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APPENDIX 'D'

Uruti Composting Facility Review & Plan [BTW Limited] 26 Nov. 2017

REPORT

Uruti Composting Facility Management Plan

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Uruti Composting Facility Management Plan

Remediation New Zealand

Reviewed

Report Author

	Greg Larkin, Environmental Scientist , BSc Ecology and MSc in Environmental Science	Date

Reviewed by

	Dave Bolger, Senior Environmental Advisor, BSc Physical Geography and Environmental Science	Date

btw company

EXECUTIVE SUMMARY

BTW Company has been engaged by Remediation New Zealand (RNZ) to undertake an environmental data review of its Uruti Composting Facility in North Taranaki. The primary objective of the report was to develop a site management plan with operational recommendations to improve soil and groundwater resources in the Haehanga Catchment.

The main points of the environmental data review can be summarised by the following main points:

- Surface soils across the site are dominated by semi-porous silty clay-loams, overlying more impervious clay soils
- Soils below 2000 mm have not been characterised
- Chloride concentrations in the soil beneath the irrigation zone are highly elevated compared to non-irrigated areas
- The shallow groundwater table is in direct connection with semi-porous loamy silty-clay
- Due to high rates of irrigation loading, shallow groundwater beneath the Uruti Composting Facility Site are moderately impacted with Chloride contamination
- Site layout, hydrogeological interactions, soil types and rainfall also influence the level of Chlorides observed in the soil, groundwater resources and the Haehanga Stream environment
- Offsite impacts have not been quantified and where not part of the scope of this report

The Uruti Composting Facility Management Plan was developed to improve the performance of the composting facility. The plan incorporates both landuse and management controls such as operational thresholds, monitoring timeframes and remediation options. These are considered necessary to ensure compliance with consent conditions and to mitigate adverse effects on the receiving environment.

The plan was developed in conjunction with RNZ and Taranaki Regional Council (TRC), and closely adheres to relevant national and international guidelines and standards.

The plan framework is based on a three tier decision tree which guides site operation. The tiered response was developed because of simplicity but also allows increased monitoring effort and reviews of site performance to minimise risks from drainage losses to groundwater and accumulation of hydrocarbon constituents within the soil. Within each tier, specific constituent threshold values for the operation have been set to protect the soil and groundwater.

The tiered operational plan also provides remediation options should the irrigation zones reach tier 2 and 3. Potential remediation options focus on irrigation and soil management.

The Uruti Composting Management Plan also makes recommends a range of site improvements with attached implementation timeframes. BTW Company considers the recommendations and timeframes necessary to improve the management of site and to reduce offsite adverse environmental effects.

Specific Site Improvements include;

- Storage dam to provide a clean water source for summer time irrigation
- Increased irrigations zone (currently pending consent variation)
- Stormwater improvements
- Predisposal and pre irrigation sampling
- Haehanga Stream riparian planting
- Deferred irrigation
- Haehanga Stream irrigation setback (25m)

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1 INTRODUCTION

1.1 Background

BTW Company has been engaged by Remediation NZ Limited (RNZ) to undertake a review of its land disposal and composting site in the Haehanga Catchment at Uruti, in North Taranaki. The review covers a synopsis of available environmental and operational data with a view to recommend steps to develop soil and groundwater management plans for the site.

The report does not aim to assess the potential adverse effects to downstream ecological receptors such as fish or invertebrate values, but rather focuses on management improvements at the Composting Site. It is envisaged as part of the upcoming consent variation to increase the irrigation areas, that a separate Assessment of Environmental Effects (AEE) will be undertaken for that consent application.

1.1.1 Activity Description

The Remediation NZ facility at Uruti processes compost material and drilling mud and fluid, from both WBM and SBM waste streams. The hydrocarbon exploration material is stockpiled on the Drill Mud Pad (DMP), where the leachate is then captured and treated in the series of ponds. The three ponds are separated by baffles whereby surface hydrocarbons are skimmed and removed back to the hydrocarbon pile. The treated leachate is held in two final ponds and then irrigated to pasture on the two irrigation areas, one upstream of the DMP and one immediately downstream of the DMP. A seven tier wetland is also used to treat run off and leachate from the composting pad 2 but only discharges treated stormwater in high flow conditions.

The estimated total capacity of the three treatment ponds is approximately 10310 m^3, whereas average pumping rates are in the order of 30,000 litres per hour, during daylight hours only. This equates to 6.75 days to pump the final treatment pit of 5360 m^3 pit.

1.1.2 Environmental/Management Issue

The Taranaki Regional Council's (TRC) historical monitoring data recorded most of the parameters tested at the Uruti site were within their consent requirements (TRC monitoring report, 2013-2014). However, concentrations of Chlorides had increased significantly in early-2014 in both irrigation fluid, groundwater and surface water samples, alongside increased sodicity of the soils beneath the irrigation areas.

The sources of the increasing Chlorides and hydrocarbons were attributed to changes to the composition and volumes of the irrigation fluid, as a result of the increases in hydrocarbon exploration waste being processed and disposed of at the site.

The following sections of the report concentrate on the issue of elevated Chlorides at the Uruti Composting site. It is acknowledged there may be potentially other contaminates of concern which may require future attention.

2 ENVIRONMENTAL DATA SYNOPSIS

2.1 Catchment

The Remediation NZ Uruti composting facility is located in the Haehanga Catchment in North Taranaki. The Haehanga Stream is a tributary of the Mimi River, a regional significant river and important recreational whitebait fishery. The Haehanga Catchment covers 5.73 km^2 (TRC explorer), with monthly rainfall averaging 176 mm. In the areas, outside the composting facility land use is dominated by extensive dry stock and sheep grazing on introduced grasslands on the valley floors. Whereas on the steep valley sides and ridgelines, exotic forests, introduced scrub and regenerating native vegetation exists. The catchment geology in the Mimi and Haehanga is dominated by Papa mudstones which are easily eroded resulting in poor water clarity in most of the water ways.

2.2 Haehanga Stream

The Haehanga Stream is an entrenched meandering stream below the site, but adjacent to the composting facility the stream has been modified and channelized to provide drainage away from composting activities. The stream was relocated and channelized on to the north-eastern side of the valley adjacent the current Drill Mud Pad (DMP). Numerous groundwater seeps are obvious across the site and adjacent the Haehanga Stream and its tributary. Immediately upstream of the DMP the Haehanga Stream branches into four separate tributaries, the largest tributary flowing in a south-eastern direction.

