C Boyd – Drilling Waste Disposal Monitoring Programme Annual Report 2013-2014

Technical Report 2014-81

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Executive summary

Colin Boyd, in conjunction with operator MI Swaco, operates two drilling waste stockpiling facilities on his property near Inglewood, within the Waitara catchment. These sites are located on adjoining properties off Derby Road North and Surrey Road. Drilling waste from the stockpiling sites is landspread over the farm-based property. Colin Boyd is the Consent Holder.

This report for the period July 2013 – June 2014 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance during the period under review, and the results and environmental effects of the consent holder's activities.

Colin Boyd holds three resource consents, and Surrey Road Landfarms Limited (a subsidiary company in relation to the landfarming operations at this site) holds one. Two of these consents permit the discharge of drilling waste onto and into land via landfarming or landspreading (7559-1 & 7591-1). One consent permits the temporary stockpiling of material prior to landfarming (6900-2) and one consent permits the discharge of stormwater (7911-1). The consents include a total of 64 conditions setting out the requirements that must be satisfied.

During the monitoring period, the consent holder demonstrated an overall 'Good' level of environmental performance and compliance with the resource consents.

The Council's monitoring programme for the period under review included 44 inspections, 29 groundwater samples, 18 surface water samples, five stormwater samples and six soil samples collected for analysis, four biomonitoring surveys of receiving waters and the review of annual reports provided by the consent holder.

The monitoring indicated that activities at the Derby Road drilling waste storage site did not have any significant adverse effect on the environment; the same was reported in terms of the landspreading operation. However, an adverse effect in terms of the in-situ species abundance had been recorded downstream from the discharge location of Surrey Road, with the consent holder achieving a 'needs improvement' level as this effect will require to be rectified.

One incident was recorded at Surrey Road incident resulted in minor short term effect on the Mangatengehu Stream. The incident is discussed in Section 3 of this report.

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

This report includes recommendations for the 2014-2015 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is the Annual Report for the period July 2013- June 2014 by the Taranaki Regional Council on the monitoring programmes associated with the resource consents held by Colin Boyd and Surrey Road Landfarms Limited. The consent holders in conjunction with MI Swaco operate two drilling waste stockpiling facilities and a landfarming/landspreading operation, situated on Colin Boyd's property between Inglewood and Tariki, as seen in Figure 1.

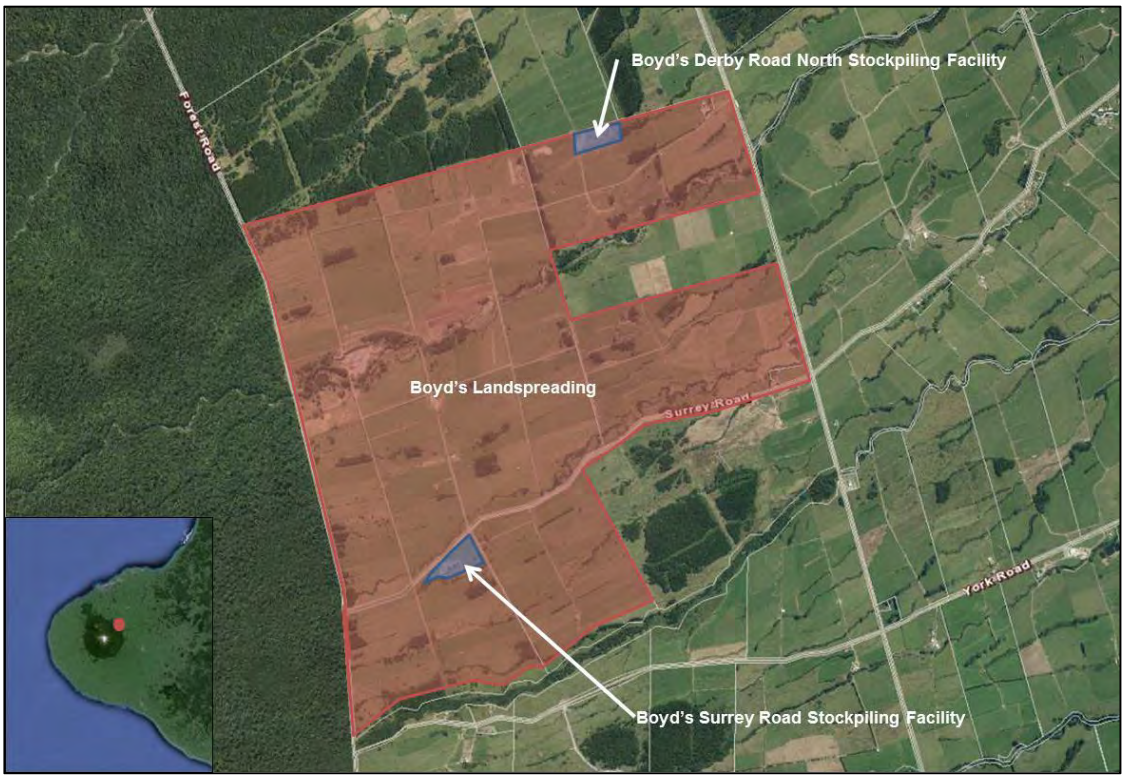

Figure 1 Aerial photograph showing the location and extent of Boyd's Landfarm and stockpiling facilities with approximate regional location (inset)

This report covers the results and findings of three monitoring programmes implemented by the Council in respect of the consents held, that relate to the discharge of drilling waste in 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 Taranaki Regional Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects associated with the exercise of the consents held by Colin Boyd and managed by MI Swaco in relation their use of water, land and air, and is the fifth report by the Taranaki Regional Council to cover the consent holders' discharges and their effects at the property covered in this report.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites though annual programmes, the resource consents held by Colin Boyd and Surrey Road Landfarms Limited, 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 at the consent holder's site.

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

Section 3 discusses the investigations, interventions and incidents associated with the sites during the 2013-2014 period.

Section 4 presents the discussion section, which evaluates the individual sites performance, the environmental effects of the consents, and any proposed modifications to the environmental monitoring program.

Section 5 presents recommendations to be implemented in the 2014-2015 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

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

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

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council recognizes 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/s during the period under review, this report also assigns a rating as to each Company's environmental and administrative performance.

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 Company'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 (i.e. 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 compliance

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

1.2 Process 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 at the Boyd operations are primarily drilling waste. Fracture return fluids are not disposed of at these sites.

1.2.1.1 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.

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.

Cuttings

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

1.2.2 Landfarming process description

Basic steps in the landfarming process include:

1. Drilling waste is transported from wellsites by truck (cuttings) or tanker (liquids). It may be discharged directly to land or placed in a dedicated storage pit. At the Boyd's sites cuttings arrive from site in metal 'D' bins directly collected from the wellsite.
2. The required area is prepared by scraping back and stockpiling existing pasture/topsoil and leveling out uneven ground.
3. Waste is transferred to the prepared area by excavator and truck and spread out with a bulldozer. Liquids may be discharged by tanker or a spray system.
4. Waste is allowed to dry sufficiently before being tilled into the soil to the required depth with a tractor and discs.
5. The disposal area is leveled with chains or harrows.

6. Stockpiled or brought in topsoil/clay is applied to aid stability and assist in grass establishment.
7. Fertiliser may be applied and the area is sown in crop or pasture at a suitable time of year.

Consents 6900-2 and 7559-1 allow for the disposal of drilling waste from hydrocarbon exploration activities with WBM and SBM via the landfarming process outlined above. Of note 6900-2 is directly concerned with stockpiling of material prior to application to land. Initial landfarming at the site revealed difficulties working with soils with higher baseline moisture content. As a result, consent 7591-1 was issued to allow for disposal via the process of landspreading.

1.2.3 Landspreading process description

The preferred method for the treatment of drilling waste at Colin Boyd's property is via landspreading (under consent **7591-1)**. A large muck spreader, shown in Photograph 1, is used for this purpose.

Photo 1 Spreader unit utilised for landspreading operations at Colin Boyd's property

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 flung up to 10 metres 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, shown in Photograph 2.

Photo 2 Tilling at Colin's Boyd's property post landspreading. The left of the frame shows landspread area yet to be tilled

1.3 Resource consents

1.3.1 Discharges of wastes to land

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

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

Condition 1 requires adoption of the best practicable option.

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

Conditions 5 and 6 are operational requirements.

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

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

Condition 11 is a review condition.

Colin Boyd holds discharge permit **7559-1**, 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. This permit was issued by the Taranaki Regional Council on 20 November 2009 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027. Site Location Surrey Road.

Condition 1 sets out definitions of stockpiling and landfarming.

Condition 2 requires adoption of the best practicable option.

Conditions 3 and 4 require the installation of groundwater monitoring wells and provision of a management plan, prior to exercise of the consent.

Conditions 5 and 6 detail notification and sampling requirements prior to discharge.

Conditions 9 and 11 to 13 specify discharge limits and loading rates.

Conditions 7, 8, 10, 14 and 15 are operational requirements.

Conditions 16 to 20 set limits on certain parameters in the soil.

Conditions 20 and 22 relate to effects on groundwater and surface water.

Conditions 23 and 24 concern monitoring and reporting.

Conditions 25 and 26 relate to lapse and review of the consent.

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

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

Conditions 3 and 7 to 9 are operational requirements.

Conditions 4 to 6 specify discharge limits and loading rates.

Conditions 10 to 14 set limits on certain parameters in the soil.

Conditions 15 and 16 relate to effects on groundwater and surface water.

Conditions 17 and 18 concern monitoring and reporting.

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

1.3.2 Discharges to water

Colin Boyd holds discharge permit **7911-1**, to discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River. This permit was issued by the Taranaki Regional Council on 27 September 2011 under Section 87(e) of the Resource Management Act. 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.

Copies of the above permits are attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

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

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

The monitoring programme for the Surrey, Derby Road North and landspreading consents consisted of five primary components.

- Programme liaison and management
- Site inspections
- Chemical Sampling
- Biomonitoring surveys; and
- Review of the analytical results

1.4.2 Programme liaison and management

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

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;

- advice on the Council's environmental management strategies and content of regional plans and;
- consultation on associated matters.

1.4.3 Site inspections

A total of 21 scheduled inspections were made of the site during the monitoring period, with regard to the consents for the discharge of drilling waste. 15 further inspections were conducted at the site during chemical sampling runs. Inspections focussed on the following aspects:

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

1.4.4 Chemical sampling

In total, six composite soil samples from disposal areas were collected by Council staff. The methodology utilised was compositing 10 soil cores (300 mm depth) taken at 10m intervals along transects through spreading areas. The methodology applied is detailed by the Guidelines for the Safe Application of Biosolids to Land in New Zealand (2003).

These samples were analysed for Chloride, Conductivity, Hydrocarbons, pH, SAR, Sodium, Total Soluble Salts. Of note, the metal analysis and speciation of Petroleum Hydrocarbons as required by the consent is provided by the proponent of the site and is discussed in the following section.

Groundwater monitoring bores were sampled on five occasions at the Derby Road North stockpiling facility and on five occasions at the Surrey Road stockpiling facility. Samples were analysed for pH, conductivity, TPH and BTEX, chloride, barium and total dissolved solids.

In addition, surface water samples were collected on three separate occasions along the Mangamawhete Stream in relation to stormwater discharges from the Derby Road North stockpiling facilities. Surface water samples were also obtained on three separate occasions along the Mangatengehu Stream in relation to stormwater discharges from the Surrey Road stockpiling facilities. These samples were analysed for barium, BOD, chloride, conductivity, hydrocarbons, pH and total dissolved solids.

Stormwater discharge samples were also obtained on three separate occasions in relation to both the Derby Road North and Surrey Road stockpiling facilities. These samples were analysed for ammonia, barium, BOD, chloride, conductivity, hydrocarbons, pH, suspended solids and total dissolved solids.

1.4.5 Review of analytical results

The Council reviewed soil sampling results and the annual reports provided by MI Swaco on behalf of the consent holders. MI Swaco collected representative pre-disposal

samples from individual waste streams (Cells 1 and 2) prior to disposal, and receiving environment soil samples from all spreading areas post waste application. These samples were sent to an independent IANZ accredited laboratory for analysis for a wider range of contaminants. Chemical parameters tested were (all solid/sludge samples):

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

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

The Company also supplied stormwater discharge results as part of their reporting requirements.

1.4.6 Biomonitoring surveys

Four biological surveys were performed during the monitoring period under review; two within the unnamed tributary of the Mangamawhete Stream in relation to activities at the Derby Road North site, and another two within the unnamed tributary of the Mangatengehu Stream in relation to activities at the Surrey Road site.

2. Annual Site Monitoring and Inspection

2.1 Derby Road North Stockpiling Facility

2.1.1 Site description

Derby Road North stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. 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, and at the end of the monitoring period, the Derby site remained unused and on standby to receive waste as a contingency or secondary site if required.

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 vegetation cover is pasture, recently converted from native bush. Average annual rainfall for the site is 1942 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 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. Both consents (7911-1 and 6900-2) are up for review this calendar year.

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

Figure 2 Aerial photograph of the Derby Road North stockpiling facility, showing locations of the storage pits and sampling sites, with approximate regional location (inset)

2.1.2 Results

2.1.2.1 Inspections

Seven scheduled compliance monitoring inspections were carried out at the Derby Road North site during the monitoring period. The site was also inspected a further seven times in conjunction with surface water and groundwater sampling runs.

29 August 2013

- No odours were detected beyond the boundary of the site.
- No recent storage activities had occurred.
- All skimmer pipes were discharging clear and very little residual surface oil was observed within the last two pits.

- The last two ponds were free of hydrocarbon sheen and no effects were observed within the receiving waters.

24 September 2013

- No objectionable odours or visible emissions were detected at the time of inspection.
- No recent disposal activities had occurred.
- All pits were essentially free of drilling muds, pits 6 and 7 were observed to hold some residual surface oils.
- All skimmer pipes were discharging at the time of inspection and were clear and free of hydrocarbon sheen.
- The discharge from the last settling pond was also clear and free of hydrocarbon sheen, no effects were observed within the receiving waters.

15 October 2013

Inspection was conducted in conjunction with surface water and stormwater samples from the Surrey Road and stockpiling facilities:-

- The Derby Road North site appeared inactive . However, it appeared that a hydrocarbon sludge within pond three may have required removal.
- The discharge appeared reasonably clear and the flow rate was estimated to be five L/S.
- No adverse effects were observed downstream of the discharge point within the receiving waters.

1 November 2013

Inspection was conducted in conjunction with groundwater sampling at both Surrey Road and Derby Road North stockpiling facilities:

- No objectionable odours or visible emissions were found during the inspection.
- No site activity occurring at the time of inspection.

9 December 2013

- Bunding around storage pits appeared to have had cow tracks around the lower half of the bunds, and the fencing near the down-gradient groundwater bore was in poor condition. All activity still appeared to have ceased at the Derby Road North site.

10 February 2014

Inspection was conducted in conjunction with groundwater sampling:-

- No material had been stored or spread via this site for some years.
- The old cells and stormwater ponds were full of rain water.
- No sheen was evident, but some odour was observed immediately downwind of the cells during groundwater sampling.
- No other issues were noted.

26 February 2014

- No objectionable odours or visible emissions were detected at the time of inspection.
- No recent stockpiling activities had occurred at the Derby Road site and
- All pits were found to be well below the skimmer pipes and no discharge had occurred, the receiving ponds were also well below the skimmer pipes.
- One cell was observed to have some residual emulsified surface oils and black staining present around some of the pit edges, the surrounding vegetation appeared healthy.

24 March 2014

Inspection conducted in conjunction with groundwater monitoring:-

- Site appeared to have remained inactive.
- Large quantity of waste/liquid remained in stockpiling pits.
- Animal prints evident directly around final discharging pit.

31 March 2014

- No recent disposal activities have occurred at the site.
- All pits essentially empty of drilling muds, although some residual surface oils still present on pits 6 and 7.
- No skimmer pipes were discharging, the receiving environment was found to be healthy and no detrimental effects were observed.

27 May 2014

- No objectionable odours or visible emissions were found during the inspection.
- Residual muds removed from cell 3, material was stockpiled in paddock 101.
- Three loads had been removed, operator outlined a bull dozer was nearby to spread the material over the required area before weather turned, the material appeared to be sticky in nature and no run-off was observed to have occurred.
- The cell which was emptied had a pump installed which drained the storm-water into the cell receiving drain and onwards to the settling ponds.
- The operator was made aware of the potential contamination issues and agreed to pump out the remaining water into a tank and land-spread it.
- The discharge from the final settling pond was minor and clear, no effects were observed within the receiving waters.
- The following action was proposed to be undertaken: Ensure no more liquid pumped from cell 3 reached the receiving ponds, the liquid must be applied to land only.

11 June 2014

The site was inspected in conjunction with the surface water/discharge sampling:-

- Site was observed to be tidy and remained on standby.
- Middle pit had been emptied.
- Other pits were holding rain water.
- Ponds were full of rain water and the stormwater system was discharging clear at approx 1 L/sec.
- No adverse effects noted.

16 June 2014

- No objectionable odours or visible emissions were found during the inspection.
- Recently emptied pit inspected and found to be satisfactory, minor volume of residual muds adhered to the walls and base, liquid in the bottom of pit clear and free of hydrocarbons.
- All other pits were found to be full of storm-water, only one pit had residual surface oils.
- No skimmer pipes were discharging.
- The ring drains were found to be satisfactory.
- The receiving ponds appeared clear and free of surface oils, no discharge to the receiving environment appeared to have occurred at time of inspection
- The adjacent stream was turbid throughout its length.

23 June 2014

- Site- found to be inactive and gates locked.
- No recent storage activities appeared to have occurred.
- No skimmer pipes were discharging and no discharge from the final pond into the receiving environment was occurring.
- Cell 3 still empty.
- Stormwater in other cells clear of surface hydrocarbons except for cell 6.

25 June 2014

Site was inspected during surface water/discharge sampling:-

- Site still not in operation.
- Site appeared tidy, no product held in any of the pits.
- The stormwater system was not discharging as rain had only just set in at the time of the inspection.
- Surface water samples were taken from the stream, all samples appeared slightly turbid from recent rain.
- There were no indications that the site had adversely impacted the water quality at this time.

2.1.3 Results of abstraction and discharge monitoring

2.1.3.1 Drilling waste

No new deliveries of drilling waste was brought to the stockpiling facility during the monitoring period under review.

2.1.3.2 Council stormwater results

The Council collected stormwater discharge samples from site IND001064 (as per Figure 2) on two occasions. The results are presented in Table 1.

Table 1 Stormwater discharge results from the Derby Road North stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	Consent 7911-1	Date	
			15 Oct 2013	11 Jun 2014
Benzene	g/m³		-	<0.0010
Toluene	g/m³		-	<0.0010
Ethylbenzene	g/m³		-	<0.0010
meta-Xylene	g/m³		-	<0.002
ortha-Xylene	g/m³		-	<0.0010
Hydrocarbons	g/m³	15	<0.5	<0.7
C7-C9	g/m³		-	<0.10
C10-C14	g/m³		-	<0.2
C15-C36	g/m³		-	<0.4
Barium (acid soluble)	g/m³		0.15	0.30
Barium (dissolved)	g/m³		0.14	-
Biochemical oxygen demand	g/m³	2	0.9	1.7
Chloride	g/m³	50	17.0	19.7
Conductivity	mS/m@20°C		7.9	11.1
pH	pH	6.0-9.0	7.1	7.0
Suspended solids	g/m³	100	8	3
Temperature	°C		12.0	10.1
Total dissolved solids	g/m³		61.1	85.9

No exceedance was detected on either occasion for the two storm water monitoring visits at location IND001604.

2.1.3.3 MI Swaco supplied stormwater results

As per the requirements of resource consent 7559-1, the consent holder is obligated to supply stormwater sampling results as part of the supplied annual report. The results for the Derby Road discharge sample from the monitoring period are supplied below in Table 2.

Table 2 MI Swaco stormwater results for the Derby Road North stockpiling facility

Parameter	Unit	Rule 23 limits	7911-1	30 Jun 2014
pH	pH	6-9	6.0-9.0	6.7
Suspended solids	g/m³	100	100	6
Free Ammonia	g/m³	0.025		<0.010
Total Ammoniacal N	g/m³	-		<0.010
Carbonaceous biochemical oxygen demand	g O_2/m³	5	2	<2
Oil and grease	g/m³	15	15	<5
Free chlorine	g/m³	-		<0.05
Combined chlorine	g/m³	0.2		<0.08

MI Swaco data supplied on the 30 June 2014 detailed no exceedance with Rule 23 Limits, Regional Freshwater Plan or the Consent Conditions stipulated by 7911-1

2.1.4 Results of receiving environment monitoring

Figure 2 shows the location of groundwater (GND), surface water (MMW) and stormwater discharge (IND) sampling sites, as well as the approximate location of stockpiling cells and stormwater ponds. The area slopes gradually away from the mountain (Left to right on Figure 2).

2.1.4.1 Council groundwater results

Three groundwater monitoring wells were installed late 2008, prior to the first delivery of drilling wastes to site. They are located up-gradient (GND2060), adjacent to pits (GND2061) and down-gradient (GND2062), as shown in Figure 1. Samples were collected from the monitoring wells on nine occasions and the results are shown in Tables 3 to 5.

Table 3 Groundwater monitoring results from bore GND2060 from the Derby Road North stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014	24 Mar 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002	<0.002
ortha-Xylene	g/m³		-	-	-	<0.0010	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7	<0.7
C7-C9	g/m³		-	-	-	<0.10	<0.10
C10-C14	g/m³		-	-	-	<0.2	<0.2
C15-C36	g/m³		-	-	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.7 MAV	0.027	0.022	0.037	0.037	0.046
Barium (dissolved)	g/m³		-	-	-	0.014	0.016
Chloride	g/m³	250 GV	5.2	4.0	4.3	7.3	7.2
Conductivity	mS/m@20°C		5.3	6.5	5.5	5.0	5.1
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	0.05	0.02	<0.01	<0.01	-
pH	pH		6.0	6.2	6.2	6.4	6.2
Sodium	g/m³	200 GV	-	-	-	-	5.7
Static water level	m		2.69	-	-	2.729	2.876
Temperature	°C		11.3	11.5	13.1	13.3	13.7
Total dissolved solids	g/m³	1000 GV	41.0	50.3	42.6	38.7	39.5

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

Table 4 Groundwater monitoring results from bore GND2061 from the Derby Road North stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014	24 Mar 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002	<0.002
ortha-Xylene	g/m³		-	-	-	<0.0010	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7	<0.7
C7-C9	g/m³		-	-	-	<0.10	<0.10
C10-C14	g/m³		-	-	-	<0.2	<0.2
C15-C36	g/m³		-	-	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.7	0.028	0.057	0.012	0.11	-
Barium (dissolved)	g/m³		-	-	-	0.134	0.139
Chloride	g/m³	250 GV	29.7	19.7	5.2	60.6	61.0
Conductivity	mS/m@20°C		16.5	14.6	8.8	36.2	39.2
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	0.03	0.05	0.07	0.04	-
pH	pH		5.9	5.8	6.3	6.2	6.0
Sodium	g/m³	200 GV	-	-	-	-	12.5
Static water level	m		1.22	-	-	1.788	2.033
Temperature	°C		11.0	12.0	14.5	13.3	14.5
Total dissolved solids	g/m³	1000 GV	127.7	113.0	68.1	280.1	303.3

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

Table 5 Groundwater monitoring results from bore GND2062 from the Derby Road North stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014	24 Mar 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002	<0.002
ortha-Xylene	g/m³		-	-	-	<0.0010	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7	<0.7
C7-C9	g/m³		-	-	-	<0.10	<0.10
C10-C14	g/m³		-	-	-	<0.2	<0.2
C15-C36	g/m³		-	-	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.7MAV	0.024	0.026	0.029	0.022	0.032
Barium (dissolved)	g/m³		-	-	-	0.015	0.017
Chloride	g/m³	250 GV	7.3	6.9	5.1	7.3	10.4
Conductivity	mS/m@20°C		5.6	5.2	4.8	6.7	6.9
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	0.01	<0.01	0.01	0.03	-
pH	pH		5.6	5.5	5.7	6.0	5.8
Sodium	g/m³	200 GV	-	-	-	-	28.2
Static water level	m		0.69	-	-	1.391	1.670
Temperature	°C		10.9	12.6	14.9	14.5	14.8
Total dissolved solids	g/m³	1000 GV	43.3	40.2	37.1	51.8	53.4

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

The above three tables (Table 3, 4, and 5 respectively) denote groundwater sample results collected from three groundwater monitoring wells (GND 2060, 2061 and 2062 respectively) located at the Derby Road Stockpiling facility.

The groundwater monitoring wells were sampled on five separate occasions to encompass seasonal variation across the facility.

No exceedance was reported in the monitoring year of 2013- 2014, with the all results detailed well below the NZDWS guidelines (amended 2008).

2.1.4.2 Council surface water results

An unnamed tributary of the Mangamawhete Stream flows adjacent to the southern boundary of the site. On three occasions samples were collected upstream (MMW000161), midstream (MMW000162), and downstream (MMW000163). The results are shown in Tables 6 to 8.

Table 6 Results obtained from the unnamed tributary of the Mangamawhete Stream at three separate sample locations, upstream, mid stream and downstream of the Derby Road Site on the 15 October 2013 during the 2013 – 2014 monitoring period

Parameter	Unit	15 Oct 2013 MMW000161 Upstream	15 Oct 2013 MMW000162 Mid Stream	15 Oct 2013 MMW000163 Downstream
Benzene	g/m³	-	-	-
Toluene	g/m³	-	-	-
Ethylbenzene	g/m³	-	-	-
meta-Xylene	g/m³	-	-	-
ortha-Xylene	g/m³	-	-	-
Hydrocarbons	g/m³	<0.5	<0.5	<0.5
C7-C9	g/m³	-	-	-
C10-C14	g/m³	-	-	-
C15-C36	g/m³	-	-	-
Barium (acid soluble)	g/m³	0.028	0.031	0.016
Barium (dissolved)	g/m³	0.025	0.027	0.015
Biochemical oxygen demand	g/m³	-	<0.5	<0.5
Chloride	g/m³	4.6	4.4	5.0
Conductivity	mS/m@20°C	5.3	5.0	5.0
pH	pH	7.0	6.8	6.9
Suspended solids	g/m³	-	-	-
Temperature	°C	10.3	10.3	10.4
Total dissolved solids	g/m³	41.0	38.7	38.7

Table 7 Results obtained from the unnamed tributary of the Mangamawhete Stream at three separate sample locations, upstream, mid stream and downstream of the Derby Road Site on the 11 June 2014 during the 2013 – 2014 monitoring period

Parameter	Unit	11 Jun 2014 MMW000161 Upstream	11 Jun 2014 MMW000162 Mid Stream	11 Jun 2014 MMW000163 Downstream
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010
Hydrocarbons	g/m³	<0.7	<0.7	<0.7
C7-C9	g/m³	<0.10	<0.10	<0.10
C10-C14	g/m³	<0.2	<0.2	<0.2
C15-C36	g/m³	<0.4	<0.4	<0.4
Barium (acid soluble)	g/m³	0.034	0.036	0.022
Barium (dissolved)	g/m³	-	-	-
Biochemical oxygen demand	g/m³	-	0.5	0.5
Chloride	g/m³	6.3	6.2	5.8
Conductivity	mS/m@20°C	9.5	8.9	8.4
pH	pH	6.7	6.7	6.8
Suspended solids	g/m³	-	-	-
Temperature	°C	10.6	10.6	10.8
Total dissolved solids	g/m³	73.5	68.9	65.0

Table 8 Results obtained from the unnamed tributary of the Mangamawhete Stream at three separate sample locations, upstream, mid stream and downstream of the Derby Road Site on the 25 June 2014the 2013 – 2014 monitoring period during the 2013 – 2014 monitoring period

Parameter	Unit	25 Jun 2014 MMW000161 Upstream	25 Jun 2014 MMW000162 Mid Stream	25 Jun 2014 MMW000163 Downstream
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010
Hydrocarbons	g/m³	<0.7	<0.7	<0.7
C7-C9	g/m³	<0.10	<0.10	<0.10
C10-C14	g/m³	<0.2	<0.2	<0.2
C15-C36	g/m³	<0.4	<0.4	<0.4
Barium (acid soluble)	g/m³	0.024	0.036	0.022
Barium (dissolved)	g/m³	-	-	-
Biochemical oxygen demand	g/m³	-	<0.5	<0.5
Chloride	g/m³	7.6	8.8	7.8
Conductivity	mS/m@20°C	10.8	11.1	10.5
pH	pH	7.1	7.0	7.1
Suspended solids	g/m³	-	-	-
Temperature	°C	10.7	10.7	10.8
Total dissolved solids	g/m³	83.6	85.9	81.2

The above results do not detail any significant variation between the sampling sites and indicate there is minimal impact on the tributary from activities at the site. Of note there is a slight elevation in the Chloride concentrations recorded in the surface water, this is similarly echoed in the Conductivity as well as the Total Dissolved Solids, however, this is considered to be minimal.

2.1.4.3 MI Swaco supplied surface water results

The result for the one Derby Road surface water sample obtained by the stockpiling facility during the monitoring period is supplied below in Table 9.

Table 9 MI Swaco surface water result for the Derby Road North stockpiling facility

Parameter	Unit	Rule 23 limits	30 Jun 2014
pH	pH	6-9	6.7
Suspended solids	g/m^3	100	6
Free Ammonia	g/m^3	0.025	<0.010
Total Ammoniacal N	g/m^3	-	<0.010
Carbonaceous biochemical oxygen demand	$g\ O_2/m^3$	5	<2
Oil and grease	g/m^3	15	<5
Free chlorine	g/m^3	-	<0.05
Combined chlorine	g/m^3	0.025	<0.08

Data received by MI Swaco from the 30th of June 2014 denote that at the time of analysis there were no exceedances in comparison to the Regional Freshwater plan Rule 23.

2.1.4.4 Council biomonitoring results

Two biological surveys were performed on 18 December 2013 and on 10 February 2014 to monitor the health of the macroinvertebrate community of an unnamed tributary of the Mangamawhete Stream, in relation to the storage of drilling waste in the vicinity.

The standard 'kick-sampling' technique was used at the four sampling sites to collect streambed macroinvertebrates. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site. 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. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

These results can be compared with pre-stockpiling communities, allowing an assessment of the sites compliance with relevant consent requirements and permitted activity rules. Unfortunately, during the baseline survey undertaken in April 2009, 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.

Both biomonitoring surveys during the monitoring period under review were undertaken at four established sites; upstream of the drilling waste stockpiling site (site 1, MMW00161), downstream of the landspreading area (site 2, MMW00162), downstream of the final pit discharge (site 3, MMW00163), and 200 m downstream of the final pit discharge (site 4, MMW000165), as seen in Figure 3.

Summaries of each biomonitoring survey are as follows. A complete copy of the biomonitoring surveys can be found within Appendix III.

Figure 3 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation the Derby Road North stockpiling facility

18 December 2013

During December 2013 a four site macroinvertebrate survey of an unnamed tributary of the Mangamawhete Stream was performed to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream.

In this survey, the MCI and $SQMCI_s$ scores recorded at the upstream 'control' site were significantly lower than the median scores recorded at this site in previous surveys, indicating upstream activities had possible caused a deterioration in preceding water quality at this site.

The results of this survey indicated that there was no deterioration in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. The taxa richness recorded at site 2 in this survey was much higher than the median richness for this site, while the MCI score was similar to the median score. However, the $SQMCI_s$ score recorded at this site was similar to that recorded in the previous survey, and slightly greater than that recorded upstream in the current survey.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by reduced (when compared to upstream) but above average taxa richnesses and at both sites. The MCI scores recorded at sites 3 and 4 were not significantly different to the MCI scores recorded at site 2, but much higher than what was recorded at site 1. This indicated that the impacts of upstream land farming activities that were possibly recorded in the previous survey were no longer present and that no further deterioration from site 1 had occurred.

