

Wai-iti Beach Retreat  
Monitoring Programme  
Annual Report  
2015-2016

Technical Report 2016-110



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## Executive summary

The consent holder operates the Wai-iti Beach Retreat, a beach camp located in North Taranaki. The consent holder holds a resource consent to discharge septic tank treated sewage to groundwater via soakage trenches. The consent holder also holds a consent to erect, place and maintain a rock wall along the front of the accommodation on the Wai-iti Beach foreshore. This report for the period July 2015 to June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the consent holder's environmental performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the consent holder's activities.

The two resource consents that the consent holder holds include a total of 24 conditions setting out the requirements that the consent holder must satisfy.

### **During the monitoring period, the consent holder demonstrated a level of environmental performance that required improvement.**

The Council's monitoring programme for the year under review included three inspections of the wastewater system, including one inspection of the rock wall, and bacteriological water sampling of the Wai-iti Stream and Wai-iti Beach on one occasion.

An additional bacteriological water sampling survey was also undertaken, following recommendations made in the 2014-2015 monitoring report.

Monitoring indicated that the camp's effluent system was contaminating an unnamed tributary and the Wai-iti Stream. These results were confirmed when the consent holder discovered a ruptured effluent soakage trench in the vicinity of the waterbodies. The rupture was promptly repaired by the consent holder. Monitoring and further works are planned in order to prevent further issues from arising. An inspection of the rock wall found that the structure remained in good repair, and that it was not causing any significant environmental effects.

An improvement in the consent holder's environmental performance is required in relation to the exercise of resource consent 1971-3. A high level of environmental and administrative performance was demonstrated in relation to the exercise of resource consent 6462-1.

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

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance was lower in the period under review than what is typically demonstrated.

This report includes recommendations for the 2016-2017 year.

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# 1. Introduction

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

### 1.1.1 Introduction

This report is for the period July 2015 to June 2016 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by the consent holder for the Wai-iti Beach Retreat. The Wai-iti Beach Retreat is situated on Beach Road in North Taranaki (Photos 1 and 2).

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the consent holder that relate to the discharge of sewage effluent to groundwater and a boulder rip rap wall on the foreshore.

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, land and air, and is the 27th combined annual report by the Council for the consent holder.



Photo 1 Wai-iti Beach Retreat



**Photo 2** Wai-iti Beach, 16 December 2014

### 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;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted at the consent holder's site.

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

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2016-2017 monitoring year.

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

### 1.1.3 The Resource Management Act 1991 and monitoring

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

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

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

### 1.1.4 Evaluation of environmental and administrative performance

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

**Environmental performance** is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with the consent 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 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

## 1.2 Process description

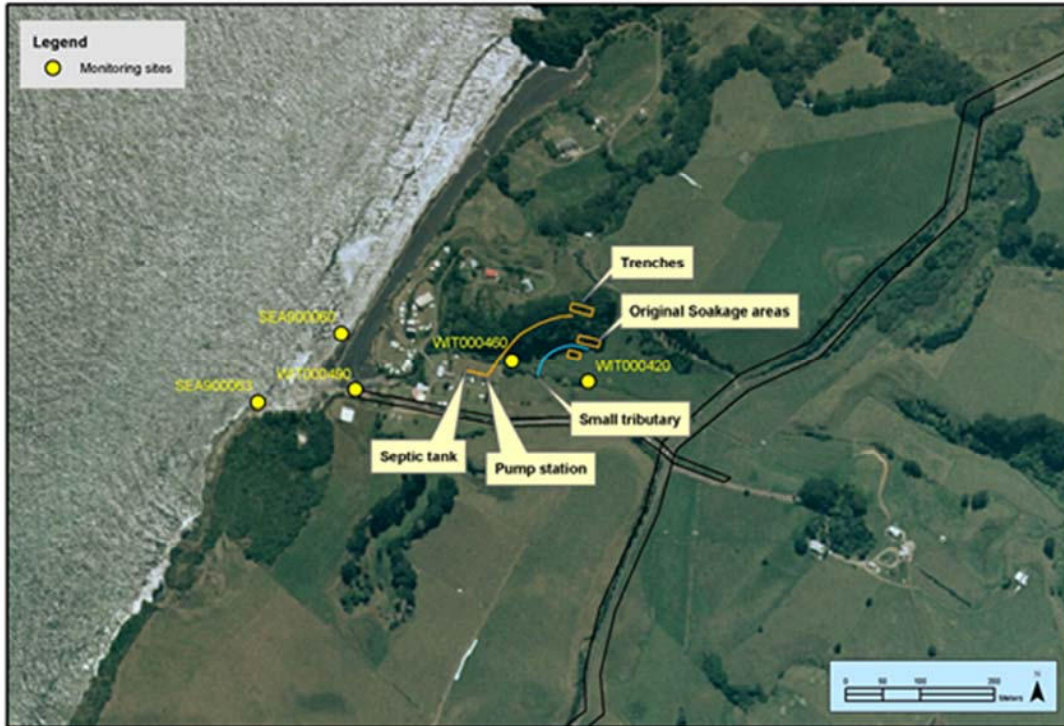
### 1.2.1 Sewage treatment system

All wastewaters from the camping ground enter a septic tank of 143 m<sup>3</sup> capacity. The effluent is then pumped via a 50 mm alkathene pipe across the Wai-iti Stream and into soakage trenches situated on a wooded hillside approximately 30 metres from the stream.

These multiple soakage trenches work on a rotational basis and were first commissioned in 1991 in response to inadequate treatment of the effluent by the previous system.

When previous proprietors took over the property in 1986-1987, the disposal system consisted of a seepage ditch situated near the base of the wooded hillside. Monitoring found that this trench system was not a suitable means of disposal, resulting in high faecal coliform counts at the mouth of the Wai-iti Stream. This inadequate treatment led to the development of the new multiple soakage trench system.





**Figure 1** Location of sewage treatment system and sampling sites at the Wai-iti Beach Retreat

### 1.2.2 Rock wall

Over the summer and autumn months of 2004, rough seas combined with high tides reached the beach toe of the coastal banks and sand dunes that front the beach camp. Fresh erosion scarps were cut into these banks for nearly the full beach frontage where no system of protection existed (Photograph 3).

In 2005 an application was received for a resource consent to provide boulder rip rap protection over a total distance of 293 metres from the stream at the south end of Wai-iti Beach to an area of existing large boulder protection in the north. This consent was granted in July 2005. To mitigate any possible end effects, the area between the public entrance and the river was also protected using the boulder rip rap method.



**Photo 3** Erosion on Wai-iti foreshore prior to construction of the rock wall

## **1.3 Resource consents**

### **1.3.1 Water discharge permit**

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

The consent holder holds water discharge permit **1971-3** to cover the discharge of up to 27 cubic metres per day of septic tank treated sewage effluent via soakage trenches to groundwater in the vicinity of the Wai-iti Stream.

This permit was first issued by the Council on 21 August 1991 and was renewed in 28 March 2003 under Section 87(c) of the RMA. It is due to expire on 1 June 2021.

There are five special conditions attached to the consent.

Condition 1 requires bacteriological monitoring of the coastal waters of the foreshore and Wai-iti Stream.

Condition 2 requires the consent holder to ensure proper maintenance of the septic tank, pumping station and soakage trenches.

Condition 3 requires the consent holder to provide records of daily effluent volumes discharged.

Condition 4 requires the consent holder to provide a contingency plan for the site.

Condition 5 deals with review of the consent.

### **1.3.2 Coastal structure**

Section 12(b) of the RMA stipulates that no person may erect, reconstruct, place, alter, extend, remove, or demolish any structure or any part of a structure that is fixed in, on, under, or over any foreshore or seabed, 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 coastal permit **6462-1** to erect, place and maintain a boulder rip rap toe protection in the coastal marine area on the Wai-iti Beach foreshore. This permit was issued in July 2005 under section 87(c) of the RMA. It is due to expire on 1 June 2021.

There are nineteen special conditions attached to the consent.

Conditions 1 to 16 deal with various aspects of the construction of the seawall.

Condition 17 deals with monitoring of the wall.

Condition 18 requires the structure to be removed if it is no longer required.

Condition 19 deals with review of consent conditions.

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

## **1.4 Monitoring programme**

### **1.4.1 Introduction**

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

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

The monitoring programme for the Wai-iti Beach Retreat consisted of three primary components.

### **1.4.2 Programme liaison and management**

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

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;



- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

### 1.4.3 Site inspections

The Wai-iti Beach Retreat was visited three times during the routine monitoring period. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. The neighbourhood was surveyed for environmental effects.

In addition, the rock wall was checked for any end effects, or further erosion of the banks behind and in front of the wall.

### 1.4.4 Bacteriological sampling

Samples were collected at five sites (Table 1, Figure 1); three in the Wai-iti Stream and two coastal sites either side of the stream mouth (Figure 1, Photograph 4).

Sites, 1, 3, 4 and 5 have been monitored since the 1994-1995 monitoring period. Site 2, approximately 50 metres downstream of the tributary, was selected during the 1999-2000 monitoring period to assess the influence of the tributary.

**Table 1** Location of bacteriological sampling sites at the Wai-iti Beach Retreat

Site	Location	Site code	GPS
1	Wai-iti Stream upstream of beach camp	WIT000420	1727999-5690544
2	Wai-iti Stream approx. 50 m d/s of tributary	WIT000460	1727896-5690572
3	Wai-iti Stream adjacent beach entrance	WIT000490	1727686-5690533
4	Sea coast approx. 75 m north of stream mouth	SEA900060	1727667-5690609
5	Sea coast approx. 30 m south of stream mouth	SEA900063	1727555-5690516

Samples were analysed for temperature, conductivity and the faecal indicator bacteria enterococci and *E. coli*. The latter were monitored to provide an indication of potential contamination of the water by animal and/or human excreta.

Water quality is of interest at this site as Wai-iti Beach receives moderate recreational use over the bathing season. In 2003, the Ministry for the Environment (MfE) developed the *Guidelines for Recreational Water Quality* to assess the safety of water for contact recreation. The coastal guidelines focus on enterococci as this indicator

provides the closest correlation with health effects in New Zealand coastal waters. 'Alert' and 'Action' guideline levels are summarised in Table 2 and are based on keeping illness risk associated with recreational use to less than approximately 2% of uses. For freshwater the MfE 2003 guidelines use *E. coli* as the preferred indicator (Table 2).

**Table 2** Marine recreational bathing guidelines (MfE 2003)

	Indicator	Mode		
		Surveillance	Alert	Action
Marine	Enterococci (cfu/100 ml)	No single sample >140	Single sample >140	Two consecutive single samples >280
Freshwater	<i>E. coli</i> (cfu/100 ml)	No single sample >260	Single sample >260	Single sample >550



**Photo 4** Taken at site 4, looking towards site 5, with the Wai-iti Stream entering from centre left

## 2. Results

### 2.1 Inspections

17 December 2015

Conditions were overcast, with a moderate north westerly wind. The camp manager was absent at the time of the inspection. No odours or visual issues were detected in the vicinity of the old soakage trenches. No odours were detected from the gate of the pump station area, nor were there any visual issues. The camp appeared to be empty, with no signs of any campers present at the time of the inspection.

An inspection of the rock wall was conducted during this visit. The cobble mound and stacked drift wood at the river mouth were continuing to provide protection for the banks in this area. Near the river mouth, at the south west end of the rock wall, the most affected section of the wall appeared to have eroded slightly further. Above the rock wall in front of the baches, there were some sections where the grasses were receding and leaving small patches of exposed sand/soil. A large volume of sand had been naturally deposited on the beach since the previous inspection. This deposition of sand was filling space between boulders at the north east end of the rock wall. This sand had also been pushed up against exposed earth further north east from the rock wall. Signs informing the general public of dune replanting and erosion control were present at appropriate locations (areas of erosion along the bank and rock wall). In summary, although there were some areas of minor erosion, the wall was generally found to be in good condition and there were no signs of notable end effects.



**Photo 5** Straightening works undertaken on the Papatiki Stream

Straightening works that had been undertaken on the Papatiki Stream at the northern end of the beach were also inspected. Due to sand build up, the stream had begun to deviate along the beach, towards the rock wall. The straightening works forced the stream to revert back around and head directly out to sea against the cliff face. These works were necessary to protect the integrity of the rock wall.

### 5 January 2016

Conditions were fine with a light north westerly wind. The performance of the sewage system was discussed with one of the new camp managers, who had taken over in April 2015. Since taking over, the manager stated that some issues had arisen with the pump station componentry. However, these issues were resolved and there had been no recent trouble. The pump station was inspected on a regular basis to prevent any further issues. According to the manager, sewage odours could be detected downwind of the soakage trenches when the pump was in operation. A faint sewage odour was detected at the pump station at the time of the inspection. No visual issues were observed. The camp was reported to be near capacity, although the number of people staying in baches was particularly variable.

Samples of the Wai-iti Stream and Tasman Sea were scheduled for this inspection. However, the samples were not collected due to significant rainfall in the days preceding this inspection (the typically high bacteria counts following rainfall would likely disguise any potential sewage contamination).

### 11 February 2016

Conditions were overcast with a slight north easterly wind in exposed areas. The camp manager reported that there had been no issues with the sewage pump station since the last visit. The campsite had been booked out to capacity over multiple weekends prior to the inspection. No sewage odours were detected at the old soakage trenches or at the eastern gate to the pump station area.

Water samples were collected during the inspection. There did not appear to have been any rain in the area for at least four days prior to sampling (based on data from the Motonui and Kotare rain gauges).

## 2.2 Results of bacteriological monitoring

A summary of historical bacteriological results from January 1993 to January 2015 is presented in Table 3. The results of the bacteriological monitoring undertaken during the 2015-2016 summer monitoring period are presented in Table 4.

