

CD Boyd Drilling Waste Stockpiling
Landfarm/Landspreading
Monitoring Programme
Annual Report
2017-2018

Technical Report 2018-41

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Executive summary

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

The consent holder holds five resource consents, which include a total of 79 conditions setting out the requirements that they must satisfy. One of which is through a subsidiary company which is owned by the consent holder; Surrey Road Landfarms Ltd. The consent holder holds three consents to stockpile and landfarm drilling waste to land, one consent to discharge stormwater to the unnamed tributary of the Mangamawhete Stream and one consent to discharge water treatment sludge to land.

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

The Council's monitoring programme for the year under review included 16 inspections, 33 water samples and 10 composite soil samples collected for physicochemical analysis. Four biomonitoring surveys of receiving waters were also undertaken on the unnamed tributaries of the Mangamawhete and Mangatengehu Streams.

Derby Road stockpiling facility: Soil sample analysis identified elevated hydrocarbons that were within consent conditions and this newly landfarmed area will be monitored until consent surrender concentrations have been reached. Pasture had been sown and growth was observed, post landfarming. Additional seeding in spring may be required. Biomonitoring and groundwater monitoring did not indicate any adverse effects this period.

Surrey Road stockpiling facility: No adverse effects were noted in the groundwater monitoring however, trace hydrocarbons were recorded discharging from a nova coil from under one of the storage cells. The discharge and surface monitoring did not indicate any measurable hydrocarbons or other analytes of concern during the two rounds undertaken. Conversely, biological monitoring did indicate that the instream communities below the discharge have been adversely affected in the unnamed tributary of the Mangatengehu Stream. Quarterly surface water and discharge monitoring will be reinstated as the facility is likely to become operational in the upcoming monitoring period.

In terms of landfarming, apart from the farming which occurred within the Derby Road site, no new landfarming was undertaken. Six paddocks were sampled this period. One of the six, (paddock 84) was found to be above the limit for surrender. Paddock 22 was found to have been landfarmed after a second sample was collected. This contrasted with the consent holder's records.

During the year, the consent holder demonstrated a good level of environmental performance and an improvement is required for administrative performance with their resource consents. An overall good performance rating was awarded, this was downgraded from a high due to the impact that was noted on the biological communities. The grading of the administrative performance related to record keeping and provision of data to the Council in the required timeframes.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

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

This report includes recommendations for the 2018-2019 year.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2017 to June 2018 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Colin Boyd (hereafter the consent holder) and his subsidiary company, Surrey Road Landfarms Ltd. The consent holder operates two stockpiling facilities, Derby Road stockpiling facility and Surrey Road stockpiling facility; while Surrey Road Landfarms Ltd hold consent for the application of the material to land.

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

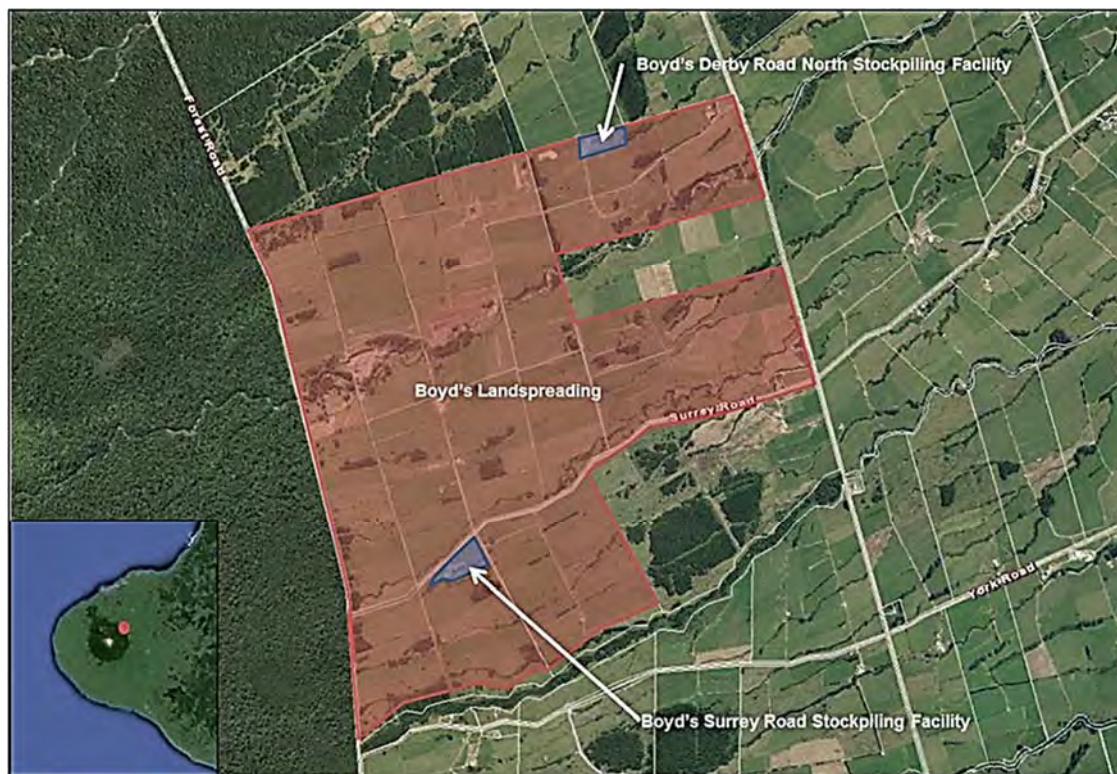


Figure 1 Derby and Surrey Road stockpiling facilities with associated landspreading area

This report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the consent holder that relate to the discharges of drilling material within the Waitara catchment.

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

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

1.1.2 Structure of this report

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

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites through annual programmes;
- the resource consents held by the consent holder in the Waitara catchment;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted in the consent holder's catchment.

Section 2, 3, 4 and 5 presents the results of monitoring during the period under review, including scientific and technical data.

Section 6 details any investigations, interventions and incidents if applicable.

Section 7 discusses the results, their interpretations, and their significance for the environment.

Section 8 presents recommendations to be implemented in the 2018-2019 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

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

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

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

1.1.4 Evaluation of environmental and administrative performance

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

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

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

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

Environmental Performance

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

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

For example:

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

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

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

Administrative performance

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

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

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

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

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

1.2.1 Hydrocarbon exploration and production wastes

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

1.2.2 Drilling wastes

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

1.2.3 Drilling fluids

Drilling fluids are engineered to perform several crucial tasks in the drilling of a hydrocarbon well. These include: transporting cuttings from the drill bit to the well surface for disposal; controlling hydrostatic pressure in the well; supporting the sides of the hole and preventing the ingress of formation fluids; and lubricating and cooling the drill bit and drill pipe in the hole. Oil and gas wells may be drilled with either synthetic based mud (SBM) or water based mud (WBM). As the names suggest, these are fluids with either water (fresh or saline) or synthetic oil as a base material, to which further compounds are added to modify the physical characteristics of the mud (for example mud weight or viscosity).

More than one type of fluid may be used to drill an individual well. In the past, oil based muds (diesel/crude oil based) have also been used. Their use has declined since the 1980s due to their ecotoxicity; they have been replaced by SBM. SBM use olefins, paraffins or esters as a base material. While this is technically still a form of oil based fluid, these fluids have been engineered to remove polynuclear aromatic hydrocarbons, reduce the potential for bioaccumulation and accelerate biodegradation compared with OBM.

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

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

1.2.4 Cuttings

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

1.2.5 Landfarming process description

Basic steps in the landfarming process include:

1. Drilling waste is transported from a specific wellsite by truck (cuttings) or tanker (liquids). It is placed in a dedicated, fit for purpose, lined storage cell. At the consent holder's facilities cuttings arrive from site in metal 'D' bins directly collected from the wellsite. Material is subjected to an analytical screen undertaken in a registered laboratory. The analysis is dictated by specific consent conditions.
2. The required area is prepared by scraping back and stockpiling existing pasture/topsoil and leveling out uneven ground.
3. Waste is transferred to the prepared area by excavator and truck and spread out with a bulldozer. Liquids may be discharged by tanker or a spray system.
4. Waste is allowed to dry sufficiently before being tilled into the soil to the required depth with a tractor and discs.
5. The disposal area is levelled with chains or harrows.
6. Stockpiled or brought in topsoil/clay is applied to aid stability and assist in grass establishment.
7. Fertiliser may be applied and the area is sown in crop or pasture at a suitable time of year.

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

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

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



Photo 1 The landspreading unit utilised by the consent holder

An auger in the base of the spreader conveys material back and through an opening (where the size is controlled by a sliding plate) where it contacts two rapidly rotating augers and is applied up to 10 m on either side. The deposition rate is controlled by the size of the opening at the rear of the unit and the speed of forward travel by the tractor. The waste is deposited onto existing pasture in small fragments, which are allowed some time to dry out before chain harrows and roman discs are used to till and break-up the waste which is dispersed back into the soil, as shown in Photo 2.



Photo 2 Tilling of the soil post landspreading

1.3 Resource consents

The consent holder holds five resource consents the details of which are summarised in Table 1 below and outlined in sections 1.3.1 to 1.3.2.

Table 1 Summary of consents held by CD Boyd Landfarming

Consent number	Purpose	Granted	Review	Expires
7911-1	To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream, in the Waitara catchment.	27 Sep 2011	June 2021	1 June 2027
6900-2	To discharge drilling wastes onto and into land for the purpose of stockpiling prior to disposal.	16 Feb 2011	June 2021	1 June 2027
7559-1.3	To discharge drilling waste cuttings from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming and landspreading, injection spreading and irrigation.	20 Nov 2009	June 2019	1 June 2027
7591-1.1	To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading.	21 Jan 2010	June 2019	1 June 2027
5821-2.2	To discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki Districts' onto and into land	14 Dec 2005	June 2021	1 June 2026

1.3.1 Water discharge permit

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

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

Condition 1 concerns adoption of the best practicable option.

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

Condition 5 relates to effects on surface water.

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

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

The permit is attached to this report in Appendix I.

1.3.2 Discharges of wastes to land

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

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

Condition 1 requires adoption of the best practicable option.

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

Conditions 5 and 6 are operational requirements.

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

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

Condition 11 is a review condition.

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

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

Condition 2 requires adoption of the best practicable option.

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

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

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

Conditions 8 to 16 detail discharge limits and loading rates.

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

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

Condition 24 and 25 detail the monitoring and reporting requirements.

Condition 26 and 27 are lapse and review conditions.

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

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

Conditions 3 to 9 detail the specific discharge limits.

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

Conditions 15 and 16 detail the receiving environment for water.

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

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

The consent holder also holds discharge consent **5821-2.2**, to discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki Districts' onto and into land. This permit was issued by the Council on 14 December 2005 under Section 87(e) of the RMA. It is due to expire on 1 June 2026. Location Surrey Road, Derby Road and surrounding land, as defined by consent.

Condition 1 concerns the adoption of the best practicable option and notifications.

Condition 2 details the exercise of consent in accordance with respect to the consent conditions.

Condition 3 and 4 details the notification requirements.

Condition 5 defines the discharge areas.

Condition 6 relates to bund and discharge requirements.

Condition 7 relates to discharge distances with respect to water courses.

Condition 8 no exceedance of specific total aluminium concentration within certain streams.

Condition 9 relates to total area of land allowed to be stripped at one time.

Condition 10 relates to re-vegetating land post application.

Condition 11 requires that the exercise of this consent shall not cause adverse impacts of groundwater/ surface water including aquatic ecosystems.

Condition 12 defines what effects should be avoided.

Condition 13 is a lapse condition.

Condition 14 relates to the review of consent.

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

1.4 Monitoring programme

1.4.1 Introduction

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

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

The monitoring programme for the stockpiling facilities of Derby and Surrey Roads and the associated landspreading areas consisted of five primary components.

1.4.2 Programme liaison and management

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

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

- consultation on associated matters.

1.4.3 Site inspections

The consent holder's stockpiling facilities and associated landspreading area were visited 16 times during the monitoring period. Additional inspections were also undertaken during sampling rounds for groundwater, surface water and soil sampling. With regard to consents the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Sources of data being collected by the consent holder were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

1.4.4 Chemical sampling

The Council collected samples of soil and water (groundwater and surface water) throughout the monitoring period. This is to assess the compliance of the consent holder with the consented conditions and to assess for any adverse effects arising from the facilities or activities of the consent holder.

1.4.4.1 Soil

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



Photo 3 An example of an extracted soil core

The analysis undertaken by the Council is provided in Table 2. Each transect is GPS referenced to allow for areas to be characterised and repeat analysis when required.

1.4.4.2 Water

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

- Surface water;
- Stormwater discharge; and
- Groundwater.

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

Surface water, groundwater, discharge and soil analytes are provided in Table 2 below.

Groundwater analysis results were obtained through the purpose built groundwater monitoring bore network. Derby and Surrey Road facilities each have three groundwater monitoring bores. These bores were installed to quantify the quality of the groundwater. Specifically to understand if any adverse effects were permeating from either facility through the storage of material in lined storage cells in the case of Surrey Road and clay lined cells in the case of Derby Road.

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

Table 2 Chemical analytes

Surface / Discharge water analytes	
Barium (acid soluble)	Calcium
Benzene	Chloride
Toluene	Conductivity
Ethylene	Total petroleum hydrocarbons
Xylene M/O	Suspended Solids
Biological oxygen demand (BOD)	Total dissolved salts (TDS)
Biochemical oxygen demand (BCOD)	Temperature
	pH
Groundwater analytes	
Barium (acid soluble)	Sodium
Barium (dissolved)	Level
Benzene	Nitrite-nitrate nitrogen
Toluene	Total dissolved salts (TDS)
Ethylene	Temperature
Xylene M/O	Level
Chloride	Total petroleum hydrocarbon
Conductivity	Biochemical oxygen demand (BCOD)
Soil analytes	
Calcium	Ammoniacal nitrogen
Chloride	Nitrite-nitrate nitrogen
Magnesium	pH
Sodium	Total soluble salts
Conductivity	Total recoverable heavy metals
Potassium	Total petroleum hydrocarbons
Moisture factor	Polycyclic aromatic hydrocarbons
Sodium absorption ratio (SAR)	Monocyclic aromatic hydrocarbons

1.4.5 Biomonitoring surveys

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

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

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

The analysis results of the biomonitoring surveys are discussed in more detail in Sections 2.3.5 and 3.3.3.

1.4.6 Review of analytical data

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

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

In an active stockpiling year, MI SWACO would undertake pre-screening analysis of the material which they received on site. This includes the collection of representative samples of the material which are then analysed by an independent laboratory for specific analytes (RJ Hill laboratory in Hamilton in this case). This is undertaken for all drilling material brought to the primary stockpiling site of Surrey Road.

Note that no stockpiling of material has been undertaken at Surrey Road since the March 2016.

MI SWACO in the previous monitoring period provided post spreading soil sampling analysis of the paddocks to which material was applied to through the practice of landfarming or landspreading. The chemical parameters for which they analysed are provided below. Note that no sampling was undertaken by MI SWACO this monitoring period.

Table 3 MI SWACO soil analytes

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

2 Derby Road North stockpiling facility

2.1 Site description

Derby Road North stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood (Figure 2). In previous monitoring years this was the primary stockpiling site for muds and cuttings. At the beginning of the 2011-2012 monitoring year activity slowed at the site. During the 2012-2013 monitoring year the Surrey Road site became the primary site while the Derby Road site remained unused and on standby to receive waste as a contingency or secondary site if required. While the site remained unused in the 2016-2017 monitoring period it still contained 1,000 m³ +/- of residual drilling material which needed to be landfarmed before the Council considered the site for surrender.

The consent holder undertook a cleaning out operation towards the end of the 2016-2017 monitoring period, whereby the remaining drilling muds were consolidated into one cell. These consolidated materials were then sampled by the consent holder and analysed. During this period the site was also utilised by the consent holder for the storage of water treatment sludge.

In the monitoring period covered by this report, the consent holder undertook landfarming at the Derby Road site, whereby the remaining consolidated material (aged drilling mud) and water treatment sludge was spread across the site area and landfarmed.

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

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

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

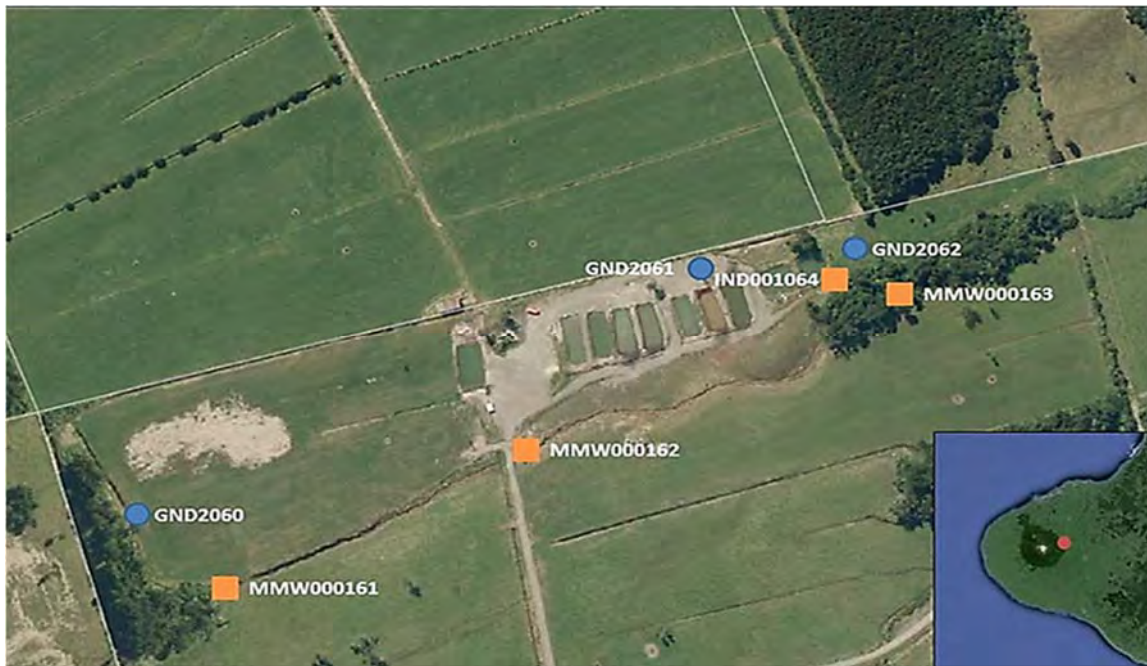


Figure 2 Derby Road stockpiling facility with sampling locations and regional insert

Site data

Location

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

2.2 Inspections

14 August 2017

At the time of inspection further works had occurred to incorporate muds into the soil. The lowest area of the site had obvious thick mud at the surface. Water treatment sludge and blue metal were observed stockpiled on the western end of the site. A bulldozer and power harrow were also present, but the weather was not conducive for running heavy machinery on the spreading area.

The ring drain along the southern perimeter of the spreading area was working well by directing run-off to the treatment ponds. No surface hydrocarbons were found on the ponds, and the discharge was clear, with no deleterious effects occurring at the time of inspection.

17 October 2017

At the time of inspection it was observed that no recent spreading activities had occurred and no drilling mud was being stockpiled on site. The spreading area where the storage pits were located was a work in progress. The weather had been far too wet over the winter/spring period to continue any works related to this development.

Muds were observed at the eastern end of the site, while treatment sludge was observed stockpiled at the western end of the spreading area. The ring drain was working well directing run-off into the stormwater ponds. The first pond was filled with sediment, while the second pond was deep. There was at the time, no discharge occurring to the receiving waters. The receiving waters were running clear and in moderate flow at the time. Iron oxide was prevalent throughout the stream. The historic spreading areas appeared healthy with good pasture cover.

15 November 2017

At the time of inspection soil sampling of the Derby Road stockpiling facility had been carried out. Three soil samples comprised of individual GPS transects were collected from the former stockpiling facility. The former storage cells had been flattened and the area turned into one large landfarmed paddock. The aim of the soil samples was to ascertain the scale of remediation required in this newly landfarmed area.

7 March 2018

At the time of inspection no recent mud deliveries had occurred. The storage pits have been removed completely. No further work had been carried out to incorporate the residual mud across the historical storage area. There were distinct drilling mud odours present at the time of inspection. Muds were prevalent on the soil surface. Further work was required before pasture could be established.

The two treatment ponds at the bottom end of the site were not removed, and run-off from the spreading area was being directed into them. Both ponds were free of any hydrocarbon sheen. No discharges were occurring and no deleterious effects were observed within the receiving waters at time of inspection.

22 May 2018

At the time of inspection the site had been levelled and pasture strike was occurring. The discharge from the storage treatment ponds was clear, with no deleterious effects being observed in the receiving waters.

23 May 2018

At the time of inspection the storage area had been extensively worked. Drilling muds and water treatment sludge had been harrowed into the soil profile and the area had been flattened by a bulldozer. The topsoil was stable and any run-off that was occurring was directed into the treatment ponds. The ponds were not discharging. The receiving waters were observed and found to be in moderate flow and running clear. No fugitive discharges or deleterious effects were observed.

2.3 Results of receiving environment monitoring

2.3.1 Drilling mud deliveries/stockpiled

The Derby Road stockpiling facility was closed to the receipt of drilling material. In this period the consent holder landfarmed the residual drilling material, which had been in storage for longer than four years estimated at 1,000 m³, to land. This material was farmed inside the Derby Road stockpiling facility site

boundaries. It also included water treatment sludge which the consent holder had been dewatering under the practice of lagooning.

For future monitoring, this area will be treated as a landfarmed area and will be monitored until consent surrender conditions are achieved as defined in consent 7591-1.1.

During the monitoring period all of the storage cells on the Derby Road stockpiling site were flattened and drilling muds incorporated into the soil.

2.3.2 Stormwater

The facility holds stormwater discharge consent 7911-1; to discharge stormwater from drilling waste storage into the unnamed tributary of the Mangamawhete Stream. In this monitoring period no discharge sample was collected as the site no longer discharges.

2.3.3 Council groundwater monitoring

Two groundwater monitoring wells currently remain active on the Derby Road site. GND2061 was sampled three times during this period, but was removed as a result of the storage facility being transformed into a landfarm area. GND2060 and GND2062 were sampled on four occasions this monitoring period. The analysis is provided in the tables below.

