A Quality Outcome for Piha – Wastewater Treatment and Disposal at one of New Zealand's Premiere Tourist Destinations

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ABSTRACT

Piha is situated on the West Coast of the North Island, approximately 28 kilometres west of Auckland City. As one of New Zealand's most famous surf beaches, it is a regular venue for national and international surfing competitions. The beaches, rock pools, bush tracks, and dramatic scenery make Piha one of Auckland's most popular visitor destinations.

Piha Beach experiences large fluctuations in visitor numbers, typical of semi-remote but popular beaches, with estimated peaks of 8,000 to 15,000 visitors usually coinciding with summer public holidays and school holidays. Visitors regularly come from the Auckland region, with Piha often being a must see for both national and international holiday makers. Piha also has a beachside community of Bach owners, with a growing number of permanent residents.

To meet this demand, Auckland Council provides a number of visitor and community facilities ranging from public toilets, reserves, campgrounds, car parks, play grounds, and public halls.

Due to its rural location, Piha is unreticulated for both drinking water and sewerage infrastructure. The Council owned treatment plant that catered for the Domain public toilets and campground was at the end of its economic life, and was undersized to meet the increased peak hydraulic flows experienced during the summer months. For a number of years the Council managed summer peak flows by pumping approximately 500,000 litres from the system by vacuum tanker.

In May 2007, Waitakere City Council applied to renew the resource consent to discharge wastewater from the Piha Domain facilities (which includes campground toilet/shower block, kitchen utility building and camp manager's house, tennis club and library), and the South Piha Public Toilet block. Additionally, discussions with the Piha-Karekare Local Water Agenda Group revealed that current wastewater management of the Piha RSA and Piha Bowling Club facilities was inadequate and having an impact on the Piha lagoon. Consequently, it was decided that the best environmental solution for Piha was to combine all of the wastewater and treat centrally via a new upgraded Council owned facility.

The paper covers wastewater treatment and disposal, resource consenting, engineering design, installation and plant performance.

KEYWORDS

Compliance, on site wastewater, resource consents

1 INTRODUCTION

Piha is situated on the west coast of the North Island, approximately 28 kilometres west of Auckland City. As one of New Zealand's most famous surf beaches, in additional to its regular crowd of surfers, it is a regular venue for national and international surfing competitions. The two black sand beaches (north and south Piha) are separated by Lion Rock and surrounded by the Waitakere Ranges. The beaches, rock pools, bush tracks, and dramatic scenery make Piha one of Auckland's most popular visitor destinations. Piha also has a beachside community of Bach owners, with a growing number of permanent residents. Piha Beach experiences large fluctuations in visitor numbers, typical of semi-remote but popular beaches, with estimated peaks of 8,000 to 15,000 visitors usually coinciding with summer public holidays and school holidays. Visitors regularly come from the Auckland region, with Piha often being a must see for both national and international holiday makers.

In recognition of Piha's importance, there are a number of visitor and community facilities administered by Auckland Council, at Piha, ranging from public toilets, reserves, car parks, play grounds, and public halls. Due to the remote location of Piha, these assets

are not reticulated for wastewater and rely on on-site treatment and disposal of treated effluent to ground. Within Piha, treatment and disposal of wastewater generated from Piha Domain and South Piha public toilets was achieved using recirculating sand filters and disposal of treated effluent to ground. These assets were approaching the end of their economic life and were undersized to manage the increasing wastewater volumes generated during the peak summer months. To manage extreme peaks over the summer period, Waitakere City Council implemented a managed pump-out regime in an effort to meet discharge limits and avoid adverse environmental effects. In summer 2009/10, approximately 500,000 litres of wastewater was pumped from the treatment systems and tankered off site for disposal.