**Table 3** Summary of previous bacteriological results (cfu/100 ml) January 1993 to January 2015

	Upstream WIT000420		50 m d/s tributary WIT000460		Stream at beach WIT000490		Coast 75 m N SEA900060		Coast 30 m S SEA900063	
	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent
Number of samples	20	22	13	14	19	21	20	23	20	22
Minimum	150	130	230	100	210	130	1	<1	<1	<1
Maximum	2,700	1,500	3,100	1,800	2,700	1,600	260	210	120	140
Median	490	575	670	650	720	590	7.5	9	7.5	4.5

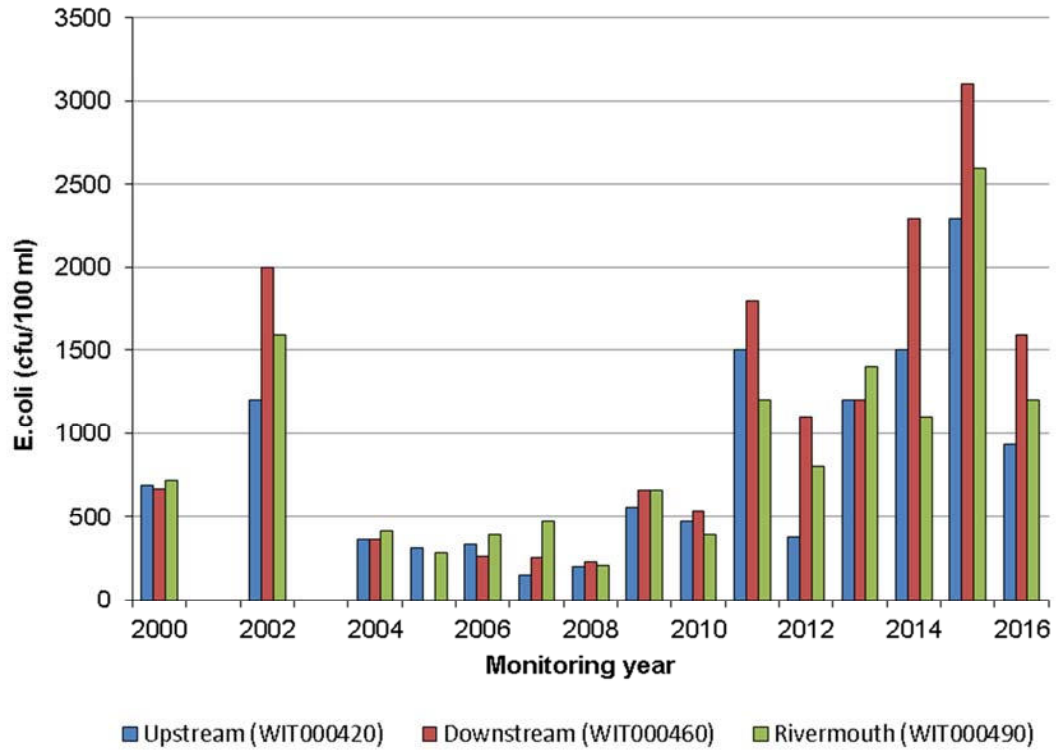
All three stream sites recorded high *E. coli* counts in the 2016 summer survey (Table 4). The counts at these stream sites were higher than historical medians and exceeded the MfE 'Action' guideline level (Tables 2, 3, 4). The enterococci counts at these sites all

exceeded historical maximums. These results were similar to those from recent summers, where the counts also increased downstream of the confluence with the tributary (Figure 2). This pattern is now reflected in the historical data, with median counts of *E. coli* and enterococci both greater at the two sites downstream of the confluence than at the upstream site (Tables 3 and 4). When the results from the 2016 survey are considered in light of the historical results, there is reasonable evidence to suggest that the elevated downstream counts are not due to chance. Instead it appears that there is some form of faecal contamination entering the stream between the upstream and downstream sites.

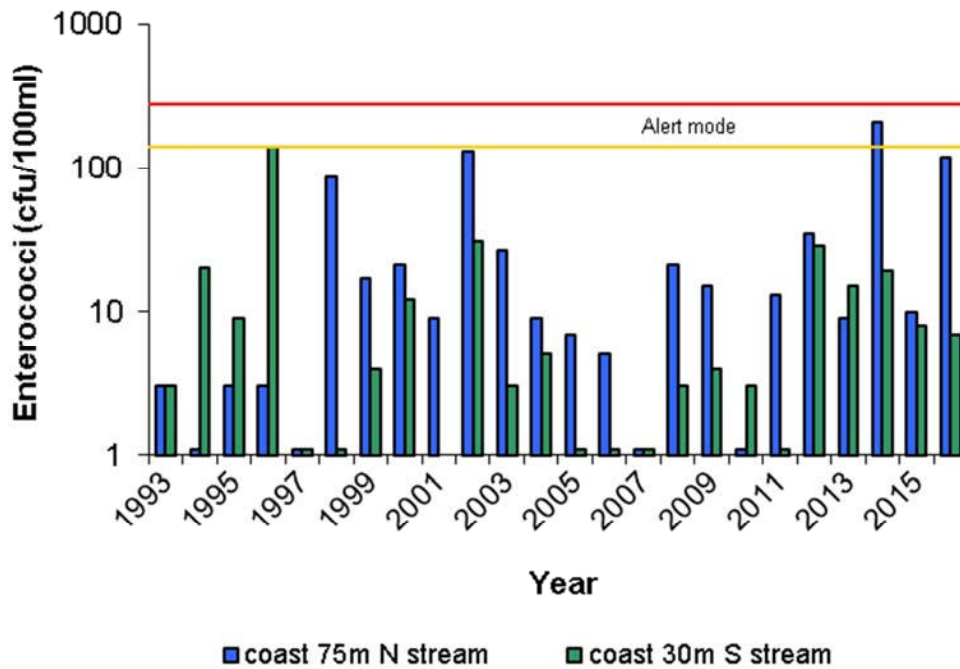
Both of the coastal sites recorded enterococci counts below the MfE 'Alert' guideline level in the 2016 summer survey (Figure 3; Tables 2 and 4). The *E. coli* and enterococci counts at both sites exceeded their respective historical medians but none exceeded historical maximums (Tables 3 and 4). As the enterococci counts were high in the stream sampling sites, a high degree of mixing and dilution where the stream meets the Tasman Sea must be acknowledged when considering the comparatively low enterococci counts at the coastal sites.

**Table 4** Bacteriological monitoring, 11 February 2016

Site	Site code	<i>E.coli</i> (cfu/ 100 ml)	Enterococci (cfu/100 ml)	Conductivity (mS/m)
Wai-iti Stream upstream of beach camp	WIT000420	930	3,100	19.3
Wai-iti Stream approx. 50 m d/s of tributary	WIT000460	1,600	3,200	20.1
Wai-iti Stream adjacent beach entrance	WIT000490	1,200	2,900	20.0
Sea coast approx 75 m N of stream mouth	SEA900060	59	120	4,660
Sea coast approx 30 m S of stream mouth	SEA900063	11	7	4,710



**Figure 2** *E. coli* counts from summer water quality surveys in the Wai-iti Stream since 2000; when all three sites were first monitored



**Figure 3** Coastal enterococci results since 1993



## 2.3 Investigations, interventions, and incidents

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

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

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

In the 2015-2016 period, the Council was required to undertake a significant additional investigation in association with the consent holder's resource consent.

Following a review of the results obtained during the 2014-2015 summer survey, a recommendation was made in the 2014-2015 monitoring report to undertake additional stream sampling, employing the use of faecal source tracking technology, during 2015-2016 monitoring period. Due to elevated *E. coli* counts recorded at the downstream sites again in the 2015-2016 summer survey, the additional survey recommended in the 2014-2015 report was undertaken.

The investigation found strong evidence of human faecal contamination in the tributary which drains the area directly below the soakage trenches. The results were less conclusive in detecting the human faecal input into the Wai-iti Stream itself, however, factors such as dilution and marker persistence must be considered when interpreting the results of faecal source analyses.

In reporting on the findings of the investigation, a number of reasons were presented to suggest that the camp's effluent soakage trench system is no longer performing at an acceptable standard and that effluent leachate is impacting on the Wai-iti Stream, also presented here:

- Inadequacies in the previous system (a seepage ditch also near the base of the slope) resulted in high faecal indicator bacteria (FIB) counts at the stream mouth;
- The 1991 effluent system report predicted a decrease in performance over time as well as leachate eventually reaching the base of the slope;
- Key recommendations made in the 1991 report in order to optimise system performance and enable effective monitoring were not carried out;
- Results from this investigation provide strong evidence for human faecal contamination in the tributary which drains the area directly below the soakage trenches;

- Of the three sites routinely monitored in relation to consent 1971-3, the site immediately downstream of the tributary and Wai-iti Stream confluence displays the highest median E.coli count over a 23 year monitoring period.

A full report of the investigation is included in Appendix II.

After being informed of the results of the investigation, the consent holder acted promptly to remedy the issue. An inspection of the soakage trenches found that one of the three disposal fields had ruptured, resulting in effluent running down the hill and entering the tributary. The original installer of the system believed the rupture to be the root cause of the contamination.

Following this discovery, the rupture was repaired. The consent holder has stated that the repair will continue to be monitored, along with the rest of the system, and that any further issues will be communicated to the Council. Furthermore, the consent holder has indicated plans to plant the bottom of the hill and the tributary with flax, as recommended in the 1991 effluent system report.

It cannot be known for certain whether the ruptured soakage trench was in fact the sole cause of the contaminated tributary and resulting contamination of the Wai-iti Stream. For this reason, the Council intends to temporarily intensify Wai-iti Beach Retreat's environmental monitoring programme.



### **3. Discussion**

#### **3.1 Discussion of site performance**

The pump station was inspected on three occasions during the 2015-2016 monitoring period; no issues were identified. The camp manager's regular monitoring and maintenance of the pump station appeared to have prevented any issues from arising here. However, a significant fault was discovered with the effluent soakage trenches, with one of the three having ruptured. It was unclear how long ago this rupture had occurred. In the future it would be advisable to conduct inspections of the entire effluent treatment and disposal system, including the pipework, pumps, soakage trenches, etc.

The rock wall was found in good repair. The consent holder was proactive in straightening the meandering Papatiki Stream, which otherwise would likely have compromised the integrity of the structure and eroded Wai-iti beach front.

#### **3.2 Environmental effects of exercise of consents**

Notable effects were had on the environment due to the exercise of resource consent 1971-3 in the year under review. Consistent with recent monitoring years, the results from routine sampling found elevated counts of FIB at the two sites downstream of the confluence with tributary in comparison with the site further upstream. Faecal source tracking technology provided strong evidence of human faecal contamination in the tributary at the base of the hill on which the effluent soakage trenches are positioned. The discovery of a ruptured effluent soakage trench confirmed that human effluent had been running in to the tributary, and likely entering the Wai-iti Stream.

The pathogens that occur in human faecal matter present a significant health risk. Although the stream is not thought to be bathed in, the presence of eels attracts people to the stream banks (Photo 6), and it is often crossed where it runs out over the beach. These considerations further highlight the importance of maintaining effluent treatment and disposal systems in the vicinity of such waterbodies. In this case, the prompt discovery and repair of the ruptured soakage trench was encouraging.

No significant environmental effects resulted from the exercise of resource consent 6462-1 in the year under review. Inspections of the rock wall only found areas of minor continued erosion. No notable end effects were identified.



**Photo 6** An eel in the Wai-iti stream, 1 April 2016

### 3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 5 and 6.

**Table 5** Summary of performance for Consent 1971-3

<b>Purpose: To discharge up to 27 cubic metres/day of septic tank treated sewage effluent via soakage trenches to groundwater in the vicinity of the Wai-iti Stream</b>		
<b>Condition requirement</b>	<b>Means of monitoring during period under review</b>	<b>Compliance achieved?</b>
1. Bacteriological sampling to be undertaken in the Wai-iti Stream and the coastal waters	Council's bacteriological sampling at five sites	Yes
2. Consent holder to ensure maintenance of septic tanks, pumps and soakage trenches is undertaken	Site inspections	<b>No – the consent holder has since repaired an identified fault</b>
3. Consent holder to provide records of daily effluent volumes discharged to the soakage trenches	Records not requested	N/A
4. Contingency plan to be provided	An updated contingency plan received June 2009	Yes
5. Optional review provision re environmental effects	Not required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		<b>Improvement required High</b>

N/A = not applicable

**Table 6** Summary of performance for Consent 6462-1

<b>Purpose: <i>To erect, place and maintain a boulder rip rap toe protection in the coastal marine area on the Wai-iti Beach foreshore</i></b>		
<b>Condition requirement</b>	<b>Means of monitoring during period under review</b>	<b>Compliance achieved?</b>
1. Notification period before construction or maintenance begins		N/A
2. Structure to be constructed and maintained in accordance with the engineering plans	Site inspections	Yes
3. Landward position of seawall is to be determined by survey to satisfaction of Council		N/A
4. Crest of structure to be no higher than reduced level plus 7.5m	Site inspections	Yes
5. Maximum size of boulders to be used	Site inspections	Yes
6. Structure to have minimum slope of 2 to 1	Site inspections	Yes
7. No refuelling of machinery within coastal marine area		N/A
8. Construction to comply with noise standards as defined in the coastal plan		N/A
9. No work to be undertaken during weekends and holiday periods		N/A
10. No maintenance to be undertaken during weekends or the summer holiday period	No maintenance work has had to be undertaken as yet	N/A
11. Sufficient signage to be in place during construction		N/A
12. In situ beach materials only to be used for foreshore reinstatement purposes		N/A
13. Area and volume of disturbance to be minimised and reinstated	Site inspections	Yes
14. Works to cease if any archaeological remains are found		N/A
15. Structure to be constructed within 12 months of issuing of consent		Yes
16. Area behind rock wall to be planted in sand binding plants	Grasses planted	Yes

<b>Purpose: <i>To erect, place and maintain a boulder rip rap toe protection in the coastal marine area on the Wai-iti Beach foreshore</i></b>		
<b>Condition requirement</b>	<b>Means of monitoring during period under review</b>	<b>Compliance achieved?</b>
17. Annual monitoring programme to be developed for integrity of the wall	An annual inspection is incorporated with the monitoring for the wastewater treatment system at the Wai-iti Beach Camp. Further monitoring (structure survey) may be required in future	Yes
18. Structure to be removed and reinstated if no longer required		N/A
19. Optional review provision re environmental effects	Not required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		<b>High</b>
Overall assessment of administrative performance in respect of this consent		<b>High</b>

N/A = not applicable

An improvement in the consent holder's environmental performance is required in relation to the exercise of resource consent 1971-3. During the year under review, results from routine monitoring and an additional investigation indicated that the camp's effluent system was contaminating an unnamed tributary and the Wai-iti Stream. These results were confirmed with the discovery of a ruptured effluent soakage trench.

The consent holder demonstrated a high level of environmental and administrative performance in relation to the exercise of resource consent 6462-1. No adverse environmental effects were observed as a result of the rock wall structure.