Table 4 Derby Road monitoring well GND2060, 2017-2018

Groundwater	Site	GND2060	GND2060	GND2060	GND2060
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 Apr 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.024	0.025	0.022	<0.11
Barium (dissolved)	g/m ³	0.024	0.024	0.023	0.021
Chloride	g/m ³	8.5	12	8.7	7.1
Conductivity	mS/m@20°C	6.8	7.5	6.6	7.7
Sodium	g/m ³	5.7	8.3	5.7	5
Nitrate/nitrite nitrogen	g/m ³ N	0.08	<0.01	0.12	0.26
pH	pH	5.8	6.2	5.9	6.6
Level	m	2.665	2.855	N/A	2.521
Temperature	°C	11.9	13.2	15.6	11.4
Benzene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
C ₇ -C ₃₆	g/m ³	<0.7	<1.3	<0.7	<0.7
C ₁₅ -C ₃₆	g/m ³	<0.4	<0.8	<0.4	<0.4
C ₁₀ -C ₁₄	g/m ³	<0.2	<0.4	<0.2	<0.2
C ₇ -C ₉	g/m ³	<0.06	<0.06	<0.06	<0.06
Ethylbenzene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Toluene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Xylene-M	g/m ³	<0.002	<0.002	<0.002	<0.002

Groundwater	Site	GND2060	GND2060	GND2060	GND2060
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 Apr 2018	25 Jun 2018
Xylene-O	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Total dissolved salts	g/m ³	52.6	58	51.1	64

Table 5 Derby Road monitoring well GND2061, 2017-2018

Groundwater	Site	GND2061	GND2061	GND2061	GND2061
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 Apr 2018	
Barium (acid soluble)	g/m ³	0.041	0.126	0.134	Well destroyed
Barium (dissolved)	g/m ³	0.039	0.094	0.143	
Chloride	g/m ³	23.4	138	91.6	
Conductivity	mS/m@20°C	22.6	75.3	42.6	
Sodium	g/m ³	7.6	22.3	16	
Nitrate/nitrite nitrogen	g/m ³ N	<0.01	0.02	0.01	
pH	pH	6.4	6.4	6.3	
Level	m	1.855	1.178	1.63	
Temperature	°C	12.9	14.6	16.2	
Benzene	g/m ³	<0.0010	<0.0010	<0.0010	
C ₇ -C ₃₆	g/m ³	<0.7	<0.7	<0.7	
C ₁₅ -C ₃₆	g/m ³	<0.4	<0.4	<0.4	
C ₁₀ -C ₁₄	g/m ³	<0.2	<0.2	<0.2	
C ₇ -C ₉	g/m ³	<0.06	<0.06	<0.06	
Ethylbenzene	g/m ³	<0.0010	<0.0010	<0.0010	
Toluene	g/m ³	<0.0010	<0.0010	<0.0010	
Xylene-M	g/m ³	<0.002	<0.002	<0.002	
Xylene-O	g/m ³	<0.0010	<0.0010	<0.0010	
Total dissolved salts	g/m ³	174.9	582.6	329.6	

Table 6 Derby Road monitoring well GND2062, 2017-2018

Groundwater	Site	GND2062	GND2062	GND2062	GND2062
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 Apr 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.049	0.081	0.091	<0.11
Barium (dissolved)	g/m ³	0.047	0.081	0.095	0.031
Chloride	g/m ³	22.5	12.3	54.7	7.3
Conductivity	mS/m@20°C	14.4	12.6	19.2	6.6

Groundwater	Site	GND2062	GND2062	GND2062	GND2062
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 Apr 2018	25 Jun 2018
Sodium	g/m ³	6.1	6.6	10	5.4
Nitrate/nitrite nitrogen	g/m ³ N	<0.01	<0.01	0.01	0.036
pH	pH	6.0	5.8	5.5	6.3
Level	m	1.218	1.683	0.890	0.532
Temperature	°C	13.7	14.6	18.6	11.7
Benzene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
C ₇ -C ₃₆	g/m ³	<0.7	<0.7	<0.7	<0.7
C ₁₅ -C ₃₆	g/m ³	<0.4	<0.4	<0.4	<0.4
C ₁₀ -C ₁₄	g/m ³	<0.2	<0.2	<0.2	<0.2
C ₇ -C ₉	g/m ³	<0.06	<0.06	<0.06	<0.06
Ethylbenzene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Toluene	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Xylene-M	g/m ³	<0.002	<0.002	<0.002	<0.002
Xylene-O	g/m ³	<0.0010	<0.0010	<0.0010	<0.0010
Total dissolved salts	g/m ³	111.4	97.5	148.6	55

Groundwater monitoring of Derby Road stockpiling facility in the 2017-2018 period indicated negligible impacts as a result of the exercise of this consent.

- No hydrocarbon impacts were noted in any of the four rounds undertaken.
- All petroleum hydrocarbon analysis, including associated benzene, toluene, ethylbenzene and xylenes (BTEX) were found below the limit of detection in all three wells, across the four rounds of sampling undertaken.
- Total dissolved salt (TDS) concentrations were similarly low, though a slight increase was observed in GND2061 (582.6 g/m³ TDS) in the December 2017 sample. A similar increase was also seen in chloride concentrations within the same sample. The value of 582 g/m³ TDS was the most elevated concentration found to date with respect to TDS.
- pH monitoring indicated that the up gradient monitoring well, GND2060 was noted to range between 5.8-6.6 pH in the four monitoring rounds undertaken. While GND2062 ranged from 5.5-6.3 pH. GND2061 was steady and ranged from 6.3-6.4 pH.
- Monitoring well GND2061 was not able to be sampled in the June 2018 monitoring round. The landfarming works of the area resulted in the destruction of this monitoring well location.

2.3.4 Derby Road soil samples

When required drilling muds have been stored at the Derby Road site, prior to them being farmed across the consent holder's paddocks. In this monitoring period, the storage cells which are visible in Figure 3, were flattened and the drilling muds incorporated into the soil across the storage cell area. This resulted in the site area now being a landfarmed area. Four soil samples were collected by the Council in this monitoring

period. Three were collected in November 2017, defined as transect A, B and C in Figure 3, while one (transect D), was collected in June 2018. The results are presented in Table 7.



Figure 3 Council soil sample locations Derby Road 2017-2018

Table 7 Derby Road soil sample results 2017-2018

Derby Road Soils	Transect	Consents limit	A	B	C	D
Parameter	Collected	6900-2/ 7591-1.1	15 Nov 2017	15 Nov 2017	15 Nov 2017	26 Jun 2018
1-Methylnaphthalene	mg/kg dry wt		0.24	0.38	0.51	0.077
2-Methylnaphthalene	mg/kg dry wt		0.41	0.67	0.88	0.15
Acenaphthene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Anthracene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Acenaphthylene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	2.1
Benzo[a]anthracene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.027	< 0.15	< 0.14	< 0.15	< 0.013
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES	mg/kg dry wt		< 0.4	< 0.4	< 0.4	< 0.04
Benzo[a]pyrene Toxic Equivalence (TEF)	mg/kg dry wt		< 0.4	< 0.4	< 0.4	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Benzo[e]pyrene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Benzo[g,h,i]perylene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013

Derby Road Soils	Transect	Consents limit	A	B	C	D
Parameter	Collected	6900-2/ 7591-1.1	15 Nov 2017	15 Nov 2017	15 Nov 2017	26 Jun 2018
Benzo[k]fluoranthene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Chrysene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Dibenzo[a,h]anthracene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Dry matter	g/100g as rcvd		67	72	71	75
Fluoranthene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Fluorene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Napthalene	mg/kg dry wt	7.2	< 0.8	< 0.7	< 0.8	< 0.07
Perylene	mg/kg dry wt		< 0.15	< 0.14	< 0.15	< 0.013
Phenanthrene	mg/kg dry wt		< 0.15	< 0.14	0.17	0.051
Pyrene	mg/kg dry wt	160	< 0.15	< 0.14	< 0.15	< 0.013
C7 - C9	mg/kg dry wt	210	< 9	11	9	< 8
C10 - C14	mg/kg dry wt	150	1,470	2,600	3,000	750
C15 - C36	mg/kg dry wt	1,300	30,000	22,000	28,000	10,300
Total hydrocarbons (C7 - C36)	mg/kg dry wt	20,000	32,000	24,000	31,000	11,000
Benzene	mg/kg dry wt	1.1	< 0.07	< 0.06	< 0.06	< 0.06
Toluene	mg/kg dry wt	82	< 0.07	0.14	0.08	< 0.06
Ethylbenzene	mg/kg dry wt	59	0.08	0.44	0.19	< 0.06
m&p-Xylene	mg/kg dry wt	59	< 0.14	0.52	0.29	< 0.12
o-Xylene	mg/kg dry wt	59	< 0.07	0.26	0.15	< 0.06
Total Recoverable Arsenic	mg/kg dry wt	17	5	4	4	3
Total Recoverable Cadmium	mg/kg dry wt	0.8	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	600	24	18	25	24
Total Recoverable Copper	mg/kg dry wt	100	41	36	36	38
Total Recoverable Nickel	mg/kg dry wt	60	6.7	7.4	7	14

Derby Road Soils	Transect	Consents limit	A	B	C	D
Parameter	Collected	6900-2/ 7591-1.1	15 Nov 2017	15 Nov 2017	15 Nov 2017	26 Jun 2018
Total Recoverable Mercury	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10	-
Total Recoverable Lead	mg/kg dry wt	160	20	16	19	5.6
Total Recoverable Zinc	mg/kg dry wt	300	52	47	47	44
Sodium absorption ratio	SAR	8	-	-	-	0.7
Soluble salts	mg/kg	2,500	-	-	-	1,800
Chloride	mg/kg dry wt	700	-	-	-	510
Nitrite/Nitrate Nitrogen	mg/kg dry wt		-	-	-	< 1.0
pH	pH Units		-	-	-	7.7
Total Recoverable Calcium	mg/kg dry wt		-	-	-	26,000
Total Recoverable Potassium	mg/kg dry wt		-	-	-	840
Total Recoverable Magnesium	mg/kg dry wt		-	-	-	2,700
Total Recoverable Sodium	mg/kg dry wt	460	-	-	-	640
Conductivity	mS/m	290	-	-	-	50
Ammoniacal Nitrogen	mg/kg dry wt		-	-	-	< 5

The analysis was compared to the consent conditions where applicable. The concentrations above the surrender criteria are in bold (defined by the consent). The analysis specially denoted the following:

- Total petroleum hydrocarbons (TPH) C₇-C₉. No concentrations above the surrender criteria were confirmed (<210 mg/kg). There were, however, measurable concentrations of this carbon chain, 9-11 mg/kg, in two of the four soil samples collected.
- TPH C₁₀-C₁₄ analysis confirmed concentrations currently above the surrender criteria (> 150 mg/kg) in all four samples analysed. The range, 750-3,000 mg/kg, denoted some variation across the four transects. Of note, transect D (750 mg/kg), which was collected from the same location as transect B (2,600 mg/kg) seven months later, detailed a decrease in concentration. The variation between the two sample results indicated that the process of natural attenuation was occurring. This was coupled with re-working and seeding exercises undertaken by the consent holder.
- TPH C₁₅-C₃₆ reported concentrations were all above the surrender criteria in all four samples analysed this period. The range, 10,300-30,000 mg/kg, indicated variation. In similarity to the above carbon chain. Transects B and D were collected along the same transect seven months apart and again suggested a significant reduction in concentrations between sample events.

- TPH C₇-C₃₆ indicated concentrations ranging from 22,000-30,000 mg/kg which would be in breach of condition 10 from consent 7591-1.1. This condition requires that an area of landfarmed soil must not exceed 2% or 20,000 mg/kg TPH at any point post soil incorporation. However, as the consent holder had not fully completed his operation at the time of the initial analysis (November 2017) and the follow up analysis, undertaken in June 2018, indicated compliance with this condition with a value of 11,000 mg/kg (1.1% TPH).
- Benzene: No analysis above the limit of detection was reported across the four soil samples collected this period.
- Toluene: Trace toluene was recorded in two of the four samples (B and D) this period, 0.08-0.14 mg/kg.
- Ethylbenzene: Three trace results were reported in transects A, B and C this period, ranging from 0.08-0.44 mg/kg. These concentrations are within surrender concentrations which are defined by the consent at 59 mg/kg.
- Xylenes M/P/O: Two trace concentrations were observed in transects C and D this period. These ranged at trace concentrations for xylene M&P 0.29-0.59 mg/kg and xylene O 0.15-0.26 mg/kg.
- Total recoverable heavy metals: No concentrations of heavy metals in the three rounds of heavy metals analysis were found above or close to surrender concentrations.
- Total recoverable sodium: The singular analysis of sodium (transect D) indicated that this analyte is still above the conditional limit for surrender, as defined by consent with a value of 640 mg/kg. The consent limit for surrender is defined as 460 mg/kg.

The Council will continue to monitor this landfarmed location until surrender concentrations have been achieved.

2.3.5 Biological monitoring

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. Two surveys were conducted, one in late spring, December 2017 and the follow up, in summer, April 2018. A brief synopsis of both surveys is provided below the methods section. The reports in full are attached in Appendix II.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200 m downstream of the skimmer pit discharge. This fourth site provides comparative information should deterioration be recorded at sites 2 or 3. Locations of the sampling sites are presented in Table 8 and Figure 3.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Figure 4) to collect streambed macroinvertebrates in December 2017. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 8 Biomonitoring locations in relation to the unnamed tributary of the Mangamawhete Stream

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



Figure 4 Biomonitoring sites in the unnamed tributary of the Mangamawhete Stream

Summary of the late spring 2017 biomonitoring survey

Overall, the results of this spring survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach of the Mangamawhete Stream. MCI scores indicated 'fair' to 'good' macroinvertebrate community health in the Mangamawhete Stream, and scores were similar to median scores for each site respectively.

Summary of the late summer 2018 biomonitoring survey

Overall, the results of this summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach of the Mangamawhete Stream surveyed. MCI scores indicated 'good' macroinvertebrate community health, and scores were similar to or higher than median scores for each site respectively.

3 Surrey Road stockpiling facility

3.1 Site description

The Surrey Road stockpiling facility (Figure 5) is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. An unnamed tributary of the Mangatengehu Stream flows adjacent to the facility. The proximity of the site to this recognised ecosystem has been taken into account in the setting of buffer distances and location of the stockpiling facilities.

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

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



Figure 5 Surrey Road stockpiling facility with associated sample locations and regional inset

Site data

Location

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

3.2 Inspections

17 October 2017

At the time of inspection no recent spreading activities had occurred on site, and no stockpiled muds were present.

8 February 2018

At the time of inspection no recent changes had occurred on site. No deliveries had been received and no recent spreading had been carried out. The discharge from stormwater ponds into the receiving waters were clear and no deleterious effects were observed.

6 March 2018

At the time of inspection it was noted that no recent deliveries had occurred and no muds were stored in any of the storage pits. On observation, all pits were holding varying levels of stormwater. Hydrocarbons were visible on the surface of the first and second storage pit, and the oily waste pit, while the discharge from the nova flow pipe contained a distinct hydrocarbon sheen.

The gooseneck pipe appeared to be working without issue as the second pond was clear of any sheen, the discharge from this pond was clear and no harmful effects were observed in the receiving waters. The unused mud tanks remained on-site, and the skimmed hydrocarbon tank remained at +/- 20,000 litres and was secure at the time of inspection.

In respect to the landfarming operation, no recent mud disposal had occurred and all pasture across previously spread areas looked healthy.

23 May 2018

At the time of inspection no recent mud deliveries had occurred and all of the storage pits were empty except for residual mud. Bulk skimmed oil remained stored in a secure tank on-site, and the vertical storage tanks were empty. The liner in the irrigation pond (cell 3) was inflated. The buried pipe under the storage pit was seen discharging into the receiving drain with a visible rainbow sheen. Windblown surface

hydrocarbons were observed in the receiving pond. The discharge into the receiving waters was clear and no adverse effects were observed

3.3 Results of receiving environment monitoring

3.3.1 Surrey Road groundwater monitoring

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

The wells were sampled on four occasions this period. The results of the quarterly monitoring are provided in the following tables below.

Table 9 Surrey Road monitoring well GND2165, 2017-2018

Groundwater	Site	GND2165	GND2165	GND2165	GND2165
Parameter	Collected	15 Nov 2017	13 Dec 17	5 Apr 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.017	Dry	0.014	<0.11
Barium (dissolved)	g/m ³	0.015		0.014	0.023
Chloride	g/m ³	7.1		7.3	8.5
Conductivity	mS/m@20°C	8		7.4	8.5
Sodium	g/m ³	4.3		4.9	4.8
Nitrate/nitrite nitrogen	g/m ³ N	1.29		1.02	1.94
pH	pH	6.1		6.1	6.3
Level	m	3.398		3.18	2.934
Temperature	°C	11.4		15.6	12.3
Benzene	g/m ³	<0.0010		<0.0010	NR
TPH C ₇ -C ₃₆	g/m ³	<0.7		<0.7	NR
TPH C ₁₅ -C ₃₆	g/m ³	<0.4		<0.4	NR
TPH C ₁₀ -C ₁₄	g/m ³	<0.2		<0.2	NR
TPH C ₇ -C ₉	g/m ³	<0.06		<0.06	NR
Ethylbenzene	g/m ³	<0.0010		<0.0010	NR
Toluene	g/m ³	<0.0010		<0.0010	NR
Xylene-M	g/m ³	<0.002		<0.002	NR
Xylene-O	g/m ³	<0.0010		<0.0010	NR
Total dissolved salts	g/m ³	61.9		57.3	64
NR= No result Dry well= monitoring well water content insufficient to collect sample					

Table 10 Surrey Road monitoring well GND2166, 2017-2018

Groundwater	Site	GND2166	GND2166	GND2166	GND2166
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 April 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.018	0.025	0.0153	<0.11
Barium (dissolved)	g/m ³	NR	0.024	0.0157	0.027
Chloride	g/m ³	6.4	8.6	7.9	11.6
Conductivity	mS/m@20°C	4.7	6.2	5.4	9.4
Sodium	g/m ³	4.8	6.2	5.7	6.9
Nitrate/nitrite nitrogen	g/m ³ N	0.44	0.55	1.45	3.4
pH	pH	5.5	5.7	5.6	6.3
Level	m	1.745	2.224	1.60	1.290
Temperature	°C	13.3	13.5	15.9	10.4
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
TPH C ₇ -C ₃₆	g/m ³	< 0.7	< 0.7	< 0.7	< 0.7
TPH C ₁₅ -C ₃₆	g/m ³	< 0.4	< 0.4	< 0.4	< 0.4
TPH C ₁₀ -C ₁₄	g/m ³	< 0.2	< 0.2	< 0.2	< 0.2
TPH C ₇ -C ₉	g/m ³	< 0.06	< 0.06	< 0.10	< 0.06
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Xylene-M	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002
Xylene-O	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m ³	36.4	48	41.8	67

Table 11 Surrey Road monitoring well GND2167, 2017-2018

Groundwater	Site	GND2167	GND2167	GND2167	GND2167
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 April 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.033	0.058	0.029	<0.11
Barium (dissolved)	g/m ³	0.033	0.057	0.030	0.075
Chloride	g/m ³	7.9	12.1	11.2	18.2
Conductivity	mS/m@20°C	7.8	10.8	8.7	15.1
Sodium	g/m ³	5.7	6.9	7.5	13.0
Nitrate/nitrite nitrogen	g/m ³ N	0.11	0.01	0.79	4.2
pH	pH	5.6	5.7	5.6	5.9
Level	m	2.289	2.544	2.212	1.914

Temperature	°C	12.8	13.6	16.3	12.3
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
TPH C ₇ -C ₃₆	g/m ³	< 0.7	< 0.7	< 0.7	< 0.7
TPH C ₁₅ -C ₃₆	g/m ³	< 0.4	< 0.4	< 0.4	< 0.4
TPH C ₁₀ -C ₁₄	g/m ³	< 0.2	< 0.2	< 0.2	< 0.2
TPH C ₇ -C ₉	g/m ³	< 0.06	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Xylene-M	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002
Xylene-O	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m ³	60.3	83.6	67.3	90

Table 12 Surrey Road pipe monitoring location GND2517, 2017-2018

Groundwater	Site	GND2517	GND2517	GND2517	GND2517
Parameter	Collected	15 Nov 2017	13 Dec 2017	5 April 2018	25 Jun 2018
Barium (acid soluble)	g/m ³	0.16	0.30	0.23	0.15
Barium (dissolved)	g/m ³	0.16	0.30	0.23	0.15
Chloride	g/m ³	41.3	12.7	38.8	28
Conductivity	mS/m@20°C	27.5	35.9	27.4	26.6
Sodium	g/m ³	10.1	14.9	9.9	8.9
Nitrate/nitrite nitrogen	g/m ³ N	0.01	<0.01	0.01	0.006
pH	pH	6.5	6.6	6.5	6.6
Temperature	°C	13.6	21.9	15.4	12.4
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
TPH C ₇ -C ₃₆	g/m ³	24	<0.7	9.7	1.4
TPH C ₁₅ -C ₃₆	g/m ³	17	<0.4	8.3	1.1
TPH C ₁₀ -C ₁₄	g/m ³	6.5	<0.2	1.4	0.3
TPH C ₇ -C ₉	g/m ³	< 0.06	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Xylene-M	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002
Xylene-O	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m ³	212.3	277.8	212	138

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

- Total petroleum hydrocarbon analysis (C₇-C₉, C₁₀-C₁₄, C₁₅-C₃₆ and C₇-C₃₆) in the three groundwater monitoring wells (GND2165, 2166 and 2167) were all below the laboratory limit of detection, which are set at <0.10, <0.2, <0.4 and <0.7 g/m³ respectively.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) analysis of the three monitoring wells (GND2165, 2166 and 2167) were also below the limit of detection for these analytes, which are set at <0.001, <0.001, <0.001 and <0.002 and <0.001 g/m³ respectively.
- Total petroleum hydrocarbon analysis (C₇-C₉, C₁₀-C₁₄, C₁₅-C₃₆ and C₇-C₃₆) in the pipe sampling location (GND2517) indicated:
 - C₇-C₉ results were below the limit of detection for this analyte.
 - C₁₀-C₁₄ was observed in the four sampling rounds undertaken by the Council this period, ranging from 0.3-6.5 g/m³.
 - C₁₅-C₃₆ was also observed in the four sampling rounds undertaken by the Council, ranging from 0.4-17 g/m³.
 - C₇-C₃₆, which is the combined total of the previous three carbon chains, ranged across the four samples collected this period, 0.7-24 g/m³.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) of the pipe sample location (GND2517) were below the limit of detection for these analytes, which is set at <0.001, <0.001, <0.001 and <0.002 and <0.001 g/m³ respectively.
- Total dissolved salt concentrations were higher in the pipe sample (ranging 138-277 g/m³ TDS) than in the groundwater monitoring well samples (ranging 36.4-90 g/m³ TDS). This may reflect the pipe sample location which is in close proximity to the storage area, situated under storage cell three.
- Groundwater pH in all three monitoring wells were observed to range between pH 5.5 and 6.3 in all four monitoring rounds.