In May 2007, Waitakere City Council Parks and Open Spaces applied to renew resource consent to discharge wastewater from the Piha Domain facilities (which includes campground toilet/shower block, kitchen utility building and camp manager's house, tennis club and library), and the South Piha Public Toilet block. The application was put on hold at the request of the applicant to allow another summer of flow data to further refine the design. Additionally, discussions with the Piha-Karekare Water Agenda Group revealed that current wastewater management of the Piha RSA and Piha Bowling Club facilities was also inadequate. It was therefore decided to provide a combined wastewater treatment and disposal system that will manage the wastewater generated from facilities at the following locations:

- Piha Domain/Campground
- Piha Tennis Club
- Piha Library
- Piha Bowling Club
- South Piha Public toilets
- Piha RSA

The wastewater generated from the four locations was managed differently as follows:

- Piha Domain and Campground – secondary treatment and land disposal
- South Piha Public Toilets – secondary treatment and land disposal
- Piha RSA – buffer storage and disposal off site (decommissioned septic tank and trenches)
- Piha Bowling Club – buffer storage and disposal off site (decommissioned septic tank and trenches).

The individual wastewater systems were not considered to be the best option for managing the wastewater generated at each subject site. Through discussions with the Piha-Karekare Local Water Agenda Group, Council and the ARC, it was proposed to provide one combined wastewater treatment plant and disposal field for all facilities that would be designed to manage the extreme peak wastewater flows generated during the summer period and treat the wastewater to a high standard prior to disposal. By combining the wastewater together and treating all flows in one treatment plant this had some distinct benefits for both the local receiving environment (Piha Lagoon), Waitakere City Council, Piha RSA and Bowling Club. These included:

- a single resource consent to manage
- one treatment plant and one disposal field
- one service and maintenance provider
- an improved level of treatment and a more suitable disposal location for the treated effluent (for the RSA and Bowling Club)
- the mixed wastewater will allow balancing of Carbon:Nitrogen ratio's
- economies of scale

2 DETERMINATION OF WASTEWATER FLOWS

The ARC requested individual estimates of daily design flows for all facilities associated with the discharge consent application. These were based on both actual flow meter records and TP58 design guidelines, thereby giving the opportunity to compare the figures to ensure that the design was robust. This also included estimates of campground occupancy at peak times and consideration of potential future growth in wastewater production from the various facilities. To achieve this, the following was undertaken:

- review of all water meter readings
- assessment of reported outcomes on all water meters and site facilities including water saving fixtures (carried out in the site investigations)
- accounting for historical pump out volumes in flow calculations

- assessment of wastewater flows at the various facilities
- water meter readings reality checked against design flow calculations based on TP58 guidelines
- discussion with key stakeholders to assist in reality checking flows and future growth/demand forecasts
- growth trends considered and future flows forecasted
- wastewater design flows.

Consequently, the design wastewater flows for each of the four facilities are shown in Table 1 below:

Table 1: Summary of flows for each facility

FACILITY	FLOW	COMMENT
Piha Domain/Campground	24m^3/d	Includes allowance for growth of 1.8%per year for 10 years
South Piha Public Toilets	8.1 m^3/d	Includes allowance growth of 1.8% per year for 10 years
Piha Bowling Club	2 m^3/d	Fixed number of patrons. Peak flows to be buffered.
Piha RSA	2 m^3/d	Fixed number of patrons. Peak flows to be buffered
	TOTAL	**36.1m^3/d**

The combined peak wastewater generated by the above facilities is 36,100 litres per day. This was used as the peak design volume. However, it must be noted that the peak only lasts for a short period between late December and mid-February, coinciding with the summer period, Christmas holidays and one off events that occur in Piha e.g. surf championships. Outside this period the wastewater volumes are approximately 30-50% of the peak volume.

3 WASTEWATER TREATMENT AND DISPOSAL

Historically, secondary treated effluent from both the South Piha Public Toilet and Piha Domain/Campground was disposed of onto the disposal field via pressure compensating drip irrigation, locally known as the “trees for babies” area. The loading rate was conservative (5mm/d) for the category 3 sandy soils. Due to the increase in peak flows at each location effluent quality deteriorated and management of the system via pump-outs was carried out during the summer months. Not only were the treatment plants undersized, they are also approaching the end of their economic life.