Substrate in the Haehanga Stream is a mixture of fine sediments such as clays in the slower flowing margins and pools and courser sands and gravel in the riffles habitats. Papa mudstones exist as a basement substrate of the stream at several locations. Stream substrates reflect the catchment geology with Papa dominating the ridges and cliff areas which are eroding and clayey loams on the side flanks and valley floors. The depth to the basement 'papa' mudstone in the Haehanga has not been accurately defined but is estimated between 3-6 metres below ground level (mbgl).

2.3 Soils

2.3.1 Classification

Soils in the Haehanga Catchment are classified as Orthic brown soils from the Whangamona Complex loams, which have a high clay content (NZ Soils Classification, V4). Orthic brown soils have a weakly structured sub soil, which is common on slopes or young land surfaces. Brown soils have a brown or yellow-brown subsoil below a dark grey-brown topsoil. The brown colour is caused by thin coatings of iron oxides weathered from the parent material. Brown soils occur in places where summer drought is uncommon and which are not waterlogged in winter. They are the most extensive soils covering 43% of New Zealand's landmass.

2.3.2 Soil Profiles

On the 8th January 2015, BTW Company staff undertook soil profile and structural analysis at four sites across the site including the proposed new area for irrigation immediately upstream of the site entrance. Soil profiles were ascertained with a hand auger and each horizon classified.

The location of soil sampling points are shown in Figure 2.1 and results are contained in Appendix A.

2.3.3 Soil Chemistry

The TRC has undertaken five sets of soil samples between 2011 and 2014, and these results are summarised in Figure 2.2. The soil chemistry data records an increasing pattern of chloride concentrations with the samples collected in April 2014, recording 1161 and 1559 mg/kg of Chloride, respectively. The movement of soluble ions in soils, such as Chloride relies on convection and diffusion fluxes. For chloride leaching it's the downward convection associated to adequate rainfall (and irrigation) which results in rapid movement through the soil, whereby it can be deeply leached, particularly in soil profiles less than one metre deep. This can result in increasing Chloride concentrations down the soil profile.

BTW company undertook four soil samples at two depths within the lower and upper irrigation areas (8th Jan 2015), and a single 'background' sample from the proposed irrigation area. These results are summarised in Appendix B and Figure 2.3. Soils samples were undertaken at 250 mm (Upper) and at 1.0 m (Lower) deep and their location was identical to the soil profile sites.

