On-site Wastewater Treatment System Environment Discharge Performance Appraisal

For Innoflow Technologies AX-20 Mode 3 (Trial 3)

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EDPA 011/08

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Acknowledgements

Thanks to Alistair Bell, Dave Anderson, Ken Jones and Andy Bainbridge at the Rotorua District Council Wastewater Treatment Plant for their vision and commitment to making these trials possible.

Thanks also to Paul Scholes of Environment Bay of Plenty for his assistance with the analysis of the data.

Disclaimer

This document reports on the measured ability of a wastewater treatment system to reduce the concentration of a range of wastewater parameters. No testing was performed on the integrity, capacity or durability of this system.

For further information refer to:

- AS/NZS 1546.1:1998 – On-site domestic wastewater treatment units Part 1: Septic tanks.
- AS/NZS 1547:2000 – On-site domestic wastewater management.
- AS/NZS 1546.3:2001 – On-site domestic wastewater treatment units Part 3: Aerated waste water treatment systems.

Summary

During OSET trial 3, which commenced on 12 November 2007, the Innoflow Technologies Orenco AX-20 - Mode 3 wastewater treatment system had influent and effluent monitored every six days over almost nine months.

A five month settling-in period was allowed, and then the following 16 consecutive samples at six day intervals (over about three months) were used for evaluating nitrogen reduction. Three blocks of seven consecutive days (week 8, 16 and 26) were also sampled to determine carbonaceous biochemical oxygen demand, and total suspended solids.

Effluent discharged from this treatment system was found to comply with Environment Bay of Plenty's standard for installation in the Bay of Plenty region outside the Rotorua Lakes catchment.

This interim report will be completed once SWANS-MAG (Small Wastewater Natural Systems – Management & Auditing Group) releases it assessment of the results of this trial, around February 2009.

In the interim, this system may continue to be installed anywhere in the Bay of Plenty region, including the Rotorua Lakes catchments, provided all conditions of the On-site Effluent Treatment Regional Plan are met.

Before choosing a waste water system it is recommended that power consumption and maintenance requirements are carefully considered.

Contents

1 Introduction

Excessive levels of nutrients in waterbodies are a known risk factor for their eutrophication. One source of these nutrients, particularly nitrogen, is from on-site waste water treatment systems treating human waste.

Many local authorities are interested in an assessment of the effectiveness of advanced (aerobic) waste water treatment where no reticulated sewerage system exists. Some regional plans, for example Environment Bay of Plenty and Environment Waikato, specify levels of treatment required by advanced waste water treatment systems. Many other areas are likely to follow as water quality comes under increasing pressure.

A trial site was established at the site of the Rotorua waste water treatment plant in 2005 to measure advanced wastewater treatment system performance. From 2005 to July 2007 fourteen different systems have been trialled.

Prior to the On-Site Effluent Treatment (OSET) trial 3 commencing an entirely new facility was established. The trial then commenced 12 November 2007 with five advanced systems, one of which subsequently pulled out. A conventional septic tank with an outlet filter was also tested during trial 3.

This report presents the results for one of the trialled systems. Reports on the other systems are available at the Environment Bay of Plenty website www.envbop.govt.nz.

2 System Information

System Name/Model:

AX-20 - Mode 3

Supplier:

Innoflow Technologies

PO Box 300-572
Albany
Auckland 0752

Phone: (09) 426 1027

Manufacturer:

Orenco

3 System Specifications

Supplier	System	Rated Flow (l/day)	Tanks Operating Capacity*	Treatment Technology
Innoflow Technologies	AX-20 Mode 3	2,000	Primary Tank: 4,000 litres Recirculation Chamber: 2,000 litres	Packed bed reactor

* In addition to this there is emergency storage of 2,000 litres.

4 Testing Regime

Untreated wastewater had grit removed and was screened down to 3 mm before being pumped into a series of header tanks. Each treatment system under test has a dedicated header tank. From each header tank influent is discharged under gravity to the treatment plant twice a day. The loading regime is 1,000 litres per day per system. Five hundred litres was delivered in the morning from 6.30 am and the other 500 litres delivered from 3.30 pm. It took 4.5 hours to completely deliver the 500 litres. This regime was designed to approximate typical household usage.

Each header tank has an overflow pipe set at the level corresponding to 500 litres. There are two fill and empty cycles per day. The valve on the base of each header tank is a pneumatically operated pinch valve. These were chosen primarily because with this type of valve blockages are very unlikely to occur.

Each tank also has a pressure transducer fitted at its base measuring volume. These are used to verify that each header tank is filling and emptying as expected. The data is collected in the Rotorua District Council (RDC) SCADA system.

Samples of influent and effluent were taken at six day intervals for:

• pH and alkalinity	• total kjeldahl nitrogen (TKN**)**
• ammonium-nitrogen (NH_4-N)	• total oxidised nitrogen (TOxN)
• nitrate-nitrogen (NO_3-N)	• total nitrogen (TN)
• nitrite-nitrogen (NO_2-N)	• total phosphorus (TP)

In addition to the regular interval sampling, there were three, seven consecutive day blocks of samples. These were analysed for the above parameters plus the following: carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS) and faecal coliforms (FC).