It was also determined that there was insufficient land available or the land was unsuitable for treated effluent disposal at both the RSA and Bowling Club.

3.1 WASTEWATER DISPOSAL OPTIONS

A comprehensive assessment of suitable disposal areas within the Piha region was carried out due to the proximity of the existing disposal field to the Piha Lagoon, and the sensitive recreational use that it provides the public during the peak summer months. As part of this assessment, several locations were considered for the disposal of treated effluent from a combined treatment plant. These were:

- utilising the reserve area on Waitakere City Council land adjacent to the existing disposal field
- pumping the treated effluent to Les Waygood Park
- disposal on the Piha Domain
- other private/ARC disposal areas

Discharge to land at the existing location was considered to be the best practicable option when the engineering costs and potential resource consenting issues were taken into account. Discharge to land is the commonly accepted alternative to discharge to water. Managed pump outs are not considered to be an acceptable long-term option for the management of wastewater.

Continuing to use the existing disposal field was the chosen option. The land is located relatively close to the subject facilities and was used for wastewater disposal from the old treatment system. There have been no odour complaints and no

evidence of breakthrough/runoff on the disposal field over the past 13 years. There was sufficient land and the sandy soil type could accommodate the proposed disposal volumes.

3.1.1 DISPOSAL AREA ASSESSMENT

In order to confirm the on-going suitability of this area as a disposal field, a subsurface assessment was carried out by a soil scientist to establish soil characteristics and proposed aeral loading rates. This was very important as the nature of the soils may have changed following 12 years of wastewater application. The soils at the site consist predominately of medium to fine black sand with some organic material and there was no evidence of any accumulation or organic material from the application of wastewater. Indeed, the continual application of treated effluent has improved dune stability and the growth of native species has been prolific due to the regular doing of nutrient rich wastewater.

Based on the investigation undertaken, the soils were classified as Category 3, which allow a loading rate of 5 mm/day via pressure compensating dripline irrigation (PCDI).

The consented discharge allows a maximum of 36.1m^3 (36,100 litres) per day. Based on a loading rate of 5.75mm/day, the disposal field is 6,280m^2, with a 33% reserve area of 2,100m^2 reserve area. Outside the peak summer period when the average flows are <50% of the peak, the loading rate will typically be <3mm/day.

3.2 TREATMENT OPTIONS

As part of the upgrade design, other treatment processes have been considered. The following alternative treatment options are discussed below:

- Conventional aeration plants
- Membrane Bioreactors (MBR's)
- Textile packed bed reactors
- Recirculating sand filters (RSF)

3.2.1 CONVENTIONAL AERATED TREATMENT PLANT

Conventional aerated treatment systems are a credible alternative to RSF technology and have been installed throughout New Zealand to treat wastewaters of similar origin, volume and strength. They can be designed to meet the current effluent quality of 10:10 (BOD:SS). However, when compared to the existing technology aeration plants rely on more mechanical equipment, utilise more power and their performance can often be compromised by wide swings in load (hydraulic and organic).

3.2.2 MEMBRANE BIOREACTORS (MBR'S)

MBR's are a variant of the conventional aerated treatment plant but utilise a membrane for solid liquid separation instead of a gravity settlement process. MBR's produce a very high quality effluent but in this situation they are not considered to be suitable because of the following reasons:

- sludge management – although they produce low volumes of sludge, they require desludging on a frequent basis
- power – high power usage when compared to the existing technology
- membrane replacement every 7-10 years
- complex control and regular maintenance required
- highly mechanical treatment plant
- very high capital costs

3.2.3 TEXTILE PACKED BED REACTORS

Textile packed bed reactors (rPBR's) are a variant of the recirculating sand filter (RSF) and have a very good track record for treating wastewater from facilities where there is a high seasonal change in organic load or flow. Textile filters also have the following benefits:

- well known to the current service provider
- consistently high quality effluent is produced
- low power users
- small footprint
- sludge production is kept to a minimum.