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

3.3.2 Surrey Road surface water

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

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

- pH: 6.0-9.0
- Oil and grease: 15 g/m³
- Biochemical oxygen demand: 5 g/m³
- Suspended solids: 100 g/m³
- Unionised ammonia: 0.025 g/m³
- And free chlorine: 0.2 g/m³

The results of the surface water and discharge sampling are provided in the following Tables 13 and 14. Each table represents the upstream surface water preceding the discharge (MTH000062) and post discharge (MTH000064) to ascertain for the effect of the discharge (IND001067) on the day of sampling.

Table 13 Surrey Road surface water monitoring, 15 November 2017

Surface water	Site	MTH000062	IND001067	MTH000064
Parameter	Collected	15 Nov 2017	15 Nov 2017	15 Nov 2017
Barium (acid soluble)	g/m ³		0.06	
Barium (dissolved)	g/m ³		0.06	
Bio-chemical oxygen demand	g/m ³	<0.5	0.6	<0.5
Chloride	g/m ³	5.8	17.0	7.5
Conductivity	mS/m@20°C	7.7	12.5	8.4
pH	pH	7.3	7.2	7.2
Temperature	°C	11.3	13.4	12.1
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010
C ₇ -C ₃₆	g/m ³	< 0.7	< 0.7	< 0.7
C ₁₅ -C ₃₆	g/m ³	< 0.4	< 0.4	< 0.4
C ₁₀ -C ₁₄	g/m ³	< 0.2	< 0.2	< 0.2
C ₇ -C ₉	g/m ³	< 0.06	< 0.06	< 0.06
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010
Xylene-M	g/m ³	< 0.002	< 0.002	< 0.002
Xylene-O	g/m ³	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m ³	59.6	96.7	65

Table 14 Surface water monitoring, 25 June 2018

Surface water	Site	MTH000060	IND001067	MTH000064
Parameter	Collected	25 Jun 2018	25 Jun 2018	25 Jun 2018
Bio-chemical oxygen demand	g/m ³	<2	<2	<2
Chloride	g/m ³	6.2	15.6	7.2
Conductivity	mS/m@20°C	8.1	14.3	9.0
pH	pH	6.9	6.8	7.6
Temperature	°C	9.0	8.1	9.0
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010
C ₇ -C ₃₆	g/m ³	<4	< 0.7	< 0.7
C ₁₅ -C ₃₆	g/m ³	<2	< 0.4	< 0.4
C ₁₀ -C ₁₄	g/m ³	<1	< 0.2	< 0.2
C ₇ -C ₉	g/m ³	< 0.06	< 0.06	< 0.06

Surface water	Site	MTH000060	IND001067	MTH000064
Parameter	Collected	25 Jun 2018	25 Jun 2018	25 Jun 2018
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010
Xylene-M	g/m ³	< 0.002	< 0.002	< 0.002
Xylene-O	g/m ³	< 0.0010	< 0.0010	< 0.0010
Total dissolved salts	g/m ³	68	65	74

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

- Total petroleum hydrocarbon (TPH) analysis (C₇-C₉, C₁₀-C₁₄, C₁₅-C₃₆ and C₇-C₃₆) of the three sample locations, resulted in no higher values than the limit of detection for these analytes. The limits of detection (LOD) are <0.10, <0.2, <0.4 and <0.7 g/m³ respectively for these carbon chains¹.
- No oil and grease analysis was undertaken this period. However the resultant TPH and BTEX analysis indicated no results above the LOD, thus negating the requirement.
- Benzene, toluene, ethylbenzene and xylenes (M&O) (BTEX) analysis of the two sampling rounds were also below the limit of detection for these analytes, which are <0.001, <0.001, <0.001 and <0.002 and <0.001 g/m³ respectively.
- pH varied between 6.8 pH and 7.2 pH in the two analyses of the discharge location IND001067 this period. A significant variation in pH was observed in the June 2018 sample rounds between upstream and downstream sample locations, MTH000060 (6.9 pH) and MTH000064 (7.6 pH), this was likely due to laboratory error.
- Bio-chemical oxygen demand was similarly compliant with all results below the requisite 5 g/m³.
- No free chlorine analysis was undertaken on the discharge this period.
- Un-ionised ammonia was not analysed this period, though the resultant pH analysis indicated the likelihood for un-ionised ammonia to be very low, <7.2 pH.

3.3.3 Biological monitoring

A macroinvertebrate survey was performed on two occasions, 7 December 2017 and the 6 April 2018. The aim of these surveys was to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream, in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land.

Drainage of water from the storage pits flows through at least two skimmer pits. From here, it is either pumped out for removal, or discharged to land, in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the RFWP for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. A brief synopsis of the findings of the two bio-monitoring surveys is provided below the methods section, the report in full is attached in Appendix II.

¹ Laboratory analysis variation observed in the sample MTH000060 (25 June 2018) for TPH chain analysis was higher than normal with the LOD reported as <4, <2 and <1 g/m³ for C₁₀-C₁₄, C₁₅ - C₃₆, C₇-C₃₆.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 7 December 2017 (Table 15 and Figure 5). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on-site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 m upstream of site 3. A new, secondary impact site (site 4) was established 100 m downstream of the stormwater discharge during the May 2012 survey.

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

Table 15 Biomonitoring sites on the unnamed tributary of the Mangatenghu Stream

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



Figure 6 Biomonitoring sites on the unnamed tributary of the Mangatenghu Stream

Summary of the early spring 2017 biomonitoring survey

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses, MCI and SQMCIS values examined compared with the 'control' sites at the time of the survey. The low scores at site 3 showed improvement since the preceding survey (which recorded the lowest results at this site to date), and further recovery in macroinvertebrate community health may still be occurring. Differences in shading and periphyton cover may explain some of the differences observed. Stockpiling activities may also have contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores.

Summary of the late summer 2018 biomonitoring survey

Overall, taxa richness decreased substantially below site 1, and remained similar between the three downstream sites. The MCI score at site 3, the 'primary impact' site was significantly lower than sites 1, 2 and 4 (which had similar scores). SQMCIS scores at the two potentially 'impacted' sites were significantly lower than the two upstream sites. The low scores at site 3 were similar to the preceding survey, although further recovery in macroinvertebrate community health may still be occurring. Differences in shading and

periphyton cover may explain some of the differences observed. Stockpiling activities may also have contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores.

3.3.4 Provision of consent holder data

As defined earlier in Section 1.46, the consent holder must submit an annual report which should include the following:

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

No stockpiling or landfarming was undertaken this period and no additional monitoring was undertaken by the consent holder. No report was supplied by the consent holder this period.

4 Landspreading/Landfarming activities

4.1 Inspection

17 October 2017

No recent landfarming exercises had been undertaken by the consent holder. The historic spreading areas were inspected and found to have good pasture cover which appeared healthy. The area north of the quarry also had pasture cover which was developing well.

23 May 2018

At the time of inspection no recent injection spreading or irrigation had occurred. While the old storage site at Derby Road had muds incorporated into the soil and pasture sown across the area.

4.2 Results of the receiving environmental monitoring

No landfarm operations were undertaken in this monitoring period. The last landfarming operations were undertaken in the 2015-2016 monitoring period. In that period 3,182 m³ of material was landfarmed across nine paddocks. The paddocks which were utilised and the associated material origins are provided in the table below. The paddock locations are provided in Figure 7.

Table 16 Most recent landfarming application dates and locations

Paddock	Mud Type	Well name	Application date	Solid m ³	Area
1	SBM	Maari MR7A5	10/12/2015-15/12/2015	546	2.75
39	SBM	Maari MR7A5	10/12/2015-15/12/2015	168	6.80
71	SBM	Todd TKN-1	29/12/2015-05/01/2016	220.5	2.40
72	SBM	Todd TKN-1	29/12/2015-05/01/2016	220	2.84
73	SBM	Maari MR7A5	10/12/2015-15/12/2015	596	2.00
83	SBM	Todd TKN-1	18/03/2016-28/03/2016	430	3.05
84	SBM	Todd TKN-1	18/03/2016-28/03/2016	592	3.45
145	SBM	Todd TKN-1	29/12/2015-05/01/2016	222	1.36
146	SBM	Todd TKN-1	29/12/2015-05/01/2016	187.5	1.80
Total drilling mud sequestered				3,182 m³	

4.3 Council soil results

Six compliance soil samples were collected from six landfarmed paddocks this period. The analysis of the soil samples is provided in the following Table 17. Five of the six paddocks were farmed in the previous monitoring period.

Table 17 Landspreading soil analysis 2017-2018 monitoring period

CD Boyd Landspreading	Sample	Consent and Surrender	Paddock 22	Paddock 71	Paddock 84	Paddock 139	Paddock 140	Paddock 141
Soil analysis 17-18	Collected	Date	25 Jun 2018	25 Jun 2018	25 Jun 2018	25 Jun 2018	25 Jun 2018	25 Jun 2018
Parameter	Time	7591-1.1	12:05	12:50	13:30	14:15	14:49	15:10
1-Methylnaphthalene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
2-Methylnaphthalene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Acenaphthene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Acenaphthylene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Anthracene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Benzo[a]anthracene	mg/kg dry wt		< 0.017	< 0.018	0.026	< 0.018	< 0.018	< 0.015
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.027	< 0.017	< 0.018	0.028	< 0.018	< 0.018	< 0.015
Benzo[a]pyrene Potency Equivalency Factor (PEF) NE	mg/kg dry wt		< 0.04	< 0.05	< 0.04	< 0.05	< 0.05	< 0.04
Benzo[a]pyrene Toxic Equivalence (TEF)	mg/kg dry wt		< 0.05	< 0.05	< 0.04	< 0.05	< 0.05	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt		< 0.017	< 0.018	0.029	< 0.018	< 0.018	< 0.015
Benzo[e]pyrene	mg/kg dry wt		< 0.017	< 0.018	0.054	0.021	< 0.018	< 0.015
Benzo[g,h,i]perylene	mg/kg dry wt		< 0.017	< 0.018	0.038	0.019	< 0.018	< 0.015
Benzo[k]fluoranthene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Chrysene	mg/kg dry wt		< 0.017	< 0.018	0.04	< 0.018	< 0.018	< 0.015
Dibenzo[a,h]anthracene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Dry Matter (Env)	g/100g as rcvd		60	56	64	57	56	67
Fluoranthene	mg/kg dry wt		< 0.017	< 0.018	0.06	< 0.018	< 0.018	< 0.015
Fluorene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt		< 0.017	< 0.018	< 0.016	< 0.018	< 0.018	< 0.015
Napthalene	mg/kg dry wt	7.2	< 0.09	< 0.09	< 0.08	< 0.09	< 0.09	< 0.08
Perylene	mg/kg dry wt		< 0.017	< 0.018	0.034	0.043	< 0.018	< 0.015
Phenanthrene	mg/kg dry wt		< 0.017	< 0.018	0.038	< 0.018	< 0.018	< 0.015
Pyrene	mg/kg dry wt	160	< 0.017	< 0.018	0.073	< 0.018	< 0.018	< 0.015
Conductivity from soluble salts	mS/m		< 20	< 20	< 20	< 20	< 20	< 20
Calcium (Sat Paste)	mg/L		10	7	47	9	5	14
Sodium (Sat Paste)	mg/L		11	6	9	8	6	7
Magnesium (Sat Paste)	mg/L		2	1	5	1	1	1
Sodium Absorption Ratio (SAR)		8	0.9	0.5	0.3	0.7	0.6	0.5

CD Boyd Landspreading	Sample	Consent and Surrender	Paddock 22	Paddock 71	Paddock 84	Paddock 139	Paddock 140	Paddock 141
Soluble Salts	g/100g dry wt	0.25	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate-N + Nitrite-N	mg/kg dry wt		7.8	3.4	< 1.0	3.5	3.5	2.3
Ammonium-N	mg/kg dry wt		7	< 5	< 5	< 5	< 5	< 5
C ₇ - C ₉	mg/kg dry wt	210	< 10	< 11	< 10	< 11	< 11	< 9
C ₁₀ - C ₁₄	mg/kg dry wt	150	< 20	< 30	330	< 30	< 30	< 20
C ₁₅ - C ₃₆	mg/kg dry wt	1,300	156	143	2,600	220	129	157
Total hydrocarbons (C ₇ - C ₃₆)	mg/kg dry wt	20,000*	156	143	2,900	220	129	157
Benzene	mg/kg dry wt	1.1	< 0.14	< 0.09	< 0.08	< 0.15	< 0.09	< 0.07
Toluene	mg/kg dry wt	82	< 0.14	< 0.09	< 0.08	< 0.15	< 0.09	< 0.07
Ethylbenzene	mg/kg dry wt	59	< 0.14	< 0.09	< 0.08	< 0.15	< 0.09	< 0.07
m&p-Xylene	mg/kg dry wt	59	< 0.3	< 0.18	< 0.15	< 0.3	< 0.18	< 0.14
o-Xylene	mg/kg dry wt	59	< 0.14	< 0.09	< 0.08	< 0.15	< 0.09	< 0.07
Total Recoverable Arsenic	mg/kg dry wt	17	< 2	< 2	2	< 2	< 2	< 2
Total Recoverable Cadmium	mg/kg dry wt	0.8	0.14	0.17	< 0.10	0.1	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	600	6	5	8	6	6	6
Total Recoverable Copper	mg/kg dry wt	100	41	46	40	48	43	50
Total Recoverable Lead	mg/kg dry wt	160	5.5	6	13.5	4.3	4	4.2
Total Recoverable Mercury	mg/kg dry wt	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	600	6	7	9	5	5	4
Total Recoverable Zinc	mg/kg dry wt	300	27	26	32	31	28	31
Total Recoverable Calcium	mg/kg dry wt		2,700	3,600	8,700	4,400	4,200	4,300
Total Recoverable Magnesium	mg/kg dry wt		730	780	1,350	620	610	710
Total Recoverable Potassium	mg/kg dry wt		270	260	600	220	210	230
Total Recoverable Sodium	mg/kg dry wt	460	450	460	430	650	560	690
Chloride	mg/kg dry wt	700	28	17	26	25	31	23
pH	pH Units		5.9	6	7.2	5.8	6	5.8
*20,000 mg/kg or 2% total petroleum hydrocarbon relates to a post farming concentration maximum								

The subsequent soil analysis indicated the following:

- Calcium ranged from 2,700-8,700 mg/kg.
- Chloride ranged from 17-31 mg/kg, the surrender limit is set at 700 mg/kg.

- Potassium ranged from 210-600 mg/kg.
- Sodium ranged from 430-690 mg/kg. Paddocks 139, 140 and 141 were found to be above the limit for surrender for this target analyte. Surrender concentration 460 mg/kg.
- Magnesium ranged from 610-1,350 mg/kg.
- Conductivity readings all were below detection limit <20 mS/m @20°C, the surrender limit is set at <290 mS/m.
- Soil pH ranged from 5.8-7.2 pH across the six samples analysed.
- Total petroleum hydrocarbon (TPH) analysis indicated variation across the six samples collected this period. Paddock 84 was found to be above the surrender concentration for mid-range and high range (C₁₀-C₁₄, 330 mg/kg and C₁₅-C₃₆, 2,600 mg/kg). Paddock 84 also reported a trace concentration of benzo (a) pyrene (BaP) which was marginally above the surrender concentration of 0.027 mg/kg.
- The remaining paddocks, 22, 71, 139, 140 and 141 were found to be below the specific concentrations for surrender as defined by consent (Table 17) for all three carbon chains in relation to TPH analysis. Note that paddock 22 contained a measurable TPH concentration of 156 mg/kg C₁₅-C₃₆ however, consent holder provided data from the previous period did not that indicate that this paddock had been farmed.
- Benzene, toluene, ethylbenzene, xylenes m & p and O (BTEX) analysis did not return any results above the LOD for these target analytes.
- Total recoverable arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc concentrations were found to be below consent defined concentrations. The consented concentrations, as defined in Table 17 must not be exceeded at any point post the landfarming operation.
- Sodium absorption ratio (SAR) was similarly at low concentrations, all results were found to be below the consented maximum of 8 SAR.
- Total soluble field salts were below detection limit in every soil sample, <0.05 g/100 g.

5 Water treatment sludge disposal

The consent holder holds water treatment sludge (WTS) which is lagooned at three locations on his property. One is located at the Derby Road stockpiling facility, while the other two are located at two locations along Surrey Road. One of which is located within the site boundary of the Surrey Road stockpiling facility. These three locations are depicted in Figure 8. In this period the consent holder exercised their consent in relation to WTS which was held at the Derby Road stockpiling facility. Two lagooned locations remain on the boundary of Surrey Road.

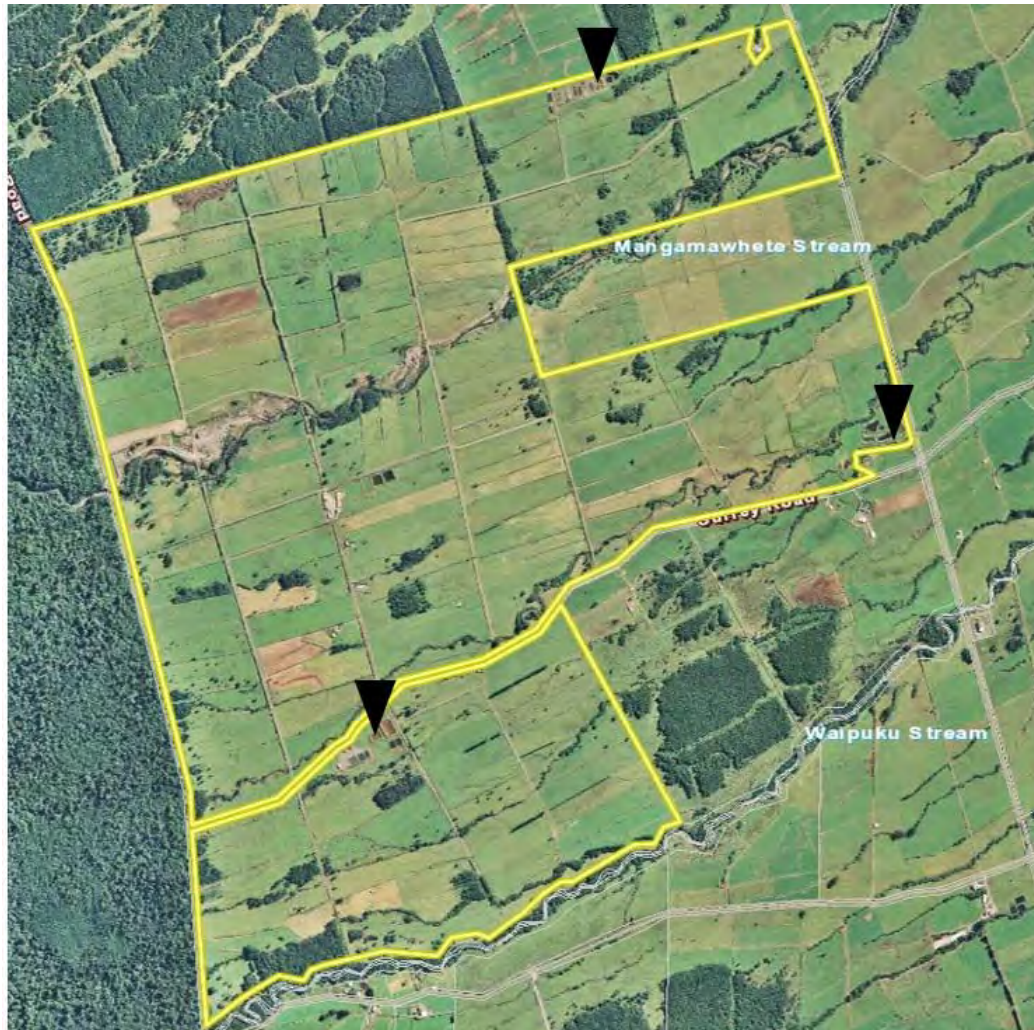


Figure 8 WTS storage locations (black inverted triangles) and consented area (yellow)

5.1 Inspections

14 August 2017

An inspection of the Surrey Road storage facilities found no works had occurred to spread any of the stored WTS. At the time of inspection the storage ponds had filled with stormwater. There were no discharges to surface water occurring from any storage pond, and plenty of capacity was available before discharge levels would be reached. All adjacent farm drains and streams were observed to be running slightly turbid and in high flow after prolonged rainfall. The stored WTS at the Derby Road site had been mixed with drilling muds, and at the time further works had occurred to spread, mix and incorporate the materials. Stormwater run-off from the spreading area was directed to a ring drain and into receiving ponds. The discharge was clear and there were no adverse effects observed within the receiving waters at the time of inspection.

8 February 2018

The inspection was undertaken with the consent holder. Discussions were held regarding the upcoming delivery of WTS from the NPDC water treatment ponds. The WTS was expected to be discharged into the bund on the northern side of the entrance. The remaining material within the bund had dried out, and approximately 1.5 m of freeboard was available within the bund. It was noted that the bund had a surface area of approximately 2,400 m². The bunded area on the southern side of the entrance was also available to receive sludge. The consent holder outlined his intention to apply the contents of the southern bund onto 30 acres of prepared land east of the storage area. The bund had approximately 1-1.5 m of freeboard available and a surface area of 2,000 m². All adjacent drains and creeks were running clear and no fugitive discharges were found. Discussion also focused on spreading some of the remaining stockpiled sludge with the recently spread drilling mud at the old Derby Road storage facility as it may help to aid the establishment of pasture across the area. The consent holder was advised to e-mail worknotification@trc.govt.nz 48 hours prior to accepting sludge onto site and 48 hours prior to commencing spreading activities.

