following monitoring period.	Yes
18. Consent holder to report to Council by 31 August each year on records specified in SC17	Provided 30 October 2017	Yes later than specified
19. Consent shall lapse on 1 June 2027 unless exercised	-	N/A
20. Optional review provision re environmental effects	Not required	N/A
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**

Table 24 Evaluation of environmental performance over time

Year	Consent no	High	Good	Improvement req	Poor
2013-2014	6900-2	1			
	7911-1		1		
	7559-1			1	
	7591-1	N/A			
2014-2015	6900-2	1			
	7911-1	1			
	7559-1		1		
	7591-1.1	1			
2015-2016	6900-2	1			
	7911-1	1			
	7559-1.3		1		
	7591-1.1		1		
Totals		6	4	1	

During the year, the consent holder demonstrated a Good level of environmental performance, however improvement on their administrative performance with the resource consents is required, as defined in Section 1.1.4.

6.4. Recommendations from the 2015-2016 Annual Report

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

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.

The storage area has now been landfarmed, as such this landfarmed area will be assessed against surrender criteria until it is within the consented concentrations for surrender, as defined by consent.

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.

One surface sampling round was not required this monitoring period due to in-activity at site.

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

This was undertaken.

6.5. Alterations to monitoring programmes for 2017-2018

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

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki exercising resource consents.

It is proposed that for 2017-2018 that:

- Discussions to be held as to the proposal for surrender sampling of the 65 landfarmed paddocks.
- Further investigation into paddock 22 spreading.
- Soil sampling of Derby road landfarmed area.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site(s) in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2017-2018.

6.6. Exercise of optional review of consent

Resource consent 7591-1.1 and 7559-1.3 provide for an optional review of the consent in June 2018. Condition 20 (7591-1.1) and 27 (7559-1.3) allows the Council to review the consent, if there are grounds that require a review as defined in the following conditions.

Condition 20 of consent 7591-1.1

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.

Condition 27 of consent 7559-1.3

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.

Based on the results of monitoring in the year under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds that require a review to be pursued.

7. Recommendations

1. THAT in the first instance, monitoring of consented activities at the Derby Road stockpiling facility in the 2017-2018 year continue at the same level as in 2016-2017 with the addition of soil samples to ascertain the soil conditions. Groundwater and surface water sampling will continue, as will biological monitoring for at least one more monitoring period year.
2. THAT should there be issues with environmental or administrative performance in 2017-2018, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
3. THAT monitoring of consented activities at the Surrey Road stockpiling facility in the 2017-2018 period continues at the same level as in 2016-2017.
4. THAT the monitoring of consented activities of the landspreading continues in line with what was undertaken in this period 2016-2017. Discussion to be held as to the proposal for surrender sampling criteria of the 65 previous landfarmed paddocks as defined by consent conditions.

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.
CBOD	Carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate.
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
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.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
$g/m^2/day$	grams/$metre^2$/day.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.

Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
m^2	Square Metres.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
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.
PM_{10}, $PM_{2.5}$, $PM_{1.0}$	Relatively fine airborne particles (less than 10 or 2.5 or 1.0 micrometre diameter, respectively).
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.
SQMCI	Semi quantitative macroinvertebrate community index.
TDS	Total dissolved salts
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
Zn*	Zinc.

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

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

Bibliography and references

Cavanagh J E, May 2015: Land application of waste from oil and gas wells, Landcare Research.

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

Ministry for the Environment and New Zealand Water and Wastes Association 2003: Guidelines for the safe application of biosolids to land in New Zealand.

M-I Swaco 2009: Consent 6900-1, Condition 26 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2010: Consent 6900-1, Condition 26 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2010: Consent 7559-1, Condition 23 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2010: Consent 7591-1, Condition 17 Annual Records, Surrey Road Landfarm, Inglewood.

M-I Swaco 2012: Consent 6900-1, Condition 26 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2012: Consent 7559-1, Condition 23 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2013: Consent 6900-1, Condition 26 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2013: Consent 7559-1, Condition 23 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2014: Consent 6900-1, Condition 26 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2014: Consent 7559-1, Condition 23 Annual Records, Boyd Landfarm, Inglewood.

M-I Swaco 2015: Annual report for Consent 6900-1, Consent 7591-1, Colin Boyd Landfarms, Surrey Road, Derby Road, Inglewood, Taranaki.

M-I Swaco 2016: Annual report for Consent 6900-1, Consent 7591-1.1, 7911.1 and 7559-1.3, Colin Boyd Landfarms, Surrey Road, Derby Road, Inglewood, Taranaki.

Taranaki Regional Council 2005: Guidelines for the control of drilling waste disposal onto and into land.

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

Taranaki Regional Council, 2011: CD Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2009-2010. Technical Report 2010-78.

Taranaki Regional Council, 2012: CD Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2010-2011. Technical Report 2011-48.

Taranaki Regional Council, 2013: CD Boyd Drilling Waste Disposal Monitoring Programmes Biennial Report 2011-2013. Technical Report 2013-63.

Taranaki Regional Council, 2014: C Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2013-2014. Technical Report 2014-81.

Taranaki Regional Council, 2015: C Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2014-15. Technical Report 2015-86.

Taranaki Regional Council 2016: CD Boyd Drilling Waste Stockpiling Landfarm/Landspreading Monitoring Programme Annual Report 2016-85.

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

Appendix I

Resource consents held by C D Boyd and Surrey Road Landfarms Ltd

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

Discharge Permit

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

Name of Consent Holder:	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

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

_____

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 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	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.

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.*

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

_____

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 Officer, Brooke Thomas
Document	1849370
Date	16 May 2017

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, December 2016

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 the first of two scheduled surveys for the site in the 2016-17 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 four 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 February 2016 (Thomas, 2016) 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 22 December 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

This December 2016 survey followed a period of seven days since a fresh in excess three times median flow and 12 days since seven times median flow.

The water temperature ranged between 14.0 °C and 15.1 °C. Water levels were low and water speeds steady. Water was uncoloured and cloudy at all four sites. Substrate composition for all sites comprised predominantly cobbles and gravels, although site 2 comprised a higher proportion of boulders than the other three sites.

Periphyton mats were patchy at site 1, however no filamentous algae was recorded. At sites 2 and 3 patchy mats and filaments of periphyton were recorded and at site 4 no periphyton was recorded. No macrophytes were recorded growing at any of the four sites. Sites 1 and 3 were partially shaded by overhanging vegetation whereas site 4 had complete shading and site 2 had no shading.

Macroinvertebrate communities

Table 2 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 2 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 22 December 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Dec 2016	Median	Range	Dec 2016	Median	Range	Dec 2016
1	14	21	12-33	19	104	83-114	106	4.9	3.2-7.4	5.9
2	14	17	6-30	16	99	80-109	94	3.6	2.0-7.4	3.6
3	14	16	5-24	23	100	88-109	99	4.2	2.5-6.7	6.2
4	14	17	6-24	20	100	73-110	114	4.6	2.1-6.8	7.0

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 (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2016).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	41	41	39
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 Mangamawhete Stream, sampled on 22 December 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		FWB16318	FWB16319	FWB16320	FWB16321
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C	R
	Lumbricidae	5	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	C	-
CRUSTACEA	Ostracoda	1	-	-	R	-
	Talitridae	5	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	-	R
	Deleatidium	8	A	C	VA	VA
	Zephlebia group	7	C	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	R	C	R
	Dytiscidae	5	-	-	C	R
	Hydraenidae	8	-	-	R	R
	Ptilodactylidae	8	R	R	R	A
	Scirtidae	8	-	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	-	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	-	R	-
	Hydrobiosis	5	R	R	C	-
	Hydrobiosella	9	R	-	-	R
	Hydrochorema	9	-	-	-	R
	Hydropsyche (Orthopsyche)	9	-	-	-	R
	Plectrocnemia	8	-	-	C	-
	Psilochorema	6	R	-	R	R
	Oeconesidae	5	R	R	-	R
	Olinga	9	R	-	-	-
	Oxyethira	2	R	R	C	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	C	-
	Eriopterini	5	R	-	R	R
	Hexatomini	5	R	-	R	R
	Paralimnophila	6	-	-	R	-
	Zelandotipula	6	-	-	R	-
	Maoridiamesa	3	-	R	-	-
	Orthocladiinae	2	C	A	A	C
	Polypedilum	3	R	-	-	R
	Tanypodinae	5	-	-	R	-
	Dolichopodidae	3	-	-	-	R
	Empididae	3	-	-	R	-
	Ephydridae	4	-	R	-	-
	Muscidae	3	-	R	-	-
	Austrosimulium	3	R	R	C	A
ACARINA (MITES)	Acarina	5	R	-	R	-
		No of taxa	19	16	23	20
		MCI	106	94	99	114
		SQMCIs	5.9	3.6	6.2	7.0
		EPT (taxa)	8	4	5	7
		%EPT (taxa)	42	25	22	35

'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 two taxa less than the median number recorded for the site (Table 2 and Figure 2). This number was seven more than that recorded by the previous survey.

The MCI score of 106 units indicated a community of 'good' biological health which was similar to the median value calculated from previous surveys at the same site (median MCI score 104; Table 2). This MCI score was also similar to the value recorded by 'control' sites at similar altitudes (Table 3). The $SQMCI_S$ score of 5.9 was substantially higher than the historical median for the site (4.9) and substantially higher than that recorded by the previous survey (by 1.2 units) (Table 2).

One taxon , the 'highly sensitive' [mayfly (*Deleatidium*)] was recorded in abundance at this site (Table 4).

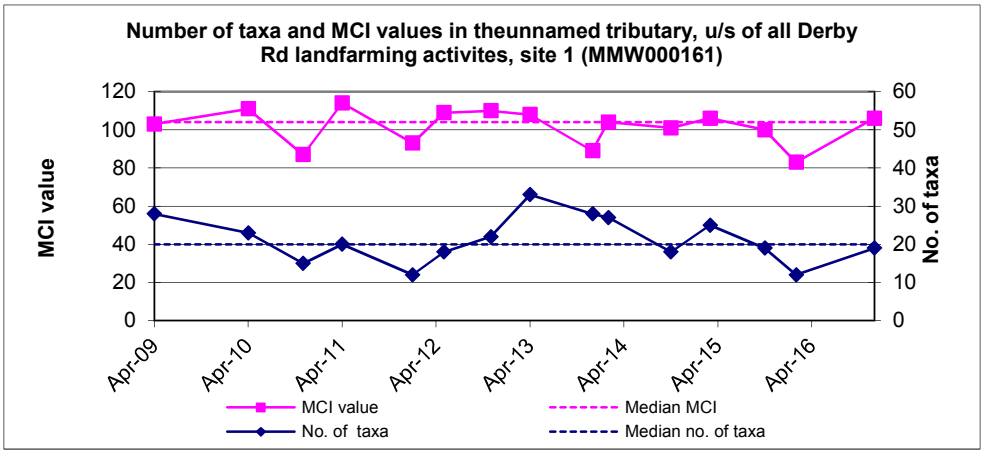


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 16 taxa was found at site 2, which was one taxon less than the median number recorded for the site and four taxa less than that recorded by the previous survey (Figure 3).

The MCI score of 94 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated by previous surveys at the same site (median MCI score 99; Table 2). The $SQMCI_S$ score of 3.6 units was the same as the median value calculated from previous surveys at the same site (Table 2) but substantially lower (by 1.4 units) than the $SQMCI_S$ score recorded by 'control' sites at similar altitudes (Table 3).The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)](Table 4).

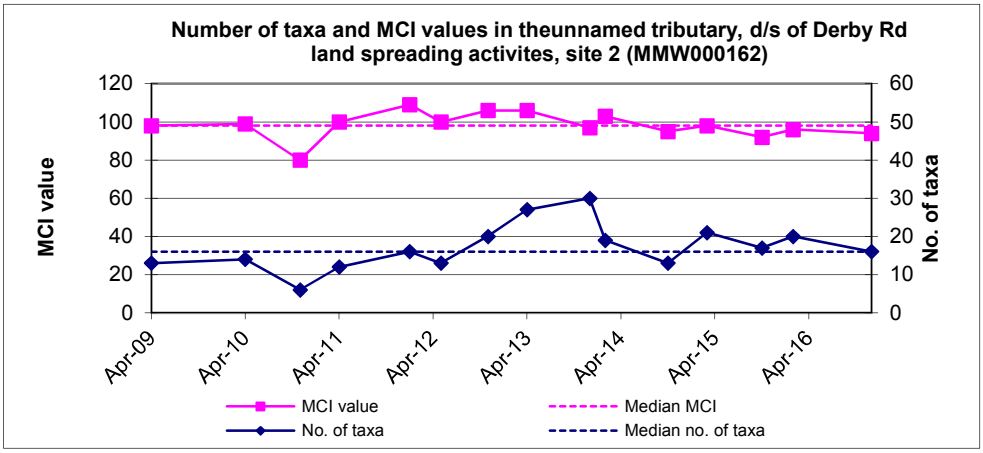


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 23 taxa was found at site 3, which was seven taxa more than the median number recorded for the site but one taxon less than that recorded by the previous sample (median taxa richness 16; Table 2 and Figure 4).

The MCI score of 99 units indicated a community of 'fair' biological health, which was slightly below the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_S$ score of 6.2 units was substantially higher than the median value calculated from previous surveys at the same site (median $SQMCI_S$ score of 4.2 units; Table 2) and significantly higher (by 2.7 units) than the February 2016 result.

