Sourcing pollution at Paekakariki

Wainui Stream Study

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INTRODUCTION

The Wainui Stream flows through the Queen Elizabeth Park (QEP) and along the banks of the Caravan Holiday Park in Paekakariki. It is popular with children of all ages who can be seen playing, wading and occasionally swimming at many sites along the stream (figure 1).

However, Wainui Stream water quality is not monitored routinely by the Greater Wellington Regional Council (GWRC) because it is not regarded as a river swimming spot (http://www.gw.govt.nz/summer-check/).

In February 2013, when Environmental Health students from Massey University collected and analysed five water samples from sites below the QEP road bridge in February 2013, for compliance testing with the New Zealand Microbiological Water Quality Guidelines for Freshwater Recreational Areas (MfE / MOH 2003). Surprisingly, extremely high levels of Escherichia coli (E.coli) counts were found. Subsequent analyses of 17 more samples taken from sites along the entire stream two days later showed that the water quality at all the sites breached the action red mode of the guidelines of greater than 550 E. coli per 100 ml. The stream was not therefore suitable for recreational activities as counts above 550 E.coli per 100 ml pose an unacceptable health risk from contact recreation.

We informed the Environmental Health Officers at the Kapiti Coast District Council (KCDC) who responded immediately by erecting temporary health warning signs. Regular health warning alerts were also published in the news media, as well as on KCDC's website.

Despite KCDC staff walking the entire length of the Wainui Stream, a definitive source of pollution could not be found (Haxton 2013). The probable causes were thought to be low rainfall, high temperatures that resulted in low flows in the stream, plus agricultural runoff from further upstream. Although the GWRC removed all the rotting logs and other debris which impeded flows from the stream, our March 2013 testing at many sites along the Wainui Stream showed that the extremely high bacterial levels persisted and that these were even higher (many sites above 2,419 E. coli per 100 ml) after heavy rainfall (Table 1).

Figure 1: Wainui stream is popular with children.

	1/03/2013	5/03/2013	19/03/2013
	Rainfall (0.0 mm)	Rainfall (0.0 mm)	Rainfall (65.0 mm)
Site	*E.coli* (per 100ml)	*E.coli* (per 100ml)	*E.coli* (per 100ml)
Site 1A	> 2419.6	> 2419.6	> 2419.6
Site 1B	> 2419.6	> 2419.6	> 2419.6
Site 1	> 2419.6	1732.9	> 2419.6
Site 2	> 2419.6		> 2419.6
Site 3	1553.1		
Site 4	1553.1	1986.3	> 2419.6
Site 5	1986.3	1986.3	> 2419.6
Site 6	1553.6		> 2419.6
Site 6A	1553.6	1413.6	
Site 7	689.3	1046.2	> 2419.6
Site 8	1046.2	1229.7	
Site 9	920.8	1413.6	> 2419.6
Site 10	816.4	1046.2	> 2419.6
Site 10A	1119.9		
Site 10B	1299.7	816.4	
Site 11	1203.3	980.4	> 2419.6
Site 12	1299.7	920.8	

Table 1: March 2013 Wainui Stream sample results

In this article, we present the results of an extensive two-year water quality monitoring study of Wainui Stream and its tributaries in order to establish the dominant faecal pollution sources of the stream.

WAINUI STREAM CATCHMENT

The Wainui Stream catchment lies to the north of the Paekakariki township and drains the coastal hills on the southern side of the Tararua Ranges. The Te Puka Stream (Smith Creek) is the only major tributary of the Wainui Stream. Depending on rainfall the flow rates and depths of the Wainui Stream can vary considerably at sampling locations – usually from as little as 20 cm to as much 160 cm in places (Figure 2). Towards the lower end of the Wainui Stream in QEP debris and logs often impede the flow of the stream.

Two large KCDC storm water pipes, from Haumia Street and

Figure 2

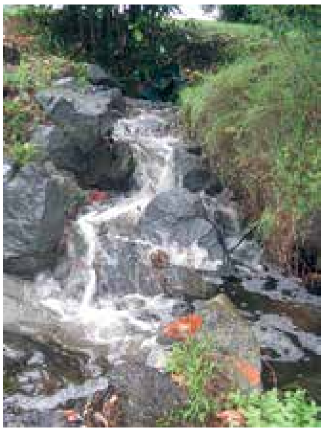

Figure 3

Figure 4: Most frequently sampled stream sites.