6 March 2018

At the time of inspection a recent delivery of Dudley Road WTS had occurred. This had been stockpiled in the bund immediately on the right of the entrance gate. The liquid inside the bund was clear with a surface iron oxide sheen. The level of the liquid was observed to be well below the discharge pipe with no indication of a discharge likely to occur during the deliveries. At the time of the inspection, the receiving waters were running clear with no adverse effects were observed. No works had occurred to spread any of the WTS stored on-site. All material was found to be secure within the bunded areas. At the time an area of land north-west of the storage area was being stripped and worked. It was previously suggested by the consent holder that some of the stored WTS would be spread across the area prior to pasture being sown.

22 May 2018

At the time of inspection stockpiled WTS muds remained across two storage areas on the Surrey Road. At the time no works appeared to have occurred to spread any of the WTS. The WTS which was located at the Derby Road stockpile facility had been spread and incorporated. Pasture had been sown and there was some evidence that it was beginning to strike.

5.1.1 Results of receiving environment monitoring

One of the three WTS storage locations, where WTS was lagooned, was spread across the former Derby Road stockpiling facility. This material was mixed with residual drilling muds which had been in storage for longer than four years. During the monitoring period there was no discharge observed from the storage locations to the receiving waters. Therefore no samples were collected.

6 Investigations, interventions, and incidents

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

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

In the 2017-2018 period, the Council was not required to undertake any significant additional investigations and interventions, or record incidents, in association with the consent holder's conditions in resource consents or provisions in Regional Plans.

7 Discussion

7.1 Discussion of site performance

Derby Road stockpiling facility

As in previous monitoring periods, the Derby Road facility is closed to the receipt of landfarmable drilling mud. In the previous monitoring period the consent holder consolidated all the residual drilling material, estimated at 1,000 m³ into one specific area. The consent holder had also utilised the remaining storage cells on the site to store WTS in the process known as lagooning.

The consent holder had been under an abatement notice to undertake the landfarming of the residual drilling mud material, which had been in storage for longer than one year.

In this monitoring period the Derby Road stockpiling facility was landfarmed. This included the WTS which was lagooned on site. The consent holder undertook considerable work to accomplish the activity with a bulldozer and a power harrow used to blend and incorporate the material. The area was then seeded, which is a consented requirement. At the end of the monitoring period it was reported that pasture strike had occurred. It was noted by the consent holder that additional seeding maybe required when ground conditions firm up in the upcoming monitoring period.

Surrey Road stockpiling facility

The Surrey Road facility, in similarity to the previous monitoring period 2016-2017, did not receive any deliveries of landfarmable material during the monitoring period. Skimmed surface hydrocarbons remain on site in a secure storage tank. The three storage cells were observed to contain varying amounts of stormwater throughout the monitoring period with residual drilling mud also observed.

At certain times during the monitoring period, surface hydrocarbons were observed in cell one and also discharging into the stormwater system via the nova coil which is situated below cell three. The discharging hydrocarbons from the nova coil, as observed in Table 12 (GND2517,) are most likely attributed to historic localised ground contamination as a process of the cell being unlined. This cell was lined in the 2015-2016 monitoring period.

This is the second monitoring period where the irrigation of cell three contents had not been undertaken.

Three years ago the fluid contents/stormwater component of cell three were pumped to an irrigation area. This was undertaken to prevent the fluid/ soluble component of the drilling mud within the storage cells from discharging via the stormwater system into the unnamed tributary of the Mangatengehu Stream. This was undertaken when a decline in species was noted downstream of the discharge location during routine biological inspections of the water course.

Landspreading/ Landfarming

No landfarming or landspreading was undertaken this period, other than what occurred on the now former Derby Road stockpiling facility, as discussed above. Inspections undertaken found that the previous landfarmed areas had pasture cover which appeared healthy.

In the previous monitoring period a soil sample was collected from paddock 22. This sample contained a measurable concentration of petroleum hydrocarbons within the sample, though the consent holder had not listed the paddock as one which had been farmed. In order to confirm this, a second sample was obtained in this monitoring period, which confirmed the result of the previous monitoring period, Table 17. The consent holder has been asked to accurately record areas which had been landfarmed.

Water Treatment Sludge (WTS) Disposal

WTS as discussed earlier in this report, had been stored across three locations on the consent holder's property. The site locations were defined as the Derby Road stockpiling facility, the Surrey Road stockpiling facility and the original site, on the corner between both Surrey and Derby Roads.

One of the three WTS storage locations, Derby Road, was landfarmed this monitoring period. The lagooned WTS was landfarmed with the residual drilling mud contained on site and the whole site area of Derby Road was cultivated into a landfarmed area.

Two other storage sites, both located on the Surrey Road remain active. In this period deliveries from the NPDC WTS lagoons were received, though no corresponding notification of this activity was received. The inspecting officer had informed the consent holder that a notification must be sent to the Council 48 hours prior to the event.

7.2 Environmental effects of exercise of consents

Derby Road

Four soil samples were collected this period (Section 2.3.4). The resultant analysis indicated elevated levels of total petroleum hydrocarbons within the soil structure. Three samples contained a total TPH concentration in excess of the consented application rate of 2% TPH (20,000 mg/kg), post landfarming. This would have been in breach of consent, however, as the job was not fully completed, a follow up soil sample was collected in June 2018. This indicated compliance with this condition, with total TPH found at 1.1%. Pasture strike was also observed to be occurring across the area, although the consent holder indicated that further seeding may be required in the upcoming spring. The Council will continue to monitor this landfarmed location until surrender concentrations have been reached.

Groundwater monitoring of the three monitoring wells indicated negligible impacts as a result of the activities occurring at the Derby Road site.

Biological monitoring of the unnamed tributary of the Mangamawhete Stream indicated that overall the activities at the drilling waste stockpiling site and landfarming area have not had any impacts on the macroinvertebrate communities through the reach of the Mangamawhete Stream surveyed. MCI scores indicated 'good' macroinvertebrate community health, and scores were similar to or higher than median scores for each site respectively.

Surrey Road

Groundwater pH, which was discussed in the previous monitoring periods' report (Technical Report 2017-10) increased during this period, with all corresponding analysis found to be above 5.4 pH.

Groundwater monitoring of three monitoring wells indicated minimal effects from the consented activities at this site. However, the nova coil sample location (GND2517), which flows from beneath the third storage cell, indicated a measurable, though decreasing concentration of TPH across the monitoring period.

The discharge and surface water analysis was performed on two occasions this period. The resultant analysis did not return any values of concern. The main effect noted was the slight elevation in sodium and TDS concentrations at the monitoring location below the discharge.

It is noteworthy to mention, that although there were trace levels of TPH in the discharge from the nova coil, the subsequent discharge sample location (IND001067, Section 3.3.2) indicated no TPH above the LOD for these analytes.

The two biological surveys indicated that taxa richness had decreased substantially below site 1, and remained similar between the three downstream sites. The MCI score at site 3, the 'primary impact' site was significantly lower than sites 1, 2 and 4 (which had similar scores). SQMCIS scores at the two potentially

'impacted' sites were significantly lower than the two upstream sites. The low scores at site 3 were similar to the preceding survey, although further recovery in macroinvertebrate community health may still be occurring. Differences in shading and periphyton cover may explain some of the differences observed. However, stockpiling activities may also have contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores.

During the 2014-2015 monitoring period, a decline in biological community richness was observed in the unnamed tributary. It was identified that the stormwater discharge location fed diluted stormwater from the holding cells into the unnamed tributary of the Mangatengehu Stream. At that time the site management decided to install a pump at the base of cell three. The purpose of the pump was to transfer the stormwater component from cell three to an irrigation area, which was then treated as a landfarmed area. This engineering control was primarily aimed at reducing the potentially contaminated stormwater from discharging into the unnamed tributary. The use of the pump and irrigator to irrigate the fluid stormwater contents to land was also included in a variation of consent 7591-1.1 (condition 7) (October 2015).

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

A reduced species composition was also observed during this period and is considered to have similarly been affected by the stormwater discharge from cell 3. The facility has not stockpiled any landfarmable material other than the remaining residual material which has remained within the cells since March 2016.

With a proposed return to stockpiling activities considered for the upcoming monitoring period. The stormwater fluid component should be managed, to limit the potential for contamination of the receiving waters.

[Landspreading/Landfarming](#)

During this period, six soil samples were collected from previously landfarmed paddocks. Paddock 22 was resampled this year as in the previous monitoring period, analysis indicated that it contained a measurable TPH concentration. This contrasted with spreading records provided by the consent holder (in the 2016-2017 period), which did not indicate this paddock had been utilised.

The analysis in this period of paddock 22 was indicative of a landfarmed paddock with calcium, magnesium and sodium values found to be within the range of the other five sampled paddocks (which according to the consent holder had been spread). The associated sodium absorption ratio (SAR) was also the most elevated of the six samples collected. Thus the analysis would suggest this paddock was farmed. The consent holder has been asked to provide accurate records moving forward.

Of the five other sampled paddocks this period, only one, (paddock 84) was found to be above the consented limit for surrender, in terms of mid-range C₁₀-C₁₄ hydrocarbons.

No additional surrender analysis was undertaken this period, though it has been discussed with the consent holder. Older landfarmed paddocks were observed by the Council's investigating officer whom noted that all contained good pasture coverage that appeared healthy.

[Water treatment sludge \(WTS\) disposal](#)

No discharge samples were collected this monitoring period as the storage locations were not discharging during inspections. Of the three locations where the consent holder held lagooned WTS, one (Derby Road) had been put to land via landfarming.

The area has been sown and pasture strike had been established, as required by the consent. Two other locations, both located on the Surrey Road remain lagooned. The Council will continue to monitor these

locations until the WTS has been put to land. There is no time frame requirement for the material to be put to land and no effects have been noted as a process of this consent to date.

7.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 18-22.

Table 18 Summary of performance for consent 6900-2

Purpose: To discharge drilling waste (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), onto and into land for the purpose of temporary stockpiling prior to disposal		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Yes
2. Notify TRC 48 hours prior receiving waste onto site for stockpiling	No material received in relation to this consent, though notification to spread the final consolidated material was given	Yes
3. Records to be kept by consent holder and made available to the Council	Records received	Not applicable in this period
4. Consent holder to report to Council by 31 August each year on records specified in condition 3	No report received	No
5. No discharge within 25 m of surface water or property boundaries	Inspection	Yes
6. Stockpiled material to be landspread under consent 7591-1 within 12 months of arrival on site	Inspection and consent holders records	Residual material finally spread
7. Total dissolved solids in any fresh water body not to exceed 2,500 g/m ³	Monitoring	Yes
8. No contamination of groundwater or surface water to exceed background concentrations	Sampling of groundwater and surface water indicated negligible impacts	Yes
9. Concentrations in soil to be met prior to expiry	Monitoring indicated concentrations still elevated	N/A
10. Consent may not be surrendered until compliance with SC9	Not applicable presently	N/A
11. Optional review provision re environmental effects	Not to be undertaken	N/A
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		Good

Table 19 Summary of performance for consent 7911-1

Purpose: To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangawhete Stream in the Waitara River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Stormwater discharged shall be from a catchment area not exceeding 1.5 hectares	Inspection and liaison with consent holder	Yes
3. Discharges shall meet the following: <ul style="list-style-type: none"> pH 6.0 – 9.0 Suspended solids <100 g/m³ Total recoverable hydrocarbons <15 g/m³ 	Sampling was not possible as no discharge was occurring during surveys	N/A
4. 25m downstream of the initial discharge point, discharges shall not exceed: BOD ₅ <2 g/m ³ Chloride <50 g/m ³	Surface water sampling not undertaken as the site no longer discharges	N/A
5. After allowing for reasonable mixing, within a mixing zone extending 25 metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all of the following effects in the receiving water: <ul style="list-style-type: none"> the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; any conspicuous change in the colour or visual clarity; any emission of objectionable odour; the rendering of fresh water unsuitable for consumption by farm animals; any significant adverse effects on aquatic life. 	Inspection indicated no discharge	N/A
6. Consent holder shall maintain a contingency plan	Inspection and liaison with consent holder	Yes
7. Optional review provision re environmental effects	Next option for review in June 2015	N/A

Purpose: To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangawhete Stream in the Waitara River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
Overall assessment of environmental performance and compliance in respect of this consent		Good
Overall assessment of administrative compliance in respect of this consent		Good

Table 20 Summary of consent 7559-1.3

Purpose: To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM onto and into land via landfarming.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions of stockpiling and landfarming	N/A	N/A
2. Adoption of the best practicable option	Inspection, the removal of the pump from cell 3 appears to have adversely affected the in stream communities below the discharge	No
3. Install groundwater monitoring wells prior to exercise of consent	Inspection	Yes
4. Install fit for purpose high grade synthetic liners for storage cells	Cell 3 now lined as of November 2015	Yes
5. Approved management plan to be reviewed annually	Not assessed this period, proposed review in upcoming monitoring period	N/A
6. Notify Council 48 hours prior to stockpiling wastes	No material stockpiled this monitoring period	Yes
7. Notify Council 48 hours prior to landfarming wastes	No material landfarmed this period under this consent	Yes
8. Limited to wastes generated in Taranaki	Including offshore region	Yes
9. Maximum stockpiling volume of 4,000 m ³ to be landfarmed/spread within nine months	Records	Yes
10. Maximum application thickness for wastes: <ul style="list-style-type: none"> • 100 mm TPH < 5% • 50 mm TPH > 5% • no ponded liquids 1 hr after application 	Sampling and inspection	Yes
11. Landfarmed areas to be used once only unless surrender criteria satisfied	Surrender criteria satisfied for paddock 83 and 84 prior to re-application. Additional surrender sampling proposed in the upcoming monitoring period	N/A

Purpose: To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM onto and into land via landfarming.

Condition requirement	Means of monitoring during period under review	Compliance achieved?
12. Incorporate wastes into the soil so that the surface 250 mm contains less than 2% hydrocarbons	Sampling	Yes
13. Maximum chloride loading 800 kg/ha	Sampling and assessment (not calculated in period under review)	N/A
14. Maximum nitrogen loading 1,000 kg/5 yrs	Sampling and assessment (not calculated in period under review)	N/A
15. Discharge area shall be resown to pasture/crop as soon as practicable	Derby Road pasture establishing post landfarming, remaining paddocks observed to have good pasture cover	Yes
16. No discharge within 6m of a water body (includes farm drains) 12 m from stream. No liquid discharged within 25 m of any water body	Inspection	Yes
17. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
18. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling indicated compliance with metal concentrations in six paddocks sampled, also in newly landfarmed Derby Road site	Yes
19. Sodium absorption ratio [SAR] must be less than 8. If background soil SAR is greater than 8, then waste application shall not increase SAR by more than 1	Sampling indicated low SAR	Yes
20. At time of expiry/cancellation/surrender, soil hydrocarbon concentrations must comply with MfE guidelines Prior to expiry/cancellation/surrender, soil parameters shall not exceed: <ul style="list-style-type: none"> conductivity 290 mS/m dissolved salts 2,500 g/m³ sodium 460 g/m³ chloride 700 g/m³ 	Surrender sampling to be proposed for paddocks in upcoming monitoring period	Not applicable
21. Consent may not be surrendered unless condition 20 is met	Sampling	Not applicable at present

Purpose: To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with WBM and SBM onto and into land via landfarming.		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
22. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m ³	Sampling indicated negligible saline impacts	Yes
23. No contamination of groundwater or surface water to exceed background concentrations	Sampling indicated that the pipe sampling location GND2517 returned measurable TPH in three monitoring rounds undertaken this period. <100 g/m ³ TPH. No trace of hydrocarbons in discharge or surface water or in other three groundwater monitoring wells.	No
24. Records to be kept by consent holder and made available to the Council	Analysis found hydrocarbons in paddock 22, this confirmed previous period's results.	Yes, though paddock 22 not recorded as spread
25. Consent holder to report to Council by 31 August each year on records specified in condition 23	No report provided by consent holder this period	No
26. Consent shall lapse on 31 Dec 2014 unless exercised		Exercised
27. Optional review provision re environmental effects		Exercised
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		Improvement required Improvement required

Table 21 Summary of performance for consent 7591-1.1

Purpose: To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Yes
2. Notify Council 48 hours prior to landspreading	Notifications received pertaining to farming of Derby Road residual material	Yes
3. Limited to wastes generated in Taranaki including the Taranaki basin	Consent holder's records	Yes
4. Discharge rate shall not exceed 100 m ³ /ha/yr and no ponded liquids shall remain after 1 hr	Inspection and consent holder's records	Yes
5. Maximum chloride loading 800 kg/ha	Not calculated during period under review	N/A

Purpose: To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading

Condition requirement	Means of monitoring during period under review	Compliance achieved?
6. Maximum nitrogen loading 1,000 kg/5yrs	Not calculated during period under review	N/A
7. Landspreading of liquid fraction of the material must be undertaken with pasture cover	No landspreading undertaken, irrigator removed	N/A
8. No waste shall be applied within: <ul style="list-style-type: none"> • 12 m of boundaries • 12 m of named streams • 6 m of other water courses 	Inspection	Yes
9. Liquid wastes which may flow overland shall not be discharged within 25 m of boundaries or water courses	Inspection	Yes
10. Post application the material must be incorporated to a depth of 100 mm and the TPH concentration must be below 2% TPH	Previous landfarmed area which was above 2% TPH re-worked and sown at Derby Road	Yes
11. Soil hydrocarbon concentrations must comply with MfE guidelines: <ul style="list-style-type: none"> • prior to areas being reused for landspreading • at the time of expiry/cancellation/surrender 	Samples collected across the six paddocks sampled indicated compliance with this condition, further time required for paddock 84	Yes
12. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Heavy metal results compliant with this condition, barium analysis proposed for upcoming period	Yes
13. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
14. Sodium absorption ratio [SAR] must be less than 8. If background soil SAR is greater than 8, then waste application shall not increase SAR by more than 1	Sampling	Yes
15. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m ³	Sampling	Yes
16. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes

Purpose: <i>To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading</i>		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
17. Records to be kept by consent holder and made available to the Council	Records inconsistent in one paddock 22. Re-analysis indicated the paddock had likely been farmed/ spread	Yes
18. Consent holder to report to Council by 31 August each year on records specified in condition 17	No report provided	No
19. Consent shall lapse on 1 June 2027 unless exercised	-	N/A
20. Optional review provision re environmental effects	Not required	N/A
Overall assessment of environmental performance and compliance in respect of this consent		Good Improvement Required
Overall assessment of administrative performance in respect of this consent		

Table 22 Summary of performance for consent 5821-2

Purpose: To discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki districts onto and into the land		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of best practicable option	Inspection	Yes
2. Exercise undertaken in accordance with application	Inspection and monitoring	Yes
3. Notification to be provided prior to exercise of consent	Notification provided	Yes
4. Notification 48 hours prior to undertaking disposal of sludge to site	Notification not provided	No
5. Sludge to be spread as per application	Inspection	Yes
6. Ensure sludge stockpiles areas adequately bunded and no discharge of leachate to any water course	Inspection indicated no discharge at either of the two current storage sites	Yes
7. No discharge of sludge to land within 25 meters of any water course, including farm drains	Inspection. Derby Road site spread with landfarming material	Yes
8. Shall not exceed a total aluminium concentration of 55 µg/L within specific stream, farm drains or water course	Monitoring not required, no discharge	N/A

Purpose: To discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki districts onto and into the land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
9. No area of land stripped for application may exceed 40 acres	Inspection	Yes
10. Post application, the area of land must be contoured and sown into pasture	Inspection indicated contouring and pasture strike	Yes
11. Exercise of consent shall not result in contamination of groundwater/ surface water or change in suitability of the water source	Monitoring and inspection	Yes
12. The exercise of consent shall not result in effects in surface water	Monitoring and inspection indicated negligible effects	Yes
13. Is a lapse condition	Not applicable, consent in effect	N/A
14. Is a review condition	Not required at present	N/A
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative compliance in respect of this consent		Good

N/A = not applicable

Table 23 Evaluation of environmental performance over time

Year	Consent no	High	Good	Improvement req	Poor
2013-2014	6900-2	1			
	7911-1		1		
	7559-1			1	
	7591-1	N/A			
2014-2015	6900-2	1			
	7911-1	1			
	7559-1		1		
	7591-1.1	1			
2015-2016	6900-2	1			
	7911-1	1			
	7559-1.3		1		
	7591-1.1		1		
2016-2017	6900-2	1			
	7911-1		1		
	7559-1.3			1	

Year	Consent no	High	Good	Improvement req	Poor
	7591-1.1		1		
Totals		7	6	2	

During the year, the consent holder demonstrated a good level of environmental and an improvement required level of administrative performance with the resource consents as defined in Section 1.1.4.

7.4 Recommendations from the 2016-2017 Annual Report

In the 2016-2017 Annual Report, it was recommended:

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

Recommendations 1, 2 and 3 were undertaken, although quarterly surface water sampling was not possible this monitoring period.

Recommendation 4 was deferred this monitoring period. Upon further investigation it is 58 paddocks opposed to 65 that require surrender. Surrender sampling will be discussed with the consent holder in upcoming monitoring period.

7.5 Alterations to monitoring programmes for 2018-2019

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

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

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

The following is proposed for the 2018-2019 monitoring period:

- Further discussion to be held for the surrender sampling of previously landfarmed paddocks.
- The following monitoring programmes are combined to reduce the overall programme administration: For this to occur they must be proposed by the consent holder.
 - Derby Road stockpiling

- Landspreading/landfarming
- Once stockpiling activities recommence at the Surrey Road facility, quarterly surface water monitoring to be undertaken.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the sites in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2018-2019.

7.6 Exercise of optional review of consent

Resource consent 7591-1.1 and 7559-1.3 provide for an optional review of the consent in June 2019. Condition 20 (7591-1.1) and 27 (7559-1.3) allows the Council to review the consent 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.

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

8 Recommendations

1. THAT, monitoring of consented activities at Derby Road stockpiling facility in the 2018-2019 year continue at the same level as in 2017-2018.
2. THAT, monitoring of consented activities at Surrey Road stockpiling facility in the 2018-2019 year continue at the same level as in 2017-2018, with provision for quarterly surface water analysis.
3. THAT, monitoring of consented activities for landspreading/ landfarming in the 2018-2019 year continue at the same level as in 2017-2018, with the provision for an increase in the number of soil samples to account for historical paddocks and surrender analysis.
4. THAT, monitoring of consented activities for water treatment sludge disposal in the 2018-2019 year continue at the same level as in 2017-2018.
5. THAT, should there be issues with environmental or administrative performance in 2018-2019, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
6. THAT the option for a review of resource consents in June 2019, as set out in condition 20 of the 7591-1.1 and condition 27 of 7559-1.3 not be exercised, on the grounds that conditions on both consents are fit for purpose.