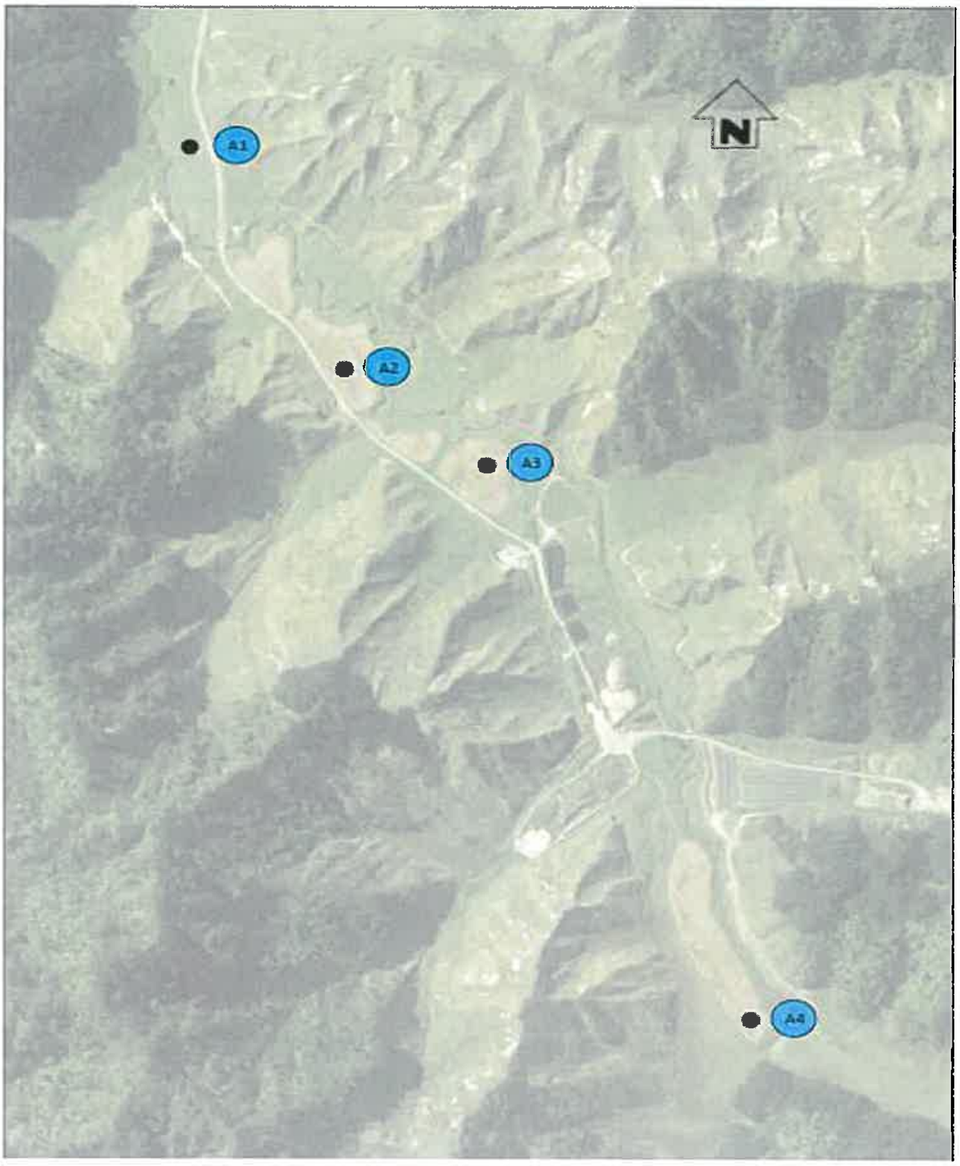

Figure 2.1: BTW Company Soil Sample and Auger Test Holes

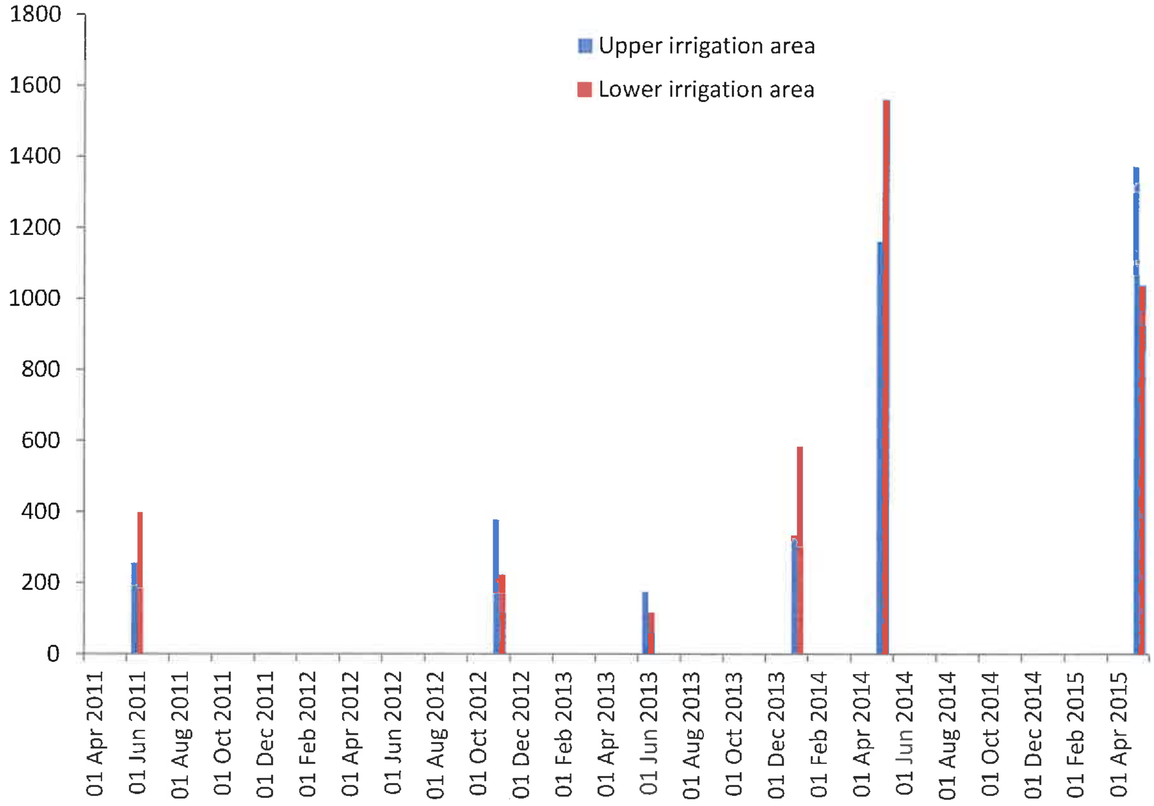

Figure 2.2: TRC soil samples for Chloride at Uruti Composting Facility (mg/kg)

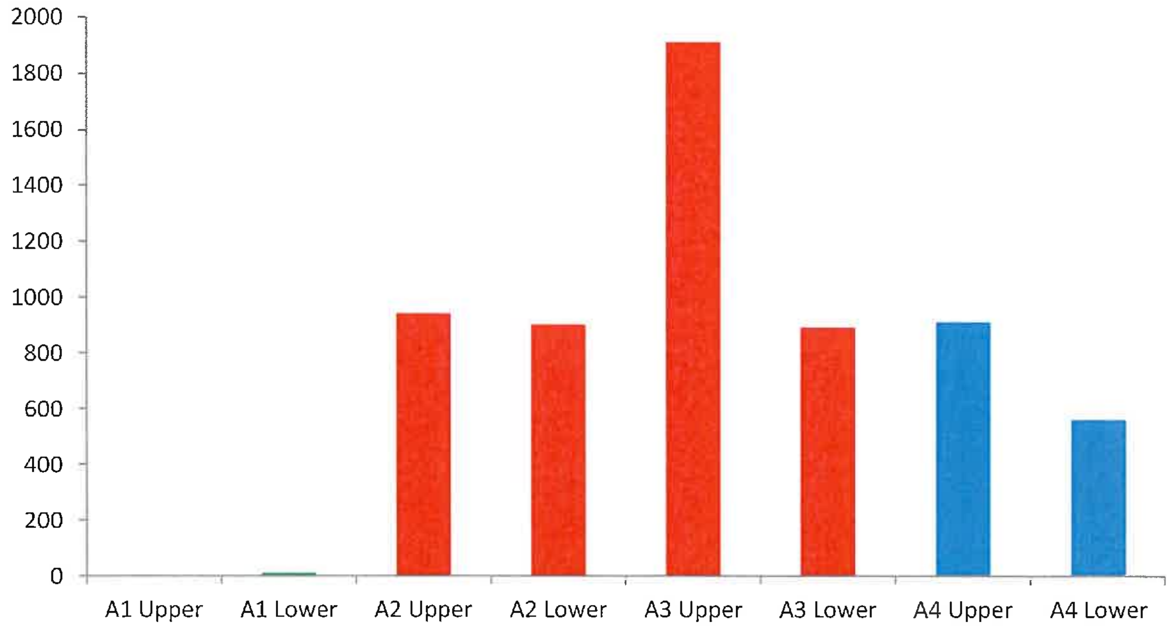

Figure 2.3: BTW Company Chloride soil profiles at Uruti Composting Facility (mg/kg)

The TRC results show that elevated chloride concentrations exist within the soil profile, initial in the lower irrigation area in 2014, then the upper irrigation area in 2015. These concentrations are consistent with BTW Company soil samples (Figure 2.3) which recorded Chloride concentrations between 1600-1910 mg/kg in the top 250 mm and 890 mg/kg at 1.0 metre deep. The difference in the Chloride concentration down the soil profile is interesting given Chlorides general nature of increasing down the soil profile. A explanation for the recorded decrease of Chloride down the soil profile may lie in the porous silty/loamy clay are in direct contact with the shallow groundwater table below 0.5-0.75 metres below ground level. This would result in drainage losses to the shallow groundwater table and probable movement down-gradient.

The BTW Company soil samples also recorded very acidic soil (pH 4.9 to 4.6) beneath the irrigation zones as well as in the background sample. A single sample undertaken by Perry Environmental Staff in 2003 prior to any development of the site is consistent with these samples, indicating that soil pH was very acidic pH=4.2. The Cation Exchange Capacity of the soil was also very low, which indicates the soils can only retain low levels of cations (Potassium, Ca, Mg and Na), and thus have limited nutrient retention. This in all probability allows the negatively charged Cl- to be further leached from the profile by severe rainfall.

The importance of higher CEC values allows acid soils to be more easily neutralised. However, for silt clay loams as in the Haehanga which have low CEC, soils will take longer to neutralise until the CEC is increased. It is therefore recommended options be investigated to increase the CEC of the soil beneath irrigation zones, such as improving the organic matter to enhance nutrient retention and to minimise losses to groundwater.