Horomona Road, run under the Caravan Holiday Park. These drain urban rainfall runoff from impervious road surfaces into the Wainui Stream in the caravan park (Figure 3). There are also two 100mm PVC pipes that drain stormwater from the roads, car parks, and roofs of buildings in the caravan park into the stream. Kerb-side stormwater drains on the road at the entrance to the caravan park drain storm water to the stream via soak pits.

SAMPLING

From February 2013 to January 2015, we collected and tested 317 water samples from 51 different sites along the entire length of the Wainui and Te Puka streams including stream samples taken in farm land above and below SH1. Upstream and downstream stormwater samples of the four outlets discharging into the Wainui Stream at the Caravan Holiday Park were also collected and rainfall depth (mm), 24 hours prior to and at the time of each sampling event was recorded (http://www.weatheronline.co.nz). Some of the most frequently sampled stream sites are shown in figure 4.

Samples were collected aseptically in daylight hours in sterile 250 ml plastic bottles using the Mighty Gripper bottle clamp (Bolton, Whangarei) at approximately 15-30cm below the surface. All samples were placed in a chilly bin containing ice and transported to the laboratory and processed within six hours of sampling. The samples were analysed for *Total coliforms* and *E.coli* using the Colilert™ / 97 Well Quanti-tray system (IDEXX Laboratories, USA). After 24 hours incubation the number *E.coli* per 100 ml, based on the number of positive wells counted, was determined by referring to a 97-well MPN table. As an MPN value for 97 positive wells is > 2419.6 *E.coli* per 100 ml (95 per cent confidence limits are 1439.5 to infinity), for data analysis each > 2419.6 result was recorded as 2500 *E.coli* per 100 ml. Results were compared with the NZ Microbiological Water Quality Guidelines for Freshwater Recreational Areas (MfE / MOH 2003) to determine compliance and which stream sites breached the guidelines (Table 2).

Mode	E.coli per 100 ml	Required management response
Green surveillance	Single sample < 260	Routine monitoring
Amber alert	Single sample 260 - 550	Increase monitoring Identify sources of contamination Conduct health risk assessment
Action red	Single > 550	Public health warnings Increase monitoring Identify sources of contamination Conduct health risk assessment

Table 2: MfE/MOH (2003): Surveillance, alert and action levels for fresh waters.

RESULTS

From 27 February to 21 August 2013, 98 per cent of samples exceeded the MfE/MoH (2003) action red mode. The exceedances occurred in samples taken along the entire length of the Te Puka and Wainui Streams. Of these samples, 36 per cent yielded counts of greater than 2419.6 E.coli per 100 ml and 38 per cent of samples results were above 1553.1 E.coli per 100 ml. These E.coli counts ranged from 689.3 to > 2419.6 with a median of 1732.9. The results of the most frequently taken samples in 2013 are shown in figure 5. Significantly, all the very high E.coli bacterial levels were found at same time that cattle, sheep and horses grazing in the two paddocks had access to unfenced Wainui and Te Puka streams in the farm land (Figure 6).

From 18 September to 22 December 2013 only 23 per cent of samples exceeded the MfE/MoH (2003) action red mode. However, 27 per cent of samples exceeded the amber alert mode and 50 per cent of samples complied with the green (acceptable) surveillance mode. These E.coli counts ranged from 62.8 to 1553.1 with a median of 435.5. Most of the non-compliant samples were from stormwater discharge sites and downstream of these (below the road bridge in QEP) that were low flow and sites that were colonised by ducks.

From 27 January to 14 December 2014, 74 per cent of samples complied with the green (acceptable) surveillance mode, 15 per cent exceeded the amber alert mode while only 11 per cent exceeded the action red mode. These E.coli counts ranged from 10.1 to >2419.6 with a median of 203.6. The results of the most frequently taken samples in 2014 are shown in figure 7. These 2014 results also revealed that stormwater discharges and ducks were responsible for most of the non-compliant results. For example, the December 2014 wet-weather counts ranged from 344.8 to > 2,419 E. coli per 100 with a median of 691.6 (13 samples above the action red mode of

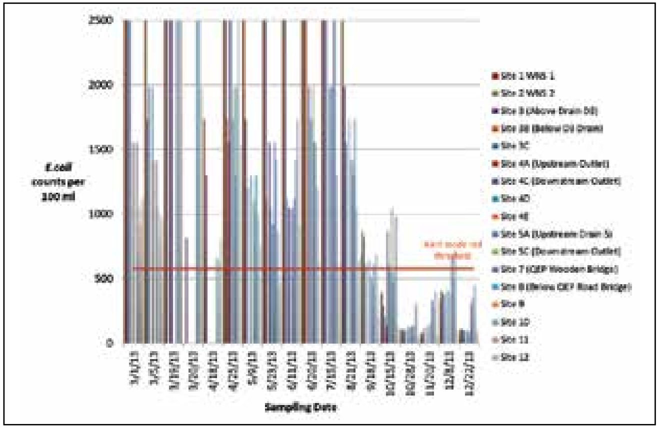

Figure 5: Wainui Stream sample results (2013).

