RECIRCULATING SANDFILTERS: MEETING ENVIRONMENTAL AND SOCIAL NEEDS

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ABSTRACT

Auckland City Council was instructed by the Minister of Health to implement a small wastewater scheme on Waiheke Island in 1995. Wastewater management on the Island had historically been exclusively by on-site systems, and adverse ground conditions and increased development (including high tourist numbers) has impacted the performance of these systems in the commercial area of Oneroa.

Resource Consents were granted in 1999 following an extensive process including options evaluation and consultation for a recirculating sandfilter system with a capacity of 70,000 L/day prior to discharge to an existing wetland that drains to the sea. A recirculating sandfilter system was specified because of its ability to deal with high flow and load fluctuations, low maintenance requirements, and its ability to consistently achieve high effluent quality while having the potential to be landscaped into the existing terrain. The consents are conditional to meeting high effluent quality criteria for the discharge to the environmentally sensitive and culturally significant receiving environment.

A Design / Build / Operate contract was let in 2001 to Reflections Treatment Systems Ltd and administered by City Design Ltd. The construction was completed in 2001 over a nine week period, and the plant has been discharging treated effluent since December 2001. The operations contract has been extended.

This paper discusses the selection process for the Reflections™ recirculating sandfilter system followed by the construction phase and the system performance for the first eighteen months of operation. Managing issues encountered with high influent quality fluctuations are also discussed.

Keywords

construction, performance, recirculating sandfilter, treatment selection, wastewater

1 Introduction

Treatment and disposal of wastewater on Waiheke Island has traditionally been carried out by on-site systems comprising of septic tanks for primary treatment, and in some instances aeration or sand filters for secondary treatment. Disposal is to ground via evapotranspiration beds or dispersal ditches (trenches). These systems have been found to be unsatisfactory where there is a combination of development intensification, clay soils and high water use commercial activities (cafes, restaurants, hairdressers etc) the results are less than satisfactory, as at Oneroa Village. Significant public and Iwi (ie Maori community) consultation was undertaken from 1997 to develop an acceptable solution.

A centralised wastewater treatment and disposal system was identified as the most appropriate solution, and a suitable site was selected. The treatment system selected was a Reflections™

Recirculating Sand Filter System capable of treating high strength effluent with fluctuating loads at daily flows of up to 70,000 L/day. The system was commissioned in December 2001 and has been operating above specifications since. It has successfully dealt with unexpected peaking of influent load characteristics – common with commercial effluent.

