Te Puke WWTP - AEE Assessment
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Water Quality, Stream and Terrestrial Ecology Assessment

Te Puke Wastewater Treatment Plant Resource Consent Renewal

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Client: Western Bay of Plenty District Council

ABN: N/A

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Quality Information

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Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	19/08/15	Draft for Internal Discussion	Justine Bennett Technical Practice Leader	pp
B	31/08/2015	Draft for Client Review	Justine Bennett Technical Practice Leader	pp
C	16/10/2015	Final	Bob Shaw Associate Director - Water	

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1.0 Introduction

1.1 Background

Western Bay of Plenty District Council (WBOPDC) has identified the need to upgrade the existing Te Puke Wastewater Treatment Plant (WWTP), and in response to predicted growth in the region of 30% by 2045 propose to increase the discharge of treated wastewater. The current resource consents for the discharge of treated wastewater from the Te Puke WWTP expire in November 2016. In support of the preparation of the Assessment of Environmental Effects (AEE) for the new resource consent application, it is necessary to determine the baseline water quality and undertake an effects assessment of the receiving environment for the proposed increase in treated wastewater discharges. AECOM has been engaged to undertake this assessment.

The WWTP location is presented in Figure 1 in the Te Puke WWTP Consent Renewals Report. The WWTP discharges treated wastewater to a constructed wetland, immediately to the southeast of the WWTP. Wastewater flows through this wetland and is discharged through 5 outlet weirs to the narrow riparian margin of the Waiari Stream; at this point overland flow of the treated wastewater enters the stream.

The wetland is intended to provide water quality polishing to treated wastewater, prior to its discharge to the stream, with a variety of wetland plants established within the contained wetland. It is understood that the wetland is un-lined and has been constructed below the local groundwater table. Inflowing wastewater migrates through the wetland both at the surface and through the root zone of the plants. Given the inferred higher levels of treated wastewater within the wetland relative to the surrounding groundwater levels, it is expected that a component of the treated wastewater discharges to ground and groundwater.

The Waiari Stream, at the wetland discharge location, is predominantly influenced by a highly modified rural catchment. After the discharge point, the Waiari Stream continues a further 2 km before feeding into the Kaituna River. Like the Waiari Stream, the Kaituna River is located within a highly modified environment, surrounded by rural land-uses. In general, water quality in the Kaituna River is good in the upper sections of the river, but declines in the lower reaches along with a trend of increasing nutrients[1]. It has also been identified that AFFCO New Zealand operate the Rangiuru freezing works approximately 5.5 km upstream from the Waiari Stream confluence. Treated wastewater from the freezing works is discharged directly into the Kaituna River[2]. There are a number of small farm drains discharging into the Waiari Stream both upstream and downstream of the WWTP.

Overall, the water quality, stream and surrounding terrestrial ecology at all of the sites are indicative of a highly modified rural environment, with reduced riparian margins, limited availability of stable habitat and potential influence of diffuse and point source discharges.

The water quality of the proposed WWTP discharge are likely to remain the same however the flow rate of the discharge will increase thus increasing the load of contamination (particularly nutrients). Therefore, there is potential that with the proposed increase in discharges into the Waiari Stream, there may be subsequent additional effects within the receiving environment. It is recommended that routine monitoring continue to identify and quantify any additional effects to inform mitigation and or improvements to treatment processes should they be required.

1.2 Purpose

The purpose of this work is to assess historical effluent quality and receiving environment monitoring data to provide a baseline or 'snapshot' for the current receiving environment, which will allow further assessment of potential impact posed by the proposed increase and discharge of treated effluent into the wetland and Waiari Stream. The focus has primarily been on establishing the localised influence of wastewater on groundwater and Waiari Stream as the immediate receiving environments of the WWTP discharge. The assessment summarises the results of this investigation, providing specifically the following:

- A brief background of the current state of the receiving environment
- Description of the monitoring locations
- Surface water quality assessment

[1] Environment Bay of Plenty, Lower Kaituna Catchment and Water Quality, 2007
[2] Bay of Plenty Regional Council, Municipal Wastewater Treatment Compliance Report, 2014

  - Historical monitoring
  - Assessment criteria
  - Water quality results and discussion
- Groundwater assessment
- Stream ecological assessment
  - Methodology of the sampling protocols
  - Assessment indices
  - Ecological results and discussion
- Riparian terrestrial ecological assessment

1.3 Discharge Characteristics

Details of the existing influent and treated effluent discharge flows, treated effluent contaminant concentrations and general consent compliance conditions are discussed in detail in the Te Puke Wastewater Treatment Plant – Process Performance Review (AECOM, 2015) and summarised in relevant sections of this report.

The current treated effluent average daily flow rate is 1800m^3/day (20.8L/s) with this projected to increase to 2348m^3/day (27L/s) in 2051 based on predicted population growth.

The WBOPDC regularly undertakes treated effluent discharge, groundwater and receiving environment (Waiari Stream) water quality monitoring in compliance with the site's existing resource consents. The parameters regularly monitored are:

Table 1 Treated Effluent discharge and water quality monitoring parameters

Parameter	Treated Effluent Discharge	Groundwater	Waiari Stream (up and down stream)
Flow (total daily flow)	✓		
pH			✓
Total suspended solids (TSS)	✓		✓
Chloride			✓
Turbidity			✓
Conductivity			✓
Biological oxygen demand (analysed as cBOD5)	✓		✓
Total nitrogen (TN)	✓		✓
Nitrate nitrogen	✓		✓
Nitrite nitrogen	✓		
Nitrate-N + Nitrite-N	✓	✓	
Ammoniacal Nitrogen	✓	✓	✓
Total Kjedahl Nitrogen (TKN)	✓		
Total phosphorus (TP)			✓
Dissolved reactive phosphorus (DRP)	✓	✓	✓
Faecal coliforms	✓ Pre and post UV, and post wetland, sampled weekly	✓	✓ Sampled weekly
Enterococci (sampled weekly)	✓		✓

Parameter	Treated Effluent Discharge	Groundwater	Waiari Stream (up and down stream)
	Pre and post UV, and post wetland		

1.4 Information Reviewed

In preparing this water quality and ecological assessment the following reports and sources of information were reviewed:

- Current resource consent (024891) and associated original application report dated December 1996.
- Draft Te Puke Wastewater Treatment Plant Capacity Assessment (November 2014) by Harrison Grierson.
- Te Puke Wastewater Treatment Plant Review (February 2002) by Opus.
- WBOPDC historical WWTP compliance monitoring results (1998-2015) and Waiari Stream monitoring results (2005-2015) and flow data.
- Te Puke Wastewater Treatment Plant – Process Performance Review (2015) by AECOM.
- Te Puke Wastewater Treatment Plant – Public Health Risk Assessment (2015) by AECOM.
- Landcare Research Soil Report, generated 19 August 2015 – Ohineangaagaf – Waiari silt loam. http//smap.landcareresearch.co.nz
- ‘Main Report – in support of Resource Consent applications for Te Puke Wastewater Treatment Plant, Alandale Group and Worley Consultants, December 1996.

2.0 Monitoring Locations

2.1 Surface Water and Ecology Monitoring

The water quality, stream ecology and riparian terrestrial monitoring was undertaken by AECOM on 30 June and 1 July 2015 from upstream and downstream of the expected discharge point within the Waiari Stream and also at a location upstream and downstream of where the Waiari Stream joins the Kaituna River.

The sampling locations in relation to the Te Puke WWTP site are as follows and are presented in Figure 1 with grid references provided in Table 2.

- W1 (WU1A) – Waiari Stream, approximately 100 m upstream of WWTP discharge point.
- W2 (WD2A) – Waiari Stream, approximately 100 m downstream of WWTP discharge point.
- K1 – Kaituna River, approximately 400 m upstream of the Waiari Stream confluence.
- K2 – Kaituna River, approximately 400 m downstream of the Waiari Stream confluence.

Photographs taken of each of the monitoring locations are presented in Figure 3 as well as the discharge point.

Table 2 Monitoring Site References

Location	NZTM Easting	NZTM Northing
W1 (WU1A)	1894120	5812948
W2 (WD2A)	1894054	5813206
K1	1894827	5814486
K2	1894650	5815150

There are several small farm drain discharge points between the monitoring locations, and also potential for non-point discharges, such as run-off from agriculture that could possibly cause variation between the monitoring sites.

During the sampling events, the weather was sunny, with no significant rainfall for approximately 9 days preceding the survey. At the time of sampling, it was noted that the stream was at typical water flow levels for this time of the year. Therefore, the weather conditions leading up to the 2015 survey were considered favourable for sampling in winter.

2.2 Groundwater Monitoring

Groundwater monitoring is conducted by WWTP staff as per resource consent 02 4889. Groundwater monitoring data is collected from four piezometers (No. 1, No. 2, No. 3, No.4) installed down-hydraulic-gradient of the WWTP and in the vicinity of the wetland (refer Figure 2).

Monitoring wells No.1, No.2 and No.3, positioned between the wetland and the Waiari Stream, are considered to be hydraulically down-gradient of the wetland. Monitoring well No.4, whilst not positioned between the wetland and the stream, is also considered to be within the radius of influence of the wetland. It is noted that, information regarding background water quality, that may represent the influence of surrounding land-use activities, is not available for the site.

Figure 1 Stream Water Quality and Ecology Monitoring Locations

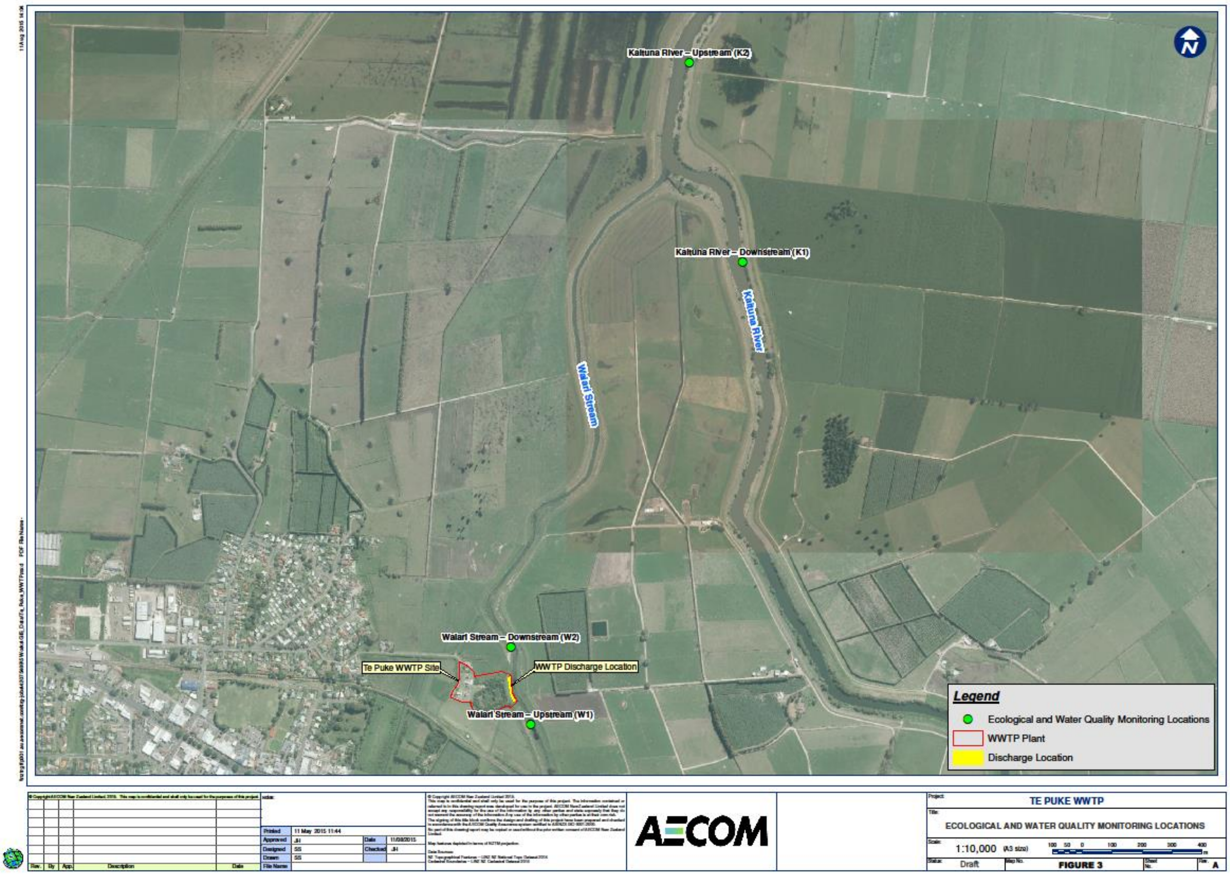

Figure 2 Te Puke WWTP Groundwater Compliance Sampling Location Plan

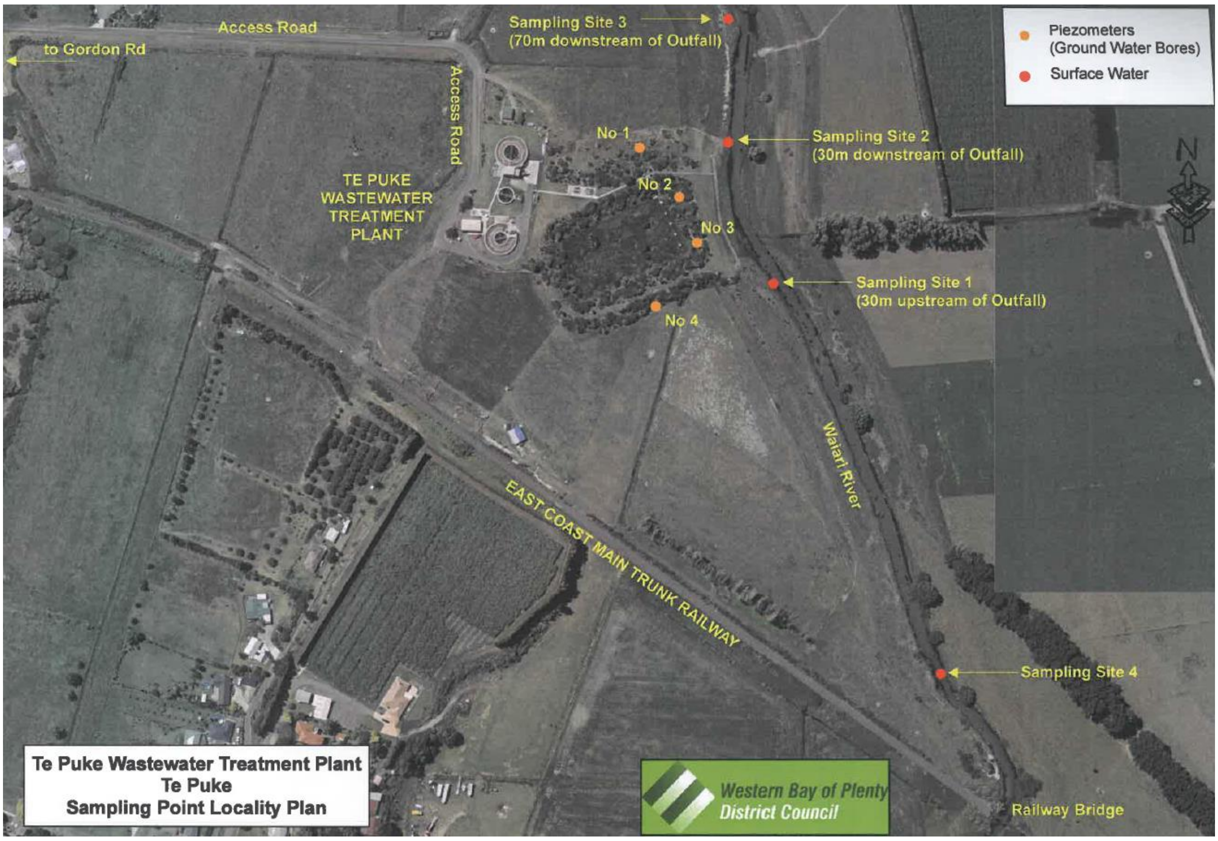

Figure 3 Site Photographs

WWTP Discharge Point – Riparian Zone

Potentially Contaminated Source – Riparian Zone

Waiari Stream – Upstream (W1)

Waiari Stream – Downstream (W2)

Kaituna River – Upstream (K1)

Kaituna River – Downstream (K2)

3.0 Surface Water Quality

3.1 Historical Monitoring

Monitoring of the wastewater treatment plant effluent (pre-treatment, post UV treatment and post wetland treatment) and the monitoring of the Waiari Stream have been conducted in accordance with existing consent conditions (consent number 02 4891) and to monitor effects on the receiving environment. Figure 4 depicts the location of these monitoring sites in relation to the WWTP discharge into the riparian zone of the Waiari Stream and Table 3 provides a description of each monitoring location.

