REDUCING THE WASTEWATER - MANAGING THE PROBLEM

Donald James Sorensen

East Coast (ECO) Wastewater Recycling Systems Ltd. Napier. New Zealand.

Abstract

Household water usage has increased dramatically with modern automated washing machines, dishwashers and waste disposal units. The result is an increase in the wastewater produced adding to the problem of wastewater disposal. The recycling of greywater back through the toilet cistern is a positive solution to the problem. The research carried out with our water recycling systems lead us to believe that we have made improvements to wastewater disposal problems and increased the efficiency of septic tanks systems. By decreasing the volume of greywater entering the septic tank, and reducing the outflow to the leach field gives recovery time, and the soil remains permeable and not blocked with bacterial growth.

Our test site was at Bay View Napier, New Zealand. The problem our client had been, a sewage smell coming from their property, the gully traps over flowing with sewage during high rainfall and the neighbours threatening to sue because of the smell. Although the house, septic tank and disposal area, were only four years old, they spent thousands of dollars increasing the size of their leach fields but to no avail. Whilst increasing the size of the leach fields, a soak pit was added with a pipe in the centre, also a metre long dipstick for checking the ground water level was added. This dipstick allowed monitoring of ground water levels before and after installation of the ECO wastewater recycling system.

Since installing the recycling system at Rogers Road the problems have been resolved. The ground water level has receded from 300 mm below ground level to a metre or more, as that was the length of the dipstick, all smells have gone as the bacteria are not polluting the soil and the client has remained satisfied since November 1997 when the system was installed.

Keywords

Greywater, leach fields, recycling, septic tanks, wastewater, water reduction.

1 Introduction

The idea of a wastewater recycling system for household use first came to me in August 1994 when the great Auckland water shortage was on. At that time I was attending a conference at the Auckland University and staying at a hotel. There were signs everywhere asking people to conserve water and even the taxi drivers were not allowed to wash their cars and could be fined if caught with a clean cab.

One evening after showering, I went to the toilet and thought why could not the water I just showered with be used to flush the toilet, I know now that the idea was not new and that others have had the same idea but as yet, there were no commercial systems available to householders in New Zealand.

After seven years and many thousands of dollars later we have a system that uses the wastewater from the shower, bath and washing machine to flush toilets, and as a secondary use for watering the garden.

Our research showed that approximately 30% of all household water is used to flush the conventional toilet. This can be reduced with some new toilet cisterns.

The ECO system was designed primarily to conserve water and not until later was it realized that wastewater was such a large environmental concern and that maybe we had an answer to many septic tank flooding problems.

2 Identifying Water Usage Problems.

Although hundreds of books, technical publications and papers have been written on water conservation and the need to recycle water, there appears to be a lack of systems that have been developed to a commercial stage for domestic use.

Our research has shown that the only systems available are those that use the shower; bath and makeup water and these sources are not the main culprit for excessive water usage, rather the automatic washing machine.

Historically, twenty years ago septic tank problems were few and far between (or not recognized) and were not the problem that they are perceived to be today. It is likely that the cause could be that modern appliances such as dishwashers, garbage disposal units and automatic washing machines produce excessive amounts of wastewater that flood out the septic tanks causing the problems that are being experienced with poor leach field dissipation.

An example of this was when we had a display of our recycling system at a Field Day. One of our display signs said "Do you have a septic tank problem" The response from most of the farming community was. "No we don't have a problem, we fixed that by piping the washing machine water down the hill into the gully". Therefore they had solved their problem and their septic tank systems were working better. They had reduced the wastewater into their septic tank, thus reducing much of their problem.

Before the advent of automatic machines the agitator washing machine with wringer was the main clothes-washing device. These machines held about 100 L of water and that water was reused several times. A normal washing operation could consist of two loads of whites, 2 loads of collared and then the work clothes. This equates to five loads of washing for a total of with 100 L of water. In comparison, the tests we carried out on our automatic washing machine was 86 L of water per fill, and on the spray rinse cycle 60 L of water. Our washing machine fills twice and on certain cycles spray rinses twice.