2.4 Irrigation fluid/Leachate

Figure 2.4 below summarises Chloride samples of the Irrigation fluid from 2011 to October 2014.

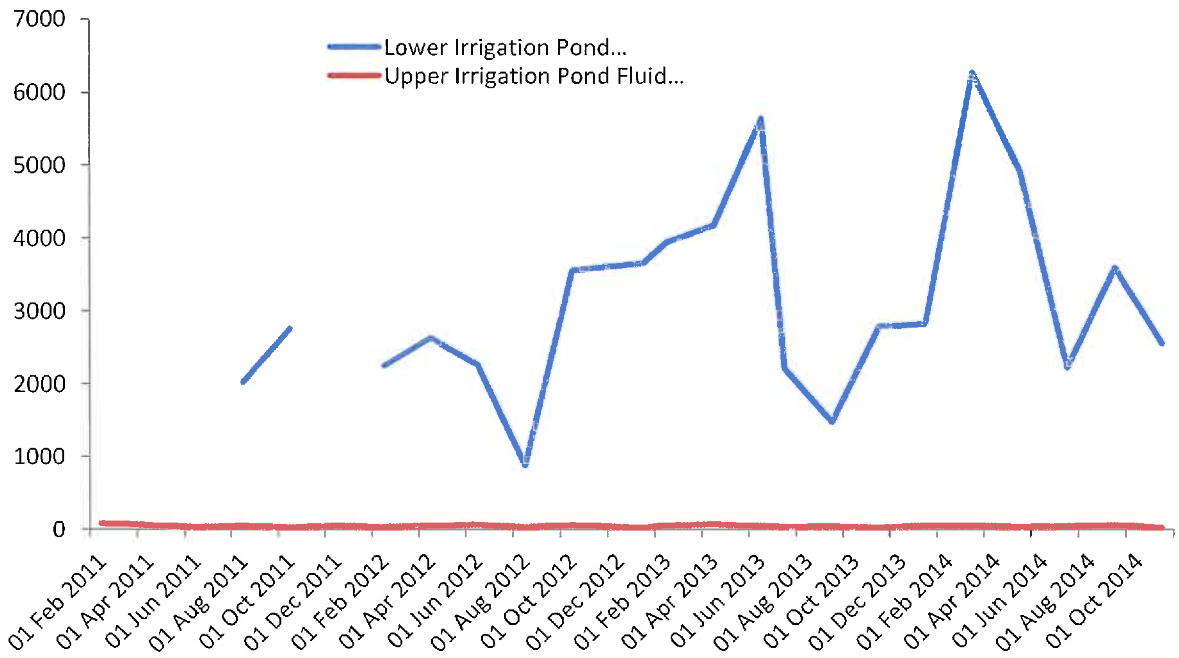

Figure 2.4: Irrigation fluid Chloride Concentrations (mg/L)

The irrigation fluid samples record large variations in Chloride concentrations with a pronounced peak in March-2014, which is consistent with all other environment data collected at that time. Following early-2014, Chloride concentrations within the fluid have dropped significant but remain between 2220 and 3600mg/l. However, as predisposal samples have not been undertaken, it is difficult to determine if the changes in Chlorides are attributed to increased hydrocarbon volumes and other material accepted at the site, and/or other operation issues, such as the treatment pit reaching capacity and yielding a low grade leachate for irrigation, particularly over summer.

The TRC has undertaken Sodium Absorption Ratio analysis on the irrigation fluid four times between September 18th 2013 and March 13th 2014. Concentrations of Calcium, Magnesium and Sodium were sampled, and the SAR calculated with the ratio between Ca, Mg and Na generally consistent. The results are summarised in Table 2.1

Table 2.1: Irrigation Fluid SAR

Date	CA (g/m3)	MG(g/m3)	NA(g/m3)	SAR
18 Sep 2013	260	30.6	550	8.59631
20 Nov 2013	518	43.9	818	9.27120
14 Jan 2014	673	43.5	753	7.59885
13 Mar 2014	1576	90.6	1852	12.27860

Leachate levels within the final DMP oscillate in response to irrigation but also surface and potentially groundwater recharge, evaporation and direct rainfall input. Typically, levels in the DMP are higher in the wetter months and lower in the late summer months. Due to evaporation over summer (and less rainfall or surface water ingress) the quality of the leachate over the summer months can be degraded (Larkin, G pers obs, 2014-15). This is partly reflected in the Irrigation SAR samples with the two highest SAR calculations in January and March, whereas the lowest Irrigation SAR values are for Spring.

2.4.1 Irrigator Loading Rates

The following table is a summary of the available irrigator flow volumes, nozzle spray flow rates, pump capacity and a basic hydraulic loading rate for Chloride fluid based on the Irrigator fluid/leachate samples (IND002244). The hydraulic loading rate takes the assumption that the lower irrigation area averages three hectares, and is based on two Chloride concentrations in the Irrigator Fluid; 1) 2000 mg/L (Lower Limit) and 2) 6000 mg/L (Upper Limit).

The hydraulic areal loading rate equation is = pump flow (m^3/day)/Area (ha)

Table 2.2: Uruti Composting Facility Operational Data

Feature	Volume
Pump Capacity (litres per hour)	33000
Pump Capacity (litres per second)	9.16
Pump Capacity 8 hrs pumping (litres per day)	264000
Lower Irrigation area Areal Loading (litres/ha/day)	88000
Lower Irrigation area Areal Loading (litres/m^2/day)	8.8
Lower Irrigation area Chloride Loading if irrigator fluid is 2000 mg/L (mg/l/m^2)	17600
Lower Irrigation area Chloride Loading irrigator fluid is 6000 (mg/l/m^2)	52800

Note: the loading rates do not take into account biases encountered from differences in nozzle spray, head differences and variable pumping speeds.

2.5 Haehanga Stream Chloride Concentrations

Surface water quality in the Haehanga Stream and its tributaries has been undertaken by the Taranaki Regional Council since 2002 at nine sites. Chloride concentrations within surface water show a clear increase in concentrations downstream of the site, with an increase of chloride adjacent discharge sites, the downstream irrigation area and in the receiving environment in March 2014. Chloride concentrations post-March 2014 then significantly decreased, with all sites well below the consented limits for Chlorides in all samples (mg/l). Figure 2.5 Chloride Concentrations in Haehanga Catchment 2011.