Figure 4 Diagram illustrating location of Te Puke WWTP water quality monitoring locations (not to scale, locations are approximate)

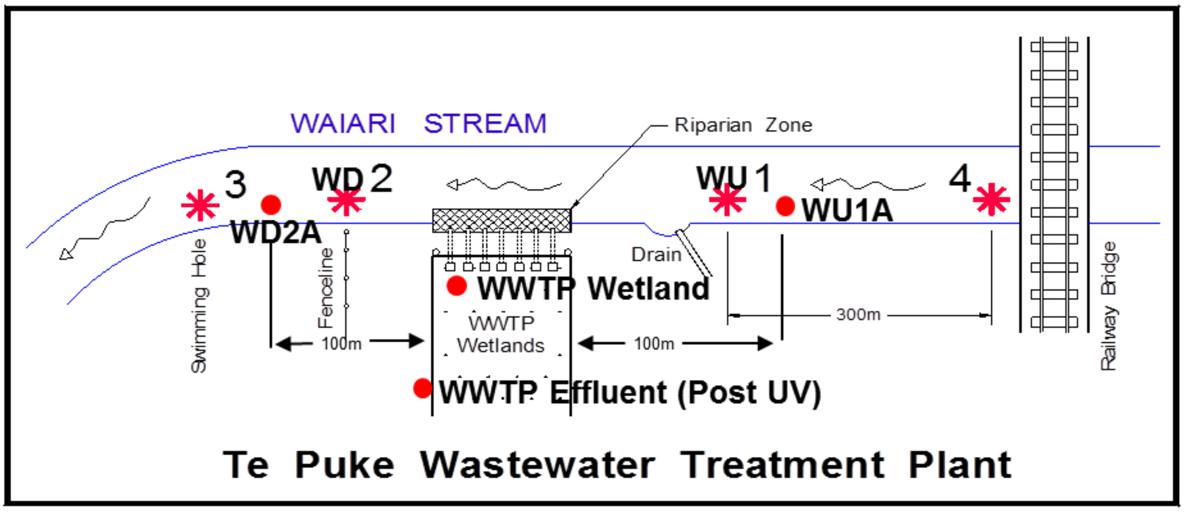

Table 3 WBOPDC and AECOM water quality monitoring locations

Location	Description
4	WBOPDC Waiari Stream background monitoring location approximately 330m upstream of the WWTP outfall. Samples only analysed for faecal coliforms and enterococci.
WU 1A	AECOM Waiari Stream sample location. Sampled on 1 July 2015. Located 100m upstream of WWTP outfall.
WU 1	WBOPDC Waiari Stream sample location. Located approximately 30m upstream of the WWTP outfall.
WWTP Treated Effluent (post UV)	WWTP treated effluent post UV discharge prior to entering the wetland.
WWTP Wetland	WWTP post wetland sample location prior to discharge into the Waiari Stream.
WD 2	WBOPDC Waiari Stream sample location. Located approximately 30m downstream of the WWTP outfall.
WD 2A	AECOM Waiari Stream sample location. Sampled on 1 July 2015. Located 100m downstream of WWTP outfall.
3	WBOPDC Waiari Stream monitoring location approximately 70m downstream of the WWTP outfall. Samples only analysed for faecal coliforms and enterococci.

Monitoring began at some locations as early as 1998 while other locations have been monitored since 2005. The frequency of monitoring (weekly/ monthly/ annually) was prescribed by the consent conditions for the site. Due to the volume of data available for the site and changes that have occurred over the years regarding monitoring locations, parameters and frequency, the last three years of data (January 2012 to January 2015) have been used to assist in characterising the WWTP treated effluent and the immediate receiving environment.

A summary of the monitoring results (2012 to 2015) are presented in the table below.

Table 4 Statistical summary of water quality monitoring data (2012 to 2015)

Sample Location		Parameter						
		Faecal Coliforms (cfu/100ml)	DRP (mg/L)	Nitrate-Nitrogen (mg/L)	Nitrate-N + Nitrite-N (mg/L)	Ammoniacal –N (mg/L)	TN (mg/L)	TP (mg/L)
WU1 - Waiari Up-stream	Average	74.4	0.081	1.26	-	0.017	1.305	0.08
	Median	62	0.057	1.14		0.01	1.175	0.05
	Min	4	0.032	0.93	-	0.01	0.109	0.033
	Max	230	0.235	2.68	-	0.11	3.44	0.266
	Count	36	35	35	-	35	36	36
WD2 - Waiari Down-stream	Average	76.8	0.166	1.416	-	0.062	1.502	0.162
	Median	63	0.142	1.36		0.01	1.47	0.143
	Min	8	0.039	1.11	-	0.01	1.05	0.043
	Max	250	0.68	2.24	-	1	2.4	0.438
	Count	36	35	35	-	35	36	36
WWTP Treated Effluent - Post UV with no dilution	Average	510	4.31	15.5	15.9	1.81	19.6	-
	Median	12	4.31	16.2	16.2	0.48	19.1	-
	Min	4	3.33	4.33	5.80	0.06	7.89	-
	Max	20400	5.19	26.2	26.4	11.60	28.5	-
	Count	162	34	34	34	34	34	-

3.1.1 Wetland Monitoring

The 2002 review of the WWTP (Opus, 2002) found the wetland was short circuiting with the WWTP treated effluent (post UV) only being retained for a short period of time before discharging to the Waiari Stream riparian wetland. The monitoring programme was adjusted to include microbial analysis of the WWTP treated effluent at three points along the treatment process, after the brush clarifier, post ultraviolet (UV) disinfection, and in the wetland. Not all parameters as listed in Table 4 are analysed at each sample location, just faecal coliforms and enterococci.

The wetland faecal coliform data was assessed and compared to the WWTP treated effluent post UV monitoring results to understand what level of contribution the wetland was having to the WWTP discharge into the Waiari Stream. These results are presented in
Table 5. The data was grouped into summer (1 November to 31 April) and winter (1 May to 31 October) seasons due to the likely variation in groundwater levels, rainfall and flood events which may affect the wetland. The summer 2014 – 2015 has not been included as data was only available to January 2015.

Table 5 Statistical summary of WWTP treated effluent post UV and wetland faecal coliform monitoring results (2012 to 2015)

Sample Location		Faecal Coliform Count (cfu/100mL)					
		Summer 2011-2012	Winter 2012	Sumner 2012-2013	Winter 2013	Summer 2013-2014	Winter 2014
Wetland	Average	4065	1287	38195	135	72	517
	Median	180	100	92	58	52	115
	Min	20	24	4	4	4	8
	Max	84000	26000	950000	830	460	9400

Sample Location		Faecal Coliform Count (cfu/100mL)					
		Summer 2011-2012	Winter 2012	Sumner 2012-2013	Winter 2013	Summer 2013-2014	Winter 2014
	Count	23	23	25	27	25	26
WWTP Treated Effluent Post UV	Average	1894	116	33	1003	11	206
	Median	32	12	4	4	8	17.5
	Min	2	4	4	4	4	4
	Max	20400	2000	400	20000	65	2400
	Count	23	26	27	27	25	26
Percentage Increase (Treated Effluent median to wetland median)		463%	733%	2,200%	1,350%	550%	557%

These results have been graphically presented in Figure 5 below.

Figure 5 **Seasonal summary of WWTP treated effluent (post UV) and wetland discharge analysis for faecal coliforms**

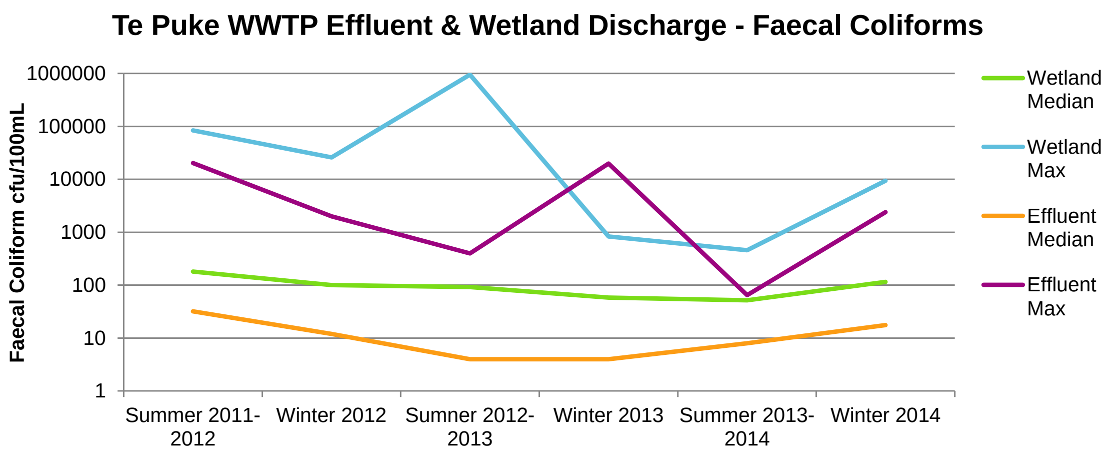

Figure 5 clearly shows the discharge from the wetland consistently has a higher count of faecal coliforms when compared to the treated effluent discharge directly after UV disinfection. There is no notable seasonal variation. These results show the wetland is significantly contributing to the overall faecal coliform contamination entering the Waiari Stream from the WWTP. The percentage change between the treated effluent discharge count and the wetland discharge is on average 976%. Nutrient samples have not been collected nor assessed at the post UV and wetland scale so no further conclusion can be made about the contribution of the wetland to overall nutrient loads entering the Waiari Stream.

3.1.2 Consent Limits and Compliance

The consent compliance limits are presented in Table 4 with the median and maximum WWTP treated effluent (post UV) monitoring results from WBOPDC for the period 2012 to 2015.

Table 6 Current resource consent (02 4891) compliance limits

Parameter	Compliance Limits			2012 to 2015 Monitoring Results		
	Median	Maximum	Maximum Load	Median	Maximum	Maximum Load
Flow	-	9000 m^3/day	-	1695 m^3/day	2600 m^3/day	-
cBOD5	-	30 g/m^3	55 kg/day	3 g/m^3	15 g/m^3	30 kg/day
TSS	-	30 g/m^3	60 kg/day	6 g/m^3	68 g/m^3	104 kg/day

Parameter	Compliance Limits			2012 to 2015 Monitoring Results		
	Median	Maximum	Maximum Load	Median	Maximum	Maximum Load
TN	-	-	90 kg/day	33.4 kg/day	-	55 kg/day
DRP	-	20 g/m^3	-	4.31 g/m^3	5.19 g/m^3	-
Faecal coliforms	200 /100 mL	1000 /100 mL	-	12 cfu/100mL	20400 cfu/100mL	-

Whilst a comprehensive compliance assessment has not been undertaken as part of the scope of the water quality assessment the median results show a general compliance with the consent limits and maximum limits have been exceeded for TSS and faecal coliforms. Some key issues associated with the operating consent and compliance have been discussed in the Te Puke Wastewater Treatment Plant – Process Performance Review (AECOM, 2015).

3.2 AECOM Monitoring 2015

One round of water quality samples were collected on 30 June and 1 July 2015 to assist in establishing a baseline data set for the Assessment of Environmental Effects (AEE) for the WBOPDC WWTP facility upgrade resource consent application. The purpose of the water quality assessment was to provide a 'snapshot' record of the current receiving environment (Waiari Stream and Kaituna River), which will allow further assessment of potential impact posed by the proposed increase of treated effluent into the Waiari Stream in the context of the existing data.

3.2.1 Sample Locations and Analysis

As discussed in Section 2.0, four locations were identified for sample collection. These locations were identified based on proximity to the expected discharge point within the Waiari Stream and within the Kaituna River. The sampling locations in relation to the Te Puke WWTP site are presented in Figure 1.

Duplicate samples were collected at each sample location for quality control and identified as A and B in laboratory analysis results.

Water quality parameters were measured using a calibrated YSI Pro Plus hand-held multi-parameter meter. Water temperature (°C), pH, dissolved oxygen (DO) (% saturation and concentration mg/L), salinity, oxidation / reduction potential (ORP), turbidity and conductivity (µS/cm) were measured.

Water samples were collected at each monitoring location and sent for laboratory analysis. The water quality assessment was undertaken in order to characterise the receiving environments, indicate where other discharges may be contributing to existing water quality and quantify the potential effects from the discharges from the existing WWTP. Additionally the potential effects of the upgraded WWTP have also been considered in the assessment.

The following parameters were analysed:

- Total Suspended Solids
- Total Nitrogen
- Faecal Coliforms
- Total Ammoniacal-Nitrogen
- Nitrate-N + Nitrite-N
- Dissolved Reactive Phosphorus
- Total Kjeldahl Nitrogen (TKN)
- Total Phosphorus

3.2.2 Assessment Criteria

The Australia and New Zealand Guidelines for Fresh and Marine Water Quality, 2000 (ANZECC, 2000) provides authoritative guidance on fresh and marine water quality management issues in both New Zealand and Australia. The guidelines provide a framework for applying levels of protection for toxicants to different ecosystem conditions. While it is arguable that the ecosystem condition of Waiari Stream and Kaituna River is a highly disturbed system based on the land use activities and point and non-point discharges to the watercourses the 95% level of species protection has been applied as a conservative approach to assessment.

Therefore the ANZECC guideline values taken from Table 3.4.1 - Trigger values for toxicants at alternative levels of protection were for 95% protection (page 3.4-5). Where trigger values are not available the default trigger values from Table 3.3.10 - Default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems (New Zealand lowland rivers) have been applied (page 3.3-17).

The National Policy Statement (NPS) for Freshwater Management (2014) provides national bottom lines and minimum acceptable states for select attributes (nitrate and ammonia) in rivers. Total nitrogen and total phosphorus numeric attribute states are only available for lakes and as such are not appropriate for the receiving environment of the Waiari Stream. The Attribute State B has been selected as it is representative of slightly impacted ecosystems and is comparable to the ANZECC 95% level of protection.

Dissolved oxygen field data has been assessed against the NPS for Freshwater Management Attribute State A for the one day minimum concentration across the whole summer period (1 November to 30 April). Attribute State A would result in no stress caused by low dissolved oxygen and any aquatic organism. Other physiochemical results were also compared to the New Zealand Stream Health Monitoring and Assessment Kit, Stream Monitoring Manual (NIWA, 2002).

Faecal coliform data has been assessed against the NPS for Freshwater Management Attribute State A (people exposed to a very low risk of infection) and the Action Level as defined in the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE 2003). Guideline values are provided for E. coli and so the Faecal coliform values have been determined using the USEPA ratios of 126 E. coli per 200 faecal coliforms (for freshwater). This is indicative only and is useful for comparative purposes.