The community was characterised by one 'tolerant' taxon; [midge (Orthocladiinae)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

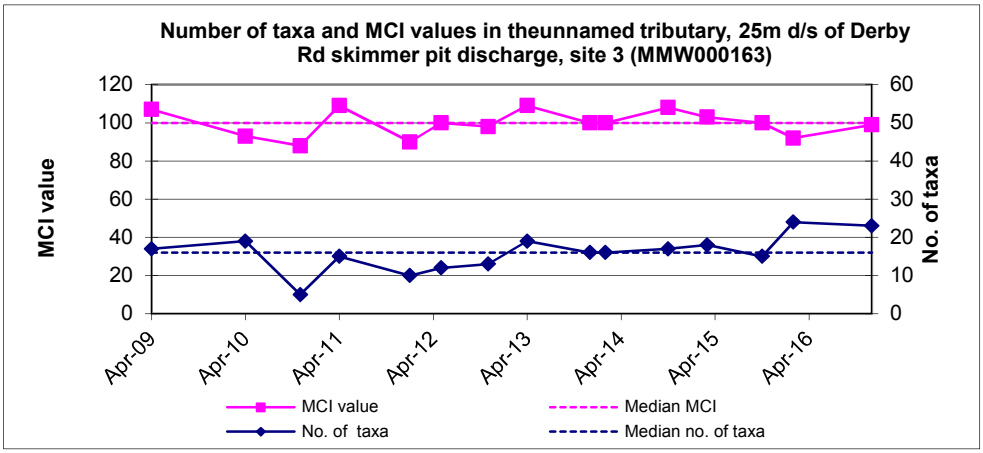


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 20 taxa was recorded at site 4, which was slightly above the median number recorded for the site and four taxa more than that recorded by the previous survey (median taxa richness 17; Table 2).

The MCI score of 114 units indicated a community of 'good' biological health which was significantly (Stark, 1998) higher than the median value calculated from previous surveys at the same site (median MCI score 100; Table 2 and Figure 5). The $SQMCI_S$ score of 7.0 units was substantially higher than the median value calculated from previous surveys at the same site (Table 2) and substantially higher than that recorded by 'control' sites at comparable altitudes (Table 3).

The community was characterised by one 'tolerant' taxon [black fly larvae (*Austrosimulium*)] and two 'highly sensitive' taxa [mayfly (*Deleatidium*)and toe-winged beetle (Ptilodactylidae)] (Table 4).

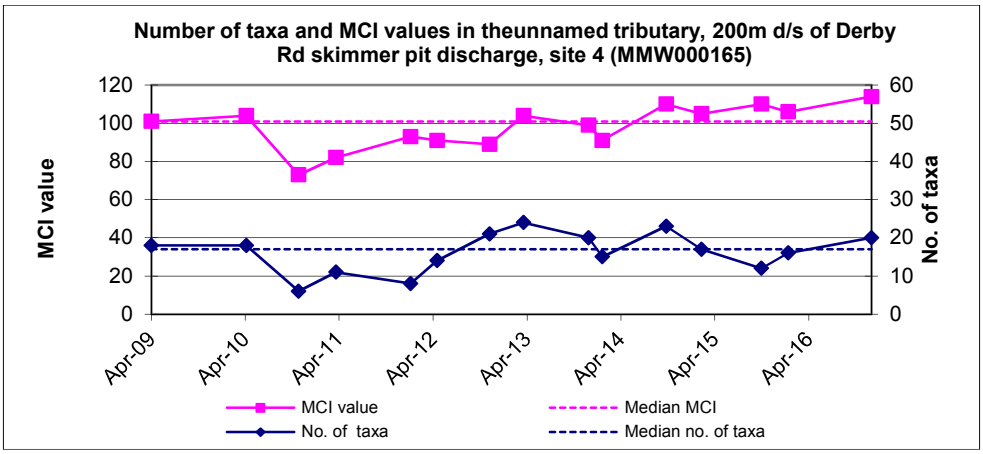


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

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 similar to the median recorded for this site and was higher than that recorded by the previous February 2016 survey. The MCI score was significantly (Stark, 1998) higher than that recorded by the previous survey but was similar to the median MCI score for the site. It is likely an improvement in the habitat available at the time of the survey has

contributed to these results. In the previous 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 previous survey, which may have also contributed to a reduction in habitat quality at this site. The $SQMCI_s$ score recorded by the current survey was substantially higher than the historical median and the previous survey result, also indicating some improvement at this site.

The results of this survey indicated that there was a decrease 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 substantial decrease in $SQMCI_s$ score (by 2.3 units) between site 1 and site 2 and a significant (Stark, 1998) decrease in MCI score (by 12 units). The $SQMCI_s$ score of 3.6 units was also substantially lower than the February 2016 score (4.9 units) but was the same as the median score recorded by the site.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by increased (when compared to the two upstream sites) taxa richnesses at both sites. The MCI score recorded at site 3 was slightly lower than that recorded at site 1 but slightly more than that recorded at site 2. The $SQMCI_s$ score recorded at site 3 was substantially higher than that recorded at site 2 and slightly higher than that recorded at site 1. It was also substantially 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 sites 2 and 3 and was slightly higher than the median recorded by previous surveys. The $SQMCI_s$ score recorded at site 4 was substantially higher than the median recorded by previous surveys and substantially higher than that recorded by the February 2016 survey.

Summary

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 of the Mangamawhete Stream surveyed. MCI values were similar to or better than the median values recorded by each site and indicated ‘fair’ to ‘good’ biological health in the Mangamawhete Stream.

References

Jansma B, 2009: Baseline biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Boyd Landfarm, April 2009. TRC report BJ054.

Jansma B, 2010: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road Landfarm, April 2010. TRC report BJ117.

Jansma B, 2011a: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, November 2010. TRC report BJ157.

Jansma B, 2011b: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, November 2010. TRC report BJ158.

Jansma B, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, April 2013. TRC report BJ213.

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, May 2012. TRC report CF579.

Smith KL and Fowles CR, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, January 2012. TRC report KS018.

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, November 2012. TRC report CF584.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. New Zealand Journal of Marine and Freshwater Research 32(1): 55-66.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark JD and Fowles CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain stream. Prepared for Taranaki Regional Council. Stark Environmental Report No. 2009-01. 47p.

Sutherland DL, 2015: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, October 2014. TRC report DS014.

Sutherland DL and Thomas BR, 2016: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, October 2015. TRC report BT046.

Taranaki Regional Council, 2012: C Boyd-Drilling waste disposal monitoring programmes Annual Report 2010-2011. Technical Report 2011-48.

Thomas BR, 2014: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, December 2013. TRC report BT021.

Thomas BR, 2016: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, February 2016. TRC report BT052.

Winterbourn MJ, Gregson KLD, Dolphin CH, 2006. Guide to the aquatic insects of New Zealand. [4th edition]. Bulletin of the Entomological Society of New Zealand 14, 108p.

To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1876109
Date	20 Jun 2017

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

Introduction

A macroinvertebrate survey was performed on 22 December 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 discharged to 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 summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The spring (October 2015) survey (Sutherland & Blakemore, 2016) 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. However, results from the latest previous survey in February 2016 (Thomas, 2016) indicated that there was no significant effect on macroinvertebrate communities from the activities.

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 22 December 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 to collect macroinvertebrates at all four sites. 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

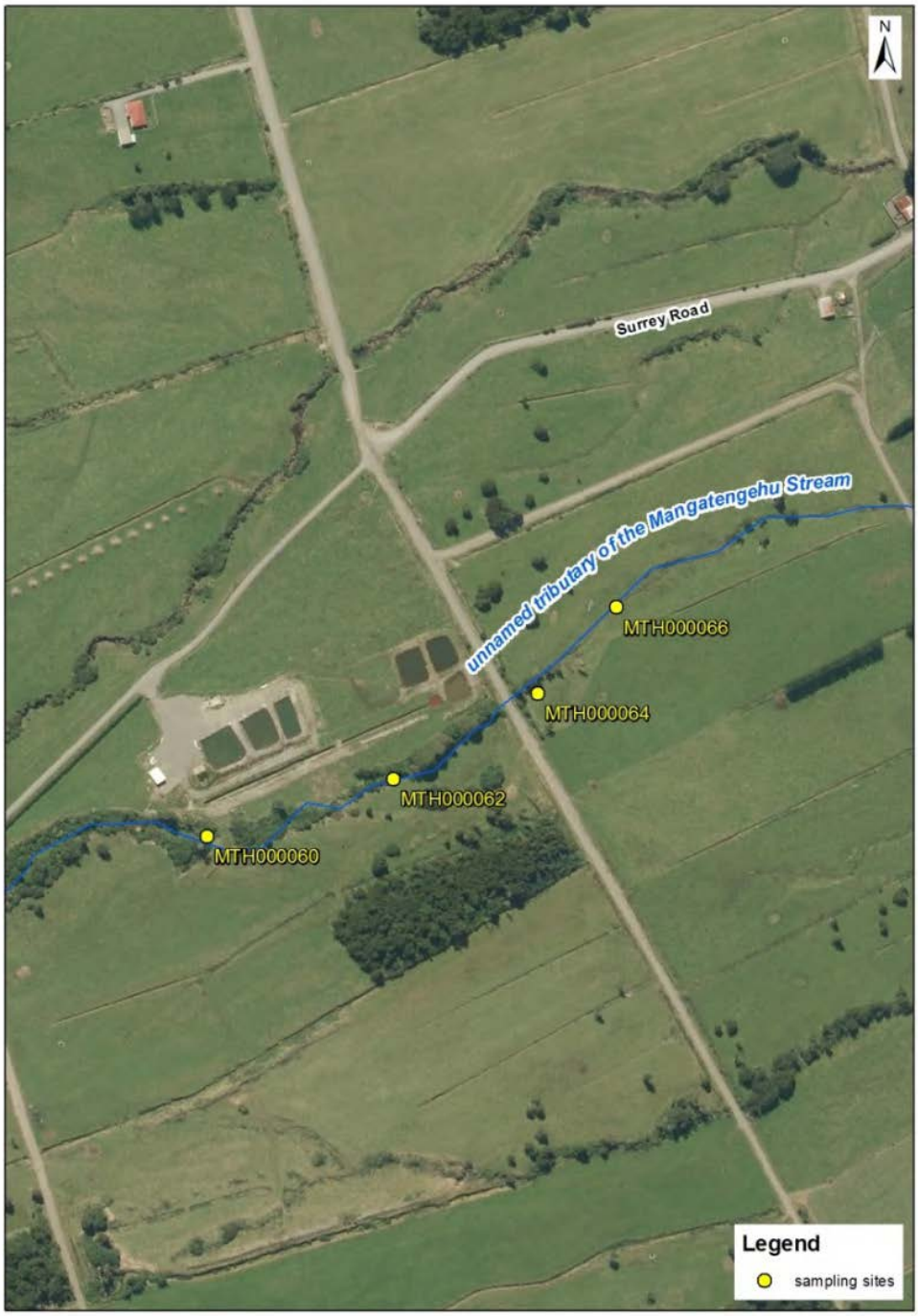


Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

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, 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.

Results

This December 2016 survey followed a period of seven days since a fresh in excess of three times median flow and 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 temperatures ranged between 12.5°C and 13.1 °C. There was an uncoloured, cloudy, moderate and steady flow at all four sites. At site 1, the substrate comprised predominantly of fine and coarse gravels with some sand, silt and cobbles. The substrate and the three downstream sites comprised predominantly cobbles, with gravels and some boulders and silt.

Slippery mats of periphyton were recorded growing at site 1 and patchy mats were recorded at sites 2, 3 and 4. No filamentous periphyton was recorded growing at sites 1 or 2, whereas patchy filamentous algae was recorded at sites 3 and 4. Macrophytes were recorded growing at the edges 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 and 2 but were most prevalent at sites 3 and 4. Cyanobacteria mats were prevalent at both sites 3 and 4.

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 22 December 2016 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Dec 2016	Median	Range	Dec 2016	Median	Range	Dec 2016
1	14	20	15-36	20	110	89-127	111	5.0	2.0-6.2	7.1
2	14	20	5-30	16	121	80-128	105	5.4	1.6-6.9	6.6
3	14	12	6-19	7	101	77-121	100	2.7	1.4-3.9	2.8
4	10	13	7-25	8	98	77-109	103	3.1	1.4-4.7	2.6

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, 2016).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	41	41	39
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 22 December 2016.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB16314	FWB16315	FWB16316	FWB16317
ANNELIDA (WORMS)	Oligochaeta	1	C	R	R	A
CRUSTACEA	*Paranephrops*	5	R	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	R	R	R
	Deleatidium	8	VA	A	R	C
	Nesameletus	9	C	-	-	-
	Zephlebia group	7	A	A	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-	R
	Austroperla	9	R	R	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	-	-	-
	Dytiscidae	5	-	R	-	-
	Hydraenidae	8	R	-	-	-
	Ptilodactylidae	8	C	R	-	R
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	R	-	-
	Psilochorema	6	R	R	-	-
	Oeconesidae	5	-	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	-	-	R
	Eriopterini	5	C	-	R	R
	Hexatomini	5	R	R	-	-
	Limonia	6	R	-	-	-
	Orthocladiinae	2	C	R	A	A
	Polypedilum	3	R	R	C	-
	Empididae	3	R	-	-	-
	Austrosimulium	3	C	C	-	-
ACARINA (MITES)	Acarina	5	-	R	-	-
		No of taxa	20	16	7	8
		MCI	111	105	100	103
		SQMCIs	7.1	6.6	2.8	2.6
		EPT (taxa)	8	7	3	3
		%EPT (taxa)	40	44	43	38

'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 20 taxa was recorded at site 1 upstream of the storage area, which was the same as the median recorded to date (Table 2 and Figure 2), and the same the median recorded by 'control' sites at similar altitudes (Table 3).