Overall, the results of this early summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed, although some impacts caused by habitat variability were noted. In general, however, poorer community richnesses and diversities of the macroinvertebrate communities within this upper reach (near the source) of a ringplain stream in comparison with similar streams elsewhere on the ringplain (Stark & Fowles, 2009/TRC, 1999) reflect the paucity of riparian and other habitat and the influence of iron-rich groundwater seepage along the length of stream surveyed.

10 February 2014

During February 2014 a four site macroinvertebrate survey of an unnamed tributary of the Mangamawhete Stream was performed to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream.

In this survey, the $SQMCI_s$ score recorded at the upstream 'control' site was significantly lower than the median score recorded at this site in previous surveys, indicating upstream activities had possibly caused a deterioration in preceding water quality at this site. This score was however significantly (Stark, 1998) higher than that recorded by the previous survey, which reflected some improvement at this site since the December 2013 survey. The MCI score and taxa richnesses were similar to the historical medians for this site.

The results of this survey indicated that there was only slight deterioration in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. There was a significant (Stark, 1998) decrease in $SQMCI_s$ score (by 1.3 units) between site 1 and site 2, although there were no significant differences in MCI scores. There were only two significant differences in taxon abundances between site 1 and site 2, which can be attributed mainly to increased algal cover at this site, rather than to impacts caused by landfarming activities.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by reduced (when compared to the upstream 'control' site) but above average taxa richnesses and at both sites. The MCI score recorded at site 3 was not significantly different to those recorded at site 1 and site 2, however the MCI score recorded at site 4 was significantly (Stark, 1998) lower than those recorded at sites 1 and 2. Despite this, the $SQMCI_s$ score recorded at site 4 was the highest for this survey and was significantly (Stark, 1998) higher than the median recorded by previous surveys for this site. This indicated that the impacts of upstream land farming activities that were possibly recorded in previous surveys were no longer present and that no further deterioration from site 1 had occurred.

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed, although some impacts caused by habitat variability were noted. In general, however, poorer community richnesses and diversities of the macroinvertebrate communities within this upper reach (near the source) of a ringplain stream in comparison with similar streams elsewhere on the ringplain (Stark & Fowles, 2009/TRC, 1999) reflect the paucity of

riparian and other habitat and the influence of iron-rich groundwater seepage along the length of stream surveyed.

2.2 Surrey Road

2.2.1 Site description

Surrey Road stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. The Mangatengehu Stream flows adjacent to the Surrey Road stockpiling 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 is consists of native bush which transitions into pasture. Average annual rainfall for the site is 1942 mm (taken from the nearby 'Stratford' monitoring station).

The stockpiling facility located at Surrey Road holds one consent (7559-1), this consent directs the holder to discharge detailed quantities of drilling waste (consisting of drilling cuttings, drilling fluids and muds, both water based and synthetic based) onto the land for the propose of land farming. This consent is up for review this year.

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.

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

Figure 4 Aerial photograph of the Surrey Road stockpiling facility, showing locations of the storage pits and sampling sites, with approximate regional location (inset)

2.2.2 Results

2.2.2.1 Inspections

There were six scheduled compliance monitoring inspections of the Surrey Road site during the monitoring period. The site was also inspected another seven times in conjunction with surface water and groundwater sampling runs.

15 July 2013

- No objectionable odours or visible emissions were found during the inspection.
- A complaint was received which regarded that the site activities may have impacted on a small stream. See Section 3.
- It was reported that operations were being undertaken as the Surrey Road site had received more material than the site had capacity for, partly due to the storm water inputs into the system from the recent prolonged heavy rainfall, and partly due to three unscheduled, large tankers (approx 330 barrels total) were delivered to the site. Discussions held with the site operator about the requirement of special condition 1 to spread materials during periods of extended dry weather and special condition 2 which requires notification to be given 48 hours prior to spreading operations commencing.
- The area of land adjacent to the storage cells had liquids pumped onto it the previous day to increase capacity so the pits wouldn't overflow into the storm water treatment system. The fine material within the discharged liquid had mixed with the ongoing rain and made its way into a small drainage channel and was running off into another drain below the site. The liquid was slightly turbid until it mixed with the receiving waters at the designated downstream sample point, no effects were observed below the mixing zone, photographs were taken.

- The two lined pits at the site were found to be at capacity, the third unlined pit was approximately half full with grey liquids from cells 1 and 2.
- The nova-flow pipe at time of inspection appeared to be discharging to the receiving drain, the first pond was found to have surface oils present, it was outlined that the oils were to be removed shortly.
- The second pond was essentially free of hydrocarbon sheen and the liquid was quite clear, the discharge into the receiving waters was occurring through two pipes.
- No effects were observed in the receiving waters from the pond discharges; the turbid run-off from the adjacent paddock was mixing at the same point and was clear above the culvert.
- Washing of bins occurred, all washings were discharged into the receiving pit, and no surface oils appeared to be present.
- The discharge from skimmer pipe appeared clear and the receiving ponds looked clear also.
- Discussions were held with regard to the utilisation of the Derby Road site for increased storage, it was agreed the site would be acceptable if the pits are lined prior to being used.
- Discussions were also held with site operator regarding the recent lack of notifications for receiving materials onto the site from different well sites, it was acknowledged that the notification was lacking due to staff changes, a new person had been tasked with ensuring all notifications are provided.
- The original unscheduled deliveries of 3 large tankers (330 barrels approx) to the site were for the purpose of temporary stockpiling as they constituted un-used SBM and WBM. The consent holder will not discharge these to land. Mi Swaco were advised by TRC they were able to store mud with plastic silos. The muds were stored in fit for purpose silos in a bunded location on the Surrey Road Site.

2 October 2013

- Three storage tanks were stored in a lined bund, a mud pump was adjacent to the tanks and is outside the bund, surrounding area tidy.
- The two lined pits at the site were both full and discharged to the third pit which was unlined.
- The surface of the pond appeared to be free of hydrocarbons and the liquid seemed to be clear water.
- The nova flow pipes were observed to have discharged potential hydrocarbon water to the receiving drain, however some oils seemed to have been caught in the vegetation within the drain, the receiving ponds were free of surface oils.
- Four IBC's full of oil were at the site adjacent to pits 1 and 2, the pits were essentially free of surface oils.
- The discharge from the last stormwater pond was inspected, no effects were observed within the receiving waters, the end of the outlet sleeve had been buried in gravel to filter the discharge.

14 October 2013

- Contacted Site Operations Manager prior to collection of storm water samples. The stormwater ponds at the time of inspection were discharging to receiving waters, contractors were unable to decant liquids from off the ponds and spread to land due to inclement weather conditions.

- A scrim wind break was to be erected along the southern ends of cells 1&2 to help protect against the forecasted NW winds - the purpose of the wind break was to prevent the potential of hydrocarbons blowing towards and entering the southern drain.

15 October 2013

- Receiving and stormwater samples were collected from the drilling waste holding ponds.
- All pond levels were high.
- Cells 1 and 2 were observed to be discharging to the southern drain.
- The final pond discharge flow rate was estimated at 6-8 L/S.
- Hydrocarbon sheen was observed at the point of discharge into the stream.
- It appeared some grass had recently been burnt from wind blown hydrocarbon residual from cells 1 and 2.

1 November 2013

- Wash-pad and cell 1 full with stormwater on the surface, cell 2 was observed to be below the liner tear level, stabilisation measures were in place, it is planned that the liner will be repaired in the near future.
- Cell 3 had approx 1 metre freeboard before discharge.
- Nova flow observed to be discharging barely visible rainbow sheen.
- Receiving ponds were observed to be slightly turbid brown with organic growth throughout, final discharge to receiving waters was clear and no effects were observed.

9 December 2013

- Inspection conducted in conjunction with groundwater sampling.
- On site discussion with Surrey Road Operational Staff detailed work was undertaken to remove (skimmed) approximately 15,000 L of hydrocarbons which was stored on site in a 60,000 L steel storage tank.
- Netting had been erected downwind of the storage pits.
- Mud tank bunding was almost at capacity due to rainwater.
- Ross explained the "Foam Preventer" at end of discharge pipe that was constructed (looks similar to gabion basket).

10 February 2014

Site inspection was conducted in conjunction with groundwater sampling:-

- The site showed several recent improvements.
- The storage silos looked good, with bunding secure.
- Pumps and the muck spreader were on site as some spreading work had been recently undertaken.
- General housekeeping around the pits looked good. Cloth had been erected around the pits to catch any wind-blown material.
- There was some oil evident on the stormwater pits.
- The Site Operations Manager had contacted the Council to inform that work had been undertaken at the site; the oily material on the pits was detailed as largely synthetic vegetable based oil that was being used as a foam suppressant.
- It was proposed that it was to be continuously monitored.

- Of some concern was the fact that there were cattle tracks and fresh cow droppings immediately adjacent to the stormwater pits.

26 February 2014

- No objectionable odours or visible emissions were found during the inspection.
- The site storage area had been tidied up.
- The two cells containing muds were almost at capacity, no surface liquids were present.
- Mud tanks were secure and in good repair, bund empty, no skimmer pipes were discharging.
- The receiving ponds were essentially free of hydrocarbon sheen/surface oils, no discharge into the receiving environment had occurred.
- The nova flow was observed conveying hydrocarbons from below the pit into the drain and on to the first pond.

24 March 2014

- Inspection conducted in conjunction with groundwater sampling. Site Operations Manager present at site - expressed concern over the potential for liners tearing, as such suggested he will maintain an agitator on site to help mitigate this.

31 March 2014

- No objectionable odours or visible emissions were found during the inspection.
- Works occurred to empty the contents of cell 1 through the use of a long reach digger, this activity was undertaken slowly to prevent any damage of the liners.
- The sides of the liner were hosed as the muds were emptied, no tears were sighted, and the mud was loaded onto the spreader and then discharged onto paddock 142.
- Cell 2 was observed to be approximately half full, the trial injection spreader was planned to be used in the coming days and some of the contents of cell 2 would be discharged onto paddock 18.
- Approximately 40-50 IBC's were delivered to the site from the MI Swaco stores in New Plymouth, the IBC's contained varying amounts of drilling muds and residues.
- No discharges from skimmer pipes were observed to have occurred during the inspection, no discharge onto the receiving environment was noted, the last pond was approximately one metre below the outlet.
- Nova-flow, was observed to be discharging into receiving drain, whereby a visible hydrocarbon sheen was sighted.
- The receiving pond was essentially free of surface oils.

27 May 2014

- No objectionable odours or visible emissions were found during the inspection.
- Lined pits at Surrey road site were found to be essentially full, due largely to storm-water from recent heavy rains.
- Unlined cell storm-water discharge to receiving drain clear, last settling pond discharge clear and no effects observed within the receiving waters. Drain was observed to be still receiving rainbow sheen from nova flow, first receiving pond retaining hydrocarbons.

- IBC's cleaning being undertaken, wash pad pit found to be free of hydrocarbons but a visible amount of muds was observed.
- The pit would be required to be emptied; material should be land-farmed including the sediment in the receiving drain.
- Pasture strike limited in the recently land farmed areas on the northern side of the new access bridge along Surrey road, the muds have been well incorporated, no run-off was observed. Pasture in trial application areas showing clearly visible horizontal lines from grass die-off, test pits along the tracks found muds still clearly identifiable in the cuts and on the surface.
- The following action is to be taken: Ensure no more liquid is pumped from cell 3 into the receiving ponds, the liquid must be applied to land only.

11 June 2014

- The Surrey site was unmanned at the time of inspection.
- Surface water and discharge samples were taken.
- The pits were observed to contain muds, the ponds were fairly full and were discharging, the final discharge point was discharging at approximately 0.5 L/sec.
- No effects were noted in the receiving waters, the samples were clean and clear, no odours, foams or sheens present.
- The site looked generally tidy.
- 2 samples were taken from the drains downstream of recent spreading areas.
- The spreading areas looked good, grass had established and there was no evidence of muds or hydrocarbons in the drains.

23 June 2014

- Storage site- cell 1 essentially empty of muds, some residue observed in the bottom where it is impractical for the digger to go any closer to the liner, some green detergent sighted on the surface of the mud residue.
- Minor repair undertaken to 7 identified perforations in the top area of the liner of cell 1, discussions with manufacturer has identified the optimum repair material; further sealing works were undertaken around the goose neck pipe.
- The wash pad had been emptied of muds and the goose neck redirected to cell 1.
- The stormwater cell below the two lined pits were observed to be discharging stormwater, no discharge to the receiving drain had occurred from the final settling pond and all ponds were free of surface hydrocarbons.
- A tractor and sucker tank, noted, adjacent to the ponds.
- Works were noted to be continuing on cleaning the IBC's.
- Periodic circulation occurred on the unused muds stored in the holding tanks; the lined bunds had clear storm water in the bottom.
- Visible hydrocarbons were observed discharging into the drain adjacent to cells 1 and 2, the receiving pond was essentially free of surface hydrocarbons, recovery operations still occurring when required.
- Delivery of offshore drilling muds likely within upcoming weeks, material likely to be SBM and WBM.

25 June 2014

- Site observed to be holding product in cell 2.
- The site looked reasonably tidy, and steady rain was setting in at the time of sampling/inspection.
- The pits looked secure, and the washdown pit had recently been cleaned out.
- Samples were taken from the upstream and mid stream sites.
- The samples were both turbid orangy brown (due to high rainfall).
- A discussion was held with Ross Henry (MI Swaco) concerned with soil sampling methodologies for the area where the injection trial was undertaken.
- Discharge and downstream samples were taken, there was some foaming from the discharge, but it was not observed downstream of the mixing zone. No other effects were noted.

2.2.3 Results of discharge monitoring

2.2.3.1 Drilling waste

Approximately 2480 metric tonnes of drilling waste was stored within pits at the site during the monitoring period and consisted predominately of synthetic based muds and water based muds.

2.2.3.2 Council stormwater results

The Council collected stormwater discharge samples from site IND001067 (as per Figure 4) on three occasions. The results are presented in Table 10.

Table 10 Stormwater discharge results from Surrey Road stockpiling facility during the 2013 – 2014 monitoring period

Parameter	Unit	RULE 23 limits RFP	Date		
			15 Oct 2013	11 June 2014	25 Jun 2014
Benzene	g/m3		-	<0.0010	<0.0010
Toluene	g/m3		-	<0.0010	<0.0010
Ethylbenzene	g/m3		-	<0.0010	<0.0010
meta-Xylene	g/m3		-	<0.002	<0.002
ortha-Xylene	g/m3		-	<0.0010	<0.0010
Hydrocarbon	g/m3	15*	8.4	<0.7	<0.7
C10-C14	g/m3		-	<0.2	<0.2
C7-C9	g/m3		-	<0.10	<0.10
C15-C36	g/m3		-	0.6	<0.4
Barium (acid soluble)	g/m3		0.19	0.21	0.24
Barium (dissolved)	g/m3		0.12	-	-
Biochemical oxygen demand	g/m3	5g/m3	24	5.8	7.3
Chloride	g/m3		62.5	24.7	49.3
Conductivity	mS/m@20C		29.1	15.5	30.3
pH	pH	6-9	6.9	6.8	6.9
Suspended solids	g/m3	100	17	11	9
Temperature	Deg.C		11.7	10.1	9.5
Total dissolved solids	g/m3		225.1	119.9	234.4

*Oil and Grease limit as per Rule 23 RFP

BOD was reported above the consent criteria of 5g/m^3 on the three separate sampling occasions. The criteria are set by the RFP, Rule 23. The highest reading, 24g/m^3, recorded on the 15 October 2013 coincided with a high rainfall event. A TRC rain gauge in the vicinity of the site recorded a reading of 432 mm of precipitation over the course of a 48 hour period which preceded the sample collection.

Consideration should be given to the fact that this accounts for a flux of storm water from the ponds to the adjacent tributary, which at the time would have been in a period of high flow as a direct result of the high rainfall. It is therefore determined, that although this reading is high by comparison with previous results it was mitigated by the high period of precipitation. The remaining two sampling runs, 11 June and the 25 June respectively, were reported above the recommended RFP rule for BOD, however they are within the Council's criteria for typical surface fresh water quality 0-8mg/L for the Taranaki Region.

2.2.3.3 MI Swaco supplied stormwater results

MI Swaco sampled the discharge from the Surrey Road stockpiling facility on three occasions. The results are supplied below in Table 11.

Table 11 MI Swaco stormwater results for the Surrey Road stockpiling facility

Parameter	Unit	Rule 23 limits	05 Nov 2013	30 Jun 2014
pH	pH	6-9	7.1	6.8
Suspended solids	g/m^3	100	18	13
Free Ammonia	g/m^3	0.025	<0.010	<0.010
Total Ammoniacal N	g/m^3	-	0.42	0.27
Carbonaceous biochemical oxygen demand	g O_2/m^3	5	4	5
Oil and grease	g/m^3	15	<4	<5
Free chlorine	g/m^3	-	<0.05	0.11
Combined chlorine	g/m^3	0.025	<0.08	<0.08

Information provided by Mi Swaco detailed in Table 11, above, denote that stormwater samples were within the consent criteria set by the RFP rule 23. However, it was also noted that Carbonaceous BOD was at the limit on one occasion.

2.2.3.4 MI Swaco Pre Landfarm Storage Cell Analysis

Prior to the Company landspreading/landfarming the stockpiled material from the storage cells on Surrey Road, the Company must undertake a pre spread analysis of the material, this is a conditional requirement of the Consent held by the Company. This information is detailed in the Annual report provided in Appendix II.

2.2.4 Results of receiving environment monitoring

2.2.4.1 Council groundwater results

Three groundwater monitoring wells were installed in late 2009, prior to the first delivery of drilling wastes to site. They are located up-gradient (GND2165) and down-gradient (GND2166, GND2167) of the site, as shown in Figure 4. Samples were collected from the monitoring wells on seven occasions. The results are presented in Tables 12 to 14.

Table 12 Groundwater monitoring results from bore GND2165 from the Surrey Road stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002
ortha-Xylene	g/m³		-	-	-	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7
C10-C14	g/m³		-	-	-	<0.2
C7-C9	g/m³		-	-	-	<0.10
C15-C36	g/m³		-	-	-	<0.4
Barium (acid soluble)	g/m³	0.7 MAV	0.027	0.010	0.013	0.031
Barium (dissolved)	g/m³		-	-	-	0.018
Chloride	g/m³	250 GV	6.4	5.7	6.7	8.7
Conductivity	mS/m@20°C		6.9	6.2	6.8	7.2
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	1.93	0.94	1.58	0.92
pH	pH		6.0	6.4	6.3	6.1
Sodium	g/m³	200 GV	-	-	-	-
Static water level	m		2.36	-	-	3.163
Temperature	°C		11.6	11.3	13.3	12.5
Total dissolved solids	g/m³	1000 GV	53.4	48.0	52.6	55.7

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

Table 13 Groundwater monitoring results from bore GND2166 from the Surrey Road stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014	24 Mar 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002	<0.002
ortha-Xylene	g/m³		-	-	-	<0.0010	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7	<0.7
C10-C14	g/m³		-	-	-	<0.2	<0.2
C7-C9	g/m³		-	-	-	<0.10	<0.10
C15-C36	g/m³		-	-	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.7 MAV	0.035	0.023	0.041	0.048	0.16
Barium (dissolved)	g/m³		-	-	-	0.019	0.021
Chloride	g/m³	250 GV	5.8	6.5	8.8	7.0	8.3
Conductivity	mS/m@20°C		5.3	5.0	6.2	6.2	7.7
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	3.06	1.05	2.49	0.38	
pH	pH		5.6	5.5	5.6	6.0	6.0
Sodium	g/m³	200 GV	-	-	-	-	6.0
Static water level	m		1.32	-	-	1.883	2.264
Temperature	°C		10.2	12.0	14.3	13.5	14.1
Total dissolved solids	g/m³	1000 GV	41.0	38.7	48.0	48.0	59.6

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

Table 14 Groundwater monitoring results from bore GND2167 from the Surrey Road stockpiling facility during the 2013-2014 monitoring period

Parameter	Unit	NZDWS 2008	17 Jul 2013	01 Nov 2013	09 Dec 2013	10 Feb 2014	24 Mar 2014
Benzene	g/m³	0.01 MAV	-	-	-	<0.0010	<0.0010
Toluene	g/m³	0.8 MAV	-	-	-	<0.0010	<0.0010
Ethylbenzene	g/m³	0.3 MAV	-	-	-	<0.0010	<0.0010
meta-Xylene	g/m³		-	-	-	<0.002	<0.002
ortha-Xylene	g/m³		-	-	-	<0.002	<0.0010
Hydrocarbons	g/m³		<0.5	<0.5	<0.5	<0.7	<0.7
C10-C14	g/m³		-	-	-	<0.2	<0.2
C7-C9	g/m³		-	-	-	<0.10	<0.10
C15-C36	g/m³		-	-	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.7 MAV	0.038	0.06	0.047	0.08	0.18
Barium (dissolved)	g/m³		-	-	-	0.035	0.029
Chloride	g/m³	250 GV	7.3	7.4	14.0	26.6	48.0
Conductivity	mS/m@20°C		6.8	7.4	9.6	13.9	24.5
Nitrite/nitrate nitrogen	g/m³ N	50 MAV	0.36	0.35	0.14	0.08	-
pH	pH		5.6	5.5	5.8	6.1	6.4
Sodium	g/m³	200 GV	-	-	-	-	14.1
Static water level	m		1.92	-	-	2.367	2.524
Temperature	°C		11.3	12.2	12.5	12.9	14.0
Total dissolved solids	g/m³	1000 GV	52.6	57.3	74.3	107.5	189.6

NZDWS Drinking Water Standards for New Zealand 2005 (Updated 2008)
MAV Maximum Allowable Value
GV Guideline Value

Groundwater monitoring data from the three monitoring wells (GND 2165, 2166, 2167) located at the Surrey Road Site are detailed in Tables 12,13 and 14 respectively. The quality of the groundwater has been compared to the National Drinking Water Standards for New Zealand (Updated 2008). No exceedance was reported during the annual monitoring period.

2.2.4.2 Council surface water results

An unnamed tributary of the Mangatengehu Stream runs along the southern boundary of the Surrey Road stockpiling facility. On three occasions samples were collected upstream (MTH000060),midstream (MTH000062) and downstream (MTH000064) of the site. The results are shown in Tables 15 to 17.

Table 15 Results obtained from the unnamed tributary of the Mangatengehu Stream across the site boundary on the 15th October 2013, during the 2013 – 2014 monitoring period

15th October 2013				
Parameter	Unit	15 Oct 2013 MTH000060 Upstream	15 Oct 2013 MTH000062 Midstream	15 Oct 2013 MTH000064 Downstream
Benzene	g/m³	-	-	-
Toluene	g/m³	-	-	-
Ethylbenzene	g/m³	-	-	-
meta-Xylene	g/m³	-	-	-
ortha-Xylene	g/m³	-	-	-
Hydrocarbon	g/m³	<0.5	<0.5	0.7
C10-C14	g/m³	-	-	-
C7-C9	g/m³	-	-	-
C15-C36	g/m³	-	-	-

15th October 2013				
Parameter	Unit	15 Oct 2013 MTH000060 Upstream	15 Oct 2013 MTH000062 Midstream	15 Oct 2013 MTH000064 Downstream
Barium (acid soluble)	g/m³	0.019	0.023	0.13
Barium (dissolved)	g/m³	0.018	0.020	0.040
Biochemical oxygen demand	g/m³	-	0.6	1.3
Chloride	g/m³	5.8	5.8	11.2
Conductivity	mS/m@20°C	3.3	3.3	5.8
pH	pH	6.5	6.6	6.7
Suspended solids	g/m³	2	2	9
Temperature	°C	9.5	9.5	9.5
Total dissolved solids	g/m³	25.5	25.5	44.9

Table 16 Results obtained from the unnamed tributary of the Mangatengehu Stream on the site boundary on the 11th June 2014 during the 2013 – 2014 monitoring period

11th June 2014				
Parameter	Unit	11 Jun 2014 MTH000060 Upstream	11 Jun 2014 MTH000062 Midstream	11 Jun 2014 MTH000064 Downstream
Benzene	g/m³	-	<0.0010	<0.0010
Toluene	g/m³	-	<0.0010	<0.0010
Ethylbenzene	g/m³	-	<0.0010	<0.0010
meta-Xylene	g/m³	-	<0.002	<0.002
ortha-Xylene	g/m³	-	<0.0010	<0.0010
Hydrocarbon	g/m³	-	<0.7	<0.7
C10-C14	g/m³	-	<0.2	<0.2
C7-C9	g/m³	-	<0.10	<0.10
C15-C36	g/m³	-	<0.4	<0.4
Barium (acid soluble)	g/m³	0.021	0.024	0.035
Barium (dissolved)	g/m³	-	-	-
Biochemical oxygen demand	g/m³	-	<0.5	<0.5
Chloride	g/m³	5.6	5.7	7.2
Conductivity	mS/m@20°C	4.8	4.9	5.8
pH	pH	6.9	6.8	6.7
Suspended solids	g/m³	5	4	4
Temperature	°C	9.9	9.9	9.9
Total dissolved solids	g/m³	37.1	37.9	44.9

Table 17 Results obtained from the unnamed tributary of the Mangatengehu Stream at the upstream sampling site MTH000064 during the 2013 – 2014 monitoring period

25th June 2014				
Parameter	Unit	25 Jun 2014 MTH000060 Upstream	25 Jun 2014 MTH000062 Midstream	25 Jun 2014 MTH000064 Downstream
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Toluene	g/m³	<0.0010	<0.0010	<0.0010
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010
Hydrocarbon	g/m³	<0.7	<0.7	<0.7
C10-C14	g/m³	<0.2	<0.2	<0.2
C7-C9	g/m³	<0.10	<0.10	<0.10

25th June 2014				
Parameter	Unit	25 Jun 2014 MTH000060 Upstream	25 Jun 2014 MTH000062 Midstream	25 Jun 2014 MTH000064 Downstream
C15-C36	g/m³	<0.4	<0.4	<0.4
Barium (acid soluble)	g/m³	0.036	0.038	0.081
Barium (dissolved)	g/m³	-	-	-
Biochemical oxygen demand	g/m³	-	<0.5	0.5
Chloride	g/m³	6.0	6.0	9.8
Conductivity	mS/m@20°C	6.0	6.0	7.4
pH	pH	6.8	7.0	6.8
Suspended solids	g/m³	37	42	61
Temperature	°C	10.2	10.3	10.2
Total dissolved solids	g/m³	46.4	46.4	57.3

The above results do not detail any significant variation between the sampling sites and indicate there is minimal impact on the tributary from activities at the site. Of note there is a slight elevation in the Chloride concentrations recorded in the surface water, this is similarly echoed in the Conductivity as well as the Total Dissolved Solids. This is minimal and typical of regional values.

2.2.4.3 MI Swaco supplied surface water results

MI Swaco obtained 5 samples of the surface waters in relation to the Surrey Road stockpiling facility, which were supplied to the Council, and are presented in Table 18.

Table 18 MI Swaco surface water results for the Surrey Road stockpiling facility

Parameter	Unit	Rule 23 limits	05 Nov 2013		29 Apr 2014		30 Jun 2014	
			Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
pH	pH	6-9	-	7.2	6.6	-	-	6.8
Suspended solids	g/m³	100	-	7	12	-	-	13
Free Ammonia	g/m³	0.025	-	<0.010	<0.010	-	-	<0.0010
Total Ammoniacal N	g/m³	-	-	0.078	0.28	-	-	0.27
Carbonaceous biochemical oxygen demand	g O_2/m³	5	<2	<2	2	4	<2	5
Oil and grease	g/m³	15	-	<4	<5	-	-	<5
Free chlorine	g/m³	-	-	<0.05	0.08	-	-	0.11
Combined chlorine	g/m³	0.025	-	<0.08	<0.08	-	-	<0.08

Surface water samples provided by MI Swaco detail that no exceedance was recorded throughout the year. However, it was noted that on the 30 June 2014 the limit in relation to BOD was reached 5g O_2/m³. Care must be exercised by the applicant for this consent to include full down stream data as the results from the 29 April demonstrate incomplete data. These are provided in the Mi Swaco Annual Report attached in Appendix II.

2.2.4.4 Council biomonitoring results

Two biological surveys were performed on 18 December 2013 and on 10 February 2014 to monitor the health of the macroinvertebrate community of an unnamed tributary of the Mangatengehu Stream, in relation to the storage of drilling waste in the vicinity.

The standard 'kick-sampling' technique was used at the four sampling sites to collect streambed macroinvertebrates. Samples were processed to provide number of taxa

(richness), MCI, and SQMCIs scores for each site. 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. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Both biomonitoring surveys during the monitoring period under review were undertaken at four established sites; upstream of the drilling waste stockpiling site (site 1, MTH000060), approximately 85 m upstream of the spring and skimmer pit discharge (site 2, MTH000062), approximately 35 m downstream of the skimmer pit discharge (site 3, MTH000064), and approximately 100 m downstream of the skimmer pit discharge (site 4, MTH000066), as seen in figure 5.

Summaries of each biomonitoring survey are as follows. A complete copy of the biomonitoring surveys can be found within Appendix III.

Figure 5 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility

18 December 2013

This biological survey undertaken during December 2013, 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.

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

The results of this survey indicated a slight improvement in the condition of the macroinvertebrate community at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. However the MCI and $SQMCI_S$ scores recorded at site 2 in this survey were below medians recorded to date at the site.

The MCI and $SQMCI_S$ scores recorded at sites 3 and 4 were severely reduced compared to those recorded at sites 1 and 2. Some of this deterioration in macroinvertebrate community may be attributable to the higher algal biomass and iron oxide sedimentation observed at these sites. However, this algal cover and iron oxide sedimentation were not unusual for these sites, yet both sites recorded depleted community richnesses, with only 12 (site 3) and seven (site 4) taxa recorded, compared with 18 and 24 taxa in the previous survey. In addition, invertebrate abundances were also severely depleted, with no 'sensitive' taxa represented by more than five individuals per taxon at either site, and only two taxa recording more than five individuals at each site. Such severe deterioration is more typically associated with the effects of a recent toxic discharge or prolonged effect of such a discharge. The current survey indicated that recent discharges into the stream from the land farming activities have caused a significant deterioration in macroinvertebrate health in this unnamed tributary.

Therefore, it is recommended that strong consideration be given to requiring this site to obtain a consent for this wastewater discharge, and that the water quality sampling regime be augmented to include testing for dissolved nutrients (total nitrogen, total phosphorus and dissolved reactive phosphorus) and other relevant parameters from both the site discharge, and also in samples collected upstream and downstream of the discharge point.

Overall, the results of this early summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have resulted in significant impacts on the macroinvertebrate communities through the lower section of the reach surveyed, and that it is likely that such impacts have been compounded by habitat variability..

10 February 2014

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 10 February 2014, 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.

In the current survey, the MCI score recorded at the upstream 'control' site was similar to the median score recorded at the site in previous surveys and was indicative of good community structure at this site. The $SQMCI_S$ score and taxa richness were above those

recorded in previous surveys and together with the presence of many 'sensitive' taxa in this community were indicative of good preceding water quality.

The results of this survey indicated deterioration in the condition of the macroinvertebrate community at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. Both the MCI and $SQMCI_S$ scores recorded at site 2 in this survey were significantly below medians recorded to date. This can be attributed to the low flow conditions and difficulty in sampling at this site at the time of the survey.

The MCI and $SQMCI_S$ scores recorded at sites 3 and 4 were severely reduced compared to those recorded at site 1. Some of this deterioration in macroinvertebrate communities may have been attributable to the higher algal biomass and iron oxide sedimentation observed at these sites. However, this algal cover and iron oxide sedimentation were not unusual for these sites, yet both sites recorded severely depleted community richnesses, with only six (site 3) and nine (site 4) taxa recorded, compared with the medians of 12 (site 3) and 17 (site 4) recorded by previous surveys. In addition, invertebrate abundances were also severely depleted, with no 'sensitive' taxa represented by more than five individuals per taxon at site 3 and only one 'sensitive' taxon recorded as common (5-19 individuals) at site 4. Such severe deterioration is more typically associated with the effects of a recent toxic discharge or prolonged effect of such a discharge. The current survey indicated that recent discharges into the stream from the land farming activities may have contributed to a significant deterioration in macroinvertebrate health in this unnamed tributary.