Figure 6: Stock near the unfenced stream.

> 550 E.coli per 100 ml Mode). Wainui Stream stormwater outlet discharge sample results for 2013 and 2014 are shown in figure 8.

CONCLUSIONS

The results of this two-year water quality monitoring study clearly show that the massive faecal pollution of the Wainui Stream was caused by non-point pollution:

- Primarily from agricultural run-off when livestock had unrestricted to unfenced streams in the farm-land;
- Diffuse and non-diffuse storm water run-off sources, especially after heavy rainfall; and
- Direct deposition of water fowl faeces.

Livestock were excluded from the farm-land at the end of August 2013 and our results strongly suggest that the dominant faecal pollution sources were from agricultural runoff, exacerbated by heavy rainfall especially when cattle, sheep and horses were in those paddocks. These results are in keeping with the faecal source tracking (DNA profiles) sample analyses commissioned by the GWRC (Personal communication Summer Greenfield, – GWRC, 4 April 2013). These samples

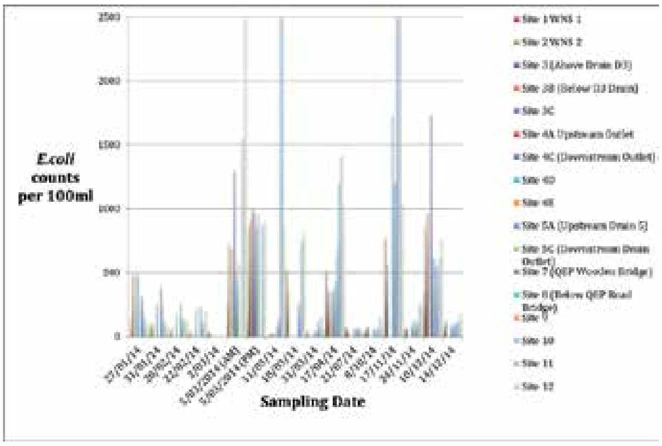

Figure 7: Wainui Stream sample results (2014)

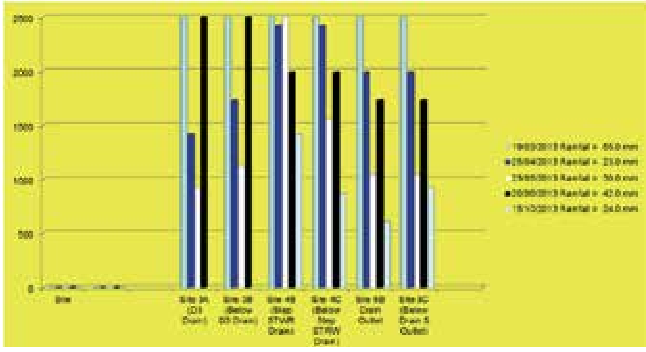

Figure 8: Wainui Stream water quality at three stormwater outlet sites (2013)

for DNA analysis were taken upstream of the Haumia Street storm water outlet and showed that the dominant faecal pollution sources were ruminant and that there was no evidence of human faecal pollution. This outcome highlights the effectiveness of using faecal source tracking methods to assist in confirming contamination sources of waterways in which high concentrations of faecal indicator bacteria are found (Kirs et. al 2011)

In October 2014, prior to restocking the farmland, all the paddocks bordering Te Puka and Wainui streams below the highway were fenced off. Excluding stock from a water body can improve water quality, improving its suitability for recreation, harvesting food, and as a habitat for fish. The Government proposes to regulate to exclude dairy cattle on milking platforms from water bodies by 1 July 2017. This will be extended to land used for dairy support, beef cattle and deer at a later date (MfE 2016). The dairy industry has made progress in voluntarily keeping stock out of water bodies. The Sustainable Dairying Water Accord has resulted in over 24,000 kilometres of fencing to keep dairy cattle on milking platforms out of more than 94 per cent of streams over one metre wide and 30cm deep (Scarsbrook and Melland 2015).