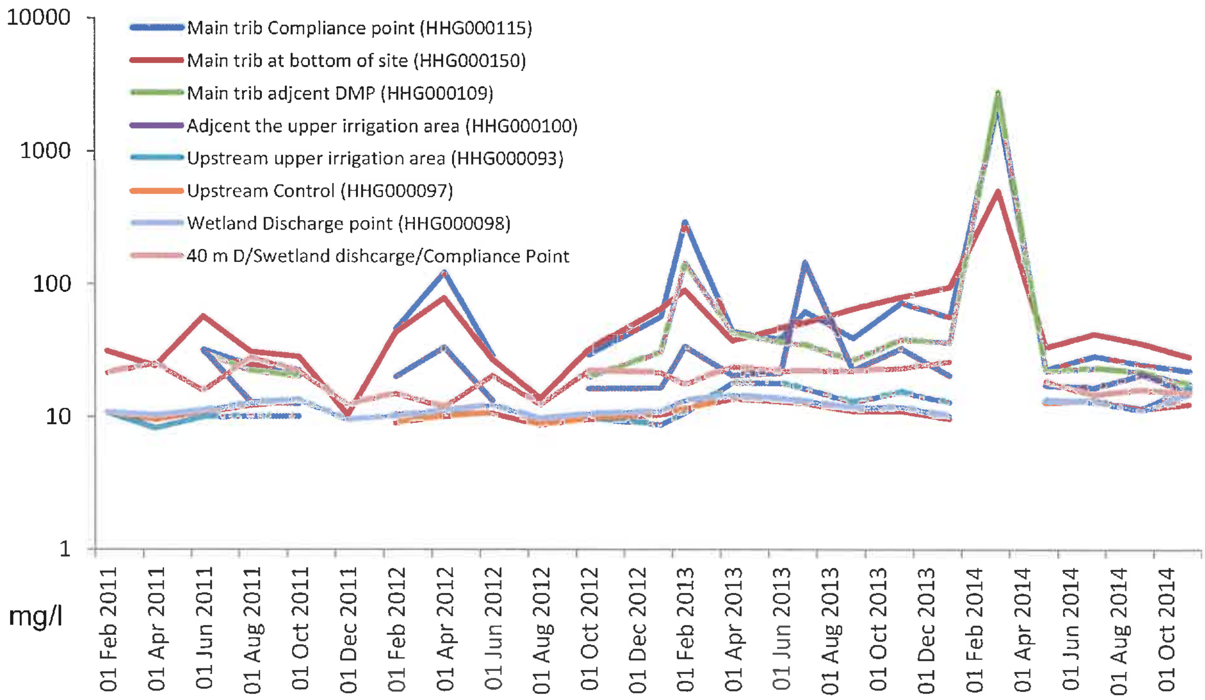

Figure 2.5: Haehanga Stream Chloride Concentrations (mg/L)

2.6 Chloride Concentrations in Groundwater

The below section summarises the two years of data from three monitoring bores at the composting facility; GND 2188 upstream (control site), GND 2189 upstream irrigation area (impact site) and GND 2190 the downstream irrigation area (impact site). Groundwater concentrations show a clear impact from chloride concentrations via drainage losses, with the upstream control site recording greatly reduced chloride levels compared to the impact monitoring bores adjacent and downstream of irrigation zones.

The TRC monitoring data was last undertaken in 30th April 2015, with Chloride concentrations recorded at 1340 mg/l in GND 2190. Chloride concentrations in GND 2189 recorded a decrease from 292 to 133 mg/l, with the upstream control bore GND 2188 consistently recording low concentrations of Chloride.

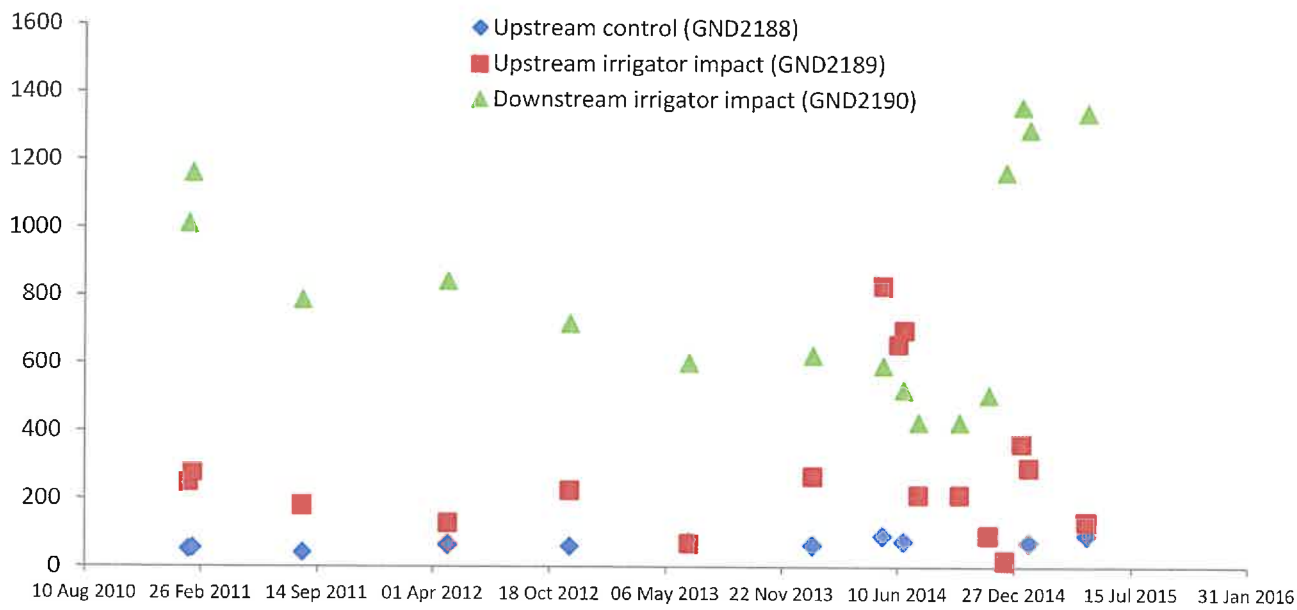

Figure 2.6: Groundwater Chloride Concentrations at Uruti Composting Facility

For a summary on the hydrogeology of beneath the Uruti Composting Facility readers are directed to the Haehanga Catchment Preliminary Groundwater Investigation.

3 URUTI COMPOSTING FACILITY SITE MANAGEMENT PLAN

The following section of the document focuses on operational management of the site with particularly emphasis on improvements to the irrigation process, stormwater management on site and a reduction in drainage losses to groundwater and surface waters. The plan incorporates both landuse and management controls such as operational thresholds, monitoring timeframes and remediation options as considered necessary to ensure compliance with consent conditions and mitigating adverse effects on the receiving environment.

The plan was developed in conjunction with RNZ and TRC and closely adheres to relevant national and international guidelines and standards.