Environmental ratings are defined in Section 1.1.4

### **3.4 Recommendations from the 2014-2015 annual report**

In the 2014-2015 annual report, it was recommended:

1. THAT routine monitoring of the sewage discharge system at the Wai-iti Motor Camp in the 2015-2016 year continues at the same level as in 2014-2015.
2. THAT in conjunction with the sewage discharge inspection one inspection is undertaken of the rock wall to assess the integrity of the structure, end effects and any erosion occurring as a result of the rock wall.
3. THAT should monitoring results indicate problems with the sewage treatment systems, extended monitoring of Wai-iti Stream and coastal water quality shall be undertaken.
4. THAT faecal source tracking technology is employed in the 2015-2016 monitoring period in addition to the routine monitoring programme in order to distinguish the source of faecal contamination.

These recommendations were implemented.

### **3.5 Alterations to monitoring programmes for 2016-2017**

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

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/ discharges and effects under the RMA; and
- to report to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/ discharging to the environment.

It is proposed that the 2016-2017 environmental monitoring programme for the Wai-iti Beach Retreat is altered. This is proposed to ensure that the repairs undertaken on the ruptured system were sufficient to prevent any further issues. In doing so this will confirm that the rupture was the sole cause of the contamination.

The major changes to the monitoring programme are as follows:

- The full sampling run will be increased from five sites to six, with the additional sample collected from the tributary at the base of the slope (if there is water in it). This will still only be carried out in conjunction with one of the three inspections during the monitoring period.
- Reduced sampling runs will be incorporated into the remaining two inspections. These runs will consist of samples being collected at three of the sites monitored in the full run. These sites include the tributary (if there is water in it) and the Wai-iti Stream sites upstream and downstream of the confluence with this tributary.

It is proposed that if no further issues are detected after two summers of monitoring, then the reduced sampling runs will no longer be included in the programme.

## 4. Recommendations

1. THAT the routine monitoring of the sewage discharge system at the Wai-iti Beach Retreat in 2016-2017 is adjusted to increase the number and frequency of samples collected, as outlined in section 3.5.
2. THAT an annual inspection is undertaken of the rock wall to assess the integrity of the structure, end effects and any erosion occurring as a result of the rock wall. This inspection will be undertaken in conjunction with the sewage discharge inspection.

## Glossary of common terms and abbreviations

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

'Action' mode	Marine: two consecutive single samples > 280 enterococci/100ml. Freshwater: single sample >550 <i>E. coli</i> /100ml.
'Alert' mode	Marine: single sample 141-280 enterococci/100ml. Freshwater: single sample 261-550 <i>E. coli</i> /100ml.
Bathers	Those who enter the water, and either partially or fully immerse themselves.
Bathing season	Generally the bathing season extends between 1 November and 31 March.
Beach	The shore or any access point to the sea.
cfu	colony forming units. A measure of the concentration of bacteria usually expressed as per 100 ml sample.
Conductivity	An indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Contact recreation	Recreation activities that bring people physically in contact with water, involving a risk of involuntary ingestion or inhalation of water.
<i>E. coli</i>	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample.
FC	Faecal coliforms, An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml sample.
FIB	Faecal Indicator Bacteria – in this report it refers collectively to <i>E. coli</i> , enterococci and faecal coliforms.
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.
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.
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.
Median	Central value when values are arranged in order of magnitude.
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> including all subsequent amendments.
Temperature	Measured in °C (degrees Celsius).
UI	Unauthorised Incident.
Water quality	The bacteriological condition of a water body as it relates to human health, measured using indicator bacteria.

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



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## **Appendix I**

### **Resource consents held by the consent holder**

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



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

Name of  
Consent Holder:           Wai-iti Motor Camp Limited  
                                  C/- 538 Carrington Road  
                                  R D 1  
                                  NEW PLYMOUTH

Consent Granted           28 March 2003  
Date:

**Conditions of Consent**

Consent Granted:        To discharge up to 27 cubic metres/day of septic tank  
                                  treated sewage effluent via soakage trenches to  
                                  groundwater in the vicinity of the Waiiti Stream at or about  
                                  GR: Q18:379-523

Expiry Date:             1 June 2021

Review Date(s):         June 2009, June 2015

Site Location:           Beach Road, Waiiti

Legal Description:       Pt Lot 2 DP 13368 Waiiti 54B3 54B2 Blk X Mimi SD

Catchment:              Waiiti

## Consent 1971-3

### 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, in conjunction with the Taranaki Regional Council, undertake such bacteriological monitoring of the Waiiti Stream and coastal waters of the foreshore as deemed necessary by the Chief Executive, Taranaki Regional Council.
2. The consent holder shall ensure proper maintenance of the septic tanks, pumping station and soakage trenches as required.
3. The consent holder shall provide records of daily effluent volumes discharged to the soakage trenches at the request of the Chief Executive, Taranaki Regional Council.
4. The consent holder shall provide a contingency plan to the satisfaction of the Chief Executive, Taranaki Regional Council, outlining measures to be undertaken in the event of power failure, pump breakdown, pipe blockage and failure of soakage trenches, within three months of granting this consent.
5. 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, 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.

Transferred at Stratford on 5 December 2003

For and on behalf of  
Taranaki Regional Council

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**Chief Executive**

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

Name of  
Consent Holder:           Wai-iti Motor Camp Limited  
                                      538 Carrington Road  
                                      R D 1  
                                      NEW PLYMOUTH

Consent Granted           12 July 2005  
Date:

**Conditions of Consent**

Consent Granted:        To erect, place and maintain a boulder rip rap toe  
                                      protection in the coastal marine area on the Wai-iti Beach  
                                      foreshore at or about GR: Q18:379-523

Expiry Date:             1 June 2021

Review Date(s):         June 2009, June 2015

Site Location:            Beach Road, Urenui

Legal Description:       Pt Lot 2 DP 13368 Blk X Mimi SD

Catchment:               Tasman Sea

**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 notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to commencement, and upon completion of initial construction, and again at least 48 hours prior to, and upon completion of, any subsequent maintenance works.
- 2. The structure authorised by this consent shall be constructed and subsequently maintained in accordance with the engineering plans submitted in support of application 3319 and to ensure the conditions of this consent are met. Any variation to these plans will be subject to the approval of the Chief Executive, Taranaki Regional Council. In the case of any contradiction between the documentation submitted in support of application 3319 and the conditions of this consent, the conditions of this consent shall prevail.
- 3. The landward position of the seawall is determined by survey to the satisfaction of the Chief Executive, Taranaki Regional Council prior to the commencement of works.
- 4. The crest of the structure shall not exceed a maximum height of reduced level plus 7.5 metres.
- 5. The maximum diameter of boulders utilised within the structure shall be no more than 0.8 metres.
- 6. The structure shall have a minimum seaward slope of 2 horizontal to 1 vertical.
- 7. There shall be no refuelling of construction machinery within the coastal marine area.



8. The construction, use, maintenance and removal of the structure authorised by this consent shall comply with the noise standards as outlined within section 4.4.3 of the Regional Coastal Plan for Taranaki.
9. During construction of the structure no work shall be undertaken during school holidays, public holidays and weekends without the approval of the Chief Executive, Taranaki Regional Council.
10. All practicable measures shall be undertaken to ensure maintenance of the structure shall not occur on weekends, public holidays or between 1 December and 31 January.
11. During construction and maintenance periods the area subject to works shall have sufficient signage to ensure public safety of any potential safety hazards.
12. In situ beach material shall be used only for foreshore reinstatement purposes seaward of the structure, and shall not be used for construction purposes.
13. The consent holder shall ensure that the area and volume of foreshore disturbance shall, so far as practicable, be minimised and any areas which are disturbed shall, so far as practicable, be reinstated.
14. In the event that any archaeological remains are discovered as a result of the exercise of this consent, the works shall cease immediately at the affected site. The Ngati Mutunga Iwi Authority and the Chief Executive of the Taranaki Regional Council shall be notified immediately, and be invited to inspect the site.
15. The structure authorised by this consent shall be constructed within twelve months of the granting of this consent. Upon completion of construction the consent holder shall submit as built plans of the structure if different to those submitted in support of application 3319.
16. The consent holder shall undertake all practicable measures to ensure the development of healthy functioning flax, spinefex and other native sand binding plants immediately behind the rock revetment wall to the satisfaction of the Chief Executive, Taranaki Regional Council.
17. An annual monitoring programme will be developed for the integrity of the rock wall , erosion of the beach and for any end effects of the surrounding environment. All costs associated with the monitoring will be met by the consent holder.
18. The structure authorised by this consent shall be removed and the area reinstated, if and when the structure is no longer required. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the structures removal and reinstatement.

19. 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, 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.

Footnote:

- i. The structure is proposed to be constructed on New Plymouth District Council esplanade reserve. The New Plymouth District Council takes no responsibility for the maintenance of the structure or effects it might have on the beach or neighbouring properties.

Signed at Stratford on 12 July 2005

For and on behalf of  
Taranaki Regional Council

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**Director-Resource Management**

## **Appendix II**

### **Wai-iti Stream - faecal contamination investigation 2016**



# Memorandum

**To:** Science Manager – Hydrology/Biology, Regan Phipps  
Scientific Officer – Marine Ecology, Emily Roberts  
**From:** Technical Officer, Thomas McElroy  
**File:** #1686853  
**Date:** 23 May 2016

## Wai-iti Stream - faecal contamination investigation 2016

### 1. Introduction

Wai-iti Motor Camp Limited holds water discharge permit 1971-3 which authorises the discharge of up to 27 cubic metres per day (m<sup>3</sup>/day) of septic tank treated sewage effluent via soakage trenches to groundwater in the vicinity of the Wai-iti Stream.

All wastewaters from the camping ground enter a septic tank of 143 m<sup>3</sup> capacity. The effluent is then pumped via a 50 mm alkathene pipe across the Wai-iti Stream and into soakage trenches situated on a wooded hillside approximately 30 metres from the stream.

These multiple soakage trenches work on a rotational basis and were first commissioned in 1991 in response to inadequate treatment of the effluent by the previous system.

When previous proprietors took over the property in 1986-1987, the disposal system consisted of a seepage ditch situated near the base of the wooded hillside. Monitoring found that this trench system was not a suitable means of disposal, resulting in high faecal coliform counts at the mouth of the Wai-iti Stream. This inadequate treatment led to the development of the current multiple soakage trench system.

An investigation was carried out in 1991 prior to the installation of the current effluent disposal system (Appendix I). The subsequent report's cover letter opens with "An important point to acknowledge is that with the low cost methods of disposal under consideration there is no final solution". The report states that the system upgrades would "in the medium term result in significant improvement to the filtration and containment of the effluent" and that the "medium to long term effectiveness of the disposal system is at this stage difficult to assess". The report predicts that discharged leachate would eventually reach the base of the slope due to the sandy soil profile. It stipulates that the effectiveness of the system is dependent on careful management and monitoring. Seven recommendations that were made in the report are included in Table 1 below.

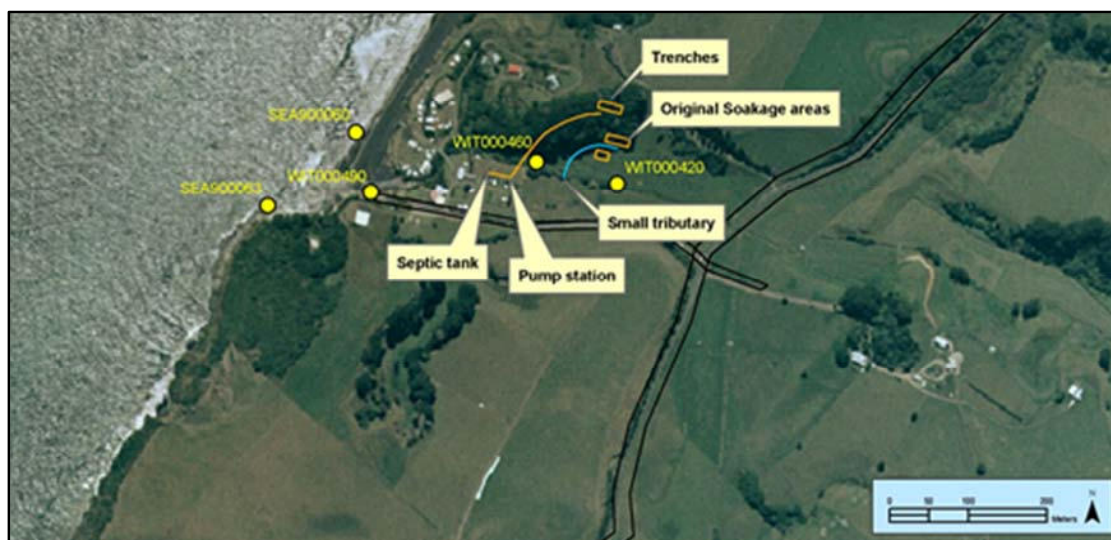
**Table 1** Recommendations from the 1991 effluent system investigation (with comment)

Recommendation	Comment
1. Construct three disposal trenches located on the elevated cut bench.	Current system
2. Each trench is to comprise "Everglas" disposal units and mushroom head breathers.	Current system

Recommendation	Comment
3. Install a distribution tank with separate feed lines to each trench.	Current system
4. Establish vegetation at the base of the slope.	Not carried out (Grant Andrew; Appendix I)
5. Consider establishing monitoring boreholes.	No boreholes installed
6. Check the ability of the existing pump to pump the additional head to the proposed new distribution tank.	No record of this occurring
7. Consider installing water restriction measures in an effort to reduce the total effluent disposal load. Such measures would include: installation of spring loaded taps, restrictions on showers and the use of washing machines.	No record of this occurring

Routine monitoring of the Wai-iti Stream and Tasman Sea undertaken by the Taranaki Regional Council (the Council) in recent years has raised concerns about the performance of the wastewater disposal system. Although counts of faecal indicator bacteria (FIB) have historically been high across the Wai-iti Stream monitoring sites (likely influenced by agriculture in the catchment), the median count remains highest at the site downstream from the old farm drain/small tributary (Figure 1, Table 2). The proximity of this small tributary to the effluent soakage trenches suggests that effluent leachate could be responsible for the elevated counts downstream of the confluence of this tributary and the stream.

Following the recommendations that were made in the 2014-2015 Wai-iti Motor Camp monitoring report, an investigative sampling run was undertaken on 1 April 2016 in order to elucidate any possible effect of the soakage trenches on the Wai-iti Stream.