As was recommended in the previous (December 2013) report, it is further recommended that strong consideration be given to requiring this site to obtain a consent for this wastewater discharge, and that the physiochemical water quality sampling regime be augmented to include testing for dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) and other relevant parameters from both the site discharge, and also from the stream upstream and downstream of the discharge point.

Overall, the results of this late summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have resulted in significant impacts on the macroinvertebrate communities through the lower section of the reach surveyed, and that it is likely that such impacts have been compounded by habitat variability.

The full bio-monitoring report is provided in Appendix III.

2.3 Landspreading activities

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

Areas spread can be identified within the aerial site map Figure 6.

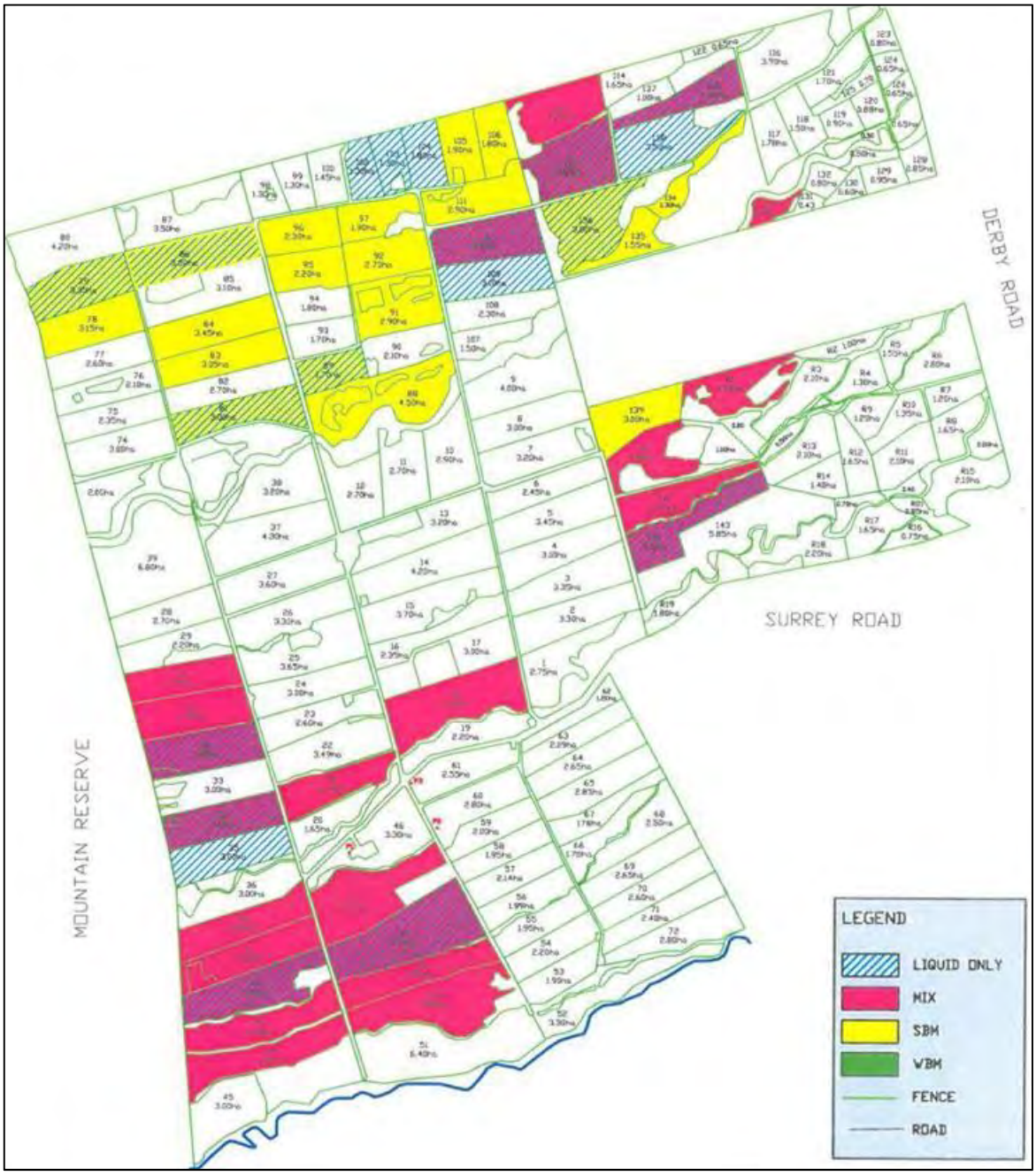

Figure 6 Aerial map of the extent of Colin Boyd's property and landspread areas as of March 2014

2.3.1 Results

2.3.1.1 Inspections

There were eight scheduled compliance monitoring inspections of the landfarmed areas of Colin Boyd's property during the monitoring period. The property was also inspected one more time in conjunction with surface water and soil sampling.

15 July 2013

- Wind South, no objectionable odours or visible emissions were found during the inspection. Complaint received regarding the site activities impacting on a small stream.
- Land spreading operations occurred during a period of poor weather.
- During the inspection the liquid portion of a cell was being discharged to land via a tanker, the pasture was inspected and found to be coping with the applications, essentially no ponding was observed around the spreading area and buffer zones were being adhered to. Some grey fine material remained on the pasture surface in places.
- The area of land adjacent to the storage cells also had liquids pumped onto it the previous day to increase capacity so the pits wouldn't overflow into the storm water treatment system. It was observed that the fine material within the discharged liquid had mixed with the ongoing rain and made its way into a small drainage channel and was running off into another drain below the site. The liquid was slightly turbid until it mixed with the receiving waters at the designated downstream sample point. No effects were observed below the mixing zone, photographs were taken.
- Run-off from paddock adjacent to storage site had discoloured a small drain until mixing with unnamed tributary above culvert at sampling site.
- The following action was proposed: Operate the storage areas in a manner which will allow capacity to retain the materials until the weather conditions are suitable for spreading. Ensure all required notifications are given prior to land spreading operations.

2 October 2013

Inspection undertaken with Colin Boyd, recent operations discussed:-

- Land preparation had occurred to receive drilling muds.
- The injection spreader yet to be trialled.
- Some muds had been spread fairly recently, the area had been rolled, power harrows were on-site to incorporate the mud which was in a thick layer after being rolled, buffer distances were adhered to, no muds appeared to entered any adjacent drains.
- Discussions were held in regard of spreading notifications, Colin was of the opinion that relevant notifications had been given to TRC, however, no notifications were received by TRC after 15 July 2013. The notification was for stormwater from cell 2, not for spreading of drilling muds.
- TRC needs to receive accurate and timely spreading notifications and the material needs to be incorporated into the soil as soon as practicable. Colin outlined that the material had been previously harrowed but rolled again prior to being re-harrowed as he wasn't happy with the way it had blended. Pasture areas where muds have previously been spread appeared healthy, historic areas where muds were applied too thick were re-grassing slowly.

26 February 2014

- The muds were being applied to one area through the use of the spreader, recently spread muds were already present on the spreading area. The area has historically received muds also, first noted in October 2013 inspection- reportedly spread during July 2013 and re-worked during October 2013. Special condition 10 of Consent 7591-1 prohibits subsequent discharges of drilling muds onto areas which have previously received muds, unless the consent holder can submit notification that the area in question had met the required criteria through chemical analysis. The chemical analysis of the area in question is provided in Table 21.
- Special condition 15 prohibits the discharge within 25 metres of a water body, the buffer distance was not adhered to but no muds were seen to discharge anywhere near the adjacent waterway on the southern side of the area receiving muds.
- A demonstration of the incorporation technique was given over a small area of applied material, the mud was well mixed into the soil profile. The new injection spreader was demonstrated in an adjacent paddock containing pasture, the discs at the rear of the machine cut into the topsoil and the trailing hoses apply mud over the disc cuts. The mud was visible on the surface in lines, test pits were dug throughout the application trail area, the mud was present up to 5 cm below the surface layer and it is thought the material will be washed into the cuts during rain, which should also reduce the likelihood of discharges to water via overland flow.
- Discussions were held with regard to applying the material mixed with dairy shed effluent, a trial is to occur as currently Consent 7591-1 allows for 1000 kg of N per hectare over a 5 year period. If the trial is successful a variation of Consent 7591-1 will likely be applied for to allow for the effluent/mud mix. The following action is to be taken: Undertake works to incorporate the remaining material into the soil matrix; ensure spreading areas are not used for subsequent applications of drilling waste material; ensure buffer distances are adhered to.

12 March 2014

Inspection undertaken during spreading operations, fine weather had preceded the activity.

- Muds were applied through the use of a spreader, harrowed. Drain buffers had been harrowed to prevent any overland flow, it was outlined that the rest of the material would be incorporated before the forecasted rain at the weekend. No muds found within any drain.
- Trial application areas inspected, muds still present on the surface, very easy to break apart, no evidence of tracking from the area occurring. Pasture appears to be dying where muds applied resulting in horizontal lines within the paddock. Some cattle had recently been grazing in the trial paddock.

31 March 2014

- The spreading of drilling muds occurred during the inspection, fine weather had preceded the activity. Muds were removed from cell 1 through the use of a long reach digger, removal activity had been undertaken with extreme care to preserve the liner integrity.
- Muds spread onto paddock 142, buffer distances around drains had been harrowed to prevent overland flow, no muds were found to have entered any drains around the spreading area.
- Cells 1 and 2 were programmed to be emptied within forty days of activity, weather dependant.
- Trial application area inspected, the pasture around the application areas appeared to have coped well and appeared greener than the area which did not receive any mud. When the pasture was pulled back the horizontal lines of mud were present under the pasture, mud/hydrocarbon odours noted on the lower pasture/roots.
- One trial area had dairy shed effluent applied over the top, horizontal spreading lines not visible in this area. Another trial application was agreed during the inspection, paddock 18 had been picked (Colin outlined that no muds had been spread in the paddock).
- The trial was to occur over the coming week; requirement to notify 48 hour hours prior to spreading in writing was waived in this instance as the notification was given verbally. The muds are to be spread from cell 2 as the consistency is more favourable for the injection spreader.

27 May 2014

- Material was stockpiled in paddock 101, three loads had been removed. A bull dozer was nearby to spread the material over the required area before the weather turned. The material was very sticky and no run-off was observed to have occurred.
- Pasture strike limited in the recently land farmed areas on the northern side of the new access bridge along Surrey road, the muds had been well incorporated, no run-off was observed.
- Pasture in trial application areas showing clearly visible horizontal lines from grass die-off, test pits along the tracks found muds still clearly identifiable in the cuts and on the surface.
- The following action is to be taken: Ensure no more liquid in pumped from cell 3 into the receiving ponds, the liquid must be applied to land only.

11 June 2014

- The spread areas appeared in good health, grass had established and there was no evidence of muds or hydrocarbons in the drains.

16 June 2014

- Muds from Derby Road site were stockpiled in paddock 101. 19 piles of mud were present; some other material had begun to be incorporated into the soil.
- Storm water run-off from stockpiled mud area discharged onto land only. Adjacent to the farm race, no hydrocarbons found were observed in the ponded water.
- The pasture in historic mud application areas appeared healthy.

- The following action was proposed: Undertake works to incorporate the stockpiled muds in paddock 101 into the soil to ensure compliance with resource consent conditions.

23 June 2014

- Muds in paddock 101 had been spread using a dozer, muds still clearly visible at the surface but some blending had occurred. It was outlined the area was to be power harrowed when it dried out further, no run-off was observed.
- Paddock 30 and 31 inspected where trial application occurred, the area had been recently grazed and the remaining pasture cover was being harrowed. During the inspection, mud was clearly visible on the surface and complete pasture die off had occurred along the horizontal injection lines. Some weathering of the mud had occurred, transects across the area found the muds to extend to an approximate depth of 5 cm. It was outlined to Ross that the operators need to be mindful of the 6 metre buffer distances from drains unless a variation of consent conditions is sought.

2.3.2 Results of abstraction and discharge monitoring

2.3.2.1 MI Swaco landfarm summary

Two deliveries were received during the 2013-2014 monitoring period. These two deliveries were IBC's containing residual SBM and barite and another delivery which encompassed 330 Barrels approximately of unused drilling mud. The unused drilling muds were stored in a fit for purpose silo, within a bunded area.

Throughout the monitoring period, the site operators landfarmed approximately 1710 m^3 of muds. This occurred during the months of February 2014, March 2014 and April 2014. The waste predominately consisted of synthetic based and water based muds. Approximately 810 m^3 of this waste originated from the KA-20 well and was landfarmed across approximately 16.3 Ha of spreading areas 18, 30, 31, 139 and 140. The remaining 900 m^3 originated from the KA-19 well and was landfarmed across approximately 5.75 Ha of spreading areas 141 and 142.

2.3.3 Results of receiving environment monitoring

2.3.3.1 Council soil results

Six composite soil samples were collected on two separate occasions by sub-sampling to a depth of 300 mm at 10 m intervals in paddocks where landspreading of drilling waste had occurred (Figure 7). The results are presented in Table 19.

Table 19 Soil results obtained from landspread areas during the 2013-2014 monitoring period at Colin Boyd's property

Parameter	Consent Condition s	Unit	Date and Landspread Areas					
			05 Aug 2013 ***31***	05 Aug 2013 ***86***	05 Aug 2013 ***88***	06 Aug 2013 ***89***	06 Aug 2013 ***102***	06 Aug 2013 ***103***
Chloride	700	mg/kg DW	60.8	54.8	44.0	28.8	50.3	31.4
Conductivity	290	mS/m@20° C	72.4	120	56.8	48.1	28.2	29.4
Hydrocarbon		mg/kg DW	7	360	160	170	10	29
Moisture factor	-	nil	1.215	1.095	1.060	1.256	1.198	1.281
pH	-	pH	5.8	6.6	6.5	6.4	5.6	5.6

Parameter	Consent Condition s	Unit	Date and Landspread Areas					
			05 Aug 2013 ***31***	05 Aug 2013 ***86***	05 Aug 2013 ***88***	06 Aug 2013 ***89***	06 Aug 2013 ***102***	06 Aug 2013 ***103***
Sodium	460	mg/kg	34.8	43.1	25.0	21.1	26.6	23.2
Total soluble salts	2500	mg/kg	566.6	939.1	444.5	376.4	220.7	230.1

Soil results detailed in Table 19 denote that the consent conditions have not been exceeded during this monitoring period. All locations are well within the soil consent conditions.

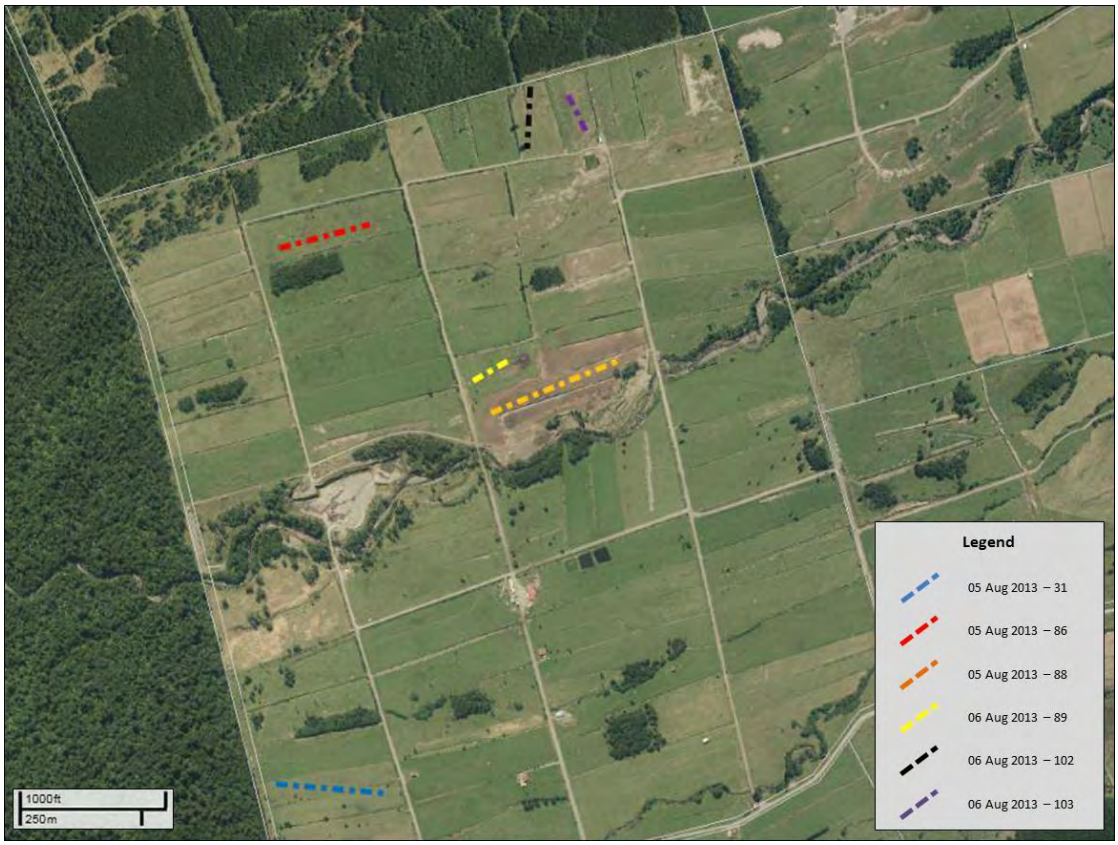

Figure 7 Council soil sampling transect locations at Colin Boyd's property during the 2013-2014 monitoring period

2.3.3.2 Council surface water results

The exercise of consent 7591-1 shall not result in contamination of groundwater or surface water (SC16). Two surface water samples were obtained on 11 June 2014 from an unnamed tributary flowing through and adjacent to paddocks where drilling wastes had been landspread. The results are presented in Table 20.

Table 20 Surface water results obtained adjacent to landspread areas during the 2013-2014 monitoring period at Colin Boyd's property

Parameter	Unit	11 Jun 2014 *D/S Paddock 142*	11 Jun 2014 *D/S Paddock 140*
Benzene	g/m3	<0.0010	<0.0010
Toluene	g/m3	<0.0010	<0.0010
Ethylbenzene	g/m3	<0.0010	<0.0010
meta-Xylene	g/m3	<0.002	<0.002
ortha-Xylene	g/m3	<0.0010	<0.0010
Hydrocarbons	g/m3	<0.7	<0.7
C7-C9	g/m3	<0.10	<0.10
C10-C14	g/m3	<0.2	<0.2
C15-C36	g/m3	<0.4	<0.4
Barium (acid soluble)	g/m3	0.20	0.06
Chloride	g/m3	10.6	6.6
Conductivity	mS/m@20C	16.1	13.9
pH	pH	6.7	6.4
Temperature	Deg.C	11.5	11.4
Total dissolved solids	g/m3	124.6	107.5

The received surface water samples indicate that no adverse effects had been detected in either of the locations. A slight increase in Chloride was reported, however, this was well within typical standards for surface waters in the region.

2.3.3.3 MI Swaco Respread Area

As stipulated in the resource consent 7591-1, the consent holder must meet a certain number of conditions prior to the re application of land farmable material on to a certain area which has historically received material.

During this annual monitoring period, only one paddock was reported to have been re-spread, Paddock 142. Analysis of the paddock showed that the area was within consented conditions for the re-application for all of the stipulated criteria with the exception of Sodium, which exceeded the criteria by 40mg/kg. While this is a negligible amount it serves as a reminder to the operator that they must be mindful of the consent conditions. The analysis of the pre-spread paddock is provided in Table 21.

Table 21 Paddock 142 Pre-Spread Initial Criteria

	Sample Name:	142
22/08/2013	Lab Number:	1165317
Dry Matter	g/100g as rcvd	56
Density	g/mL at 20°C	1.48 #1
Total Recoverable Barium	mg/kg dry wt	34
Total Recoverable Sodium	mg/kg dry wt	500
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg		
Total Recoverable Arsenic	mg/kg dry wt	< 2
Total Recoverable Cadmium	mg/kg dry wt	0.1
Total Recoverable Chromium	mg/kg dry wt	5
Total Recoverable Copper	mg/kg dry wt	45
Total Recoverable Lead	mg/kg dry wt	5.8
Total Recoverable Mercury	mg/kg dry wt	< 0.10

Total Recoverable Nickel	mg/kg dry wt	< 2
Total Recoverable Zinc	mg/kg dry wt	18
BTEX in Soil by Headspace GC-MS		
Benzene	mg/kg dry wt	< 0.09
Toluene	mg/kg dry wt	< 0.09
Ethylbenzene	mg/kg dry wt	< 0.09
m&p-Xylene	mg/kg dry wt	< 0.18
o-Xylene	mg/kg dry wt	< 0.09
Polycyclic Aromatic Hydrocarbons Screening in Soil		
Acenaphthene	mg/kg dry wt	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04
Anthracene	mg/kg dry wt	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	< 0.04
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.04
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04
Chrysene	mg/kg dry wt	< 0.04
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04
Fluoranthene	mg/kg dry wt	< 0.04
Fluorene	mg/kg dry wt	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04
Naphthalene	mg/kg dry wt	< 0.2
Phenanthrene	mg/kg dry wt	< 0.04
Pyrene	mg/kg dry wt	< 0.04
Total Petroleum Hydrocarbons in Soil		
C7 - C9	mg/kg dry wt	< 12
C10 - C14	mg/kg dry wt	< 30
C15 - C36	mg/kg dry wt	< 50
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 90

2.3.3.4 MI Swaco receiving soil results

During the monitoring period MI Swaco took six receiving soil samples from spreading areas and submitted them to RJ Hill Laboratories for analyses. The tabulated analysis of the soil samples are tabulated below in Table 22 below. Their results are presented in full in their supplied annual report for the 2013-2014 monitoring period, included in Appendix II.

Table 22 MI Swaco Post Landspreading Soil Results

	Sample Name:	Paddock 18 30-Jun-2014	Paddock 30 30-Jun-2014	Paddock 31 30-Jun-2014	Paddock 140 30-Jun-2014	Paddock 141 30-Jun-2014	Paddock 142 30-Jun-2014
Dry Matter	g/100g as rcvd	63	61	59	66	60	61
Density	g/mL at 20°C	0.72	0.81	0.8	0.84	0.8	0.88
Total Recoverable Barium	mg/kg dry wt	1,930	2,000	3,000	3,500	4,600	3,500
Total Recoverable Sodium	mg/kg dry wt	740	640	500	630	620	560
Heavy metals							
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	< 2	< 2	2	2
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.17	0.16	< 0.10	0.21	0.17
Total Recoverable Chromium	mg/kg dry wt	7	7	7	6	10	7
Total Recoverable Copper	mg/kg dry wt	50	40	41	45	33	44
Total Recoverable Lead	mg/kg dry wt	3.4	6.8	6.1	4.9	9.8	6.5
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	2	2	3	2	7	3
Total Recoverable Zinc	mg/kg dry wt	34	30	29	34	40	34
BTEX in Soil							
Benzene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13	< 0.13
Toluene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13	< 0.13
Ethylbenzene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13	< 0.13
m&p-Xylene	mg/kg dry wt	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
o-Xylene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13	< 0.13
PAH in Soil							
Acenaphthene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.04	< 0.04	0.04	0.03	0.05	0.05
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.04	0.04	0.06	0.06	0.07	0.09
Benzo[g,h,i]perylene	mg/kg dry wt	0.07	0.08	0.12	0.09	0.14	0.19
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Chrysene	mg/kg dry wt	0.05	0.06	0.08	0.1	0.11	0.11
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	0.08	0.09	0.13	0.21	0.17	0.18
Fluorene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	0.04
Naphthalene	mg/kg dry wt	< 0.18	< 0.19	< 0.18	< 0.17	< 0.18	< 0.18
Phenanthrene	mg/kg dry wt	0.04	0.07	0.07	0.28	0.16	0.1
Pyrene	mg/kg dry wt	0.16	0.18	0.25	0.28	0.32	0.37
TPH in Soil							
C7 - C9	mg/kg dry wt	< 11	< 11	< 11	< 10	< 11	< 11
C10 - C14	mg/kg dry wt	30	64	142	1,370	690	83
C15 - C36	mg/kg dry wt	1,290	1,750	2,200	14,300	10,800	2,300
Total hydrocarbons (C7 - C36)	mg/kg dry wt	1,320	1,820	2,400	15,600	11,500	2,400

The tabulated results from Table 22, above, denote no exceedance with regard to the consent criteria as detailed in consent 7591-1. However, all paddock soils are still above the consent required surrender or re-application criteria, which the consent holder must comply with in order to reapply material to landfarming areas. This will be achieved through the careful management and monitoring of the individual areas.

3. Investigations, interventions, and incidents

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

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

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

In the 2013-2014 period, the Council was required to undertake additional investigations and interventions, or record incidents, in association with the conditions in resource consents or provisions in Regional Plans.

Incident- 23746
On 15 July 2013 at 10:20, a complaint was received regarding the activities of a land farm impacting on a small stream at Surrey Road, Inglewood. An inspection of the storage site found that run-off from the area of land adjacent to the storage area was slightly turbid. The run-off was entering a small drain. The drain discharged into an unnamed tributary and after mixing no discolouration was observed. The site operator outlined that the previous day the liquid portion of a cell used to store drilling mud had been applied to land. The liquid contained some fine drilling mud material which mixed with the on-going rainfall and found its way into a natural drainage channel. Abatement Notice 12032 was issued requiring the resource consent conditions to be complied with at all times.

4. Discussion

4.1 Discussion of site performance

The initial discussion will focus on each individual location.

4.1.1 Derby Road

Throughout the monitoring period the site at Derby Road remained inactive. Some lesser site activities did occur, primarily the removal of stockpiled mud from the pits which were eventually landfarmed over the period. The site did not receive any deliveries of landfarmable material.

In terms of the operator's sufficiency with the site, a potential issue was outlined in terms of the clearing of storage cells, however this was minor and the route forward was agreed, one of draining cell fluids and spreading them, as permitted in their consent across the landfarmed areas, rather than the initial process of feeding them through the stormwater system. Considering the fact that the site was inactive, the operator demonstrated that they were managing the site in a proactive and agreeable manner.

4.1.2 Surrey Road

This location was the main focus for the monitoring period of 2013-2014 in terms of stockpiling pre-landfarmable drilling waste, whilst in comparison Derby Road was inactive.

The site operators landfarmed approximately 1710 m^3 of 2480 m^3 of drilling related waste during the months of February 2014, March 2014 and April 2014. The material consisted of synthetic based and water based muds. Approximately 810 m^3 of this waste originated from the KA-20 well and was landfarmed across approximately 16.3 Ha, which encompassed spreading areas 18, 30, 31, 139 and 140. The remaining 900 m^3 originated from the KA-19 well, this was landfarmed across approximately 5.75 Ha, spreading areas 141 and 142.

The site performance required some prompting from inspectorate staff with inspections for example and ongoing environmental monitoring through out the monitoring year. Some advances have been noted and these are discussed, although there is also room for improvement.

The removal of visible surface oil from the storage cells to an onsite tanker has prevented the potential for the surface oils from entering the storm water system during a heavy rainfall event. The use of this system for skimming of surficial oils has allowed the site operator to recover 30,000 litres of hydrocarbon.

In addition to this, inspections have found that skimming has not been undertaken often enough. The consent holder must ensure that the pits are routinely monitored, as at times a sheen had been observed conveying hydrocarbon contaminated storm water from the storm water system into the stream discharge area.

The nova flow pipe which is situated under the un-lined cell 3 has been observed conveying hydrocarbon contaminated water into the drainage network. The unlined cell (Cell 3) needs to be lined and this will be stipulated in the review of the consent

later this year. Once this pit is lined, the nova flow pipe will serve as an additional monitoring location to quantify the groundwater quality on site. Of note, no significant detection in relation to hydrocarbon has been observed off site in the down gradient groundwater monitoring well network since 2010.

The facility is expected to comply with the RFP Rule 23, as such it does not hold a discharge permit consent, in comparison, Derby Road does. The annual monitoring of the stream, storm water discharge location resulted in a breech of the RFP Rule 23 on all three occasions of sampling throughout the year in terms of biological chemical oxygen deficit.

The bio-monitoring on the tributary of the Mangatengehu Stream indicated a marked decline in species diversity and abundance throughout the monitoring period, this was observed below the discharge location.

4.1.3 Landfarming Operations

The council requires notification from the consent holder when they intend to spread and re-spread areas which have historically received drilling muds, they accomplish this by presenting data on the area under consideration, detailing how it has met stipulated criteria in terms of re-spreading, as detailed by the consent. The ratification of the consent condition with respect to re-spreading had been supplied.

Poor weather is a major factor for the site operators with regard to spreading the liquid fraction associated with stockpiled material in the cells. Discharge of liquid has to be undertaken when conditions allow for the absorption of it by the consented receiving environment and not when a saturated paddock will result in overland flow to adjacent water bodies.

The evolution of land farming technique is evident with this consent; the holder has undertaken numerous trials throughout the monitoring period which may improve the workability and the speed of biodegradation of the applied muds and cuttings, this coupled with the landspreading of the liquid fraction from the storage cells details that the operator is evolving their technique. Of interest is the application of the diary shed effluent, which in line with the consented limit for nitrate, may well increase the bio mechanism for bacterial growth and subsequent decay of the quantified, spread hydrocarbon layers of drilling mud. Council Inspectorate, as detailed earlier in this report, have observed how the trial application had encouraged good pasture strike and that the layer of drilling mud which is visible in un applied areas is not present. The council is interested in the progression of this application.

In addition to the trial of dairy shed effluent, the consent holder has undertaken the application of the mud through the use of an injection spreader, whereby the soil is sliced open via a disc blade and then a trail hose is utilised to inject the mud into the soil. This option is of interest as it is thought to allow the mud to wash into the slice and prevent the potential for overland flow in periods of intense rainfall. However, the application thus far has resulted in lines of mud, visible from the surface. The council will continue to monitor this process as the consent holder shall maintain pasture cover in areas used for landspreading. A variation of the Consent will be required if this trial application is to become the status quo.

The use of this trial method does allow for greater control in terms of the land spreading and as such it may be possible to better adhere to boundary conditions especially when working near surface water or tributaries which occasionally run near some of the landfarmed paddocks.

4.2 Environmental effects of exercise of consents

The council monitors the groundwater in the vicinity of both stockpiling facilities, Derby and Surrey Road respectively. The monitoring well network is constructed to encapsulate the groundwaters which precede the site as well as the waters which flow under it. As such it would be possible to detect if any contamination was permeating from either facility.

The results from this monitoring period through the analysis of the network have indicated no adverse effects in terms of contamination have been detected in any monitoring well.

Derby Road holds consent to discharge storm waters from the site to an unnamed tributary of the Managmawhete Stream. The council undertook stormwater sampling to monitor this discharge and surface water sampling of the tributary above and below the discharge location. In addition to the discharge monitoring the council also undertook bio monitoring surveys which are primarily aimed at assessing the diversity of the species which reside in this portion of the catchment and to ascertain whether the site activities have caused any adverse impact.

The biomontoring of Derby Road concluded; overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed, although some impacts caused by habitat variability were noted. In general, however, poorer community richnesses and diversities of the macroinvertebrate communities within this upper reach (near the source) of a ringplain stream in comparison with similar streams elsewhere on the ringplain (Stark & Fowles, 2009/TRC, 1999) reflect the paucity of riparian and other habitat and the influence of iron-rich groundwater seepage along the length of stream surveyed.

The Surrey Road stockpiling facility was the active site throughout the monitoring year. In comparison to the Derby Road Site, it does not hold a stormwater discharge permit, rather to comply with rule 23 of the Regional Fresh Water Plan. Analysis of stormwater samples by the council had found that at certain times, the facility had breeched this rule, namely with BOD on all three sample occasions.

The evolution of skimming the pits for surface oils and to limit the through flow of the stormwaters from the storage cells into the stormwater system by pumping out excess waters and spreading them when conditions allow, would seek to mitigate the potential for any future breeches associated with this rule. The application of a discharge consent would also add a second line of monitoring to address this issue. This is being considered. The proposal for a discharge permit is similarly echoed in the conclusion of the biomonitoring survey undertaken for the Surrey Road.