There were three taxa recorded in abundance including two 'moderately sensitive' taxa; [mayflies (*Zephlebia* group) and (*Austroclima*)]and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).The community comprised of a high proportion (73%) of 'sensitive' taxa which contributed to the 'good' MCI score of 111 units. This was similar to both the historical median (110 units; Table 2) and the score recorded by the previous summer survey (107 units; Figure 2).

A high $SQMCI_s$ score of 7.1 units was recorded, a substantial (2.1 units) higher than the median for the site recorded by previous surveys and the highest score recorded at this site to date (Table 2). This score reflected the three 'sensitive' taxa that were recorded as abundant to very abundant at this site.

The MCI score recorded was reflective of 'good' macroinvertebrate health. This coupled with a high $SQMCI_S$ 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.

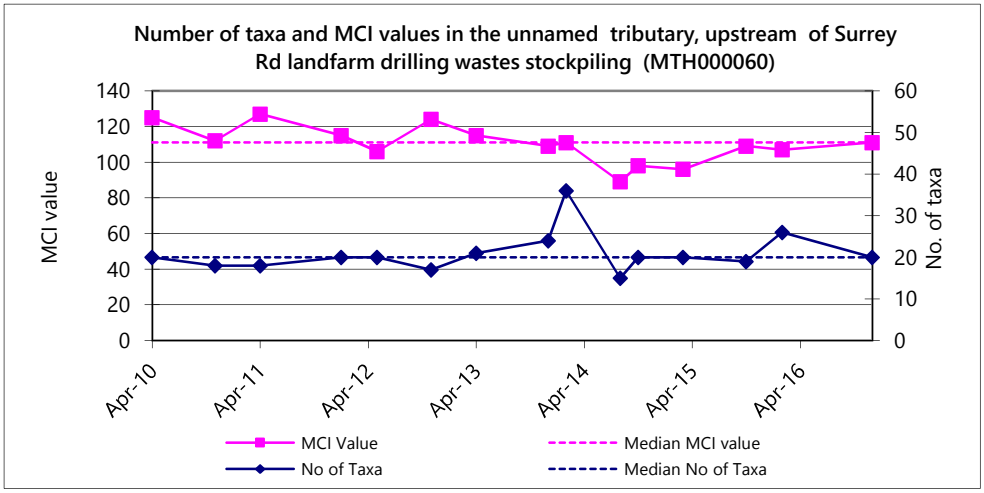


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 16 taxa was found at site 2, which was lower than the previous survey result (Figure 3), and lower than the median for the site (Table 2). Taxa richness was also slightly below the median recorded by similar sites at comparable altitudes (Table 3). Although this result was 14 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 four taxa less than that recorded by site 1 in the current survey.

The community comprised a high proportion of 'sensitive' taxa (75%) which was reflected by the MCI score of 105 units. This MCI score indicated a community of 'good' biological health, however it was significantly (Stark, 1998) lower than the previous survey score (Figure 3) and significantly lower than the median value calculated from previous surveys at the same site (Table 2). This score was however similar to that recorded by the upstream 'control' site and only three significant changes in taxa abundances were recorded. The

$SQMCI_S$ score of 6.6 units was substantially higher than the previous survey score ($SQMCI_S$ score of 5.0 units) and higher than the median value calculated from previous surveys at the same site, although was slightly lower than that recorded at the upstream 'control' site (Table 2).

The community was characterised by one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

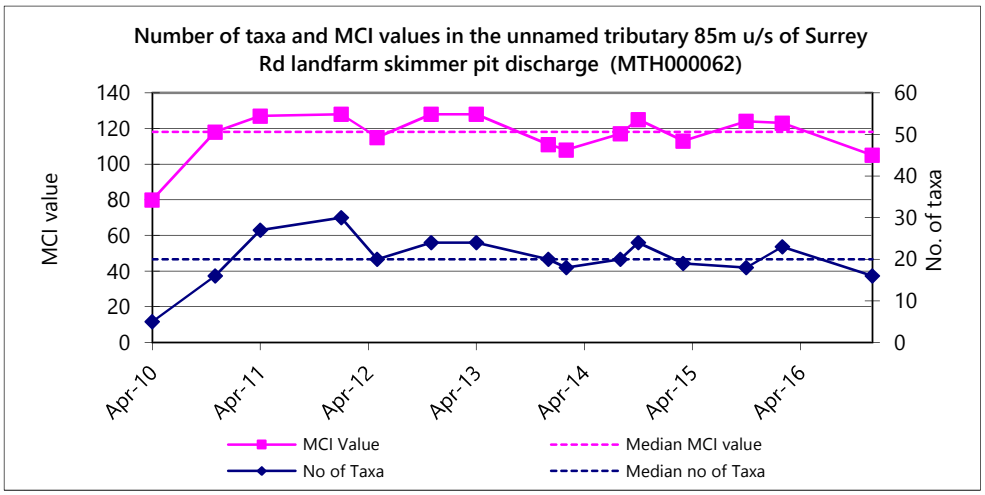


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A low macroinvertebrate community richness of seven taxa was found at site 3, which was substantially less than that found by the previous survey (Figure 4). Furthermore, the sample contained five taxa less than the median number recorded for the site (Table 2) and 13 taxa fewer than the median calculated from similar sites at comparable altitudes (Table 3). This community richness was 13 taxa lower than that recorded at site 1 and nine taxa less than that recorded at site 2. This result was also only one taxon above the lowest number ever recorded at the site (Figure 4). Low taxa richness may be an indicator of toxic discharges, though other factors such as poor habitat quality may also cause low taxa richness.

The community had very low taxa abundances with only one abundant 'tolerant' taxon [orthoclad midges]. 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.

In the current survey, 'sensitive' taxa comprised 57% of the macroinvertebrate community, which contributed to the 'good' MCI score of 100 units. This score was similar to the median for this site (Table 2), but significantly (Stark, 1998) lower than the previous survey score (Figure 4). It was not significantly different to that recorded upstream at site 2, but was significantly lower than the MCI score recorded by the upstream 'control' site.

The $SQMCI_S$ score of 2.8 units was lower than the previous survey score ($SQMCI_S$ score of 3.6 units) but was similar to the median value calculated from previous surveys at the same site ($SQMCI_s$ score of 2.7) (Table 2).The current $SQMCI_s$ score of 2.8 units represented a substantial downstream decrease of 3.8 units in $SQMCI_s$ score between sites 2 and 3. There were four significant changes in individual taxon abundance

between site 2 and 3, including the decrease of two 'sensitive' taxa and one 'tolerant' taxon and the increase of one 'tolerant' taxon. The 'highly sensitive' taxon, mayfly (*Deleatidium*), was 'rare' to site 3 but 'abundant' to 'very abundant' at sites 1 and 2 and 'common' to site 4. The proliferation of algal mats, together with increased iron oxide sedimentation can possibly explain the reduction in taxa richness, $SQMCI_S$ and MCI scores at this site, compared to site 2.

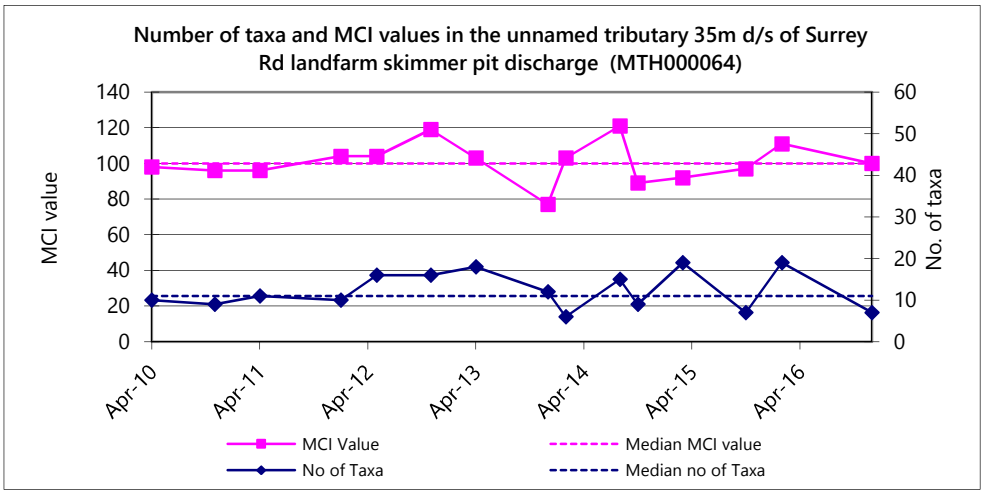


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of eight taxa was found at site 4 which was substantially less than that recorded by the previous survey and substantially less than that recorded by the upstream 'control' site (Figure 5). Furthermore, the sample contained five taxa less than the median number recorded for the site (Table 2) and 12 taxa less 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.

The MCI score of 103 units indicated a community of 'good' biological health, which was not significantly different (Stark, 1998) to the previous survey (Figure 5) or to the median value calculated from previous surveys at the same site or to the upstream control site (Table 2). The $SQMCI_S$ score of 2.6 units was substantially lower than the previous survey score ($SQMCI_S$ score of 4.5 units) and was lower than the median value calculated from previous surveys at the same site (Table 2). This $SQMCI_S$ score was also significantly lower than that recorded at site 1 and site 2.

The community was characterised by two 'tolerant' taxa [oligochaete worms and orthoclad midges] (Table 4).

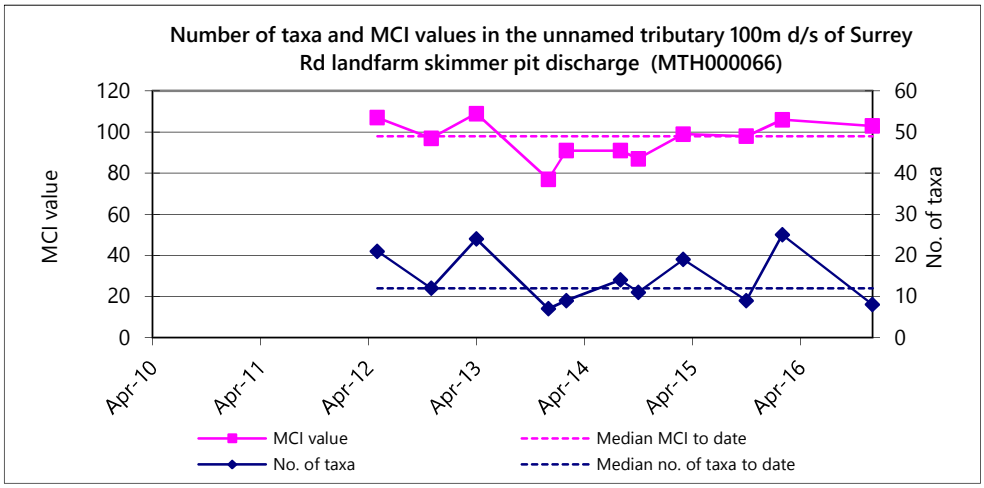


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 22 December 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 or well above 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 a slight decrease in MCI score at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. However there were no significant (Stark, 1998) differences in macroinvertebrate indices between sites 1 and 2 and MCI scores were reflective of 'good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were also both reflective of 'good' macroinvertebrate community health, although both had much lower taxa richnesses and $SQMCI_S$ scores compared with the two upstream sites. This can be attributed to habitat differences including an increase in iron oxide deposits and nuisance periphyton cover together with a lack of shading at the two downstream sites. 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 summer (February 2016) survey the 'impacted' sites in the current survey recorded decreased MCI scores and taxa richnesses. Taxa richness at site 3 had decreased by 12 taxa and the MCI score had decreased by a significant (Stark, 1998) 11 units. At site 4, the MCI score had decreased by 3 units and taxa richness had decreased by 17. This can in part can be explained by an increase in periphyton cover and iron oxide deposits present during the current survey. However, these results may also reflect impacts occurring as a result of stockpiling activities.

Comparison of taxa richnesses, MCI and $SQMCI_S$ values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites had results either similar to or well above the median values. However, the two 'impacted' sites recorded taxa richnesses and $SQMCI_S$ values well below median values though MCI values were not significantly (Stark, 1998) different to the median value.

Summary

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses and $SQMCI_S$ values 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.

References

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, November 2012. TRC Report CF585.

Jansma B, 2010: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Landfarm, April 2010. TRC Report BJ118.

Jansma B, 2011: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Landfarm, November 2010. TRC Report BJ153.

Jansma B, 2011: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, April 2011. BJ154.

Jansma B, 2013: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, April 2013. BJ214.

Smith K, 2012: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, January 2012. KS001.

Smith K, 2012: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, May 2012. KS012.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. New Zealand Journal of Marine and Freshwater Research 32(1): 55-66.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark JD and Fowles CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain stream. Prepared for Taranaki Regional Council. Stark Environmental Report No. 2009-01. 47p.

Sutherland DL, 2015a: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, October 2014. DS016.

Sutherland DL, 2015b: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, March 2015. DS017.

Sutherland DL & Blakemore K, 2016: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, October 2015. DS037.

Taranaki Regional Council, 2012: C Boyd-Drilling waste disposal monitoring programmes. Annual Report 2010-2011. Technical Report 2011-48.

Thomas B, 2014a: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, December 2013. BT023

Thomas B, 2014b: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, February 2014. BT031

Thomas B, 2014c: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to an incident investigation at the Surrey Road Drilling Waste Stockpiling site, August 2014. BT032

Thomas B, 2016: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to an incident investigation at the Surrey Road Drilling Waste Stockpiling site, February 2016. BT053

TRC, 2015: Some statistics from the Taranaki Regional Council database (Esam) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 30 September 2014. Technical Report 2014-105.

Winterbourn MJ, Gregson KLD, Dolphin CH, 2006. Guide to the aquatic insects of New Zealand. [4th edition]. Bulletin of the Entomological Society of New Zealand 14, 108p.