3.2.3 Field Water Quality Results

The water quality parameters measured in the field were compared against the ANZECC trigger values for slightly disturbed NZ lowland rivers where values were available and the up and down stream results were compared to each other in the respective watercourses. Duplicate field measurements were not taken. Reference has also been made to the NZ Stream Health Monitoring and Assessment Kit (SHMAK) (NIWA, 2002[3]) to provide further context of results in regards to stream habitat and quality.

pH

The pH ANZECC NZ lowland river default trigger value is between 7.2 and 7.8. All monitoring results were below the lower limit trigger value with a range of 6.5 to 6.8. While the results were below the assessment criteria there are a number of factors which can cause pH to fluctuate within a water body throughout the day and seasonally which do not adversely affect the water quality or stream health. The SHMAK has been used to further assess the potential impact of the pH results. Low pH (≤5) can be due to high concentrations of humic substances (vegetation decay) or pollution source. Neutral range of pH is considered between 6.5 to 7.5 and is good for stream life. pH ≥8 can signify aquatic plant growth which will fluctuate throughout the day and seasonally. As the recorded results are between 6.5 and 7.5 this is considered neutral and is excellent quality with respect to pH. In both instances the downstream pH results are slightly lower than the corresponding upstream results.

Conductivity

The electrical conductivity can indicate the amount of mineral salts in a water sample and presence of dissolved nutrients which will influence algal growth rates. The Waiari Stream conductivity results recorded a higher concentration at the downstream sample location (83.2 µs/cm) when compared to the upstream sample location (74.1 µs/cm). The variation of results from the Kaituna River sample locations were less pronounced with an upstream result of 162.8 µs/cm and downstream result of 164.9 µs/cm. Using the SHMAK habitat quality ratings

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[3] Biggs, B.J.F., Kilroy, C., Mulcock, C.M., Scarsbrook, M.R., Ogilvie, S.C. 2002: *New Zealand Stream Health Monitoring and Assessment Kit. Stream Monitoring Manual. Version 2K – A tool for Kaitiaki*. NIWA Technical Report 111-1. 190 p.

the Waiari Stream is considered good (results of 50 to 149 µs/cm) while the Kaituna River is considered fair (results of 150 to 249µs/cm). Flow rates, substrate and water depth will also influence algal growth.

Dissolved Oxygen

The dissolved oxygen levels recorded in the downstream sample locations were lower than the upstream results in the both the Waiari Stream and Kaituna River. However all results recorded were above the recommended levels for protection of native freshwater fish[4] and the NPS Attribute State A (≥7.5mg/L). Water should be greater than 80 percent saturated with dissolved oxygen to support healthy and diverse aquatic communities (http://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Rivers/healthyrivers/Water-quality-glossary/).

Turbidity

The turbidity results were recorded at less than 7 NTU at all sample locations, both up and downstream from discharge points and stream/ river confluence. The turbidity results indicate that both the Waiari Stream and Kaituna River are low turbid environments with low levels of sediment in the water column. High turbidity can adversely impact aquatic vegetation growth and fish life.

Temperature

The temperatures recorded at all sample locations are below the ANZECC NZ lowland river default trigger value. However it should be noted that the ANZECC temperature trigger value was devised from temperatures recorded in February; the water quality monitoring was conducted in June/ July. The downstream results were also compared to the respective upstream results. There is little variation between up and downstream results indicating there is no discernible change in temperature and the minor variation is not significant. SHMAK provides a habitat quality rating of excellent for temperature readings between 10 to 14.9 ºC (very suitable for most invertebrates and periphyton).

[4] NIWA, 2013. *National Objectives Framework – Temperature, Dissolved Oxygen and pH, Proposed thresholds for discussion*. Prepared for the Ministry for the Environment.

Table 7 Water quality stream monitoring results – field physiochemical parameters

Field Parameters	W1 A	W2 A	K1 A	K2 A	ANZECC NZ Lowland River Default Value [5]	NPS for Freshwater – Attribute State A (1-day min, summer)	SHMAK (NIWA, 2002)
pH	6.65	6.5	6.8	6.56	7.2ɸ – 7.8 ж		6.5 to 7.5 (excellent)
Electrical Conductivity (µs/cm)	**74.1**	**83.2**	162.8	164.9	125-2200		< 50 (excellent) 50 to 149 (good) 150 to 249 (fair)
Salinity (ppt)	0.03	0.04	0.08	0.08	-		
Temperature (ºC)[a]	12.8	12.8	12.2	11.5	21.5 ж		10 to 14.9 (excellent)
Dissolved Oxygen (%L Saturation)	99.5	98.2	**110.7**	100.9	98ɸ – 105 ж		
Dissolved Oxygen (mg/L)	10.45	10.4	11.92	10.98	-	≥7.5	
Turbidity (NTU)	**<7**	**<7**	**<7**	**<7**	5.6ɸ		

Table Reference Notes

Ж Upper limit trigger value

ɸ Lower limit trigger value

BOLD does not meet guideline trigger value for New Zealand Lowland Rivers

a Temperature for February only

[5] ANZECC, 2000. National Water Quality Management Strategy: Australia and New Zealand Guidelines for Fresh and Marine Water Quality, 2000. Values taken from Table 3.3.10 Default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems (New Zealand lowland rivers) and or Table 3.4.1 (Trigger values for toxicants at alternative levels of protection)

Table 8 Water quality stream monitoring results – laboratory parameters

Laboratory Analysis	W1 A	W1 B	W2 A	W2 B	K1 A	K1 B	K2 A	K2 B	ANZECC Trigger Level[6] 95% Protection	NPS for Freshwater – Attribute State B (annual median)
TSS (mg/L)	5	5	<3	<3	<3	<3	<3	<3	-	-
Total Nitrogen (mg/L)	**1.16**	**1.19**	**1.93**	**1.87**	**0.75**	**0.74**	**0.78**	**0.76**	0.614[a]	-
Total Ammoniacal-Nitrogen (mg/L)	0.014	0.011	0.01	0.012	0.018	0.018	0.016	0.018	0.9[b]	>0.03 & ≤0.24
Nitrate Nitrogen (mg/L)	**1.08**	**1.07**	**1.71**	**1.69**	-	-	-	-	0.7[b]	>1.0 & ≤2.4
Nitrate-N + Nitrite-N (mg/L)	**1.13**	**1.13**	**1.75**	**1.74**	**0.6**	**0.61**	**0.62**	**0.62**	0.444[a]	-
Total Kjeldahl Nitrogen (mg/L)	<0.1	<0.1	0.18	0.13	0.15	0.13	0.16	0.14	-	-
Dissolved Reactive Phosphorus (mg/L)	**0.036**	**0.034**	**0.14**	**0.144**	**0.022**	**0.022**	**0.022**	**0.022**	0.01[a]	-
Total Phosphorus (mg/L)	**0.04**	**0.041**	**0.140**	**0.144**	0.029	0.028	0.029	0.031	0.033[a]	-
Faecal Coliforms (cfu/ 100mL)	1	46	100	110	47	6	9	7	-	412[c]

Table Reference Notes:

Bold text denotes ANZECC guideline exceedance

Underline denotes NPS Attribute State B exceedance

- Data or guideline value not available

a) ANZECC, 2000. Values taken from Table 3.3.10 Default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems (New Zealand lowland rivers) in Lowland Rivers

b) ANZECC, 2000. Table 3.4.1 (Trigger values for toxicants at alternative levels of protection) – Trigger values for freshwater at 95% level of protection.

c) Level has been determined using the USEPA ratios of 126 E. coli per 200 faecal coliforms (for freshwater). This is indicative only and is useful for comparative purposes only. Less than 412cfu/100mL is acceptable/ green mode (Attribute State A of the NPS) and greater than 412 cfu/100mL is alert/ amber mode in the MfE guidelines (Attribute State B of the NPS).

[6] a) ANZECC, 2000. National Water Quality Management Strategy: Australia and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.

3.2.4 Laboratory Water Quality Results

Samples were submitted to Hill Laboratories for analysis. All laboratory results were compared to the ANZECC guidelines trigger values for 95% level of species protection and the NPS for Freshwater Management (Attribute State B). Upstream and downstream results were compared to each other to assess discharge influence (see result summary in Table 8).

Total Suspended Solids

The upstream TSS result for the Waiari stream recorded the highest TSS recorded of all the sample locations with a concentration of 5mg/L. All other results were below the laboratory detection level of 3mg/L. These results correspond to the low turbidity results recorded in the field.

Total Nitrogen

All total nitrogen results exceeded the ANZECC guideline of 0.614mg/L with Waiari Stream recording higher total nitrogen concentrations than Kaituna River. The downstream Waiari Stream concentrations (1.93 and 1.87 mg/L) were notably higher than the upstream concentrations (1.16 and 1.19mg/L) indicating a source of nitrogen input to the Waiari Stream between the sample locations. The difference in up and downstream total nitrogen concentrations within the Kaituna River are not significant with upstream results of 0.75 and 0.74mg/L and downstream results of 0.78 and 0.76mg/L.

Total Ammoniacal Nitrogen

Ammonia can be toxic to fish and comes from fertiliser, sewage and animal urine. Ammonia will increase toxicity with temperature and pH. In this case, all total ammoniacal nitrogen results were below the ANZECC guideline trigger value of 0.9mg/L with the Kaituna River results recording higher concentrations than the Waiari Stream. There is no discernible difference between upstream and downstream results for either watercourse. All results are below the NPS numeric attribute state B (>0.03 to ≤0.24mg/L).

Nitrate Nitrogen and Oxides of Nitrogen (Nitrate-N + Nitrite-N)

Sources of nitrate nitrogen and oxides of nitrogen include point sources such as sewage disposal systems and livestock facilities, non-point sources such as fertilized cropland, pasture, parks, golf courses, lawns, and gardens. Excess nitrates can accelerate aquatic plant growth and cause changes to the biota of the receiving water body.

The Waiari Stream results for nitrate-nitrogen concentrations exceeded the ANZECC guideline 95% trigger value of 0.7mg/L. The Waiari Stream recorded lower concentrations in the upstream samples (1.07 and 1.08mg/L) when compared to the downstream sample results (1.71 and 1.69 mg/L). However these results fall within the range for the NPS Attribute State B of >1.0 and ≤2.4mg/L. This indicates that there is potential for some growth effects on up to 5% of species i.e. increased growth rate.

The Kaituna River recorded lower concentrations of nitrate-n + nitrite-n when compared to the Waiari Stream with no discernible difference between upstream (0.6 and 0.61mg/L) and downstream (0.62mg/L) concentrations. The Kaituna River results exceeded the ANZECC NZ lowland river default trigger value of 0.444mg/L.

Total Kjedahl Nitrogen (TKN)

The upstream TKN concentrations recorded at Waiari Stream were below the laboratory level of detection (0.1mg/L) and the downstream results were 0.18 and 0.13mg/L. The Kaituna River results were 0.15 and 0.13mg/L upstream and 0.16 and 0.14mg/L. Total kjedahl nitrogen is the measure of organic nitrogen, ammonia and ammonium. There are no specific guidelines for this parameter.

Dissolved Reactive Phosphorus

All dissolved reactive phosphorus concentrations recorded exceeded the ANZECC NZ lowland river default trigger value of 0.01mg/L. The Waiari Stream downstream results were an order of magnitude higher than the upstream concentrations. Waiari Stream upstream results were 0.036 and 0.034mg/L and downstream results were 0.14 and 0.144mg/L. There was no recorded difference in the up and downstream results from samples collected in the Kaituna River (0.022mg/L). Dissolved reactive phosphorus is the amount of phosphorus in a dissolved state and available for plant and algae (periphyton) growth.

Total Phosphorus

Waiari Stream total phosphorus results exceeded the ANZECC NZ lowland river default trigger value of 0.033mg/L with upstream concentrations of 0.04 and 0.041mg/L and downstream concentrations of 0.14 and

0.144mg/L. The up and downstream concentrations of total phosphorus recorded in the Kaituna River were below the ANZECC trigger value and had no discernible difference between up and downstream results.

Faecal Coliforms

The two samples collected at each sample location recorded different faecal coliform counts. This is not surprising as microbial difference can vary greatly between samples. Counts recorded below 20 cfu/100ml are considered statistical estimates due to the low number count. The faecal coliform count recorded at the downstream Waiari Stream sample location was higher than the counts recorded at the upstream sample location, despite the upstream samples differing by a factor of 10. The Waiari upstream results were 1 and 46 cfu/100ml and the downstream results were 100 and 110 cfu/100ml.

The difference in faecal coliform counts recorded in the Kaituna River are not as significant with upstream results of 47 and 6 cfu/100ml and downstream results of 9 and 7 cfu/100ml. Results for both the Waiari Stream and Kaituna River comply with the MfE microbiological guidelines acceptable (green) mode limit of 412 cfu/100mL.

3.3 Surface Water Quality Results Discussion

The recent AECOM samples were compared with existing water quality data and WWTP treated effluent data. It is understood that the wetland is not operating effectively and as a result is likely to be decommissioned in the near future (as discussed in section 3.1.1). Therefore the WWTP treated effluent quality data used in the data analysis was the 'post-UV' treated effluent. This treated effluent is concentrated and is not directly comparable to the Waiari Stream water quality data. Therefore a dilution factor equal to the 5%tile flow rate of the Waiari Steam was used to normalise the data to allow a direct comparison between treated effluent water quality and the Waiari Stream water quality. This results in a conservative dilution under low flow conditions.

This section of this report focusses on the discharges to the Waiari stream which is the immediate receiving environment. The relative contribution of the WWTP discharge to Kaituna River will be significantly less due to the increased flow rate in the river and the greater contribution of contaminants from wider catchment sources.

3.3.1 Dilution Factor

The dilution factor used in this assessment is the same as that used in the public health assessment. Full details are provided in the Te Puke Wastewater Treatment Plant, Public Health Risk Assessment (AECOM, 2015).

The flow records for Waiari Stream for 2014 were provided by NIWA (included in the Public Health Risk Assessment) which was collected at Te Puke. The typical flow range for Waiari Stream varies from 3500 L/s (5%ile) to 4400 L/s (95%ile). The minimum and maximum flow recorded in 2014 was 3399 L/s and 83270 L/s, respectively. For the purpose of the water quality assessment, only the low flow condition of Waiari Stream (3500 L/s, 5%ile) was considered to provide a conservative assessment. The current average flow rate of treated effluent from the WWTP is 20.8 L/s (1800 m^3/d). The dilution factor applied to the treated effluent water quality data is 168. Higher stream flow rates will result in greater dilution potential.

3.3.2 Water Quality Parameters

Not all parameters analysed by AECOM are included in the consent compliance monitoring. The following parameters were compared with the historical compliance data as presented in Table 4. The full statistical data summary for the monitoring locations discussed in this report and the treated effluent results with the dilution factor applied are presented in Appendix A.

- Faecal coliforms
- Total nitrogen
- Dissolved reactive phosphorus (DRP)
- Nitrate-nitrogen
- Total ammoniacal nitrogen

3.3.3 Historical Result Discussion

The following graphs show the results of the historical monitoring from January 2012 to January 2015, the WWTP treated effluent (post UV) monitoring results with the dilution factor applied, the AECOM stream monitoring conducted in July 2015 and where applicable the consent limits or assessment guideline trigger values.