As was recommended in the previous (December 2013 bio-monitoring) report, it is further recommended that strong consideration be given to requiring this site to obtain a consent for this wastewater discharge. The physiochemical water quality sampling

regime should be augmented to include testing of dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) from both the site discharge, and also from the stream upstream and downstream of the discharge point.

Overall, the results of this late summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have resulted in significant impacts on the macroinvertebrate communities through the lower section of the reach surveyed, and that it is likely that such impacts had been compounded by habitat variability.

The council takes this decline seriously and has requested that the consent holder limit the discharge to the storm water system. The route forward, as already described is to pump and spread the liquid related storm water on to landspreadable paddocks and in doing so prevent the through flow of contaminants across the storm water system and into the stream. The council also followed up with an additional biomonitoring survey which was undertaken in August 2014, note that this was outside of the monitoring period of this report, however, the initial results detailed that the communities were showing signs of recovery.

The Landspreading operations undertaken throughout the year indicated that no exceedance was detected in terms of total metals in the soil and the hydrocarbon related loadout rates were within stipulated criteria. However, there were certain times when spreading of liquid factions from the cells had resulted in an initial high suspended solid count as well as a brief discolouration of the adjacent stream in one case, however suitable mixing downstream mitigated the visual assessment.

The operator had been warned to regard boundary conditions which are consented, these are designed to mitigate the potential for overland flow, the operator must also be reactive to adverse weather conditions while applying the liquid factions of the storage cells. Spot surface sampling conducted by the council at tributaries located on the boundaries of two landspread paddocks had indicated no adverse effects, a slight increase in the chloride level was noted, however this was negligible.

4.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 21 to 24.

Table 23 Summary of performance for Consent 6900-2
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

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
2. Notify TRC 48 hours prior receiving waste onto site for stockpiling	Notifications received	Yes Verbally
3. Records to be kept by consent holder and made available to the Council	Records received	Yes
4. Consent holder to report to Council by 31 August each year on records specified in SC3	Reports received	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
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	Yes
7. Total dissolved solids in any fresh water body not to exceed 2500 g/m^3	Sampling	Yes
8. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
9. Concentrations in soil to be met prior to expiry	Not applicable	N/A
10. Consent may not be surrendered until compliance with SC9	Not applicable	N/A
11. Optional review provision re environmental effects	Next option for review in June 2015	Yes
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

The consent holder 6900-2 demonstrated a high degree of environmental compliance and administration compliance throughout the monitoring period. The Derby Road stockpiling facility was unused in terms of new deliveries of stock pile able material throughout the monitoring period. The residual muds which were contained on the site from the previous year were stockpiled on paddocks then land spread throughout the year, landspreading was accomplished under consent 7591-1.

A few minor issues were outlined by inspectorate throughout the year; however no adverse effects were detected in the groundwater monitoring network, the storm water discharge monitoring of the stream/ surface water surveys. The Bio-monitoring indicated that no adverse effects were permeating from the facility.

Table 24 Summary of performance for Consent 7559-1
To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions of stockpiling and landfarming	N/A	N/A
2. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Yes
3. Install groundwater monitoring wells prior to exercise of consent	Inspection	Yes
4. Approved management plan to be reviewed annually	Plan approved 4 December 2009, no update provided	N/A
5. Notify Council 48 hours prior to stockpiling wastes	Wastes received during period under review	Retrospectively
6. Notify Council 48 hours prior to landfarming wastes	Not applicable. Waste landspread under consent 7591	N/A
7. Limited to wastes generated in Taranaki	Consent holders records	N/A
8. Maximum stockpiling volume of 2,000 m^3 to be landfarmed/spread within nine months	Inspection and consent holders records	N/A
9. Maximum application thickness for wastes: a) 100 mm TPH < 5% b) 50 mm TPH > 5% c) no ponded liquids 1 hr after application	Not applicable. Waste landspread under consent 7591-1	N/A
10. Landfarmed areas to be used once only	Not applicable. Waste landspread under consent 7591-1	N/A
11. Incorporate wastes into the soil so that the surface 250mm contains less than 5% hydrocarbons	Not applicable. Waste landspread under consent 7591-1	N/A
12. Maximum chloride loading 800 kg/ha	Not applicable. Waste landspread under consent 7591-1	N/A
13. Maximum nitrogen loading 1,000 kg/5yrs	Not applicable. Waste landspread under consent 7591-1	N/A
14. Discharge area shall be resown to pasture/crop as soon as practicable	Not applicable. Waste landspread under consent 7591-1	N/A
15. No discharge within 25 m of a water body (includes farm drains)	Not applicable. Waste landspread under consent 7591-1	N/A
16. 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	Not applicable. Waste landspread under consent 7591-1	N/A

17. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Not applicable. Waste landspread under consent 7591-1	N/A
18. Sodium absorption ratio [SAR] must be less than 18. If background soil SAR is greater than 18, then waste application shall not increase SAR by more than 1	Not applicable. Waste landspread under consent 7591-1	N/A
19. At time of expiry/cancellation/ surrender, soil hydrocarbon concentrations must comply with MfE guidelines	N/A	N/A
20. Prior to expiry/cancellation/surrender, soil parameters shall not exceed: a) conductivity 290 mS/m b) dissolved salts 2500 g/m^3 c) sodium 460 g/m^3 d) chloride 700 g/m^3	N/A	N/A
21. Total dissolved solids in surface water or groundwater shall not exceed 2500 g/m^3	Sampling	N/A
22. No contamination of groundwater or surface water to exceed background concentrations	Sampling	N/A
23. Records to be kept by consent holder and made available to the Council	See SC24	N/A
24. Consent holder to report to Council by 31 August each year on records specified in SC23	Report received for 2011-2012 and 2012-2013	Yes
25. Consent shall lapse on 31 Dec 2014 unless exercised	Not applicable - consent exercised	N/A
26. Optional review provision re environmental effects	Recommendation not to review in June 2014	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		N/A

The majority of the application of drilling waste to land was undertaken through the use of Consent 7591-1 during this monitoring period. As such the rationale to grade this consent throughout the monitoring period is not applicable.

Table 25 Summary of performance for Consent 7591-1
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	No
2. Notify Council 48 hours prior to landspreading	Notifications received	Yes
3. Limited to wastes generated in Taranaki	Consent holders 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 holders 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. Pasture cover to be maintained at all times	Inspections	Yes
8. No waste shall be applied within: a) 12 m of boundaries b) 12 m of named streams c) 6 m of other water courses	Inspection	Mostly
9. Liquid wastes which may flow overland shall not be discharged within 25 m of boundaries or water courses	Inspection	Mostly
10. Soil hydrocarbon concentrations must comply with MfE guidelines: a) prior to areas being reused for landspreading b) at the time of expiry/cancellation/surrender	Consent notification	Yes
11. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling -	Yes
12. 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
13. Sodium absorption ratio [SAR] must be less than 18. If background soil SAR is greater than 18, then waste application shall not increase SAR by more than 1	Sampling	N/A
14. Soil parameters shall not exceed: a) conductivity 290 mS/m b) dissolved salts 2500 g/m^3 c) sodium 460 g/m^3 d) chloride 700 g/m^3 prior to areas being reused for landspreading, and at the time of expiry/cancellation/surrender	Sampling	Re-used paddock had slight exceedance in relation to Sodium, however, it was minor.

15. Total dissolved solids in surface water or groundwater shall not exceed 2500 g/m^3	Sampling	Yes
16. No contamination of groundwater or surface water to exceed background concentrations	Sampling	NO- RFP Breech on 3 Occasions Adverse effects on aquatic life (Bio-Monitoring)
17. Records to be kept by consent holder and made available to the Council	See SC18	Yes
18. Consent holder to report to Council by 31 August each year on records specified in SC17	Reports received	Yes
19. Consent shall lapse on 1 June 2027 unless exercised	Not applicable - consent exercised	N/A
20. Optional review provision re environmental effects	Next option for review in June 2015	Yes
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		Improvement required Good

As previously discussed, the main application of drilling mud and liquid fraction were undertaken through the use of Consent 7591-1. This consent covered the application areas; it also contained the condition which allowed the consent holder to re-apply an application if the applied area had met stipulated conditions as laid down in the consent.

Over the course of the monitoring period the consent holder did meet the majority of there goals which were outlined by the consent, however there is still improvement required.

In terms of environmental effects associated with the facility, the decline in species diversity and abundance, coupled with flux's through the storm water facility have contributed to a reduced score in this monitoring period.

Of note, action undertaken post this monitoring period has stemmed the impacts seen on the communities down stream of discharge point. The operator has responded with more direct action across the facility and preliminary data from the 2014-2015 year appear more positive.

Administration performance of the site was graded as Good for the 2013-2014 year. The Consent holder were able to quantify their material, define their application areas and undertake trial applications through different methods and treatments which may well lead to future developments in application rates.

Table 26 Summary of performance for Consent 7911-1
To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Stormwater discharged shall be from a catchment area not exceeding 1.5 hectares	Inspection and liaison with consent holder	Yes
3. Discharges shall meet the following: a. pH 6.0 – 9.0 b. Suspended solids <100 gm^{-3} c. Total recoverable hydrocarbons <15 gm^{-3}	Sampling	Yes
4. 25m downstream of the initial discharge point, discharges shall not exceed: a. BOD_5 <2 gm^{-3} b. Chloride <50 gm^{-3}	Sampling	Yes
c. Disposal of waste shall not result in any significant adverse environmental effects in the receiving waters	Inspection and sampling	Yes
d. Consent holder shall maintain a contingency plan	Inspection and liaison with consent holder	
e. Optional review provision re environmental effects	Next option for review in June 2015	Yes
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative compliance in respect of this consent		Good Good

Consent 7911-1 was concerned with the discharge of stormwaters from the Derby Road Facility. The facility as previously discussed did not receive any additional deliveries of storage material.

Monitoring data from the period detailed that no exceedance was found in terms of the discharge sample, surface sample and no adverse effects were found in the bio-monitoring.

4.4 Recommendations from the 2011-2013 Biennial Report

In the 2011-2013 Biennial Report, it was recommended:

1. THAT the monitoring programme for the Derby Road North site in the 2013-2014 year, is changed from that for 2011-2013 to include sampling for BTEX and TPH in all water samples.

2. THAT the monitoring programme for the Surrey Road site in the 2013-2014 year, is changed from that for 2011-2013 to include sampling for BTEX and TPH in all water samples.

3. THAT the monitoring programme for landspreading activities in the 2013-2014 year, remain unchanged from that for 2011-2013, unless the level of site activity changes.

4. THAT the consent holder addresses the discharge of residual hydrocarbons into the surface water drain.

5. THAT the consent holder is either required to apply for a stormwater consent for the Surrey Road stockpiling site, as stormwater discharges from site were not within the RFWP Rule 23 limits, or, modifies the pond and drainage system to prevent any discharges of water from the storage pits into the stormwater system and then into the Mangatengehu Stream.

4.5 Alterations to monitoring programmes for 2014-2015

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

It is proposed that for the 2014-2015 chemical analysis TPH and BTEX be included in the samples of surface waters and discharge samples, and to include testing for dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) and other relevant parameters from both the site discharge, and also from the stream upstream and downstream of the discharge point.

The inclusion of additional sampling of dissolved nutrients is proposed to understand if the site may have an effect in increasing the potential for more algal cover as has been observed in the bio-monitoiring surveys of Surrey Road.

The option of a stormwater discharge consent for the Surrey Road facility is under consideration if the consent holder cannot prevent the discharges from the storage pits into the stormwater system, and to comply with the RFP Rule 23. This will be monitored throughout the coming year as will the species diversity breakdown in the adjacent tributary through continued bio-monitoring. The site operations will also be altered to prevent the through flow from the storage cells into the stormwater system. The operation will enable the fluid fraction of the storage cells to be spread under the Consent 7591-1.

4.6 Exercise of optional review of consent

Resource consent 7559-1 provides for an optional review of the consent in June 2014. Condition 26 allows the Council to review the consent, if there are grounds that need further explanation or amendment.

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 grounds that require a review to be pursued. However, the option for a review is available in June 2015, with the Council most likely to undertake a review at that time. The Council would like to monitor the progress of the operational changes proposed in this report.

5. Recommendations

1. THAT monitoring of consented activities at the locations of Derby Road Stockpiling facility in the 2014-2015 year continues at the same level as in 2013-2014 with the inclusion of TPH and BTEX to all water samples collected.

2. THAT monitoring of consented activities at the locations of Surrey Road Stockpiling facility in the 2014-2015 year continues at the same level as in 2013-2014 with the inclusion of TPH, BTEX and dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) from both the site discharge, and also from the stream upstream and downstream of the discharge point.

3. THAT the monitoring programme for landspreading activities in 2014-2015 continue at the same level as in 2013-2014, unless the level of site activity changes.

4. THAT the consent holder must address the breaches to the RFP Rule 23 in relation to the Surrey Road Stockpiling facility.

5. THAT the option for a review of resource consent 7559-1 in June 2014, as set out in condition 25 of the consent, not be exercised, on the grounds that that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of the consents. However, recommendation 4 must be satisfied.

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.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cu*	Copper.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1}).
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.

l/s	Litres per second.
MASL	Meters above sea level
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}	Relatively fine airborne particles (less than 10 micrometre diameter).
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	*Resource Management Act* 1991 and including all subsequent amendments.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
Zn*	Zinc.

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

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

Appendix I

Resource consents

Discharge Permit

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

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

Conditions of Consent

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

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

General condition

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

Special conditions

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

Notifications, monitoring and reporting

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

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

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

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

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

4. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 3, for the period of the previous 12 months, 1 July to 30 June.

Operational requirements

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

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

Receiving environment limits - water

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

8. Other than as provided for in condition 7, the exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which after reasonable mixing, exceeds the background concentration for that particular contaminant.

Receiving environment limits - soil

9. From 1 March 2027 [three months prior to the consent expiry date], constituents in the soil of previously landfarmed areas shall not exceed the standards shown in the following table:

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

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

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

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

Review

11. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 16 February 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Consent Granted Date:	20 November 2009

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming at or about (NZTM) 1701847E-5651476N
Expiry Date:	1 June 2027
Review Date(s):	June 2010, June 2011, June 2012, June 2013, June 2014, June 2015, June 2021
Site Location:	Surrey Road, Inglewood
Legal Description:	Sec 17 & 18 Blk XIV Egmont SD
Catchment:	Waitara
Tributary:	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.

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. 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

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

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

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

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

   In order to demonstrate compliance with conditions 9, 12 and 13 of this consent.

Discharge limits

7. The exercise of this consent is limited to wastes generated within the Taranaki region.

8. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 2,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.

9. 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.

10. An area of land used for the landfarming of drilling wastes in accordance with condition 9 of this consent shall not be used for any subsequent discharges of drilling waste.

11. 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 so that the hydrocarbon concentration at any point in the soil/waste mix is less than 50,000 mg/kg dry weight.

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

13. 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.

14. 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.

15. No discharge shall take place within 25 metres of a water body [including farm drains], or property boundary.

Receiving environment limits for soil

16. 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.

17. The concentration of metals in the soil layer containing the discharge shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the "Guidelines for the safe application of biosolids to land in New Zealand" [MfE and NZWWA 2003].

18. The sodium absorption ratio [SAR] of the soil layer containing the discharge shall be less than 18, or alternatively if the background soil SAR exceeds 18, the application of waste shall not increase the SAR by more than 1.

19. At the time of expiry, cancellation, or surrender of this consent the concentrations of hydrocarbons in the soil shall comply with the guideline values for sandy silt set out in Tables 4.12 and 4.15 of the "Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand" [MfE, 1999].

20. At the time of expiry, cancellation, or surrender of this consent soil parameters shall not exceed the following limits: chloride, 700 mg/kg; conductivity, 290 mS/m; sodium, 460 mg/kg; and total soluble salts, 2500 mg/kg.

Receiving environment limits for water

21. 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.

22. 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

23. 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.

24. 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

25. 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.

26. 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 2010 and/or June 2011 and/or June 2012 and/or June 2013 and/or June 2014 and/or 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, 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 20 November 2009

For and on behalf of
Taranaki Regional Council

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Chief Executive

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 P O Box 44 INGLEWOOD
Consent Granted Date:	21 January 2010

Conditions of Consent

Consent Granted:	To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading at or about (NZTM) 1701750E-5652370N
Expiry Date:	1 June 2027
Review Date(s):	June 2011, June 2012, June 2015, June 2021
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
Catchment:	Waitara
Tributary:	Mangamawhete Mangatengehu Waipuku

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

General conditions

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

Special conditions

1. 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 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 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 landspread;
    d) the volume and weight of the waste to be landspread;
    e) the concentration of chlorides, nitrogen and hydrocarbons in the waste; and
    f) the specific location and area over which the waste will be landspread.

    In order to demonstrate compliance with conditions 4, 5 and 6 of this consent.

3. The exercise of this consent is limited to wastes generated within the Taranaki region.

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 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. The consent holder shall maintain pasture cover at all times in areas used for the landspreading of drilling waste.

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. The concentration of hydrocarbons in the soil shall comply with the guideline values for sandy silt set out in Tables 4.12 and 4.15 of the "Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand" [MfE, 1999]. This condition shall apply:

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

11. The concentration of metals in the soil layer containing the discharge shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the "Guidelines for the safe application of biosolids to land in New Zealand" [MfE and NZWWA 2003].

12. 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.

13. The sodium absorption ratio [SAR] of the soil layer containing the discharge shall be less than 18, or alternatively if the background soil SAR exceeds 18, the application of waste shall not increase the SAR by more than 1.

14. Soil parameters shall not exceed the following limits: chloride, 700 mg/kg; conductivity, 290 mS/m; sodium, 460 mg/kg; and total soluble salts, 2500 mg/kg. This condition shall apply:

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

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, including concentrations of chloride, nitrogen and total hydrocarbons
    c) landspreading areas, including a map showing individual disposal areas with GPS co-ordinates
    d) volumes and weights of wastes landspread
    e) dates of commencement and completion of landspreading 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 2011 and/or June 2012 and/or June 2013 and/or June 2014 and/or 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, 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 21 January 2010

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

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

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

Conditions of Consent

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

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

General condition

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

Special conditions

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

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

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

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

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

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

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

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

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

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

7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 27 September 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Appendix II

MI Swaco supplied annual report

MI SWACO

A Schlumberger Company

ANNUAL REPORT FOR

CONSENT# 6900-1

CONSENT# 7591-1

COLIN BOYD LAND FARMS

SURREY ROAD

DERBY ROAD

INGLEWOOD

TARANAKI

31 JULY 2014

Status of Derby Rd and Surrey Rd Land Farm Facilities:

Both cells #1 and #2 had product stored from the 2013 period.This was spread in the summer/autumn of 2014.

24 predominantly empty IBC's containing residual SBM and barite were received in March 2014 at the Surrey Rd landfarm. Some were cleaned and returned to MI SWACO depot while others were emptied into cell 1 and cut up for disposal.

In August 2013, three storage silos were placed in a bunded and lined area at the Surrey Rd landfarm. These silos arere used to store unused SBM and are circulated regularly.

Cell #1 contained 967 metric tonnes of drilling cuttings.
Cell #2 contained 1513 metric tonnes of drilling cuttings.
Both of these cells have since been emptied and spread by a variety of methods, including a trial authorised by the Taranaki Regional Council.

Cell #1 was Land spread under Consent #7559-1. Colin Boyd had a large area of ground being cultivated and the contents of Cell #1 were land farmed down to a depth of 350mm using a 150hp Komatsu bulldozer towing Rome giant discs.
As per past experience, this resulted in excellent incorporation into the soil, which has since been seeded. The farm manager does not foresee any grazing of these paddocks until the autumn of 2015, when only young stock will be used to lessen pasture damage.
The material from Cell #2 was used as a trial for a proposed new method of processing drilling waste. After consultations between the Taranaki Regional Council, various contractors, Colin Boyd and MI SWACO staff, a demonstration day was organised to show TRC and several clients this new option.
(An overview of the trial and proposed new method will be given in this report.)

The summer drought again meant that our stormwater ponds were not discharging for much of the year. Stormwater samples were taken during times of discharge, the results tabled in this report.

There was evidence that accumulated hydrocarbon floating on cells #1 & #2 was being blown by strong Northerly winds onto an adjacent paddock. Although the

actual quantity was minimal, there was still discolouration of the grass. Two large windbreak fences were erected on the South edge of the storage cells. These fences have been totally successful in containing the hydrocarbon, restoring the healthy pasture beside the landfarm.

Our company has improved our techniques for removing hydrocarbons from the storage cells. A 60,000 litre steel tank is used to store the recovered product at the landfarm. Over the last year, in excess of 30,000 litres of hydrocarbon has been recovered from the storage cells and other ponds. This product was thus prevented from entering the environment. MI SWACO is pro-actively working with the TRC to improve our drilling waste management systems to minimise any potential environmental effects.

Several modifications have recently been made to the bin wash-down pit area.

- The skim pipe outfall is now routed into cell #1 rather than the external drain. All wash-down water now goes through another 2 skim pipes prior to being stored in cell #3.
- A PVC liner has been fitted to the wash-down pond to prevent any product entering the surrounding environment.
- A surface drain has been incorporated into the loading pad, as a safety precaution against any potential spills. This links to the skim piped wash-down pit.

MI SWACO and Colin Boyd have recently met with TRC staff to discuss important modifications to the Surrey Road landfarm site management. The stormwater and cell discharges were previously fed into a series of three skim piped stormwater ponds, finally exiting into the adjacent stream. This outfall is tested by both ourselves and TRC when discharges occur during periods of rain.
We have now proposed a major improvement to this system. All rainwater that falls directly into cells #1 and #2 will now be stored into cell #3 and spread directly onto designated pasture. Other separate rainwater falling onto the metal pad and tracks will still pass through the original stormwater ponds and into the stream.
This development will significantly prevent any diluted drilling waste from entering directly into the stream. This should be shown by future monitoring of the stormwater outlets, with an improvement in stream health predicted.

All new paddocks used for spreading of drilling waste have been tested by Hill Laboratories, including heavy metals. We noted a slightly elevated chloride level in

2014 Direct Drilling Trial.

Colin Boyd and MI SWACO staff have investigated practices used in many overseas countries to spread drilling waste onto pasture.

Paddocks 18, 30, 31 were initially used. Subsequently, paddocks 21 & 34 have also been used to complete the trial in July 2014 to be tested in 2015.
One method involves the forming of a slurry transported in a sealed tanker unit. This unit incorporates a mixing system which then injects small quantities of the drilling waste directly into the ground, via slots created by metal discs.
A local Taranaki contractor has this equipment available for our use, including an extremely powerful pond stirrer to mix the slurry. This allowed removal of the drilling waste from the cells without major damage to the expensive plastic liners and thus prevented groundwater contamination. Trials were done to find the optimum consistency for loading the slurry into the tanker and injection unit.

Various application rates were trialled, and we now consider that we have a very good system for possible future use. The Colin Boyd dairy farm has in excess of 500 hectares of useable pasture potentially available. This allows us to use a 'little and often' approach in the future.

Advantages over previous systems may include:-

- Minimising any possibility of runoff into waterways.
- Significantly reduced application rates per hectare.
- Consistent application rates, using GPS tracking to document.
- Ability to incorporate with dairy effluent for faster breakdown via micro-organisms.
- Minerals will improve pasture health.
- Aeration of the soil.
- Use of a soil laboratory to maximise blends, possibly including fertilisers etc.
- Allows applications over a greater number of days per annum, meaning less product stored in cells.
- Allows both TRC and our clients in future to use an internationally rated system that will spread drilling waste at application levels markedly less than current allowable levels.

Soil tests were taken from all paddocks used in the trial. Due to the short time duration since spreading to sampling, we took a 100mm deep by 300mm wide cross-section of soil. This incorporated two strips of still evident drilling waste in each sample, which was thoroughly mixed prior testing by Hill Laboratories.
We consider this to be a very fair representative sample of the affected soil, and will retest within the next 12 months once the material has broken down by bioremediation.

Several months after application, we have observed varying changes in pasture health relative to application rates. It was noted that a light application rate gave significant improvements in pasture plant health compared to untreated areas.
The dairy farm manager was very pleased with these results, mainly attributed to the high amounts of minerals contained in the ground up rock from deep beneath the earth. We note that the pasture samples analysed show good levels of selenium and other minerals possibly absent in chemical fertilisers.

NO.	MUD TYPE	WELL NAME	APPLICATION DATE	SOLID M3	LIQUID M3	EASTING	NORTHING	AREA /HA
RED 1	SBM	MANAIA	31.3.2011		40	1702844.3067	5652779.6369	2.50
18	SBM/WBM	KA 20	07.4.2014	229	32	1702094.895	5651953.036	5.10
21	SBM/WBM	KA 20	31.7.2014	220	105	1701749.885	5650673.564	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		1701336.229	5650874.282	3.40
32	SBM/WBM LIQUID	K1A	17.1.2011		40	1701371.6464	5651757.2574	3.40
34	LIQUID	K1A	18.2.2011	110		1701438.3514	5650561.4748	3.10
34	SBM/WBM	KA 20	01.8.2014	175		1701436.3514	5651561.4748	3.10
35	LIQUID	K1A	10.3.2011		190	1701455.8797	5651475.0048	3.00
40	SBM/WBM	K3E	11.3.2010	130		1701492.1158	5651271.2579	3.20
41	SBM/WBM	K3E	11.3.2010	130		1701502.736	5651096.724	3.20
42	SBM/WBM	K1A	7.4.2010		295	1701581.4211	5651294.6354	3.80
43	SBM/WBM	K3E	11.3.2010	120		1701545.8045	5650992.3507	3.35
44	SBM/WBM	K3E	22.2.2010	120		1701557.7698	5650909.443	3.50
47	SBM/WBM	K3E	12.3.2011	140		1700861.7859	5651372.4641	4.70
48	SBM/WBM LIQUID	K1A	12.4.2010	170	240	1700945.0284	5651029.9243	5.96
49	SBM/WBM	K3E	22.2.2010	100		1700978.1650	5651143.14	3.20
50	SBM/WBM	K3E	15.3.2011	160		1702004.6929	5652066.7448	5.00
78	SBM	MANAIA	2.3.2011	130		1700840.4093	5652946.4908	3.15
79	SBM	MANAIA	23.3.2011	50	50	1701021.3305	5653041.987	3.30
81	SBM	OOBMZA	1.4.2011	80	90	1701449.729	5652706.3823	3.00
83	SBM	MANAIA	28.3.2011	120		1701420.905	5652836.1608	3.25
84	SBM	MANAIA	28.3.2011	110		1701400.5436	5652943.2301	3.45
86	LIQUID	BELUGA 1	21.05.2012		130	1701324.9500	5653143.5600	3.56
86	SBM	BELUGA 1	22.05.2012	50		1701324.9500	5653140.5600	3.56
86	SBM	BELUGA 1	23.05.2012	80		1701324.9500	5653140.5600	3.56
88	SBM	BELUGA 1	02.04.2012	70		1700880.2617	5652751.1995	4.50
88	SBM	BELUGA 1	05.04.2012	60		1700880.2617	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	1700894.5895	5653415.3953	1.30
104	LIQUID	BELUGA 1	21.03.2012		130	1701801.7281	5653430.4192	1.80
104	LIQUID	BELUGA 1	22.03.2012		30	1701801.7281	5653430.4192	1.80
104	LIQUID	BELUGA 1	26.03.2012		145	1701801.7281	5653430.4192	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
105	SBM	MR2P1	30.3.2010	120		1702086.3883	5653451.5115	1.90
106	SBM	MR2P1	30.3.2010	100		1702185.2250	5653468.9424	1.80
109	LIQUID	MANAIA	9.9.2010		20	1702181.9172	5653079.8321	3.10
110	SBM/WBM	MANAIA	2.6.2010		380	1702151.6533	5653086.4314	3.50
111	SBM	MANAIA	28.3.2011	120		1702129.2835	5653302.9084	2.90
112	SBM/WBM	BELUGA 1	17.6.2010		430	1702405.5903	5653403.0984	3.95
113	SBM/WBM	MANGAHEWA A/ MK3PB/MK4PA/M KOPUZ	23.4.2009	660		1702366.1241	5653356.1796	7.20
115	SBM/WBM	BELUGA 1	11.2.2010		190	1702713.8302	5653586.2564	2.30
133	SBM/WBM	BELUGA 1				1702547.5995	5653291.296	0.72
134	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702579.6848	5653306.86	1.30
135	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702585.413	5653298.2808	1.55
136	SBM	MR1P7 / MR2P1	8.9.2010	90	190	1702142.6469	5653242.1715	3.80
138	LIQUID	BELUGA 1	18.6.2010		370	1702646.6426	5653461.9077	3.50
139	SBM/WBM	KA 20	26.2.2014	22		1702588.453	5650787.447	3.00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.520	5650609.139	2.10
141	SBM/WBM	KA 19	03.3.2014	296	265	1702692.770	5650472.580	2.65
142	SBM	MANAIA	28.3.2011	150	150	1702742.880	5652416.2866	3.10
142	SBM/WBM	KA 19	20.3.2014	180	159	1702742.880	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

DRAWN BY	BP	18-08-2014
PROJECT No.	103	
LOCATION	SURREY ROAD	
SCALE	1 : 1500	

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

DRAWING No. MI SWACO 101 REV 3

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1222420 SPv2
Contact:	Ross Henry	**Date Registered:**	11-Jan-2014
	C/- Schlumberger Seaco Inc	**Date Reported:**	07-Mar-2014
	PO Box 7100	**Quote No:**	56425
	Fitzroy	**Order No:**	978
	NEW PLYMOUTH 4341	**Client Reference:**	
		Submitted By:	Ross Henry

Amended Report

This report replaces an earlier report issued on the 20 Jan 2014 at 4:24 pm
Following a client query [QOWQ52120], the total nitrogen and chloride analyses were added (missed at sample registration) and the client name has been updated.

Sample Type: Sludge

Sample Name:		Surrey Rd Cell 1 08-Jan-2014				
Lab Number:		1222420.1				
Individual Tests						
Dry Matter	g/100g as rcvd	39	-	-	-	-
Chloride*	mg/kg as rcvd	1,350	-	-	-	-
Total Nitrogen*	g/100g as rcvd	0.18	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	230	-	-	-	-
C10 - C14	mg/kg dry wt	93,000	-	-	-	-
C15 - C36	mg/kg dry wt	181,000	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	270,000	-	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

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

Sample Type: Sludge

Test	Method Description	Default Detection Limit	Sample No
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1
Total Chloride in Oil*	Determination using Titraclor-c, used oil quantification kit.	50 mg/kg as rcvd	1
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g as rcvd	1

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1237350	SPv1
Contact:	Ross Henry	**Date Registered:**	19-Feb-2014	
	C/- Schlumberger Seaco Inc	**Date Reported:**	07-Mar-2014	
	PO Box 7100	**Quote No:**	34979	
	Fitzroy	**Order No:**	1049	
	NEW PLYMOUTH 4341	**Client Reference:**	Cell 2 Pre-Farm	
		Submitted By:	Ross Henry	

Sample Type: Sludge

Sample Name:		Pre-Landfarm Surrey Road Cell 2 17-Feb-2014 2:00 pm				
Lab Number:		1237350.1				
Individual Tests						
Dry Matter	g/100g as rcvd	43	-	-	-	-
Chloride*	mg/kg as rcvd	1,320	-	-	-	-
Total Nitrogen*	g/100g as rcvd	0.23 #1	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	550	-	-	-	-
C10 - C14	mg/kg dry wt	136,000	-	-	-	-
C15 - C36	mg/kg dry wt	290,000	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	420,000	-	-	-	-

Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample. The average of the results of the replicate analyses has been reported.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

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

Sample Type: Sludge

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1
Total Chloride in Oil*	Determination using Titraclor-c, used oil quantification kit.	50 mg/kg as rcvd	1
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g as rcvd	1

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1270635	SPv1
Contact:	Ruka Te Moana	**Date Registered:**	03-May-2014	
	C/- Schlumberger Seaco Inc	**Date Reported:**	19-May-2014	
	PO Box 7100	**Quote No:**	31151	
	Fitzroy	**Order No:**	1196	
	NEW PLYMOUTH 4341	**Client Reference:**	Stormwater Analysis	
		Submitted By:	Ruka Te Moana	

Sample Type: Aqueous

Sample Name:	Surrey RD SW 3 Upstream 29-Apr-2014	Surrey RD SW 3 Downstream 29-Apr-2014			
Lab Number:	1270635.1	1270635.2			
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	-	-	-	-
pH pH Units	6.6	-	-	-	-
Total Suspended Solids g/m³	12	-	-	-	-
Sample Temperature* °C	20	-	-	-	-
Total Ammoniacal-N g/m³	0.28	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	2	4	-	-	-
Oil and Grease g/m³	< 5 #1	-	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	0.08	-	-	-	-
Combined Chlorine g/m³	< 0.08	-	-	-	-

Analyst's Comments

#1 There was insufficient sample to perform the oil and grease analysis on this sample . Therefore a smaller aliquot was taken prior to analysis, resulting in a detection limit higher than that normally achieved.