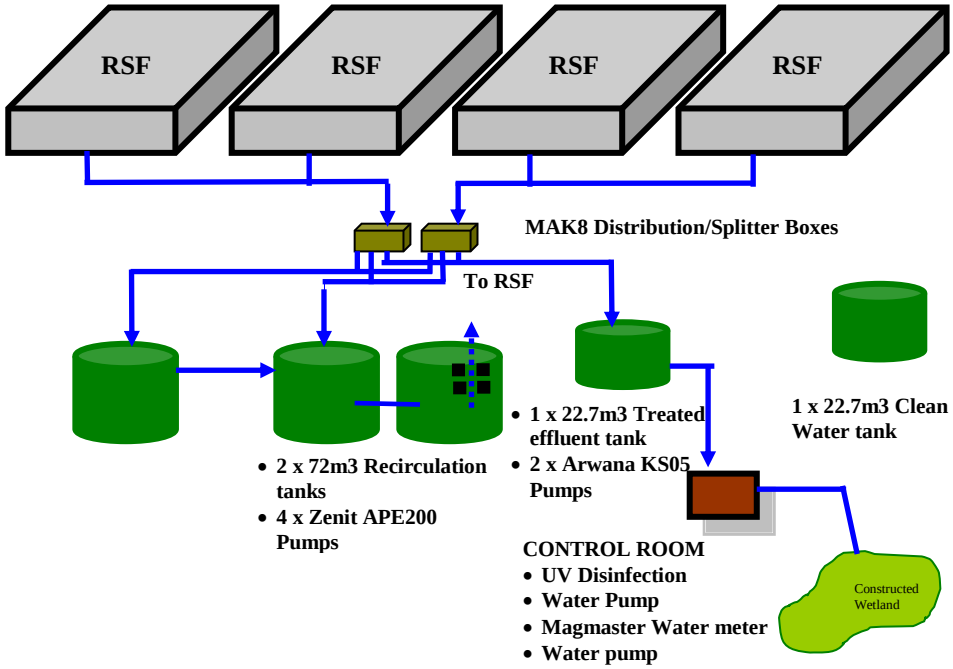


Figure 1: Process Flow Diagram

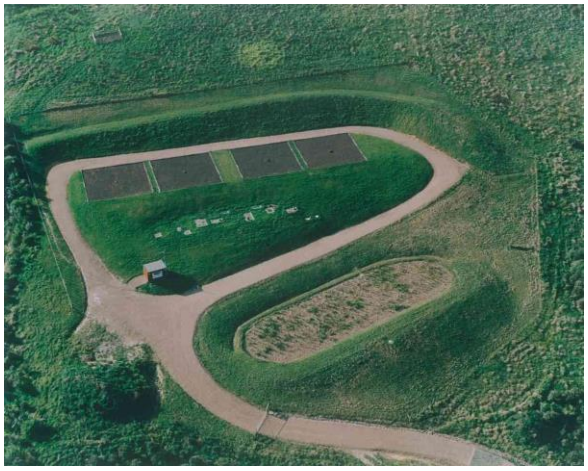


Photo 1 : Aerial View of Sandfilters and Wetland

2 Background

Waiheke Island, translated to "Cascading Waters", is situated in Auckland's Hauraki Gulf, famed for its sailing, and most recently the last two America's Cup sailing Regattas. It is the largest and most populous of the "Gulf Islands", with a permanent population of 8,000 residents, rising to 30,000 at peak holiday times such as the annual Easter Jazz Festival. The island has a total area of 2,200 ha, and consists of undulating hills, many bays and inlets, numerous streams and wetlands with a total length of 128 km of coastline. The soils are predominantly clayey in nature. It is a popular getaway for Aucklanders and travellers alike.

Waiheke is known for its natural beauty, its beautiful bays, wetlands of high ecological value, and its namesake "cascading waters". It has a very vocal community, with local Maori and Pakeha (non-Maori) alike having a strong sense of environmental responsibility, resulting in the implementation of high environmental standards for any development proposals.

The Island has been subject to significant development over the last two decades including: residential intensification, concentrated commercial intensification, and numerous tourism and hospitality developments. More than twenty vineyards have established recently in what has become a boom industry due to local soil and climatic conditions. There are about ten community clusters on the western half of the Island, each consisting of a few shops and cafes. The largest is the western-most Oneroa with more than thirty shops and cafes. Waiheke was first settled by Maori in 1200 AD. The dominant "Iwi" (the local Maori) are from the tribe Ngati Paoa.

Wastewater management on the Island has been exclusively by on-site treatment and disposal systems. The Oneroa commercial area has been identified as encountering the most serious disposal problems due to poor drainage, high (and fluctuating) effluent loads, and small sites. The Minister of Health, in a letter to the Auckland City Mayor commented (January 1997):

> *"Whilst I appreciate the difficulties in resolving issues of sewage treatment on Waiheke Island, I believe that if there is adequate will on the part of your council, a sewage treatment and disposal scheme for parts of Waiheke Island can and should be implemented as soon as practical."*

CITY Design Ltd, for Auckland City Council, conducted an investigation that concluded:

- Local geology of Oneroa has limited effluent soakage capability and carries the risk of instability from introduced wastewater;
- Off-site migration of effluent has occurred at least intermittently, and has adversely affected water quality both north, and south of the commercial area;
- On-site upgrade was not a recommended option; and
- An off-site reticulation network and treatment system was needed.

Options were investigated and assessed using criteria including cost, public health risk, public perception, cultural acceptability and environmental risk parameters.

After consultation with the Waiheke Community Board, and others, the Works and Services Committee resolved in June 1997 to proceed with a community reticulation network for the Oneroa commercial area. The design flows for the system are for up to 70,000 litres per day.

3 New Zealand's Legislative Context

The Resource Management Act 1991 (the Act) is New Zealand's primary environmental legislation, under which regional and district plans are developed and administered. While the Act does not provide specific guidance on the preferable means of wastewater disposal, it does state that the purpose of the Act *"is to promote the sustainable management of natural and physical resources*'. This means *"managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well being and for their health and safety while –*

a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and
c) *Avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

The Act requires recognition of the relationship of Maori to their culture and traditions. Water is considered by Maori to possess mauri, a life force. The discharge of contaminants to water reduces its ability to sustain life, thereby reducing its mauri. The ethic of Kaitiakitanga (guardianship/stewardship) of the environment creates a duty of Maori to protect and enhance the mauri of water for future generations. The traditional system of Kaitiakitanga is holistic, ensuring balance and harmony between the universe, the environment and the people. Consultation with Maori is thus important in the development of a wastewater system in NZ.