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.
Bund	A wall around a tank to contain its contents in the case of a leak.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cu*	Copper.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m ³ s ⁻¹).
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m ² /day	Grams/metre ² /day.
g/m ³	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
Incident register	The incident register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
LOD	Limit of detection set by the laboratory.
m ²	Square Metres.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH ₄	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH ₃	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NNN	Nitrite/ nitrate nitrogen.

NO ₃	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	<i>Resource Management Act 1991</i> 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.
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 a Science Services Manager.

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- M-I Swaco 2016: Annual report for Consent 6900-1, Consent 7591-1.1, 7911.1 and 7559-1.3, Colin Boyd Landfarms, Surrey Road, Derby Road, Inglewood, Taranaki.
- M-I Swaco 2017: Annual report for Consent 7591-1.1 and Consent 7559-1.3 Colin Boyd landfarms, Surrey Road, Inglewood Taranaki
- Taranaki Regional Council 2005: Guidelines for the control of drilling waste disposal onto and into land.
- Taranaki Regional Council, 2010: Boyd Landfarm Monitoring Programme Annual Report 2008-2009. Technical Report 2009-53.
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- Taranaki Regional Council, 2013: CD Boyd Drilling Waste Disposal Monitoring Programmes Biennial Report 2011-2013. Technical Report 2013-63.
- Taranaki Regional Council, 2014: C Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2013-2014. Technical Report 2014-81.
- Taranaki Regional Council, 2015: C Boyd Drilling Waste Disposal Monitoring Programmes Annual Report 2014-15. Technical Report 2015-86.
- Taranaki Regional Council 2016: CD Boyd Drilling Waste Stockpiling Landfarm/Landspreading Monitoring Programme Annual Report. Technical Report 2016-85.

Taranaki Regional Council 2017: CD Boyd Drilling Waste Stockpiling Landfarm/ Landspreading Monitoring Programme Annual Report 2016-2017. Technical Report 2017-10.

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

Appendix I

Resource consents held by CD Boyd

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

Consent number	Purpose	Granted	Review	Expires
7911-1	To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream, in the Waitara catchment.	27 Sep 2011	June 2021	1 June 2027
6900-2	To discharge drilling wastes onto and into land for the purpose of stockpiling prior to disposal.	16 Feb 2011	June 2021	1 June 2027
7559-1.3	To discharge drilling waste cuttings from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming and landspreading, injection spreading and irrigation.	20 Nov 2009	June 2019	1 June 2027
7591-1.1	To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading.	21 Jan 2010	June 2019	1 June 2027
5821-2.2	To discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki Districts' onto and into land	14 Dec 2005	June 2021	1 June 2026

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
(Change): 5 February 2014

Commencement Date
(Change): 5 February 2014 (Granted: 14 December 2005)

Conditions of Consent

Consent Granted: To discharge sludge and other residuals from water treatment plants in the New Plymouth and South Taranaki Districts onto and into land

Expiry Date: 1 June 2026

Review Date(s): June 2015, June 2021

Site Location: Surrey Road, Inglewood

Legal Description: Secs 9, 10 & Pt Sec 13 Blk XII Egmont SD
Lot 2 DP 344156 Blk XII Egmont SD
Secs 17 & 18 Blk XVI Egmont SD (Discharge sites)

Grid Reference (NZTM) 1701925E-5652253N

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. 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 exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of the original application and any subsequent applications to change conditions. In the case of any contradiction between the documentation submitted in support of previous applications and the conditions of this consent, the conditions of this consent shall prevail.
- 3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least seven days prior to the exercise of this consent.
- 4. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to the transportation of the sludge to the disposal site, and again at least 48 hours prior to beginning the actual disposal operation. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
- 5. The sludge shall only be spread in the areas specified in application 4067 and 6784.
- 6. The consent holder shall ensure that sludge stockpiles are adequately bunded to ensure that there is no stormwater or leachate runoff to any surface watercourse, including farm drains.
- 7. The sludge shall not be deposited within 25 metres of the Mangamawhete Stream, the Mangatengehu Stream or the Waipuku Stream, or within 10 metres of any open drain or other watercourse.
- 8. The exercise of the consent shall not result in a total aluminium concentration exceeding 55ug/L in the Mangamawhete Stream, the Mangatengehu Stream or the Waipuku Stream or any open drain or watercourse including farm drains.

Consent 5821-2.2

9. The area of bare land, stripped for receipt of the residuals, exposed at any particular time shall not exceed 40 acres.
10. As soon as practicable following discharge and incorporation, the discharge area shall be contoured and sown into pasture.
11. The exercise of this consent shall not result in any adverse impacts on groundwater as a result of leaching, or on surface water including aquatic ecosystems, and/or result in a change to the suitability of use of the receiving water as determined by the Chief Executive, Taranaki Regional Council.
12. The exercise of this consent shall not result in any of the following effects on surface water:
 - a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended material;
 - b) Any conspicuous change in the colour or visual clarity
 - c) Any emission of objectionable odour;
 - d) The rendering of freshwater unsuitable for consumption by farm animals;
 - e) Any significant adverse effects on aquatic life.
13. This consent shall lapse on the expiry of five years after the date of issue of this consent, 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.
14. 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 2009 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.

Signed at Stratford on 5 February 2014

For and on behalf of
Taranaki Regional Council

A D McLay
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: 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/m³.
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:

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

MAHs - benzene, toluene, ethylbenzene, xylenes

PAHs - naphthalene, non-carc. [pyrene], benzo(a)pyrene eq.

TPH - total petroleum hydrocarbons [C₇-C₉, C₁₀-C₁₄, C₁₅-C₃₆]

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

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

Review

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

Signed at Stratford on 16 February 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Colin David Boyd
PO Box 44
Inglewood 4347

Decision Date
(Change): 25 February 2016

Commencement Date
(Change): 25 February 2016 (Granted Date: 20 November 2009)

Conditions of Consent

Consent Granted: To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming, landspreading, injection spreading and irrigation

Expiry Date: 1 June 2027

Review Date(s): June 2016, June 2017, June 2018, June 2019, June 2025

Site Location: Surrey Road, Inglewood

Legal Description: Secs 17 & 18 Blk XIV Egmont SD (Discharge site)

Grid Reference (NZTM) 1701847E-5651476N

Catchment: Waitara

Tributary: Manganui
Waipuku
Mangamawhete
Mangatengehu

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

General conditions

- a. On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b. Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c. The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i. the administration, monitoring and supervision of this consent; and
 - ii. charges authorised by regulations.

Special conditions

1. For the purposes of this consent the following definitions shall apply:
 - a. stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating into the soil within 24 hours of such discharge; and
 - b. landfarming means the discharge of drilling waste onto land, subsequent spreading, incorporation into the soil and re-sowing into pasture or crop.
 - c. landspreading means the discharge to land of the liquid fraction of drilling wastes. This includes the stormwater component of the storage cells through the use of a landspreader and/or irrigator and/or injection spreader. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times.
2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landfarming of drilling waste during extended periods of dry weather.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall install a minimum of three groundwater monitoring wells. The wells shall be at locations and to depths, that enable the collection of groundwater samples (to assess any changes in groundwater quality) to the satisfaction of the Chief Executive, Taranaki Regional Council. The wells shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.
4. Any pits used for stockpiling solid or liquid waste shall be lined with 'fit for purpose' high-grade synthetic liner or equivalent and the consent holder shall demonstrate, that the lined pits are suitable for storing liquid without leakage through the base or side walls. The Consent holder shall monitor the integrity of the pit liners and repair or replace liners as required.

5. Prior to the exercise of this consent, the consent holder shall provide, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a landfarming and stockpiling management plan to demonstrate the activity will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually and shall include as a minimum:
- a. control of site access;
 - b. procedures for notification to Council of disposal activities;
 - c. procedures for the receipt and stockpiling of drilling wastes onto the site;
 - d. procedures for the management of stormwater recovered from, or discharging from, the drilling waste stockpiling area;
 - e. methods used for the mixing and testing of different waste types;
 - f. procedures for landfarming drilling wastes (including means of transfer from stockpiling area, means of spreading, and incorporation into the soil);
 - g. contingency procedures;
 - h. sampling regime and methodology; and
 - i. post-landfarming management, monitoring and site reinstatement.

Notification and sampling requirements prior to discharge

6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to permitting drilling wastes onto the site for stockpiling, from each well drilled. Notification shall include the following information:
- a. the consent number;
 - b. the name of the well(s) from which the waste was generated;
 - c. the type of waste to be stockpiled; and
 - d. the volume of waste to be stockpiled.
7. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to the application of stockpiled material. Notification shall include the following information:
- a. the consent number;
 - b. the name of the well(s) from which the waste was generated;
 - c. the type of waste to be applied to land;
 - d. the volume and weight of the waste to be applied to land;
 - e. the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land; and
 - f. the specific location and area over which the waste will be applied.

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

Discharge limits

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

Consent 7559-1.3

9. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 4,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.
10. For the purposes of landfarming, drilling wastes shall be applied to land in a layer not exceeding:
 - a. 100 mm thick for wastes with a hydrocarbon concentration less than 50,000 mg/kg dry weight; or
 - b. 50 mm thick for wastes with a hydrocarbon concentration equal to or greater than 50,000 mg/kg dry weight; and
 - c. in a rate and manner such that no ponded liquids remain after one hour, for all wastes;prior to incorporation into the soil.
11. The areas which are irrigated, injection spread, landspread or landfarmed may receive future applications of material if they are below the consented criteria outlined by conditions 18, 19 and 20 of this consent.
12. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250 mm for landfarming and 100 mm for the injection spreader, so that the hydrocarbon concentration at any point in the soil/waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point'.
13. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.
14. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.
15. As soon as practicable following the landfarming of drilling wastes the discharge area shall be re-sown into pasture (or into crop). If revegetation cannot be established within two months of the discharge, the consent holder shall undertake appropriate land stabilisation measures to minimise wind and/or stormwater erosion.
16. No drilling waste shall be discharged within:
 - a) 12 metre(s) of property boundaries; or
 - b) 12 metre(s) of the Mangamawhete, Mangatengehu and Waipuku Streams; or
 - c) 6 metre(s) of any other surface water course (including farm drains).

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

Receiving environment limits for soil

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

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

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

19. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.
20. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

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

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

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

Receiving environment limits for water

22. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m³.
23. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

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

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

25. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 23, for the period of the previous 1 July to 30 June.

Lapse and review

26. This consent shall lapse on the 31 December 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

27. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2017 and/or June 2018 and/or June 2019 and/or June 2025 for the purpose of ensuring that the conditions 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 25 February 2016

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Advice Note

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

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

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

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

Name of
Consent Holder: Surrey Road Landfarms Limited
CD Boyd
PO Box 44
Inglewood 4347

Decision Date
(Change): 29 October 2015

Commencement Date
(Change): 29 October 2015 (Granted Date: 21 January 2010)

Conditions of Consent

Consent Granted: To discharge drilling waste cuttings (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landspreading, injection spreading and irrigation

Expiry Date: 1 June 2027

Review Date(s): June 2016, June 2017, June 2018, June 2019, June 2025

Site Location: Surrey Road, Inglewood

Legal Description: Lot 2 DP 344156, Secs 9, 10 & Pt Sec 13 Blk XII Egmont SD, Secs 17 & 18 Blk XVI Egmont SD (Discharge site)

Grid Reference (NZTM) 1701750E-5652370N

Catchment: Waitara

Tributary: Manganui
Waipuku
Mangatengehu

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

General condition

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

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landspreading/ injection spreading of drilling waste during extended periods of dry weather.
2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, (by emailing worknotification@trc.govt.nz) at least 48 hours prior to landspreading/ injection spreading waste from each separate storage cell. Notification shall include the following information:
 - a) the consent number;
 - b) the name of the well(s) from which the waste was generated;
 - c) the type of waste to be applied;
 - d) the volume and weight of the waste to be applied;
 - e) the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land;
 - f) the specific location and area over which the waste will be applied; and
 - g) the method of application.

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

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

Discharge limits

4. Drilling waste shall be applied to land at a rate not exceeding 100 m³/ha/yr, and in a rate and manner such that no ponded liquids remain after one hour.
5. The exercise of this consent shall not result in a chloride loading in the soil exceeding 800 kg/ha.
6. The nitrogen loading (including that from any application of nitrogen fertiliser) over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.
7. Landspreading of liquid fraction of drilling wastes and or stormwater component of the storage cells shall be undertaken through the use of a landspreader or injection spreader or irrigator. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times

Consent 7591-1.1

8. No drilling waste shall be discharged within:
- 12 metres of property boundaries; or
 - 12 metres of the Mangamawhete, Mangatengehu and Waipuku Streams; or
 - 6 metres of any other surface water course (including farm drains).
9. Any liquid drilling waste which may flow overland, shall not be discharged within 25 metres of property boundaries or surface water courses (including farm drains).

Receiving environment limits for soil

10. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 100 mm so that the hydrocarbon concentration at any point in the soil/ waste mix is equal to or less than 20,000 mg/kg (2%) dry weight at any point.
11. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

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

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

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

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

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

13. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.
14. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

Receiving environment limits for water

15. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m³.
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:
- wastes from each individual well;
 - composition of wastes, as analysed in condition 2 e);
 - application areas, including a map showing individual disposal areas with GPS co-ordinates;
 - volumes and weights of wastes applied;
 - dates of commencement and completion of application events;
 - details of monitoring, including sampling locations, sampling methods and the results of analysis;

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

18. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 17, for the period of the previous 1 July to 30 June.

Lapse and review

19. This consent shall lapse on the 31 March 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
20. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2017 and/or June 2018 and/or June 2019 and/ or June 2025 for the purpose of ensuring that the conditions area adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent

Signed at Stratford on 29 October 2015

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Advice Note

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

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

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

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

Name of
Consent Holder: Colin David Boyd
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.

<u>Constituent</u>	<u>Standard</u>
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 [BOD₅] to exceed 2 gm⁻³, or
 - b) the chloride concentration to exceed 50 gm⁻³.
5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all of the following effects in the receiving water:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.

6. The consent holder shall maintain a contingency plan. The contingency plan shall be adhered to in the event of a spill or emergency and shall, to the satisfaction of the Chief Executive, Taranaki Regional Council, detail measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.
7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 27 September 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring reports

To Job Manager, Nathan Crook
From Environmental Scientist, Katie Blakemore
Report No KB045
Document 2048716
Date 07 May 2018

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road Landfarm, December 2017

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The spring survey was the first of two scheduled surveys for the site in the 2017-2018 year.

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

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

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

The previous survey performed in February 2017 (Thomas, 2017b) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

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

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

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

Samples were preserved with Kahle's Fluid and ethanol 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 based on the abundance categories in Table 2.

Table 2 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	> 140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

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

Results

This survey was carried out 29 days after a fresh in excess of both 3x and 7x median flow. Flows were very low, with clear and uncoloured flow which was very slow/still at site 1 and steady at sites 2-4. Water temperatures ranged from 16.8 °C – 19.6 °C at the four sites. Substrate comprised predominantly cobble and coarse gravel at all sites, with significant amounts of silt present at sites 1-3 and a small amount of silt at site 4. All sites had small amounts of sand, fine gravel and boulder present. An iron oxide coating was present on the streambed at all sites.

Periphyton mats were slippery at site 2 and absent at the remaining three sites, while filamentous periphyton was absent from all four sites. Leaves were patchy on the streambed at sites 1, 3 and 4 but absent at site 2. Wood was patchy on the streambed at sites 3 and 4 only. Macrophytes and moss were absent from all four sites. Site 1 was partially shaded by overhanging vegetation, while sites 3 and 4 were completely shaded by undercut banks and overhanging vegetation. Site 2 had no shading.

Macroinvertebrate communities

Table 4 provides a summary of results from previous surveys carried out in relation to the Derby Rd drilling waste stockpiling site along with the current survey results.

Table 4 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 7 December 2017 and a summary of historical data for these sites

Site No.	N	No of taxa			MCI value			SQMCI _s value		
		Median	Range	Dec 2017	Median	Range	Dec 2017	Median	Range	Dec 2017
1	16	20	12-33	11	105	83-114	104	4.9	3.2-7.4	3.4
2	16	17	6-30	22	99	80-109	95	3.7	2.0-7.4	4.1
3	16	16	5-24	14	100	88-109	90	4.5	2.5-6.7	4.4
4	16	17	6-24	16	103	73-121	98	4.8	2.1-7.0	6.5

Table 5 provides a summary of macroinvertebrate indices for 'control' sites situated in Taranaki ringplain streams arising outside of Egmont National Park at altitudes greater than 400m above sea level.

Table 5 Range and median number of taxa, MCI and SQMCI_s values for 'control' sites in ringplain streams with sources outside of Egmont National Park at altitudes greater than 400m asl (TRC 2017)

	No. of taxa	MCI value	SQMCI _s value
No. Samples	45	45	43
Range	8-36	82-127	2.0-7.5
Median	20	109	5.1

The full results of the current survey are presented in Table 6.

Table 6 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 7 December 2017 in relation to the Derby Rd Landfarm

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB17449	FWB17450	FWB17451	FWB17452
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C	C
MOLLUSCA	<i>Potamopyrgus</i>	4	-	C	R	R
CRUSTACEA	Ostracoda	1	-	A	R	-
	<i>Paranephrops</i>	5	R	R	-	-
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	R	R	-	-
	<i>Deleatidium</i>	8	C	A	A	VA
	<i>Zephlebia group</i>	7	-	R	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R	R	R
	Dytiscidae	5	-	R	-	-
	Ptilodactylidae	8	R	C	-	C
	Staphylinidae	5	R	-	-	-
TRICHOPTERA (CADDISFLIES)	<i>Costachorema</i>	7	-	R	-	-
	<i>Hydrobiosis</i>	5	-	C	R	-
	<i>Hydropsyche (Orthopsyche)</i>	9	R	-	R	R
	<i>Plectrocnemia</i>	8	-	-	R	R
	<i>Psilochorema</i>	6	-	R	-	R
	<i>Oxyethira</i>	2	-	R	-	-
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	-	R	-	-
	Eriopterini	5	-	-	-	R
	Hexatomini	5	-	C	-	R
	<i>Limonia</i>	6	-	R	-	-
	<i>Paralimnophila</i>	6	-	R	-	-
	<i>Zelandotipula</i>	6	-	-	-	R
	<i>Corynoneura</i>	3	-	-	R	-
	Orthocladiinae	2	A	A	A	A
	<i>Polypedilum</i>	3	C	C	C	C
	Empididae	3	-	R	-	-
	Muscidae	3	-	-	R	-
	Psychodidae	1	-	-	-	R
	<i>Austrosimulium</i>	3	C	R	C	C
No of taxa			11	22	14	16
MCI			104	95	90	98
SQMCIs			3.4	4.1	4.4	6.5
EPT (taxa)			3	6	5	4
%EPT (taxa)			27	27	36	25
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare

C = Common

A = Abundant

VA = Very Abundant

XA = Extremely Abundant

Site 1

A moderately low community richness of 11 taxa was recorded, four taxa less than that recorded in the previous survey and a substantial nine taxa less than the median richness for this site and the median richness for 'control' sites in similar streams at similar altitude (Figure 2, Table 4, Table 5). This is also the lowest richness recorded at this site to date (Table 4). One 'tolerant' taxon [orthoclad midges] characterised the macroinvertebrate community at this site (Table 6).

The MCI score of 104 units indicated 'good' macroinvertebrate community health (Table 3). This score was not significantly different (Stark 1998) from the previously recorded score of 107 units (Figure 2) or from the median score for this site of 105 units (Table 4). It was also similar to the median MCI score for 'control' sites in similar streams at similar altitude (Table 5). A SQMCI_s score of 3.4 units was recorded, a significant (Stark 1998) 1.1 units lower than that recorded in the previous survey and 1.5 units lower than the median score recorded at this site (Table 4).

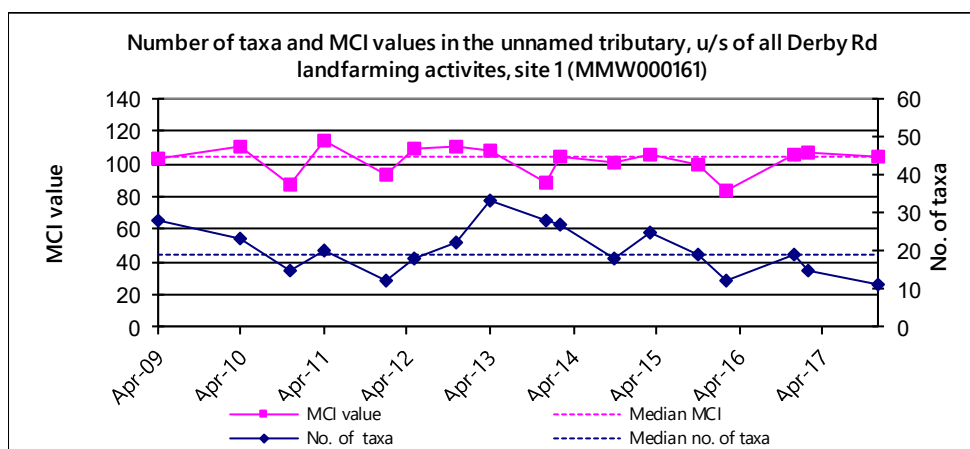


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary of the Mangamawhete Stream

Site 2

A moderate macroinvertebrate community richness of 22 taxa was recorded at site 2, five taxa more than both the richness recorded in the preceding survey and the median richness for this site (Figure 3, Table 4). This was two taxa more than the median richness for 'control' sites at similar altitude in similar streams (Table 5). The macroinvertebrate community was characterised by three taxa, the 'moderately sensitive' taxon [mayfly (Deleatidium)] and the two 'tolerant' taxa [seed shrimp (Ostracoda) and midge larvae (Orthocladinae)] (Table 6).

The MCI score of 95 units indicated a macroinvertebrate community in 'fair' health (Table 3). This score was significantly lower (Stark 1998) than the preceding score of 109 units and the median score for 'control' sites at similar altitude in similar streams, but similar to the median score for this site (Figure 3, Table 4, Table 5). The recorded SQMCI_s score of 4.1 units was slightly lower than was recorded in the preceding survey and slightly higher than the median score for this site (Table 4).