To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1884877
Date	21 Jun 2017

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility, February 2017

Introduction

A macroinvertebrate survey was performed on 27 February 2017 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 discharged to 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 summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The spring (October 2015) survey (Sutherland & Blakemore, 2016) 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. Results from the more recent February 2016 survey (Thomas, 2016) indicated that there was no significant effect on macroinvertebrate communities from the activities. However, results from the latest previous survey in December 2016 (Thomas, 2017) again indicated 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.

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 27 February 2017 (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 to collect macroinvertebrates at all four sites. 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

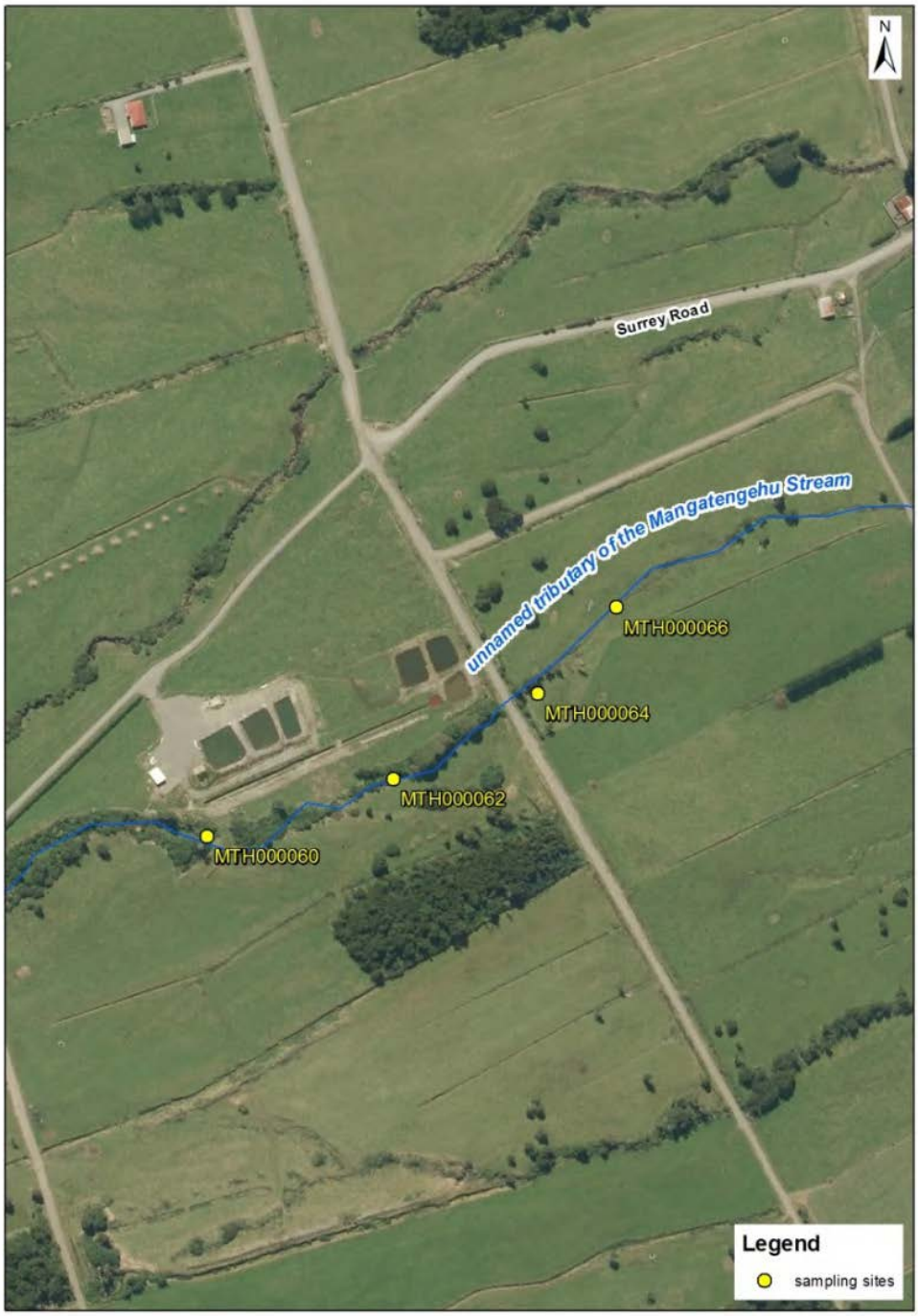


Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

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, 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.

Results

This February 2017 survey followed a period of 24 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 temperatures ranged between 14.0°C and 15.1 °C. There was an uncoloured, cloudy, moderate and steady flow at all four sites. At site 1, the substrate comprised predominantly of fine and coarse gravels with some sand, silt and cobbles. The substrate and the three downstream sites comprised predominantly cobbles, with gravels and some boulders, sand and silt.

Slippery mats of periphyton were recorded growing at sites 1 and 2, whereas widespread mats were recorded at sites 3 and 4. Patchy filamentous periphyton was recorded growing at site 1 whereas widespread filamentous algae was recorded at sites 3 and 4. No filamentous algae was observed growing at site 2. 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 all sites but were most prevalent at sites 3 and 4. Cyanobacteria mats were prevalent at both sites 3 and 4.

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 27 February 2017 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2017	Median	Range	Feb 2017	Median	Range	Feb 2017
1	15	20	15-36	24	111	89-127	113	5.0	2.0-7.1	5.4
2	15	20	5-30	17	118	80-128	119	5.5	1.6-6.9	5.8
3	15	11	6-19	4	100	77-121	60	2.8	1.4-3.9	2.0
4	11	12	7-25	13	98	77-109	94	2.8	1.4-4.7	2.1

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, 2016).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	41	41	39
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 27 February 2017.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB17128	FWB17129	FWB17130	FWB17131
ANNELIDA (WORMS)	Oligochaeta	1	A	C	C	A
	Lumbricidae	5	R	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	R	-	-
CRUSTACEA	Ostracoda	1	-	-	-	R
	Talitridae	5	R	-	-	-
	Paranephrops	5	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	A	A	-	R
	Nesameletus	9	C	R	-	-
	Zephlebia group	7	A	C	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	R
	Spaniocerca	8	R	R	-	-
	Stenoperla	10	R	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	R	-	-	-
	Dytiscidae	5	R	-	-	-
	Hydrophilidae	5	-	R	-	-
	Ptilodactylidae	8	C	C	-	-
	Scirtidae	8	-	R	-	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	-	-	R
	Hydrobiosis	5	R	R	-	-
	Polyplectropus	6	C	-	-	R
	Psilochorema	6	C	C	-	R
	Triplectides	5	R	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	-	-	R
	Eriopterini	5	R	-	-	-
	Limonia	6	-	-	R	-
	Paralimnophila	6	R	-	-	-
	Orthocladiinae	2	C	C	A	VA
	Polypedilum	3	C	C	-	R
	Tanypodinae	5	R	-	-	-
	Paradixa	4	R	-	-	-
	Empididae	3	-	-	R	-
	Muscidae	3	-	-	-	R
	Austrosimulium	3	C	C	-	-
ACARINA (MITES)	Acarina	5	C	-	-	R
		No of taxa	24	17	4	13
		MCI	113	119	60	94
		SQMCIs	5.4	5.8	2.0	2.1
		EPT (taxa)	10	8	0	5
		%EPT (taxa)	42	47	0	38

'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 24 taxa was recorded at site 1 upstream of the storage area, which was four taxa more than the median recorded to date (Table 2 and Figure 2), and four taxa more than the median recorded by 'control' sites at similar altitudes (Table 3).

There were three taxa recorded in abundance including one 'tolerant' taxon; [oligochaete worms], one 'moderately sensitive' taxon; [mayflies (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).The community comprised of a high proportion (79%) of 'sensitive' taxa which contributed to the 'good' MCI score of 113 units. This was similar to both the historical median (111 units; Table 2) and the score recorded by the previous survey (111 units; Figure 2).

A $SQMCI_S$ score of 5.4 units was recorded, 0.4 unit higher than the median for the site recorded by previous surveys (Table 2). This score was slightly above the median value calculated from similar 'control' sites at comparable altitudes (Table 3).

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.

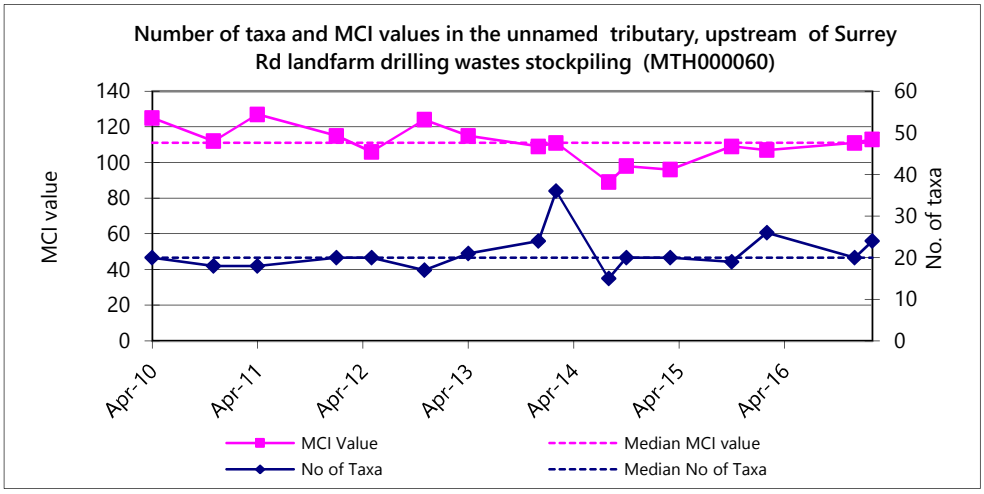


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 17 taxa was found at site 2, which was similar to the previous survey result (Figure 3), but slightly lower than the median for the site (Table 2). Taxa richness was also slightly below the median recorded by similar sites at comparable altitudes (Table 3). Although this result was 13 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 seven taxa less than that recorded by site 1 in the current survey.

The community comprised a high proportion of 'sensitive' taxa (70%) which was reflected by the MCI score of 119 units. This MCI score indicated a community of 'good' biological health, and was significantly (Stark, 1998) higher than the previous survey score (Figure 3) but similar to the median value calculated from previous surveys at the same site (Table 2). This score was slightly higher than that recorded by the upstream 'control' site and only two significant changes in taxa abundances were recorded. The $SQMCI_S$ score of 5.8 units was substantially lower than the previous survey score ($SQMCI_S$ score of 6.6 units) but was slightly higher than the median value calculated from previous surveys at the same site, and was slightly higher than that recorded at the upstream 'control' site (Table 2).

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 4).

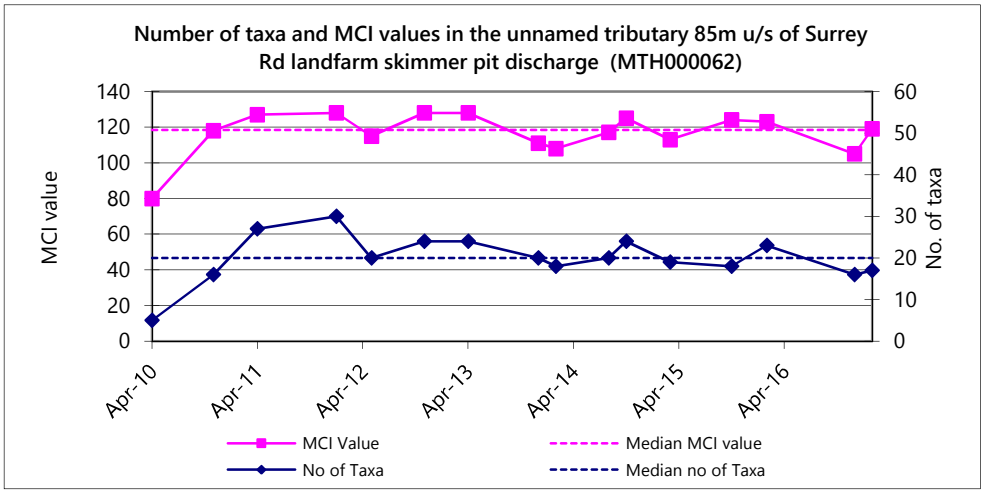


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A very low macroinvertebrate community richness of four taxa was found at site 3, which was three taxa less than that found by the previous survey (Figure 4). Furthermore, the sample contained seven taxa less than the median number recorded for the site (Table 2) and 16 taxa fewer than the median calculated from similar sites at comparable altitudes (Table 3). This community richness was 20 taxa lower than that recorded at site 1 and 13 taxa less than that recorded at site 2. This result was also the lowest number ever recorded at the site (Figure 4). Low taxa richness may be an indicator of toxic discharges, though other factors such as poor habitat quality may also cause low taxa richness.

The community had very low taxa abundances with only one abundant 'tolerant' taxon recorded [orthoclad midges]. 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.

In the current survey, 'tolerant' taxa comprised 75% of the macroinvertebrate community, which contributed to the 'poor' MCI score of 60 units. This score was significantly (Stark, 1998) lower than the median for this site (Table 2), and significantly lower than the previous survey score (Figure 4). It was also significantly lower than that recorded upstream at sites 1 and 2 (Table 2).

The $SQMCI_S$ score of 2.0 units was lower than the previous survey score ($SQMCI_S$ score of 2.8 units) and was lower than the median value calculated from previous surveys at the same site ($SQMCI_s$ score of 2.8) (Table 2).The current $SQMCI_s$ score of 2.0 units represented a substantial downstream decrease of 3.8 units in $SQMCI_s$ score between sites 2 and 3. There were six significant changes in individual taxon abundance between site 2 and 3, including the decrease of four 'sensitive' taxa and two 'tolerant' taxa. The 'highly sensitive' taxon, mayfly (*Deleatidium*), was absent at site 3 but 'abundant' at sites 1 and 2 and 'rare' to site 4. The proliferation of algal mats, together with increased iron oxide sedimentation can possibly explain the reduction in macroinvertebrate indices at this site, although this may also be indicative of impacts caused by activities at the drilling waste stockpiling site.