**Figure 1** Location of sewage treatment system and sampling sites at the Wai-iti Motor Camp

**Table 2** Summary of previous bacteriological results (cfu/100 ml) from routine monitoring (1993 to 2016)

	Upstream WIT000420		50 m d/s tributary WIT000460		Stream at beach WIT000490		Coast 75 m N SEA900060		Coast 30 m S SEA900063	
	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent	<i>E. coli</i>	Ent
Number of samples	21	23	14	15	20	22	21	24	21	23
Minimum	150	130	230	100	210	130	1	<1	<1	<1
Maximum	2,700	3,100	3,100	3,200	2,700	2,900	260	210	120	140
Median	510	580	885	680	760	605	8	9	8	5

## 2. Method

Samples were collected at the same three stream sites sampled routinely as part of the consent compliance monitoring programme (Figure 1, Table 2), as well as from the small tributary beneath the soakage trenches. Samples were initially analysed for temperature, conductivity and faecal indicator bacteria (FIB: *E. coli*, Enterococci and Faecal Coliforms). Faecal source analysis was then undertaken to provide an indication of the likely origin of the faecal contamination. The specific markers that were incorporated into the faecal source analysis were those used to differentiate between human, ruminant and avian sources.

## 3. Results

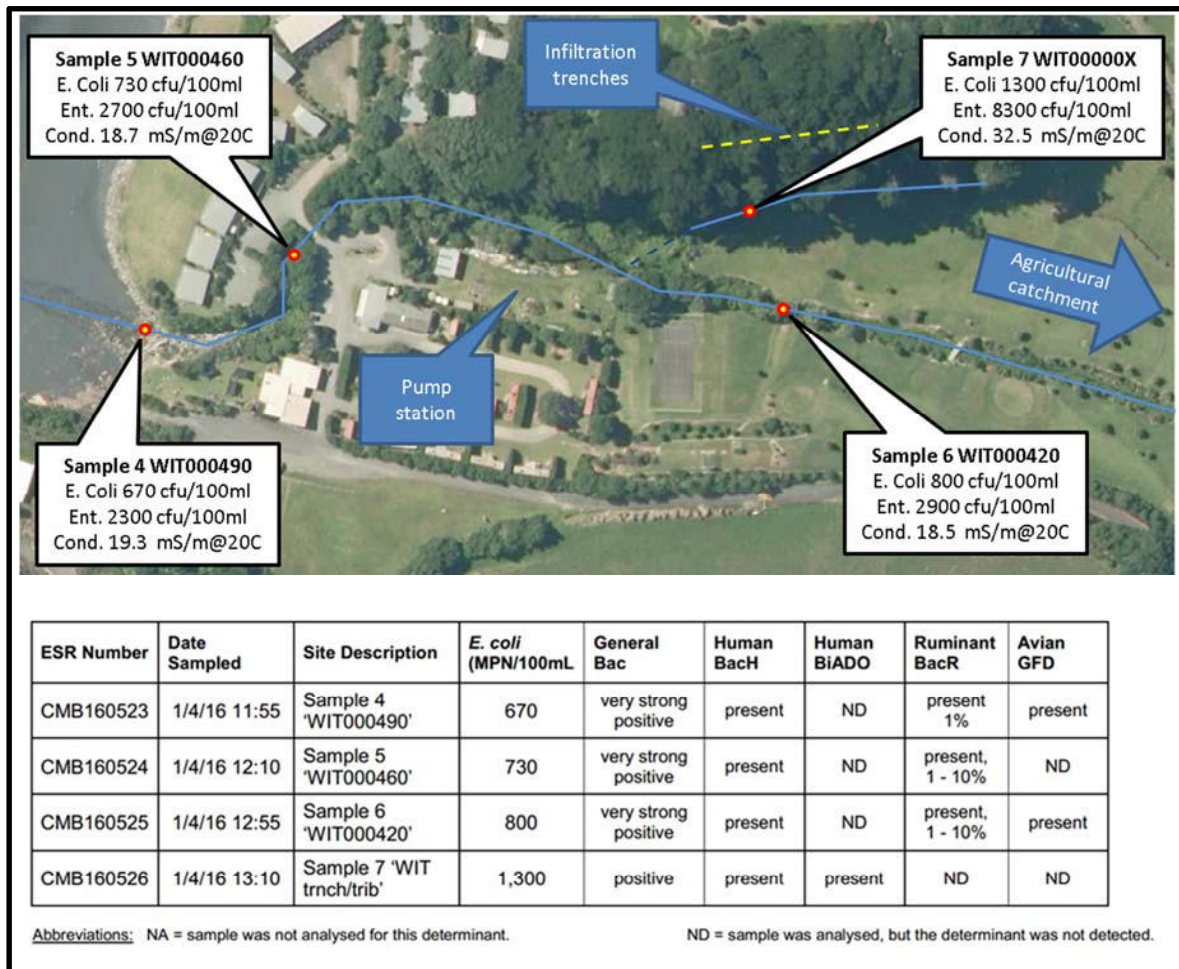
### FIB counts:

High counts of *E. coli* and Enterococci were recorded at all of the sites sampled (Figure 2). The highest counts recorded were associated with the sample collected from the small tributary, which drains the area directly below the soakage trenches. All samples exceed the 'Action' limit from the MfE Guidelines for Recreational Water Quality (Table 3).

### Faecal source analysis:

The Human BacH marker was present in all four samples. The Human BiADO marker was only present in the sample from the tributary (sample 7). The Ruminant BacR marker was present at low levels in all of the Wai-iti Stream samples (samples 4, 5 and 6). The Avian GFD marker was detected in the sample from the stream mouth and the upstream sample (samples 4 and 6, respectively).

An interpretation of the results is presented in section 4.



**Figure 2** Results of faecal indicator bacteria in samples collected from the Wai-iti Stream and a small tributary are overlaid on an aerial image of the area (Ent. = Enterococci, Cond. = Conductivity). Results of the faecal source analysis are presented in the table (Full report in Appendix II).

**Table 3** Recreational bathing guidelines (MfE 2003)

	Indicator	Mode		
		Surveillance	Alert	Action
Marine	Enterococci (cfu/100 ml)	No single sample >140	Single sample >140	Two consecutive single samples >280
Freshwater	<i>E. coli</i> (cfu/100 ml)	No single sample >260	Single sample >260	Single sample >550

## 4. Discussion

On 1 April 2016 an investigative sampling run was undertaken at the Wai-iti Motor Camp in order to elucidate the potential impact of effluent soakage trenches on the Wai-iti Stream. The investigation comprised of surface water sampling at four locations to assess FIB concentrations, with subsequent analysis to identify the likely source of bacteriological contamination. The interpretation of the faecal source analysis results is drawn from ESR's report (Appendix II) and correspondence with ESR staff.

The detection of both human markers (BacH and BiADO) in the sample taken from the tributary is strongly indicative of human faecal contamination. No other potential sources (i.e. ruminant and



avian) were detected in the samples obtained. This, in conjunction with the high FIB counts, provides strong evidence to suggest the effluent from the soakage trenches is leaching down the slope and into the tributary.

One of the two human markers (BacH) was detected in each of the Wai-iti Stream samples, including those taken downstream of the confluence with the tributary. These results indicate lower levels of human faecal contamination when compared to the tributary sample results. However, there are some important factors to consider when interpreting this result. Firstly, the BacH analysis tends to be more sensitive than the BiADO analysis, and the corresponding BacH marker may endure for longer in aged faecal material. "Therefore, detection of only the BacH marker may be indicative of aged or lower levels of human faecal contamination" (ESR; Appendix II). In the context of this investigation, the levels of the other human marker (BiADO) may have dissipated prior to reaching the stream. Additionally, the dilution of the tributary in the Wai-iti Stream will also affect the detectability of both human markers.

No human markers were expected to be found in the Wai-iti Stream upstream of the confluence with the tributary, however, the human BacH marker was detected. Outside of the possibility of human faecal contamination further up the catchment, this could be explained by the cross-reactivity of the BacH marker. That is, faecal contamination from other species can result in a false positive detection with the BacH marker analysis. Species that can result in this cross-reaction include possums, rabbits, goats, cats and dogs.

As mentioned earlier, there is a history of high FIB counts in the Wai-iti Stream which has often been attributed to agriculture in the catchment. Accordingly, it was also expected that there would be a strong presence of the ruminant BacR marker in the Stream samples. However, the results of the faecal source analysis were considered to be inconsistent with a fresh ruminant source of *E. coli*. This does not discount ruminants as a source of faecal contamination in the stream. Rather, it indicates that there is little direct contamination in the vicinity of the camp. The bacteria in which the BacR gene is found exist within ruminants and cannot survive in the environment, unlike *E.coli*. Therefore, the more time the bacterium is exposed to the environment, the less likely it is to survive and be detected in the analysis, whereas *E.coli* may still be detected in substantial numbers. So it is reasonable to infer that any faecal contamination in the Wai-iti stream stemming from ruminant sources may have:

- entered the stream a sufficient distance upstream for the levels of BacR to dissipate; and/or
- been subjected to a form of effluent treatment prior to entering the stream; and/or
- resulted from overland run-off.

## 5. Conclusion

This investigation has found strong evidence of human faecal contamination in the tributary which drains the area directly below the soakage trenches. While in this particular instance the results were less conclusive in detecting the human faecal input into the Wai-iti Stream itself, factors such as dilution and marker persistence must be considered when interpreting the results of faecal source analyses.

Following this investigation there are a number of reasons to suggest that the soakage trench system at the Motor Camp is no longer performing at an acceptable standard and that effluent leachate is impacting on the Wai-iti Stream:

- Inadequacies in the previous system (a seepage ditch also near the base of the slope) resulted in high FIB counts at the stream mouth;
- The 1991 effluent system report predicted a decrease in performance over time as well as leachate eventually reaching the base of the slope;
- Key recommendations made in the 1991 report in order to optimise system performance and enable effective monitoring were not carried out;
- Results from this investigation provide strong evidence for human faecal contamination in the tributary which drains the area directly below the soakage trenches;
- Of the three sites routinely monitored in relation to consent 1971-3, the site immediately downstream of the tributary and Wai-iti Stream confluence displays the highest median *E.coli* count over a 23 year monitoring period.

## **Bibliography**

Taranaki Regional Council 2015. Wai-iti Motor Camp Monitoring Programme Annual Report for 2014-2015. TRC Technical Report 15-15.

**Appendix I:** Wai-iti Motor Camp Ltd Contingency Plan(Document numbers 561816 & 561817)

# WAI-ITI BEACH MOTOR CAMP ARK

PUKEARUHE ROAD : R.D. 44 : PHONE 752-3726: URENUI

Hosts : Shirley & Grant Andrew.

Averil Bray  
Taranaki Regional Council  
Stratford

8 September 1995

**RECEIVED**  
12 SEP 1995  
TARANAKI REGIONAL COUNCIL

Dear Averil,

Please find enclosed one copy of the Wai-iti Beach Motor Camp sewerage trench plans as required for Special Consent of Water Right 1971. Would you please note that all of this correspondence is addressed to Ken Homer. Your last reply to me concerning whose responsibility it was to provide these documents puts us as lessee in a catch 22 situation. The fact of the matter is that these consents should never have been put into our name **WITHOUT OUR CONSENTS**. Why did this happen, when it now seems to require the lessors signature to transfer the consents back to him? We have had exactly the same situation occur for our District Council rates, whereby we ended up paying all rates for a 14 hectare property when we only leased 3.5 hectares.

## **Contingency Plan in the event of Pump Failure.**

The Motor Camp has a total of three pumps:-

1. Main Water Pump
2. Secondary Water Pump
3. Sewerage Pump.

Our secondary water pump is identical to our sewerage pump and can be used as parts for the sewerage pump or as a complete swap-out unit should the sewerage pump have a total failure.

## **Contingency Plan in the event of a failure of the Soakage Trenches.**

As contained in the attached plans, "land filtration of effluent eventually reaches a saturation level and it is then a case of going back to the starting point again."

This saturation level will be the point of concern and when the new "starting point" will need to be re-addressed. The Council's monitoring program is the tool to establish when that is.

Please note that the contractors recommendations stated that the planting of flax and canna lilly vegetation at the base of the slope *should* be undertaken. (To extend the life of the new system). The lessor has chosen not to have these works performed.

I do understand the Councils position in regard to whose name appears on the consents. This is a hopeless case in regard to how it applies to lessor / lessee situations. It is the Council's policies and administration of these consents that should be addressed to ensure that a person or company is **NOT** the "grantee" of the consent without their own authority given to this effect.

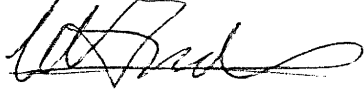
The issue of the septic waste pipe that *may* collapse into the Wai-iti Stream, will for our part have to remain as " we hope it doesn't happen while we still hold the lease of the camp ". But, should it occur and the Regional Council decide to prosecute (which of course it should) then we feel we have ample protection in a clause of our lease for the ultimate responsibility of this inaction to fall back to our lessor.

**Consent no 1967 - for taking of water.**

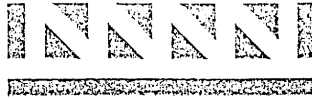
I have written to have this right cancelled as we no longer require it. As stated due to the lessor not building additional amenities as required by District council requisition and the subsequent reduction of sites at the camp, we no longer require a consent for the lower volume of water required.


I was advised by the Council that the lessor did not want this cancelled and that he had agreed to have this transferred to his name, he has not honoured that agreement. As the grantee of this consent, PLEASE CANCEL this consent.

Thank you once again for your time and concern in these matters.

A handwritten signature in black ink, appearing to read 'Grant Andrew', with a stylized flourish at the end.

Yours faithfully  
Grant Andrew



Copy. 

84 Pendarves Street  
New Plymouth

1/12/1991

Dear Ken

Please find attached a report on the investigation into the effluent disposal problem at Wai-iti.

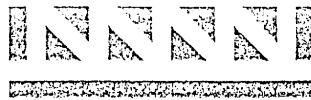
An important point to acknowledge is that with the low cost methods of disposal under consideration there is no final solution. Land filtration of effluent eventually reaches a saturation level and it is then a case of going back to the starting point again. Careful management of the disposal system will extend the life of the system. How long the system will remain effective is hard to predict. What is clear is that the existing arrangement is living on borrowed time.