4 Resource Consent Process

The resource consent process requires the development of options, in consultation with Iwi and the community, that ensures environmental impacts of any discharge are remedied, avoided, or mitigated. Exploring options identified the difficulty of disposal to land due to low permeability of the available clayey soils, and the high value (socially, culturally, and environmentally) placed on any receiving surface water. An options assessment of potential sites was conducted in April 1997 including :

1. Direct disposal to sea,
2. Disposal to sea by infiltration through beach sands,
3. Disposal to ground,
4. Direct disposal to a natural wetland,
5. Disposal of treated effluent via a constructed wetland discharging to a natural wetland,
6. Reticulation to the mainland.

Following extensive consultation with Maori and Community Groups Option 5 was selected as the most appropriate, at the Owhanake Reserve site. Other options had been eliminated due to social / cultural unacceptability, site availability, identification of archaeological features, or distance from the Oneroa commercial area. The wetland at Owhanake Reserve, and Matiatia Bay to which it drains are of high value, in particular due to the uniqueness of the wetland and because the main ferry terminal for Waiheke is located 500m from the location at which the wetland enters Matiatia Bay.

Consequently consents were granted subject to high quality discharge requirements:

Parameter	Consent Limit	Design Influent	Actual Average Influent	Average Effluent	% Reduction
BOD (mg/L)	10	220	340	2.25	99%
SS (mg/L)	10	220	268	3	99%
Total Phosphorus (mg/L)	7	3	13	6	46%
Total Nitrogen (mg/L)	35	40	91	2	97%
NH4 (mg/L)	2	25	73	0.8	99%
FC No./100mL	50	N/A	1.24 million	3	99.998%

5 Tender Process and Selected Treatment Method

Design, Build, Operate tender documentation was sent to nine interested contractors, and four complying tenders were received for competitive evaluation. This process included assessing the following criteria :

- Design Suitability
- Ability to guarantee performance criteria
- Track Record
- Financial, Physical and Labour Resources
- Cost

Reflection Treatment Systems™ was selected as the winning tenderer. Their design consisted of the following components:

1. **Utilising Existing on-site Treatment Systems** (minimum requirement for septic tank fitted with effluent filter) to provide primary treatment prior to discharge to a large bore gravity reticulation network.
2. **Additional Primary Treatment Tank** (APT Tank) receives the effluent and is mixed with a portion of the treated effluent from the sandfilter. The APT Tank removes solids, floating grease and scum that may be carried over from the existing on-site systems.
3. **Recirculation Tank** receives the flow from the APT Tank and the recirculated flow from the sandfilter.
4. **Recirculating Sandfilter** (RSF), four separate sand filter beds, (each 12m x 12m x 1.2m deep) receive the diluted effluent from the Recirculation Tank. Effluent is treated to a high quality as micro-organisms living in the sand use the organic material in the effluent as a food source.
5. **Treated Effluent Tank**, receives the treated effluent from the RSF, and splits the flow to either be recirculated or for disinfection (UV) prior to discharge.

Two recirculation boxes are utilised (MAK 8s) to provide fully adjustable recirculation ratios to optimise treatment performance. They receive the treated effluent from the RSF and split the flow to either the recirculation tank, the APT, or the treated effluent tank (for discharge).

This system was selected as the most appropriate method for treatment because of its :

- Ability to modulise construction to allow for possible future expansion;
- Ability to accommodate treatment upgrade requirements in association with other treatment processes (aeration etc);
- Relatively low maintenance (incl. remote operation/monitoring by cell-phone);
- Low power usage (approximately 4kWhrs per day);
- Highly stable treatment process; and
- Ability to accommodate large load and flow fluctuation.

Photo 2 : Reflections Treatment System Director Rick Soar Testing Squirt Height From Nozzles (Scoria is backfilled over nozzles after testing).

Photo 3 : Scoria Spreading over Sand Bed

The disinfected effluent is discharged into a constructed subsurface horizontal flow wetland (approximately 700 m^2). The constructed wetland provides effluent polishing, and a further reduction in organic material, suspended solids and nutrients. The final effluent from the constructed wetland discharges into the existing wetland.