3.2.4 RECIRCULATING SAND FILTER (RSF'S)

The existing process used to treat the wastewater from the South Piha Public Toilets and the Piha Domain/Campground is based on RSF technology. Expanding the existing sand filter to cater for the proposed design flows was considered but there are a number of reasons why it was rejected, namely:

- availability of land – RSF's have a high land requirement when compared to other treatment processes e.g. aerated or textile filters
- availability of good quality sand – sourcing sand with a consistent size and without fines in the North Island is difficult.

3.3 TREATMENT PLANT UPGRADE

A recirculating packed bed reactor was selected, as it was determined to be the most stable treatment system capable of handling fluctuating loads while having the smallest footprint. This type of system is based on the well known recirculating sand filter system. However, rather than using sand it uses a textile medium which has a much greater surface area than sand, and therefore can accept a higher loading rate while achieving the same discharge standard. This results in a smaller treatment plant footprint.

For the above reasons, textile packed bed reactor technology was specified as part of the resource consent application. The following consent conditions, relating to the discharge volume and effluent quality, were agreed with the ARC:

Table 2: Discharge Consent Requirement

Biochemical Oxygen Demand (BOD_5)	15 mg/l
Total Suspended Solids (TSS)	15 mg/l
Ammoniacal Nitrogen (NH_4)	<5mg/l
Treated Effluent Volume	36,100 litres/day
Disposal field loading rate	5.75 mm/day
Pressure compensating dripline	6,280m^2
Reserve area (33%)	2,100m^2

There was no requirement to disinfect the effluent due to the conservative loading rate on the disposal field and the sandy nature of the soils. However, Council decided that to protect the receiving water (Piha Lagoon and Piha beach) the installation of a UV disinfection system would ensure that bathing waters were protected from the discharge from the Council system.

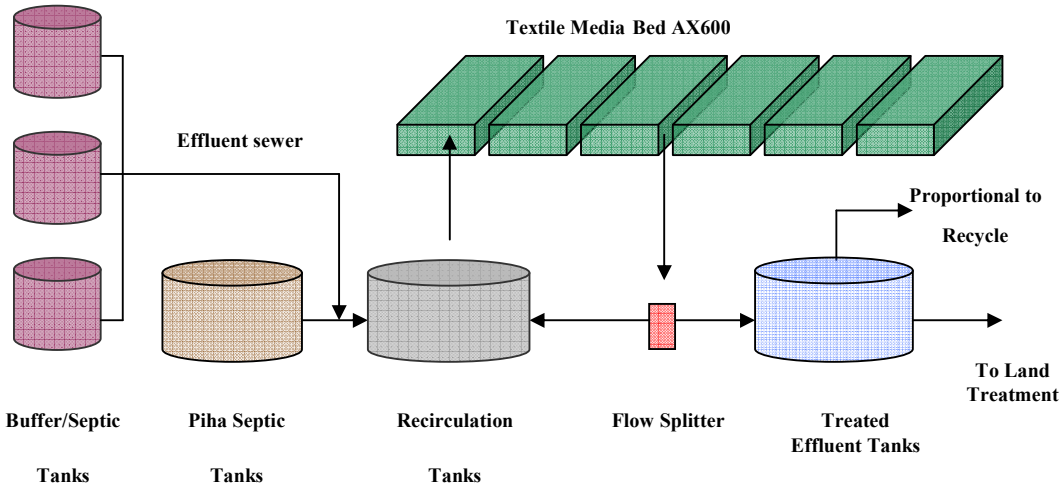
A performance based tender was assembled and let by Council with a requirement that the treatment system had to be installed by Christmas 2010. The tenderers had the option of reusing some or all of the existing treatment plant, e.g. tanks, pipes, etc. Three tenders were received and following negotiations, the tender was awarded to Innoflow Technologies Ltd. The following equipment was installed at the each of the facilities:

Table 3: Treatment Plant Equipment

Facility	**Equipment**
Piha RSA	5,200litre grease trap (new) 23,000litre buffer/septic tank c/w outlet filter (new) Flow meter and telemetry (new)
Piha Bowling Club	4,500 litre grease trap (new) 23,000litre buffer/septic tank c/w outlet filter (new) Flow meter and telemetry (new)
South Piha public toilets	4 x 5,000 litre septic tanks in series with outlet filter (existing)

	22,000litre buffer tank, pump, flow meter and telemetry (modified)
Piha Domain and Campground, library and tennis club	5,200litre kitchen grease trap and 3 x 4,500litre septic tanks with outlet filters (existing) 1 x 5,600 litre septic tanks with outlet filter (existing) Public toilets – 17,000 and 23,000 litre septic tanks with outlet filter (existing)
Treatment plant	2 x 23,000litre buffer/recirculation tanks with pumps and control system (modified) AX600 recirculating textile packed bed reactor (new) 2 x 23,000litre treated effluent tanks (modified) UV disinfection system (new) Alkalinity dosing system (new) Flow meter and telemetry system (new)
Recycle system	Chlorine contact tank (refurbished) Redox probe (new) Recycled effluent flow meter (new) Telemetry (new)
Disposal system	6,280m^2 pressure compensating drip irrigation area @ 1.0m centres (new)

Figure 2: Schematic Drawing of the Karekare Wastewater Treatment System



A remote monitoring alarm is installed and is connected to a WCC central control centre via an Irrinet platform. This type of system immediately alerts the operating company when an alarm is triggered (i.e. if a pump fails within one of the tanks). If necessary, emergency on-site storage can be utilised while the problem is rectified. The overall system has in excess of 24 hours emergency on-site storage.

4 PLANT PERFORMANCE SINCE COMMISSIONING

The treatment plant was installed by mid-December 2010 and has been installed for approximately 9 months. During the post installation/commissioning period, the wastewater treatment and disposal system has been operating effectively and has produced a high quality effluent.

4.1 WASTEWATER FLOWS

The flows generated by each facility are recorded and monitored by the Irrinet Telemetry system. The information allows Council to manage the system effectively during the peak summer period and can utilise the generous storage volume within the treatment system. Additionally, the flow data allows the Council to charge the RSA and the Bowling Club for being connected to the treatment system. The flows generated by the Piha RSA and Bowling Club are shown in Figs. 3 and 4 below.