I have discussed the proposal with Mr A Culpin and Mr C Dixon of the New Plymouth District Council, both of whom were very helpful. I believe that the NPDC will support the proposal as described.

I have enclosed a "plumbing permit" form for your attention. The completion of this form together with the appropriate fee and workscope should enable you to secure a permit. I have made an initial approach Trevor Reid (plumber) in Waitara for an estimate on cost. Subject to the estimate value it may be prudent to put an enquiry to two other contractors. Please advise what further services that you require from me.

Regards

Nigel Wilson



## WAI-ITI MOTOR CAMP SEPTIC TANK DISPOSAL INVESTIGATION

### 1. Preamble :

At the request of Mr K Horner an investigation of the Wai-iti motor camp septic tank effluent disposal has been carried. Effluent from the septic tank is currently discharged into open trenches located at the base of a tree clad slope approximately 60m north of the septic tank, Refer plate 1. The effluent soakage area is directly adjacent to a flat paddock which has a ground water level 1.0 to 1.5 m below the surface. The paddock is dissected by a stream running through its centre and other surface drainage features ensure that runoff is reasonably direct.

A 3 metre wide bench has been cut in the macrocarpa clad slope at an elevation of approximately 9 metres above the paddock level, Refer Plate 2. It is along the length of this bench that it is proposed to construct a new effluent soakage trench.

### 2. Field Investigation.

#### 2.1 Percolation Tests :

Three precolation tests have been carried at locations identified on figure 1. The tests were conducted in line with the procedures presented in NZS 4610:1982, amendment No.1 June 1991. The results of the tests indicate a percolation rate of 149 to 635 mm per hour, the full test results are presented in the appendix. The measured rate of percolation suggests that the soils in the selected disposal area have an "A" category rating.

#### 2.2 Borehole :

In order to gain an appreciation of the soil profile a hand augered borehole was put down adjacent to the central percolation test hole P2, refer figure 1. The borehole was advanced a total depth of 5.65 metres and indicated a uniform profile of "silty fine SAND". It was noted that the bore was dry for its entire depth. A copy of the borehole log is presented in the appendix.

#### 2.3 Survey :

Abney level cross sections have been taken at each of the three percolation test areas. These sections have been plotted and are presented in figures 2, 3 & 4.

The main features of these cross sections are ; the slope angle of 34 degrees and the vertical height of the bench above the existing disposal trench estimated to be 7 metres.





## Disposal strategy

The proposal is to construct three soakage trenches located along the cut bench already formed within the macrocarpa clad slope. One trench will be 35 metres in length and the other two will both be 25 metres long thus providing a total trench length of 85 metres. Each trench will have a horizontal separation of 4 to 5 metres, Refer figure 5 which illustrates the main features of the disposal trenches.

In addition to the disposal trenches, as described above, the following features should be incorporated in the constructed works:

- 1) Pump effluent from the septic tank to a low head distribution tank located at bench level.
- 2) Install three distribution drain lines, one to each of the three trenches. Each line should have a control valve.
- 3) Establish flax and canna lily vegetation at the base of the slope.

(Note. The installation of a distribution tank will enable local dosing to take place should the need arise during high summer effluent flows.)

The proposed modifications to the effluent disposal arrangements will in the medium term result in a significant improvement to the filtration and containment of the effluent. However, as observed in the borehole, the entire soil profile is sandy and the leachate will steadily work its way to the base of the slope. The medium to long term effectiveness of the disposal system is at this stage difficult to assess as it depends on the effectiveness of the vegetation to screen out the effluent and the continued careful management of the system as a whole. In order to monitor the effectiveness of the disposal system it would be prudent to install several observation boreholes downstream towards the base of the disposal slope. Periodic testing of these boreholes would enable remedial action to be considered in a timely manner before contaminants reach the paddock drainage systems.

## Recommendations.

- 1). Construct three disposal trenches located on the elevated cut bench.
- 2). Each trench is to comprise "Everglas" disposal units and mushroom head breathers.
- 3). Install a distribution tank with separate feed lines to each trench.
- 4). Establish vegetation at the base of the slope.
- 5). Consider establishing monitoring boreholes.
- 6). Check the ability of the existing pump to pump the additional head to the proposed new distribution tank.
- 7). Consider installing water restriction measures in an effort to reduce the total effluent disposal load. Such measures would include:  
installation of spring loaded taps, restrictions on showers and the use of washing machines.

## APPENDIX

Photographic plates

Location plan Fig 1

Percolation test results P1,P2 & P3

Borehole log BH1

Cross Sections Figures 2,3 & 4

Disposal trench details Fig 5



ACCESS TO 3m WIDE BENCH

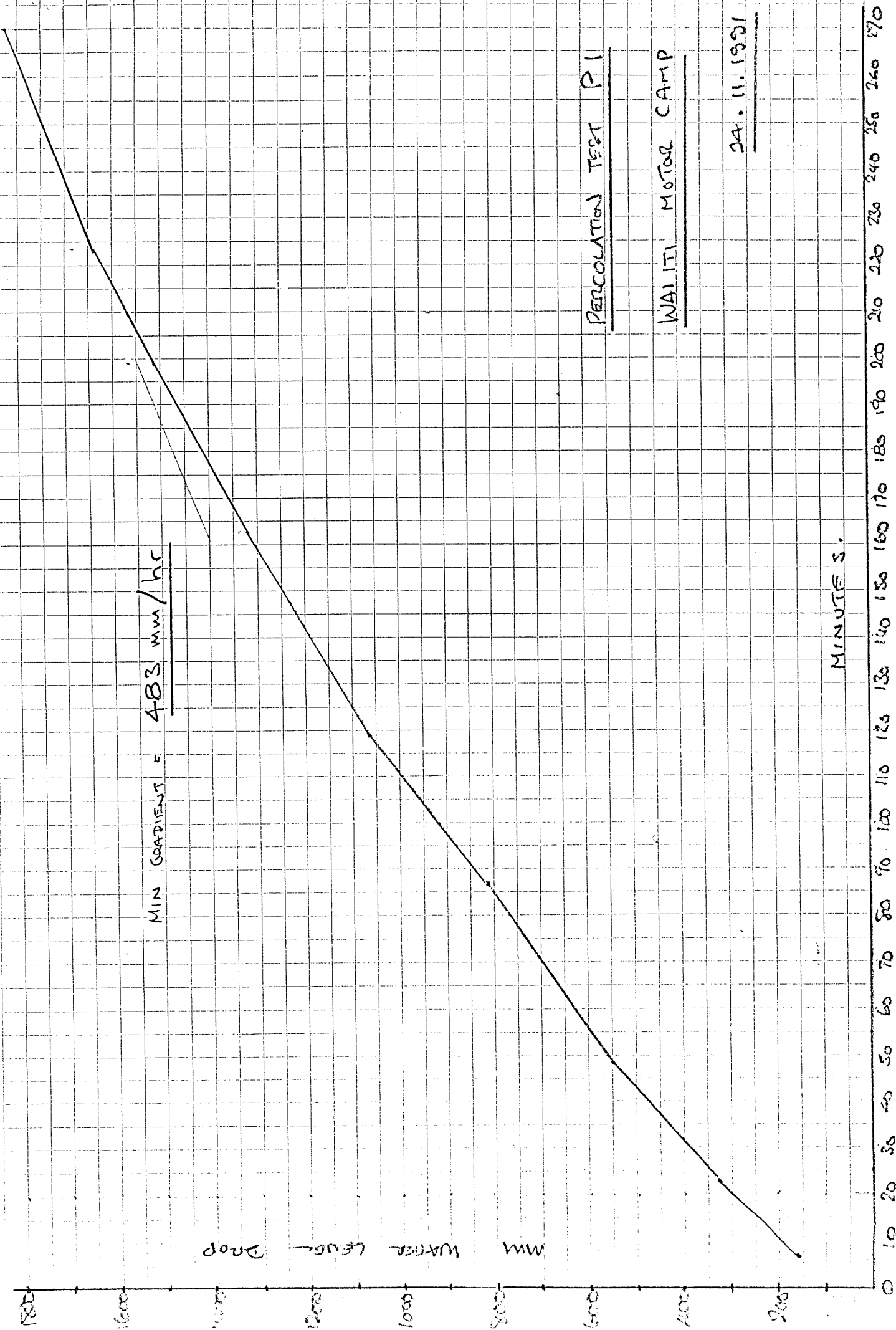
PLATE 1.

WAITI MOTOR CAMP

EXISTING DISPOSAL AT THE BASE OF THE TREE CLAD SLOPE. ACCESS TO PROPOSED NEW DISPOSAL AREA AS MARKED



PLATE 2.  
WAI-ITI MOTOR CAMP  
3 M WIDE BECH,



PERCOLATION TEST P 1

WAIITI MOTOR CAMP

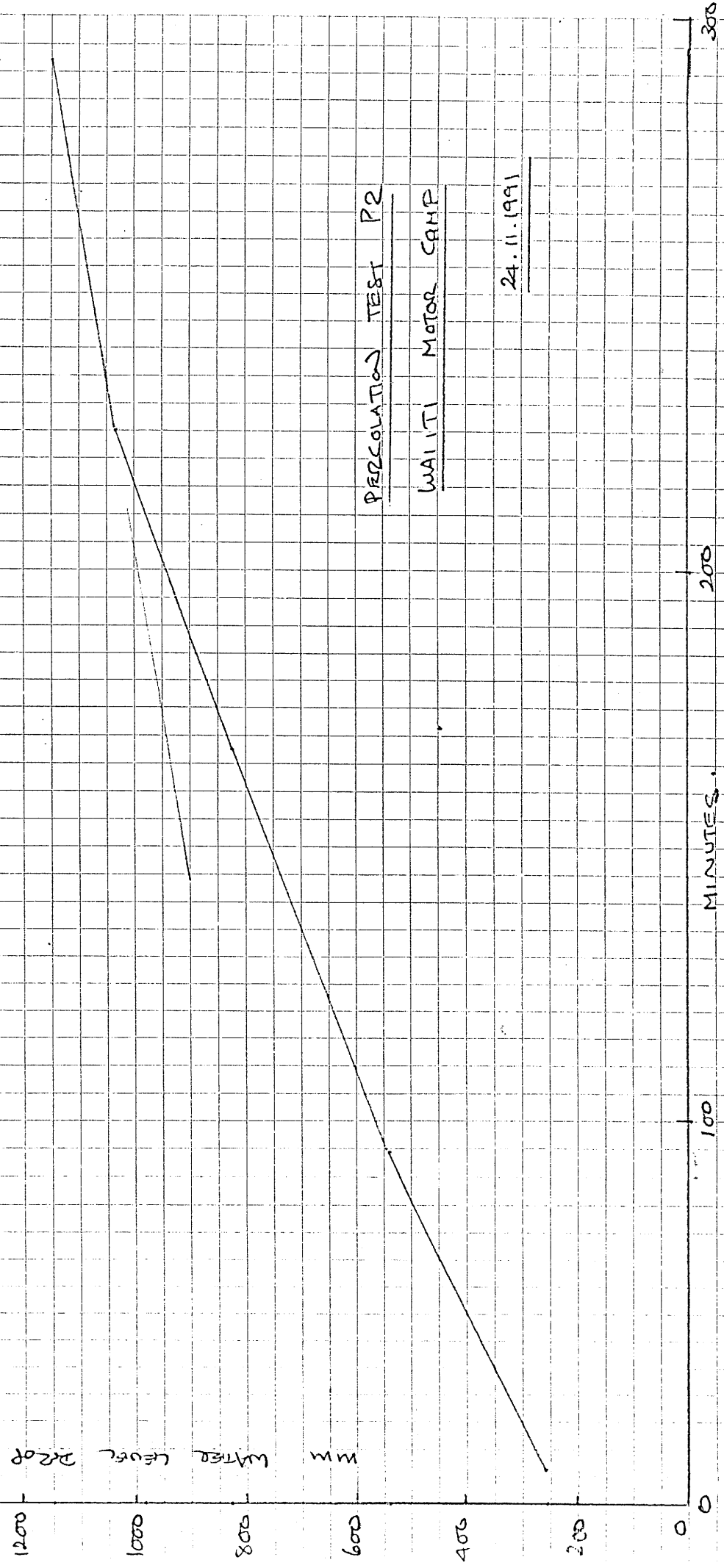
24. 11. 1991

MINUTES.