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.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m³	1
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.10 °C	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-2
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1

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ANALYSIS REPORT

Client:	MI Swaco	**Lab No:**	1200160	SPv1
Contact:	Ross Henry	**Date Registered:**	07-Nov-2013	
	C/- MI Swaco	**Date Reported:**	15-Nov-2013	
	C/- MI-NZ Limited	**Quote No:**	31151	
	PO Box 7100	**Order No:**	849	
	Fitzroy	**Client Reference:**	Surrey Road Landfarm SW3	
	NEW PLYMOUTH 4341	**Submitted By:**	Ross Henry	

Sample Type: Aqueous

Sample Name:	Drain 05-Nov-2013 12:00 pm	Downstream Creek 05-Nov-2013 12:00 pm	Upstream 05-Nov-2013 12:00 pm		
Lab Number:	1200160.1	1200160.2	1200160.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	< 0.010	-	-	-
pH pH Units	7.1	7.2	-	-	-
Total Suspended Solids g/m³	18	7	-	-	-
Sample Temperature* °C	20	20	-	-	-
Total Ammoniacal-N g/m³	0.42	0.078	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	4	< 2	< 2	-	-
Oil and Grease g/m³	< 4	< 4	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	< 0.05	< 0.05	-	-	-
Combined Chlorine g/m³	< 0.08	< 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	Samples
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	1-2
Chlorine, Free & Combined	DPD Colorimetric	-	1-2
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1-2
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	1-2
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.10 °C	1-2
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	1-2
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 22nd ed. 2012.	2 g O_2/m³	1-3
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1-2

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1294654	SPv1
Contact:	Ross Henry	**Date Registered:**	03-Jul-2014	
	C/- Schlumberger Seaco Inc	**Date Reported:**	15-Jul-2014	
	PO Box 7100	**Quote No:**	31151	
	Fitzroy	**Order No:**	1351	
	NEW PLYMOUTH 4341	**Client Reference:**		
		Submitted By:	Ross Henry	

Sample Type: Aqueous

Sample Name:		Surrey Rd SW3 30-Jun-2014 1:00 pm	Surrey Rd Upstream 30-Jun-2014 1:00 pm	Derby Rd SW2 30-Jun-2014 2:00 pm	Derby Rd Upstream 30-Jun-2014 2:00 pm	
Lab Number:		1294654.1	1294654.2	1294654.3	1294654.4	
Individual Tests						
pH	pH Units	6.8	-	6.7	-	-
Total Suspended Solids	g/m³	13	-	6	-	-
Free Ammonia*	g/m³ at 20°C	< 0.010	-	< 0.010	-	-
Total Ammoniacal-N	g/m³	0.27	-	< 0.010	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	5	< 2	< 2	< 2	-
Oil and Grease	g/m³	< 5 #1	-	< 5 #1	-	-
Chlorine, Free & Combined						
Free Chlorine	g/m³	0.11	-	< 0.05	-	-
Combined Chlorine	g/m³	< 0.08	-	< 0.08	-	-

Analyst's Comments

#1 There was insufficient sample to perform the oil and grease analysis on samples 1294654/1&3. Therefore a smaller aliquot was taken prior to analysis, resulting in a detection limit higher than that normally achieved for these samples.

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
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	1, 3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1, 3
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1, 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	1, 3
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 20°C	1, 3
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, 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	1-4
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, 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.

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

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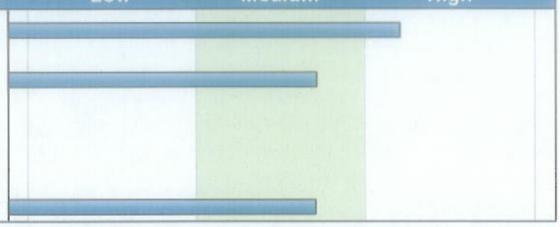
ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	11-Jul-2014
		Date Reported:	17-Jul-2014
		Quote No:	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

Sample Name: Paddock 18 **Lab Number:** 1297887.1
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.5	5.8 - 6.3
Volume Weight	g/mL	0.89	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	12	
Total Nitrogen	%	0.51	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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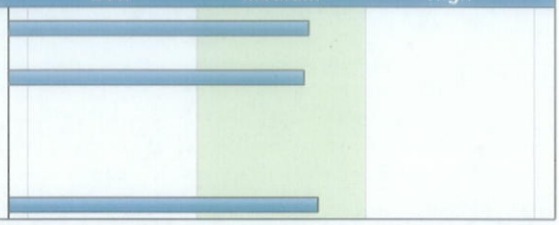
ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	11-Jul-2014
		Date Reported:	17-Jul-2014
		Quote No:	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

Sample Name: Paddock 30 **Lab Number:** 1297887.2
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.1	5.8 - 6.3
Volume Weight	g/mL	0.85	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	< 10	
Total Nitrogen	%	0.52	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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Hamilton 3240, New Zealand

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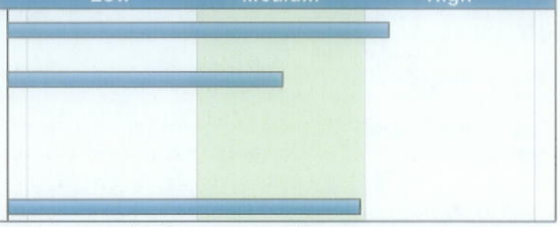
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887	shpv1
Address:	PO Box 7100	**Date Registered:**	11-Jul-2014	
	Fitzroy	**Date Reported:**	17-Jul-2014	
	NEW PLYMOUTH 4341	**Quote No:**	34979	
		Order No:	1375	
		Client Reference:		
Phone:	06 755 0037	**Submitted By:**	Ross Henry	

Sample Name: Paddock 31 **Lab Number:** 1297887.3
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.4	5.8 - 6.3
Volume Weight	g/mL	0.80	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	< 10	
Total Nitrogen	%	0.59	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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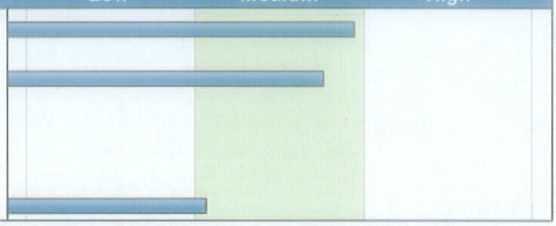
ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	11-Jul-2014
		Date Reported:	17-Jul-2014
		Quote No:	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

Sample Name: Paddock 140 **Lab Number:** 1297887.4
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.3	5.8 - 6.3
Volume Weight	g/mL	0.90	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	13	
Total Nitrogen	%	0.32	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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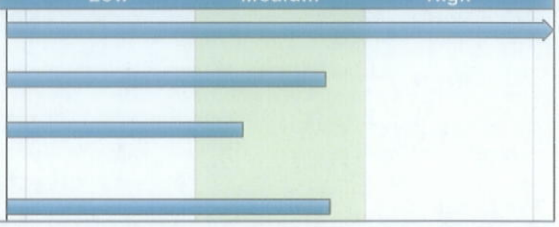
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	11-Jul-2014
		Date Reported:	17-Jul-2014
		Quote No:	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

Sample Name: Paddock 141 **Lab Number:** 1297887.5
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	8.0	5.8 - 6.3
Volume Weight	g/mL	0.91	0.60 - 1.00
Soluble Salts (Field)	%	0.12	0.05 - 0.30
Chloride	mg/kg	231	
Total Nitrogen	%	0.54	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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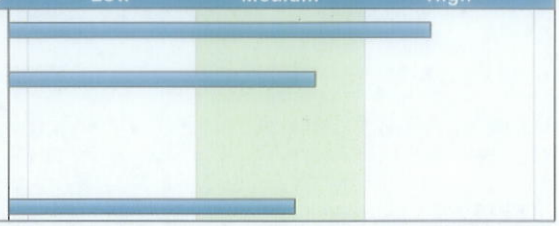
ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100	**Date Registered:**	11-Jul-2014
	Fitzroy	**Date Reported:**	17-Jul-2014
	NEW PLYMOUTH 4341	**Quote No:**	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

Sample Name: Paddock 142 **Lab Number:** 1297887.6
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.7	5.8 - 6.3
Volume Weight	g/mL	0.88	0.60 - 1.00
Soluble Salts (Field)	%	< 0.05	0.05 - 0.30
Chloride	mg/kg	< 10	
Total Nitrogen	%	0.48	0.30 - 0.60



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1297887 shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	11-Jul-2014
		Date Reported:	17-Jul-2014
		Quote No:	34979
		Order No:	1375
		Client Reference:	
Phone:	06 755 0037	**Submitted By:**	Ross Henry

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-6
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-6
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-6
Total Nitrogen	Dumas combustion.	0.04 %	1-6
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35.	0.05 %	1-6
Chloride	Saturated Calcium Sulphate extraction followed by Potentiometric Titration.	10 mg/kg	1-6
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-6

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.

W.M.Homewood

Wendy Homewood
Operations Support - Agriculture Division

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1298215	SPv1
Contact:	Ross Henry	**Date Registered:**	12-Jul-2014	
	C/- Schlumberger Seaco Inc	**Date Reported:**	18-Jul-2014	
	PO Box 7100	**Quote No:**	34979	
	Fitzroy	**Order No:**	137S	
	NEW PLYMOUTH 4341	**Client Reference:**	Soil	
		Submitted By:	Ross Henry	

Sample Type: Soil

Sample Name:		Paddock 18 30-Jun-2014	Paddock 30 30-Jun-2014	Paddock 31 30-Jun-2014	Paddock 140 30-Jun-2014	Paddock 141 30-Jun-2014
Lab Number:		1298215.1	1298215.2	1298215.3	1298215.4	1298215.5
Individual Tests						
Dry Matter	g/100g as rcvd	63	61	59	66	60
Density*	g/mL at 20°C	0.72	0.81	0.80	0.84	0.80
Total Recoverable Barium	mg/kg dry wt	1,930	2,000	3,000	3,500	4,600
Total Recoverable Sodium	mg/kg dry wt	740	640	500	630	620
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	< 2	< 2	2
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.17	0.16	< 0.10	0.21
Total Recoverable Chromium	mg/kg dry wt	7	7	7	6	10
Total Recoverable Copper	mg/kg dry wt	50	40	41	45	33
Total Recoverable Lead	mg/kg dry wt	3.4	6.8	6.1	4.9	9.8
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	2	2	3	2	7
Total Recoverable Zinc	mg/kg dry wt	34	30	29	34	40
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13
Toluene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13
Ethylbenzene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13
m&p-Xylene	mg/kg dry wt	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
o-Xylene	mg/kg dry wt	< 0.13	< 0.13	< 0.14	< 0.12	< 0.13
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.04	< 0.04	0.04	0.03	0.05
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.04	0.04	0.06	0.06	0.07
Benzo[g,h,i]perylene	mg/kg dry wt	0.07	0.08	0.12	0.09	0.14
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Chrysene	mg/kg dry wt	0.05	0.06	0.08	0.10	0.11
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	0.08	0.09	0.13	0.21	0.17
Fluorene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Naphthalene	mg/kg dry wt	< 0.18	< 0.19	< 0.18	< 0.17	< 0.18
Phenanthrene	mg/kg dry wt	0.04	0.07	0.07	0.28	0.16
Pyrene	mg/kg dry wt	0.16	0.18	0.25	0.28	0.32

Sample Type: Soil						
Sample Name:		Paddock 18 30-Jun-2014	Paddock 30 30-Jun-2014	Paddock 31 30-Jun-2014	Paddock 140 30-Jun-2014	Paddock 141 30-Jun-2014
Lab Number:		1298215.1	1298215.2	1298215.3	1298215.4	1298215.5
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 11	< 11	< 11	< 10	< 11
C10 - C14	mg/kg dry wt	30	64	142	1,370	690
C15 - C36	mg/kg dry wt	1,290	1,750	2,200	14,300	10,800
Total hydrocarbons (C7 - C36)	mg/kg dry wt	1,320	1,820	2,400	15,600	11,500

Sample Name:		Paddock 142 30-Jun-2014				
Lab Number:		1298215.6				
Individual Tests						
Dry Matter	g/100g as rcvd	61	-	-	-	-
Density*	g/mL at 20°C	0.88	-	-	-	-
Total Recoverable Barium	mg/kg dry wt	3,500	-	-	-	-
Total Recoverable Sodium	mg/kg dry wt	560	-	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	2	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.17	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	7	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	44	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	6.5	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	3	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	34	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.13	-	-	-	-
Toluene	mg/kg dry wt	< 0.13	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.13	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.3	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.13	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.04	-	-	-	-
Anthracene	mg/kg dry wt	< 0.04	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.05	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.09	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.19	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	-	-	-	-
Chrysene	mg/kg dry wt	0.11	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	-	-	-	-
Fluoranthene	mg/kg dry wt	0.18	-	-	-	-
Fluorene	mg/kg dry wt	< 0.04	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.04	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.18	-	-	-	-
Phenanthrene	mg/kg dry wt	0.10	-	-	-	-
Pyrene	mg/kg dry wt	0.37	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 11	-	-	-	-
C10 - C14	mg/kg dry wt	83	-	-	-	-
C15 - C36	mg/kg dry wt	2,300	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	2,400	-	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

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

Sample Type: Soil

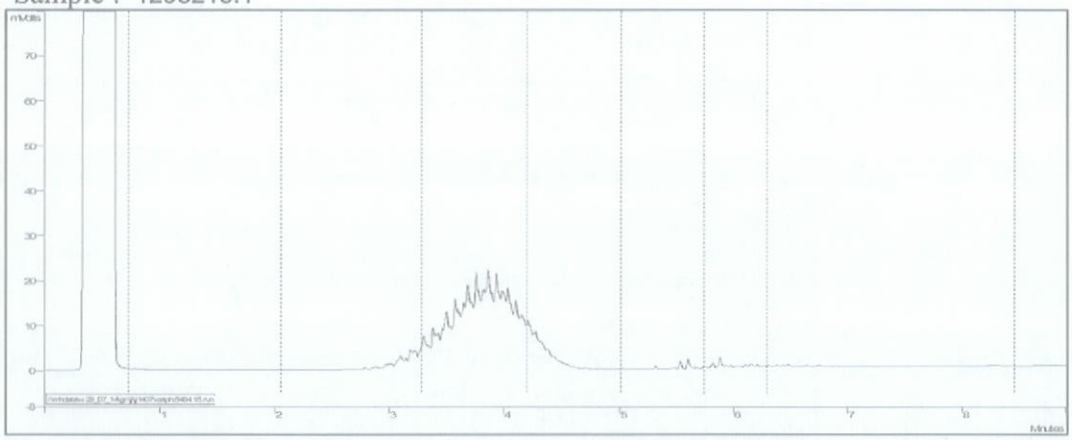
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-6
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,26687,3629]	0.05 - 0.10 mg/kg dry wt	1-6
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1-6
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1-6
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1-6
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-6
Total Recoverable Barium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-6
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-6

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

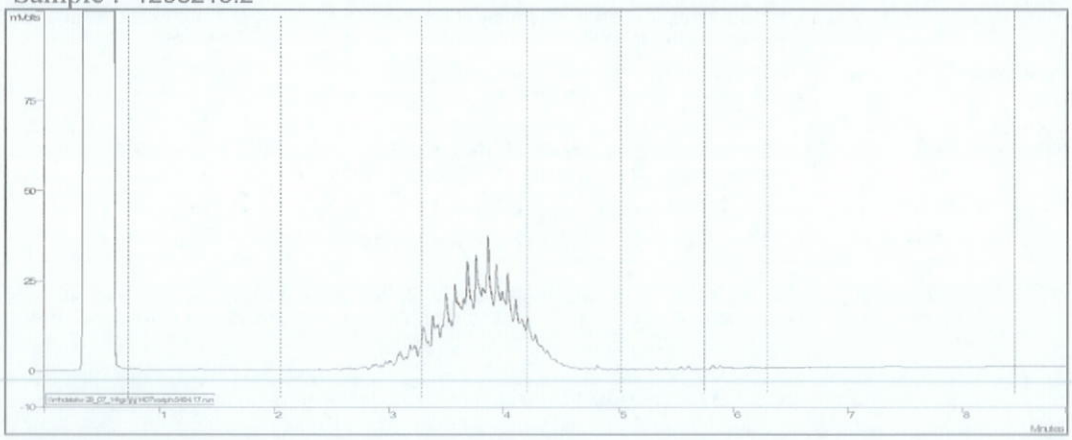
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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

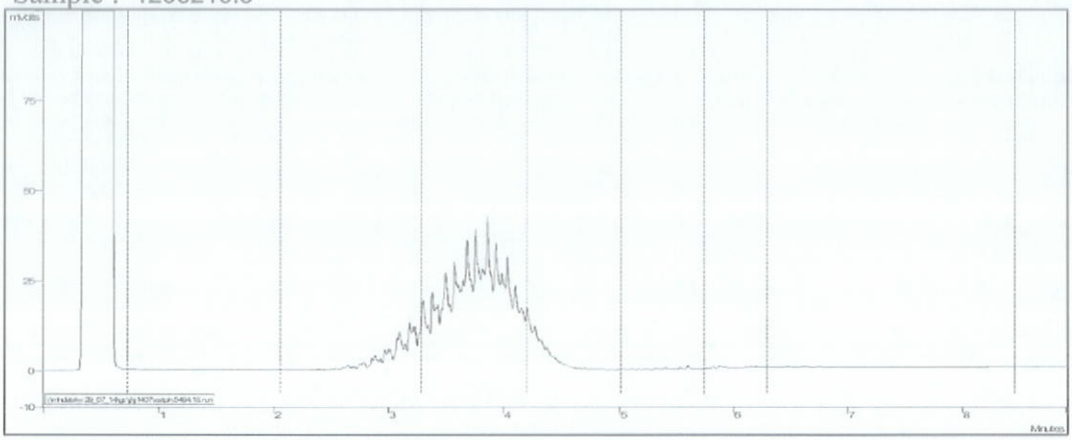
Sample : 1298215.1



Sample : 1298215.2

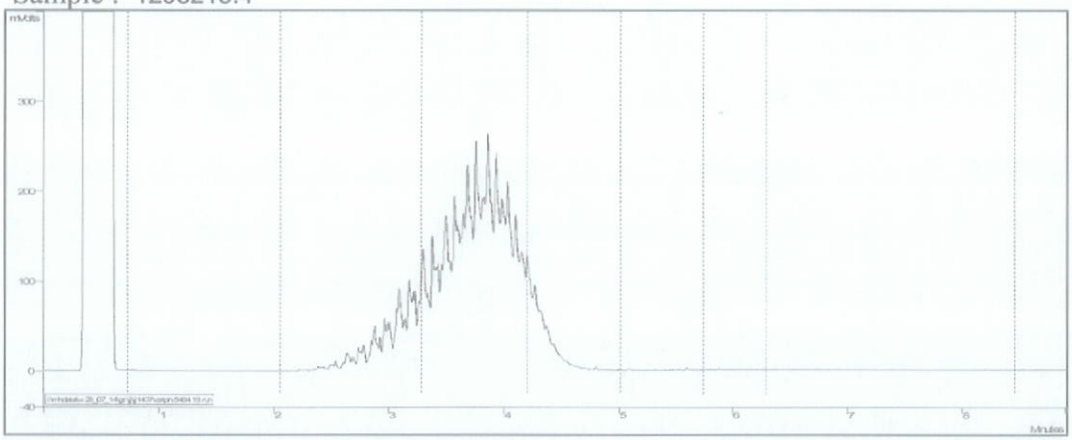


Sample : 1298215.3

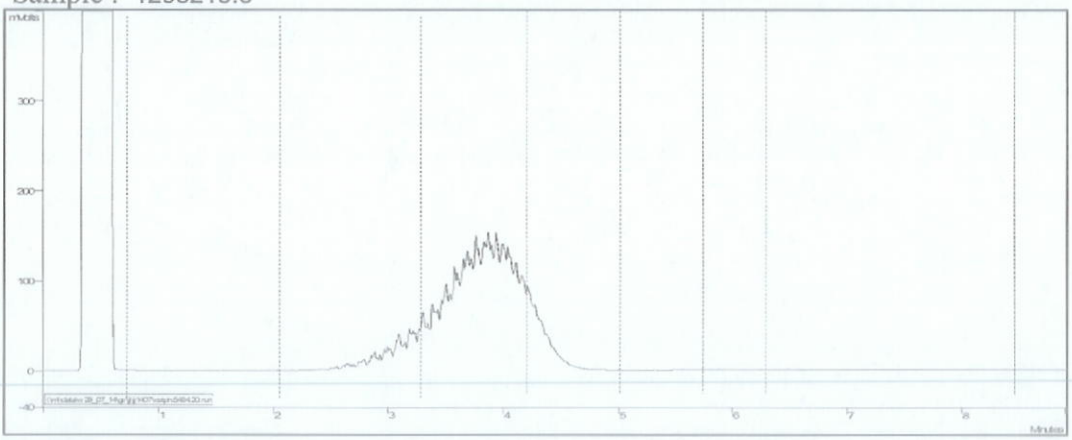


C7 C10 C15 C20 C25 C30 C34 C44

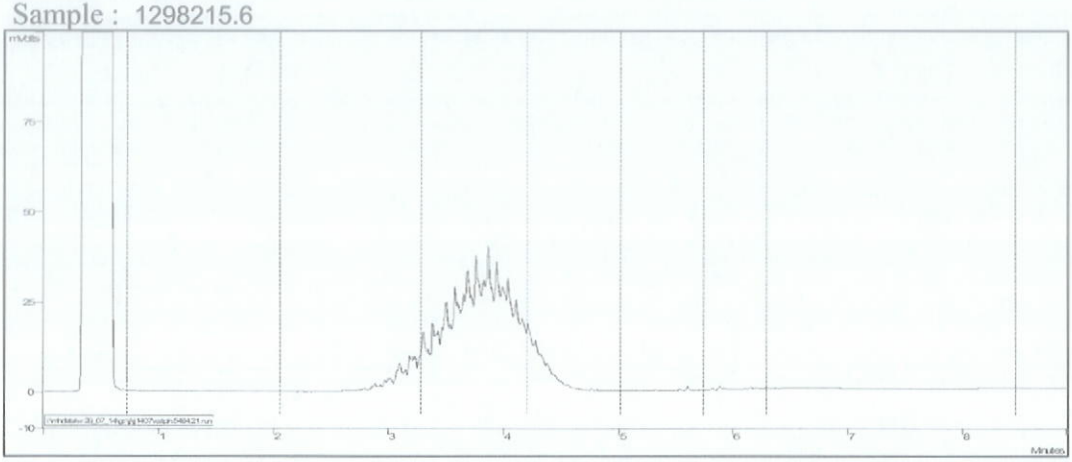
Sample : 1298215.4



Sample : 1298215.5



Sample : 1298215.6



C7 C10 C15 C20 C25 C30 C34 C44

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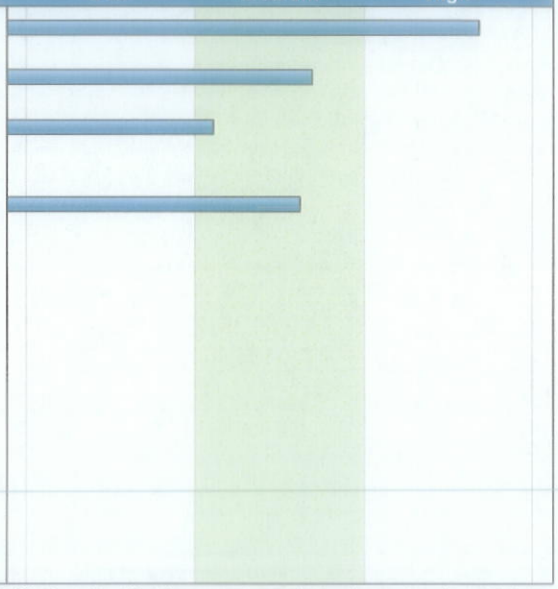
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1309566	shpv1
Address:	PO Box 7100	**Date Registered:**	09-Aug-2014	
	Fitzroy	**Date Reported:**	20-Aug-2014	
	NEW PLYMOUTH 4341	**Quote No:**	34979	
		Order No:	1460	
		Client Reference:	Padock 141 Soil	
Phone:	06 755 0037	**Submitted By:**	Ross Henry	

Sample Name: Paddock 141 04-Aug-2014 **Lab Number:** 1309566.1
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range
pH	pH Units	6.9	5.8 - 6.3
Volume Weight	g/mL	0.88	0.60 - 1.00
Soluble Salts (Field)	%	0.08	0.05 - 0.30
Chloride	mg/kg	135	
Total Nitrogen	%	0.48	0.30 - 0.60
Total Soluble Salts*	mg/L	680	
Electrical Conductivity (Sat Paste)*	mS/cm	1.0	
Nitrate-N (Sat Paste)*	mg/L	< 1	
Ammonium-N (Sat Paste)*	mg/L	4	
Phosphorus (Sat Paste)*	mg/L	< 1	
Potassium (Sat Paste)*	mg/L	136	
Calcium (Sat Paste)*	mg/L	78	
Magnesium (Sat Paste)*	mg/L	6	
Sodium (Sat Paste)*	mg/L	22	
Sodium Absorption Ratio*		0.7	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1309566	shpv1
Address:	PO Box 7100 Fitzroy NEW PLYMOUTH 4341	**Date Registered:**	09-Aug-2014	
		Date Reported:	20-Aug-2014	
		Quote No:	34979	
		Order No:	1460	
		Client Reference:	Padock 141 Soil	
Phone:	06 755 0037	**Submitted By:**	Ross Henry	

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1
Total Nitrogen	Dumas combustion.	0.04 %	1
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35.	0.05 %	1
Chloride	Saturated Calcium Sulphate extraction followed by Potentiometric Titration.	10 mg/kg	1
Total Soluble Salts*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	1.0 mg/L	1
Electrical Conductivity (Sat Paste)*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	0.1 mS/cm	1
Nitrate-N (Sat Paste)*	Saturated Paste extraction followed by Salicylate colorimetry.	1 mg/L	1
Ammonium-N (Sat Paste)*	Saturated Paste extraction followed by Berthelot colorimetry.	1 mg/L	1
Phosphorus (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1
Potassium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1
Calcium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1
Magnesium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1
Sodium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1
Sodium Absorption Ratio (SAR)*	Calculation from the sodium, calcium and magnesium determined on a Saturated Paste extract.	0.2	1
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1

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

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

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Fiona Calvert NZCS
Client Services Manager - Agriculture Division

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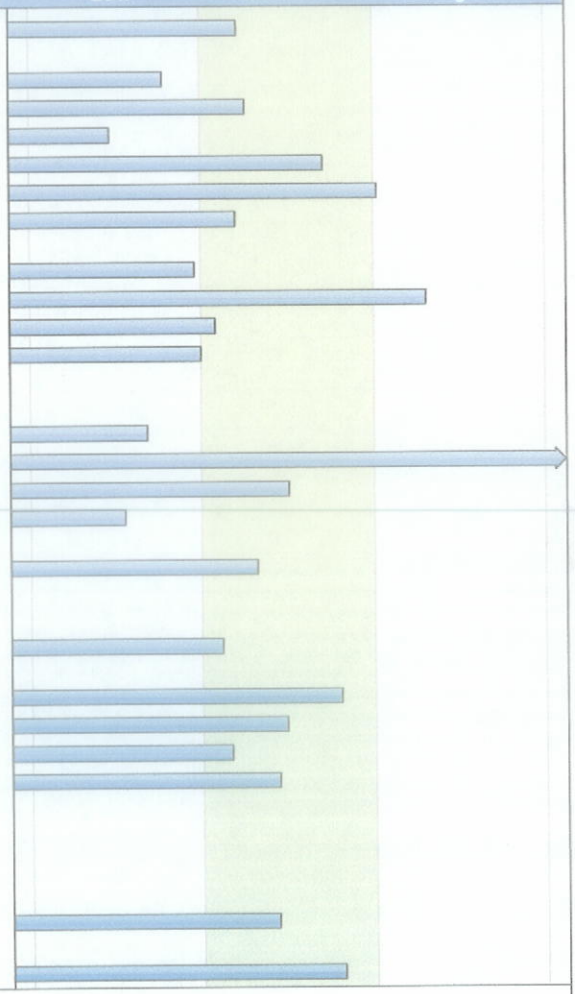
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 140 B **Lab Number:** 1266477.1
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Medium Range
Nitrogen*	%	4.2	4.0 - 5.0
Phosphorus	%	0.35	0.38 - 0.45
Potassium	%	2.6	2.5 - 3.0
Sulphur	%	0.25	0.30 - 0.40
Calcium	%	0.88	0.60 - 1.00
Magnesium	%	0.30	0.20 - 0.30
Sodium	%	0.180	0.150 - 0.300
Iron	mg/kg	98	100 - 250
Manganese	mg/kg	230	60 - 150
Zinc	mg/kg	32	30 - 50
Copper	mg/kg	10	10 - 12
Boron	mg/kg	13	
Molybdenum	mg/kg	0.41	0.50 - 1.2
Cobalt	mg/kg	0.35	0.10 - 0.20
Selenium	mg/kg	0.12	0.08 - 0.15
Iodine	mg/kg	0.24	0.40 - 0.80
Chloride*	%	0.97	0.30 - 2.4
Nitrate-N	mg/kg	< 100	
Dry Matter*	%	14.1	12.0 - 30.0
Crude Protein*	%DM	28.0	20.0 - 30.0
Acid Detergent Fibre*	%DM	24.9	20.0 - 30.0
Neutral Detergent Fibre*	%DM	32.6	30.0 - 45.0
Ash*	%DM	10.1	7.0 - 14.0
Organic Matter*	%DM	89.9	
Soluble Sugars*	%DM	9.5	
Starch*	%DM	0.8	
Crude Fat*	%DM	3.9	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	71.5	65.0 - 80.0
Metabolisable Energy*	MJ/kgDM	11.4	9.0 - 12.0