Figure 6 Water Quality Results Waiari Stream and WWTP Treated Effluent (post UV) 2012 to 2015 – Total Nitrogen

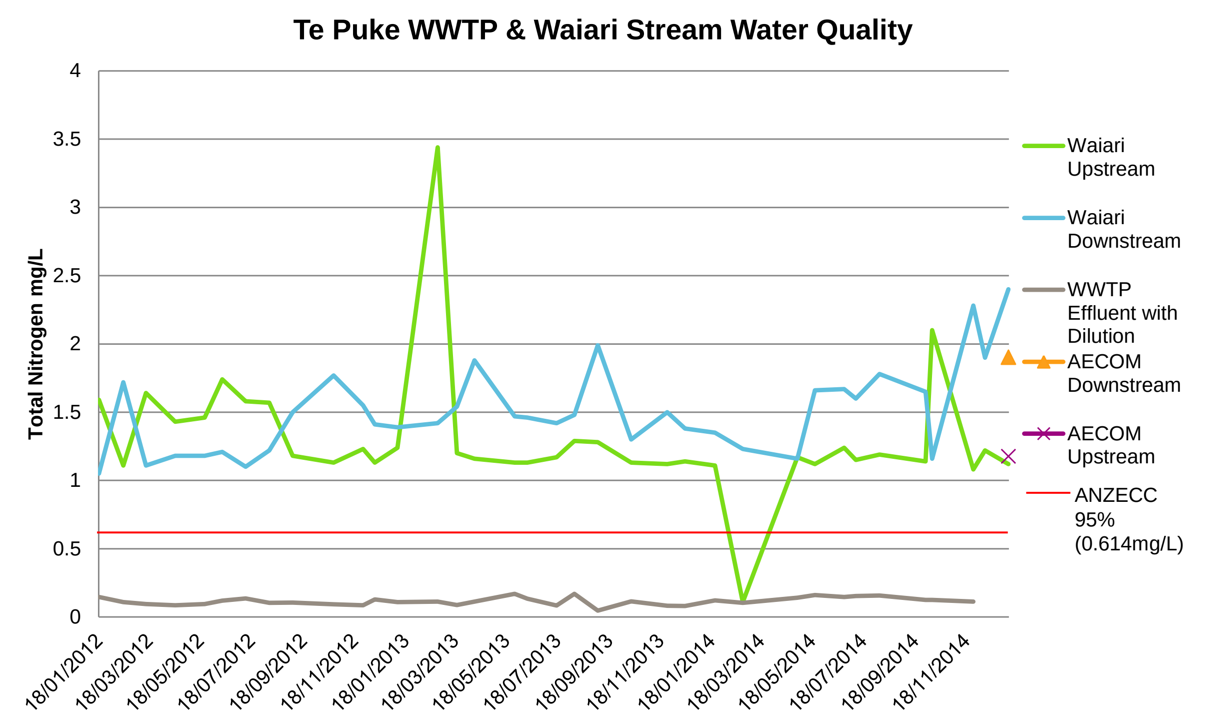


Figure 6 shows the results for total nitrogen. As shown in the graph the Waiari Stream upstream total nitrogen is already showing high concentrations which consistently exceed the ANZECC assessment criteria (0.614mg/L). While the downstream total nitrogen concentration is higher than the upstream results for the most part, the difference can not entirely be attributed to the WWTP treated effluent. The difference between the average upstream and downstream concentrations is 0.197 mg/L while the average concentration of the diluted WWTP treated effluent is 0.116 mg/L, suggesting a contribution of 0.08mg/L from other sources. The respective lines on the graph also show that the WWTP provides a relatively small contribution in terms of concentration when compared to concentrations flowing from upstream.

Figure 7 Water Quality Results Waiari Stream and WWTP Treated Effluent (post UV) 2012 to 2015 – Total Ammoniacal Nitrogen

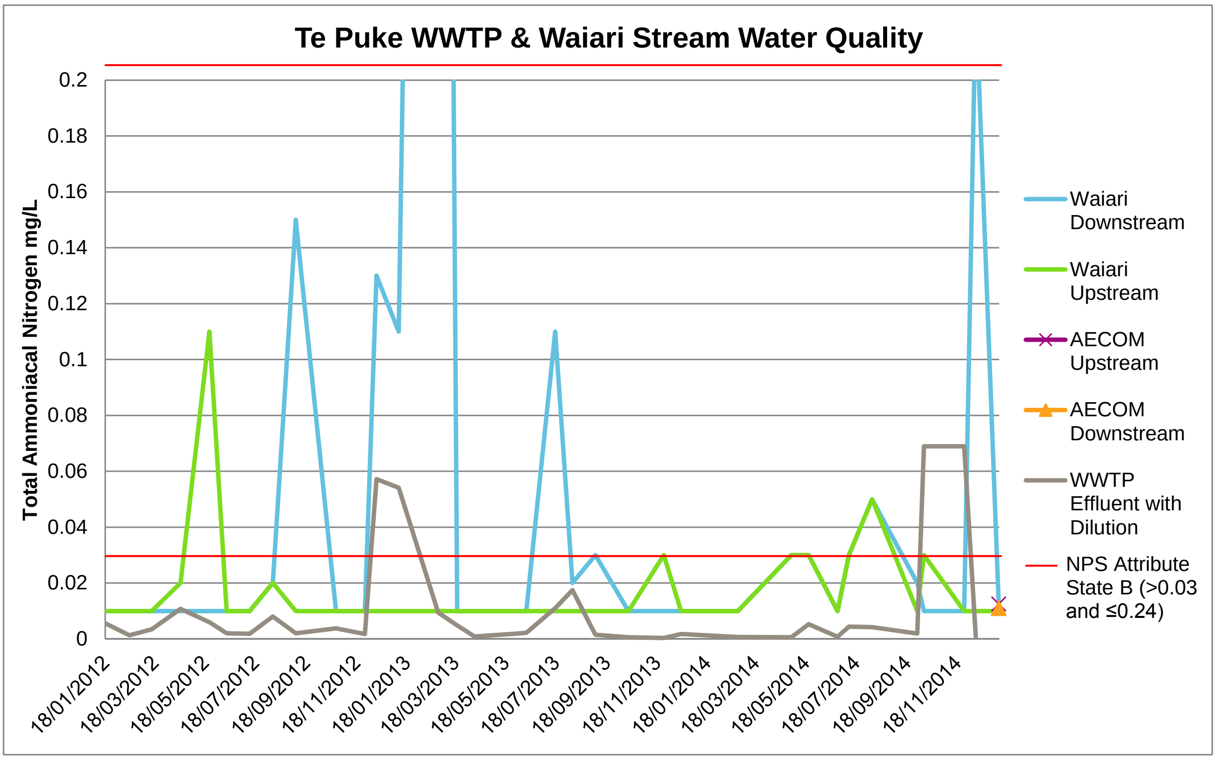


Figure 7 shows the total ammoniacal nitrogen concentrations of the Waiari Stream and the diluted WWTP treated effluent. The variability between the up and down stream concentrations are not as pronounced as with other parameters. The downstream concentration only exceeded the upper limit of the NPS Attribute State B (0.24mg/L) once with a concentration recorded at 1mg/L on 25 February 2013, however the results show the laboratory level of detection was recorded at 1mg/L which is significantly higher than the normal level of detection of 0.01mg/L. The laboratory level of detection can be influenced by a number of factors including sample quantity and ‘dirtiness’ (interference by other contaminants within the sample). In this instance this exceedance is not considered significant.

Figure 8 **Water Quality Results Waiari Stream and WWTP Treated Effluent (post UV) 2012 to 2015 – Faecal Coliforms**

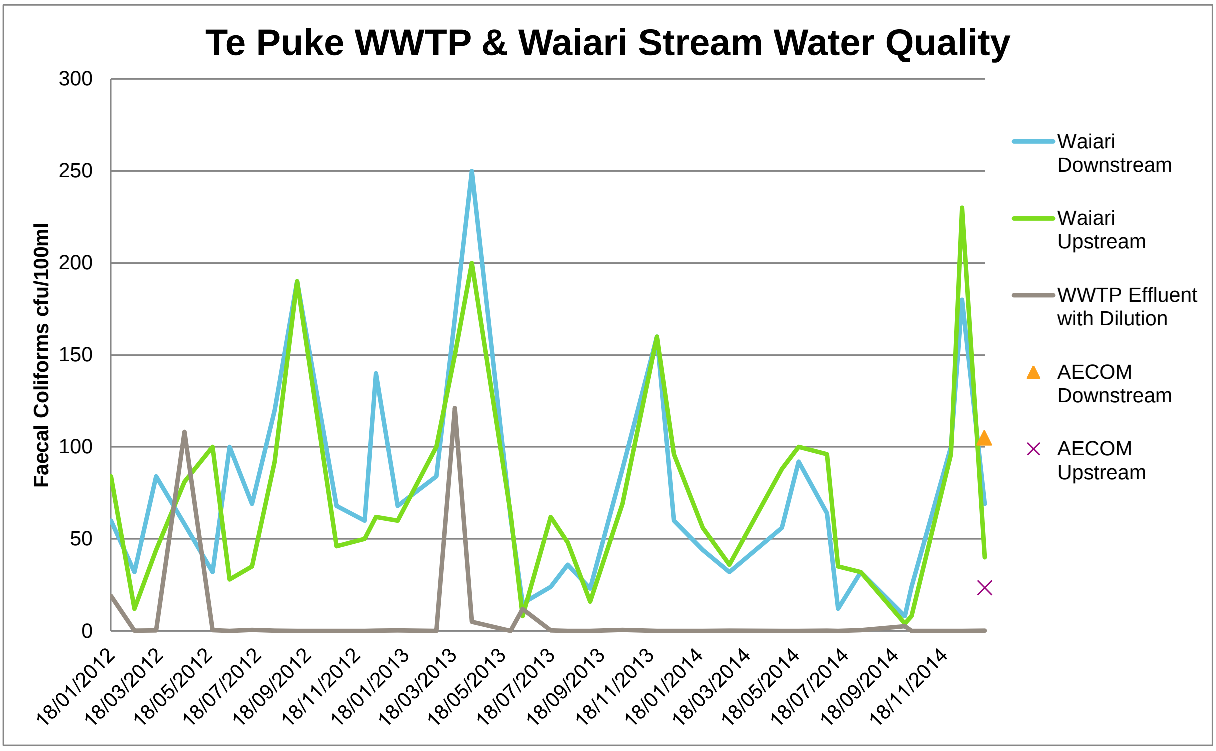


Figure 8 shows the results for the faecal coliform monitoring. The Waiari Stream upstream and downstream faecal coliform counts are similar with the upstream results exceeding the downstream counts 40% of the time (2012 – 2015), recorded no difference between up and downstream counts 11% of the time and recorded higher downstream concentrations 49% of the time. This indicates significant upstream sources of microbial contamination potentially from other point discharges, wildlife and farming activities (the dominant land use). The average upstream count is 74.38 cfu/100ml, downstream is 76.83cfu/100ml and the diluted treated effluent average is 3.04 cfu100/ml. This suggests that the WWTP treated effluent (post UV) is not the major contributor to the level of faecal coliforms (an indicator of microbial and pathogen contamination) in the Waiari Stream as the treated effluent (post UV) with dilution is approximately 4% of the upstream faecal coliform count.

However, Section 3.1.1 discusses the contribution of the wetland to the faecal coliform counts in the stream with an average percentage increase of 976% between the post UV treated effluent and the discharge from the wetland.

Figure 9 Water Quality Results Waiari Stream and WWTP Treated Effluent (post UV) 2012 to 2015 – Dissolved Reactive Phosphorus

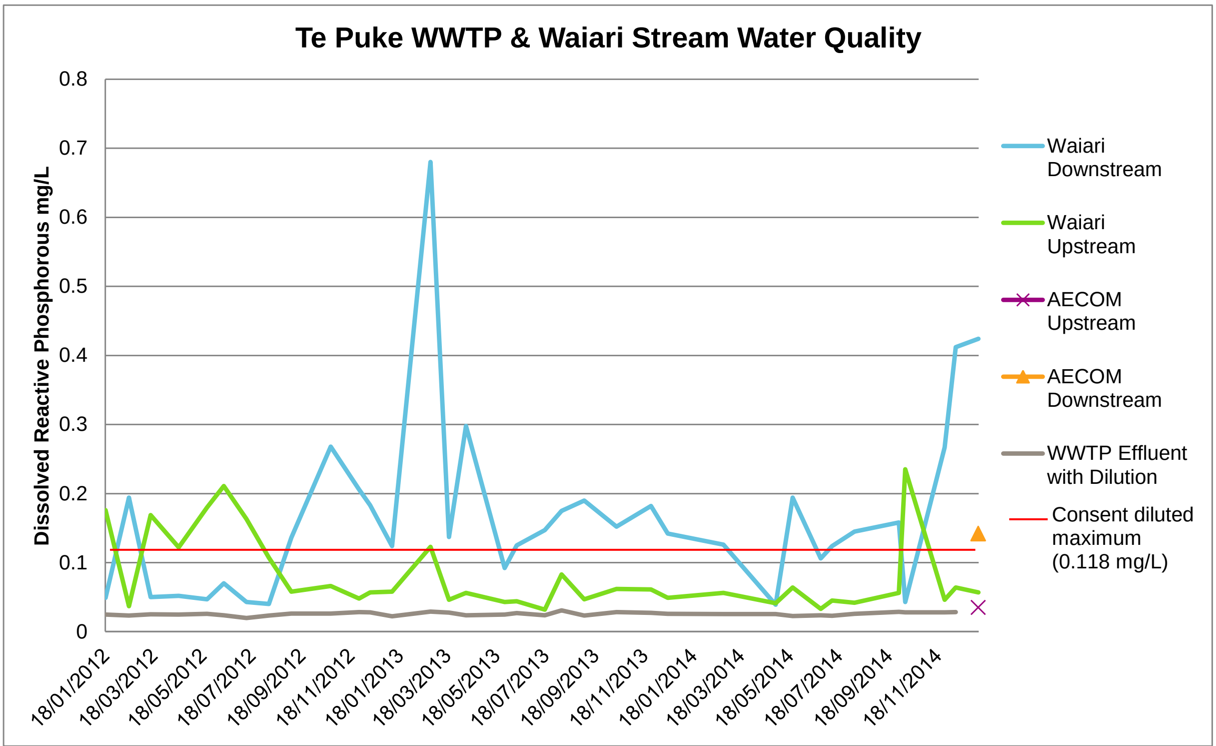


Figure 10 Water Quality Results Waiari Stream and WWTP Treated Effluent (post UV) 2012 to 2015 – Nitrate Nitrogen

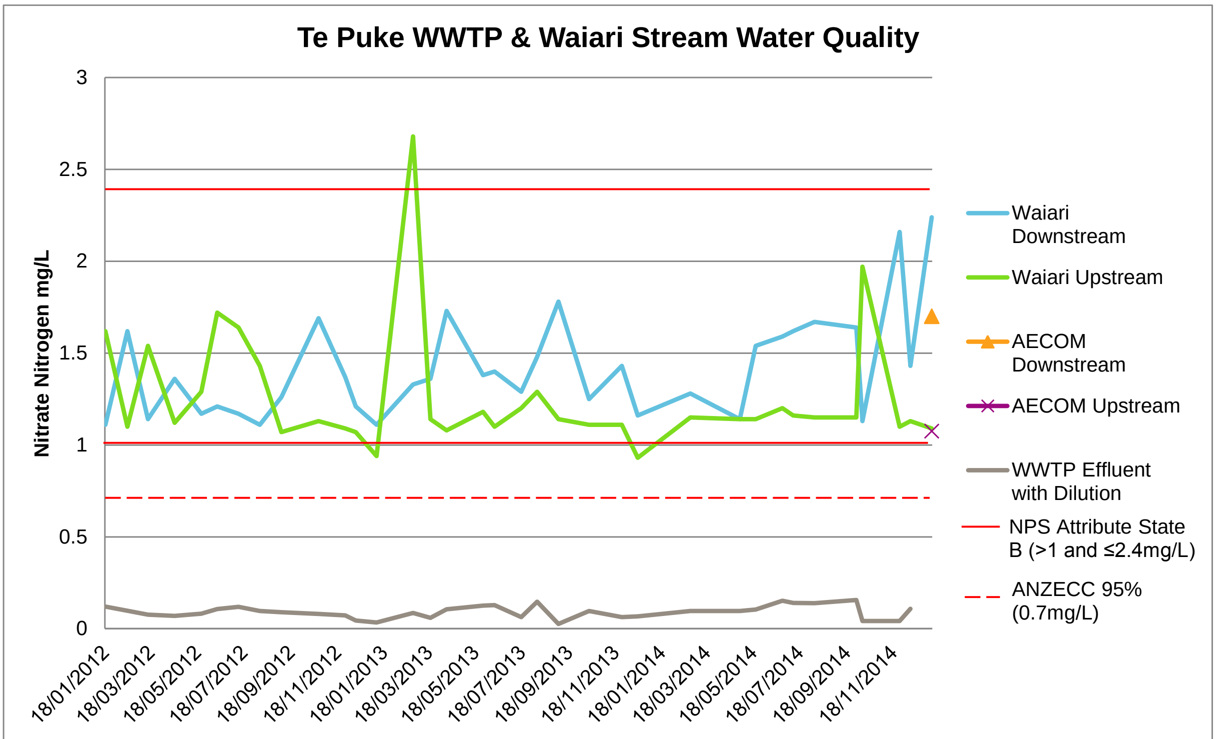


Figure 9 and 10 further demonstrate the nutrient enrichment of the Waiari Stream. The average DRP concentration of the diluted treated effluent discharge is 0.025mg/L while the average difference between the upstream and downstream concentrations is 0.085mg/L. This suggests that the WWTP treated effluent contributes approximately 30% of this downstream increase. The average nitrate concentration of the diluted treated effluent discharge is 0.092mg/L while the average difference between the upstream and downstream concentrations is 0.156mg/L. On this basis the WWTP is contributing approximately 60% of this downstream increase but it is noted that, on the basis of concentration, the treated effluent levels are low when compared to the upstream concentrations indicating that a significant nitrogen load is sourced from the wider upstream catchment.