MM WATER LEVEL DROP

MIN GRADIENT 149 mm/hr

WATER LEVEL (mm)



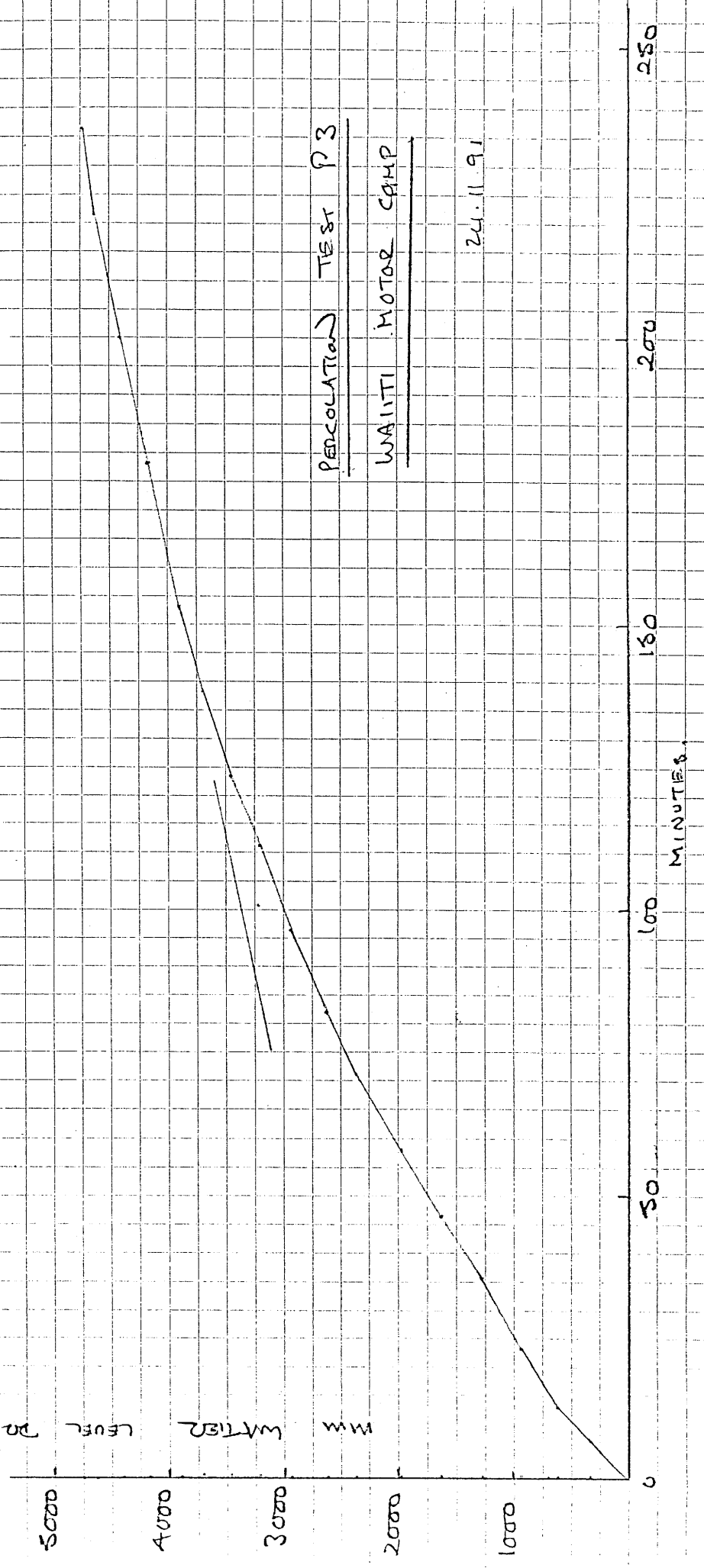
PERCOLATION TEST P2

WALITI MOTOR CAMP

24.11.1991

MIN GRADIENT  
6.35 mm/hr

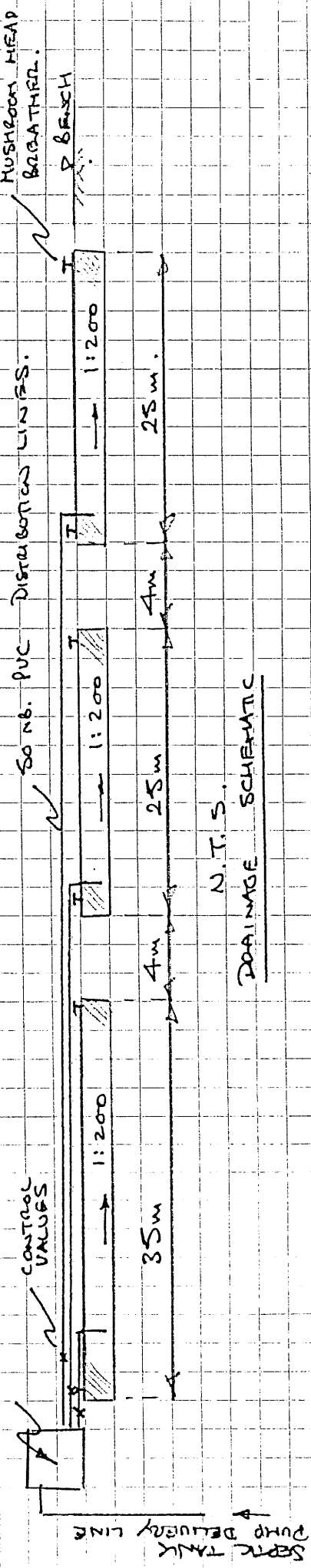
MIN GRADIENT  
6.35 mm/hr





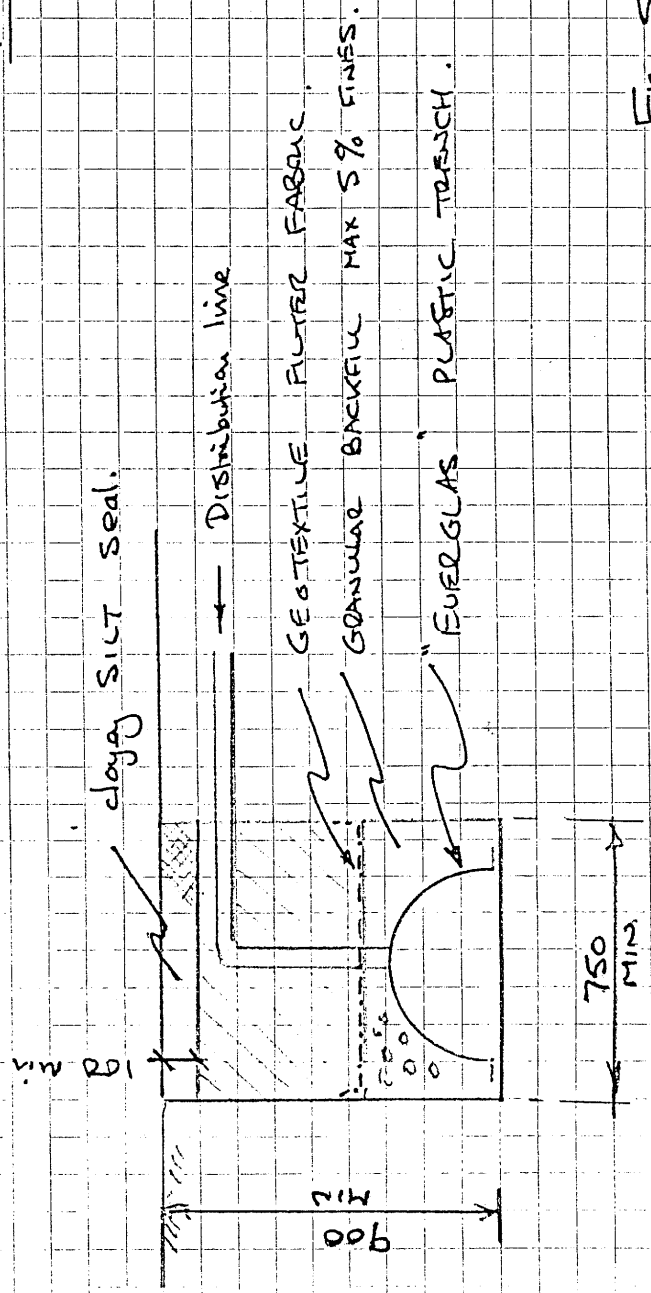


HDPPE 1000 mm DISTRIBUTION TANK



N.T.S.  
DRAINAGE SCHEMATIC

NOTE: MUSHROOM HEAD BREATHERS TO BE LOCATED AT BOTH ENDS OF EACH TRENCH



TRENCH DETAIL

Fig. 5  
DISPOSAL TRENCH CONSTRUCTION DETAILS

# SAFELY UNDERGROUND

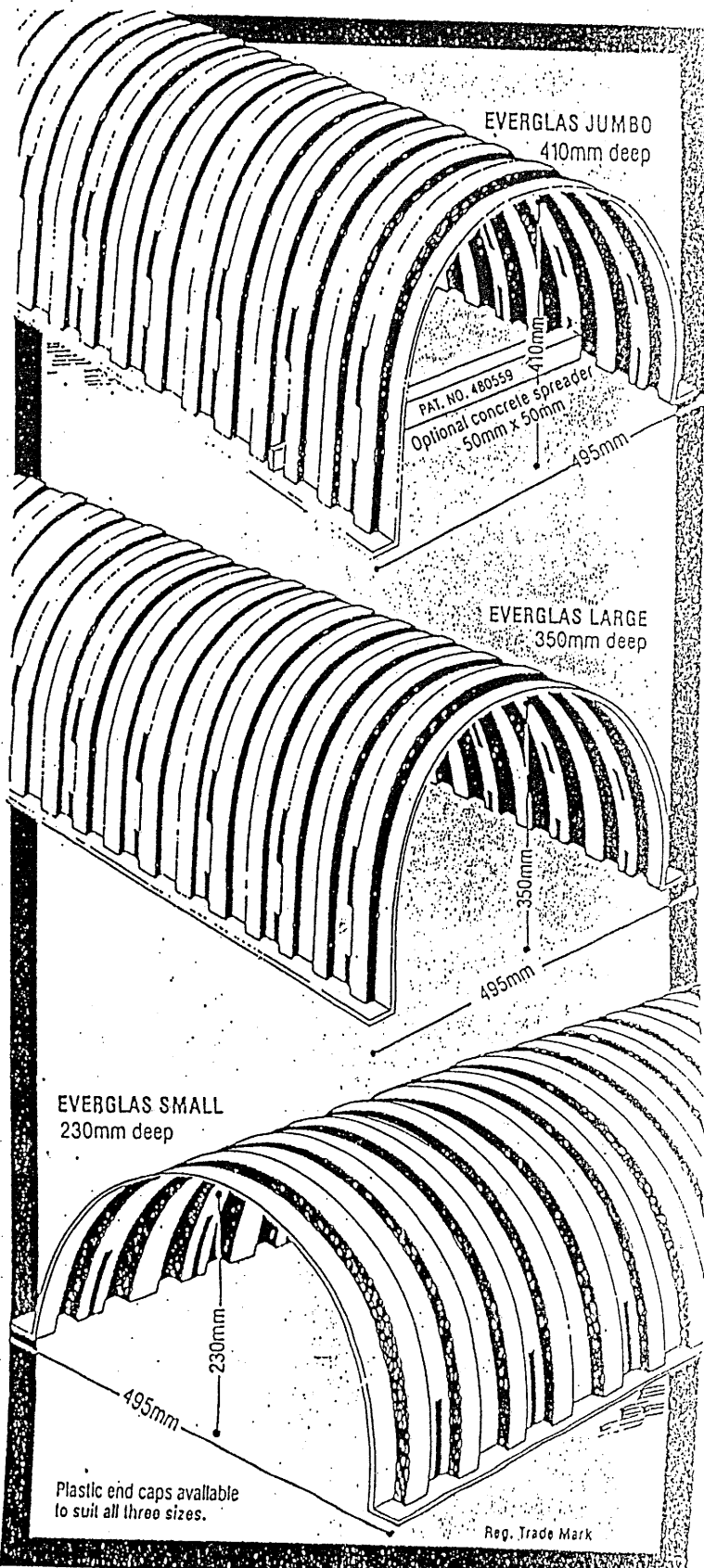
# and protect your family's health

If you are building your new home in an unsewered area here's the best and most economical way to dispose of your waste water from kitchen sink, toilet, shower and laundry tubs, and septic stem.

Bury it! With Everglas Squareline Plastic Trench for underground waste water disposal.

Installation of Everglas is easy, simple and fast. Everglas is injection moulded in premium grade high density polypropylene or polyethylene with U.V. (ultra violet light) stabilisers, giving high strength and long life expectancy for trouble free operation in easy to handle light weight lengths each measuring 1.5 metres. Each length has overlapping joints to prevent soil spilling in.

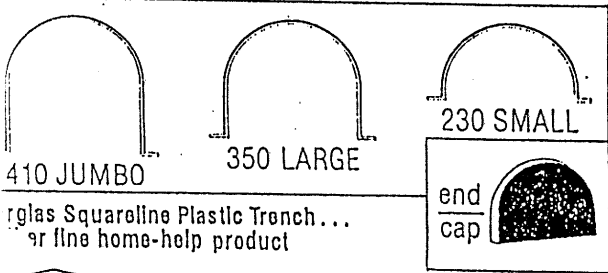
Plastic end caps are available to seal off the ends. Specially designed slots along the sides allow the water to percolate through the surrounding gravel. Install Everglas and you will agree that it's the most time-saving and cost-saving method of soakage trench installation.



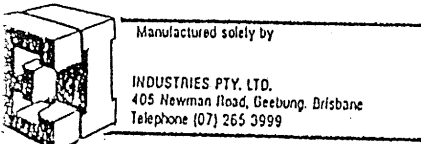
## EVERGLAS SCHEDULE OF SIZES AND CAPACITIES

EVERGLAS TYPE	OVERALL DEPTH mm	LENGTH OF UNIT mm	OVERALL EXT. WIDTH AT BASE mm	AVERAGE INTERNAL WIDTH mm	STORAGE CAPACITY PER LIN. METRE (litres)	WEIGHT OF UNIT kg
SMALL	230	1500	495	455	70	3
LARGE	350	1500	495	455	140	4.15
JUMBO	410	1500	495	455	175	4.75

Dimensions may be subject to minor variations during post-moulding cooling and transport. Plastic end caps available to suit all THREE types.



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- Y: Enterprise St., Molendinar, Southport, 4215. Telephone: (075) 39 3599
- JORE: Maroochyodore Rd. 4558. Telephone: (071) 45 1688
- cos Trading (Agent), 37 Anloino St., Rydalmere, 2116. Telephone: (02) 684 4311
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- 361 Johnston St., Abbotsford, Vic, 3067. Telephone: (03) 419 9044
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- F. Hodgo & Co. (Agent), 65 Brewer St., Perth, 6000. Telephone: (09) 328 6844
- A. WAGGA: Marshall Agencies (Agent),
- Morgan St., Wagga Wagga, 2650. Telephone: (089) 21 5900
- David Davies Pty. Ltd. (Agent), 9 Yalovon St., Fyshwick, 2609. Telephone: (062) 80 4177
- cos Trading (Agent), 198-200 Sturt St., Adelaide, 5000. Telephone: (08) 212 1700

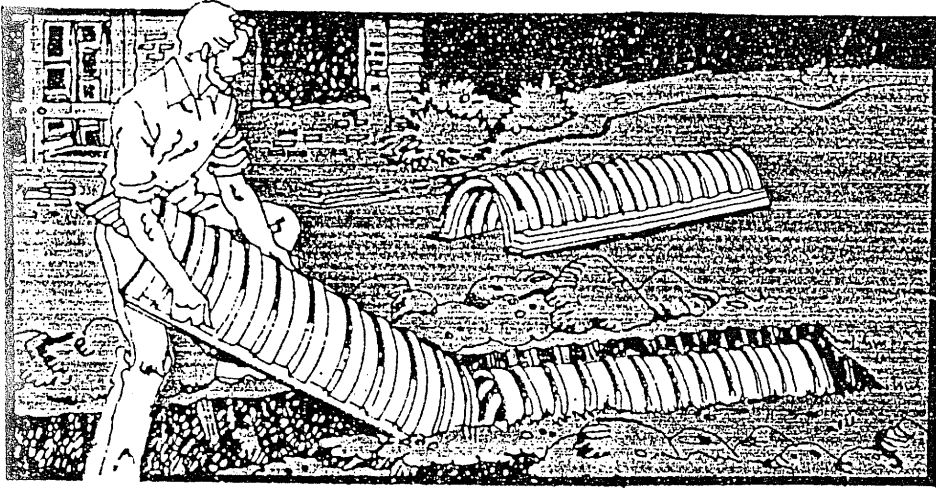
Plastic end caps available to suit all three sizes.