The framework is based on a three tier decision tree which guides site operation. The tiered response was developed because of simplicity but also allows increased monitoring efforts and reviews of site performance to minimise risks from drainage losses to groundwater and accumulation of hydrocarbon constituents within the soil.

Within each of the operational tiers, specific constituent threshold values for the operation have been set to protect the soil and groundwater. Caution is advised that these values set for constituents are upper limits, and RNZ should not view these levels as recommended targets but should aim to operate well within these values to safeguard the operation, and reduce potential environmental effects on and off site.

3.1 Site Operational Plan

The site operational plan framework is summarised in the Tables 3.1 & 3.2. It uses a simple three tier approach with threshold values to guide irrigation and site activities.

Table 3.1: Uruti Composting Facility Site Operational Plan

Tier	Operation Status of irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

Once a trigger or threshold value is met within a specific tier, RNZ management would make the decision to operate within the next tier level until monitoring data provides sufficient evidence that an irrigation area could either go down or up a level as per the tier system.

Tier	Receptor	Target or Trigger	Monitoring frequency	Timeline for Change	Reference for Guideline
One	Leachate Fluid	Cl^-(Chloride)- 0-2000 mg/l results in a Areal Loading of approximately up to 17600 mg/l/m^2/day	Weekly	N/A as standard operation phase	
		TPH (Total Hydrocarbon) 0-2500 mg/l (½ of 5% TPH consent limit)	Monthly	N/A as standard operation phase	
	Soil	Cl^-(Chloride)- 0-700 mg/kg (based on the surrender criteria for NZ landfarms soil criteria) **Note Sodium Absorption Ratio 0-6**	Monthly	N/A as standard operation phase	
		TPH (Total Hydrocarbon) upper limits of each hydrocarbon fraction C7 – C9 2700mg/kg C10 – C14 58mg/kg C15 – C36 4000mg/kg	3 Monthly	N/A as standard operation phase	Ministry for the Environment, Guidelines for Assessing and Managing Petroleum Hydrocarbon contaminated sites in New Zealand. Tier 1 acceptance criteria for TPH Agriculture use All. Soil type Silty Clay.
	Groundwater	Cl^-(Chloride)- 0-1000 mg/L or Conductivity of 350 µS/m	Bimonthly in GND 2189 & 2190	N/A as standard operation phase	
		TPH (Total Hydrocarbon) All fractions of Hydrocarbons under	Biennially	N/A as standard operation phase	

		detectable levels (essentially background level)			
Two	Soil	Cl^-(Chloride)- 700- 1800 mg/kg **Note Sodium Absorption Ratio in the range of 6-18**	Monthly	If the Chlorides within the soil stay within this tier for 6 months, consider moving to Tier 3- remediation options Consider clean water irrigation to allow recovery from elevated SAR	
		TPH (Total Hydrocarbon) Total hydrocarbon concentration shall be less the 20,000 mg/kg dry weight at any point	Monthly	Upper limit for bioremediation to be effective for hydrocarbons, leachate fluid to contain no TPH.	Canada's Drilling Waste Management directive 050 (ERCB, 2012)
	Leachate Fluid	Cl-(Chlorides) -2000 to 10,000mg/L TPH (Total Hydrocarbons)-2500-3000 mg/L	Monthly	If rainfall and soil moisture are expected to increase, irrigation can continue, however, if drier period are forecast, irrigation should cease especially over the summer months.	
	Groundwater	Cl-(Chlorides) -1000- 2000mg/L Or conductivity 350- 700 µS/m	Monthly	All irrigation to cease on this zone. Note: If chlorides within the monitoring bores (GND 2189 & 2190) remain in this range for six months, consider moving to Tier 3 remediation options.	
Three	Soil	Cl^-(Chloride)- >1800mg/kg **Note Sodium Absorption Ratio >18**	Monthly	Initiate soil remediation measures (see Section 5) alongside clean water irrigation.	Cavanagh et al (2014)

		TPH (Total Hydrocarbons) Above 20,000 mg/kg	Monthly	Initiate soil remediation measures (see Section 5)	
	Groundwater	Cl⁻(Chlorides) > 2000mg/L or Conductivity > 700 µS/m	Monthly	Initiate groundwater remediation measure (see section 5)	

***Sodium absorption ratio** (**SAR**) is a measure of the suitability of water for use in agricultural irrigation as determined by the concentrations of solids dissolved in the water. It is also a measure of the **sodicity** of soil, as determined from analysis of water extracted from the soil. When SAR rises above 12 to 15, physical soil problems begin to arise such as loss of soil structure, and decreases in infiltration and permeability.

4 SITE IMPROVEMENTS

This section of the management plan is designed to outline recommended improvements and additional management techniques which will support the site operational plan. Time lines for implantation are also included from the date this document is formalised.

4.1 Storage Dam

To continue irrigation during periods of low rainfall and to provide clean water to be mixed with leachate fluid a storage dam is considered a necessary management option to provide this clean water. The dam will be a clean water source upstream of all irrigation areas (Red Line in Figure 4.1). It's use will also be a remediation step in Tier 2 and 3 but will depend on water availability, soil moistures on site, predicted and seasonal variation in rainfall totals.

It is envisaged the lined storage dam will have a capacity of approximately 3500 m^3 to allow for 15 days of storage which equates 250m^3 per day of clean irrigation water. It is planned to irrigate primarily over the summer months when groundwater and surfacewater resources are limited.

The use of the current 'duck pond' immediately adjacent the final leachate pond should also be investigated to be incorporated into the irrigation plan. The pond has 4,800 m^3 of storage capacity of clean water which will further enhance irrigation of clean water on the irrigation areas. The use of clean water irrigation on chloride impacted soil has been used previously overseas, as an in-situ remediation step to soil health (Alberta Environment, 2001, Daily & Whalen, 2005).

Timeline for implementation = 6 months

4.2 Increased Irrigation Area

A suggested management control for the Uruti Site is to increase the irrigation area, from currently five hectares to over 11 hectares. By increasing the irrigation areas, a decrease in loading of any elevated constituents is envisaged, and also provide a management option to semi-retire areas before they are returned to the active irrigation area. Having greater area would provide options, without the need to overload one area.

It is envisaged that following the adoption of this site management plan, RNZ will apply for a resource consent variation to developed Phase 1. As part of that application it's highly recommended RNZ develop an irrigation plan which will integrate the new irrigation zones into the decision tree to minimise irrigation zones becoming overloaded (Table 4.1). The proposed Phase 2 irrigation zones will be incorporated into the irrigation plan over the next two years and be closely monitored by RNZ (See figure 4.2 and 4.3 for the proposed new irrigation areas).