While stormwater outlets discharge directly into Wainui Stream during heavy rainfall events, we have found no evidence of any malfunctioning or poorly sited septic tanks in the Paekakariki Holiday Park that could have affected the water quality of the stream. Similarly, we have also found no evidence of any septic tank pollution emanating from nearby houses.

Regardless of the apparent "improved" overall water quality of the Wainui Stream, we doubt whether the stream is (even now) entirely safe for recreational use. That's because

Site	Value	E.coli (per 100 ml)
Upstream from outlet	Median Range	1050 120 - 93000
Haumia street outlet	Median Range	5150 220 - 56000
Downstream from outlet	Median Range	2700 100 - 80000

Table 3: KCDC Haumia Street storm water outlet water quality results

we have found that stream water quality will always fluctuate due to the following.

- Heavy rainfall events discharging contaminated storm water run-off into the stream.
- Persistent low flows at some sites because of the build-up of debris, vegetation and logs impeding stream water flows.
- Possible faecal pollution from agricultural runoff from animals that may gain access to any unfenced streams higher up in the farmlands or animals breaching the recently fenced off streams in farmland below the highway.
- Duck faecal pollution, especially at sites below the road bridge in QEP. A freshwater microbiology research project involving 25 sites in New Zealand found that catchments with waterfowl were the most contaminated across nearly all micro-organisms surveyed and that the critical value for E. coli as an indicator of increased Campylobacter infection was in the range of 200-500 E. coli per 100 ml (McBride et al. 2002). Using data from all sites, these authors estimated that four per cent of notified campylobacteriosis in New Zealand could be attributable to recreational water contact.

DISCUSSION

Previous GWRC monitoring results indicate that there is significant microbiological stormwater contamination present in many urban streams (GWRC 2005).

The purpose of most existing stormwater systems is to collect stormwater and discharge it quickly to natural water bodies. Apart from a sump, there is usually no treatment of stormwater before it is discharged. The effectiveness of sumps is directly related to their design and maintenance regime and even then their efficiency is limited during heavy rainfall events (GWRC 2005). The KCDC's Haumia Street stormwater discharge water quality results for 2006 to 2013 (54 samples) are summarised in table 3 (KCDC 2014).

The risk of gastrointestinal illness following incidental recreational water contact can be reduced by efforts to decrease exposure such as public education about the hazards of capsizing and swallowing water and promoting frequent hand washing (Dorevitch et. al 2015). A recent health impact assessment of urban waterway decisions demonstrated that the impacts of water quality on health are often modified by users' behaviours and perceptions (Korfmacher et. al 2015).

A study of waterborne pathogens and associated health risks associated with exposure in urban waterways found that while E. coli concentrations were variable, high concentrations of Campylobacter were found that revealed risks above the annual disease incidence of campylobacteriosis in The Netherlands (Sales-Ortells et. al 2015). Recommended measures to reduce the gastrointestinal health risks included informing the public that waterways may have elevated levels of contamination after rainfall events and water contact should be avoided.

Given that the QEP and the Paekakariki Caravan Holiday Park is so hugely popular with families – especially in the summer – vigorous efforts to prevent the public from acquiring waterborne infections from the Wainui Stream during recreational activities that could involve water immersion and ingestion are appropriate. To this end we are happy to report that KCDC have now erected public health warning signs about stream contact after heavy rainfall.

In New Zealand, the National Policy Statement for Freshwater Management (NPS–FM) requires all regional councils to set limits for water quality in all waterways by 2025 (New Zealand Government (2014). For each identified value, specific water quality attributes must be set (e.g. for *E. coli* levels that indicate suitability for contact recreation) and every regional council must ensure that the values are set at or above the national bottom lines. Given that high concentrations *E.coli* that continue to occur in the Wainui Stream from storm water outlet discharges after heavy rainfall, it remains problematic if the GWRC will consider it appropriate to set values for the Wainui Stream below the national bottom line because the annual median is already below the national bottom line. The Paekakariki community, interest groups and environmental scientists alike await with expectation what this will mean for fresh water quality on the Kapiti Coast and potentially beyond in the wider region.

For a copy of the full report on this study (including all relevant references) contact Stan Abbott.

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- *Dedication: This article is dedicated to the memory of Margaret McNeill, who passed away recently, during the preparation of this article for publication. Margaret's co-authors wish to acknowledge her high standards of professionalism and commitment in her role as a Senior Technician at Massey University and in providing technical support for the investigations described in this article.*

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