3.3.4 Phosphorus and Nitrogen Limiting

Nutrient enrichment of waterways leads to excess growth of algae (periphyton) and aquatic plants which can reduce ecological and recreational values and overall water quality. Nitrogen and phosphorus are described as limiting nutrients as low concentrations of one or the other can limit growth within a water body. The ratio of total phosphorus to total nitrogen can indicate whether a water body is considered “phosphorus limited” or “nitrogen limited”. The ratio of total nitrogen to total phosphorus was calculated as follows:

- Median Waiari upstream TN:TP Ratio is 1:17
- Median Waiari Downstream TN:TP Ratio is 1:5

New Zealand studies of macronutrient limitation have determined the ranges which indicate whether water bodies are nitrogen, phosphorus or co-limited. The Waiari Stream ratios indicate that upstream from the WWTP discharge the Waiari Stream is co-limited (balanced algal growth) while downstream from the WWTP discharge the Waiari Stream becomes nitrogen limited. Further assessment of the monthly water quality data for the Waiari Stream (2012 to 2015) shows variability with the stream exhibiting both phosphorus and nitrogen limiting states at different times. This is likely influenced by changes in stream flow. Nuisance algal growth is more likely during low flow, summer conditions.

3.3.5 Nutrient Mass Load

The median daily nutrient mass loads were calculated based on the average daily WWTP flow of 1800m^3/day and the 2012-2015 median concentration. Specific total phosphorus concentration data is not available for the WWTP treated effluent therefore the mass load has not been calculated. The calculated nutrient mass loads in Waiari Stream were calculated using the 5%tile flow rate used to calculate the dilution factor (3500L/s), a conservative approach to calculating nutrient mass load. The calculated nutrient mass loads are presented in the Table 9 below.

Table 9 Median nutrient mass load for Waiari Stream and WWTP treated effluent (post UV)

Sample Location	Dissolved Reactive Phosphorus (kg/day)	Total Phosphorus (kg/day)	Total Nitrogen (kg/day)
Waiari Upstream	17.23	15.12	355.32
Waiari Downstream	42.94	43.24	443.02
Variance Upstream – Downstream	25.71	28.12	87.70
Current WWTP Treated Effluent (post UV)	7.75		34.31
Current WWTP Treated Effluent mass load as percentage of Waiari upstream mass load	45%		10%
Current Percentage Contribution of WWTP Treated Effluent to Waiari downstream variance mass load	30%		40%
Projected WWTP Treated Effluent (post UV adjusted for dilution) Based on 30% Population Increase	10.08		44.60
Projected Percentage Contribution of the WWTP Treated Effluent to Waiari downstream variance mass load	39%		51%

The mass load calculations show that the WWTP is contributing to the nutrient loads of the Waiari Stream. The WWTP treated effluent total nitrogen mass load is only 10% of the Waiari upstream mass load, whereas the DRP is 45%. While total phosphorus data is not available for the WWTP treated effluent the results for the Waiari

Stream show a pollution source of total phosphorus between the upstream and downstream sample locations. The current and projected percentage contribution of the WWTP treated effluent to the downstream variance mass load (as presented in Table 9) is the percentage of the difference between upstream and downstream Waiari Stream nutrient mass loads that can be attributed directly to the WWTP treated effluent. This shows that, currently, 60% of the total nitrogen increase and 70% of the DRP increase between upstream and downstream is from sources within the catchment other than the WWTP.

The projected percentage contribution of the WWTP treated effluent to the downstream nutrient load is based on the following:

- Projected flow rates of the WWTP in 2051 of 2348 m^3/day (based on 30% population increase)
- Waiari Stream nutrient mass load remains unchanged
- Concentration of nutrients in the treated effluent remains unchanged

The projected treated effluent flow increase would result in the treated effluent discharge being a significant contributor to the Waiari Stream nutrient mass loads.

3.4 Surface Water Quality Monitoring Summary

The surface water quality assessment has focused primarily on the Waiari Stream as this is the direct receiving environment of the WWTP treated effluent discharge and localised water quality has been monitored consistently for over 10 years. The AECOM 'snap-shot' sampling of the Kaituna River showed no significant variation between up and downstream results from the Waiari Stream confluence in the Kaituna River.

The Waiari stream is located in a rural catchment which is dominated by pastural farming activities. This type of land use is known to result in degradation of stream values through reductions in riparian vegetation, stock access to stream banks, and high nutrient loads from stock urine and fertiliser usage. Faecal contamination is also prevalent. The historical water quality monitoring data for the Wairai Stream aligns with this typical pattern and shows a nutrient enriched environment due to the total nitrogen and total phosphorus concentrations from both the Waiari Stream upstream and downstream sample locations.

The WWTP discharge also is contributing to the nutrient enrichment, however further analysis of the contribution made by the treated effluent (post UV) indicates other contaminant sources within the wider catchment are also significant contributors to the enrichment of the Waiari Stream. Waiari Stream (up and downstream) total nitrogen, total phosphorus, nitrate-nitrogen and dissolved reactive phosphorus (DRP) concentrations consistently exceed the ANZECC default trigger values for NZ slightly disturbed ecosystems. As shown in Table 9 above the nutrient mass load calculations show the current percentage contribution of the WWTP treated effluent to the difference in upstream and downstream mass loads is 40% for total nitrogen and 30% for DRP. This indicates the majority of nitrogen and DRP input to the downstream nutrient load is coming from other sources within the catchment.

Total ammoniacal nitrogen is toxic to fish and so the ANZECC trigger values and NPS numeric attribute states are set at levels which reduce the risk to fish life. The median total ammoniacal nitrogen concentration of the up and downstream Waiari Stream results do not exceed the ANZECC trigger level (0.9mg/L) nor the NPS Attribute State B (>0.03 to ≤0.24 mg/L). This indicates that the levels of total ammoniacal nitrogen within the Waiari Stream are unlikely to be toxic to fish.

Faecal coliform counts within the Waiari Stream are, on average, well below the MfE recreational areas action levels for freshwater environments which is calculated at 412 cfu/100mL. The WWTP treated effluent (post UV) is contributing low concentrations of faecal coliforms to the downstream receiving environment (in the region of 4%). However, preliminary analysis of the wetland monitoring results, indicate that this may be a bigger contributor to the downstream faecal coliform contamination.

The WWTP discharge is expected to increase from a current annual average flow of 1800m^3/day to 2348m^3/day in 2051 (based on 30% population increase). This increase will reduce the dilution factor of the Waiari Stream from approximately 168 to 130 (23% decrease) based on the 5%tile flow rate. Assuming that contributions from the surrounding catchment remain at current levels and no improvements are made to nutrient removal efficiencies at the WWTP this would mean an increase in relative contribution to the contaminant loads being discharged into the receiving environment. This would have the potential to contribute to nuisance algal growth, especially under summer low flow conditions.

4.0 Groundwater Assessment

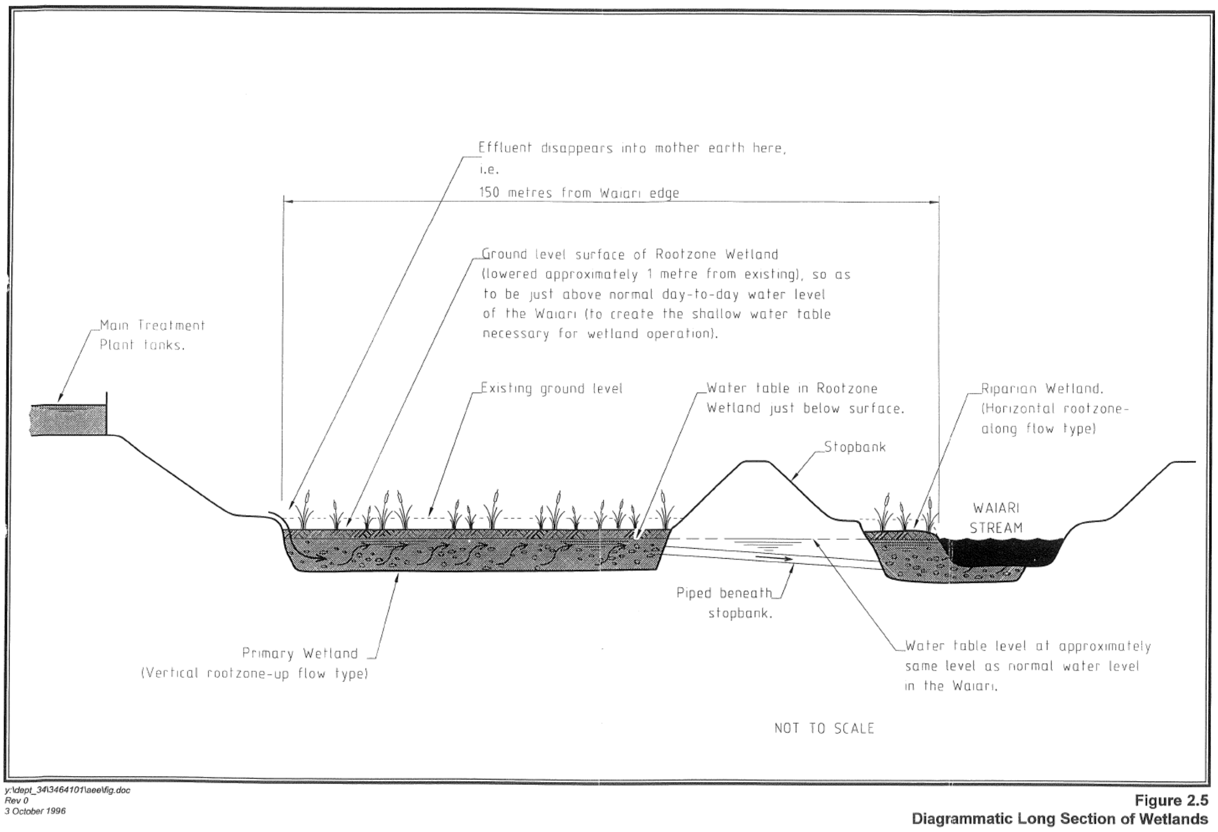
4.1 Hydrogeological Setting and Wetland Construction

The monitoring well bore logs, supplied by WBoPDC, indicate that the geology underlying the site consists of peaty silts and a combination of fine and coarse pumiceous sands. The peaty silts are consistent with descriptions from Landcare Research's S-map series, where the shallow soils are described as Waiari silt loam. This soil is described as a poorly draining loam over sandy loam, with moderate to low permeability. The lowest permeability horizon within 20 – 30 cm of the ground surface, inferred to have hydraulic conductivity in the order of 1 x 10^{-7} m/s. The soil type is also prone to generating runoff, due to its low permeability. The coarser sands, interlayered with the shallow peaty silts, are expected to have some control over drainage of the site and constitute the primary material for groundwater flow. Shallow groundwater is expected to flow generally towards the Waiari Stream (east to north east) and discharge where the stream channel intersects the sand layers.

The wetland has been constructed into the natural soil profile and below groundwater level. Understood to be unlined, this has likely provided a hydraulic connection between the wetland and shallow groundwater.

The WWTP wetland layout is illustrated in Figure 11.

Figure 11 Diagrammatic Long Section of Wetland - from Alandale Group and Worley Consultants, December 1996 (Figure 2.5)



4.2 Groundwater Quality

Groundwater represented by sampling of monitoring wells between 2007 to 2015 (refer Table 10), demonstrates elevated nutrient and faecal coliform concentrations, with these inferred to be characteristic of the influence of wastewater. Conditions vary to some extent between each of the wells, as follows:

- Faecal coliforms concentrations are significantly greater in groundwater samples from monitoring well No.4 than other locations, suggesting a direct influence of wastewater.
- Phosphorous concentrations are relatively low (inferred to be due to adsorption on pumiceous soils), but highest in monitoring well No.2.

- Total nitrogen concentrations are generally consistent (Average of 4-5 mg/L) in groundwater samples collected from monitoring wells No.1, No.2 and No.3. These average concentrations fluctuate over time.

Figures 12 to 16 illustrate measured groundwater concentrations over time for key wastewater indicator parameters.