Figure 3: Wastewater Flows from the Piha RSA

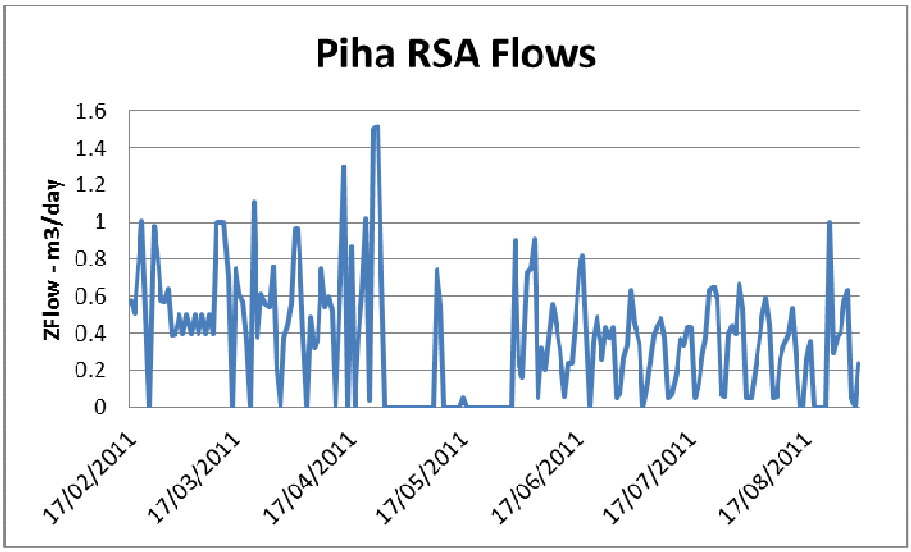
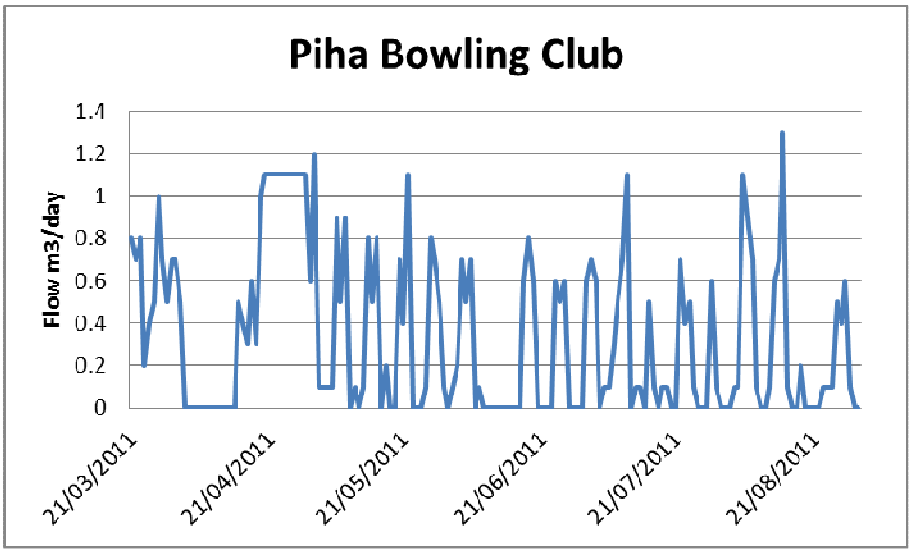
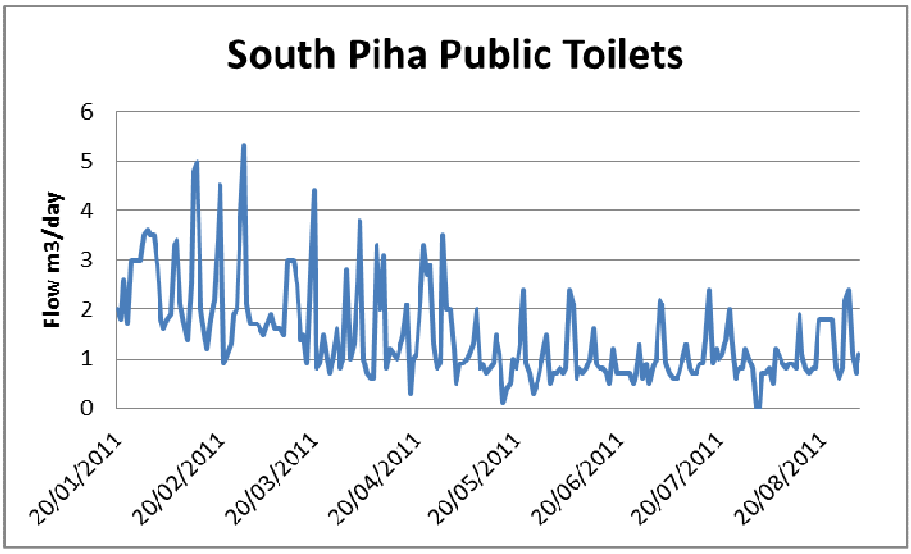