Non Structural Carbohydrate*	%DM	25.4	
OMD in-vivo*	%DM	79.6	
Grass Staggers Index*	me	1.0	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		15	(<10 recommended, >20 increased risk)
Ca/P Ratio*		2.5	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	324	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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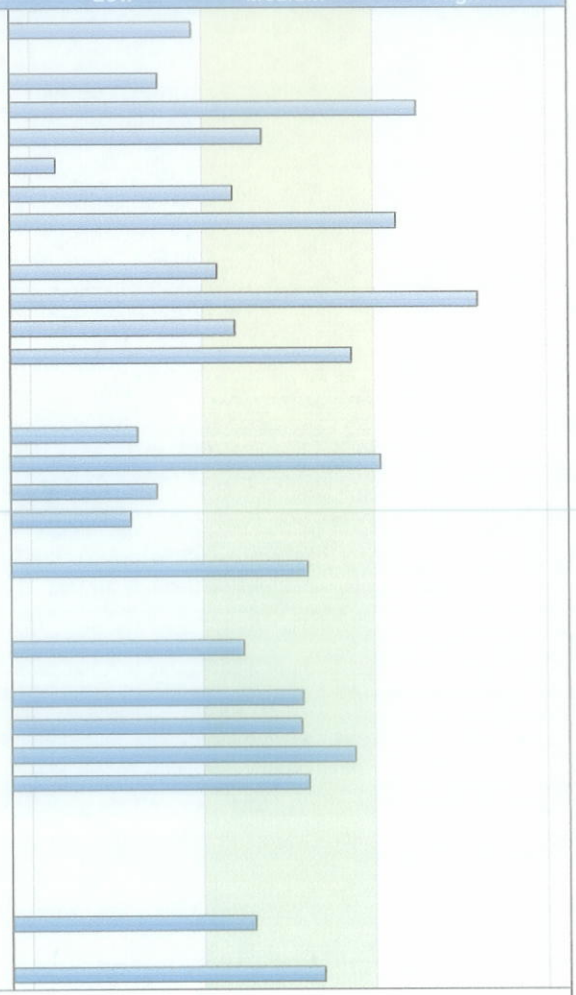
ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 140 T **Lab Number:** 1266477.2
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Medium Range
Nitrogen*	%	3.9	4.0 - 5.0
Phosphorus	%	0.35	0.38 - 0.45
Potassium	%	3.3	2.5 - 3.0
Sulphur	%	0.34	0.30 - 0.40
Calcium	%	0.34	0.60 - 1.00
Magnesium	%	0.22	0.20 - 0.30
Sodium	%	0.367	0.150 - 0.300
Iron	mg/kg	113	100 - 250
Manganese	mg/kg	300	60 - 150
Zinc	mg/kg	34	30 - 50
Copper	mg/kg	12	10 - 12
Boron	mg/kg	4	
Molybdenum	mg/kg	0.38	0.50 - 1.2
Cobalt	mg/kg	0.20	0.10 - 0.20
Selenium	mg/kg	0.06	0.08 - 0.15
Iodine	mg/kg	0.25	0.40 - 0.80
Chloride*	%	1.59	0.30 - 2.4
Nitrate-N	mg/kg	831	
Dry Matter*	%	16.2	12.0 - 30.0
Crude Protein*	%DM	25.8	20.0 - 30.0
Acid Detergent Fibre*	%DM	25.8	20.0 - 30.0
Neutral Detergent Fibre*	%DM	43.3	30.0 - 45.0
Ash*	%DM	11.3	7.0 - 14.0
Organic Matter*	%DM	88.7	
Soluble Sugars*	%DM	8.5	
Starch*	%DM	< 0.5	
Crude Fat*	%DM	3.6	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	69.4	65.0 - 80.0
Metabolisable Energy*	MJ/kgDM	11.1	9.0 - 12.0



Non Structural Carbohydrate*	%DM	16.0	
OMD in-vivo*	%DM	78.3	
Grass Staggers Index*	me	2.4	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		9	(<10 recommended, >20 increased risk)
Ca/P Ratio*		1.0	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	350	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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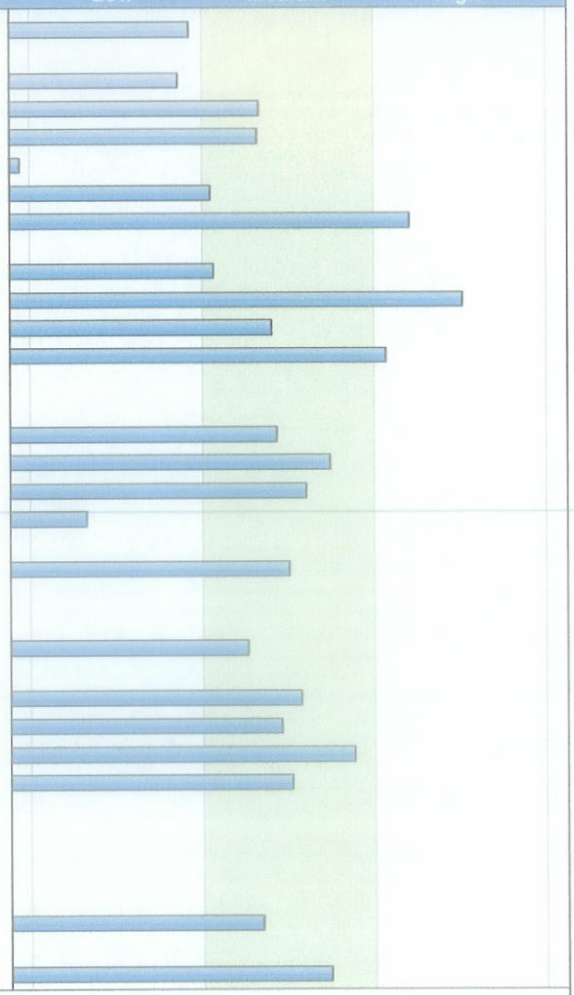
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 139 T **Lab Number:** 1266477.3
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Medium Range
Nitrogen*	%	3.9	4.0 - 5.0
Phosphorus	%	0.36	0.38 - 0.45
Potassium	%	2.7	2.5 - 3.0
Sulphur	%	0.33	0.30 - 0.40
Calcium	%	0.28	0.60 - 1.00
Magnesium	%	0.20	0.20 - 0.30
Sodium	%	0.404	0.150 - 0.300
Iron	mg/kg	110	100 - 250
Manganese	mg/kg	280	60 - 150
Zinc	mg/kg	38	30 - 50
Copper	mg/kg	13	10 - 12
Boron	mg/kg	3	
Molybdenum	mg/kg	0.80	0.50 - 1.2
Cobalt	mg/kg	0.17	0.10 - 0.20
Selenium	mg/kg	0.12	0.08 - 0.15
Iodine	mg/kg	0.16	0.40 - 0.80
Chloride*	%	1.36	0.30 - 2.4
Nitrate-N	mg/kg	242	
Dry Matter*	%	16.7	12.0 - 30.0
Crude Protein*	%DM	25.7	20.0 - 30.0
Acid Detergent Fibre*	%DM	24.6	20.0 - 30.0
Neutral Detergent Fibre*	%DM	43.2	30.0 - 45.0
Ash*	%DM	10.6	7.0 - 14.0
Organic Matter*	%DM	89.4	
Soluble Sugars*	%DM	9.9	
Starch*	%DM	0.6	
Crude Fat*	%DM	3.6	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	70.2	65.0 - 80.0
Metabolisable Energy*	MJ/kgDM	11.2	9.0 - 12.0



Non Structural Carbohydrate*	%DM	16.8	
OMD in-vivo*	%DM	78.5	
Grass Staggers Index*	me	2.2	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		7	(<10 recommended, >20 increased risk)
Ca/P Ratio*		0.8	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	270	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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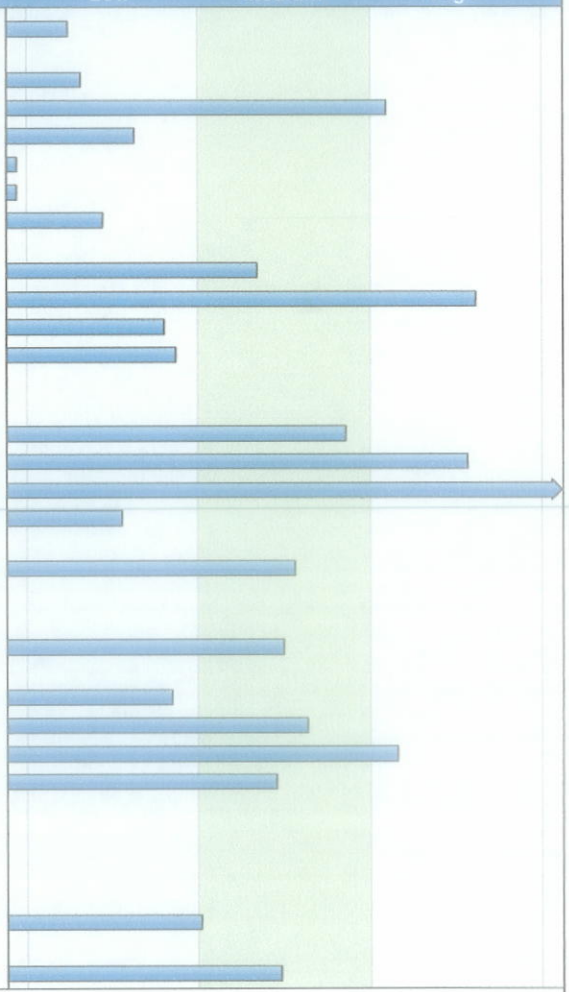
ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 139 B **Lab Number:** 1266477.4
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Medium Range
Nitrogen*	%	2.9	4.0 - 5.0
Phosphorus	%	0.29	0.38 - 0.45
Potassium	%	3.1	2.5 - 3.0
Sulphur	%	0.26	0.30 - 0.40
Calcium	%	0.30	0.60 - 1.00
Magnesium	%	0.12	0.20 - 0.30
Sodium	%	0.095	0.150 - 0.300
Iron	mg/kg	152	100 - 250
Manganese	mg/kg	300	60 - 150
Zinc	mg/kg	28	30 - 50
Copper	mg/kg	9	10 - 12
Boron	mg/kg	2	
Molybdenum	mg/kg	1.10	0.50 - 1.2
Cobalt	mg/kg	0.26	0.10 - 0.20
Selenium	mg/kg	0.43	0.08 - 0.15
Iodine	mg/kg	0.24	0.40 - 0.80
Chloride*	%	1.48	0.30 - 2.4
Nitrate-N	mg/kg	< 100	
Dry Matter*	%	21.0	12.0 - 30.0
Crude Protein*	%DM	18.9	20.0 - 30.0
Acid Detergent Fibre*	%DM	26.3	20.0 - 30.0
Neutral Detergent Fibre*	%DM	46.6	30.0 - 45.0
Ash*	%DM	10.2	7.0 - 14.0
Organic Matter*	%DM	89.8	
Soluble Sugars*	%DM	9.5	
Starch*	%DM	0.9	
Crude Fat*	%DM	3.5	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	65.3	65.0 - 80.0
Metabolisable Energy*	MJ/kgDM	10.4	9.0 - 12.0



Non Structural Carbohydrate*	%DM	20.8	
OMD in-vivo*	%DM	72.7	
Grass Staggers Index*	me	3.2	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		33	(<10 recommended, >20 increased risk)
Ca/P Ratio*		1.0	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	257	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Analyst's Comments

Samples 1-4 Comment:
The nutrient ratio indices have been calculated to assist in evaluating the suitability of this sample as a dairy feed. Although based on published calculations, they should be used with caution, as metabolic disorders can be induced by a multitude of factors, and not just these nutrient ratios alone. For further details of the calculations, please contact this laboratory. Note that the nutrient balances and indices are calculated on the basis that the pasture/forage tested is the total animal diet. These may not be appropriate where additional supplements are included in the animal diet.

Samples 1-4 Comment:
The medium range for Dry Matter% shown above is for fresh samples. If the sample has been cut and wilted prior to sampling, then higher DM% levels will result. Typical DM% values range from:
12-15% (spring); 15-20% (summer); 20-30% (summer dry); 13-18% (aut/winter); above 30% (wilted herbage for silage/balage).

Samples 1-4 Comment:
Pastures and Feeds with Nitrate-N levels below 1000mg/kg are generally safe to feed.
If results are wanted as Nitrate (rather than Nitrate-N) then use the following equation to convert:
Nitrate-N (mg/kg) x 4.427 x 0.0001 = Nitrate (%). Please refer to Hill Laboratories Technical Note - Nitrate-Nitrogen in Pasture and Stock Feeds for further information.

Samples 1-4 Comment:
The medium ranges shown are the higher of either the minimum requirement for lush grass growth or animal nutritional requirements fed on an 'ad-lib' basis.

Samples 1-4 Comment:
The boron level in mixed herbage is especially difficult to interpret. This is because grasses typically have 5 - 10 mg/kg and clover 18 - 25 mg/kg, making the mixed herbage B level very dependent upon the relative proportions of grass and clover in the sample. It is further complicated by the natural seasonal trend of low levels of boron during winter/spring c.f. higher levels in summer/autumn. As a consequence, we no longer provide a graphical interpretation for B in mixed herbage. A clover-only sample is recommended for monitoring boron status in pasture.

Samples 1-4 Comment:
The starch analysis is not a precise test at low levels (0 - 10%). Low levels of starch reported are therefore not reliable and must be interpreted with caution.

Samples 1-4 Comment:
Low Iodine has been linked to reduced survival rates of new-born lambs and calves, as well as reduced conception rates and milk production in cows and ewes. This may happen where clinical 'goitre' symptoms are not observed.

Samples 1-4 Comment:
The medium range guidelines shown in the histogram report relate to sampling protocols as per Hill Laboratories' crop guides and are based on reference values where these are published. Results for samples collected at different growth stages or from different plant parts than those described in the crop guide should be interpreted with caution.

Samples 1-4 Comment:
Iron levels greater than 350 mg/kg indicate some soil contamination is present on the herbage sample. This may result in an elevated cobalt level due to soil containing significantly higher levels of cobalt than herbage.

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

SUMMARY OF METHODS

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

Sample Type: Plant

Test	Method Description	Default Detection Limit	Sample No
Crude Fat*	Estimated by NIR, calibration based on Petroleum Spirit extraction by Ankom auto analyser, AOCS Official Procedure AM-5-04. Reported on a Dry Matter basis.	0.5 %	1-4
Sample Registration*	Samples were registered according to instructions received.	-	1-4
Plant Prep (Dry & Grind)*	Oven dried at 62°C overnight and ground to pass through a 1.0mm screen. Analytical results are reported from this sample fraction and are not corrected for residual moisture (typically 5%), unless units denoted as %DM.	-	1-4
Nitrogen*	Estimated by NIR, calibration based on N by Dumas combustion. Result not corrected for residual moisture (typically 5%).	0.1 %	1-4
Phosphorus	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Potassium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.1 %	1-4
Sulphur	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Calcium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Magnesium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Sodium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.002 %	1-4
Iron	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	5 mg/kg	1-4
Manganese	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	3 mg/kg	1-4
Zinc	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	2 mg/kg	1-4
Copper	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	1 mg/kg	1-4
Boron	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	1 mg/kg	1-4
Molybdenum	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.02 mg/kg	1-4
Cobalt	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.01 mg/kg	1-4
Selenium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.01 mg/kg	1-4
Iodine	TMAH extraction followed by ICP-MS.	0.05 mg/kg	1-4
Chloride*	Estimated by NIR, calibration based on 2% acetic acid extraction, potentiometric titration.	0.05 %	1-4
Nitrate-N	2% acetic acid extraction followed by Salicylate colorimetry or Cd reduction followed by NED colorimetry.	100 mg/kg	1-4
Dry Matter*	Weight Loss on drying at 105°C for 24 hours. (Silage corrected for loss of volatiles).	0.5 %	1-4
Crude Protein*	Nitrogen multiplied by 6.25. Reported on DM basis.	0.5 %DM	1-4
Acid Detergent Fibre*	Estimated by NIR (calibration based on ADF by a modified NFTA method). Reported on DM basis.	0.5 %	1-4
Neutral Detergent Fibre*	Estimated by NIR, calibration based on NDF by NFTA method. Reported on DM basis.	0.5 %	1-4
Ash*	Estimated by NIR, calibration based on weight loss after ashing at 600°C for two hours. Reported on DM basis.	0.5 %	1-4
Organic Matter*	Organic Matter is 100 - Ash. Reported on DM basis.	0.5 %DM	1-4

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Type: Plant

Test	Method Description	Default Detection Limit	Sample No
Organic Matter Digestibility (in-vitro)*	Organic Matter Digestibility (OMD) estimated by NIR, calibration based on AFIA (Australian Fodder Industry Association) Pepsin-Cellulase procedure.	1.0 %	1-4
Digestibility of Organic Matter in Dry Matter (DOMD)*	Calculated from Organic Matter Digestibility (OMD) using AFIA (Australian Fodder Industry Association) Standard Equation.	0.5 %	1-4
Metabolisable Energy*	Calculated from Dry Organic Matter Digestibility (DOMD) using AFRC and Lincoln University standard formulae.	0.5 MJ/kgDM	1-4
Soluble Sugars*	Estimated by NIR, calibration based on an 80:20 ethanol:water extraction and colorimetric determination. Reported on DM basis.	0.5 %	1-4
Starch*	Estimated by NIR, calibration based on Enzymic Hydrolysis of Starch. Reported on DM basis.	0.5 %	1-4
OMD in-vivo*	Organic Matter Digestibility in-vivo (OMD in-vivo) determined using AFIA (Australian Fodder Industry Association) in vitro Pepsin-Cellulase procedure and derived as in-vivo using a linear regression based on calibration samples from Lincoln University. Reported on DM basis.	1.0 %DM	1-4
Non Structural Carbohydrate*	NSC = 100 - (CP + Ash + CFat + NDF). Reported on DM basis.	0.5 %DM	1-4

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

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

Shelley Edhouse
Quality Assurance Officer - Agriculture Division

Appendix III

Biomonitoring surveys

To	Job Manager, David Olson
From	Scientific Officer - Freshwater Biology, Brooke Thomas
Document	1385438
Report No	BT021
Date	08 August 2014

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, December 2013

Introduction

This biological survey was the first of two scheduled surveys for the 2013-2014 monitoring period, intended 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 site receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. Unfortunately, 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. The upstream control site was relatively unaffected. This makes temporal comparisons with results difficult, as recovery from the original disturbance and sedimentation may mask any impact from drilling waste disposal activities, if any such impact occurs.

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 standard 'kick-sampling' technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 18 December 2013. 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 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 and discussion

At the time of this late morning survey there was a slow, low flow at all sites. Due to significant upstream iron oxide seepage into this stream, the flow at all sites was grey and cloudy. The stream bed was also affected by this iron oxide seepage, with iron oxide sedimentation being observed at all sites.

Sites 1 and 2 were unshaded at the time of this survey, whereas sites 3 and 4 were completed shaded by overhanging vegetation. Growths of slippery algal mats and patchy filaments were recorded at site 2. Slippery algal mats were recorded at sites 1, 3 and 4.

The substrate at all sites consisted predominantly of boulders, cobbles and gravels, with some silt and sand.

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. The full results from the current survey are presented in Table 3.

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 18 December 2013 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Apr 2013	Median	Range	Apr 2013	Median	Range	Apr 2013
1	8	21	12-33	28	109	87-114	89	6.1	3.2-7.4	3.5
2	8	14	6-27	30	100	80-109	97	3.0	2.0-7.4	4.1
3	8	14	5-19	16	99	88-109	100	4.2	2.5-5.9	4.9
4	8	16	6-24	20	92	73-104	99	3.9	2.1-6.8	5.0

Table 3 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 18 December 2013

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3	Site 4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB13402	FWB13403	FWB13404	FWB13405
NEMATODA	Nematoda	3	R	-	-	-
ANNELIDA (WORMS)	Oligochaeta	1	R	C	C	C
	Lumbricidae	5	R	C	-	-
MOLLUSCA	*Gyraulus*	3	-	R	-	-
	Potamopyrgus	4	A	A	R	R
CRUSTACEA	Ostracoda	1	VA	A	-	R
	Paranephrops	5	R	-	-	-
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	-	R	-	-
	Austroclima	7	-	R	-	-
	Deleatidium	8	A	A	C	A
	Zephlebia group	7	C	C	C	C
COLEOPTERA (BEETLES)	Elmidae	6	A	C	R	R
	Dytiscidae	5	-	C	-	-
	Hydraenidae	8	-	-	-	R
	Hydrophilidae	5	-	R	-	-
	Ptilodactylidae	8	R	R	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	-	-	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	R	R	R
	Hydrobiosis	5	C	C	-	R
	Plectrocnemia	8	-	C	-	-
	Polyplectropus	6	A	C	R	R
	Psilochorema	6	C	C	R	R
	Oeconesidae	5	-	-	R	R
	Oxyethira	2	C	A	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	-	-	-
	Eriopterini	5	C	R	R	C
	Hexatomini	5	R	R	-	R
	Paralimnophila	6	-	-	R	-
	Zelandotipula	6	R	C	-	-
	Chironomus	1	-	R	R	-
	Orthocladiinae	2	C	A	R	-
	Polypedilum	3	C	R	-	R
	Tanypodinae	5	C	R	R	C
	Empididae	3	R	R	-	C
	Muscidae	3	R	R	-	-
	Psychodidae	1	R	-	-	-
	Austrosimulium	3	C	A	C	A
	Stratiomyidae	5	R	-	-	-
	Tanyderidae	4	-	-	-	R
ACARINA (MITES)	Acarina	5	C	C	-	-
		No of taxa	28	30	16	20
		MCI	89	97	100	99
		SQMCIs	3.5	4.1	4.9	5.0
		EPT (taxa)	5	9	6	7
		%EPT (taxa)	18	30	38	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 richness of 28 taxa was found at site 1 (Table 2), five taxa less than recorded by the previous survey and seven more than the median number of taxa recorded at this site. There were five taxa recorded in abundance; one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Polyplectropus*)]; and two 'tolerant' taxa [*Potamopyrgus* snails and ostracod seed shrimp].

The community was comprised of a moderate proportion (61%) of 'sensitive' taxa, which included one 'highly sensitive' mayfly taxon (*Deleatidium*) . This moderate proportion of 'sensitive' taxa contributed to the MCI score of 89 units which was significantly lower (by 20 units) than the historical median (Figure 2).

A moderate $SQMCI_s$ score of 3.5 units was recorded, which was significantly lower than the median for this site and significantly lower than what was recorded in the previous survey. This result reflected the numerical dominance of the community by one low scoring 'tolerant' taxon (ostracod seed shrimp), which was tempered by three 'sensitive' taxa.

The reduction in MCI and $SQMCI_s$ scores from historical medians indicates that activities upstream of site 1 may have caused a reduction in water quality prior to this survey.

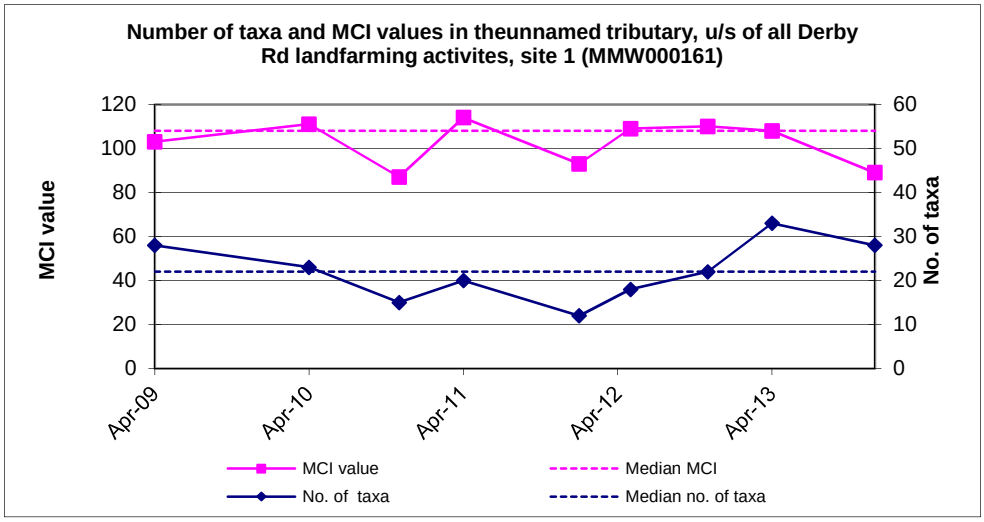

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary

Site 2

A slightly higher richness (30 taxa) was recorded at site 2, two taxa more than recorded at site 1 and three taxa more than the maximum richness recorded to date at this site (Table 2, Figure 3). The community was comprised of a moderate proportion of 'sensitive' taxa (63%) which was reflected in the moderate MCI score of 97 units; three units fewer than the median score recorded at this site to date and an insignificant eight units higher than the score at the upstream 'control' site. There were four significant changes in individual taxon abundance between sites 1 and 2 including one 'tolerant' taxon and three 'moderate' taxa.

The community was numerically dominated by six taxa, one 'highly sensitive' mayfly taxon (*Deleatidium*), and five 'tolerant' taxa [ostracod seed shrimp, snails (*Potamopyrgus*), orthoclad midges, sandfly larvae (*Austrosimulium*) and axe head caddis (*Oxyethira*)]. All dominant taxa were abundant which resulted in the $SQMCI_s$ score of 4.1 units, which was slightly higher

than the score recorded at site 1, but significantly higher than the median to date for this site (by 1.1 units).

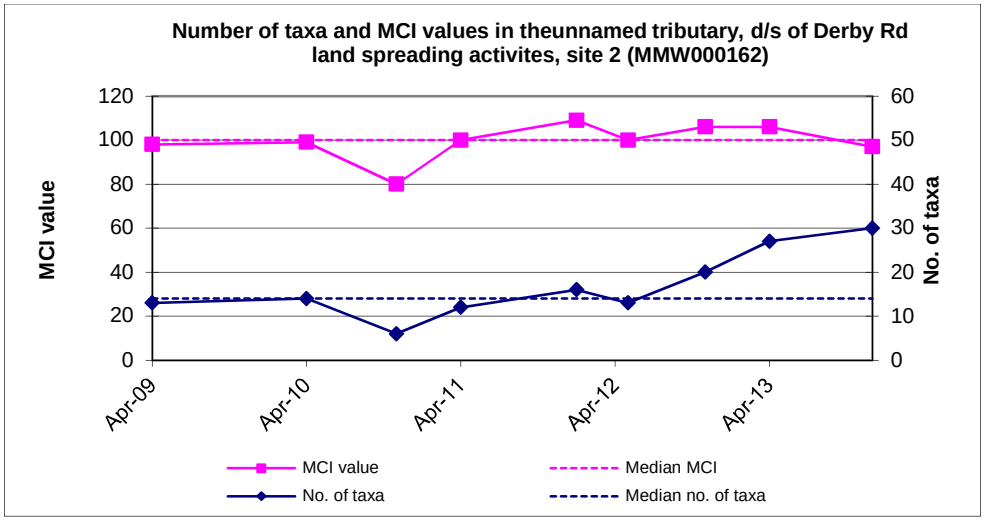

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in the unnamed tributary

An increased cover of filamentous algae can explain the abundance of three taxa in particular; [*Potamopyrgus* snails, axe head caddis (*Oxyethira*) and orthoclad midges], together with the overall higher taxa richness at this site.

Site 3

A moderate richness (16 taxa) was recorded at this site, two taxa more than the median richness, but three taxa fewer than the maximum richness recorded to date (Table 2, Figure 4). This community richness was twelve taxa lower than that recorded at site 1 and fourteen taxa less than recorded at site 2. The community at site 3 was comprised of a moderate proportion of 'sensitive' taxa (69 %) resulting in the MCI score of 100 units. This score was similar to the median of MCI scores recorded at this site by previous surveys, and nine taxa less than the maximum score recorded at this site to date. The score was similar to that at site 2 and significantly higher than that recorded at site 1.

Very sparse fauna were recorded at site 3. Taxa were recorded as either common (5-19 individuals) or rare (less than 5 individuals). Common taxa included two 'tolerant' taxa and two 'sensitive' taxa. The sparse taxa recorded at this site can be attributed to habitat change together with difficulty in sampling at this site. A moderate $SQMCI_s$ score of 4.9 was recorded for this site which was slightly higher than the historical median score and significantly higher (by 1.4 units) than what was recorded at site 1(Stark, 1998).

The significantly higher MCI and $SQMCI_s$ scores indicated no further deterioration from the upstream control site 1 and no effects from drilling wastes storage and/or discharge activities nearby.

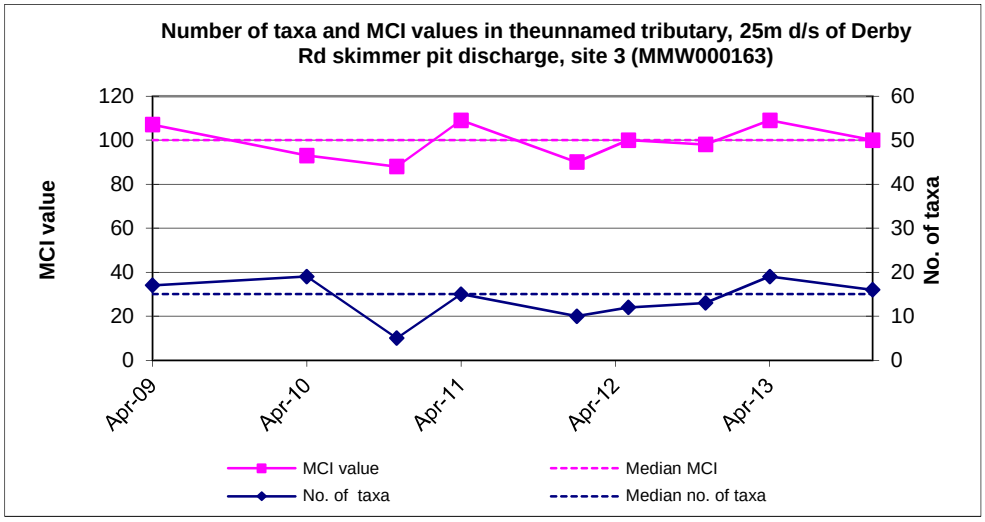

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in the unnamed tributary

Site 4

A moderate richness of 20 taxa was recorded at site 4, which was four taxa more than site 3 and eight taxa less than the upstream control site. This richness was four taxa above the historical maximum for the site (Table 2).

The community was comprised of a moderate proportion of 'sensitive' taxa (65 %), but many of these taxa were recorded as rarities (Table 3). This contributed to the MCI score of 99 units, which was seven units higher than the median for the site, and five units below the maximum score previously recorded at this site (Figure 5). This score was similar to that recorded at sites 2 and 3 but was slightly higher than that recorded at the upstream control site.

The moderately high $SQMCI_s$ score of 5.0 units was principally due to the numerical dominance of the community by one 'highly sensitive' mayfly taxon (*Deleatidium*), which was tempered by one 'tolerant' taxon (sandfly larvae *(Austrosimulium*). This $SQMCI_s$ score was significantly higher than the median recorded at the site to date (by 1.1 units) and similar to $SQMCI_s$ score recorded at site 3, but not the upstream 'control' site (1).

The results at site 4 in the current survey are above average; however the MCI score is not an improvement on that recorded in the previous survey. Results suggest that there was no impact from upstream landfarming activities, and that there was no further deterioration from the upstream control site 1.

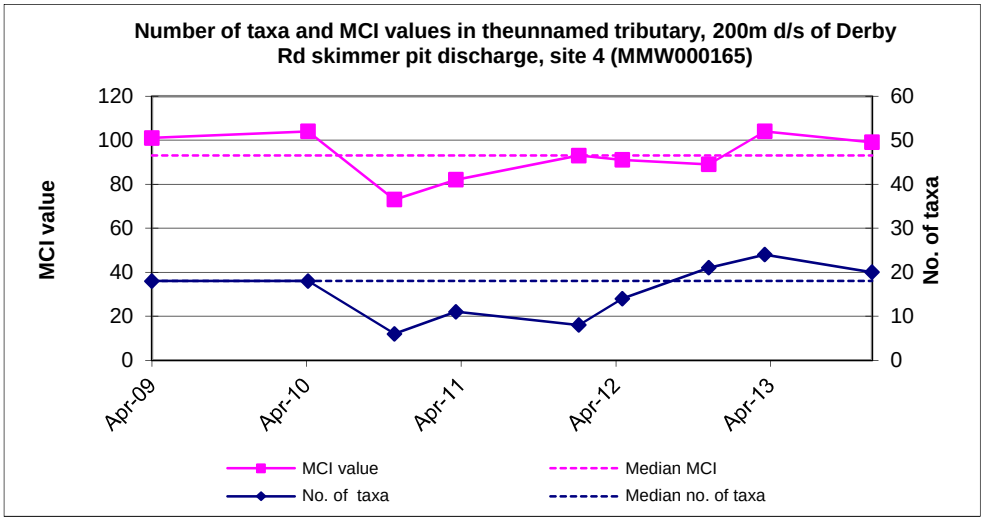

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in the unnamed tributary

The MCI score recorded at the furthest downstream site 4 was much higher than that recorded at the upstream site 1 indicating that the condition of the macroinvertebrate community at this downstream site was better than that at the upstream 'control' site. This overall improvement along the length (700 m) is likely due to subtle habitat variability between sites and a potential reduction in water quality at the upstream control site.