Table 10 Medians, Averages and Ranges of Measured Parameters in Groundwater Bores

Sample Location		Groundwater Parameters			
		Ammonia Nitrogen g/m3	Total Oxidised Nitrogen g/m3	Phosphorus - Dissolved Reactive g/m3	Faecal Coliforms per 100mL
Bore 1	Median	1.89	1.83	0.03	6
	Average	2.73	2.34	0.03	477
	Min	< 0.05	0.07	0.01	< 1
	Max	8.00	7.99	0.06	3700
Bore 2	Median	3.07	3.72	0.04	2
	Average	2.97	3.35	0.12	59
	Min	0.08	< 0.015	0.01	< 1
	Max	4.13	4.90	0.79	700
Bore 3	Median	< 0.05	3.72	0.03	4
	Average	0.29	4.52	0.03	25
	Min	<0.05	0.05	0.01	< 1
	Max	1.44	13.30	0.06	98
Bore 4	Median	0.05	1.62	0.02	29
	Average	0.45	2.28	0.03	570
	Min	< 0.05	< 0.01	0.01	< 1
	Max	3.78	7.18	0.07	6200

Figure 12 Ammoniacal Nitrogen Concentrations in Groundwater

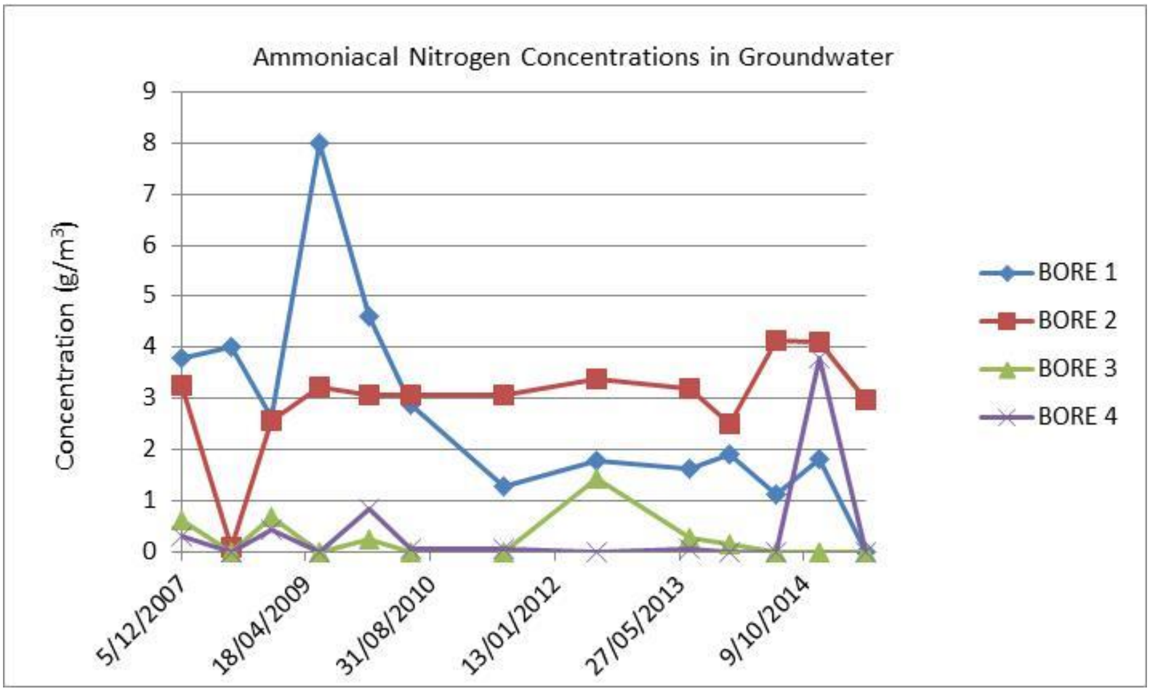


Figure 13 Nitrate + Nitrite- Nitrogen Concentrations in Groundwater

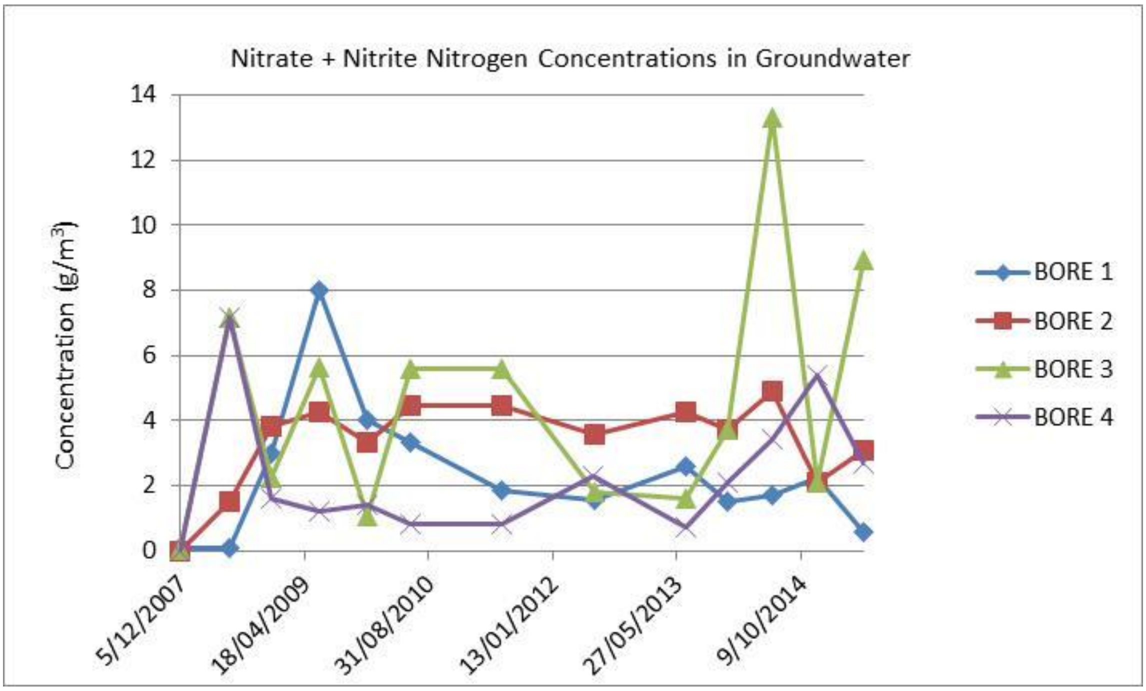


Figure 14 Dissolved Reactive Phosphorous Concentrations in Groundwater

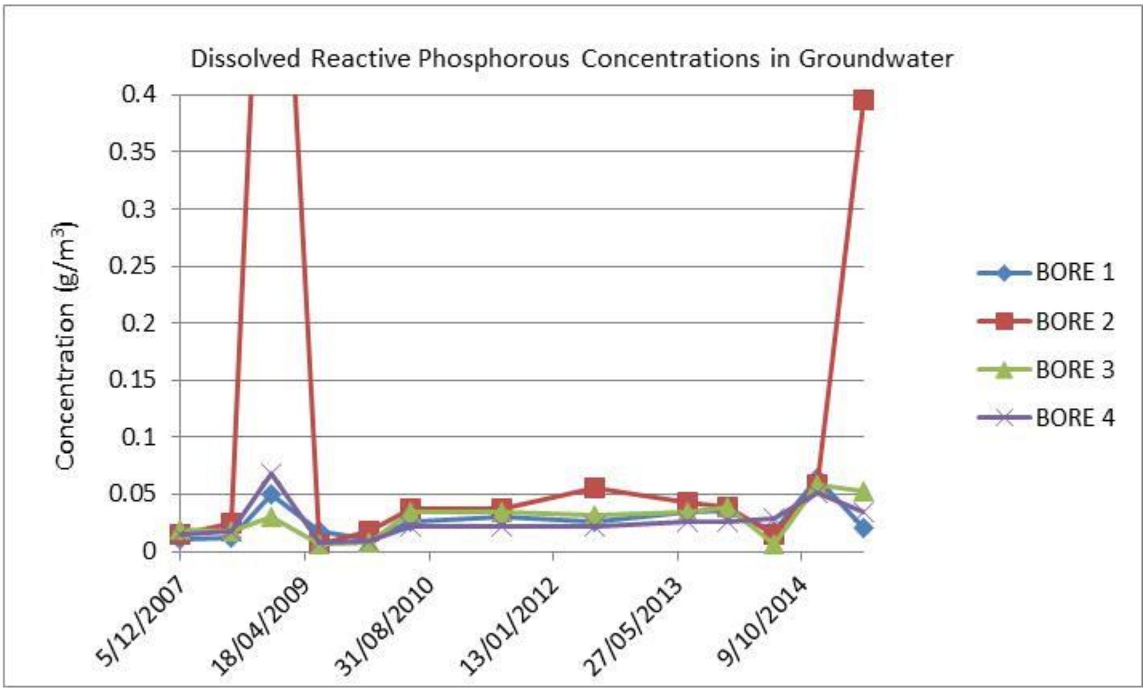
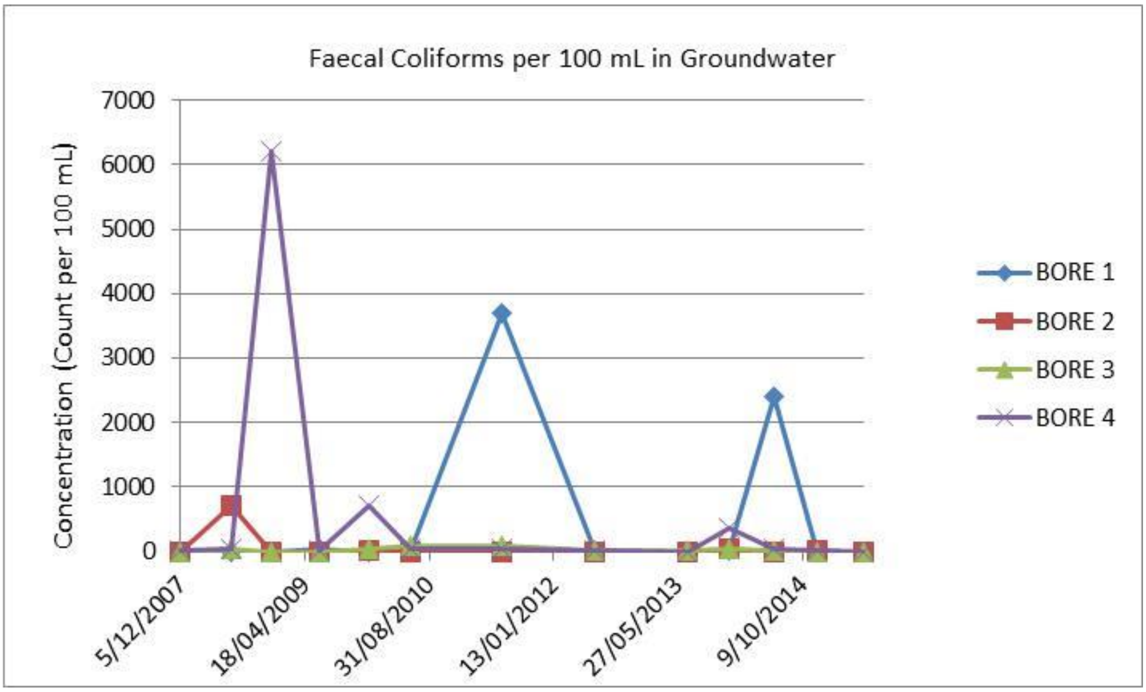


Figure 15 Faecal Coliform Concentrations in Groundwater (counts per 100 mL)



4.3 Groundwater Assessment

The inflow of treated wastewater into the wetland results in elevated water levels within the wetland relative to the surrounding groundwater levels, this mounding of water, creates hydraulic gradients downwards and outwards from the wetland and is expected to generate flow of treated wastewater into the surrounding shallow groundwater system. Inferred to flow primarily through the coarse sand lenses, the influence of this treated wastewater is evident with the quality of groundwater samples collected from the site monitoring wells.

Treated wastewater is expected to flow radially outwards from the wetland. However, due to the inferred groundwater flow being towards the stream, it is expected that the influence of treated wastewater on groundwater will be limited to within the immediate vicinity of the wetland.

The significantly slower rate of flow of impacted groundwater to the stream, relative to surface water discharges, is also expected to enable additional attenuation of microbiological contaminants and nutrients prior to discharge to the stream; to some extent this provides additional polishing of water quality exiting the wetland.

The surrounding land-use, which comprises farming activities, also typically contributes to nutrient loading on groundwater. However, it is unclear from the available information to what extent background groundwater quality is already impacted by nutrients. Regardless of the extent to which groundwater is locally affected, the receiving environment of the affected groundwater is the same as the treated wastewater discharge ie: to the Waiari Stream and the relative health of the stream is discussed elsewhere in this report.

Overall, it is considered that effects to groundwater are relatively limited since they are so localised.

5.0 Stream Ecology

As discussed in Section 2.0, stream ecological monitoring, including a habitat and macroinvertebrate assessment was undertaken at four locations. These locations were identified based on proximity to the expected discharge point within the Waiari Stream and within the Kaituna River and are presented in Figure 1.

5.1 Methodology

5.1.1 Habitat Assessment

At each monitoring location, run, riffle and pool habitat types were quantified for a reach of the stream. This habitat characterisation provides key information on general stream health and likely macroinvertebrate communities. Visual assessments of the inorganic and organic substrates were carried out at each site. Also at each of the sites, factors such as overhead vegetation cover, lateral riparian extent along the stream banks, dominant vegetation types, and riparian understory and canopy vegetation were assessed and recorded to determine the shade proportions

AECOM has used the Auckland Council (AC) scoring system for assessing habitat quality, which is based on methods used by the USEPA (USEPA, 2006). The functions of this assessment that were observed and recorded include aquatic habitat diversity and abundance, hydrologic heterogeneity, channel shade and riparian vegetation integrity. This system provides a scoring mechanism based on a score out a possible 100. Each parameter is based on a scoring category of either optimal, suboptimal, marginal and poor.

5.1.2 Macroinvertebrate Sample Collection Methodology

Following Protocol C2, developed for the sampling of macroinvertebrates in wadeable, soft-bottomed New Zealand streams, samples were collected from each site with a D-net (0.5 mm mesh). The method of collection involved disturbing 10 fixed areas of 0.3m² (total 3 m² substrate disturbed for each sample) and then collection of disturbed materials downstream in the net. This material was then sorted to remove any large debris and leaves, and the final sample preserved in an alcohol mixture. The samples were sent to Brett Stansfield (Environmental Impact Assessments Ltd), a qualified macroinvertebrate taxonomist for expert identification. All samples were analysed in line with the MfE P3 Protocol[7].

For soft-bottomed streams, such as the Waiari Stream and Kaituna River, wood in particular and also rooted macrophytes in flowing water provide the most stable and productive habitats for macroinvertebrate species[8]. Table 11 presents the total number of each type of substrate sampled at the sites during the monitoring.

Table 11 Summary Substrate Type Sampled

Location	Wood Debris	Aquatic Roots	Submerged Macrophytes	Emergent Macrophytes	Bankside Vegetation
W1	8	0	1	0	1
W2	8	0	1	1	0
K1	5	2	1	2	0
K2	6	1	2	1	0

* Note – includes the total substrate type sampled for the four replicate samples with each sample unit equivalent of 0.3 m^2

[7] Protocols for Sampling Macroinvertebrates in Wadeable Streams. Sustainable Management Fund Project No. 5103. Prepared for the Ministry for the Environment. November 2001:
[8] Regional Guidelines for Ecological Assessments of Freshwater Environments – Macroinvertebrate Sampling in Wadeable Streams, Environment Waikato Technical Report 2005/02, January 2005

5.1.2.1 Ecological Assessment Indices

Biological indices were calculated from the macroinvertebrate data for each site. The indices were comprised of data on:

Taxonomic Richness – a measure of the number of macroinvertebrate taxa present in each sample – generally a larger measure of taxa will represent a higher quality of aquatic environment.

Abundance – the total number of macroinvertebrates in each sample.

Community Composition- assessment of major macroinvertebrate groups within communities in relation to the totals. Groups include Ephemeroptera (mayfly), Plecoptera (stonefly), Trichoptera (caddisfly), Odonata (damselfly & dragonfly), Diptera (truefly), Hemiptera & Coleoptera (bug & beetle), Crustacea, Mollusca, Oligochaetes, Collembola and Other (leeches, mites, flatworms and nemertean etc.).

Macroinvertebrate Community Index – for soft bottomed streams (MCI-sb) – MCI-sb is the original MCI altered for use with soft bottomed streams. The index uses a scoring system between 1 (tolerance to organic enrichment) and 10 (sensitive to organic enrichment), where a score is assigned to each taxon. The MCI-sb can be used to describe the 'health' of the stream (Table 12).

Quantitative Macroinvertebrate Community Index – for soft bottomed streams (QMCI-sb) – The QMCI-sb uses abundance data and is based on a relative sensitivity of different taxa in a sample to changes in water quality. The QMCI-sb is particularly sensitive to changes in the relative abundance of individual taxa within a community and interpreted using the guidelines outlined in Table 12.

Table 12 Interpretation of MCI-sb and QMCI-sb Values from Soft-Bottomed Streams

Quality	Descriptions	MCI-sb	QMCI-sb
Excellent	Clean water	> 120	> 6
Good	Doubtful quality/possible mild pollution	100 - 120	5 - 6
Fair	Probable moderate pollution	80 - 100	4 - 5
Poor	Probable severe pollution	< 80	< 4

5.2 Ecological Monitoring Results and Discussion

The results and discussion of the habitat and macroinvertebrate monitoring has been presented in the following sections.

5.2.1 Habitat Assessment

While the habitat and stream morphology was comparable between the upstream and downstream locations within each of the watercourses, the habitat in the Waiari Stream and Kaituna River were quite different. Presented in Table 13 is a summary of the physical habitat recorded at each of the monitoring locations.