Analysis was performed by the RDC Environmental Laboratory (IANZ accredited) in accordance with “Standard Methods for the Examination of Wastewater”, APHA, AWWA, WPCF.

Effluent from each wastewater treatment system was discharged into a 20 litre container placed within a 200 litre drum, from where it returned to the sewer.

Samples were taken from the 20 litre container to ensure that completely fresh and representative samples were taken every time. Temperature of the effluent was measured at the time of sampling.

5 Test Results

Flow to the AX-20 wastewater treatment system commenced on 12 November 2007. Sampling was carried out from 16 November 2007 through to 19 August 2008.

The pre-determined TN evaluation period is a three month period from 14 April 2008 to 13 July 2008 inclusive, following a 'settling-in' period of five months. Nitrogen test results are based on data from sampling every six days over the evaluation period.

Table 1 displays total nitrogen influent and effluent results for this three month evaluation period. Six of the 16 effluent results over the evaluation period are under 15 gm^{-3} with the average being 15.8 gm^{-3}. Based on the average of the 91 day TN evaluation period results, the system reduced nitrogen by 74.4%.

Table 1 Summary of total nitrogen results over the TN evaluation period.

Date	Day	Influent (gm^{-3})	Effluent (gm^{-3})	Parameter	Influent (gm^{-3})	Effluent (gm^{-3})
14-Apr-08	1	68.3	12.8	n	16	16
20-Apr-08	7	65.0	12.8	mean	61.6	15.8
26-Apr-08	13	69.9	12.4	median	61.6	16.9
2-May-08	19	52.0	12.2	SD	8.1	2.4
8-May-08	25	54.2	13.1	Max	75.2	18.8
14-May-08	31	64.8	14.7	Min	46.7	12.2
20-May-08	37	54.9	15.1	lower quartile	54.9	13.0
26-May-08	43	72.9	16.7	upper quartile	68.6	17.8
1-Jun-08	49	55.1	18.6			
7-Jun-08	55	65.5	17.8			
13-Jun-08	61	58.5	18.8			
19-Jun-08	67	54.8	17.5			
25-Jun-08	73	46.7	17.0			
1-Jul-08	79	69.4	17.4			
7-Jul-08	85	58.5	18.0			
13-Jul-08	91	75.2	17.7			
	Average	**61.6**	**15.8**			
Average TN Reduction		**74.4%**				

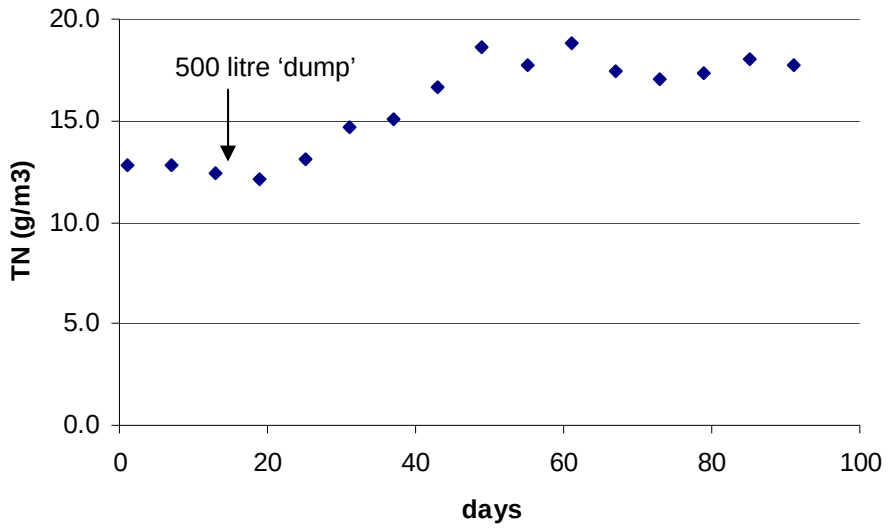

Figure 1 Graph of total nitrogen results over the TN evaluation period.

5.1 $CBOD_5$[1], Faecal Coliform and TSS Test Results[1]

Three one week (seven day consecutive) duration test periods at week 8 (7-13 January 2008), week 16 (3-9 March 2008) and week 26 (12-18 May 2008) were delineated for testing $CBOD_5$, TSS, FC and TN.

[1] Note that the CBOD values are likely to be lower than those presented in table 2, due to treating results lower than the detection limit as being at the upper limit of detection.

Table 2 Average influent and effluent results over seven days for weeks 8, 16 and 26.