Summary and conclusions

On 18 December 2013, a four site macroinvertebrate survey of an unnamed tributary of the Mangamawhete Stream was performed to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site.

In the current survey, the MCI and $SQMCI_s$ scores recorded at the upstream 'control' site were significantly lower than the median scores recorded at this site in previous surveys, indicating upstream activities had possible caused a deterioration in preceding water quality at this site.

The results of this survey indicated that there was no deterioration in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. The taxa richness recorded at site 2 in this survey was much higher than the median richness for this site, while the MCI score was similar to the median score. However, the $SQMCI_s$ score recorded at this site was similar to that recorded in the previous survey, and slightly greater than that recorded upstream in the current survey.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by reduced (when compared to upstream) but above average taxa richnesses and at both sites. The MCI scores recorded at sites 3 and 4 were not significantly different to the MCI scores recorded at site 2, but much higher than what was recorded at site 1. This indicated that the impacts of upstream land farming activities that were possibly recorded in the previous survey were no longer present and that no further deterioration from site 1 had occurred.

Overall, the results of this early summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed, although some impacts caused by habitat variability were noted. In general, however, poorer community richnesses and diversities of the macroinvertebrate communities within this upper reach (near the source) of a ringplain stream in comparison with similar streams elsewhere on the ringplain (Stark & Fowles, 2009/TRC, 1999) reflect the paucity of riparian and other habitat and the influence of iron-rich groundwater seepage along the length of stream surveyed.

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To Job Manager, David Olson
From Scientific Officer, Brooke Thomas
Document 1386386
Report No BT023
Date 12 August 2014

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road Drilling Waste Stockpiling site, December 2013.

Introduction

This biological survey was the first of two programmed for the 2013-2014 monitoring year, intended 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.

The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as it is intended for this discharge 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.

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

Methods

This biomonitoring survey was undertaken at four sites on 18 December 2013 (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 standard 'kick-sampling' technique was used at all four sites (Table 1) to collect streambed macroinvertebrates. 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

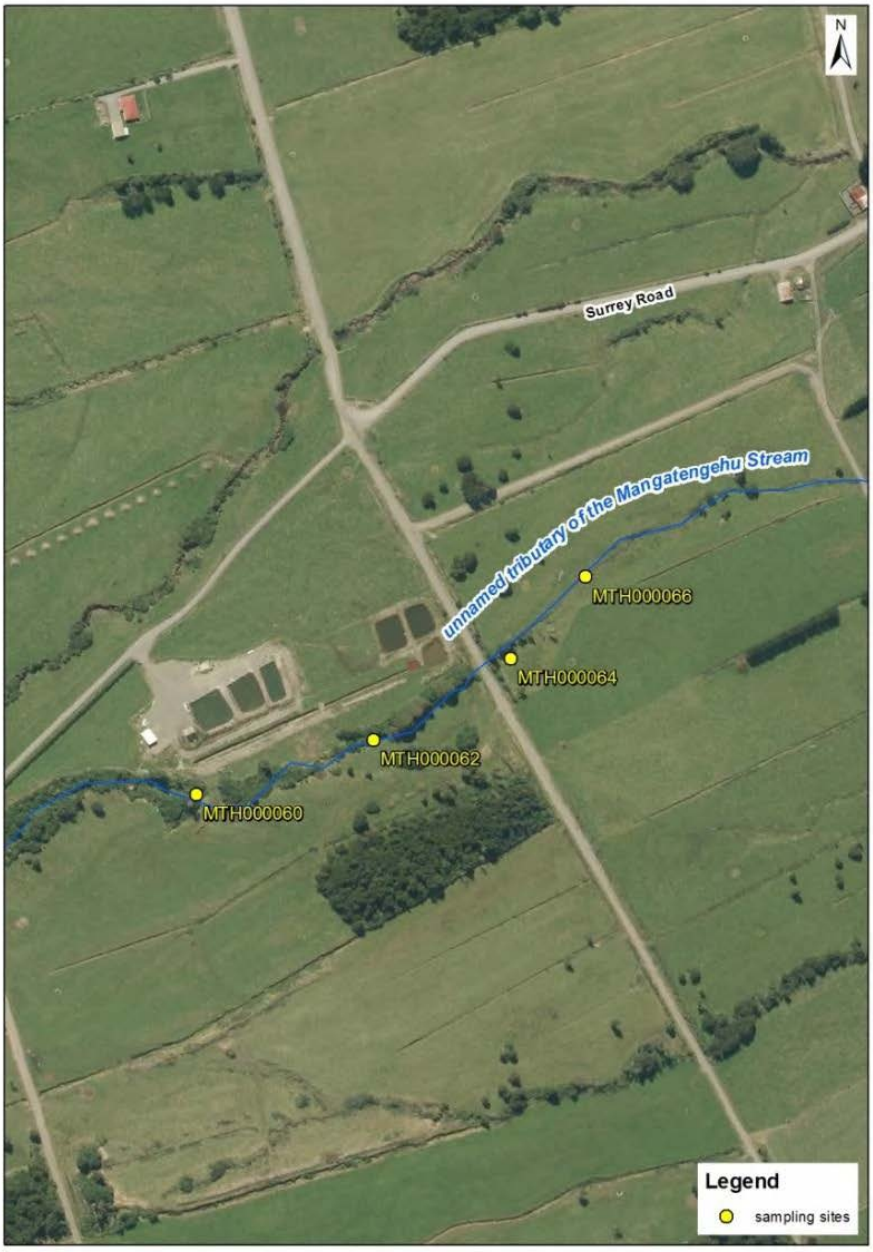

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site

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

Results and discussion

This December 2013 survey followed a period of 11 days since the nearby Manganui River experienced a fresh in excess of three and seven times median flow. A low, steady flow of uncoloured, clear water was recorded at site 1 in this survey. The substrate at this site was predominantly cobbles and coarse gravels with some fine gravel, silt and sand. There was a very small amount of iron oxide sedimentation visible. In this open section of stream with overhanging grasses and blackberry, only a slippery algal film was recorded.

There was a low, slow flow of uncoloured, clear water recorded at site 2. Cobbles, coarse and fine gravels dominated the bed of the stream at this site where there was also a minor amount of iron oxide sediment. Patchy algal mats and widespread leafy debris were recorded at this completely shaded site.

Sites 3 and 4 recorded a low, steady flow of uncoloured and clear water. Neither sites 3 or 4 were shaded. At both sites, the bed substrate primarily consisted of cobbles, coarse and fine gravels, with some sand, silt and boulders. The periphyton recorded at site 3 included patchy thick algal mats and patchy filamentous algae, while at site 4, filamentous algae was widespread, and the algal mats were only present as a slippery film. Iron oxide sediment was also widespread at both sites.

Macroinvertebrate communities

Table 2 provides a summary of the results for the current survey sampled in relation to the Surrey Road drilling waste stockpiling site together with a summary of historical results. The full results from this current survey are presented in Table 3.

Table 2 Number of taxa, MCI, and $SQMCI_s$ values for an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site, and a summary of historical data for these sites

Site No.	Number of taxa				MCI value			$SQMCI_s$ value		
	No. of samples	Median	Range	Dec 2013	Median	Range	Dec 2013	Median	Range	Dec 2013
1	7	20	17-21	24	115	106-127	109	4.5	2.3-5.4	5.1
2	7	24	5-30	20	127	80-128	111	6.0	1.6-6.9	5.5
3	7	11	9-18	12	103	96-119	77	1.9	1.4-3.6	2.1
4	3	21	12-24	7	107	97-109	77	2.1	2.1-3.4	1.8

Table 3 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 18 December 2013

Taxa List	Site Number	MCI	Site 1	Site 2	Site 3	Site 4

	Site Code	score	MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB13398	FWB13399	FWB13400	FWB13401
NEMERTEA	Nemertea	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	A	C	A	A
MOLLUSCA	*Potamopyrgus*	4	-	R	-	-
CRUSTACEA	*Paranephrops*	5	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	-	R	-	-
	Austroclima	7	A	-	-	-
	Coloburiscus	7	R	-	-	-
	Deleatidium	8	C	A	-	-
	Nesameletus	9	R	-	-	-
	Zephlebia group	7	A	C	R	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R	-	R
	Austroperla	9	-	R	-	-
	Stenoperla	10	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C	R	R
	Dytiscidae	5	-	-	R	-
	Ptilodactylidae	8	C	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosella*	9	-	R	-	-
	Hydrochorema	9	R	-	-	-
	Plectrocnemia	8	-	R	-	-
	Polyplectropus	6	R	-	-	-
	Psilochorema	6	R	-	-	-
	Alloecentrella	8	-	R	-	-
	Oxyethira	2	-	R	R	-
DIPTERA (TRUE FLIES)	Eriopterini	5	R	C	-	-
	Hexatomini	5	C	R	-	-
	Zelandotipula	6	C	-	R	-
	Orthocladiinae	2	C	C	A	C
	Polypedilum	3	C	C	R	R
	Tanypodinae	5	R	-	-	-
	Dolichopodidae	3	-	-	R	-
	Paradixa	4	R	-	-	-
	Empididae	3	R	R	R	-
	Muscidae	3	-	-	R	-
	Psychodidae	1	R	-	-	-
	Austrosimulium	3	C	C	-	-
ACARINA (MITES)	Acarina	5	R	-	R	-
		No of taxa	24	20	12	7
		MCI	109	111	77	77
		SQMCIs	5.1	5.5	2.1	1.8
		EPT (taxa)	10	8	1	2
		%EPT (taxa)	42	40	8	29

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

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

Site 1

Survey results to date at this site are illustrated in Figure 2.

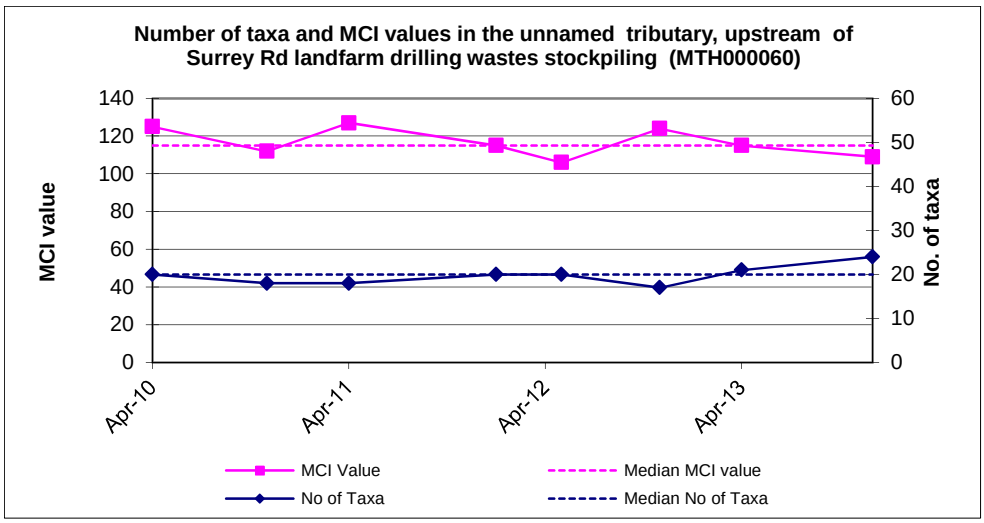

Figure 2 Taxa richnesses and MCI scores recorded to date at site 1

A moderate richness of 24 taxa was recorded at site 1 upstream of the storage area, which was three taxa higher than recorded at the site to date, although the range had previously been very narrow (Table 2 and Figure 2).

There were only three taxa recorded in abundance; a 'tolerant' taxon [oligochaete worms], and two 'sensitive' taxa [mayflies (*Austroclima*) and (*Deleatidium*)]. The community was comprised of a high proportion (71%) of 'sensitive' taxa which included five 'highly sensitive' taxa (two mayflies, one stonefly, one beetle, and one caddisfly). This high proportion of 'sensitive' taxa contributed to the MCI score of 109 units which was an insignificant (Stark, 1998) six units less than the historical median and six units lower than the score recorded by the previous survey, six months earlier.

A moderate $SQMCI_s$ score of 5.1 units was recorded, an insignificant (0.6 unit) higher than the median for the site recorded by previous surveys (Stark, 1998). This score reflected the two 'sensitive' taxa and one 'tolerant' taxon that were recorded as abundant.

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

Site 2

Survey results to date at this site are illustrated in Figure 3.

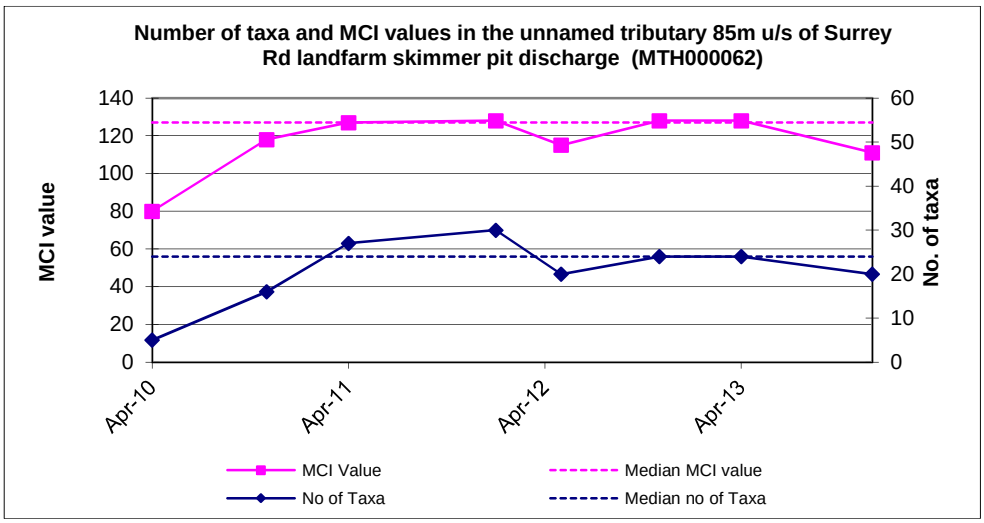

Figure 3 Taxa richnesses and MCI scores recorded to date at site 2

A moderate richness of 20 taxa was recorded at site 2, four taxa less than the median yet well within the range recorded at the site previously (Table 2 and Figure 3). Although this result was 10 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 four taxa less than that recorded at site 1 in the current survey.

The community was comprised of a high proportion of 'sensitive' taxa (65%) but a large proportion (64%) of these were rarities (less than five individuals per taxon). The MCI score of 111 units was a significant 16 units (Stark, 1998) less than the median score recorded at this site to date but two units higher than the score at the upstream 'control' site. There were two significant changes in individual taxon abundances, between sites 1 and 2, in relation to two 'sensitive' taxa which were present at site 1 but absent at site 2.

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]. The numerical dominance by only this one taxon resulted in the relatively high $SQMCI_s$ score of 5.5 units, which was 0.4 unit higher than the score recorded at site 1 but 0.5 unit less than the median for this site.

This community showed a slight decrease in taxa richness and MCI from the two previous surveys, but an overall continuation of the improvement recorded since 2010, subsequent to the change in discharge location. Overall the results indicated relatively good preceding water quality.

Site 3

Survey results to date at this site are illustrated in Figure 4.

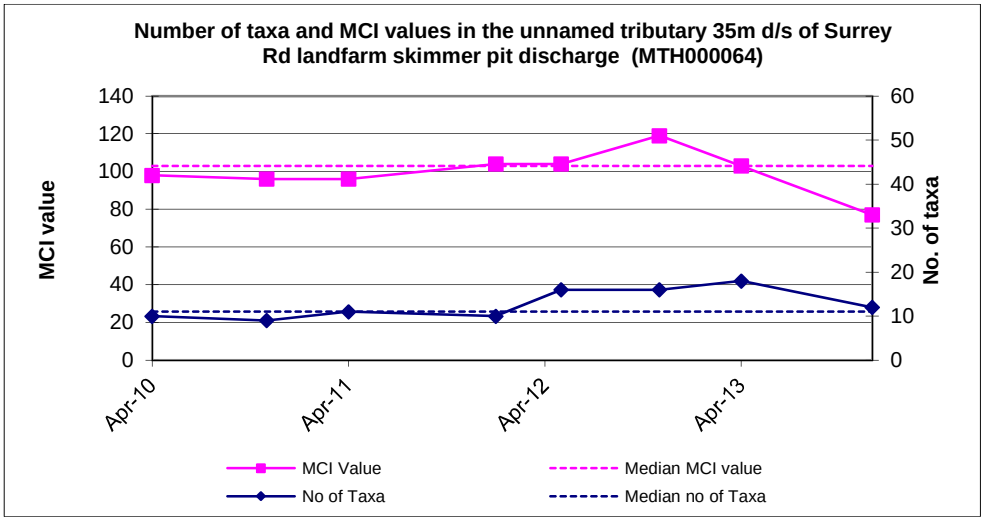

Figure 4 Taxa richnesses and MCI scores recorded to date at site 3

A moderately low richness (12 taxa) was recorded at this site which was six taxa fewer than the maximum richness recorded at the site previously. However, 10 of these taxa (83% of richness) were present only as rarities (i.e. less than five individuals per taxon). This community richness was 12 taxa lower than that recorded at site 1 and eight taxa less than that recorded at site 2.

The community was characterised by two 'tolerant' taxa [oligochaete worms and orthoclad midges]. 'Tolerant' taxa comprised a relatively high proportion (58%) of the macroinvertebrate community which resulted in the MCI score of 77 units. This score was a significant 26 units lower than the median for this site, and a very significant 42 units (Stark, 1998) less than the maximum MCI score (Figure 4). It was also a very significant 34 units less than that recorded at site 2 and 32 units lower than the score at the upstream 'control' site.

The numerical domination by the two 'tolerant' taxa coupled with the complete loss of 'highly sensitive' *Deleatidium* mayflies (which were abundant at site 2) resulted in a significant downstream decrease of 3.4 units in $SQMCI_s$ score (to 2.1 units) between sites 2 and 3. This score was 0.8 unit less than that recorded in the previous survey, and only slightly higher than the median for this site (Table 2).

The proliferation of filamentous algae, together with increased iron oxide sedimentation has impacted on the macroinvertebrate community at this site and can, to some extent, explain the significant reductions in MCI and $SQMCI_S$ scores recorded at this site compared to sites 1 and 2. However the reduction in taxa richness and absence of all 'highly sensitive' taxa, together with the reduction in MCI and $SQMCI_s$ scores, may be indicative of a recent toxic discharge related to the storage of drilling wastes near the unnamed tributary of the Mangatengehu Stream.

Site 4

Survey results for this site to date are illustrated in Figure 5.

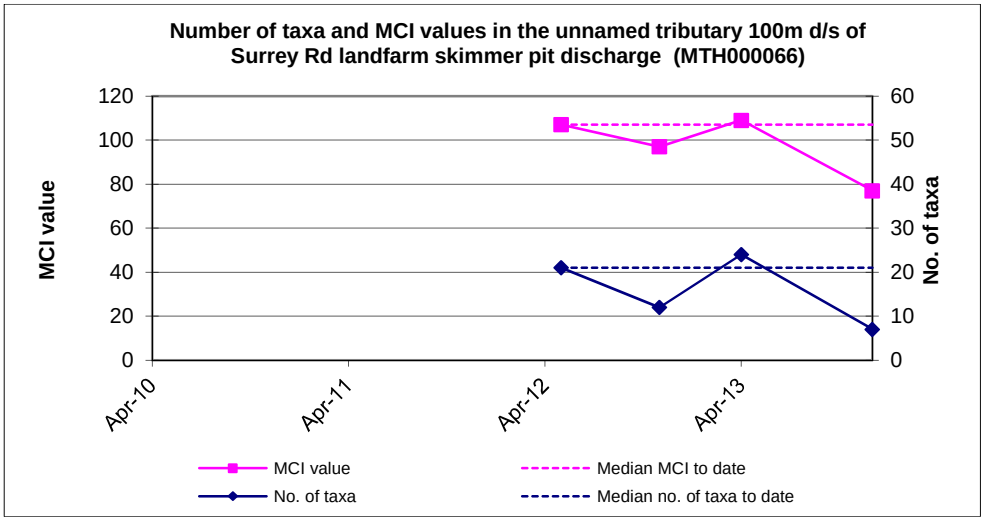

Figure 5 Taxa richnesses and MCI scores recorded to date at site 4

In terms of community richness and invertebrate abundance, this site showed further deterioration from the community at site 3. A very low richness of seven taxa was recorded, approximately 65 metres downstream of the skimmer pit discharge area. This taxa richness was much lower than that recorded at the other three sites sampled in this survey and was the lowest number of taxa recorded to date at this site (Figure 5). It was also a marked 17 taxa less than that recorded in the previous survey. Again, this may be related to increased algal cover and iron oxide sedimentation but the loss of taxa was a strong indication that a toxic discharge preceded this survey, a discharge likely related to the storage of drilling wastes, entering the unnamed tributary of the Mangatengehu Stream.

Only three 'sensitive' taxa were recorded at this site, all as rarities. However, due to an absence of 'highly sensitive' taxa and the high proportion of low-scoring 'tolerant' taxa in the community at this site, a very low MCI score of 77 units was recorded. This MCI score was significantly less than recorded at site 1 (by 32 units) and site 2 (by 34 units), but the same as what was recorded at site 3. This MCI score was also significantly lower than the median for this site (by 30 units) and the lowest score recorded to date (Figure 5). This is considered a poor result for this site, and represents a significant reduction in community health from previous surveys, and from that recorded at sites 1 and 2 in the current survey.

The $SQMCI_s$ of 1.8 units was principally due to the numerical dominance of the community by one low scoring 'tolerant' taxon (oligochaete worms), and the absence of any abundant 'sensitive' taxa. This $SQMCI_s$ score was significantly less than that recorded at sites 1 and 2 upstream, and was 0.3 unit lower than that recorded at site 3.

These results indicate significant deterioration from that recorded at site 1 and site 2 and from that recorded in previous surveys. Profuse filamentous algal substrate cover, together with widespread iron oxide sedimentation has detrimentally impacted this site, and provides some explanation for the significant reductions in MCI and $SQMCI_S$ scores that were recorded in comparison to those recorded at site 1 and site 2. However previous surveys undertaken at this site have recorded similar algal cover and iron oxide

sedimentation while recording much healthier invertebrate communities. Therefore, as with site 3, the reductions are more likely to be the result of the effects of a toxic discharge associated with the disposal of drilling wastes downstream of the stormwater discharge outfall near the unnamed tributary of the Mangatengehu Stream.

Summary and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 18 December 2013, 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.

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

The results of this survey indicated a slight improvement in the condition of the macroinvertebrate community at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. However the MCI and $SQMCI_S$ scores recorded at site 2 in this survey were below medians recorded to date at the site.

The MCI and $SQMCI_s$ scores recorded at sites 3 and 4 were severely reduced compared to those recorded at sites 1 and 2. Some of this deterioration in macroinvertebrate community may be attributable to the higher algal biomass and iron oxide sedimentation observed at these sites. However, this algal cover and iron oxide sedimentation were not unusual for these sites, yet both sites recorded depleted community richnesses, with only 12 (site 3) and seven (site 4) taxa recorded, compared with 18 and 24 taxa in the previous survey. In addition, invertebrate abundances were also severely depleted, with no 'sensitive' taxa represented by more than five individuals per taxon at either site, and only two taxa recording more than five individuals at each site. Such severe deterioration is more typically associated with the effects of a recent toxic discharge or prolonged effect of such a discharge. The current survey indicated that recent discharges into the stream from the land farming activities have caused a significant deterioration in macroinvertebrate health in this unnamed tributary.

Therefore, it is recommended that strong consideration be given to requiring this site to obtain a consent for this wastewater discharge, and that the water quality sampling regime be augmented to include testing for dissolved nutrients (total nitrogen, total phosphorus and dissolved reactive phosphorus) and other relevant parameters from both the site discharge, and also in samples collected upstream and downstream of the discharge point.

Overall, the results of this early summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have resulted in significant impacts on the macroinvertebrate communities through the lower section of the reach surveyed, and that it is likely that such impacts have been compounded by habitat variability.

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To Job Manager, David Olson
From Scientific Officer, Brooke Thomas
Document 1412438
Report No BT031
Date 03 October 2014

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

Introduction

This biological survey was the second of two programmed for the 2013-2014 monitoring year, intended 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.

The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as it is intended for this discharge 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.

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

Methods

This biomonitoring survey was undertaken at four sites on 10 February 2014 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at site 4 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques was used at sites 1, 2 and 3 (Table 1). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New

Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

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

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

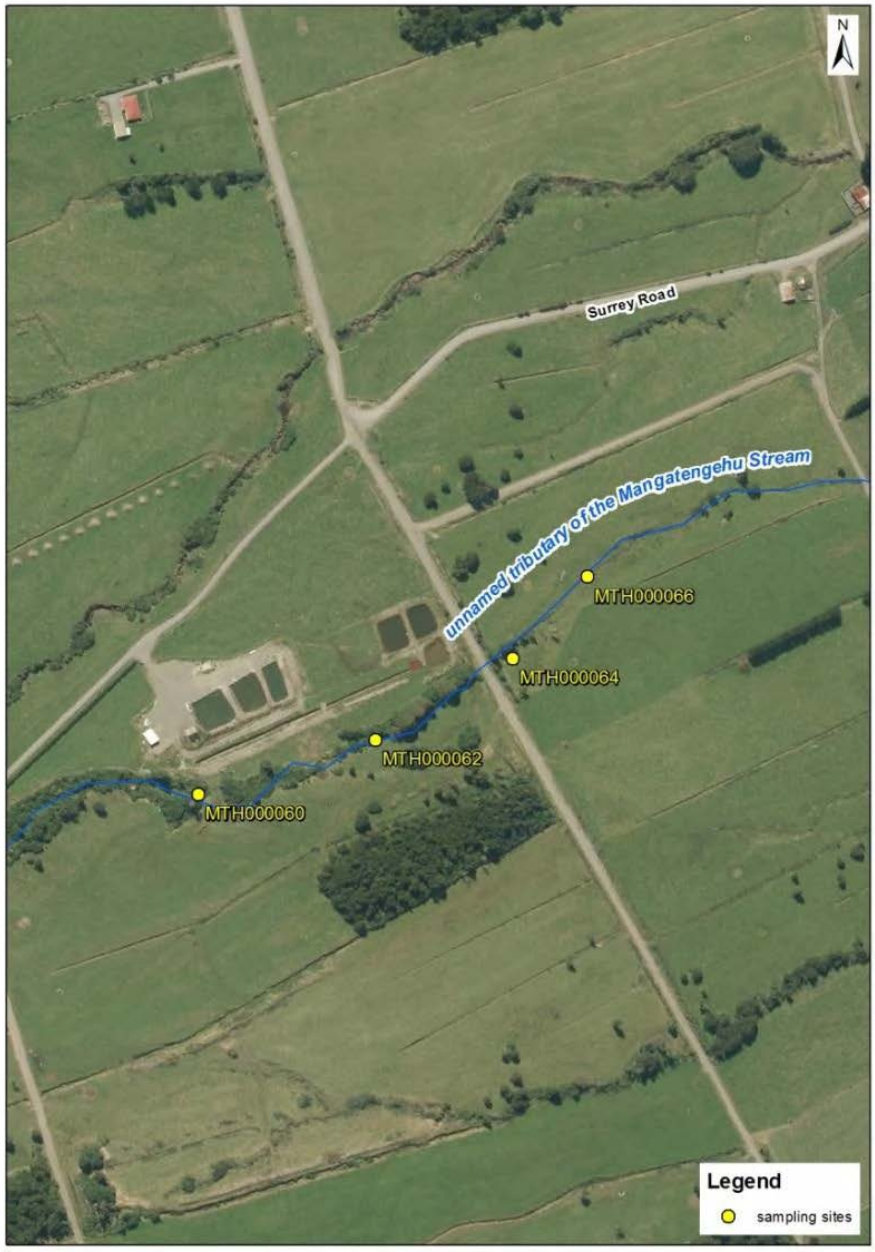

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site

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

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

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

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

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

Results and discussion

This February 2014 survey followed a period of 14 days since the nearby Manganui River experienced a fresh in excess of three times median flow. A low, slow flow of uncoloured, cloudy water was recorded at site 1 in this survey. The substrate at this site was predominantly gravels and silt with some sand and cobbles. There was a very small amount of iron oxide sedimentation visible. In this open section of stream both patchy mats and filaments of algae were recorded.

There was a low, slow flow of uncoloured, cloudy water recorded at site 2. Cobbles, silt, sand and coarse and fine gravels dominated the bed of the stream at this site where there was also iron oxide sediment visible. Slippery algal mats and patchy leafy debris were recorded at this partially shaded site.

Sites 3 and 4 also recorded a low, slow flow of uncoloured and cloudy water. Neither sites 3 nor 4 were shaded. At both sites, the bed substrate primarily consisted of cobbles, silt and coarse and fine gravels, with some boulders recorded at site 4 only. The periphyton recorded at both sites included widespread thick algal mats and widespread filamentous algae. Iron oxide sediment was also widespread at both sites.

Macroinvertebrate communities

Table 2 provides a summary of the results for the current survey sampled in relation to the Surrey Road drilling waste stockpiling site together with a summary of historical results. The full results from this current survey are presented in Table 3.

Table 2 Number of taxa, MCI, and $SQMCI_s$ values for an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site, and a summary of historical data for these sites

Site No.	Number of taxa				MCI value			$SQMCI_s$ value		
	No. of samples	Median	Range	Feb 2014	Median	Range	Feb 2014	Median	Range	Feb 2014
1	8	20	17-24	36	115	106-127	111	4.7	2.3-5.4	5.6
2	8	22	5-30	18	123	80-128	108	5.8	1.6-6.9	3.6
3	8	12	9-18	6	101	77-119	103	2.0	1.4-3.6	2.0
4	4	17	7-24	9	102	77-109	91	2.1	1.8-3.4	2.8

Table 3 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 10 February 2014

Taxa List	Site Number	MCI	Site 1	Site 2	Site 3	Site 4

	Site Code	score	MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB14074	FWB14075	FWB14076	FWB14077
NEMERTEA	Nemertea	3	R	-	-	-
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	A	A	A	A
MOLLUSCA	*Potamopyrgus*	4	C	-	-	-
CRUSTACEA	Copepoda	5	-	R	-	-
	Ostracoda	1	R	-	-	-
	Isopoda	5	-	R	-	-
	Paranephrops	5	-	R	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	R	-	C
	Deleatidium	8	A	R	-	-
	Neozephlebia	7	R	-	-	-
	Nesameletus	9	C	C	-	-
	Zephlebia group	7	A	R	R	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	R	-
	Spaniocerca	8	R	-	-	-
	Stenoperla	10	R	-	-	-
HEMIPTERA (BUGS)	*Saldula*	5	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	-	-	-
	Hydraenidae	8	R	-	-	-
	Hydrophilidae	5	R	-	-	-
	Ptilodactylidae	8	C	R	-	-
	Scirtidae	8	R	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrochorema*	9	R	-	-	-
	Plectrocnemia	8	-	R	-	-
	Polyplectropus	6	C	-	-	-
	Psilochorema	6	C	R	R	R
	Oxyethira	2	R	-	-	-
	Pycnocentria	7	R	-	-	-
	Triplectides	5	R	-	-	-
DIPTERA (TRUE FLIES)	Eriopterini	5	R	R	-	R
	Hexatomini	5	R	-	-	-
	Paralimnophila	6	R	-	-	-
	Zelandotipula	6	R	-	-	-
	Orthocladiinae	2	C	-	-	R
	Polypedilum	3	C	C	-	-
	Tanypodinae	5	C	-	-	-
	Dolichopodidae	3	R	-	-	-
	Paradixa	4	R	-	-	-
	Empididae	3	R	R	-	-
	Psychodidae	1	-	R	-	-
	Austrosimulium	3	C	R	R	-
ACARINA (MITES)	Acarina	5	C	R	R	R
		No of taxa	36	18	6	9
		MCI	111	108	103	91
		SQMCIs	5.6	3.6	2.0	2.8
		EPT (taxa)	13	6	3	3
		%EPT (taxa)	36	33	50	33

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

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

Site 1

Survey results to date at this site are illustrated in Figure 2.