Table 1. Comparison of two washing scenarios

Washing Machine Type	Number and types of washing operations	Total water use for five loads
Old agitator and wringer	Two loads whites, two loads collared one load work clothes	100 L
Modern top loading automatic washing machine	One load of clothes	1460 L

These figures are a guide only, and can vary with different machines but the difference in water usage in the example above is considerable and the automatic washing machine produces large volumes of wastewater, all of which has to be disposed of through the septic tank and the leach fields.

3 Greywater Recycling

3.1 Problems in recycling

Recycling of greywater can cause problems in the transport and storage of the water. The following issues are seen as critical to effective recycling and have been addressed in the "Eco-system".

a. Soap and soap powders can cause residue build-up in pipe work leading to blockages and excessive foaming in toilet bowl.
b. Lint and dirt block pipes and valves and lead to maintenance problems. .
c. Bacteria from clothes and body wastes leading to foul water smells are being dangerous to health.
d. Cross contamination with potable water causing health hazards. The design factor in the connections for the water entering the toilet cistern must be such that cross contamination cannot occur. There must be a 50 mm air gap between the recycled greywater and the potable water supply. This we achieved by entering the recycled water from the other side of the cistern.

3.2 Solutions to recycling problems.

The problems indicated above have been addressed in the design of the "ECO-SYSTEM" to make the recycling operation as maintenance free as possible.

a. **Soap and soap powders**. The system has a method of causing the soaps to foam out of the water before entering the recycling system and then floating them out of an overflow pipe into the gully trap. This removes about 95% for the soap from the greywater. The water in the toilet bowl is slightly opaque and acceptable in appearance. After five years of trial there has been no visible sign of soap build-up in the pipes and no foaming of soapsuds in the toilet bowl.

   The soap residue has a beneficial effect in keeping the interior of the toilet cistern clean Previous to the installation of the "ECO SYSTEM" recycling system the interior of the toilet cistern was black with the build up of iron from the water supply, this has now all been removed and does not reform.
b. **The lint and dirt** from the water are removed by an ECO patented filter in No 1 chamber. This consists of a series of polyethylene plastic cones that are removable for cleaning. Cleaning is recommended every three months. Trials however have shown that depending on usage these cleaning frequencies can be extend up to one year. The final filtration of the wastewater before entering the toilet cistern is through a 50-mesh stainless gauze filter situated on the 12-volt pump.
c. **Bacteria** are associated with greywater come from the washing of underclothes, shower and bath water. The bacteria identified are total and faecal coliforms. These bacteria are indicators only of possible contamination from sewage. Together with other bacteria the greywater produces an obnoxious smell and create a health hazard when recycled without disinfection.

   The initial tests on the greywater were carried out by Analytical Research Laboratories (ARL) and showed that without treatment both counts for total coliforms and faecal coliforms were at extremely high levels.

The laboratory reported the results as TNC (To numerous to count). With such high bacterial levels, some type of treatment was required.

The three common methods for killing bacteria are: hydrogen peroxide, ultra-violet light and chlorination. Each method was considered on its merits in conjunction with advice from our chemical consultants.

Hydrogen peroxide is a strong oxidizing product and unless handled by experienced people, can be very dangerous. The consultant chemist advised against its use as the potential for an accident with an inexperienced person could lead to serious injury and claims for compensation.

Ultra-violet light was too expensive for a domestic system and the danger of 230 volts in close proximity to the wastewater recycling system made it impractical to use. Its use could be considered in commercial situations where cost and maintenance were not deciding factors.

Chlorination was the preferred method of disinfection for bacterial control in the wastewater recycling system. It was the recommendation of our chemical consultants as the chlorine tablets to be used are the same type as those used in small swimming and spa pools and are generally accepted by the public.

3.3 Bacterial water tests

The design and effectiveness of a disinfection system for installation into ECO SYSTEM had to be tested.