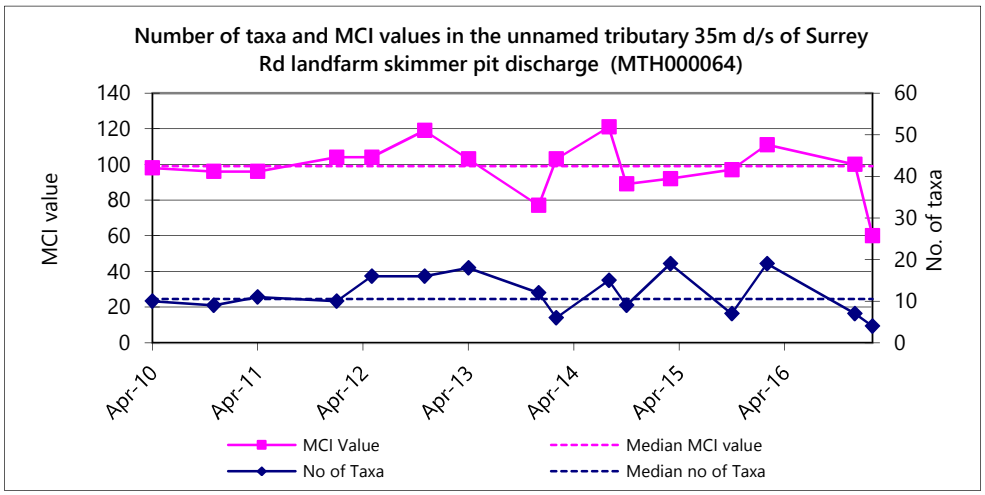


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of 13 taxa was found at site 4 which was slightly higher than that recorded by the previous survey and similar to the median for the site but substantially less than that recorded by the upstream 'control' site (Table 2 and Figure 5). Furthermore, the sample contained seven taxa less than the median calculated from similar sites (Table 3).

The MCI score of 94 units indicated a community of 'fair' biological health, which was not significantly different (Stark, 1998) to the previous survey (Figure 5) or to the median value calculated from previous surveys at the same site (Table 2). It was however, significantly lower than that recorded upstream at 'control' site 1 and site 2.

The $SQMCI_S$ score of 2.1 units was lower than the previous survey score ($SQMCI_S$ score of 2.6 units) and was lower than the median value calculated from previous surveys at the same site (Table 2). In addition, this $SQMCI_S$ score was substantially lower than that recorded at site 1 or site 2.

The community was characterised by two 'tolerant' taxa [oligochaete worms and orthoclad midges] (Table 4).

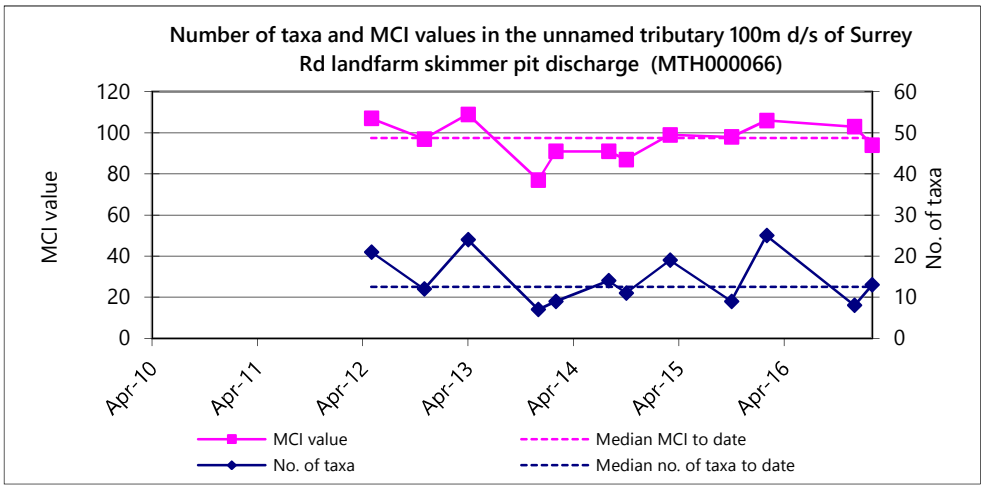


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 27 February 2017, 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. However there were no significant (Stark, 1998) differences in macroinvertebrate indices between sites 1 and 2. The MCI score was reflective of 'good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were reflective of 'poor' (site 3) and 'fair' (site 4) macroinvertebrate community health. Both had substantially lower taxa richnesses and $SQMCI_S$ scores compared with the two upstream sites. In addition, the MCI scores recorded at site 3 and site 4 were both significantly (Stark, 1998) lower than those recorded by the two upstream sites. Site 3 recorded the lowest MCI score for the site to date. This MCI score was significantly (Stark, 1998) lower than the previous lowest score (by 17 units).

The decreases in macroinvertebrate indices at the two 'impacted' sites can (to an extent) be attributed to habitat differences, including an increase in iron oxide deposits and nuisance periphyton cover and a lack of shading at the lower sites. 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. However, the extremely low taxa richness and abundance, together with low MCI and $SQMCI_S$ scores recorded below the discharge point at site 3 indicate that activities at the drilling waste stockpiling site and stockpiling area have likely resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

In relation to the previous spring (December 2016) survey the 'impacted' sites in the current survey recorded decreased MCI and $SQMCI_S$ scores. Taxa richness at site 3 had also decreased (by three taxa) and the MCI score decreased by a significant (Stark, 1998) 40 units. The $SQMCI_S$ score at site 3 had decreased by a substantial 0.8 unit. At site 4, the MCI score had decreased by 9 units although taxa richness had increased by 5 and the $SQMCI_S$ score had decreased by 0.5 unit.

Comparison of taxa richnesses, MCI and $SQMCI_S$ values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites had results either similar to or well above the median values. However, the two 'impacted' sites recorded taxa richnesses and $SQMCI_S$ and MCI values well below median values.

Summary

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses, MCI and $SQMCI_S$ values examined compared with the 'control' sites at the time of the survey. Differences in periphyton cover and amount of iron oxide deposits would explain some of the differences observed. Stockpiling activities are likely to have also contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores. Further investigation into the extent to which stockpiling activities are responsible for the low taxa richnesses, abundances and MCI scores in the lower section of the tributary of the Mangatengehu Stream would be useful, particularly whether or not stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites.

References

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, November 2012. TRC Report CF585.

Jansma B, 2010: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Landfarm, April 2010. TRC Report BJ118.

Jansma B, 2011: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Landfarm, November 2010. TRC Report BJ153.

Jansma B, 2011: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, April 2011. BJ154.

Jansma B, 2013: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, April 2013. BJ214.

Smith K, 2012: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, January 2012. KS001.

Smith K, 2012: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, May 2012. KS012.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. New Zealand Journal of Marine and Freshwater Research 32(1): 55-66.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark JD and Fowles CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain stream. Prepared for Taranaki Regional Council. Stark Environmental Report No. 2009-01. 47p.

Sutherland DL, 2015a: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, October 2014. DS016.

Sutherland DL, 2015b: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, March 2015. DS017.

Sutherland DL & Blakemore K, 2016: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, October 2015. DS037.

Taranaki Regional Council, 2012: C Boyd-Drilling waste disposal monitoring programmes. Annual Report 2010-2011. Technical Report 2011-48.

Thomas B, 2014a: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, December 2013. BT023

Thomas B, 2014b: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, February 2014. BT031

Thomas B, 2014c: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to an incident investigation at the Surrey Road Drilling Waste Stockpiling site, August 2014. BT032

Thomas B, 2016: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to an incident investigation at the Surrey Road Drilling Waste Stockpiling site, February 2016. BT053

Thomas B, 2017: Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to an incident investigation at the Surrey Road Drilling Waste Stockpiling site, December 2016. BT072

TRC, 2015: Some statistics from the Taranaki Regional Council database (Esam) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 30 September 2014. Technical Report 2014-105.

Winterbourn MJ, Gregson KLD, Dolphin CH, 2006. Guide to the aquatic insects of New Zealand. [4th edition]. Bulletin of the Entomological Society of New Zealand 14, 108p.

To	Job Manager, Nathan Crook
From	Scientific Officer, Brooke Thomas
Document	1885559
Date	21 June 2017

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, February 2017

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 the second of two scheduled surveys for the site in the 2016-17 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 four 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 December 2016 (Thomas, 2017) 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 27 February 2017. 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

This February 2017 survey followed a period of 24 days since a fresh in excess of seven times median flow.

The water temperature ranged between 16.1 °C and 17.8 °C. Water levels were moderate and water speeds steady. Water was uncoloured and cloudy at sites 1, 2 and 3, and grey and cloudy at site 4. Substrate composition for all sites comprised predominantly cobbles and gravels, with some silt, sand and boulder. Site 2 and site 3 comprised a higher proportion of cobbles and boulders in comparison with the other two sites.

Periphyton mats were slippery at sites 1 and 4, however no filamentous algae was recorded. At sites 2 and 3 patchy mats and widespread filaments of periphyton were recorded. No macrophytes were recorded growing at any of the four sites. Sites 1 was partially shaded by overhanging vegetation whereas site 4 had complete shading and sites 2 and 3 had no shading.

Macroinvertebrate communities

Table 2 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 2 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 27 February 2017 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2017	Median	Range	Feb 2017	Median	Range	Feb 2017
1	15	20	12-33	15	104	83-114	107	5.0	3.2-7.4	4.5
2	15	16	6-30	17	98	80-109	109	3.6	2.0-7.4	4.1
3	15	16	5-24	15	100	88-109	99	4.4	2.5-6.7	4.6
4	15	17	6-24	16	101	73-114	121	4.6	2.1-7.0	5.0

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 (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2016).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	41	41	39
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 Mangamawhete Stream, sampled on 27 February 2017 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		FWB17124	FWB17125	FWB17126	FWB17127
ANNELIDA (WORMS)	Oligochaeta	1	-	R	C	-
MOLLUSCA	*Potamopyrgus*	4	R	R	-	R
CRUSTACEA	Ostracoda	1	C	-	C	-
	Talitridae	5	-	R	-	-
	Paranephrops	5	R	-	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	-	R	R
	Deleatidium	8	C	C	C	A
	Nesameletus	9	R	R	C	R
	Zephlebia group	7	R	R	-	R
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	-	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	C	R	R	-
	Ptilodactylidae	8	-	R	-	R
	Scirtidae	8	C	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	-	R
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	-	R	R	R
	Hydrochorema	9	-	R	-	-
	Hydropsyche (Orthopsyche)	9	-	-	-	R
	Polyplectropus	6	C	-	R	R
	Psilochorema	6	C	R	R	R
	Oxyethira	2	-	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R	C	-
	Eriopterini	5	-	R	-	-
	Hexatomini	5	R	R	-	R
	Orthocladiinae	2	A	A	C	A
	Polypedilum	3	-	-	-	C
	Tanypodinae	5	-	-	R	-
	Austrosimulium	3	R	R	R	C
ACARINA (MITES)	Acarina	5	C	R	-	-
	No of taxa		15	17	15	16
	MCI		107	109	99	121
	SQMCIs		4.5	4.1	4.6	5.0
	EPT (taxa)		5	6	6	9
	%EPT (taxa)		33	35	40	56

'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 15 taxa was found at site 1, which was five taxa less than the median number recorded for the site (Table 2 and Figure 2). This number was four less than that recorded by the previous survey.

The MCI score of 107 units indicated a community of 'good' biological health which was similar to the median value calculated from previous surveys at the same site (median MCI score 104; Table 2). This MCI score was also similar to the value recorded by 'control' sites at similar altitudes (Table 3). The $SQMCI_S$ score of 4.5 was lower than the historical median for the site (5.0) and substantially lower than that recorded by the previous survey (by 1.4 units) (Table 2).

One 'tolerant' taxon [orthoclad midges] characterised the macroinvertebrate community at this site (Table 4).

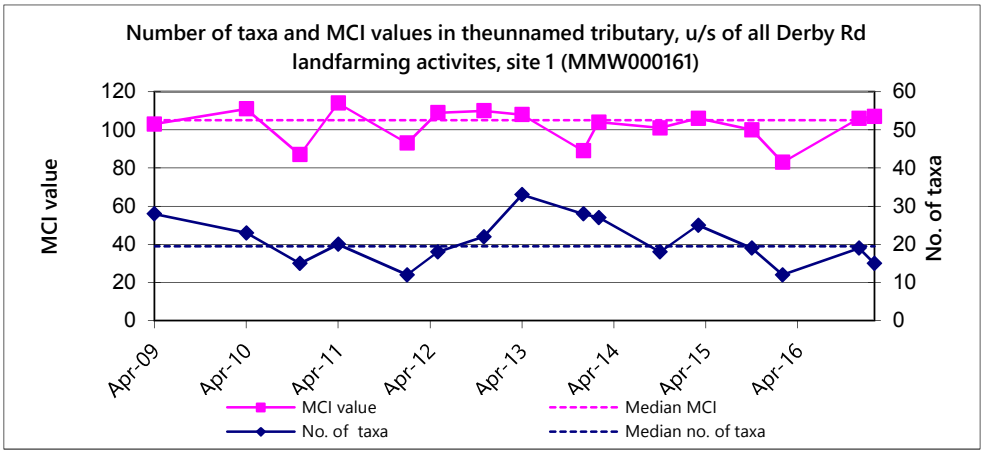


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 17 taxa was found at site 2, which was one taxon more than the median number recorded for the site and one taxon more than that recorded by the previous survey (Figure 3).