Reg. Trade Mark

William Brooks Queensland

# 7 reasons why your home needs EVERGLAS PLASTIC TRENCH

Reg. Trade Mark



## 1 Stores more water underground.

Everglas has 100% uncluttered capacity allowing it to store more than double the amount of waste water held in traditional trench methods filled with broken bricks or crushed rock.

Everglas stores the water for absorption into the surrounding soil and still has the capacity to take additional amounts of waste water from the drainage system.

Slots along the sides allow percolation to the surrounding aggregate for maximum evapotranspiration.

Slotted P.V.C. pipe is considered inadequate for underground storage.

## 2 Easy-to-handle light weight sections.

Sections 1500mm long permit easy installation by one person.

## 3 Faster installation time.

Place one length in the trench and keep adding lengths, making sure each piece overlaps the one before. It's simple and fast. (Refer methods this page.)

## 4 Structurally strong to withstand soil pressures.

The exclusive squarline profile is specially designed for structural strength.

## 5 Long life operation.

Everglas trenches will work at maximum efficiency over long periods of time when installed correctly in accordance with recommended methods.

## 6 THREE convenient sizes for all types of soil.

The range of sizes has been specially designed to cater for different soil types, depths and for special problems (such as sandy areas).

## 7 Plastic end caps available to seal off ends.

End caps fit neatly over the end of the trench (see diagram).

Everglas is approved and recommended by the Australian Council of Building Inspectors and used by leading drainers throughout Australia. Fully approved by The Joint Committee.

## SIMPLE, FAST, EASY INSTALLATION

Check these three recommended methods. (Consult your Local Health Surveyor for precise requirements.)

All three types of Everglas can be used in any of the three methods. The choice will be governed by:

- Volume of water to be disposed of
- Rate of absorption of surrounding soil
- Required length of trench
- Geographical limitations of the area.

### METHOD 1. For use as sullage/waste water disposal by absorption.

1. Excavate the trench in the ground to the required length, width and depth, sited on a level contour with the bottom of the trench level along its entire length. Avoid any low spots as extra load will be placed at these points.

2. Place the lengths of Everglas into position in the trench, starting at one end and overlapping each end profile. Pay special attention to the position of the inlet pipe.

3. Patented spreaders (Pat. 480559) are recommended for extra structural support for 350mm and 410mm types.

4. Fit the end caps, and backfill both sides to the top of the Everglas with 45mm crushed aggregate or gravel.

5. Complete the back-filling with at least 100mm cover of approved sandy loam top dressing. Cover with turf if desired.

### METHOD 2. For use as septic tank effluent disposal by absorption.

Follow steps 1 to 5 as for method 1 above.

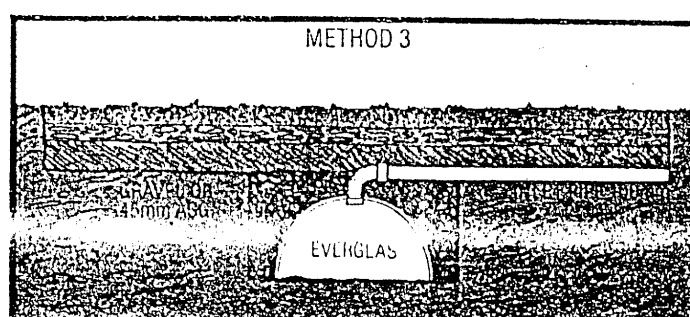
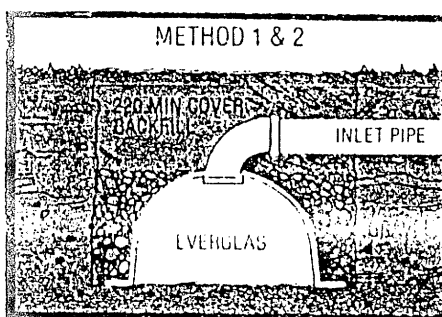
Special note. The depth of the trench is determined by depth below ground line of the septic tank outlet pipe and the contour of the ground.

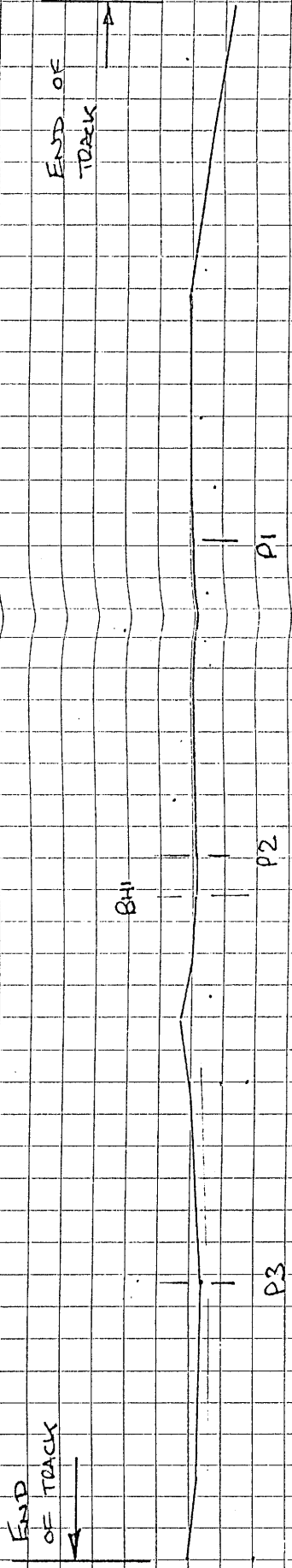
### METHOD 3. For use as sullage/waste water disposal by combined absorption and evapotranspiration.

Follow steps 1 to 4 as for method 1.

Special note. When preparing the trench, excavate evaporation caps 600mm wide each side x 300mm deep (as per diagram)

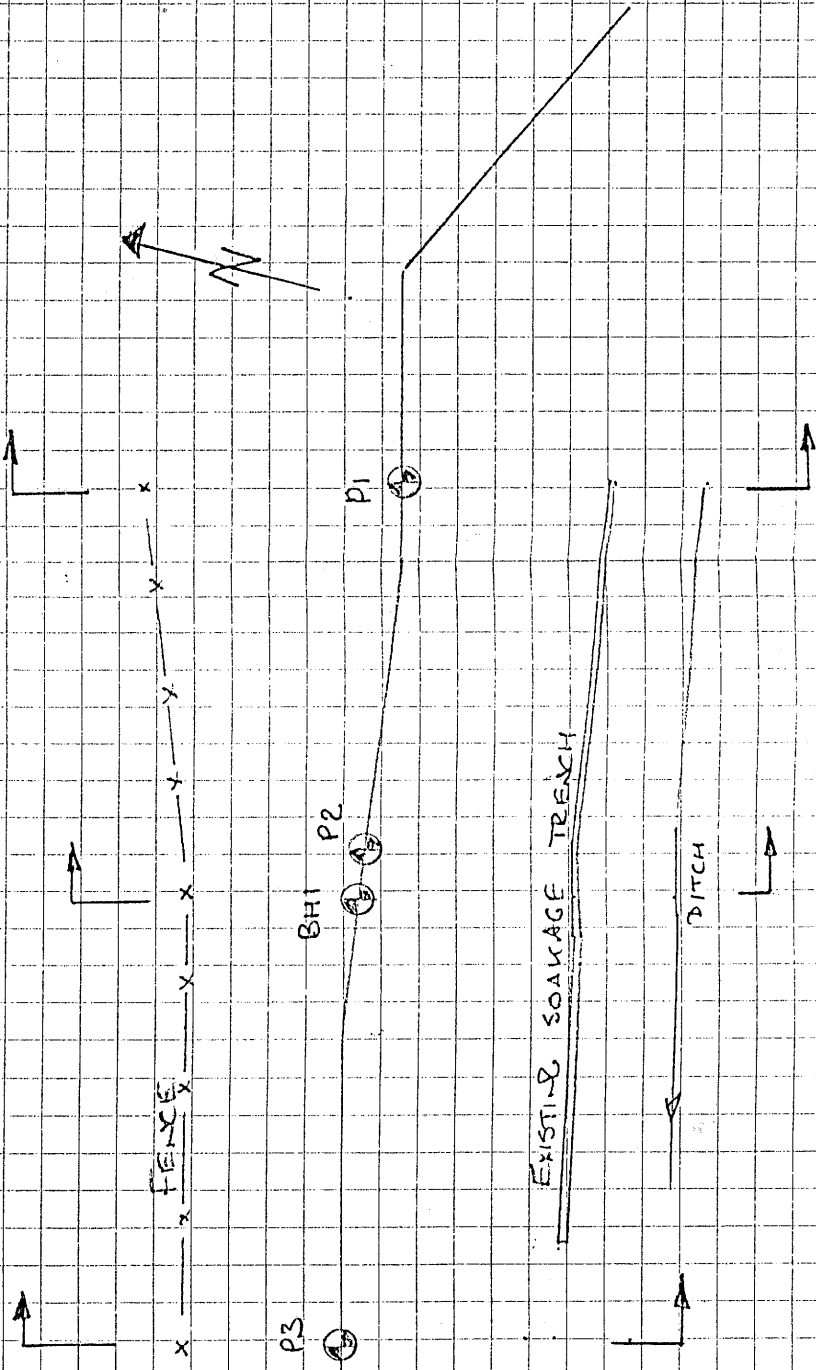
5. Backfill the caps with layer of 10mm gravel covered with multigrade sand and top with approved sandy loam.