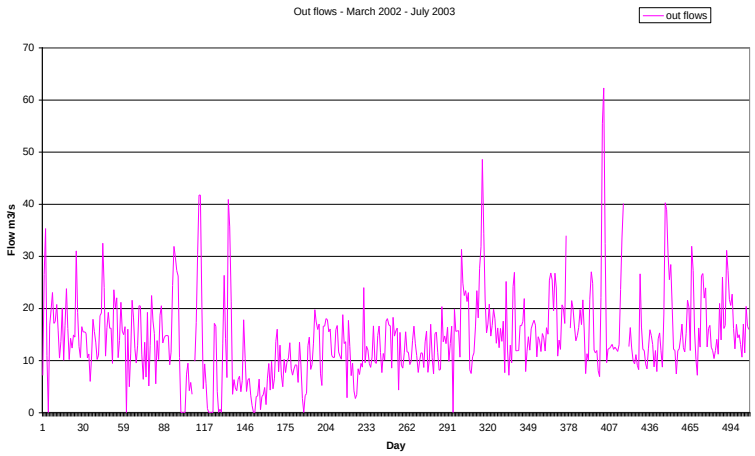
The Wastewater Treatment Plant (WWTP) was constructed over nine weeks. A state of the art telemetry system allows remote monitoring and operation of the WWTP by text messaging via cell phone. This is of high importance because of the remote location of the WWTP, particularly if inclement weather and seas prevent immediate ferry access.

The telemetry system provides for:

- Alarm if high water levels are reached in the reticulation or treated effluent tanks;
- Ultraviolet (UV) disinfection unit operational status;
- Pump status and indication of failure;
- Automatic adjustment of pump delivery cycle to recirculating sand filters if inflow increases; and
- Text message facilities to monitor inflow, outflow and recirculation tank level.

6 Monitoring, and Operational Performance

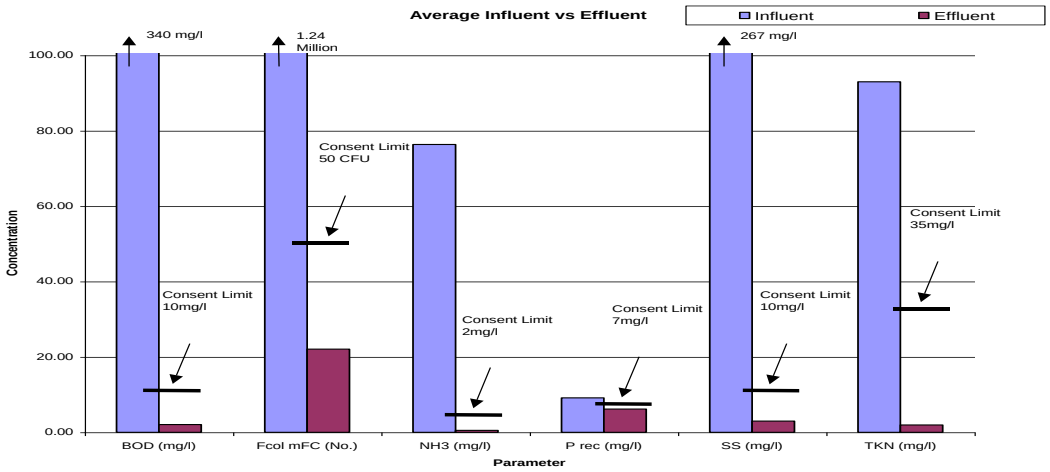
In-flows received to date have fluctuated significantly, as anticipated, to up to 110m3/day (note not all properties have connected to date), and generally only two sand filters have been operating at any one time. Graph 1 shows outflows for the period March 2002 to July 2003.



Graph 1: Outflows

Discharge is currently monitored independently on a monthly basis (following weekly monitoring for the first four months of operation). The treatment levels are consistently above design expectations.

During the bedding in period (January-April 2002) unexpectedly high ammonia levels in the influent (almost seven times of the design loading) have resulted in a breach of discharge requirements, and the Auckland Regional Council was notified immediately. The unexpected high loading was attributed to the nature of the commercial activities in the catchment (including hospitalities, hairdresser, and medical centre) and the timing of the Waiheke Jazz Festival that occurs over this period (the single largest tourist event on the Island).



Graph 2: Average Influent and Effluent Quality

No single source was identified and the situation was successfully addressed by altering the recirculation ratios to provide increased denitrification.

7 Conclusions

The selected recirculating sandfilter system is the ideal solution for Waiheke Island's sensitive environmental, social and cultural context. It has treated a range of flow rates and quality parameters and continues to maintain and enhance Waiheke Island's cascading waters.

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