The MCI score of 109 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the median value calculated by previous surveys at the same site (median MCI score 98; Table 2). The $SQMCI_S$ score of 4.1 units was higher than the median value calculated from previous surveys at the same site (Table 2) but substantially lower (by 0.9 unit) than the $SQMCI_S$ score recorded by 'control' sites at similar altitudes (Table 3). One 'tolerant' taxon [orthoclad midges] characterised the macroinvertebrate community at this site (Table 4).

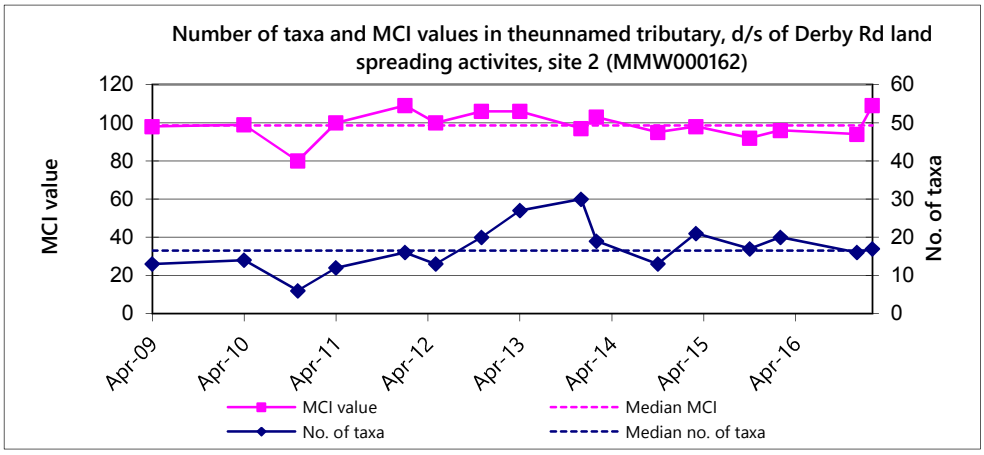


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

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 eight taxa less than that recorded by the previous sample (median taxa richness 16; Table 2 and Figure 4).

The MCI score of 99 units indicated a community of 'fair' biological health, which was just below the median value calculated from previous surveys at the same site (Table 2). The $SQMCI_S$ score of 4.6 units was slightly higher than the median value calculated from previous surveys at the same site (median $SQMCI_S$ score of 4.4 units; Table 2) but substantially lower (by 1.6 units) than the December 2016 result.

No taxa were found in abundance at this site (Table 4).

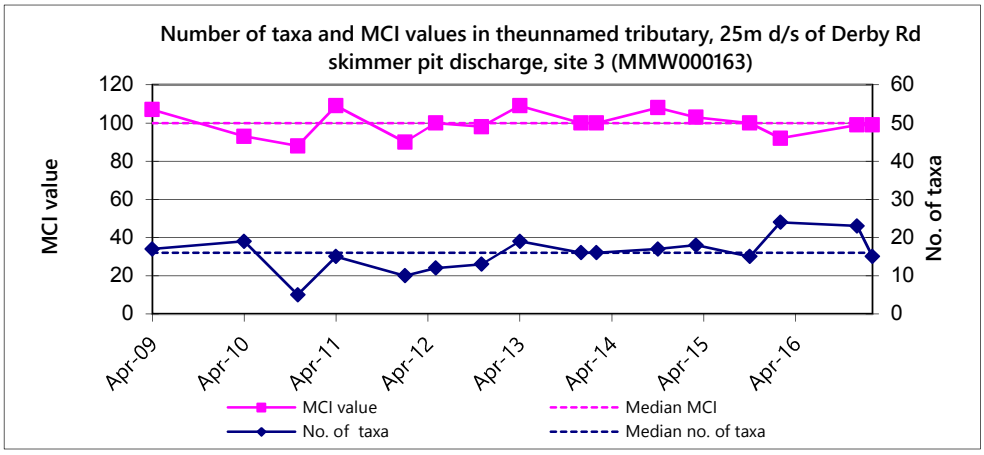


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 16 taxa was recorded at site 4, which was just below the median number recorded for the site and four taxa less than that recorded by the previous survey (median taxa richness 17; Table 2).

The MCI score of 121 units indicated a community of 'very good' biological health which was significantly (Stark, 1998) higher than the median value calculated from previous surveys at the same site (median MCI score 101; Table 2 and Figure 5) and the highest MCI score recorded by the site to date. The $SQMCI_S$ score of 5.0 units was slightly higher than the median value calculated from previous surveys at the same site (Table 2) but the same as that recorded by 'control' sites at comparable altitudes (Table 3).

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

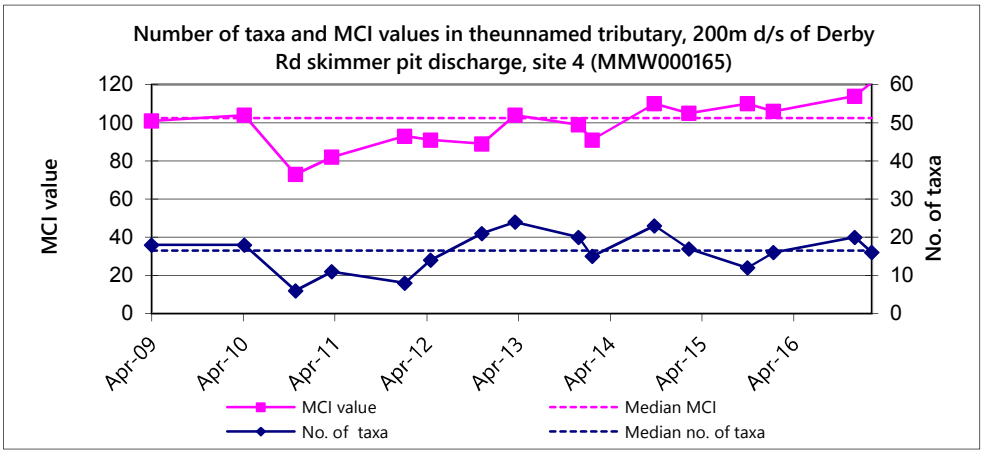


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

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 slightly below the median recorded for this site and was lower than that recorded by the previous December 2016 survey. The MCI score was similar to that recorded by the previous survey and was similar to the median MCI score for the site. The $SQMCI_s$ score recorded by the current survey was lower than the historical median and the previous survey result.

The results of this survey indicated 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) was similar to that recorded at site 1. There was only a slight increase in MCI score (by 2 units) and a slight decrease in $SQMCI_s$ score (by 0.4 units) between site 1 and site 2. The $SQMCI_s$ score of 4.1 units was substantially higher than the December 2016 score and the median for the site (by 0.5 unit) and the MCI score was significantly (Stark, 1998) higher than that recorded by the December 2016 survey.

The macroinvertebrate communities at the two downstream sites (3 and 4) had similar taxa richnesses to the two upstream sites. The MCI score recorded at site 3 was slightly lower than that recorded at sites 1 and 2, although the $SQMCI_s$ score was slightly higher than those recorded by the two upstream sites. The MCI score recorded at site 4 was significantly (Stark, 1998) higher than that recorded by the three upstream sites and was the highest MCI recorded at this site to date. The $SQMCI_s$ score recorded at site 4 was slightly higher than the median recorded by previous surveys but substantially lower than that recorded by the December 2016 survey.

Summary

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 of the Mangamawhete Stream surveyed. MCI values were similar to or better than the median values recorded by each site and indicated 'fair' to 'very good' biological health in the Mangamawhete Stream.

References

Jansma B, 2009: Baseline biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Boyd Landfarm, April 2009. TRC report BJ054.

Jansma B, 2010: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road Landfarm, April 2010. TRC report BJ117.

Jansma B, 2011a: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, November 2010. TRC report BJ157.

Jansma B, 2011b: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, November 2010. TRC report BJ158.

Jansma B, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, April 2013. TRC report BJ213.

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, May 2012. TRC report CF579.

Smith KL and Fowles CR, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, January 2012. TRC report KS018.

Fowles CR and Smith KL, 2013: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, November 2012. TRC report CF584.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. New Zealand Journal of Marine and Freshwater Research 32(1): 55-66.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark JD and Fowles CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain stream. Prepared for Taranaki Regional Council. Stark Environmental Report No. 2009-01. 47p.

Sutherland DL, 2015: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, October 2014. TRC report DS014.

Sutherland DL and Thomas BR, 2016: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, October 2015. TRC report BT046.

Taranaki Regional Council, 2012: C Boyd-Drilling waste disposal monitoring programmes Annual Report 2010-2011. Technical Report 2011-48.

Thomas BR, 2014: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, December 2013. TRC report BT021.

Thomas BR, 2016: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, February 2016. TRC report BT052.

Thomas BR, 2017: Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling site, December 2016. TRC report BT069.

Winterbourn MJ, Gregson KLD, Dolphin CH, 2006. Guide to the aquatic insects of New Zealand. [4th edition]. Bulletin of the Entomological Society of New Zealand 14, 108p.

Appendix III

MI SWACO Annual Report
CD Boyd Landfarms
29 October 2017

ANNUAL REPORT FOR

CONSENT# 7591-1.1

CONSENT# 7559-1.3

COLIN BOYD LAND FARMS

SURREY ROAD

INGLEWOOD

TARANAKI

29 October 2017

Status of Surrey and Derby Road Land Farm Facilities:

Derby Road:

MI SWACO has relinquished responsibility of the Derby Road facility as mentioned in last years TRC annual report.

Consents :

- 7911-1
- 6900-2

Surrey Road:

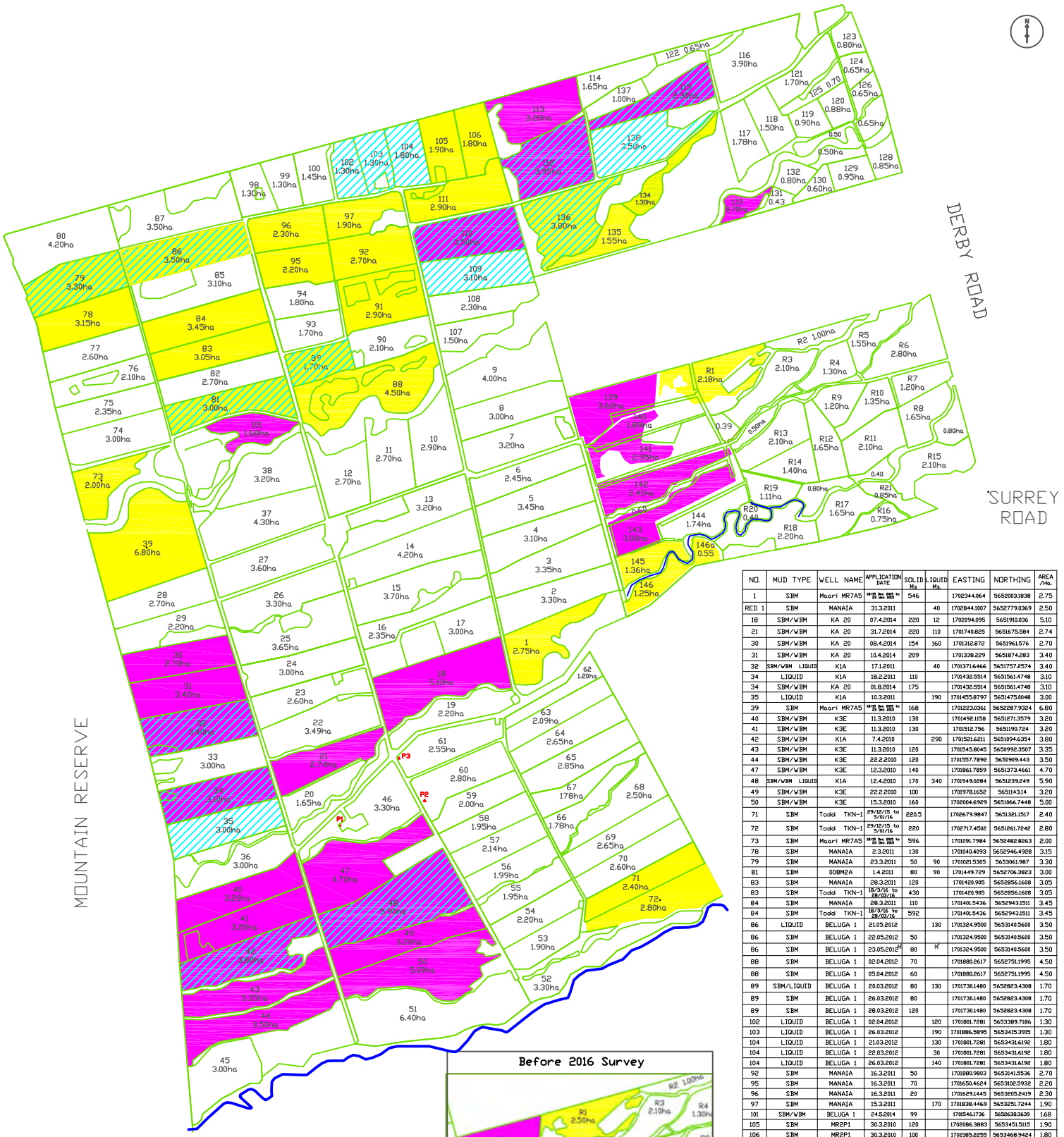
The last drilling waste receipted to the facility was from the Todd TKN-1 well on 5 January 2016. In April 2016 the last of the waste able to be extracted from the holdings cells was spread to paddocks. Since that time the facility at Surrey Road has received no incoming drilling or other product waste.