Table 13 Summary of Stream Habitat Assessment

Location	AC Habitat Score	Predominant Substrate	Organic Substrate	Channel Shade	Channel Width	Channel Depth
W1	41	Sand	Wood (8%)	Very low (30%)	11 m	> 1 m
W2	43	Sand	Wood (13%)	Low (45%)	9 m	> 1 m
K1	29	Silt/Mud	Wood (2%)	Ineffective (10%)	30 m	> 2 m
K2	31	Silt/Mud	Wood (5%)	Very low (15%)	35 m	> 2 m

A potentially contaminated point discharge was evident during the site survey, within the riparian margin, which consisted of stagnant water, dead organic vegetation build-up and brown algae growth. It appears, based on aerial photography that this discharge is associated with rural runoff from the surrounding farms (Figure 3 - Potentially Contaminated Source)

As presented in Table 13, the Kaituna River is a much larger watercourse than the Waiari Stream, with a silty/muddy substrate, lower proportion of wood debris and a much lower shade category. The Auckland Council (AC) Habitat score was relatively low at all of the sites (when scored out of a possible 100), but higher at the Waiari Stream, largely owing to greater habitat abundance and diversity observed. It was noted that due to the water level in the Kaituna River, the macroinvertebrate sampling was undertaken along the right bank margins. Despite only sampling the river margins, difficulties were still encountered, as the Kaituna River has a steep profile with very soft sediment. Also the majority of the stable habitat that was sampled was imbedded within the sediment. Additionally, it was noted during the survey that while there was evidence of instream macrophytes at all of the sites, the growth was not considered excessive and threatening to choke up the water course, as is often the case in lowland streams in rural catchments. Photographs of the monitoring sites as well as the discharge location are provided in Figure 3.

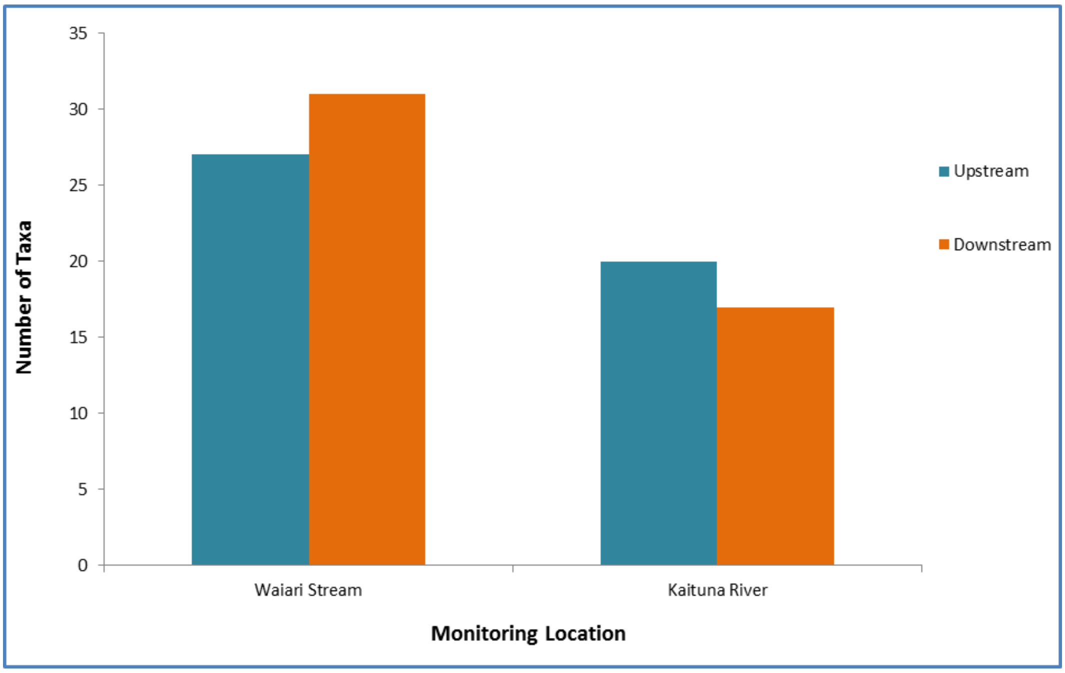
5.2.2 Macroinvertebrates

5.2.2.1 Taxa Richness (Diversity)

The diversity of macroinvertebrate communities ranged from 17 species (K2) to 31 (W2) (Figure 16).

The results show that the taxa diversity is much greater at the Waiari Stream locations compared to the Kaituna River. As discussed in Section 5.2.1, due to the habitat difference between the watercourses, namely the wood debris being smothered with sediment within the Kaituna River, there are likely to be large disparities between the taxa diversity. However, the results show similar diversity when comparing the upstream site with downstream site.

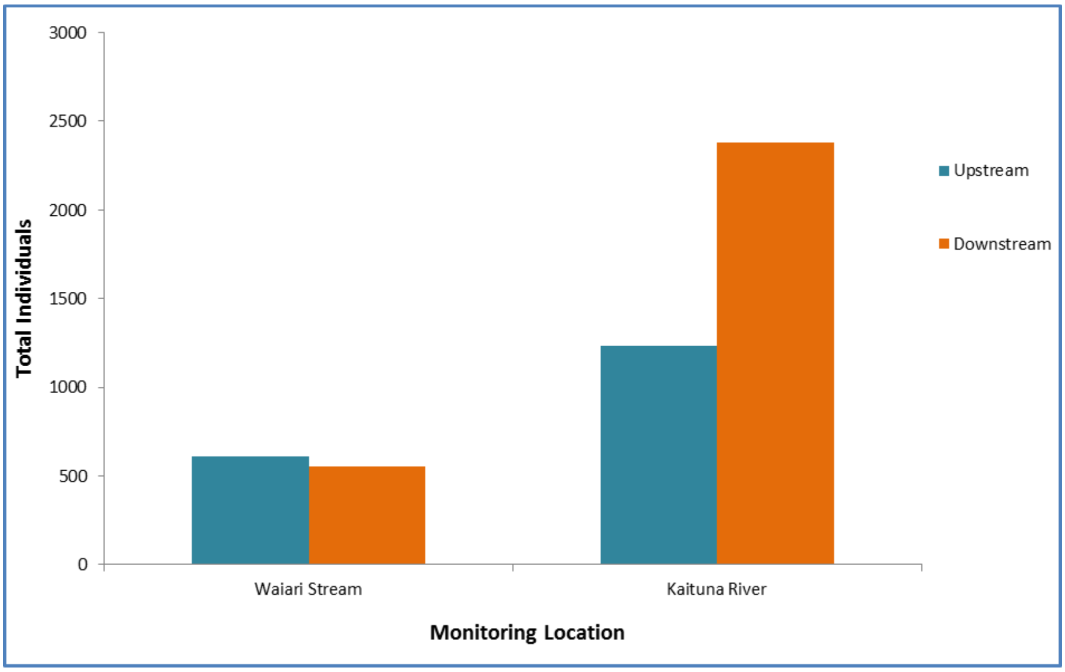
Figure 16 Taxonomic Richness Recorded in 2015



5.2.2.2 Taxa Abundance

Figure 17 presents the abundance of macroinvertebrate individuals ranged from 555 individuals (W2) to 2,383 (K2). The taxa abundance plot shows very similar numbers at both the Waiari sites, however a significant increase at the downstream sites within the Kaituna River. This increase is associated with the substantial number (1,037 at K1 & 2,286 at K2) of *Potamopyrgus* mollusc that was recorded at the downstream site, which were likely attached to the submerged macrophytes that were sampled.

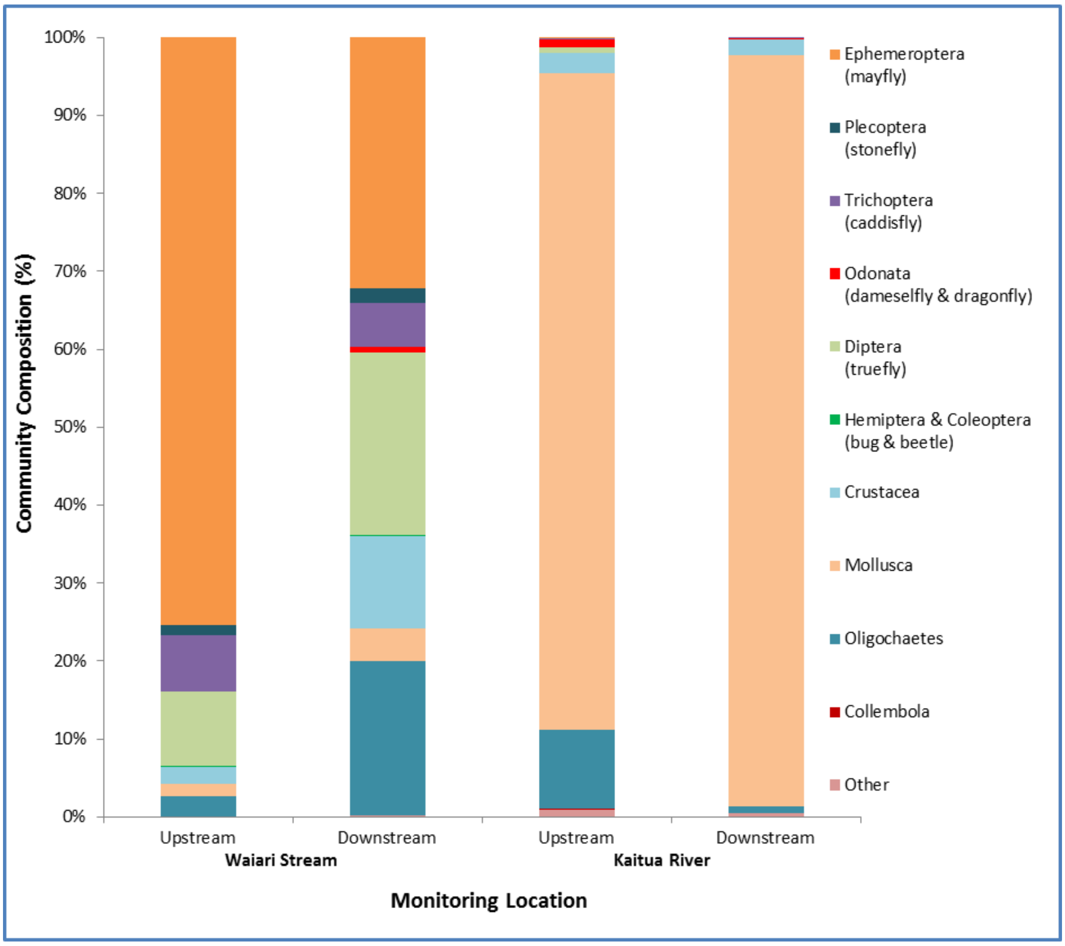
Figure 17 Taxonomic Abundance Recorded in 2015



5.2.2.3 Community Composition

The proportional abundance of the main macroinvertebrate taxonomic groups recorded from the Waiari Stream and Kaituna River is presented in Figure 18.

Figure 18 Macroinvertebrate Community Composition (%) Recorded in 2015



Waiari Stream - Upstream

This site was dominated by the *Zephlebia* and to a lesser extent the *Austroclima* mayfly (total of 75%). Both of these species are common in moderate to high quality, cool, gravelly or woody streams in the North Island. These are likely to have been attached to the wood that made up the majority of the substrate sampled. The other species that were in abundance included truefly (10%), caddisfly (7%) and oligochaetes, crustacea and mollusca (each less than 5%). Most of this second group of species, except for the caddisfly are typically associated with nutrient enriched streams.

Waiari Stream - Downstream

Similar to the upstream site, there was a dominance of mayfly (32%), with *Zephlebia* making up the majority at the downstream site. Also abundant was the caddisfly (6%). These are generally high scoring taxa and often associated with moderate to high quality streams. However, there was also a strong presence of lower scoring taxa such as the truefly (23%, mostly consisting of *Chironomid),* oligochaetes (20%), crustacea (12%) and mollusca (4%).

Kaituna River - Upstream

The macroinvertebrate community at the upstream site on Kaituna River was dominated by the *Potamopyrgus* mollusca (84%), with the remaining population being made up from oligochaetes (10%), crustacea (3%), damselfly (1%) and truefly (1%). The majority of these species are those that are often found in abundance in low quality watercourses. There were no high scoring species identified in abundant numbers at this location.

Kaituna River - Downstream

At the Kaituna Downstream site, the *Potamopyrgus* mollusc was found in prolific numbers (96%). There were also a small proportion of crustacea (2%) and oligochaetes (1%). These species are commonly found in weedy streams and are tolerant of nutrient enriched waters. Similar to the upstream site, higher scoring taxa were absent.

Summary

The Waiari Stream had abundant high scoring taxa at both sites with the mayfly being the dominant species, which are common in cool gravelly and woody streams. This stream had a very swift flow and a sandy bottom, with the high scoring taxa likely inhabiting the abundant stable woody debris that made up the majority of the samples. Based on the community composition results, the upstream site consisted of a greater proportion of higher scoring species, with a large number of *Zephlebia* and *Austroclima* mayfly present. However, this could be a result of variations and availability of habitat condition and type sampled at the time of the survey rather than differences in water quality between the upstream and downstream locations.

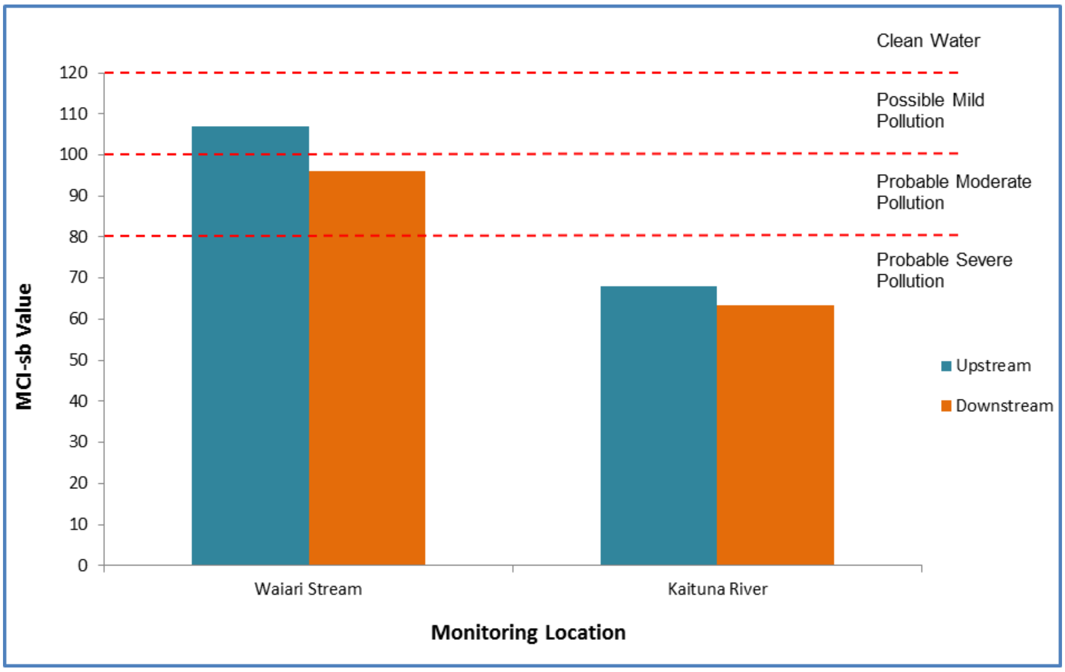
By comparison, both sites at the Kaituna were dominated by *Potamopyrgus* mollusca, which were likely inhabiting the wood debris that was submersed in sediment and also found within the macrophytes sampled. *Potamopyrgus* are typically found in most freshwater habitats, and can be very abundant in nutrient rich and silty streams. As the composition results indicate, both sites within the Kaituna River are dominated by species typically associated with nutrient enriched waters and sediment rich streams.