Figure 4: Wastewater Flows from the Piha Bowling Club



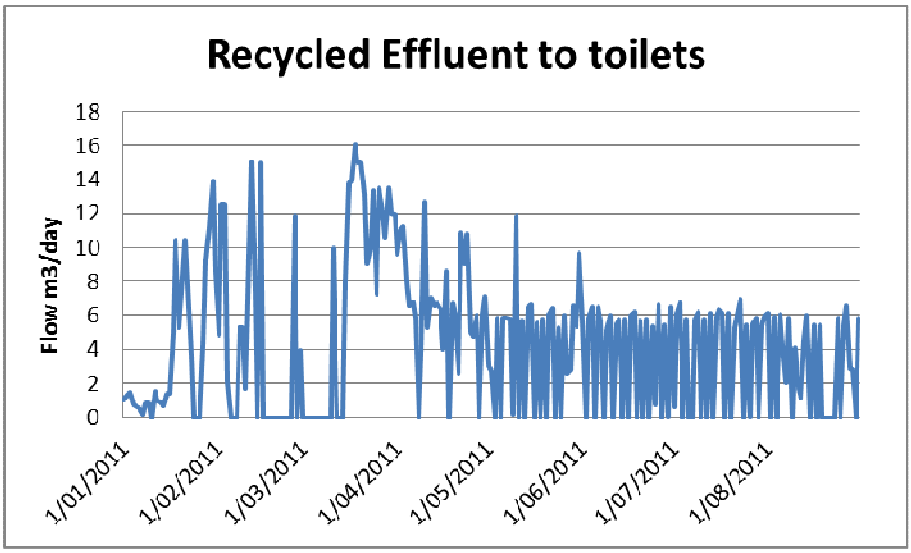
It can be seen that both of the facilities are within their allowable discharge of 2,000litres per day. This will be a function of the buffer storage volume. The flows generated by these facilities are anticipated to be consistent throughout the year.

Figure 5: Wastewater Flows from the South Piha Public Toilets



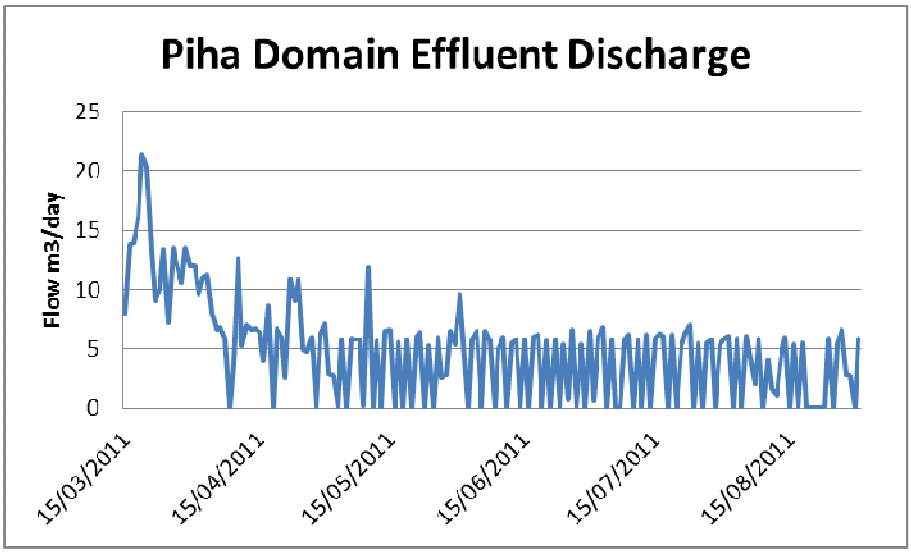
The wastewater volumes shown in Figure 5 above for the South Piha public toilets clearly show a decline following the peak summer period.

Figure 6: Volume of Recycled Effluent to Public Toilets



The volume of wastewater returned to the toilet block is between 7-10m^3/day during the peak usage period (approximately 25%) and depending on the water usage at the Domain toilets may go higher during the peak period. The gaps in the data are due to commissioning issues and ensuring sufficient sodium hypochlorite is available on site for chlorination of the recycled effluent.