- The last irrigation of Cell 3 onto the farm paddocks was on 28th October2016.
- Water samples from the Storm Water 3 cell outlets and upstream were undertaken on :
  - 2nd February 2017 - Lab Report 1720484 and
  - 15th June 2017 - Lab Report 1795750.
- Paddock Samples were taken of Paddocks 73, 83 and 84 on :
  - 29th July 2017 – Lab Report 1822731 and 1824487.

The Hill Laboratory reports on the water and paddock samples are included.

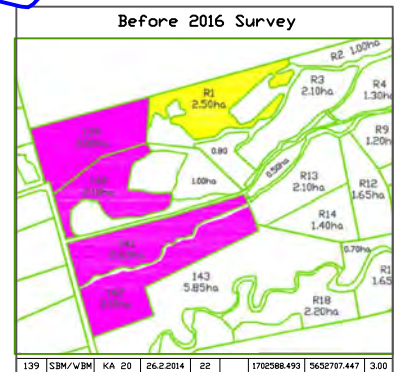
The site map from last year's report is included for reference.

The access gate to the site remains locked.



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	MANGAREVA 'A' MR3P8/MR4P9/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
MAPS DESIGNS DATA AGENTS
FREEPHONE 0800 752 705
CELLPHONE 027 477 6271

DRAWING No. MI SWACO 101

REV 7

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1720484	SPv1
Contact:	Ruka Te Moana	**Date Received:**	09-Feb-2017	
	C/- Schlumberger New Zealand Limited	**Date Reported:**	21-Feb-2017	
	PO Box 7100	**Quote No:**	31151	
	Fitzroy	**Order No:**	M16600266A	
	New Plymouth 4341	**Client Reference:**		
		Submitted By:	Mark Brennan	

Sample Type: Aqueous

Sample Name:	Surrey Road SW3 02-Feb-2017 12:00 pm	Surrey Road SW3 Upstream 02-Feb-2017	Surrey Road SW3 Downstream 02-Feb-2017		
Lab Number:	1720484.1	1720484.2	1720484.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	-	-	-	-
pH pH Units	6.8	-	-	-	-
Total Suspended Solids g/m³	15	-	-	-	-
Sample Temperature* °C	20.0	-	-	-	-
Total Ammoniacal-N g/m³	0.24	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	3	< 2 #1	3	-	-
Oil and Grease g/m³	< 4	-	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	0.23	-	-	-	-
Combined Chlorine g/m³	< 0.08	-	-	-	-

Analyst's Comments

#1 The original results obtained for carbonaceous Biochemical Oxygen Demand (cBOD5) on the various dilutions performed were not in good agreement. The analysis was therefore repeated using a sub-sample that had been stored frozen.

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.

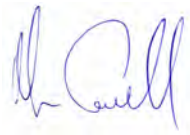
Sample Type: Aqueous

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 Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
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

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.



Martin Cowell - BSc
Client Services Manager - Environmental

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1795750	SPv1
Contact:	Mark Brennan	**Date Received:**	21-Jun-2017	
	C/- Schlumberger New Zealand Limited	**Date Reported:**	07-Jul-2017	
	PO Box 7100	**Quote No:**	31151	
	Fitzroy	**Order No:**	M16600301A	
	New Plymouth 4341	**Client Reference:**	Stormwater Analysis	
		Submitted By:	Mark Brennan	

Sample Type: Aqueous

Sample Name:	Surrey Road SW3 Downstream 15-Jun-2017	Surrey Road SW3 Upstream 15-Jun-2017 4:00 pm	Surrey Road SW3 Outlet 15-Jun-2017 4:00 pm		
Lab Number:	1795750.1	1795750.2	1795750.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	-	-	< 0.010	-	-
pH pH Units	-	-	7.0	-	-
Total Suspended Solids g/m³	-	-	5	-	-
Sample Temperature* °C	-	-	20.0	-	-
Total Ammoniacal-N g/m³	-	-	0.51	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	3	3	< 2	-	-
Oil and Grease g/m³	-	-	6	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	-	-	0.11	-	-
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.

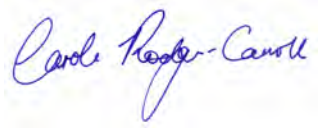
Sample Type: Aqueous

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	3
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	3
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	3
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	3
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.1 °C	3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 22nd ed. 2012.	0.010 g/m³	3
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	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	3

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.

This report must not be reproduced, except in full, without the written consent of the signatory.



Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T **0508 HILL LAB** (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job Information Summary

Client:	Schlumberger New Zealand Limited	**Lab No:**	1795750
Contact:	Mark Brennan	**Date Registered:**	22-Jun-2017 4:01 pm
	C/- Schlumberger New Zealand Limited	**Priority:**	Normal
	PO Box 7100	**Quote No:**	31151
	Fitzroy	**Order No:**	Required
	New Plymouth 4341	**Client Reference:**	Stormwater Analysis
		Add. Client Ref:	
		Submitted By:	Mark Brennan
		Charge To:	Schlumberger New Zealand Limited
		Target Date:	05-Jul-2017 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	Surrey Road SW3 Downstream 15-Jun-2017	Surface Water	BOD	Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)
2	Surrey Road SW3 Upstream 15-Jun-2017 4:00 pm	Surface Water	BOD	Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)
3	Surrey Road SW3 Outlet 15-Jun-2017 4:00 pm	Surface Water	UP1L, OAG500, UP250, S250	Free Ammonia; Chlorine, Free & Combined; Total Suspended Solids; Sample Temperature; Oil and Grease; pH; Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)

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/m^3 at Client Temperature	3
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m^3	3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	3
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	3
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/m^3	3
Sample Temperature	Supplied by customer, otherwise 20°C.	0.1 °C	3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 22nd ed. 2012.	0.010 g/m^3	3
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/m^3	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/m^3	3

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

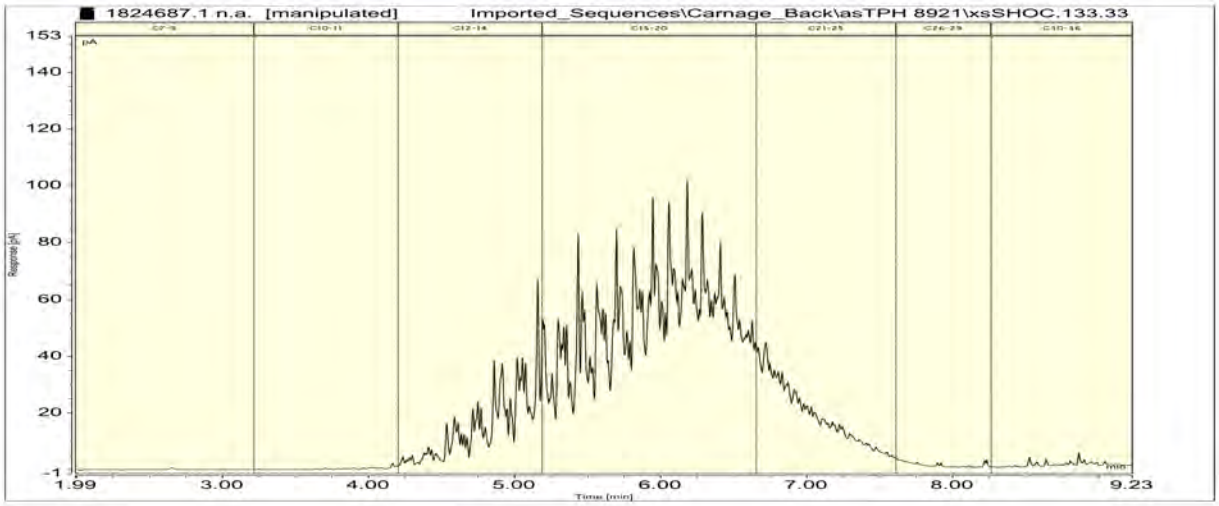
Client:	Schlumberger New Zealand Limited	**Lab No:**	1824687	SPv1
Contact:	Mark Brennan	**Date Received:**	12-Aug-2017	
	C/- Schlumberger New Zealand Limited	**Date Reported:**	18-Aug-2017	
	PO Box 7146	**Quote No:**	34979	
	New Plymouth 4341	**Order No:**	M16600320A	
		Client Reference:		
		Submitted By:	Mark Brennan	

Sample Type: Soil

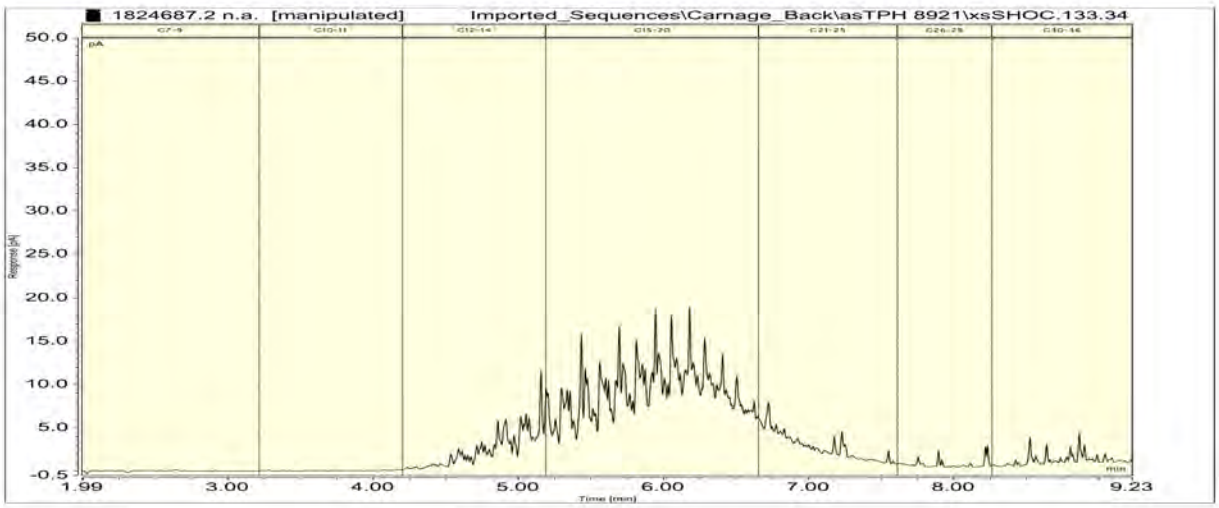
Sample Name:		Paddock 73 29-Jul-2017	Paddock 83 29-Jul-2017	Paddock 84 29-Jul-2017		
Lab Number:		1824687.1	1824687.2	1824687.3		
Individual Tests						
Dry Matter	g/100g as rcvd	63	61	59	-	-
Density*	g/mL at 20°C	0.92	0.90	0.86	-	-
Total Recoverable Barium	mg/kg dry wt	4,000	1,470	3,200	-	-
Total Recoverable Sodium	mg/kg dry wt	510	650	510	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	2	< 2	< 2	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.12	< 0.10	-	-
Total Recoverable Chromium	mg/kg dry wt	16	6	5	-	-
Total Recoverable Copper	mg/kg dry wt	66	38	43	-	-
Total Recoverable Lead	mg/kg dry wt	12.7	5.9	8.9	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	-	-
Total Recoverable Nickel	mg/kg dry wt	7	2	4	-	-
Total Recoverable Zinc	mg/kg dry wt	55	29	34	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.08	< 0.08	< 0.09	-	-
Toluene	mg/kg dry wt	< 0.08	< 0.08	< 0.09	-	-
Ethylbenzene	mg/kg dry wt	< 0.08	< 0.08	< 0.09	-	-
m&p-Xylene	mg/kg dry wt	< 0.15	< 0.16	< 0.17	-	-
o-Xylene	mg/kg dry wt	< 0.08	< 0.08	< 0.09	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
1-Methylnaphthalene	mg/kg dry wt	0.20	< 0.017	< 0.017	-	-
2-Methylnaphthalene	mg/kg dry wt	0.127	< 0.017	< 0.017	-	-
Perylene	mg/kg dry wt	0.016	0.037	< 0.017	-	-
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES	mg/kg dry wt	< 0.04	< 0.04	< 0.04	-	-
Benzo[a]pyrene Toxic Equivalence (TEF)	mg/kg dry wt	< 0.04	< 0.05	< 0.05	-	-
Acenaphthylene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Acenaphthene	mg/kg dry wt	0.46	0.078	0.136	-	-
Anthracene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Benzo[e]pyrene	mg/kg dry wt	< 0.016	< 0.017	0.027	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Chrysene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-

Sample Type: Soil						
Sample Name:		Paddock 73 29-Jul-2017	Paddock 83 29-Jul-2017	Paddock 84 29-Jul-2017		
Lab Number:		1824687.1	1824687.2	1824687.3		
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Fluoranthene	mg/kg dry wt	0.022	< 0.017	0.020	-	-
Fluorene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.016	< 0.017	< 0.017	-	-
Naphthalene	mg/kg dry wt	0.15	< 0.09	< 0.09	-	-
Phenanthrene	mg/kg dry wt	0.072	< 0.017	< 0.017	-	-
Pyrene	mg/kg dry wt	< 0.016	< 0.017	0.034	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 10	< 10	< 10	-	-
C10 - C14	mg/kg dry wt	1,510	250	300	-	-
C15 - C36	mg/kg dry wt	9,100	1,730	2,600	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	10,600	1,980	2,900	-	-