Timeline for Implementation (Phase 1) = 2 months based on approval of consent variation

Timeline for Implementation (Phase 2) = 24 months based on performance of the site, the outcomes of the increased monitoring effort (soil, groundwater, surfacewater and hydrological data)

Table 4.1: Proposed Irrigation Zones

Irrigation Zone	Total Area (ha)	Irrigation Phase	Timeline for inclusion in Irrigation Plan
A	1.68	Phase 2	24 months
B	2.15	Phase 2	24 months
C	1.37	Phase 2	24 months
D	2.48	Phase 2	24 months
E	1	Phase 1	2 months
F	2.63	Phase 1	2 months
Total	**11.31**		

Figure 4.1: Proposed Irrigation Areas C, D & F and Storage Dam in red

Figure 4.2: Proposed Irrigation Area A, B & E

4.3 Stormwater Improvements

The location of the Drill Mud Pits (DMP) also influences the volume of fluid which are required to be irrigated for several reasons. The DMP's are located on the flat valley floor between two steep papa ridgelines, in a location which is topographical constricted. This results in an accumulation of both surfacewater, stormwater flows and likely groundwater having to pass the DMP en-route to the Haehanga Stream. Through this section of the Uruti Composting Site, the shallow groundwater table is approximately 0.5-0.75 metres below ground level, whereas the final DMP pit is 4 metres deep (See Conceptual Site Model in Haehanga Groundwater Investigation). The Haehanga Streambed level is also above the base of the final DMP. Previous compression tests on the freshly compressed papa recorded 0.91 permeability, but it's uncertain the current DMP integrity after several years of site operation. Although outside the scope of this Site Management Plan the hydrological connectivity between the DMP, the shallow groundwater table and the Haehanga Stream should then be investigated further.

It is also recommended the following be investigated to improve stormwater across the site:

- Investigate the placement of a drainage ditch behind pad one down the western side of the access road to avoid the DMP to drain stormwater directly to the main culvert on the Haehanga Stream.
- Realigned the DMP so that there is clear separation between the solids pile and the fluids, to stop stormwater draining into the area and whereby 'clear water' is directed away from the treatment pits.
- Ensure the DMP's are lined to reduce potential contaminate losses to groundwater/surface water.
- Place water level gauges on the final leachate pond alongside flow meters on the irrigator pump as to accurately define pond capacity, discharge rates and irrigation loading rates. This should be undertaken in conjunction with regularly sampling of the irrigation fluid prior

to disposal and where possible defer irrigation if hydrocarbon constituents are elevated (see later comments on Irrigation Plan).

Timeline for Implementation = 3-6 months

4.4 Riparian Protection

To mitigate the potential for any overland flow of contaminates discharging into the Haehanga Stream it is recommended that an earth bund be constructed along the length of the stream and it's tributary. It is considered the riparian protection zone should be a minimum of 5 metres from the stream bank and then fenced and planted with appropriate species. The planting would also provide shade for the Haehanga Stream biota.

Timeline for Implementation = 12 months

4.5 Deferred Irrigation Management

It is recommended the management of the site consider deferred leachate irrigation under certain environmental conditions. The combination of a poor leachate quality in summer and limited attenuation in the hydrological cycle results in reduced site performance. The site performance over the summer months represents an increased probability of off-site environmental effects being recorded. By instigating deferred irrigation over the critical summer months potential adverse effect can be minimised. It's recommended that RNZ in the development of their irrigation plan consider this option in combination with the storage dam.

Timeline for Implementation = 6 months

4.6 Setback from Haehanga Stream

Recommended best practice is to incorporate a 25 meter setback from any surface water body in relation to irrigating fluid. We suggest this management technique would obviously reduce any potential overland flow from the irrigation fluid into the stream in conjunction with a planted bund. Also this management option would create a buffer and natural attenuation zone for contaminate migration towards the stream, which would likely reduce any impacts on the Haehanga Stream. Setback requirements are a standard management requirement for discharges closes to water bodies, and often enforced by Regional Councils.

Timeline for Implementation = Immediate for Phase 1 Consent Variation granted

4.7 Pre disposal Analysis

We recommend RNZ consider implementing an acceptance criterion for any new source of waste material entering the site. This procedure could be easily implemented and provides data of the level of constituents entering the site.

This management option provides not only business certainty to RNZ but will also allow consideration for future irrigation plans from potential issues arising from hydrocarbon fluids entering the site. RNZ could request laboratory results of the proposed material to be disposed and specify certain parameters for constituents like Hydrocarbons and Chloride for acceptance. Predisposal samples are common practice and considered best practice, with all costs usually incurred by the company requesting disposal.

Timeline for Implementation = Immediately after Phase 1 Consent Variation granted

5 TIER 2 AND 3 REMEDIATION OPTIONS

If monitoring results from tier 1 & 2 (normal and alert operation) indicate contaminate levels are continually increasing, i.e SAR, Hydrocarbon and Chloride increases, such that a Tier 3 response is required, mitigation and remediation should be initiated.

5.1 Remediation Options

Due to the sensitive nature of the Uruti Site in relation to shallow groundwater effects, proximity to the surface water of the Haehanga Stream, and downstream to the regionally significant Mimi River any in-situ remediation must be approached with extreme caution.

Potential mitigation steps are summarised below, however, it's recognised that a full site remediation plan may be required before selection of suitable remediation method(s) are finalised.

Table 5.1: Mitigation and Management Options for Uruti Composting Site

Options	Consideration of use	Caveats
1. Irrigation Management/Source Mitigation Addition of $CaCO_3$ or dissolved gypsum in the irrigation fluid to increase the soil pH and CEC to reduce sodicity. Also reduce the high salt content in the irrigation fluid.	Possibly only a short term solution on semi-retired irrigation zones, as a greater potential for Chloride concentrations to remain in the soil and not leached to groundwater.	On soils with low pH (4-5.2) may require multiple applications to be effective. Need field trials to verify, starting with lower irrigation zone already in Tier 2.
2. Irrigation Management Addition and mixing of clean low salt content water from the storage dam to decrease the chloride loadings within the irrigation fluid.	Due to limited rainfall recharge of the shallow groundwater table over the summer months will require most leachate mixing to occur in late Dec-March. Literature suggests a mixture with 20% leachate is most effective to control soil salinity, reduce the effects on plant growth and soil structure, such as reduced porosity and degraded soil structure.	Requires enough storage within the dam to allow use if no sustained rainfall for 15 days Scheduling leachate irrigation in response to soil moisture increases and high evapotranspiration losses May have strict regulatory constraints as off-site effects requires assessment, particular ecological and cultural receptors in the Mimi River
3. Irrigation and Groundwater Management Subsequent flushing with clean irrigation water to increase the leaching and drainage losses to GW and Surface water bodies	Due to limited rainfall recharge of the shallow groundwater table over the summer months will require irrigation to occur in late Dec-March.	Requires enough storage within the dam to allow use if no sustained rainfall for at least 15 days If the Groundwater and Surface water resources such as the Mimi River are deemed to have high value this method requires considerable scrutiny. May have strict regulatory constraints as off-site effects requires assessment