Tests and modifications to the chlorine dispensers were then made over the period between June1997 and November 1997. Tests were carried out each day measuring the pH, total alkalinity and free chlorine levels these were recorded on a graph. The equipment used to make these daily checks was a standard swimming pool test kit. Validations of the daily tests were carried out on samples sent to ARL.

Discussions took place in June 1997 with the chemists from Clark Products and ARL. It was decided that as a starting point for the tests no form of chlorination should be used for two weeks to arrive at a bench mark for future testing.

On the 19 July 1997 it was decided to test the pH, total alkalinity and free chlorine to show more precisely what was happening to the water. ARL advised that all greywater samples be taken from the pipe leading to the toilet cistern as the water in the toilet bowl could be contaminated with faecal bacteria.

Readings were then taken using the amounts of free chlorine as the guide to the frequency and quantities placed in the chlorine dispensers. The ideal disinfection was four chlorine tablets per week, two in each dispenser.

Table 2. Results of tests of greywater

Test and date 1997	Total coliforms cfu/100 mL	Faecal coliforms cfu/100 mL
Test 1 (17 June) No chlorination	TNC	TNC
Test 2 (26 June) Chlorine added	< 1	< 1
Test 3 (9 July) Chlorine added	< 1	< 1

The tests were performed by ARL.

Table 3. Tests results when free chlorine level >1 mg/L for eight days.

Test 4 21 August , 1997	**Total alkalinity**	**pH**	**Free chlorine**
Para Rubber water test	140/150 mg/L	8	0 mg /L
	Total Coliforms cfu/100 mL		**Faecal coliforms cfu/100 mL**
ARL water test	TNC		Count 200 cfu/100 mL

Table 4. Tests carried out when the free chlorine was 3mg/L

Test 5 22 October	**Total alkalinity**	**pH**	**Free chlorine**
Para Rubber water test	160 mg/L	7.9	3 mg/L
	Total Coliforms cfu/ 100 mL		**Faecal coliforms cfu/100 mL**
ARL water test	Count nil		Count <1 cfu/100 ml.

From these results, the preferred method of disinfection was obtained as: four chlorine tablets per week, two in each dispenser, which maintained a low free chlorine level and an undetectable bacteria count (<1 cfu/100 mL). The small amount of chlorine required is unlikely to affect the bacteria in the septic tanks and there have been no complaints from our clients to the contrary. It appears that their septic tanks are working well and from all reports are requiring cleaning less often.

4 Case History on Ground Water Levels at Bay View, Napier, NZ.

The owners of 89 Rogers Road, Bay View, Napier, moved into their new house in December 1991. Bay View is a rural suburb of Napier with most of the houses connected to individual septic tanks and a reticulated town water supply.

At first the owners did not have any problems with their 3,300L septic tank. This changed as more houses were built on higher ground next to their property and the problem of ponding and sewage smell became worse. For a few years, they put up with a septic tank that overflowed during heavy use, as the effluent was unable to seep away through the ground due to a high water table. They tried contouring their ground to create a low bog area and had it planted with suitable vegetation to minimize the effect of the ponding sewerage, to no avail.

In October 1997 an extra soakage field and pit were dug, filled with pea metal and topped off with novaflow and larger sized stones. A metre long pipe was also installed vertically down into the pit so the water level could be monitored with a dipstick. The soakage pit still did not rectify their problem of ponding and sewage smell.

During 1997 Council dug an open drain, along the fence line of a field on the western boundary of the property to try to overcome the problem. This meant that they no longer had to put up with effluent ponding on their property, as it was able to flow into the open drain.

The drain solved their immediate problem but caused the neighbours to complain about the effluent smell drifting past their houses. This led them to investigate other solutions to rectify their problem. Perhaps in desperation they then approached us to see if our system would overcome their problem.

On 22 November 1997 the ECO SYSTEM wastewater recycling system was installed and since that day they have not had any further problems. The smells are no longer a problem and their water consumption reduced by over 30%. The financial benefit has been that last year, unlike previous years they did not have to pay any water rates, as they have not exceed their allowable limit of 300 m^3 of water per year.