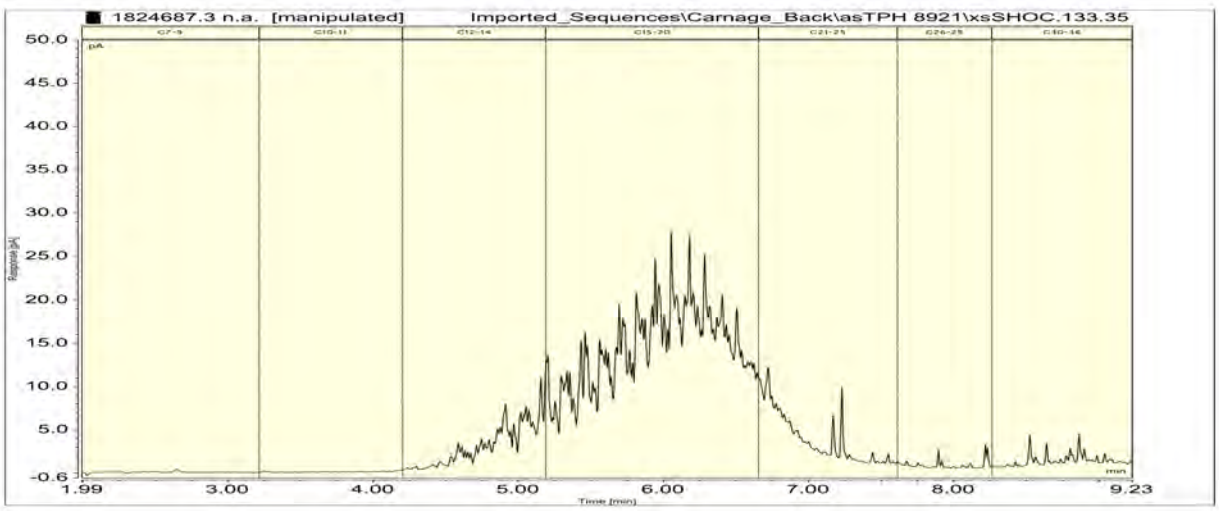
1824687.1
Paddock 73 29-Jul-2017
Client Chromatogram for TPH by FID



1824687.2
Paddock 83 29-Jul-2017
Client Chromatogram for TPH by FID



1824687.3
Paddock 84 29-Jul-2017
Client Chromatogram for TPH by FID



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.

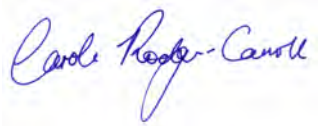
Sample Type: Soil

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. Analysed at 1 Clyde Street, Hamilton	0.10 - 4 mg/kg dry wt	1-3
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] Analysis performed at 1 Clyde Street, Hamilton	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] Analysis performed at 1 Clyde Street, Hamilton	0.002 - 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] Analysis performed at 1 Clyde Street, Hamilton	8 - 60 mg/kg dry wt	1-3
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis Analysis performed at 1 Clyde Street, Hamilton	0.002 - 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. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). Analysis performed at 1 Clyde Street, Hamilton. US EPA 3550.	0.10 g/100g as rcvd	1-3
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination. Analysed at 1 Clyde Street, Hamilton.	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. Analysed at 1 Clyde Street, Hamilton. US EPA 200.2.	0.4 mg/kg dry wt	1-3
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. Analysed at 1 Clyde Street, Hamilton. US EPA 200.2.	40 mg/kg dry wt	1-3
1-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis Analysis performed at 1 Clyde Street, Hamilton. Modified US EPA 8270.	0.010 mg/kg dry wt	1-3
2-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis Analysis performed at 1 Clyde Street, Hamilton. Modified US EPA 8270.	0.010 mg/kg dry wt	1-3
Perylene	Sonication extraction, SPE cleanup, GC-MS SIM analysis Analysis performed at 1 Clyde Street, Hamilton. Modified US EPA 8270.	0.010 mg/kg dry wt	1-3

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES	BaP Potency Equivalence calculated from Benz(a)anthracene x 0.1 + Benzo(b)fluoranthene x 0.1 + Benzo(j)fluoranthene x 0.1 + Benzo(k)fluoranthene x 0.1 + Benzo(a)pyrene x 1 + Chrysene x 0.01 + Dibenz(a,h)anthracene x 1 + Fluoranthene x 0.01 + Indeno(1,2,3-c,d)pyrene x 0.1 Analysis performed at 1 Clyde Street, Hamilton. Ministry for the Environment. 2011. Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health. Wellington: Ministry for the Environment.	0.002 mg/kg dry wt	1-3
Benzo[a]pyrene Toxic Equivalence (TEF)	BaP Toxic Equivalence calculated from Benzo(a)anthracene x 0.1 + BaP x 1 + Benzo(b)fluoranthene x 0.1 + Benzo(k) fluoranthene x 0.1 + Chrysene x 0.01 + Dibenzo(a,h)anthracene x 1.1 + Indeno(1,2,3-c,d)pyrene x 0.1 Analysis performed at 1 Clyde Street, Hamilton. Guidelines for assessing and managing contaminated gasworks sites in New Zealand (GMG) (MfE, 1997).	0.002 mg/kg dry wt	1-3

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

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

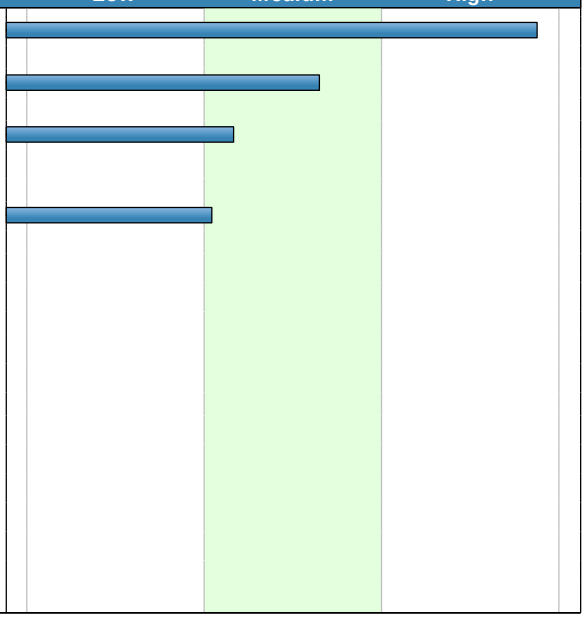
T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1822731 shpv1
Address:	PO Box 7146 New Plymouth 4341	**Date Received:**	09-Aug-2017
		Date Reported:	18-Aug-2017
		Quote No:	34979
		Order No:	M16600320A
		Client Reference:	Soil
Phone:	06 755 0037	**Submitted By:**	Mark Brennan

Sample Name: Paddock 73 **Lab Number:** 1822731.1
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	7.1	5.8 - 6.2
Volume Weight	g/mL	0.86	0.60 - 1.00
Soluble Salts (Field)	%	0.09	0.05 - 0.30
Chloride	mg/kg	196	
Total Nitrogen	%	0.31	0.30 - 0.60
Total Soluble Salts*	mg/L	990	
Electrical Conductivity (Sat Paste)*	mS/cm	1.5	
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	30	
Calcium (Sat Paste)*	mg/L	217	
Magnesium (Sat Paste)*	mg/L	14	
Sodium (Sat Paste)*	mg/L	36	
Sodium Absorption Ratio*		0.6	



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.

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

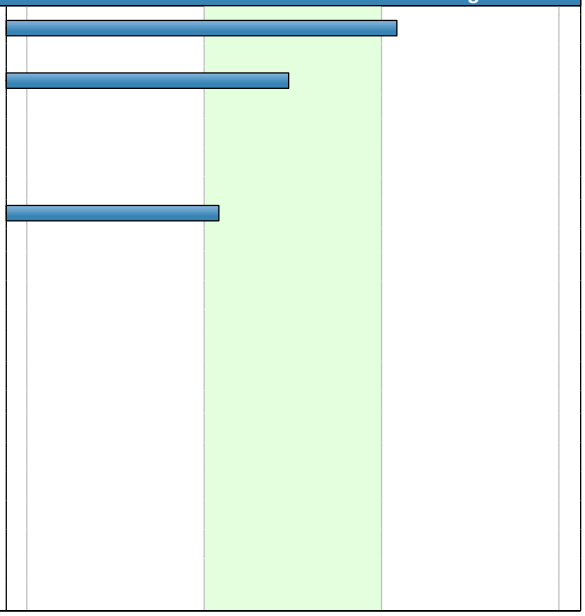
T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1822731 shpv1
Address:	PO Box 7146 New Plymouth 4341	**Date Received:**	09-Aug-2017
		Date Reported:	18-Aug-2017
		Quote No:	34979
		Order No:	M16600320A
		Client Reference:	Soil
Phone:	06 755 0037	**Submitted By:**	Mark Brennan

Sample Name: Paddock 83 **Lab Number:** 1822731.2
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.3	5.8 - 6.2
Volume Weight	g/mL	0.79	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	53	
Total Nitrogen	%	0.32	0.30 - 0.60
Total Soluble Salts*	mg/L	264	
Electrical Conductivity (Sat Paste)*	mS/cm	0.4	
Nitrate-N (Sat Paste)*	mg/L	< 1	
Ammonium-N (Sat Paste)*	mg/L	1	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	13	
Calcium (Sat Paste)*	mg/L	46	
Magnesium (Sat Paste)*	mg/L	3	
Sodium (Sat Paste)*	mg/L	15	
Sodium Absorption Ratio*		0.6	



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.

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

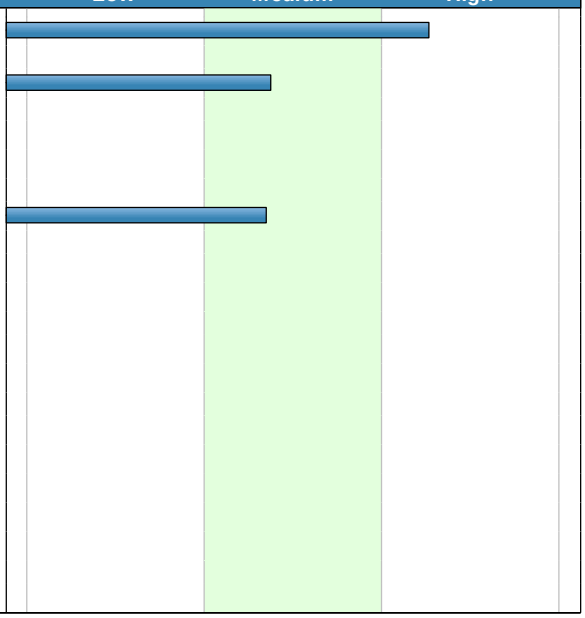
T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1822731 shpv1
Address:	PO Box 7146 New Plymouth 4341	**Date Received:**	09-Aug-2017
		Date Reported:	18-Aug-2017
		Quote No:	34979
		Order No:	M16600320A
		Client Reference:	Soil
Phone:	06 755 0037	**Submitted By:**	Mark Brennan

Sample Name: Paddock 84 **Lab Number:** 1822731.3
Sample Type: SOIL Mixed Pasture (S1)

Analysis		Level Found	Medium Range
pH	pH Units	6.5	5.8 - 6.2
Volume Weight	g/mL	0.75	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	36	
Total Nitrogen	%	0.41	0.30 - 0.60
Total Soluble Salts*	mg/L	231	
Electrical Conductivity (Sat Paste)*	mS/cm	0.4	
Nitrate-N (Sat Paste)*	mg/L	< 1	
Ammonium-N (Sat Paste)*	mg/L	1	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	20	
Calcium (Sat Paste)*	mg/L	47	
Magnesium (Sat Paste)*	mg/L	3	
Sodium (Sat Paste)*	mg/L	14	
Sodium Absorption Ratio*		0.5	



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.

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1822731 shpv1
Address:	PO Box 7146 New Plymouth 4341	**Date Received:**	09-Aug-2017
		Date Reported:	18-Aug-2017
		Quote No:	34979
		Order No:	M16600320A
		Client Reference:	Soil
Phone:	06 755 0037	**Submitted By:**	Mark Brennan

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.	-	1-3
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen. Analysed at 25 Te Aroha Street, Hamilton.	-	1-3
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH. Analysed at 1 Clyde Street, Hamilton.	0.1 pH Units	1-3
Total Nitrogen	Dumas combustion. Analysed at 1 Clyde Street, Hamilton.	0.04 %	1-3
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35. Analysed at 1 Clyde Street, Hamilton.	0.05 %	1-3
Chloride	1:5 Soil:Saturated Calcium Sulphate extraction followed by Potentiometric Titration. Analysed at 1 Clyde Street, Hamilton.	10 mg/kg	1-3
Total Soluble Salts*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C). Analysed at 1 Clyde Street, Hamilton.	1.0 mg/L	1-3
Electrical Conductivity (Sat Paste)*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C). Analysed at 1 Clyde Street, Hamilton.	0.1 mS/cm	1-3
Nitrate-N (Sat Paste)*	Saturated Paste extraction followed by Salicylate colorimetry. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Ammonium-N (Sat Paste)*	Saturated Paste extraction followed by Berthelot colorimetry. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Phosphorus (Sat Paste)*	Saturated Paste extraction followed by ICP-OES. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Potassium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Calcium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Magnesium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Sodium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES. Analysed at 1 Clyde Street, Hamilton.	1 mg/L	1-3
Sodium Absorption Ratio (SAR)*	Calculation from the sodium, calcium and magnesium determined on a Saturated Paste extract. Analysed at 1 Clyde Street, Hamilton.	0.2	1-3
Volume Weight	The weight/volume ratio of dried, ground soil. Analysed at 1 Clyde Street, Hamilton.	0.01 g/mL	1-3

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.

This report must not be reproduced, except in full, without the written consent of the signatory.

Shelley Edhouse
Quality Assurance Coordinator - Agriculture