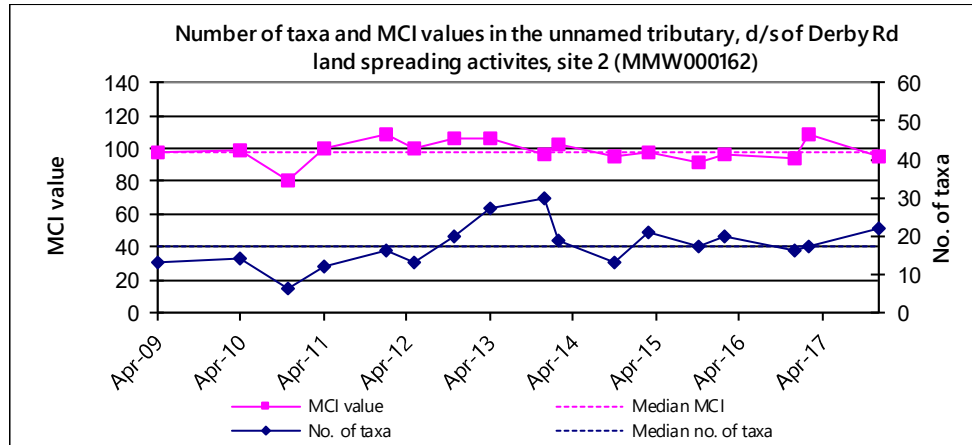


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in the unnamed tributary of the Mangamawhete Stream

Site 3

A moderate taxa richness of 14 taxa was recorded, one taxon less than was recorded in the preceding survey and two taxa less than the median for this site (Figure 4, Table 4). This was six taxa less than the median for 'control' sites in similar streams at similar altitude (Table 5). The macroinvertebrate community was characterised by only two taxa, the 'highly sensitive' taxon [mayfly (*Deleatidium*)] and the 'tolerant' taxon [midge larvae (*Orthocladinae*)] (Table 6).

The MCI score of 90 units indicated a macroinvertebrate community of 'fair' health (Table 3). This score was a non-significant (Stark 1998) 9 units less than recorded in the preceding survey and 10 units less than the median score for this site (Figure 4, Table 4). This score was significantly lower (Stark 1998) than the median score for 'control' sites at similar altitude in similar streams (Table 5). A SQMCI₅ score of 4.4 units was recorded, similar to the preceding result and the median score for this site (Table 4).

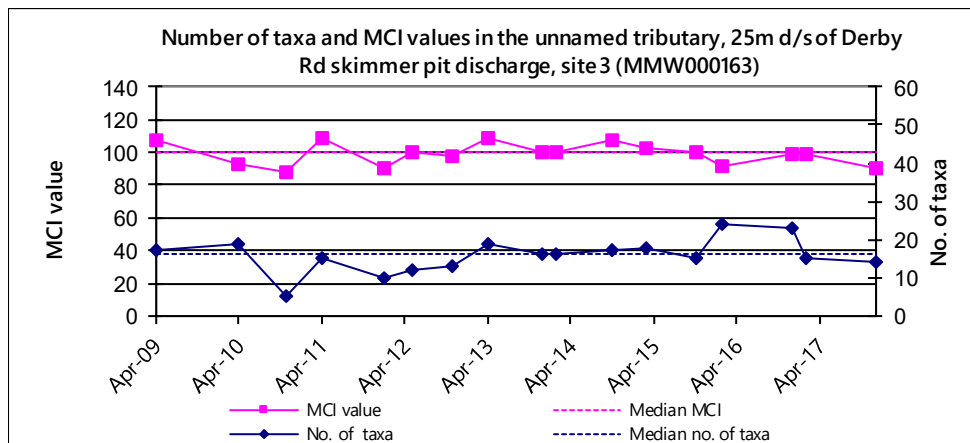


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in the unnamed tributary of the Mangamawhete Stream

Site 4

A moderate taxa richness of 16 taxa was recorded, equal to that recorded in the preceding survey and one taxon less than the median score for this site (Figure 5, Table 4). The macroinvertebrate community was characterised by only two taxa, the 'highly sensitive' taxon [mayfly (*Deleatidium*)] and the 'tolerant' taxon [midge larvae (*Orthocladinae*)] (Table 6).

The MCI score of 98 units indicated a macroinvertebrate community of 'fair' health (Table 3). This was a significant (Stark 1998) 23 units lower than was recorded in the preceding survey and was slightly lower than the median MCI score for this site and the median MCI score for 'control' sites in similar streams at comparable altitude (Figure 5, Table 4, Table 5). A SQMCI_s score of 6.5 units was recorded, a significant (Stark 1998) 1.5 units higher than the score recorded in the preceding survey and significantly higher than the median score for this site (Table 4).

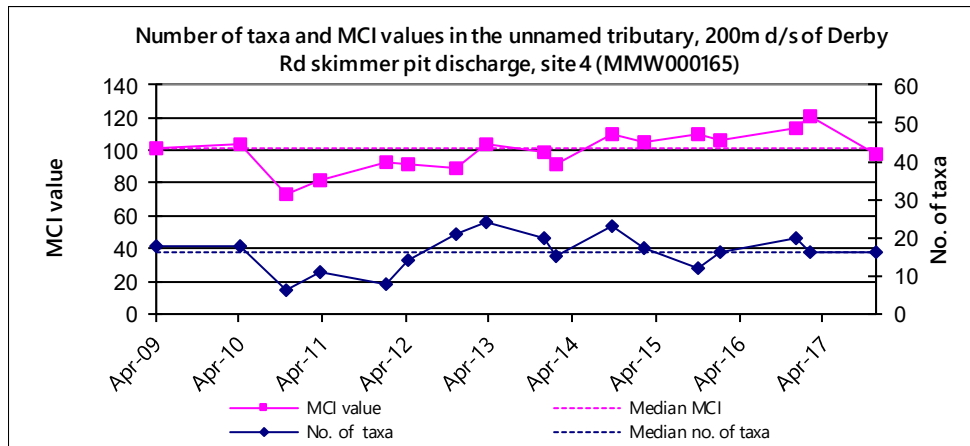


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in the unnamed tributary of the Mangamawhete Stream

Discussion and conclusions

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

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

This survey found moderate or moderately low taxa richnesses, with site 1 (the upstream 'control' site) recording the lowest taxa richness in the survey and its lowest richness to date. This richness was substantially lower than was recorded at site 2, but was similar to the richnesses at sites 3 and 4.

MCI scores in this survey categorised site 1 as having 'good' macroinvertebrate community health and sites 2-4 as having 'fair' macroinvertebrate community health. Site 1 recorded the highest score, which was significantly higher than that recorded at site 3. There were no other significant differences in MCI score between sites. All MCI scores were similar to median scores for the respective sites. The MCI scores at sites 2 and 4 decreased significantly since the preceding survey, while the scores at sites 1 and 3 remained similar.

SQMCI_s scores increased in a downstream direction. Site 1 recorded a score significantly lower than sites 3 and 4, while the score at site 4 was significantly higher than the score at any of the other sites. There were

no other significant differences in SQMCI_s score between the sites. When compared to historic medians for each site, and also compared to the preceding survey, site 1 showed a significant decrease, sites 2 and 3 remained similar and site 4 showed a significant improvement.

Overall, the lower taxa richness at site 1, upstream of the landfarming area, and the increasing SQMCI_s scores in a downstream direction and similar to median MCI scores found by this survey, provide no evidence that the activities at the drilling waste stockpiling site and landfarming area have caused any recent detrimental impacts on the macroinvertebrate communities of this unnamed tributary of the Mangamawhete Stream.

Summary

A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to drilling waste stockpiling and landfarming activities at the Derby Rd site. Taxa richnesses were moderately low to moderate at the site, and were lowest at the upstream 'control' site. MCI scores indicated 'fair' to 'good' macroinvertebrate community health, and scores were similar to median scores for each site respectively. SQMCI_s scores increased in a downstream direction. Overall the results of this survey provide no evidence of any recent significant detrimental effects on the macroinvertebrate communities of this unnamed tributary of the Mangamawhete Stream.

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To Job Manager, Nathan Crook
From Environmental Scientist, Katie Blakemore
Report No KB043
Document 2042608
Date 24 April 2018

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

Introduction

A macroinvertebrate survey was performed on 7 December 2017 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here, it is either pumped out for removal, or discharged to land, in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. However, results from the summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The spring (October 2015) survey (Sutherland & Blakemore, 2016) again indicated some impact on macroinvertebrate communities from stockpiling activities, however the extent to which could not be determined due habitat variables such as periphyton growth and iron oxide deposits. It was recommended an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream. Results from the February 2016 survey (Thomas, 2016) indicated that there was no significant effect on macroinvertebrate communities from the activities. However, results from the two most recent previous surveys in December 2016 (Thomas, 2017a) and February 2017 (Thomas, 2017b) again indicated activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

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

Methods

This scheduled biomonitoring survey was undertaken at four sites on 7 December 2017 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was

observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

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

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

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

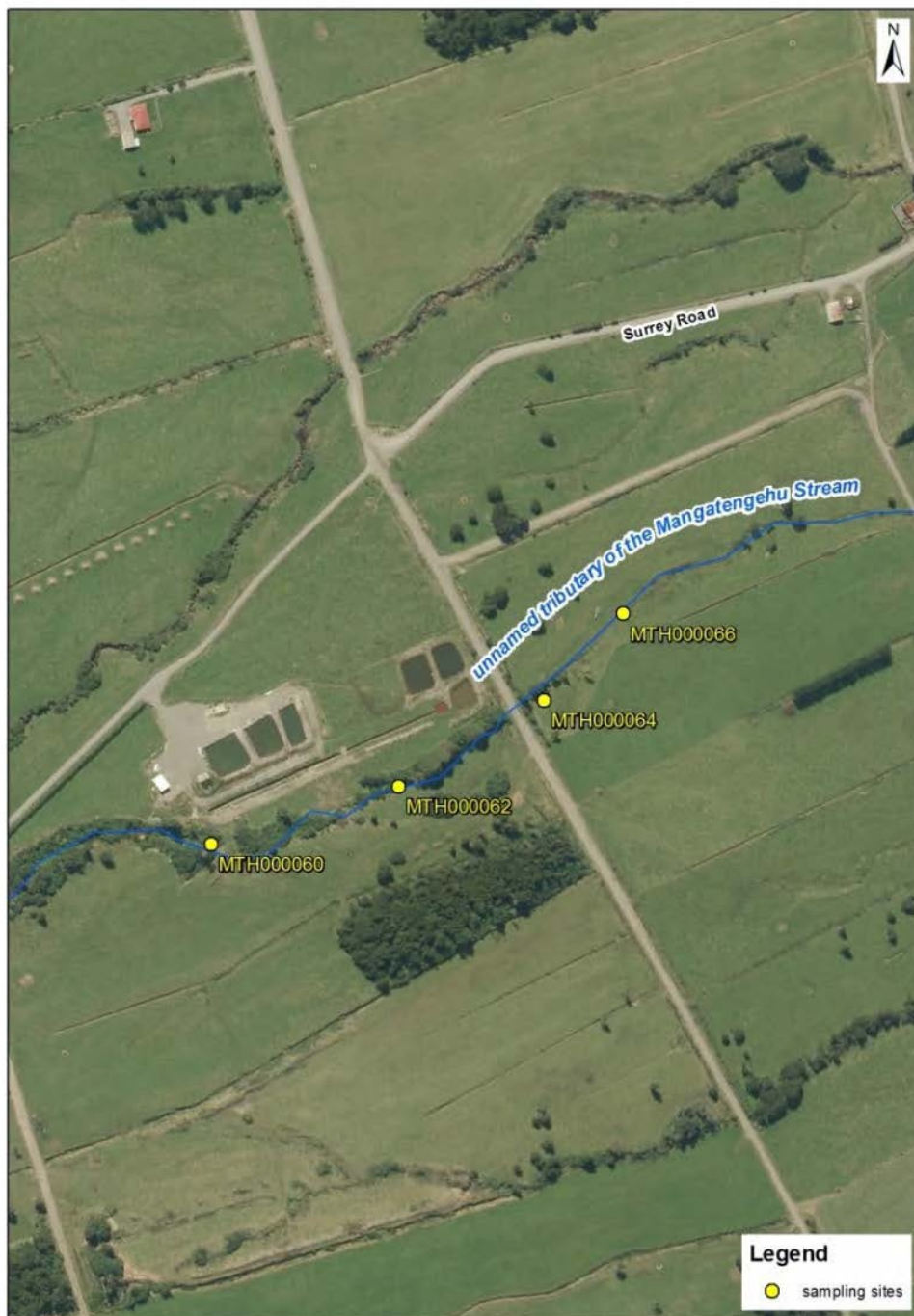


Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark *et al.* 2001). Macroinvertebrate taxa found in each sample were recorded based on the abundance categories in Table 2.

Table 2 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	>140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

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

Results

This December 2017 survey followed a period of 29 days since a fresh in excess of seven times median flow, based on the nearest flow gauging site on the Manganui river at SH3 Midhirst.

Water temperatures ranged between 15.7 °C and 16.0 °C. There was an uncoloured, clear, very low and steady flow at all four sites. The substrate at the four sites comprised predominantly coarse gravel and

cobble, with small amounts of fine gravel, sand and silt present. Sites 2, 3 and 4 also had some boulder present.

No periphyton mats were recorded growing at sites 1 and 2, whereas patchy mats were recorded at sites 3 and 4. Filamentous periphyton was absent from all four sites. Macrophytes were not present at any of the four sites. Leaves were patchy on the streambed at sites 1 and 2 and absent from sites 3 and 4.

Site 2 had complete shading while sites 1, 3 and 4 had no shading. Iron oxide deposits were evident at all sites.

Macroinvertebrate communities

Table 4 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 4 Number of taxa, MCI and SQMCI_s values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 7 December 2017 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			SQMCI _s value		
		Median	Range	Dec 2017	Median	Range	Dec 2017	Median	Range	Dec 2017
1	16	20	15-36	21	111	89-127	99	5.1	2.0-7.1	5.8
2	16	20	5-30	13	119	80-128	114	5.7	1.6-6.9	4.7
3	16	11	4-19	10	99	60-121	82	2.7	1.4-3.9	2.2
4	12	13	7-25	14	98	77-109	109	2.7	1.4-4.7	2.4

Table 5 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 5 Range and median number of taxa, MCI values and SQMCI_s scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2017).

	No. of taxa	MCI value	SQMCI _s value
No. Samples	45	45	43
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 6 .

Table 6 Macroinvertebrate fauna of an unnamed tributary of the Mangatangaehu Stream, sampled on 7 December 2017

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB17453	FWB17454	FWB17455	FWB17456
ANNELIDA (WORMS)	Oligochaeta	1	A	R	C	A
CRUSTACEA	Ostracoda	1	-	-	R	-
	Talitridae	5	-	R	-	-
	<i>Paranephrops</i>	5	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	-	R	R
	<i>Deleatidium</i>	8	VA	A	-	C
	<i>Nesameletus</i>	9	R	R	-	-
	<i>Zephlebia group</i>	7	A	C	-	R
PLECOPTERA (STONEFLIES)	<i>Acroperla</i>	5	R	-	-	R
	<i>Austroperla</i>	9	R	R	-	-
	<i>Spaniocerca</i>	8	-	R	-	-
	<i>Zelandobius</i>	5	R	-	-	-
	<i>Zelandobius illiesi</i>	10	-	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	R	-	-	-
	Ptilodactylidae	8	-	-	R	R
TRICHOPTERA (CADDISFLIES)	<i>Hydrochorema</i>	9	-	-	-	R
	<i>Psilochorema</i>	6	C	R	-	R
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	R	-	R	R
	Eriopterini	5	-	-	R	R
	Hexatomini	5	R	-	-	-
	<i>Limonia</i>	6	-	-	R	-
	<i>Paralimnophila</i>	6	R	-	-	-
	<i>Chironomus</i>	1	R	-	-	-
	Orthocladiinae	2	A	A	VA	VA
	<i>Polypedilum</i>	3	C	A	C	-
	<i>Paradixa</i>	4	R	-	-	-
	Ephydriidae	4	R	-	-	-
	Muscidae	3	R	-	C	R
	Psychodidae	1	-	R	-	-
	<i>Austrosimulium</i>	3	A	-	-	-
ACARINA (MITES)	Acarina	5	R	R	-	R
No of taxa			21	13	10	14
MCI			99	114	82	109
SQMCIs			5.8	4.7	2.2	2.4
EPT (taxa)			8	7	1	6
%EPT (taxa)			38	54	10	43
'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 21 taxa was recorded at site 1 upstream of the storage area, which was one taxon more than the median recorded to date (Table 4 and Figure 2), and one taxon more than the median recorded by 'control' sites at similar altitudes (Table 5). There were five taxa recorded in abundance including three 'tolerant' taxa [oligochaete worms, midge larvae (*Orthocladinae*) and sandfly larvae (*Austrosimulium*)], one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 6).

The community comprised of a moderate proportion (62%) of 'sensitive' taxa which contributed to the 'fair' MCI score of 99 units. This was significantly lower (Stark 1998) than both the historical median (111 units; Table 4) and the score recorded by the previous survey (113 units; Figure 2). A SQMCI_s score of 5.8 units was recorded, 0.4 unit higher than the result recorded in the previous survey and 0.7 unit higher than the median for the site recorded by previous surveys (Table 4). This score was slightly above the median value calculated from similar 'control' sites at comparable altitudes (Table 5).

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

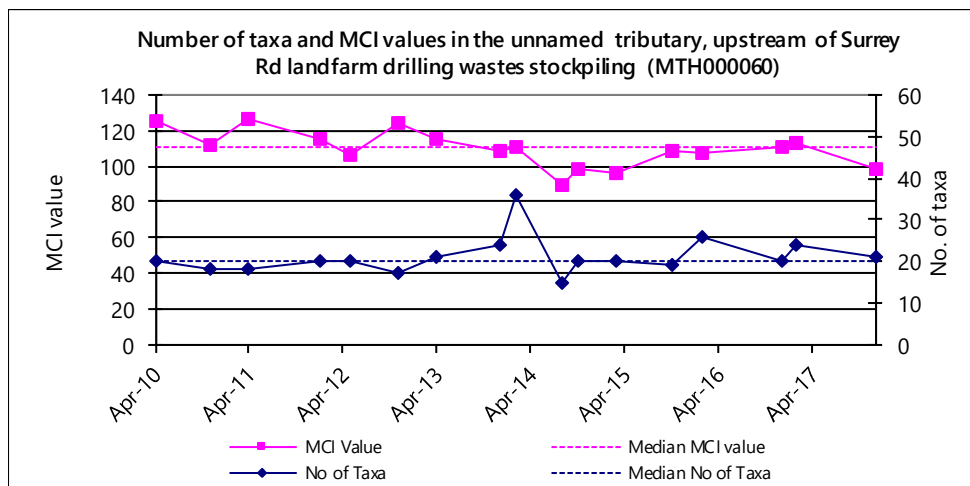


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in an unnamed tributary of the Mangatengehu Stream.

Site 2

A low taxa richness of 13 taxa was found at site 2, which was slightly lower than the previous survey result (Figure 3), and a substantial seven taxa lower than the median for the site (Table 4). Taxa richness was also substantially below the median recorded by similar sites at comparable altitudes (Table 5). Although this result was 17 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 substantial eight taxa less than that recorded by site 1 in the current survey.

The community comprised a high proportion of 'sensitive' taxa (69%) which was reflected by the MCI score of 114 units. This MCI score indicated a community of 'good' biological health, and was similar to the previous survey score (Figure 3) and the median value calculated from previous surveys at the same site (Table 4). This score was significantly higher than that recorded by the upstream 'control' site. The SQMCI_s

score of 4.7 units was significantly lower than the previous survey score (SQMCI_s score of 5.8 units) and than the median value calculated from previous surveys at the same site, and was significantly lower than that recorded at the upstream 'control' site (Table 4).

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)] and two 'tolerant' taxa [midge larvae (*Orthoclaadiinae* and *Polypedilum*)] (Table 4).

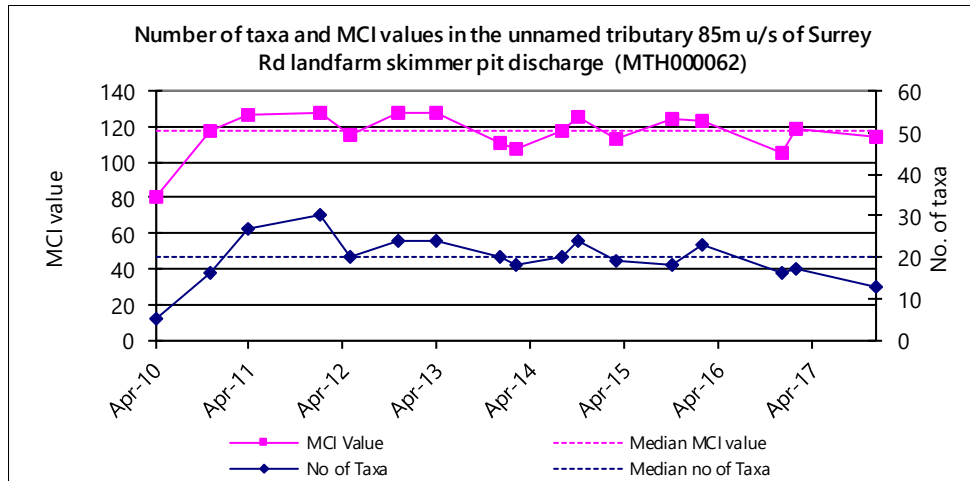


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A low taxa richness of ten taxa was found at site 3, which was six taxa more than that found by the previous survey (Figure 4) and only one taxon less than the median number recorded for the site (Table 4). This was ten taxa fewer than the median calculated from similar sites at comparable altitudes (Table 5). This taxa richness was 11 taxa lower than that recorded at site 1, and three taxa less than that recorded at site 2. This result showed some improvement from the previous survey, which recorded the lowest number to date at the site (Figure 4). Low taxa richness may be an indicator of toxic discharges, though other factors such as poor habitat quality may also cause low taxa richness.

The community had low taxa abundances with only one very abundant 'tolerant' taxon recorded [orthoclad midges]. Low taxa abundances, especially when associated with low taxa richness, may also indicate a macroinvertebrate community affected by discharges. The low taxa abundances could be due to the majority or all individuals from a particular taxon either dying or actively migrating downstream to avoid discharges. Individuals collected at the time of the survey may naturally be more tolerant to contaminants or more likely represent recolonisation of the reach since any discharges occurred.