LONG SECTION

Scale 1:500



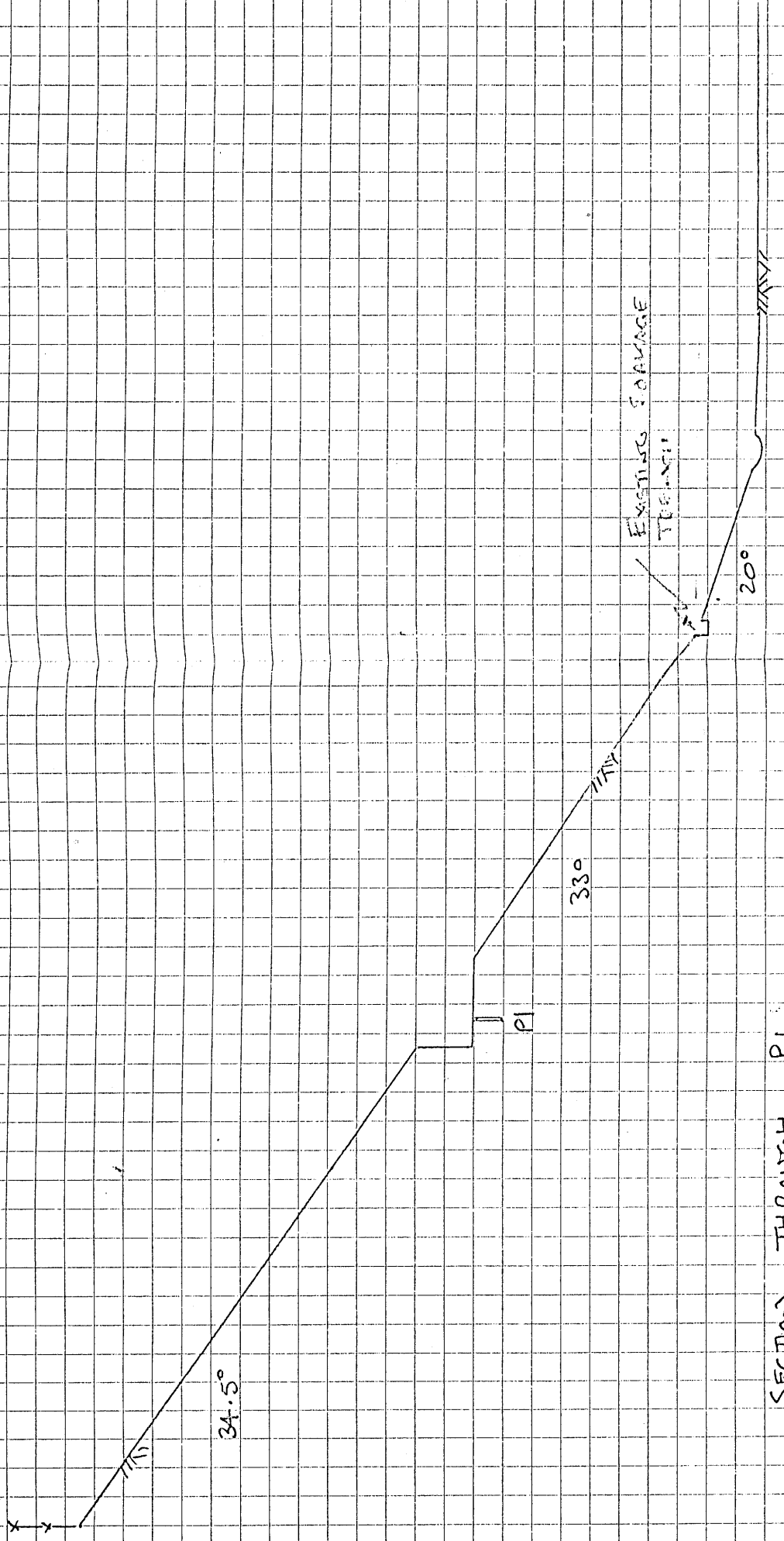
PLAN

Scale 1:500

Figure 1

WAIITI MOTOR CAMP

2A.11.1551



SECTION THROUGH P1

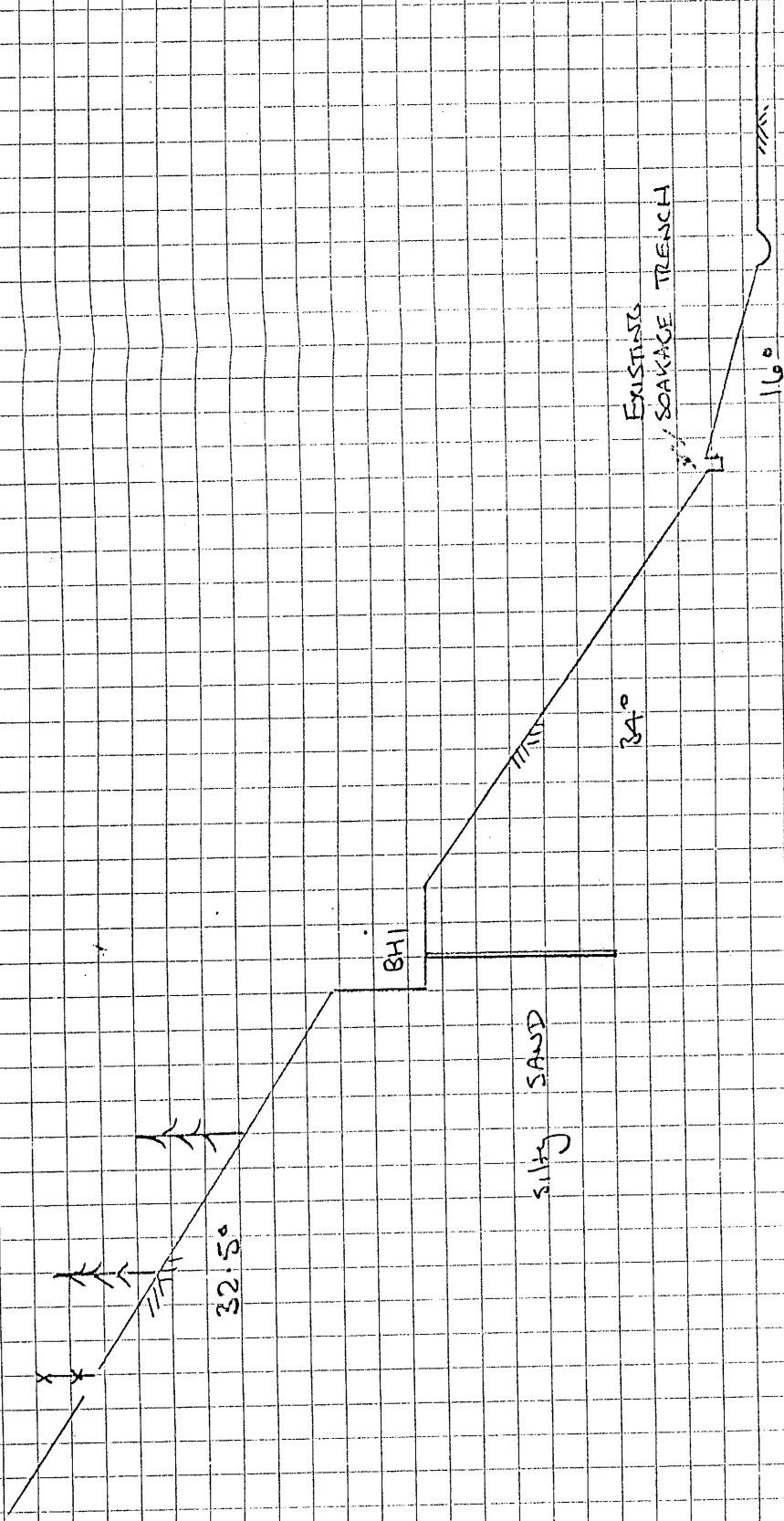
Scale 1:200

FIG 2

WALITI MOTOR CAMP

24.11.1991





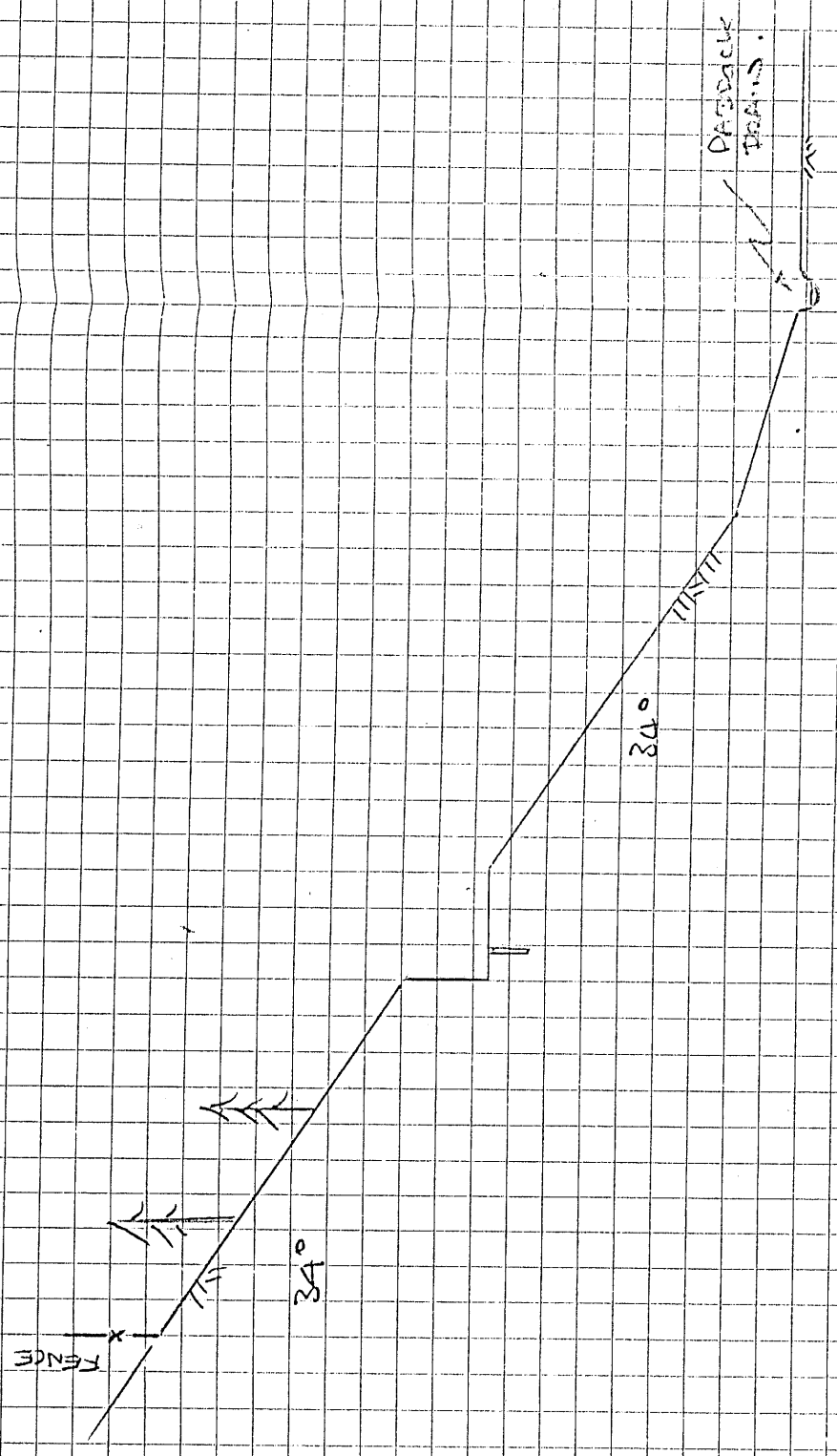
SECTION THROUGH BH1 & P2

Scale 1:200

Fig 3

WALITI MOTOR CAMP

24.11.1991



SECTION THROUGH P3

Scale 1:200

Fig 4  
WAITI MOTOR CAMP

29.11.1951

**Appendix II: ESR Report on Faecal Source Tracking Analysis  
(Document number 1687234)**



20<sup>th</sup> April 2016

**To:** Taranaki Regional Council  
Private Bag 713  
STRATFORD 4352

Email: [thomas.mcelroy@trc.govt.nz](mailto:thomas.mcelroy@trc.govt.nz)

**From:** Dr Brent Gilpin  
ESR Christchurch Science Centre  
PO Box 29181  
CHRISTCHURCH

## REPORT ON FAECAL SOURCE TRACKING ANALYSIS

The following samples were received on 2nd April 2016. After evaluation of *E. coli* and Enterococci results the Wai-iti Stream samples were selected for analysis by faecal source PCR markers.

ESR Number	Date Sampled	Site Description	<i>E.coli</i> cfu/100mL	Enterococci cfu/100mL
CMB160520	1/4/16 10:30	Sample 1 'ONR000450'	77	100
CMB160521	1/4/16 10:45	Sample 2 'ONR mid site'	130	180
CMB160522	1/4/16 11:05	Sample 3 'ONR000470'	69	210
CMB160523	1/4/16 11:55	Sample 4 'WIT000490'	670	2,300
CMB160524	1/4/16 12:10	Sample 5 'WIT000460'	730	2,700
CMB160525	1/4/16 12:55	Sample 6 'WIT000420'	800	2,900
CMB160526	1/4/16 13:10	Sample 7 'WIT trench/trib'	1,300	8,300

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### Results of PCR Marker Analysis:

ESR Number	Date Sampled	Site Description	<i>E. coli</i> (MPN/100mL)	General Bac	Human BacH	Human BiADO	Ruminant BacR	Avian GFD
CMB160523	1/4/16 11:55	Sample 4 'WIT000490'	670	very strong positive	present	ND	present 1%	present
CMB160524	1/4/16 12:10	Sample 5 'WIT000460'	730	very strong positive	present	ND	present, 1 - 10%	ND
CMB160525	1/4/16 12:55	Sample 6 'WIT000420'	800	very strong positive	present	ND	present, 1 - 10%	present
CMB160526	1/4/16 13:10	Sample 7 'WIT trnch/trib'	1,300	positive	present	present	ND	ND

Abbreviations: NA = sample was not analysed for this determinant.

ND = sample was analysed, but the determinant was not detected.

### Comments

Very low levels of ruminant markers were detected in Samples 4, 5 and 6, with the lowest levels detected at the mouth of the stream. The levels present are not consistent with a fresh ruminant source of the *E. coli*.

Avian markers were detected in samples 4 and 6.

No ruminant markers or avian markers were detected in sample 7. However both human indicative markers were detected suggesting a human source of faecal matter in this sample.

Both the BacH and BiADO human markers were detected in sample 7 – this is a strong indicator of a human source in this sample. The other three samples (4, 5 and 6) had only the BacH human marker present, with no Human BiADO. There are two possible explanations for this:

- BacH tends to be more sensitive than BiADO, and may persist longer in aged faecal material. Therefore, detection of only the BacH marker may be indicative of aged or lower levels of human faecal contamination.
- The BacH marker has some cross-reaction with other species, namely possums, rabbits, goats, cats and dogs which could result in weak signals being detected.

**Notes:**

Brief details of the methods of analysis are available on request.

These results relate to samples as received.

This report may not be reproduced except in full.



Paula Scholes  
Laboratory Operations Coordinator



Beth Robson  
Senior Technician

## APPENDIX: Assay Interpretation Guidance Notes

### PCR Marker interpretation notes

- Each marker is strongly associated with, but not exclusive to the source tested for. They each have some degree of non-specificity. The detection limit of these methods is 1.00E+03, or 1.00x10<sup>3</sup>.
- Both Human markers are required to be present for a positive human result.
- Ruminant specific markers are reported using a percentage value based on levels of this marker relative to the general indicator in fresh ruminant faeces.
  - Samples reported as 50-100% ruminant are consistent with all of the general faecal marker having come from a ruminant source.
  - The lower levels reported (10-50%) may be a consequence of the presence of other sources of pollution, or in fact ruminant sources may still account for all the pollution, but this may include aged faecal material where relative levels of the ruminant marker decline more rapidly than the general indicator.
  - Levels less than 10% ruminant suggest a very minor contribution from ruminant sources.

### FWA interpretation notes

The analysis of FWAs in septic tank and community wastewater consistently identifies levels between 10 and 70 µg/L. In previous analysis of water samples levels of FWA greater than 0.1 µg/L suggest human sewage, with levels greater than 0.2 µg/L strongly indicative of human sewage. Levels greater than 0.1 µg/L correlate well with other indicators of human pollution and indicate a local or recent source of pollution. FWAs degrade under sunlight exposure and will undergo dilution. Levels lower than 0.1 µg/L may be indicative of dilute or distant sources of human pollution.

Reference: Devane M., Saunders D. and Gilpin B. (2006). Faecal sterols and fluorescent whiteners as indicators of the source of faecal contamination. *Chemistry in New Zealand* 70(3), 74-7.

[http://www.nzic.org.nz/CiNZ/articles/Devane\\_70\\_3.pdf](http://www.nzic.org.nz/CiNZ/articles/Devane_70_3.pdf)

**Faecal sterol Interpretation Notes:**

Faecal sterol ratios must be interpreted with consideration to the levels of sterols, and relative to one another. For example H1 is typically also above 5-6% in ruminant faeces. Human and ruminant sources generally require at least two of three ratios to reach thresholds. Plant sterols and mixed sources also have differing effects on sterol interpretations which must be considered.

**Conclusions** are the best interpretation of sterols in our opinion. Conclusions in **bold** are highly supported by the sterol data, conclusions in brackets are supported by sterol data with some variation from a pure source, or with a lower degree of certainty.

**Ratio Key:***Ratios indicative of faecal pollution (either human or animal)*

F1	coprostanol/cholestanol..	>0.5 indicative of faecal source of sterols
F2	24ethylcoprostanol/ 24-ethylcholestanol.	>0.5 indicative of faecal source of sterols.

*Human indicative ratios (values exceeding threshold in red)*

H3	coprostanol/ 24-ethylcoprostanol	Ratio >1 suggests human source
H1	% coprostanol	Ratio >5-6% suggests human source
H2	coprostanol/(coprostanol+cholestanol)	Ratio >0.7 suggests human source
H4	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio >0.75 suggests human source

*Ruminant indicative ratios (values exceeding threshold in blue)*

R3	24-ethylcholesterol/24-ethylcoprostanol	Ratio <1 suggests ruminant source, ratio >4 suggests plant decay
R1	% 24-ethylcoprostanol	Ratio >5-6% suggests ruminant source
R2	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio <30% suggests ruminant source

*Avian indicative ratios (values exceeding threshold in yellow)*

A1	24-ethylcholestanol/(24-ethylcholestanol+24-ethylcoprostanol+24-ethylepicoprostanol)	A1 Ratio >0.4 suggests avian source AND
A2	cholestanol/(cholestanol+coprostanol+epicoprostanol)	A2 Ratio >0.5 suggests avian source