4. Soil Management Excavation of salt contaminated soil and disposal onsite	Contaminated soil maybe reincorporated into composting activities, such as up on Pad 2 (sawdust and compost pad)	Cost effectiveness needs scrutiny
5. Soil Management Addition of liquid/solid calcium/Gypsum or similar to replace the sodium in soil.	The loss through the soil profile to groundwater of the additions of Calcium/Gypsum. Is natural precipitation enough over the year to exceed evaporation, if not don't use. May require multiple applications of calcium which may have unpredicted effects. Normally only used when shallow groundwater is not present	What are the downstream uses of groundwater, what are the effect of the increased of chloride in GW and Haehanga Stream. May require a groundwater fate and transport model to determine off site effects to surface waters
6. Soil Management Other soil amendments such as organic matter, humus, if the soil have low pH and EC	Has good potential as composting facility will have material on site, hence capital costs are low	Requires further investigation and trials onsite, but recommend all zones currently in Tier 2
7. Soil Management Plantation of shore rotation woody crops which are salt tolerant	Investigation what plant species would be practical	The use of bio-sorption techniques requires more investigation as the natural acidic clay soil with low pH will limited uptake of chlorides. May be feasible once soil pH are neutralised

6 CONCLUSION

BTW Company was engaged by RNZ to provide a report outlining management and procedural controls with an aim to improve site performance. A significant part of the project was to provide the Taranaki Regional Council with a site management plan to improve soil and groundwater conditions to mitigate potential environmental effects beyond the site boundary.

The report is not an assessment of environmental effects but rather a procedural document for RNZ to assist in the development of a Uruti Composting Site Irrigation Plan and associated monitoring plan.

The outcomes from the initial environmental data review can be summarised by the main points below.

- Both soil and groundwater resources are recording elevated levels of chlorides (Cl^-) as a result of prolonged irrigation of the leachate fluid.
- The quality of the irrigation leachate over the summer months is often degraded
- Chloride concentrations in the Haehanga Stream are usually below consent conditions, but in March 2014, multiple sampling sites were over consent limits.
- Over the summer months there is limited water in the hydrological cycle to attenuate the irrigated leachate.

The report developed the Uruti Composting Facility site management plan. The three tier plan features operational triggers which govern monitoring requirements and/or remediation options. The three tiers can be summarised by;

1. Normal site operation- weekly and monthly sampling of leachate fluid, soil quality and groundwater resources.
2. Alert level of site operation- increased level of monitoring with deferred irrigation on areas which are deemed overloaded for certain constituents. If monitoring results suggest no improvements in the levels of contaminates after six months it would be recommended moving to Tier 3 response.
3. Action level of site operation-irrigation to cease on all affected areas. Initiate remediation efforts to improve health of soil and groundwater resources.

BTW Company also highly recommended site improvement options with attached timeframes, which are summarised below:

- A water storage dam - to allow mixing with irrigation leachate and to provide a clean water irrigation source on areas which require remediation (tier 3)
- Increase irrigation areas - Phase 1 Consent Variation
- Stormwater improvements, riparian edge protection and deferred irrigation
- Haehanga Stream setbacks
- Predisposal and pre-irrigation samples

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APPENDIX A BTW SOIL PROFILES

SCALA PENETROMETER, AUGER & SHEAR VANE TEST SHEET

Client:	Remediation NZ
Client Contact:	Kerry O'Neil
Location:	Uruti
Test Date:	8/01/2015
BTW Job No:	14745
BTW Project Manager:	Luke Bunn
Tested By	Luke Bunn

Test Location: A1

Depth (mm)	Description	Log
0-200	Light brown/grey silty topsoil	
200-2000	Light grey silty clay, traces of brown/orange clay material, small particle size, friable, low moisture content, low plasticity	
1000	Low-medium moisture content, medium plasticity	
1500	Increase in clay content, light brown/grey in color	
2000	End Auger	

Auger 1: depth 0.8m

Auger 1: depth 1.5m

SCALA PENETROMETER, AUGER & SHEAR VANE TEST SHEET

Client: Remediation NZ
Client Contact: Kerry O'Neill
Location: Uruti
Test Date: 8/01/2015

BTW Job No: 14745
BTW Project Manager: Luke Bunn
Tested By: Luke Bunn

Test Location: **A2**

Depth (mm)	Description	Log
0-100	Light brown/grey silty topsoil	
100-1800	Light grey, silty clay, traces of brown/orange clay material, small particle size, friable, low moisture content, low plasticity	
1100	Increase in clay content. Light brown/grey in color, medium moisture content, medium plasticity	
2000	End Auger	

Auger 2: depth 1.0m

SCALA PENETROMETER, AUGER & SHEAR VANE TEST SHEET

Client: Remediation NZ
Client Contact: Kerry O'Neill
Location: Uruti
Test Date: 8/01/2015

BTW Job No: 14745
BTW Project Manager: Luke Bunn
Tested By: Luke Bunn

Test Location: A3

Depth (mm)	Description	Log
0-200	Light brown/grey silty topsoil	
200-2000	Light grey/brown silty clay, small particle size, friable, low-medium moisture content, medium plasticity, traces of dark brown clay material	
800	Increase in clay content, light brown/grey in color	
1500	Increase in moisture content, increase in plasticity, reduction in clay content, light grey/brown color	
2000	End Auger	

Auger 3: depth 0.5m

Auger 3: depth 1.2m

SCALA PENETROMETER, AUGER & SHEAR VANE TEST SHEET

Client: Remediation NZ
Client Contact: Kerry O'Neill
Location: Uruti
Test Date: 8/01/2015

BTW Job No: 14745
BTW Project Manager: Luke Bunn
Tested By: Luke Bunn

Test Location: A4

Depth (mm)	Description	Log
0-150	Light brown/grey silty topsoil	
150-2000	Light grey silty clay, small particle size, friable, low moisture content, low plasticity	
500	Increase in clay content, light grey/brown in color, low-medium moisture content, low-medium plasticity	
1000	Medium-high moisture content, medium-high plasticity	
2000	End Auger	

Auger 4: depth 0.3m

Auger 4: depth 1.5m