Figure 6: Treatment Plant Discharge Volume



The wastewater flow data presented above in Figure 6 does not capture the peak summer period when the plant was under maximum hydraulic loading. This was due to commissioning issues with the telemetry system and accurately capturing and data logging the flow data. However, during the peak summer period of late December to mid-February, there were no pump outs required at the treatment plant. Therefore, there is sufficient storage capacity within the treatment plant to buffer extreme peak wastewater flows.

Additionally, due to the high quality effluent, which is very low low in BOD/TSS/Ammonia, it can be returned to the Piha Domain public toilets for toilet flushing (following chlorination). This has significantly reduced the potable water used at the campground.

4.2 EFFLUENT QUALITY

The effluent quality is analysed on a weekly basis between December and March. Table 3 below, shows the performance of the treatment system since it was installed in early December 2010.

Table 3: Piha Domain and Campground Effluent Quality

Date	BOD (mg/l)	TSS (mg/l)	NH4-N (mg/l)	E.Coli (MPN/100ml)	Total Coliforms (MPN/100ml)	Enterococci (MPN/100ml)	Nitrate (mg/l)	TN (mg/l)	Alkalinity (mg/l CaCO3)	pH
14/12/10	11	5	-	17300	>24200	1420	-	-	-	-
21/12/10	13	4	-	<100	<100	<100	-	-	-	-
29/12/10	2	2	-	<1	2	<10	-	-	-	-
5/01/11	<2	2	-	<1	1	<10	-	-	-	-
10/01/11	3	3	-	<1	1	<10	-	-	-	-
18/01/11	2	5	-	<10	410	40	-	-	-	-
27/01/11	<1	1	4.7	<1	5	<10	61.4	69	27	5.9
2/02/11	1	2	9.3	<1	5	<10	72.1	86	<1	3.7
8/02/11	2	2	4.1	<1	2	<10	62.8	64	<1	4.3

15/02/11	2	2	19.9	<1	7	<10	77.4	96	<1	4.8
1/03/11	2	1	12.2	<1	10	<10	69	85	<1	4.6
14/03/11	3	1	0.9	<1	5	<10	39.5	44	64	7.4
23/03/11	2	1	<0.4	<1	220	<10	53.7	60	24	6.5
29/03/11	1	2	0.087	<1	1	<10	47.2	51	38	7.3
CONSENT	15mg/l	15mg/l	<5mg/l	-	-	-	-	-	-	-

Start-up of the treatment plant was on 10th December 2010. Within four days the treatment plant was within the consent limits for BOD and TSS. The effluent quality was consistent throughout the peak period which coincides with peak wastewater volumes and maximum organic loading. Within 2 weeks the effluent was disinfected.

At the end of January 2011, the treatment plant was being sampled for a wide range of other parameters to assess the overall performance of the plant. It can be seen that there is a steady reduction in the pH of the effluent as the plant nitrifies and consumes alkalinity. Indeed, alkalinity (and available carbon) is the limiting factor for ammonia conversion to nitrate. In mid-March the alkalinity (sodium bicarbonate) dosing system was commissioned and this was followed by a rapid reduction in ammonia, an increase in pH/residual alkalinity and also a reduction in nitrate.

5 CONCLUSIONS

The installation of the new Piha Domain wastewater treatment system has meant that peak summer pump outs of raw wastewater are a thing of the past. The new treatment system has been designed to service a number of facilities, generating advanced secondary quality effluent that can be safely discharged to land.

The use of recirculating textile packed bed reactors produces a very high quality effluent in locations where there are wide swings in flow and loads. The quality of the disinfected effluent produced by the treatment plant is of a very high standard and meets discharge consent requirements for BOD, TSS and Ammonia. The key to effective removal is the addition of alkalinity in the form of sodium bicarbonate. The UV disinfection system, although not required by the resource consent, ensures that the discharge has extremely low levels of Faecal Coliforms, E.Coli and Enterococci.

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