It was noted during the survey, that there was a lack of stable habitat available along the bankside margins at the Kaituna River, with most of the habitat that was sampled being buried in mud and silt. This silt deposition is potentially a consequence of the surrounding rural land-use, where much of the immediate riparian margins have been modified, thus removing the filtering ability of the bank margins. There did not appear to be any significant difference that may be a result of the discharges from the Waiari Stream, with the general poor habitat quality is most likely related to the surrounding rural environment.

5.2.2.4 Biological Indices

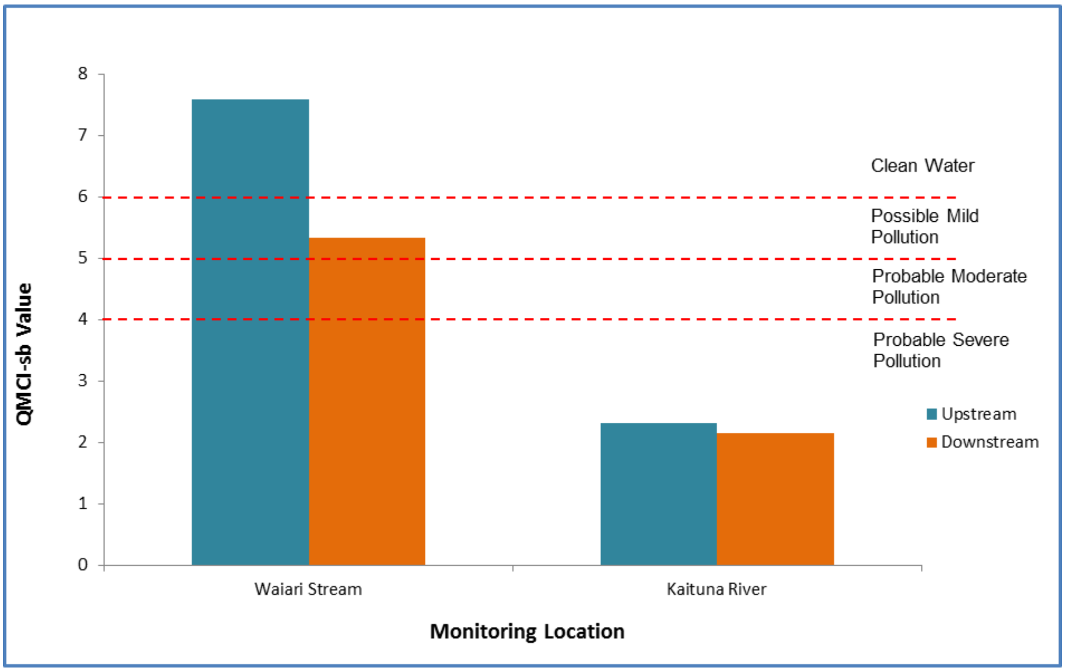
The MCI-sb values calculated from the macroinvertebrate data recorded from the monitoring sites are shown in Figure 19 and ranged from 64 (K2) to 107 (W1). The upstream and downstream indices within each watercourse are relatively comparable, with both of the upstream sites scoring slightly higher than the downstream sites. What is evident from the biological index results is the water quality of the Waiari Stream appears to be much better than the Kaituna River. The MCI-sb results from the Waiari Stream are indicative of a stream of ‘probable moderate pollution’ and ‘possible mild pollution’, while the values recorded from the Kaituna River signify a river of ‘probable severe pollution’.

Figure 19 MCI-Sb Values Calculated from Macroinvertebrate Community Data Recorded in 2015



The QMCI-sb values calculated from the macroinvertebrate data recorded from the monitoring sites are shown in Figure 20 and ranged from 2.1 (K2) to 7.6 (W1). Similar to previous discussions, the biological index results indicate that the water quality within the Waiari Stream is of much higher quality than within the Kaituna River. There is a considerable difference between the sites within the Waiari Stream, which is largely associated with the abundance of *Zephlebia* and *Austroclima* mayfly recorded at the upstream location, while the values recorded at the Kaituna River are very comparable. The results from the Waiari Stream are indicative of a stream of 'possible mild pollution' and 'clean water', while the values recorded from the Kaituna River signify a river of 'probable severe pollution'.

Figure 20 QMCI-Sb Values Calculated from Macroinvertebrate Community Data Recorded in 2015



5.3 Summary

Overall the results from the ecological survey show that there are significant differences between the Waiari Stream and the Kaituna River, however with good agreement when comparing the upstream and downstream locations. There is potential that the variances between the two watercourses are related to the physical habitat abundance, diversity and the substrate type. With the stream bed and margins along the Kaituna River being a silty/mud substrate, the majority of the available habitat was completely submerged in sediment.

The biological results from the Kaituna River are very comparable between the upstream and downstream sites, with both sites showing 'probable severe pollution' or 'poor' quality. The results from the Waiari Stream show a slight disparity between the upstream and downstream sites, with the upstream site indicating a stream of 'good' and 'excellent' quality, while the downstream site a stream of 'fair' to 'good' quality. It is likely that the decreased ecological community at the downstream site is associated with sampling methods, the type and condition of the substrate sampled at the time. These differences could, in part, be attributed to discharges from the WWTP, other point source discharges such as the one identified in Figure 2 and diffuse inputs from the surrounding agricultural land use.

While the results indicate that the Waiari Stream is generally more supportive of aquatic life, the Kaituna River is of poorer health, and typical of low lying streams and rivers draining predominantly agricultural catchments. However, as mentioned previously, due to the scale of the Kaituna River and winter flows at the time of the survey, sampling was only possible along the bank margins. During lower flow conditions, the sampling may have been possible within the body of the stream, rather than just along the edges. Consequently with faster flows in the centre of the river (and less chance for sediment deposition), and potentially more access to stable habitat, the results at the Kaituna River may be significantly different to those reported in this assessment. Therefore, it is worth reiterating that this survey is a 'snapshot' of the current conditions, and due to the disparities in size and limitations of sampling techniques, it is of more value to compare the upstream against the downstream sites rather than draw comparisons between the Kaituna River and the Waiari Stream.

6.0 Riparian Terrestrial Ecology

The WWTP is located within pastoral farmland to the east of Te Puke, in an area that has been largely cleared of indigenous vegetation cover. The process for the Te Puke WWTP is presented in **Section 2.2 of the AEE**, and shows that after aeration and clarification, the effluent is treated by ultraviolet radiation before dispersing beneath a wetland and ultimately discharging into the Waiari Stream via a number of diffuse discharge points within the riparian margin. Approximately 2 km downstream of the discharge point, the Waiari Stream flows into the Kaituna River. The riparian margins of the Waiari Stream and Kaituna River have been degraded by drainage, grazing and invasive exotic weeds. AECOM undertook a site visit on 30 June and 1 July 2015 to assess the terrestrial ecology of the receiving environment.

6.1 Waiari Stream Terrestrial Environment

The discharge point of the treated wastewater is via a number of diffuse outlets located within a stepped/cut section (or ‘riparian wetland’) of the stream’s flood bank (Figure 21). The terrestrial vegetation within this riparian wetland is typical of pastoral and exotic grasses, with no tree canopy or indigenous vegetation. Both upstream and downstream of the discharge location, there were small clusters of indigenous trees and shrubs (crack willow) along the right bank that provide some shading to the surface of the stream. Both of the bank margins were very narrow, and although fenced from cattle, grazing was evident immediately adjacent to the streams edge.

Figure 21 Discharge Location – Waiari Stream Riparian Zone

Diffuse Discharge Point (Left Bank)

Grazing Upstream of Discharge Point (Left Bank)

Waiari Stream Riparian Margin (Left Bank)

Algae and Stagnant Water in vicinity of Discharge Point

It was identified by WWTP staff, that during flood events (typically a one-year event), the stream inundated the riparian zone and back flowed into the treatment plant's wetland.

6.2 Kaituna River Terrestrial Environment

The Kaituna River at the Waiari Stream confluence is also surrounded in pastoral farmland. Grazing is evident adjacent to the riparian zones along both banks, with a wider margin along the right bank. There were patches of crack willow tree extending the width of the riparian zones, small clusters of pampas with a predominant ground cover of reed sweet-grass and willow weed along the water's margin.

Figure 22 Kaituna River Riparian Zone

Kaituna River Riparian Margin (Right Bank)	Kaituna River Riparian Margin (Right Bank)

6.3 Summary

Based on the assessment undertaken by AECOM on 30 June and 1 July 2015, there is little evidence to suggest that the existing Te Puke WWTP is having any environmental impact on the terrestrial ecology of the receiving environment. The terrestrial ecology at all of the sites was dominated by exotic species, namely clusters of crack willow and pampas as the canopy and reed sweet-grass, willow weed and long grasses as ground cover. Both of the watercourses at the site locations were completely fenced off from stock, however the margins were very narrow and with the terrestrial vegetation at being significantly impacted by the highly modified surrounding rural environment.

7.0 Assessment Summary

The existing treated WWTP discharge is contributing concentrations of nutrients to groundwater in the vicinity of the wetland and to the Waiari Stream, however the surrounding agricultural land use and other point source discharges (e.g. farm drains) have all contributed to enriching the Waiari Stream with nutrients prior to reaching the WWTP discharge point. The WWTP treated effluent discharge is having an effect on the water quality chemical properties of the Waiari Stream. However the results of the physiochemical field surface water quality monitoring found good to excellent quality conditions. It should be noted that the physiochemical monitoring was conducted in winter when stream flows are usually higher. The water quality monitoring results for the Kaituna River show that the discharge of the Waiari Stream is having a minimal effect on water quality in the Kaituna River.

Elevated nutrient levels have been identified in all monitored groundwater bores (all located down gradient of the wetland) with the wetland construction is inferred to provide a direct hydraulic connection between wetland and surrounding shallow groundwater system. It is most likely that the discharge of treated wastewater to the wetland results in localised groundwater mounding, however, the radial influence of the wetland on groundwater is expected to be limited to within the immediate vicinity. It is likely that background groundwater in the area also contains elevated nutrient levels due to farming activities, however, background groundwater data is unavailable to confirm this.

Similar to the surface water quality results, the ecological assessment for the Waiari Stream indicates that discharges (diffuse and point) between the upstream and downstream locations are potentially having an impact on the ecological health of the stream, along with localised habitat availability. The MCI results from the Waiari Stream indicate the upstream site is of ‘good’ and ‘excellent’ quality, while the downstream site a stream of ‘fair’ to ‘good’ quality. The results also indicate that there appears to be little ecological difference between the upstream and downstream sites within the Kaituna, suggesting that the Waiari Stream discharges are having minimal effect on this larger watercourse. As discussed previously, it is worth reiterating that this assessment provides a ‘snapshot’ of the conditions at the time of survey, and due to the disparities in size between the watercourses and sampling limitations, it is of more value to compare the upstream against the downstream sites rather than draw comparisons between the Kaituna River and the Waiari Stream.

Overall, the water quality, stream and surrounding terrestrial ecology at all of the sites are indicative of a highly modified rural environment, with reduced riparian margins, limited availability of stable habitat and potential influence of diffuse and point source discharges.

The water quality of the proposed treated WWTP discharge are likely to remain the same however the flow rate of the discharge will increase thus increasing the load of contamination (particularly nutrients). Therefore, there is potential that with the proposed increase in treated discharges into the Waiari Stream, there may be subsequent additional effects within the receiving environment. It is recommended that routine monitoring continue to identify and quantify any additional effects to inform mitigation and or improvements to treatment processes should they be required.

8.0 Report Limitations

AECOM has prepared this Assessment for the Water Quality, Stream and Terrestrial Ecology Receiving Environment in accordance with the usual care and thoroughness of the consulting profession for the WBOPDC for use in a statutory process from the BOPRC under the Resource Management Act 1991 for activities undertaken at the Te Puke WWTP.

Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party except as provided for by the Resource Management Act 1991.

Nor does AECOM accept any liability for any loss, damage, cost or expenses suffered by any third party using this report for any purpose other than that stated above.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated 27 March 2015.

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in this Report. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared during July and September 2015 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

Appendix A

Water Quality Results Summary

Water Quality Monitoring Summary Results (2012 to 2015)

Sample Location		Parameter						
		Faecal Coliforms (cfu/100ml)	Dissolved Reactive Phosphorus (mg/L)	Nitrate-Nitrogen (mg/L)	Nitrate-N + Nitrite-N (mg/L)	Total Ammoniacal Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
WU1 - Waiari Upstream	Avg	74.39	0.081	1.26	-	0.017	1.305	0.08
	Median	62	0.057	1.14		0.01	**1.175**	**0.05**
	Min	4	0.032	0.93	-	0.01	0.109	0.033
	Max	230	0.235	2.68	-	0.11	3.44	0.266
	Count	36	35	35	-	35	36	36
WD2 - Waiari Downstream	Avg	76.83	0.166	1.416	-	0.062	1.502	0.162
	Median	63	0.142	1.36	-	0.01	**1.47**	**0.143**
	Min	8	0.039	1.11	-	0.01	1.05	0.043
	Max	250	0.68	2.24	-	1	2.4	0.438
	Count	36	35	35	-	35	36	36
WWTP Effluent - Post UV with no dilution	Avg	510.15	4.31	15.50	15.87	1.81	19.56	-
	Median	12	4.31	16.15	16.22	0.48	19.06	
	Min	4	3.33	4.33	5.80	0.06	7.89	-
	Max	20400	5.19	26.2	26.39	11.60	28.46	-
	Count	162	34	34	34	34	34	-
WWTP Effluent - Post UV with dilution factor applied	Avg	3.05	0.026	0.092	0.094	0.011	0.116	-
	Median	0.07	0.026	0.096	0.096	0.003	0.113	
	Min	0.02	0.020	0.026	0.034	0.000	0.047	-
	Max	121.24	0.031	0.156	0.157	0.069	0.169	-
	Count	161	34	34	34	34	34	-
WU1A	Avg	23.5	0.035	1.075	1.13	0.0125	1.175	0.0405
	Min	23.5	0.035	1.075	1.13	0.0125	1.175	0.0405
	Max	23.5	0.035	1.075	1.13	0.0125	1.175	0.0405
	Count	1	1	1	1	1	1	1
WD2A	Avg	105	0.142	1.7	1.13	0.011	1.9	0.142
	Min	105	0.142	1.7	1.13	0.011	1.9	0.142
	Max	105	0.142	1.7	1.13	0.011	1.9	0.142
	Count	1	1	1	1	1	1	1
NPS[a]	A	≤413		≤1		≤0.03		
	B	**>413 to ≤857**		**>1.0 to ≤2.4**		**>0.03 to ≤0.24**		
	C	>857 to ≤1587	-	>2.4 to ≤6.9	-	>0.24 to ≤1.3	-	-
	Bottom Line	1587		6.9		1.3		
	D	>1587		>6.9		>1.3		
ANZECC[b]	99%			0.017		0.32		
	95%	-	0.01[c]	0.7	0.444[c]	0.9	0.614[c]	0.033[c]
	90%			3.4		1.43		
	80%			17		2.3		

Water Quality Monitoring Summary Results (2012 to 2015)

Table Notes
- = no value
Bold results denote an exceedence of the ANZECC guideline trigger value
Underline results denote an exceedance of the NPS numeric attribute states
a = National Policy Statement for Freshwater Management 2014 (gazetted 4 July 2014); River Annual Median (unless otherwise stated)
b = ANZECC, 2000. National Water Quality Management Strategy: Australia and New Zealand Guidelines for Fresh and Marine Water Quality, 2000
NPS Faecal Coliform - Derived from E.Coli nurmeric attribute states by applying the USEPA ratio of 126 E.Coli per 200 faecal coliforms
NPS Total Nitrogen - Polymictic lake annual median converted to mg/L
NPS Total Phosphorus - Lake annual median converted to mg/L
c = ANZECC default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems (Table 3.3.10)