Influent	CBOD5 (gm^{-3})	FC (cfu/100mL)	TSS (gm^{-3})	TN (gm^{-3})
Wk 8	191	4.3×10^7	212	61.5
Wk 16	204	3.5×10^7	239	62.3
Wk 26	179	4.0×10^7	232	59.0

Effluent	CBOD5 (gm^{-3})	FC (cfu/100mL)	TSS (gm^{-3})	TN (gm^{-3})
Wk 8	6.7	4.6×10^5	15	19.6
Wk 16	2.0	3.7×10^4	5	12.2
Wk 26	4.1	1.3×10^5	9	15.3

Effluent	CBOD5 (gm^{-3})	FC (cfu/100mL)	TSS (gm^{-3})	TN (gm^{-3})
Mean	4.3	2.1×10^5	10	15.7
Median	3.0	7.2×10^4	8	15.1
SD	2.5	5.1×10^5	6	3.4
n	21	21	21	21
Minimum	2.0	1.0×10^4	2	10.2
Maximum	10.0	2.4×10^6	24	21.4
Lower Quartile	2.0	5.0×10^4	4	12.6
Upper Quartile	6.0	1.5×10^5	15	19.2

5.2 Other Results

Table 3 Other treated effluent statistics from the TN evaluation period.

	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	SD
pH	7.1	7.0	6.3	8.3	6.8	7.3	0.5
Temp	12.3	12.9	7.2	16.9	9.8	14.1	2.9
DRP	4.3	4.3	3.1	5.4	3.7	4.8	0.7
TP	4.9	4.7	4.1	6.2	4.5	5.5	0.7
NH_4	3.7	3.9	0.6	8.3	1.6	5.5	2.4
Nitrite	0.163	0.143	0.086	0.348	0.118	0.195	0.069
Nitrate	9.4	9.5	7.0	10.9	8.7	10.3	1.1
TOXN	9.6	9.7	7.3	11.1	8.9	10.4	1.1
TKN	6.2	6.2	2.3	10.4	3.2	9.1	2.9
TN	15.8	16.9	12.2	18.8	13.0	17.8	2.4

Table 4 Untreated influent statistics from the TN evaluation period.

	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	SD
Alk	239	233	207	284	220	259	24
pH	7.7	7.7	7.1	8.0	7.6	7.9	0.2
Temp	18.6	19.3	13.6	21.0	17.4	20.2	2.1
DRP	5.0	4.95	3.2	7.7	4.3	5.6	1.1
TP	8.1	7.8	5.6	11.7	6.4	9.5	1.9
NH_4	42.7	42.9	33.4	49.2	40.9	45.3	4.1
Nitrite	0.020	0.012	0.001	0.139	0.008	0.018	0.032
Nitrate	0.014	0.003	0.001	0.141	0.002	0.010	0.034
TOXN	0.033	0.017	0.003	0.280	0.011	0.023	0.066
TKN	61.6	61.6	46.4	75.2	54.8	68.9	8.4
TN	61.6	61.6	46.7	75.2	54.9	68.9	8.3

All values in table 3 and 4 are expressed in gm^{-3}, with the exception of pH, alkalinity and temperature (^0C).

5.3 Electricity Consumption

Electricity consumption of the Innoflow AX-20 - Mode 3 wastewater treatment system averaged 1.1 kWh per day over the three month TN evaluation period.

There was a 0.85 kW irrigation pump present during the trial, capable of delivering a maximum total head of 35 m (at zero flow).

5.4 Insulation

Temperature has a significant influence on the ability of advanced treatment system to reduce nitrogen. Where systems are buried in the ground, as is typical, the impact of seasonal temperature fluctuations are far less than where the treatment systems are positioned above ground, such as was the case for this trial.

This Innoflow AX-20 system utilised a concrete tank, with no additional exterior insulation applied. Concrete tanks typically offer better insulation characteristics than plastic tanks.

5.5 Discharge of 500 Litres

On 28 April 2008 500 litres of wastewater was delivered to the treatment plant over a very short space of time, rather than being spaced out over a number of hours. This may have resulted in some slight reduction in the level of treatment over the short term. All treatment systems in trial 3 experienced the same event.

This event occurred 2 weeks before the start of the third week long test period used for determining $CBOD_5$, FC and TSS test results. It occurred about 2 weeks (day 15) after the start of the TN evaluation period as shown on figure 1.

6 Compliance Statement

This will be completed once the results of the SWANS-MAG (Small Wastewater Natural Systems – Management and Auditing Group) are released. This is likely to be around February 2009.

7 Compliance Standard

The performance standard for on-site wastewater treatment systems are based on the rules stated in Environment Bay of Plenty's Operative On-site Effluent Treatment Regional Plan 2006.

Discharges from on-site effluent treatment systems located within the Rotorua Lakes catchments are described by rules 11 and 13 as a permitted activity provided that the effluent quality of systems after a maximum settling in period of six months does not exceed:

- a total nitrogen (TN) level of 15 grams per cubic metre as nitrogen;
- 30 grams per cubic metre of $CBOD_5$; and
- 45 grams per cubic metre of suspended solids, prior to discharge to the dispersal system.

For installations outside Rotorua catchments the nitrogen limit does not apply.

Refer to rules 12 and 13 for compliance details for installations of new on-site wastewater treatment systems in the Bay of Plenty.

For confirmation of any details in this report please contact Sam Weiss at:

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