5 The Outcome

By reducing the wastewater through the septic tank and reducing the water into the leach field's bacterial action has not blocked the soil thus maintaining permeable nature and allowing the water to take it's dissipate away from the leach field.

Figure 1 shows the reduction in ground water level from 330 mm below ground level on the 22nd November 1997, the day the system was installed. 1 metre or more on the 23rd April 1998 and the comments from the owner's notebook for that date were: "Dry sludge, appears to look more like silt. Septic tank outfall at correct level".

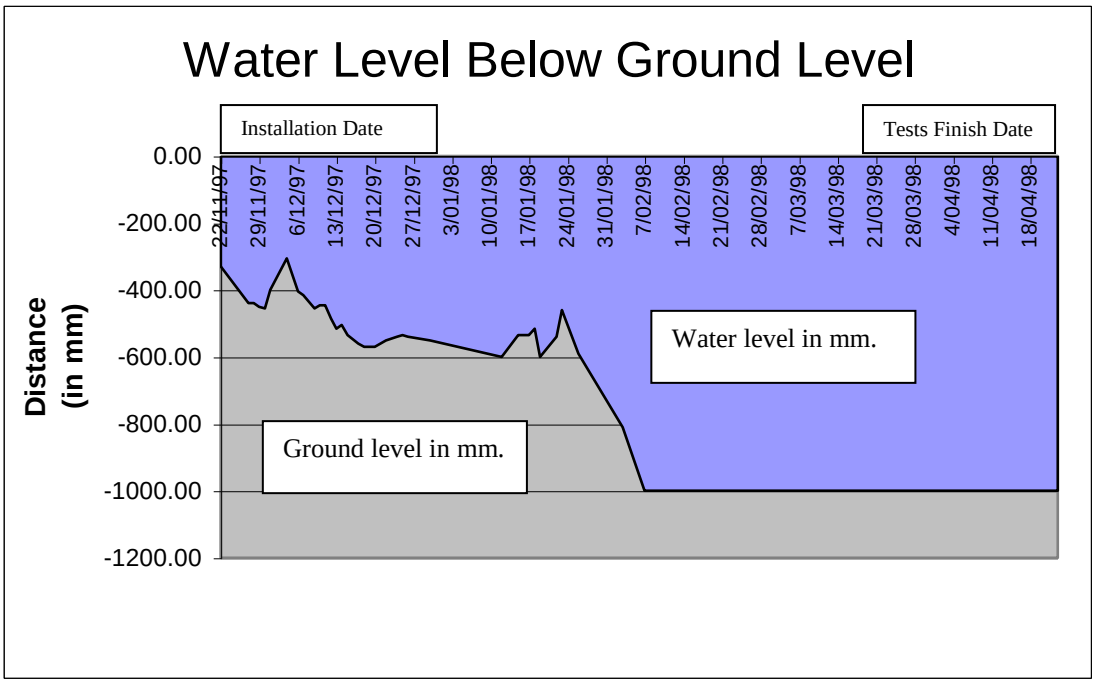

Figure 1. Reductions in groundwater levels after installation of ECO SYSTEM

All readings were recorded by the owner of 89 Rogers Road, Bay View and supplied to us for our documentation and reports. It should be noted that the maximum length below ground level that could be measured was one metre, as that was the length of the dipstick.

The graph shows the water level reduced to one metre below ground level between the 22nd November 1997 and the 6 Febuary1998 and has remained at one metre or more since the testing finished on the 8th April 1998 .

5 Conclusion

To date 38 ECO wastewater systems have been installed in New Zealand and we have received hundreds of enquires from people who are planning their houses or who are having septic tank problems from both here in New Zealand and overseas. The ECO Wastewater Recycling Systems is a BRANZ (Building Research Association of New Zealand) appraised product. Appraisal Certificate No 378 (1999) and under the "BRANZ Green House Scheme" The ECO System is eligible for four bonus points.

References

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