In the current survey, 'tolerant' taxa comprised 50% of the macroinvertebrate community, which contributed to the 'fair' MCI score of 82 units. This score was significantly (Stark, 1998) lower than the median for this site (Table 4), but represented a significant improvement from the previous survey score (Figure 4). It was also significantly lower than that recorded upstream at sites 1 and 2 (Table 4).

The SQMCI_s score of 2.2 units was slightly higher than the previous survey score (SQMCI_s score of 2.0 units) and was lower than the median value calculated from previous surveys at the same site (SQMCI_s score of 2.7) (Table 4). The current SQMCI_s score of 2.2 units represented a substantial downstream decrease of 2.5 units in SQMCI_s score between sites 2 and 3. The proliferation of algal mats (due to reduced shading) may possibly explain the reduction in macroinvertebrate indices at this site, although this may also be indicative of impacts caused by activities at the drilling waste stockpiling site.

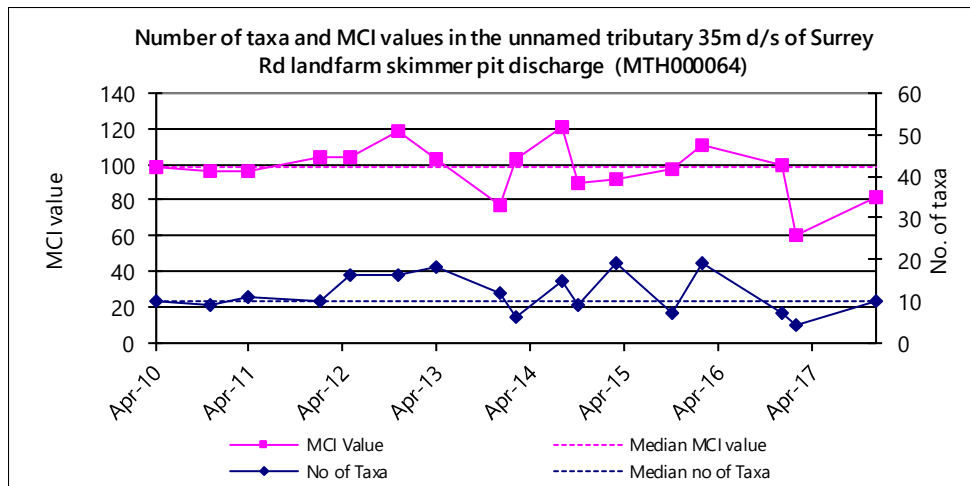


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of 14 taxa was found at site 4, which was slightly higher than that recorded by the previous survey and the median for the site but six taxa less than that recorded by the upstream 'control' site 1 (Table 4 and Figure 5). Furthermore, the sample contained six taxa less than the median calculated from similar sites (Table 5). The community was characterised by two 'tolerant' taxa [oligochaete worms and midge larvae (Orthocladiinae)] (Table 4).

A high proportion (79%) of 'sensitive' taxa contributed to the recorded MCI score of 109 units, which indicated a community of 'good' biological health. This was significantly higher (Stark, 1998) than the previous survey (Figure 5) and the median value calculated from previous surveys at the same site (Table 4). It was not significantly different from the scores recorded upstream at 'control' sites 1 and 2.

The SQMCI_s score of 2.4 units was higher than the previous survey score (SQMCI_s score of 2.1 units) but was lower than the median value calculated from previous surveys at the same site (Table 4). In addition, this SQMCI_s score was significantly lower than that recorded at site 1 or site 2.

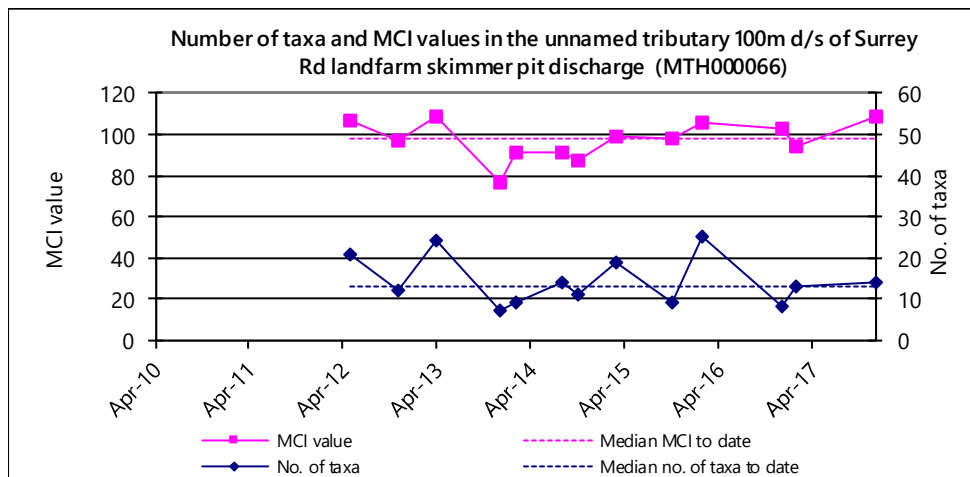


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 7 December 2017, to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s score for each site.

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

In the current survey, the MCI recorded at the upstream 'control' site was significantly lower than the previously recorded median at this site, while the SQMCI_s score was similar to the median score recorded at the site in previous surveys. The MCI score was indicative of 'fair macroinvertebrate health and together with the presence of many 'sensitive' taxa in this community was indicative of good preceding water quality.

The results of this survey indicated an increase in MCI score at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall. However while the MCI score was significantly higher than at site 1, the SQMCI_s score was significantly lower. The MCI score was reflective of 'good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were reflective of 'fair' (site 3) and 'good' (site 4) macroinvertebrate community health. Both had substantially lower SQMCI_s scores compared with the two upstream sites. In addition, the MCI score recorded at site 3 was significantly (Stark, 1998) lower than that recorded by any other site. In the previous survey, site 3 recorded the lowest MCI score for the site to date. The current MCI score was significantly (Stark, 1998) higher than this preceding score (by 22 units). The MCI score at site 4 was similar to those recorded at sites 1 and 2. Taxa richnesses at both sites were similar to site 2, but were somewhat lower than at site 1.

The decreases in macroinvertebrate indices at the two 'impacted' sites can to an extent be attributed to habitat differences, including periphyton cover caused by a lack of shading at the lower sites. The iron oxide deposits, which were found at all four sites, may reduce macroinvertebrate habitat quantity and quality by infilling spaces in the benthos and potentially creating a hard impregnable pan. This could potentially reduce both taxa richness and taxa abundances. However, the low taxa richness, MCI and SQMCI_s scores recorded below the discharge point at site 3 indicate that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

In relation to the previous (February 2017) survey the 'impacted' sites in the current survey recorded significantly increased MCI scores and slightly increased SQMCI_s scores. Taxa richness at site 3 had also increased (by six taxa). At site 4, taxa richness had increased by one taxon. In contrast, sites 1 and 2 recorded decreased taxa richness, while the MCI score decreased significantly at site 1 and decreased slightly at site 2. SQMCI_s increased slightly at site 1 and decreased significantly at site 2.

Comparison of taxa richnesses, MCI and SQMCI_s values of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both 'control' sites had MCI and SQMCI_s similar to the median values, while the taxa richness was lower than the median at site 2. However, the two 'impacted' sites recorded taxa richnesses and SQMCI_s values well below median values, and site 3 recorded a MCI score significantly below the median value.

Summary

Overall, the two potentially 'impacted' sites showed significant differences in taxa richnesses, MCI and SQMCI_s values examined compared with the 'control' sites at the time of the survey. The low scores at site 3 showed improvement since the preceding survey (which recorded the lowest results at this site to date), and further recovery in macroinvertebrate community health may still be occurring. Differences in shading and periphyton cover may explain some of the differences observed. Stockpiling activities may also have contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores.

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To Job Manager, Nathan Crook
From Environmental Scientist, Katie Blakemore
Report No KB059
Document [2079948](#)
Date 29 June 2018

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road Landfarm, April 2018

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. This was the second of two scheduled surveys for the site in the 2017-2018 year.

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

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

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

The surveys performed in February 2017 and December 2017 (Thomas, 2017b, Blakemore 2018) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit

discharge. This fourth site provides comparative information should deterioration be recorded at sites 2 or 3. Locations of the sampling sites are presented in Figure 1 and Table 1.

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

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

Samples were preserved with Kahle's Fluid and ethanol 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 based on the abundance categories in Table 2.

Table 2 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	> 140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

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

Results

This survey was carried out eight days after a fresh in excess of 3x median flow and 13 days after a fresh in excess of 7x median flow. Flows were moderate, with cloudy, grey flow which had a steady velocity. Water temperatures ranged from 13.1 °C – 14.6 °C at the four sites. Substrate comprised predominantly cobble at all sites, with small amounts of silt, sand, fine gravel, coarse gravel and boulder present. A silt coating was present on the streambed at all sites, with some iron oxide also present at sites 2 and 3.

Periphyton mats were slippery at site 1 and patchy at the remaining three sites, while filamentous periphyton was patchy at sites 1 and 3, and widespread at sites 2 and 4. Leaves were patchy on the streambed at sites 1 and 3 and widespread at site 4 but absent at site 2. Wood was patchy on the streambed at sites 3 and 4 only. Moss was patchy at all four sites, while macrophytes were present on the stream margins at site 1 and absent at the remaining three sites. Sites 1, 3 and 4 was partially shaded by overhanging vegetation. Site 2 had no shading.

Macroinvertebrate communities

Table 4 provides a summary of results from previous surveys carried out in relation to the Derby Rd drilling waste stockpiling site along with the current survey results.

Table 4 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 6 April 2018 and a summary of historical data for these sites

Site No.	N	No of taxa			MCI value			SQMCI _s value		
		Median	Range	Apr 2018	Median	Range	Apr 2018	Median	Range	Apr 2018
1	17	19	11-33	23	104	83-114	105	4.8	3.2-7.4	6.7
2	17	17	6-30	16	98	80-109	105	3.8	2.0-7.4	4.7
3	17	16	5-24	21	100	88-109	110	4.4	2.5-6.7	5.5
4	17	16	6-24	14	101	73-121	116	4.9	2.1-7.0	6.8

Table 5 provides a summary of macroinvertebrate indices for 'control' sites situated in Taranaki ringplain streams arising outside of Egmont National Park at altitudes greater than 400m above sea level.

Table 5 Range and median number of taxa, MCI and SQMCI_s values for 'control' sites in ringplain streams with sources outside of Egmont National Park at altitudes greater than 400m asl (TRC 2017)

	No. of taxa	MCI value	SQMCI _s value
No. Samples	45	45	43
Range	8-36	82-127	2.0-7.5
Median	20	109	5.1

The full results of the current survey are presented in Table 6.

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

Site 1

A moderately low macroinvertebrate community richness of 23 taxa was recorded, a substantial 12 taxa more than that recorded in the previous survey, and four taxa more than the median richness for this site and three taxa more than the median richness for 'control' sites in similar streams at similar altitude (Figure 2, Table 4, Table 5). The macroinvertebrate community at this site was characterised by one 'moderately sensitive' taxon [beetles (Elmidae)] and three 'highly sensitive' taxa [mayflies (*Deleatidium*) and (*Nesameletus*) and beetle (Scirtidae)] (Table 6).

The MCI score of 105 units indicated 'good' macroinvertebrate community health (Table 3). This score was not significantly different from the previously recorded score of 104 units (Figure 2) or from the median score for this site of 104 units (Table 4) (Stark 1998). It was also similar to the median MCI score for 'control' sites in similar streams at similar altitude (Table 5). A SQMCI_s score of 6.7 units was recorded, a significant 3.3 units higher than that recorded in the previous survey and 1.9 units higher than the median score recorded at this site (Table 4) (Stark 1998).

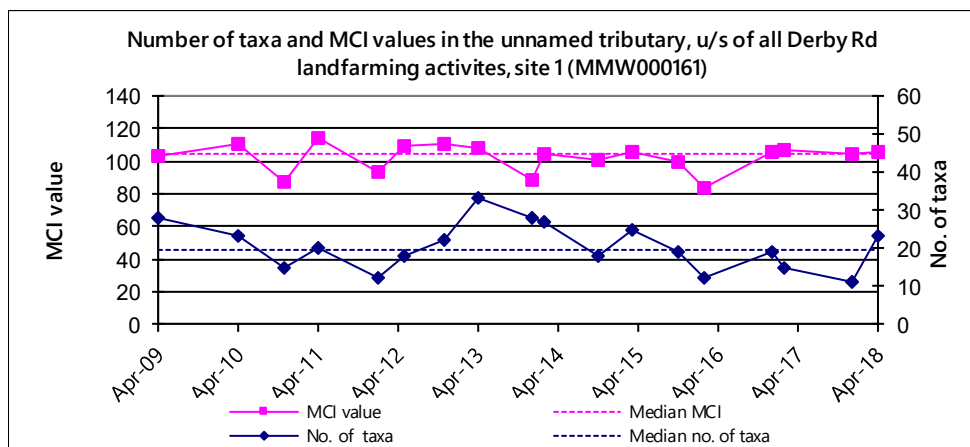


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary of the Mangamawhete Stream

Site 2

A moderate macroinvertebrate community richness of 16 taxa was recorded at site 2, six taxa less than the richness recorded in the preceding survey and one taxa less than the median richness for this site (Figure 3, Table 4). This was four taxa less than the median richness for 'control' sites at similar altitude in similar streams (Table 5). The macroinvertebrate community had no taxa categorised as 'abundant' or higher in this survey (Table 6).

The MCI score of 105 units indicated a macroinvertebrate community in 'good' health (Table 3). This score was a non-significant ten units higher than the preceding score (Stark 1998) and was similar to the median score for 'control' sites at similar altitude in similar streams and to the median score for this site (Figure 3, Table 4, Table 5). The recorded SQMCI_s score of 4.7 units was slightly higher than was recorded in the preceding survey and significantly higher than the median score for this site (Table 4) (Stark 1998).

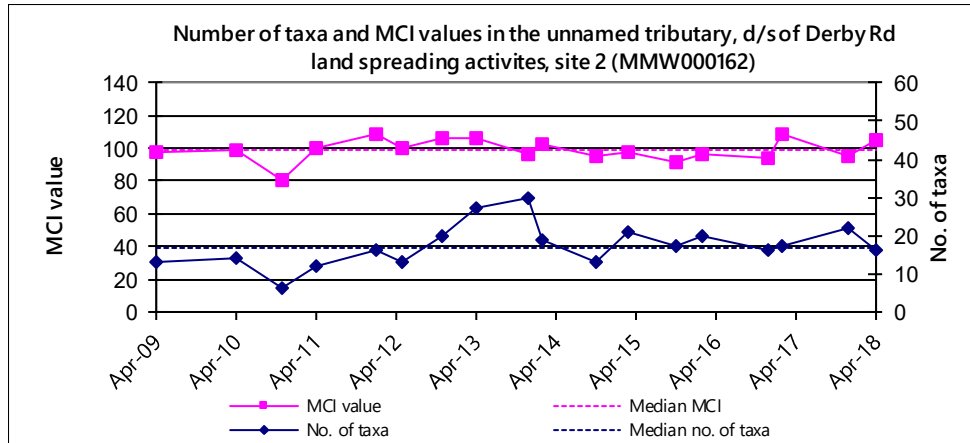


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in the unnamed tributary of the Mangamawhete Stream

Site 3

A moderate macroinvertebrate community richness of 21 taxa was recorded, seven taxa more than was recorded in the preceding survey and five taxa more than the median for this site (Figure 4, Table 4). This was one taxon more than the median for 'control' sites in similar streams at similar altitude (Table 5). The macroinvertebrate community had no taxa categorised as 'abundant' or higher in this survey (Table 6).

The MCI score of 110 units indicated a macroinvertebrate community of 'good' health (Table 3) and was the highest score recorded to date at this site (Figure 4, Table 4). This score was a significant 20 units higher than recorded in the preceding survey (Stark 1998) and 10 units more than the median score for this site (Figure 4, Table 4). This score was similar to the median score for 'control' sites at similar altitude in similar streams (Table 5). A SQMCI_s score of 5.5 units was recorded, significantly higher than the preceding result and the median score for this site (Table 4) (Stark 1998).

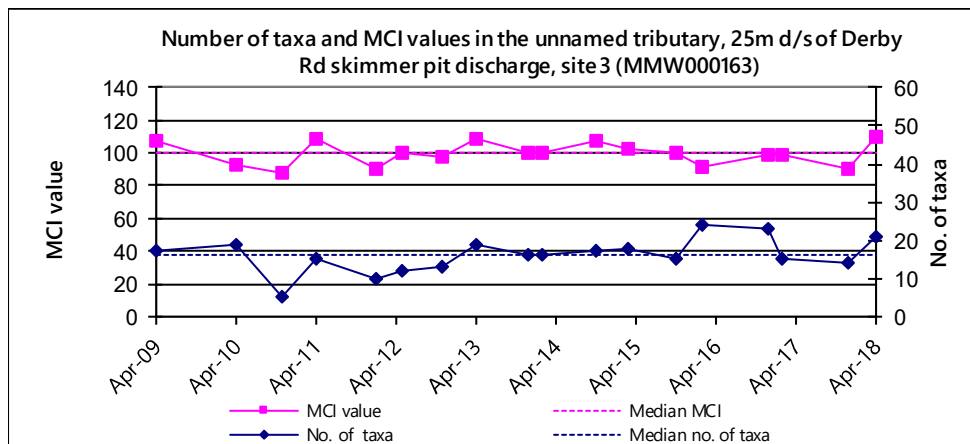


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in the unnamed tributary of the Mangamawhete Stream

Site 4

A moderate taxa richness of 14 taxa was recorded, two taxa less than that recorded in the preceding survey and the median score for this site (Figure 5, Table 4). The macroinvertebrate community was characterised by only two 'highly sensitive' taxa [mayfly (*Deleatidium*) and beetle (*Ptilodactylidae*)] (Table 6).

The MCI score of 116 units indicated a macroinvertebrate community of 'good' health (Table 3). This was a significant 18 units higher than was recorded in the preceding survey (Stark 1998) and was also significantly

higher than both the median MCI score for this site and the median MCI score for 'control' sites in similar streams at comparable altitude (Figure 5, Table 4, Table 5). A SQMCI₅ score of 6.8 units was recorded, similar to the score recorded in the preceding survey and significantly higher than the median score for this site (Table 4) (Stark 1998).

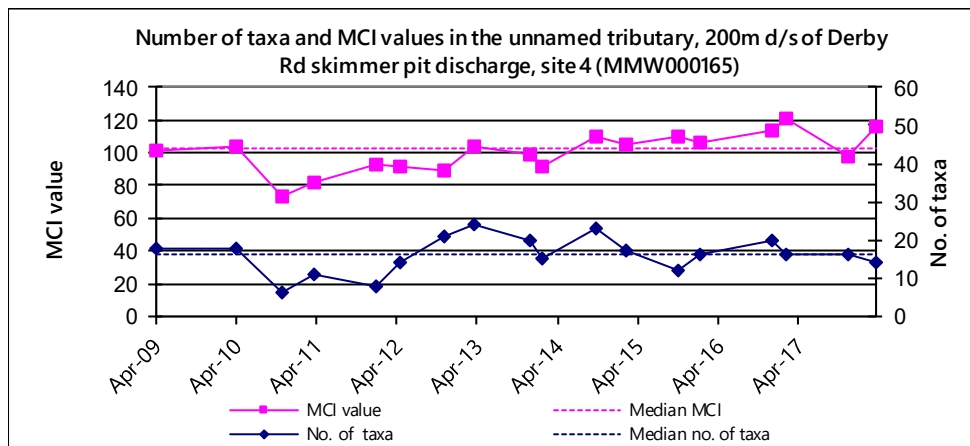


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in the unnamed tributary of the Mangamawhete Stream

Discussion and conclusions

The Council's kick-sampling technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage and disposal to land of drilling waste in the vicinity of the Stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI and SQMCI₅ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI₅ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or SQMCI₅ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This survey found moderate taxa richnesses, with site 1 (the upstream 'control' site) recording the highest taxa richness in the survey. This richness was substantially higher than was recorded at sites 2 and 4, but was similar to the richnesses at site 3. It is notable that taxa abundances were relatively low in this survey, with no taxa at any site recorded 'very abundant' or 'extra abundant' (i.e. less than 100 individuals), and sites 2 and 3 recording only 'rare' and 'common' taxa (or less than 20 individuals of each taxon).

MCI scores in this survey increased in a downstream direction and categorised all four sites as having 'good' macroinvertebrate community health. Site 4 recorded the highest score, which was significantly higher than that recorded at sites 1 and 2. There were no other significant differences in MCI score between sites. All MCI scores were similar to median scores for the respective sites, except site 4 which was significantly higher. Despite being not significantly different from the historic median, site 3 recorded its highest MCI score to date. The MCI scores at sites 1 and 2 remained similar to the preceding survey, while sites 3 and 4 increased significantly.

SQMCI_s scores varied between sites. Scores at sites 1 and 4 were similar, while sites 2 and 3 were also similar to each other but were significantly lower than sites 1 and 4. All four sites had scores significantly higher than respective historic medians. Compared with the preceding survey, sites 1 and 3 had significantly higher scores, while sites 2 and 4 showed no significant change.

Overall, the moderate taxa richnesses, the increasing MCI scores in a downstream direction and similar to or higher than median MCI scores found by this survey, provide no evidence that the activities at the drilling waste stockpiling site and landfarming area have caused any recent detrimental impacts on the macroinvertebrate communities of this unnamed tributary of the Mangamawhete Stream.

Summary

A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to drilling waste stockpiling and landfarming activities at the Derby Rd site. Taxa richnesses were moderately low to moderate at the site, and were lowest at the upstream 'control' site. MCI scores indicated 'good' macroinvertebrate community health, and scores were similar to or higher than median scores for each site respectively. SQMCI_s scores varied between, with no significant difference between site 1 and site 4. Overall, the results of this survey provide no evidence of any recent significant detrimental effects on the macroinvertebrate communities of this unnamed tributary of the Mangamawhete Stream.