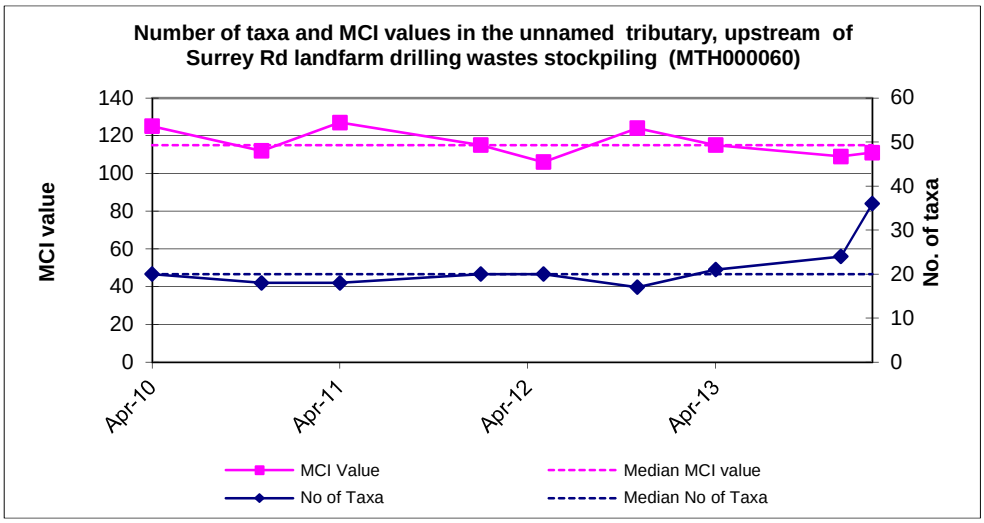

Figure 2 Taxa richnesses and MCI scores recorded to date at site 1

A high richness of 36 taxa was recorded at site 1 upstream of the storage area, which was 12 taxa higher than recorded at the site to date, although the range had previously been very narrow (Table 2 and Figure 2).

There were four taxa recorded in abundance; a 'tolerant' taxon [oligochaete worms], two 'moderately sensitive' taxa [mayflies (*Austroclima*) and (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)]. The community was comprised of a high proportion (69%) of 'sensitive' taxa which included nine 'highly sensitive' taxa (two mayflies, three stoneflies, three beetles, and one caddisfly). This high proportion of 'sensitive' taxa contributed to the MCI score of 111 units which was an insignificant (Stark, 1998) four units less than the historical median and two units more than the score recorded by the previous survey, two months earlier.

A moderate $SQMCI_s$ score of 5.6 units was recorded, an insignificant (0.9 unit) higher than the median for the site recorded by previous surveys (Stark, 1998). This score reflected the one 'tolerant' taxon and three 'sensitive' taxa that were recorded as abundant.

This community recorded a moderately high MCI score and a moderate $SQMCI_s$ score. This, coupled with the number of 'sensitive' taxa in the community, indicated that water quality in the weeks prior to this survey had been relatively good.

Site 2

Survey results to date at this site are illustrated in Figure 3.

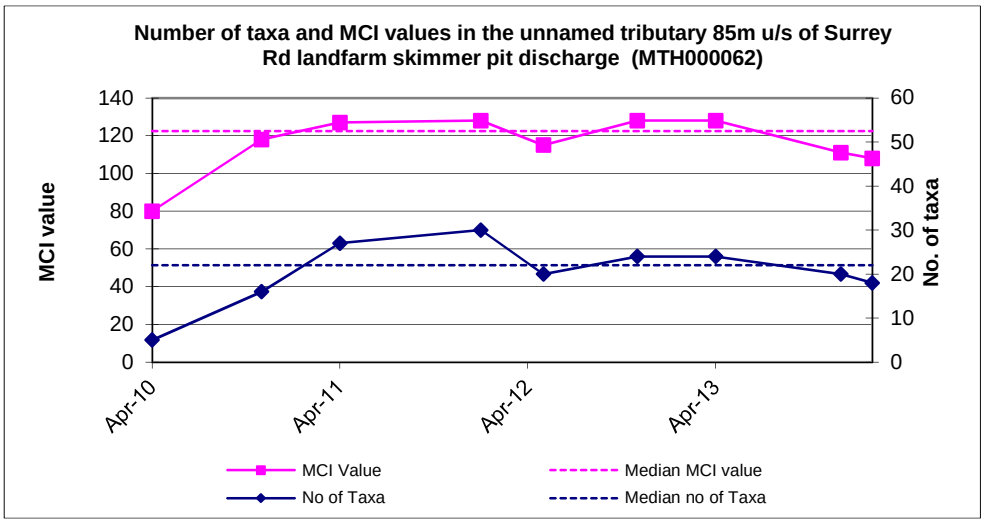

Figure 3 Taxa richnesses and MCI scores recorded to date at site 2

A moderate richness of 18 taxa was recorded at site 2, four taxa less than the median yet well within the range recorded at the site previously (Table 2 and Figure 3). Although this result was 12 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 a significant 18 taxa less than that recorded at site 1 in the current survey.

The community was comprised of a high proportion of 'sensitive' taxa (72%) but almost all of these (92%) were rarities (less than five individuals per taxon). The MCI score of 108 units was a significant 15 units (Stark, 1998) less than the median score recorded at this site to date and three units lower than the score at the upstream 'control' site. There were nine significant changes in individual taxon abundances, between sites 1 and 2. These were all related to seven 'sensitive' taxa and two 'tolerant' taxa which were significantly reduced in abundance at site 2.

Only one taxon was found in abundance at this site, the 'tolerant' taxon [oligochaete worms]. The numerical dominance by this one taxon resulted in the relatively low $SQMCI_s$ score of 3.6 units, which was a significant (Stark, 1998) 2.0 units lower than the score recorded at site 1 and 2.2 units less than the median for this site.

This community showed a slight decrease in taxa richness and MCI from the two previous surveys, but an overall continuation of the improvement recorded since 2010, subsequent to the relocation of the discharge to the stream. Overall the results indicated reasonable preceding water quality but also a significant decrease in taxa richness and $SQMCI_s$ score from site 1, indicative of the habitat differences between the two sites. At site 1 the wetted width of the stream was much narrower in comparison to that at site 2. The shallow and slow flow at site 2 made sampling difficult and supported fewer taxa than the slightly deeper and swifter flow at site 1.

Site 3

Survey results to date at this site are illustrated in Figure 4.

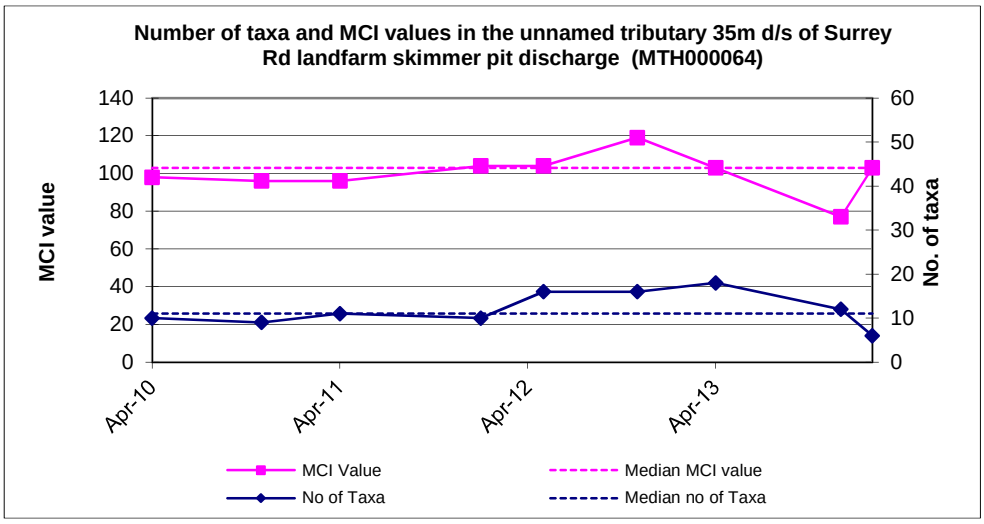

Figure 4 Taxa richnesses and MCI scores recorded to date at site 3

A very low richness (6 taxa) was recorded at site 3 which was 12 taxa fewer than the maximum richness recorded at the site previously and the lowest richness recorded to date. All but one of these taxa were recorded as rarities (i.e. less than five individuals) and for all five rare taxa only one individual was recorded. This community richness was 30 taxa lower than that recorded at site 1 and 12 taxa less than that recorded at site 2.

The community was characterised by one 'tolerant' taxon [oligochaete worms]. 'Tolerant' taxa comprised 33% of the macroinvertebrate community which contributed to the MCI score of 103 units. This score was similar to the median for this site, but a significant 16 units (Stark, 1998) less than the maximum MCI score (Figure 4). It was also similar to that recorded at site 2 and to the upstream 'control' site score.

The numerical domination by one 'tolerant' taxon resulted in the $SQMCI_s$ score of 2.0 units which represented a significant downstream decrease of 1.6 units in $SQMCI_s$ score between sites 2 and 3. This score was 0.1 unit less than that recorded in the previous survey, and the same as the median for this site (Table 2).

The proliferation of filamentous algae, together with increased iron oxide sedimentation, impacted on the macroinvertebrate community at this site and can, to some extent, explain the significant reductions in taxa richness and $SQMCI_S$ scores recorded at this site compared to sites 1 and 2. However the reduction in taxa richness and extremely low numbers within each of the 'sensitive' taxa, together with the reduction in $SQMCI_s$ score, may be indicative of a recent toxic discharge related to the storage of drilling wastes near the unnamed tributary of the Mangatengehu Stream.

Site 4

Survey results for this site to date are illustrated in Figure 5.

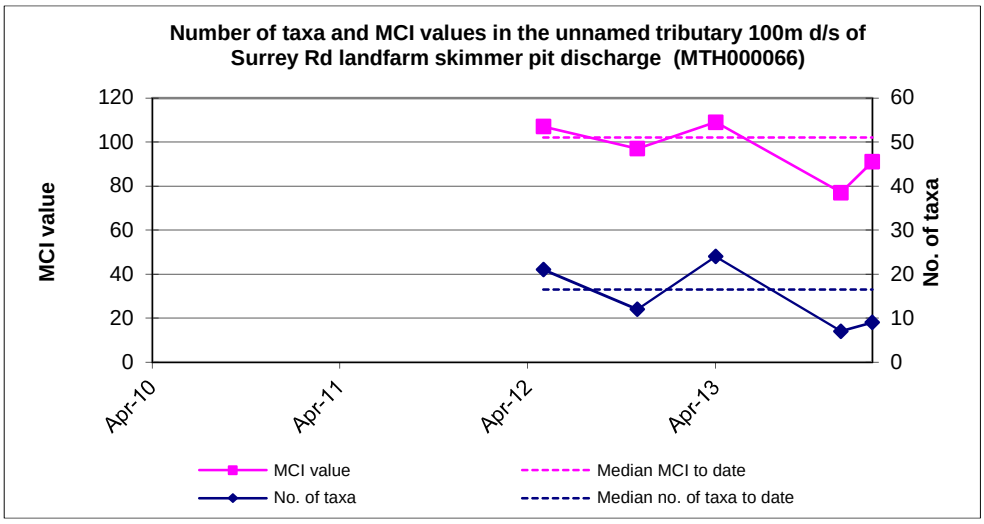

Figure 5 Taxa richnesses and MCI scores recorded to date at site 4

In terms of community richness and invertebrate abundance, this site showed only minor improvement from the community at site 3. A low richness of nine taxa was recorded, approximately 65 metres downstream of the skimmer pit discharge area. This taxa richness was much lower than that recorded at site 1 and site 2 and eight taxa fewer than the median richness for this site (Figure 5). Again, this may have been related to increased algal cover and iron oxide sedimentation but the loss of taxa was a strong indication that a toxic discharge preceded this survey, a discharge likely related to the storage of drilling wastes, entering the unnamed tributary of the Mangatengehu Stream.

Only six 'sensitive' taxa were recorded at this site, all but one as rarities. The presence of several 'tolerant' taxa in the community at this site contributed to the MCI score of 91 units. This MCI score was significantly (Stark, 1998) less than recorded at site 1 (by 20 units), site 2 (by 17 units) and site 3 (by 12 units). This MCI score was also significantly lower than the median for this site (by 11 units) (Figure 5). This is considered a poor result for this site, and represented a significant reduction in community health from that recorded at sites 1 and 2.

The $SQMCI_s$ of 2.8 units was principally due to the numerical dominance of the community by one low scoring 'tolerant' taxon (oligochaete worms), and the absence of any abundant 'sensitive' taxa. This $SQMCI_s$ score was significantly less than that recorded at sites 1, and was 0.8 unit lower than that recorded at site 2 but 0.8 unit higher than that recorded at site 3.

These results indicated significant deterioration from that recorded at site 1 and site 2. Profuse filamentous algal substrate cover, together with widespread iron oxide sedimentation had detrimentally impacted on the biological community at this site, as illustrated by the significant reductions in MCI and $SQMCI_S$ scores that were recorded in comparison with those recorded at site 1. However, previous surveys undertaken at this site have recorded similar algal cover and iron oxide sedimentation while recording much healthier invertebrate communities. Therefore, similar to the conditions recorded at site 3 the reductions were more likely to have been the result of the effects of a toxic discharge associated with the disposal of drilling wastes downstream of the stormwater discharge

outfall near the unnamed tributary of the Mangatengehu Stream.

Summary and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 10 February 2014, 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.

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

The results of this survey indicated deterioration in the condition of the macroinvertebrate community at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. Both the MCI and $SQMCI_S$ scores recorded at site 2 in this survey were significantly below medians recorded to date. This can be attributed to the low flow conditions and difficulty in sampling at this site at the time of the survey.

The MCI and $SQMCI_s$ scores recorded at sites 3 and 4 were severely reduced compared to those recorded at site 1. Some of this deterioration in macroinvertebrate communities may have been attributable to the higher algal biomass and iron oxide sedimentation observed at these sites. However, this algal cover and iron oxide sedimentation were not unusual for these sites, yet both sites recorded severely depleted community richnesses, with only six (site 3) and nine (site 4) taxa recorded, compared with the medians of 12 (site 3) and 17 (site 4) recorded by previous surveys. In addition, invertebrate abundances were also severely depleted, with no 'sensitive' taxa represented by more than five individuals per taxon at site 3 and only one 'sensitive' taxon recorded as common (5-19 individuals) at site 4. Such severe deterioration is more typically associated with the effects of a recent toxic discharge or prolonged effect of such a discharge. The current survey indicated that recent discharges into the stream from the land farming activities may have contributed to a significant deterioration in macroinvertebrate health in this unnamed tributary.

As was recommended in the previous (December 2013) report, it is further recommended that strong consideration be given to requiring this site to obtain a consent for this wastewater discharge, and that the physiochemical water quality sampling regime be augmented to include testing for dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) and other relevant parameters from both the site discharge, and also from the stream upstream and downstream of the discharge point.

Overall, the results of this late summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have resulted in significant impacts on the macroinvertebrate communities through the lower section of the reach surveyed, and that it is likely that such impacts have been compounded by habitat variability.

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To	Job Manager, David Olson
From	Scientific Officer, Brooke Thomas
Document	1426862
Report No	BT041
Date	November 2014

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, February 2014

Introduction

This biological survey was the second of two scheduled surveys for the 2013-2014 monitoring period, intended 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 site receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. Unfortunately, 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. The upstream control site was relatively unaffected. This makes temporal comparisons with results difficult, as recovery from the original disturbance and sedimentation may mask any impact from drilling waste disposal activities, if any such impact occurs.

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.

A combination of the standard 'kick-sampling' and 'vegetation-sweep' sampling techniques was used at these four sites (Table 1) to collect streambed macroinvertebrates on 10 February 2014. The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the 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 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 and discussion

At the time of this midday survey there was an uncoloured, slow, low flow at all sites. Due to significant upstream iron oxide seepage into this stream, the flow at all sites was cloudy. The stream bed was also affected by this iron oxide seepage, with iron oxide sedimentation being observed at all sites.

Site 2 was unshaded at the time of this survey, whereas site 1 was partially shaded. Site 3 and 4 were completed shaded by overhanging vegetation. Growths of slippery algal mats were recorded at all sites and patchy filamentous algae was recorded at site 1. Widespread filamentous algae was recorded at site 2, whereas no filamentous algae was noted at site 3 or 4.

The substrate at all sites consisted predominantly of cobbles and gravels, with some silt and boulders.

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. The full results from the current survey are presented in Table 3.

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 10 February 2014 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2014	Median	Range	Feb 2014	Median	Range	Feb 2014
1	9	22	12-33	27	108	87-114	104	6.0	3.2-7.4	4.7
2	9	14	6-30	19	100	80-109	103	3.1	2.0-7.4	3.4
3	9	15	5-19	16	99	88-109	100	4.4	2.5-5.9	3.9
4	9	18	6-24	15	93	73-104	91	4.0	2.1-6.8	4.9

Table 3 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 10 February 2014

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3	Site 4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB14070	FWB14071	FWB14072	FWB14073
ANNELIDA (WORMS)	Oligochaeta	1	-	C	C	R
MOLLUSCA	*Potamopyrgus*	4	A	C	C	R
CRUSTACEA	Ostracoda	1	A	A	C	C
	Paranephrops	5	R	-	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	R	-
	Deleatidium	8	A	C	C	C
	Nesameletus	9	-	R	-	-
	Zephlebia group	7	R	-	R	R
COLEOPTERA (BEETLES)	Elmidae	6	A	C	R	-
	Dytiscidae	5	R	R	-	-
	Ptilodactylidae	8	R	-	R	-
	Scirtidae	8	R	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	-	R	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	R	-	-
	Hydrobiosis	5	R	C	-	-
	Hydrochorema	9	R	-	-	-
	Orthopsyche	9	R	-	-	-
	Plectrocnemia	8	-	R	R	-
	Polyplectropus	6	R	R	-	A
	Psilochorema	6	C	C	R	C
	Oxyethira	2	C	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	-	-
	Eriopterini	5	C	R	R	-
	Hexatomini	5	-	R	-	R
	Limonia	6	-	-	-	R
	Orthocladiinae	2	C	A	C	R
	Polypedilum	3	R	-	-	C
	Tanypodinae	5	R	R	R	R
	Ceratopogonidae	3	R	-	-	-
	Dolichopodidae	3	-	-	-	R
	Paradixa	4	R	-	-	-
	Empididae	3	R	-	-	-
	Austrosimulium	3	C	C	C	C
ACARINA (MITES)	Acarina	5	R	-	-	-
No of taxa			27	19	16	15
MCI			104	103	100	91
SQMCIs			4.7	3.4	3.9	4.9
EPT (taxa)			8	8	5	4
%EPT (taxa)			30	42	31	27
'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 27 taxa was found at site 1 (Table 2), one taxon less than recorded by the previous survey and five taxa more than the median number of taxa recorded at this site. There were four taxa recorded in abundance; one 'highly sensitive' taxon [mayfly

(*Deleatidium*)]; one 'moderately sensitive' taxon [elmid beetles]; and two 'tolerant' taxa [*Potamopyrgus* snails and ostracod seed shrimp].

The community was comprised of a moderate proportion (67%) of 'sensitive' taxa, which included one 'highly sensitive' mayfly taxon (*Deleatidium*). This moderate proportion of 'sensitive' taxa contributed to the MCI score of 104 units which was slightly lower (by 4 units) than the historical median (Figure 2).

A moderate $SQMCI_s$ score of 4.7 units was recorded, which was significantly lower than the median for this site (by 1.3 units) but significantly higher than what was recorded in the previous survey (by 1.2 units). This result reflected the numerical dominance of one 'highly sensitive' taxon and one 'moderately sensitive' taxon, which was tempered by the abundance of two 'tolerant' taxa.

The reduction in $SQMCI_s$ score from the historical median indicates that activities upstream of site 1 may have caused a reduction in water quality prior to this survey (although there was some improvement from the previous survey).

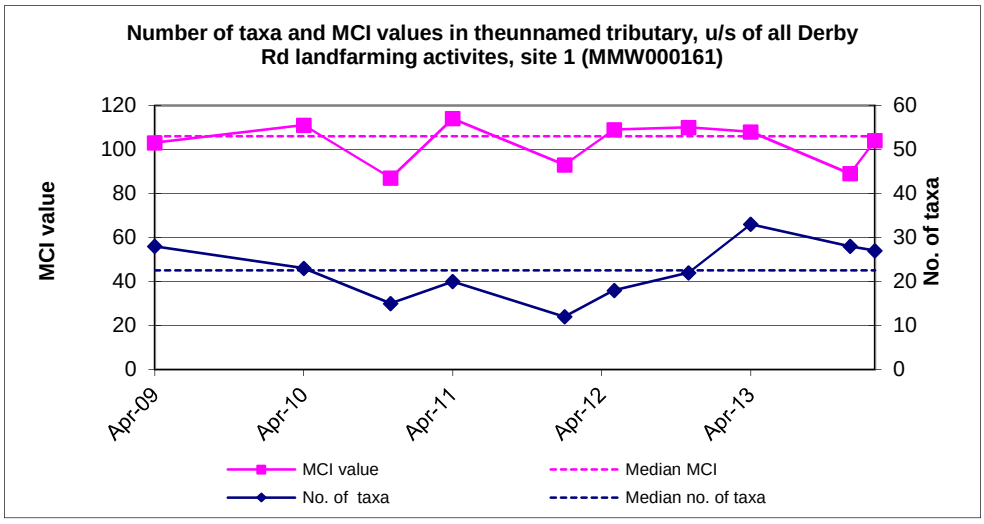

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary

Site 2

A lower richness (19 taxa) was recorded at site 2, eight taxa less than recorded at site 1 and 11 taxa less than the maximum richness recorded to date at this site (Table 2, Figure 3). The community was comprised of a high proportion of 'sensitive' taxa (74%) which was reflected in the moderate MCI score of 103 units; three units above the median score recorded at this site to date and an insignificant (Stark, 1998) one unit less than the score at the upstream 'control' site.

The community was numerically dominated by two 'tolerant' taxa; [ostracod seed shrimp and orthoclad midges], which resulted in the $SQMCI_s$ score of 3. 4 units, which was significantly lower than the score recorded at site 1, but slightly higher than the median to date for this site (by 0.3 unit). The abundance of orthoclad midges in particular, can be attributed to the increase in algal cover recorded at this site. There were only two significant differences in taxa abundances between site 1 and site 2 including the significant increase of one 'tolerant' and one moderately sensitive' taxon.

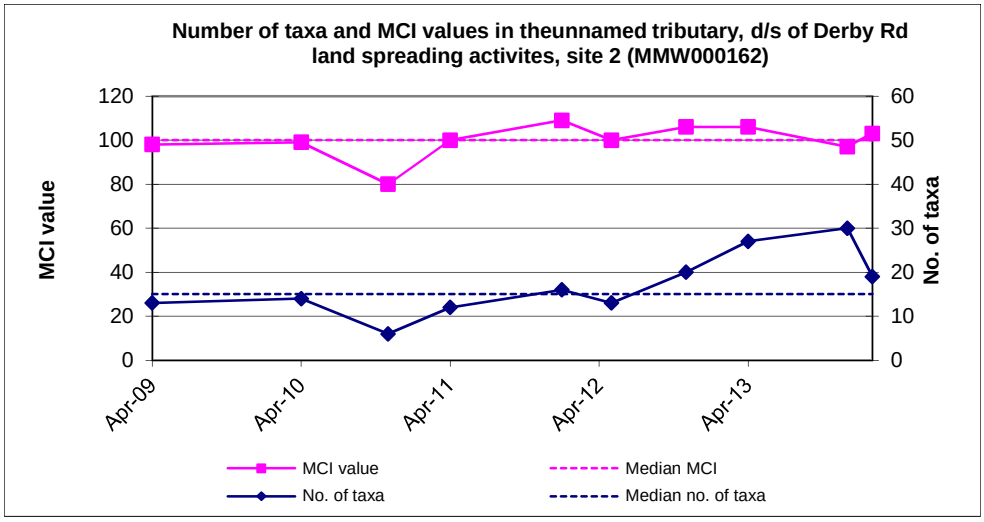

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in the unnamed tributary

Site 3

A moderate richness (16 taxa) was recorded at this site, one taxon less than the median richness, and three taxa fewer than the maximum richness recorded to date (Table 2, Figure 4). This community richness was 11 taxa lower than that recorded at site 1 and three taxa less than recorded at site 2. The community at site 3 comprised of a moderate proportion of 'sensitive' taxa (62 %) resulting in the MCI score of 100 units. This score was similar to the median of MCI scores recorded at this site by previous surveys and nine taxa less than the maximum score recorded at this site to date. The score was similar to that recorded at site 1 and 2.

Very sparse fauna were recorded at site 3. Taxa were recorded as either common (5-19 individuals) or rare (less than 5 individuals). Common taxa included five 'tolerant' taxa and one 'sensitive' taxon. The sparse taxa recorded at this site can be attributed to habitat change together with difficulty in sampling at this site. A moderate $SQMCI_s$ score of 3.9 was recorded for this site which was lower (by 0.5 unit) than the historical median score and lower (by 0.8 unit) than what was recorded at site 1(Stark, 1998).

These results indicated no further deterioration from the upstream control site 1 and no effects from drilling wastes storage and/or discharge activities nearby.

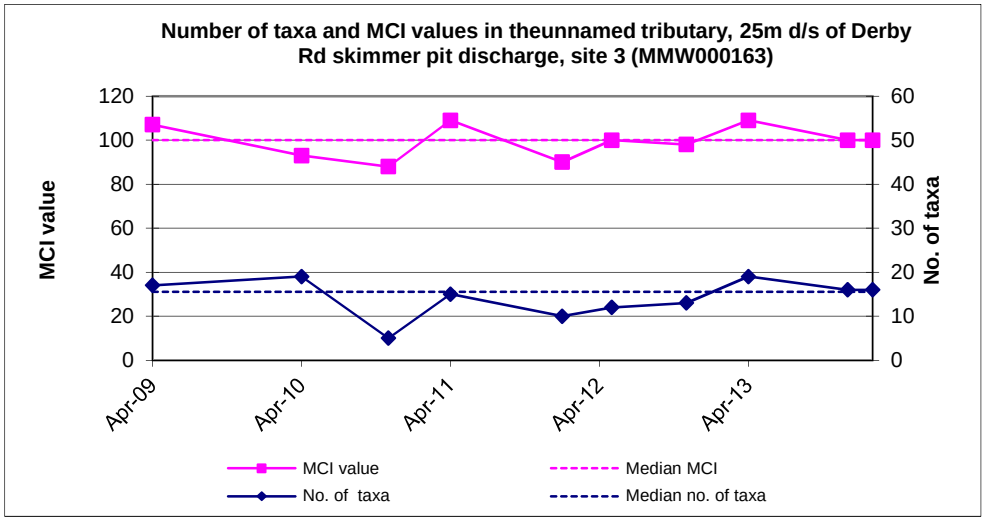

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in the unnamed tributary

Site 4

A moderate richness of 15 taxa was recorded at site 4, which was one taxon less than site 3 and 12 taxa less than the upstream control site. This richness was three taxa below the historical maximum for the site (Table 2).

The community was comprised of a moderate proportion of 'sensitive' taxa (53 %) (Table 3). This contributed to the MCI score of 91 units, which was two units below the median for the site, and thirteen units below the maximum score previously recorded at this site (Figure 5). This score was slightly lower than that recorded at site 3 but significantly (Stark, 1998) lower than that recorded at site 1 and site 2.

Like site 3, very sparse fauna were recorded at site 4, with only one taxon recorded in abundance. Common taxa (5-19 individuals) included three 'tolerant' taxa, one 'moderately sensitive' taxon and one 'highly sensitive' taxon. The moderate $SQMCI_s$ score of 4.9 units was principally due to the numerical dominance of the community by one abundant 'moderately sensitive' taxon, free-living caddis (*Polyplectropus*).This $SQMCI_s$ score was significantly higher than the median recorded at the site to date (by 0.9 unit) and similar to $SQMCI_s$ score recorded at the upstream 'control' site (1), but significantly higher than that recorded at site 2 and site 3.

The results at site 4 in the current survey are average for MCI score and above average for $SQMCI_s$ score, although slightly below those recorded by the previous survey. Results suggest that there was no impact from upstream landfarming activities.

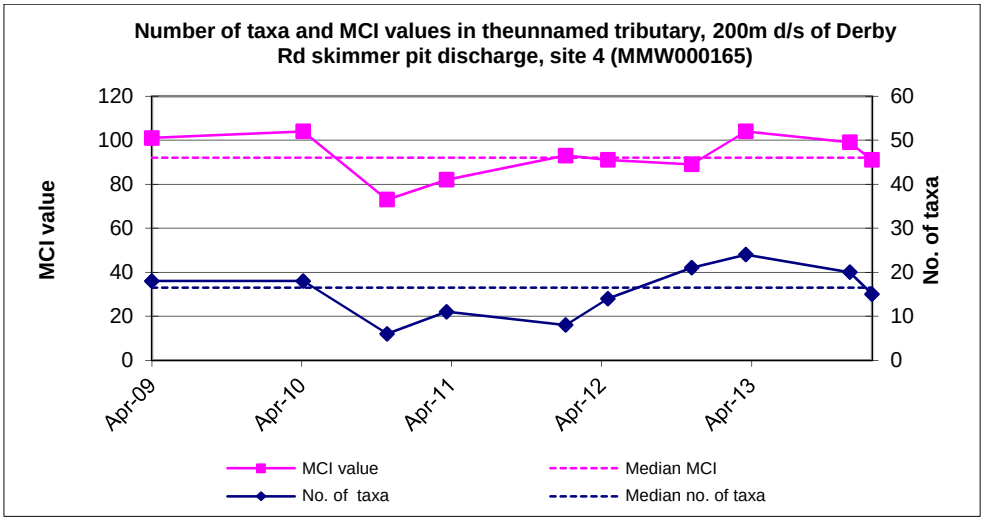

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in the unnamed tributary

Summary and conclusions

On 10 February 2014, a four site macroinvertebrate survey of an unnamed tributary of the Mangamawhete Stream was performed to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site.

In the current survey, the $SQMCI_s$ score recorded at the upstream 'control' site was significantly lower than the median score recorded at this site in previous surveys, indicating upstream activities had possibly caused a deterioration in preceding water quality at this site. This score was however significantly (Stark, 1998) higher than that recorded by the previous survey, which reflected some improvement at this site since the December 2013 survey. The MCI score and taxa richnesses were similar to the historical medians for this site.

The results of this survey indicated that there was only slight deterioration in the condition of the macroinvertebrate community at site 2, located between the land treatment area and the storage pits, and upstream of the stormwater discharge outfall. There was a significant (Stark, 1998) decrease in $SQMCI_s$ score (by 1.3 units) between site 1 and site 2, although there were no significant differences in MCI scores. There were only two significant differences in taxon abundances between site 1 and site 2, which can be attributed mainly to increased algal cover at this site, rather than to impacts caused by landfarming activities.

The macroinvertebrate communities at the two downstream sites (3 and 4) were characterised by reduced (when compared to the upstream 'control' site) but above average taxa richnesses and at both sites. The MCI score recorded at site 3 was not significantly different to those recorded at site 1 and site 2, however the MCI score recorded at site 4 was significantly (Stark, 1998) lower than those recorded at sites 1 and 2. Despite this, the $SQMCI_s$ score recorded at site 4 was the highest for this survey and was significantly (Stark, 1998) higher than the median recorded by previous surveys for this site. This indicated that the impacts of upstream land farming activities that were possibly recorded in previous surveys were no longer present and that no further deterioration from site 1 had occurred.

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach surveyed, although some impacts caused by habitat variability were noted. In general, however, poorer community richnesses and diversities of the macroinvertebrate communities within this upper reach (near the source) of a ringplain stream in comparison with similar streams elsewhere on the ringplain (Stark & Fowles, 2009/TRC, 1999) reflect the paucity of riparian and other habitat and the influence of iron-rich groundwater seepage along the length of stream surveyed.

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