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Report No KB060
Document 2080658
Date 2 July 2018

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road stockpiling facility, April 2018

Introduction

A macroinvertebrate survey was performed on 6 April 2018 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here, it is either pumped out for removal, or discharged to land, in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015a) indicated that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. However, results from the summer March 2015 survey (Sutherland, 2015b) indicated that there was no significant effect on macroinvertebrate communities from the activities. The spring (October 2015) survey (Sutherland & Blakemore, 2016) again indicated some impact on macroinvertebrate communities from stockpiling activities, however the extent to which could not be determined due habitat variables such as periphyton growth and iron oxide deposits. It was recommended an investigation into whether stockpiling activities were responsible for the high level of iron oxide deposits observed at the two 'impacted' sites would be useful in determining whether stockpiling activities were responsible for the low taxa richnesses and abundances found in the unnamed tributary of the Mangatengehu Stream. Results from the February 2016 survey (Thomas, 2016) indicated that there was no significant effect on macroinvertebrate communities from the activities. However, results from the two surveys in December 2016 (Thomas, 2017a) and February 2017 (Thomas, 2017b) again indicated activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream. The most recent (December 2017) survey (Blakemore 2018) also indicated some impacts, which were less severe than in the two prior surveys.

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

Methods

This scheduled biomonitoring survey was undertaken at four sites on 6 April 2018 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge.

During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

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

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

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

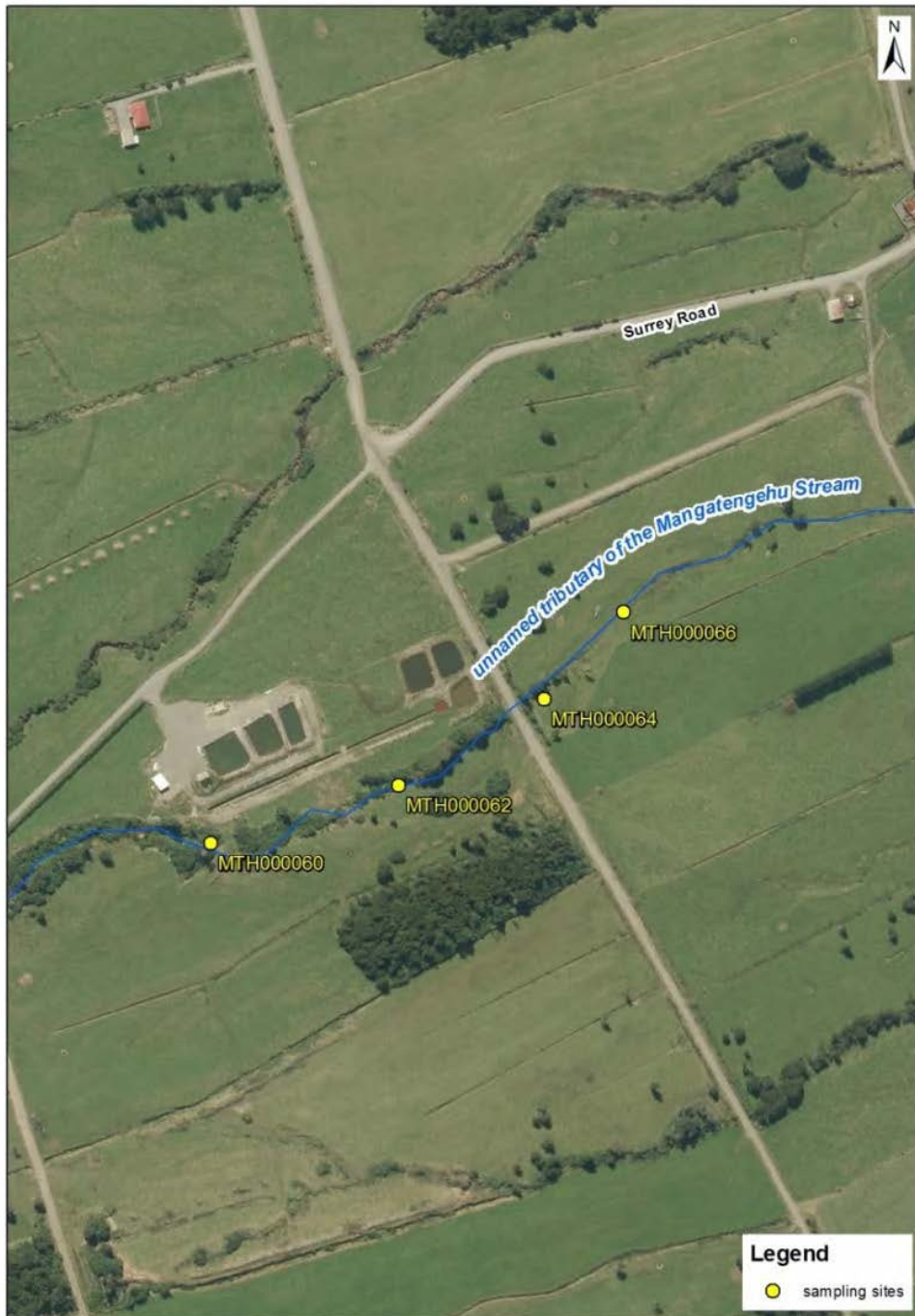


Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark *et al.* 2001). Macroinvertebrate taxa found in each sample were recorded based on the abundance categories in Table 2.

Table 2 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	> 140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

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

Results

This April 2018 survey followed a period of eight days since a fresh in excess of three times median flow and 13 days since a fresh of seven times median flow, based on the nearest flow gauging site on the Manganui river at SH3 Midhirst.

Water temperatures ranged between 13.1 °C and 13.7 °C. There was a moderate, steady, clear flow, which was uncoloured at site 1 and grey at sites 2, 3 and 4. The substrate at the four sites comprised predominantly coarse gravel and cobble, with small amounts of boulder, fine gravel, sand and silt present.

Periphyton mats were patchy at sites 1 and 4, slippery at site 2 and widespread at site 3. Filamentous periphyton was patchy at sites 1 and 3, widespread at site 4 and absent at site 2. Macrophytes were present on the stream margins at sites 1 and 4, and were absent at sites 2 and 3. Leaves were patchy on the streambed at sites 2, 3 and 4 and absent at site 1.

Site 2 had complete shading while site 3 had partial shading, and sites 1 and 4 had no shading. Iron oxide deposits were evident at all sites.

Macroinvertebrate communities

Table 4 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 4 Number of taxa, MCI and SQMCI_s values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 6 April 2018 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			SQMCI _s value		
		Median	Range	Apr 2018	Median	Range	Apr 2018	Median	Range	Apr 2018
1	17	20	15-36	26	111	89-127	107	5.1	2.0-7.1	5.4
2	17	20	5-30	11	118	80-128	105	5.5	1.6-6.9	5.9
3	17	10	4-19	9	98	60-121	82	2.5	1.4-3.9	2.9
4	13	13	7-25	10	98	77-109	108	2.6	1.4-4.7	3.4

Table 5 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 5 Range and median number of taxa, MCI values and SQMCI_s scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2017).

	No. of taxa	MCI value	SQMCI _s value
No. Samples	45	45	43
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 6 .

Table 6 Macroinvertebrate fauna of an unnamed tributary of the Mangatangaehu Stream, sampled on 6 April 2018

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB18215	FWB18216	FWB18217	FWB18218
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C	A
	Lumbricidae	5	R	-	-	-
MOLLUSCA	<i>Potamopyrgus</i>	4	R	-	-	-
CRUSTACEA	Ostracoda	1	C	-	-	-
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	R	-	-	-
	<i>Deleatidium</i>	8	A	A	-	C
	<i>Nesameletus</i>	9	C	C	-	R
	<i>Zephlebia group</i>	7	A	R	R	C
PLECOPTERA (STONEFLIES)	<i>Acroperla</i>	5	-	-	R	-
	<i>Austroperla</i>	9	R	-	-	-
	<i>Stenoperla</i>	10	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	R	-	-	-
	Hydraenidae	8	C	-	-	-
	Ptilodactylidae	8	C	-	-	R
	Scirtidae	8	R	R	-	-
TRICHOPTERA (CADDISFLIES)	<i>Hydropsyche (Aoteapsyche)</i>	4	R	-	-	-
	<i>Plectrocnemia</i>	8	-	R	-	-
	<i>Psilochorema</i>	6	C	C	R	R
	Oeconesidae	5	C	-	-	-
	<i>Oxyethira</i>	2	R	-	-	-
	<i>Tripletides</i>	5	R	-	-	-
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	-	-	R	R
	Eriopterini	5	R	-	-	R
	Hexatomini	5	R	-	-	-
	Orthoclaadiinae	2	A	C	C	C
	<i>Polypedilum</i>	3	R	C	C	C
	Empididae	3	R	R	R	-
	<i>Austrosimulium</i>	3	C	R	-	-
ACARINA (MITES)	Acarina	5	R	-	R	-
No of taxa			26	11	9	10
MCI			107	105	82	108
SQMCIs			5.4	5.9	2.9	3.4
EPT (taxa)			10	5	3	4
%EPT (taxa)			38	45	33	40
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare

C = Common

A = Abundant

VA = Very Abundant

XA = Extremely Abundant

Site 1

A moderately high richness of 26 taxa was recorded at site 1 upstream of the storage area, which was six taxa more than both the median recorded at this site to date (Table 4 and Figure 2), and the median recorded by 'control' sites at similar altitudes (Table 5). There were three taxa recorded in abundance including one 'tolerant' taxon [midge larvae (Orthoclaadiinae)], one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 6).

The community comprised of a moderate proportion (65%) of 'sensitive' taxa which contributed to the 'good' MCI score of 107 units. This was not significantly different (Stark 1998) to the historical median (111 units; Table 4) and the score recorded by the previous survey (99 units; Figure 2). A SQMCI_s score of 5.4 units was recorded, 0.4 unit lower than the result recorded in the previous survey and 0.3 unit higher than the median for the site recorded by previous surveys (Table 4). This score was slightly above the median value calculated from similar 'control' sites at comparable altitudes (Table 5).

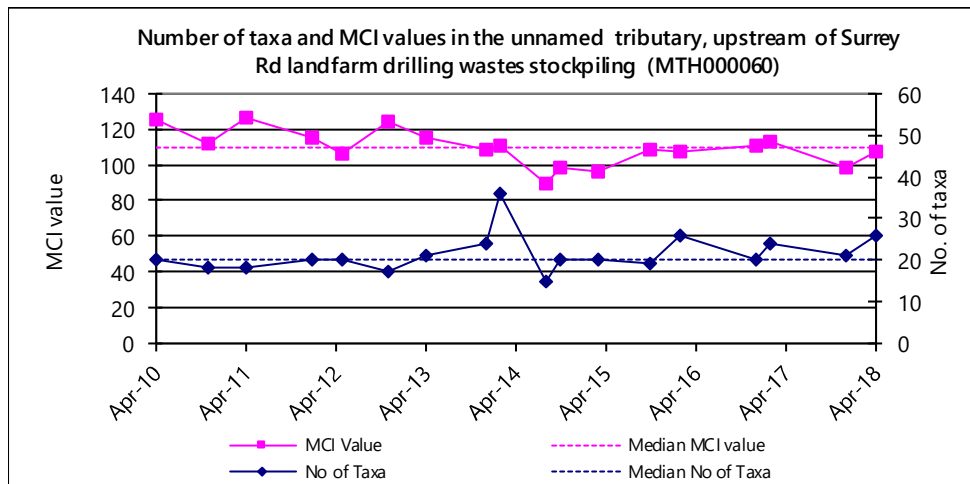


Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in an unnamed tributary of the Mangatengehu Stream.

Site 2

A low taxa richness of 11 taxa was found at site 2, which was slightly lower than the previous survey result (Figure 3), and a substantial nine taxa lower than the median for the site (Table 4). Taxa richness was also substantially below the median recorded by similar sites at comparable altitudes (Table 5). Although this result was 19 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).

The community comprised a moderate proportion of 'sensitive' taxa (55%) which was reflected by the MCI score of 105 units. This MCI score indicated a community of 'good' biological health, and was similar to the previous survey score (Figure 3) but was significantly lower (Stark 1998) than the median value calculated from previous surveys at the same site (Table 4). The SQMCI_s score of 5.9 units was significantly higher than the previous survey score (SQMCI_s score of 4.7 units) but similar to the median value calculated from previous surveys at the same site (Table 4).

The community was characterised by only one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 6).

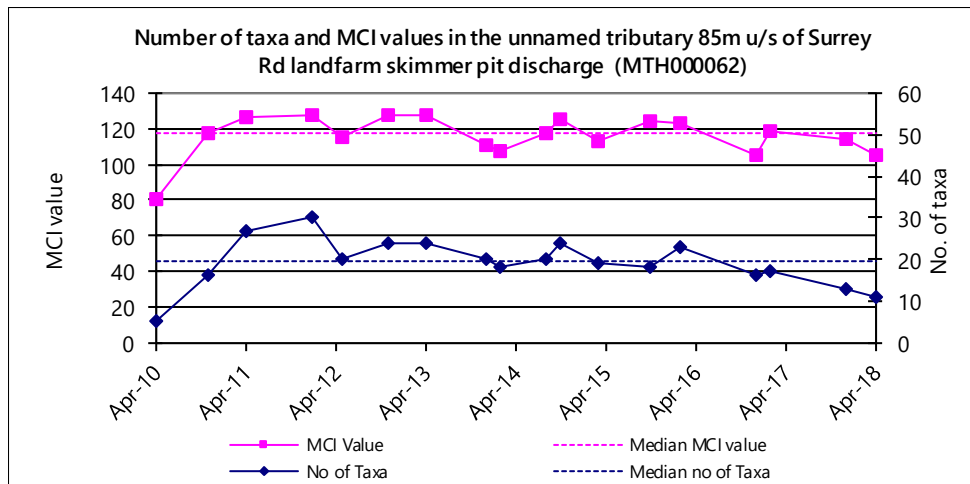


Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A low taxa richness of nine taxa was found at site 3, which was one taxon less than that found by the previous survey (Figure 4) and only one taxon less than the median number recorded for the site (Table 4). This was 11 taxa fewer than the median calculated from similar sites at comparable altitudes (Table 5). This result showed some improvement since the March 2017 survey, which recorded the lowest number to date at the site (Figure 4). Low taxa richness may be an indicator of toxic discharges, though other factors such as poor habitat quality may also cause low taxa richness.

The community had low taxa abundances with no taxa recorded as 'abundant' or higher (less than 20 individuals of each taxon present in this sample). Low taxa abundances, especially when associated with low taxa richness, may also indicate a macroinvertebrate community affected by discharges. The low taxa abundances could be due to the majority or all individuals from a particular taxon either dying or actively migrating downstream to avoid discharges. Individuals collected at the time of the survey may naturally be more tolerant to contaminants or more likely represent recolonisation of the reach since any discharges occurred.

In the current survey, 'tolerant' taxa comprised 44% of the macroinvertebrate community, which contributed to the 'fair' MCI score of 82 units. This score was significantly (Stark, 1998) lower than the median for this site (Table 4), but equal to the previous survey score (Figure 4).

The SQMCI_s score of 2.9 units was slightly higher than the previous survey score (SQMCI_s score of 2.2 units) and the median value calculated from previous surveys at the same site (SQMCI_s score of 2.5) (Table 4). The proliferation of algal mats (due to reduced shading) may possibly explain the reduction in macroinvertebrate indices at this site, although this may also be indicative of impacts caused by activities at the drilling waste stockpiling site.

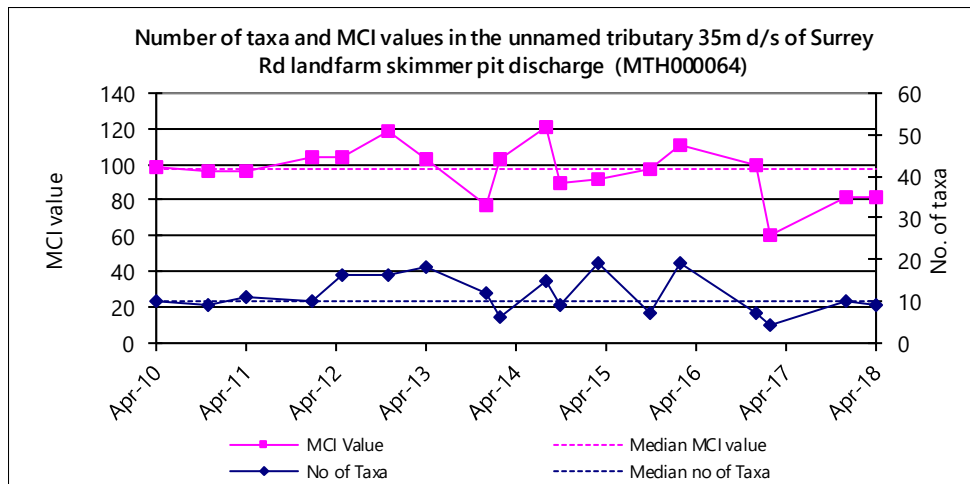


Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of ten taxa was found at site 4, which was slightly lower than that recorded by the previous survey and the median for the site (Table 4 and Figure 5). Furthermore, the sample contained ten taxa less than the median calculated from similar sites (Table 5). The community was characterised by only one 'tolerant' taxon [oligochaete worms] (Table 6).

A high proportion (70%) of 'sensitive' taxa contributed to the recorded MCI score of 108 units, which indicated a community of 'good' biological health. This was similar to the previous survey (Figure 5) and the median value calculated from previous surveys at the same site (Table 4).

The SQMCI_s score of 3.4 units was significantly higher than the previous survey score (SQMCI_s score of 2.4 units and was slightly higher than the median value calculated from previous surveys at the same site (Table 4).

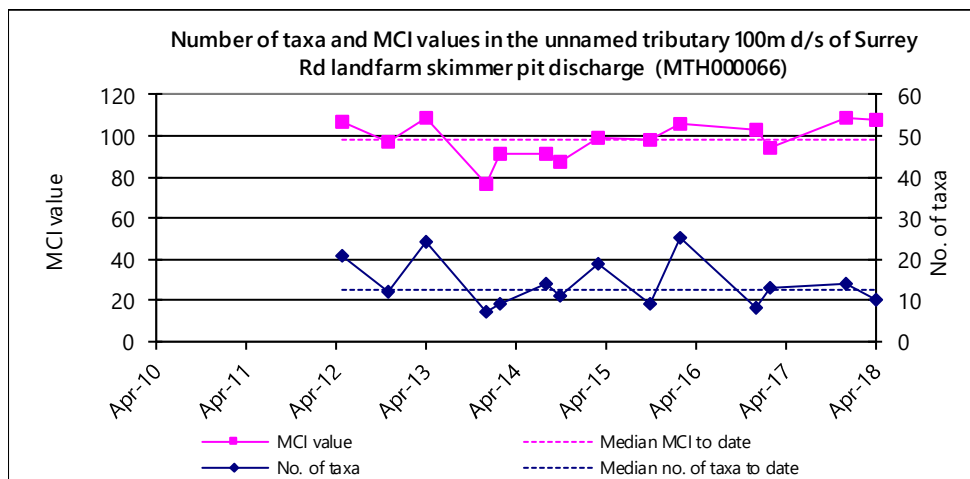


Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and conclusions

This biological survey of four sites in an unnamed tributary of the Mangatengehu Stream was performed on 6 April 2018, to monitor the 'health' of the macroinvertebrate community of the tributary, in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s score for each site.

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

Taxa richnesses ranged widely in this survey, with a moderately high richness of 26 taxa at the site 1. A substantial decrease of 15 taxa was recorded between site 1 and site 2, with richnesses remaining low at sites 3 and 4. The previous survey showed the same pattern for taxa richness, although it was more pronounced in the current survey. This contrasts with the pattern usually seen, where taxa richness decreases between sites 2 and 3. Taxa abundances in this survey were also relatively low, with only one 'abundant' taxon at site 2 and at site 4, and only 'common' or 'rare' taxa at site 3.

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

The MCI and SQMCI_s scores at site 2, located between the wastes storage pits and upstream of the stormwater discharge outfall, remained similar to those at site 1. This MCI score was significantly higher than the previously recorded median for this site. The MCI score was reflective of 'good' macroinvertebrate community health.

The macroinvertebrate communities present at the two 'impacted' sites were reflective of 'fair' (site 3) and 'good' (site 4) macroinvertebrate community health. In addition, the MCI score recorded at site 3 was significantly (Stark, 1998) lower than that recorded by any other site, and the previously recorded median for this site. The current MCI score was significantly (Stark, 1998) at site 3 was equal to the preceding score. The MCI score at site 4 was similar to those recorded at sites 1 and 2 and to the previously recorded median for this site. Both sites had substantially lower SQMCI_s scores compared with the two upstream sites, with a slight increase between sites 3 and 4. These scores were similar to the previously recorded medians for the respective sites, and to the preceding score at site 3. Site 4 showed a significant increase since the preceding survey.

The decreases in macroinvertebrate indices at the two 'impacted' sites can to an extent be attributed to habitat differences, including periphyton cover caused by a lack of shading at the lower sites. The iron oxide deposits, which were found at all four sites, may reduce macroinvertebrate habitat quantity and quality by infilling spaces in the benthos and potentially creating a hard impregnable pan. This could potentially reduce both taxa richness and taxa abundances. However, the low MCI and SQMCI_s scores recorded below the discharge point at site 3 and the low SQMCI_s score at site 4 indicate that activities at the drilling waste stockpiling site and stockpiling area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

In relation to the previous (December 2017) survey, the 'impacted' sites in the current survey recorded similar MCI scores and slightly or significantly increased SQMCI_s scores. Taxa richness at these sites also remained similar. In contrast, sites 1 and 2 recorded similar taxa richness while the MCI score increased significantly at site 1 and decreased slightly at site 2. SQMCI_s remained similar at site 1 and increased significantly at site 2.

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

median values, while the taxa richness was higher than median at site 1 and substantially lower than the median at site 2. The SQMCI_s was similar to median at site 1 and a significant 0.9 unit higher at site 2. However, the two 'impacted' sites recorded taxa richnesses and SQMCI_s values well below median values, and site 3 recorded a MCI score significantly below the median value. This indicates that stockpiling activities may be having detrimental impacts on the stream macroinvertebrate communities, although habitat differences between sites may also be contributing to differences in the macroinvertebrate communities.

Summary

Overall, taxa richness decreased substantially below site 1, and remained similar between the three downstream sites. The MCI score at site 3, the 'primary impact' site was significantly lower than sites 1, 2 and 4 (which had similar scores). SQMCI_s scores at the two potentially 'impacted' sites were significantly lower than the two upstream sites. The low scores at site 3 were similar to the preceding survey, although further recovery in macroinvertebrate community health may still be occurring. Differences in shading and periphyton cover may explain some of the differences observed. Stockpiling activities may also have contributed to low macroinvertebrate taxa richnesses, taxa abundances and MCI scores.

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