ON-SITE SEWAGE TREATMENT SYSTEMS

Short Duration – Peak Load Storage and Treatment Options

Low Pressure Effluent Dosing (LPED) and Sand Contactors

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INTRODUCTION

The cost of providing full sewage treatment for existing facilities, which produce peak flows over a short period, can be prohibitive for the owners.

In the examples in this paper I have designed systems which store the peak loads to treat and/or dose the effluent into the ground at a lower rate over an extended period of time. This approach can substantially reduce the cost to the owners while not compromising treatment quality.

These systems can also have secondary treatment systems added to them without having to undo any of the work already in place. This approach is suitable for maraes, community halls, schools and any facility with a short duration, peak wastewater flow. The examples all use 25,000 litre septic tanks although the same principle could apply to smaller situations.

The principle I use for Low Pressure Effluent Dosing (LPED) systems is to retain the septic tank sludge in the tank by using an efficient effluent filter and timer dosing the filtered effluent into the ground at a rate that the ground can absorb and treat.

If there is not sufficient land area or topsoil depth available, or there are environmental reasons which require secondary treatment, the peak load can be stored and the filtered effluent dosed to a treatment plant at a prescribed rate with the treated effluent being pumped into the soil through Raam trickle irrigation tubing.

Other examples are displayed on my website at: www.davemiller.co.nz

PEAK STORAGE SEPTIC TANK AND PUMPING SYSTEM

With the selection of 25,000 litre septic tanks I would recommend this needs to be more than a flat top water tank with a bit of extra reinforcing. I know of flat top water tanks have developed a ‘sinking lid’ feeling when used as septic tanks.

When I required a 25,000 litre septic tank I engaged Ormond Stock and Associates Ltd (Palmerston North) to design the tanks with the result that each one weighs 14 tonnes compared with about 8 tonnes for a beefed up water tank. The tanks also have an extended anti-flotation ring around the base. As an added precaution the peak load storage in each tank is approximately 50% of the tank capacity (12,500 litres per tank).

[Note: Additional storage percentage can be gained by locating the storage tanks above ground however this will involve an additional pump and can be culturally insensitive in some areas. If the sewage is pumped from a smaller in-ground pump chamber this may increase the chance of sewer pump breakdown.]

The screened pump vault is located in the last tank in series to maximise natural settling as the effluent makes its way through the tanks. In my designs I utilise timer controlled dosing in which the fluctuating peak loads are stored in the septic tank and dosed to the disposal trenches (or treatment plant) at a prescribed rate. As the pump out rate is relatively slow (110-120 litres per minute) there is minimal disturbance in the tank which significantly reduces the clogging rate of the filter in the pump vault.

The screened pump vault not only protects the pump from solids, the pump is suspended off the floor in the vault, which acts as an additional protection to solids carry over into the LPED or treatment system. The Orenco high head turbine pumps that I specify have a working life of 25+ years.

The Orenco pump also comes with three control floats:

- a high level alarm – the level of which is set in the tank to allow time for pump out if necessary while allowing the function to continue without interruption.
- An operating float which is timer controlled to pump out a prescribed dose to the LPED trenches or Protec sand contactor. It will only operate when the timer comes on AND there is sufficient effluent to lift the float into an active position.
- A low-level alarm and automatic off float. The greatest danger to a pump is to run dry. This feature provides an additional level of safety in that it not only alerts to a fault (i.e.: a jammed float etc) but also automatically turns off the pump, thereby preventing pump burn out.

Please note I do not have any financial interest in any wastewater products, tank manufacturing, installation or associated businesses and only specify brand names where necessary to guarantee the quality and the designed result.

NEWBURY HALL RELOCATION – (Approx installation cost $10,000) – Design and Build

The Newbury Hall, near Palmerston North, has been situated over the road from the Newbury School and pupils u sing the hall had to cross a busy highway going to and from the hall.

In 2000 a group of parents raised sufficient funds to relocate the hall alongside the school.

The new hall sewage system had to be designed to cater for the peak load, and distribute the effluent into the ground. The scenario was similar to Flemington School (see next page) except that funds were considerable tighter and this ruled out secondary sewage treatment in the original proposal.

The design chosen was to store the peak load sewage in a 25,000 litre septic tank and timer dose to 200 metres (**This should be 100 metres)** of LPED trenches, spaced 2 metres apart, alongside the car parking area. The DLR is 2.5 mm per m2 per day with the daily timed dose being 500 litres per day pumped in 4 doses of 125 litres per dose.

(150 people @ 20 litres per person per day = 3000 litres per function
Disposal area 200 m^2 (4 x 25 metres @ 2 metre centres)
DLR – 2.5mm per square metre per day)

FLAT HILLS HOLIDAY PARK – (Approx cost $27,000 – Design and Build

Flat Hills is situated on State Highway 1 just south of Taihape and had grown (in an ad-hoc manner) from a simple roadside tearooms into a restaurant-tourist facility with jet sprints and a deer and animal park, now catering for up to 500 visitors a day.

When building extensions were proposed, including a public toilet block, the local Council requested an investigation of the existing wastewater system. This was found to consist of a 3300 litre septic tank gravity feeding onto an effluent trench with the surplus flowing into a nearby stream.

[I have found that facilities with peak loads flowing into existing septic tank with gravity trenches can be flowing into either into a stream or a nearby gully. In porous soils the effluent may be soaking from the soakage field as intended but, due to the high percolation, the rate and concentration of effluent discharge can result in a rapid flow into the water table.]

Fortunately Flat Hills had surplus land available which enabled a Low Pressure Effluent Dosing (LPED) system to be installed to take the full daily flow. The wastewater usage was calculated at 15,000 litres per day (500 people @30 litres per person per day), with the septic tank being 25,000 litres in capacity.

As you can see I use 25,000 litre septic tanks quite often, a reason being that there is only a relatively small increase in cost between a 15,000 litre tank and a 25,000 litre tank and both these tanks are usually about 3.6metres in diameter and are transportable. Another reason is a the larger the tank, the less disturbance is caused by the inflowing sewage and, a large single chamber tank with say, an Orenco Biotube effluent filter, will perform better than a multi-chamber tank.

The soil profile was 300mm of topsoil overlaying a heavy clay base. I assessed the DLR at 12mm per square metre (**error DLR is 8.3mm/m2/per day)** per day and designed a 6 sector LPED disposal area, each sector consisting of 6 x 25 metre trenches 250mm deep and 250mm wide.

Usage 15,000 litres per day (500 people @30 litres per person per day)
6-sectors each with 6 x 25 metre trenches spaced 2 metres apart – total disposal area=1800m2
DLR 8.3 mm per m2 per day.

LACTOSE NEW ZEALAND – (Approximate cost $45,000) – Project Manger

LNZ is a rural factory in Taranaki with a workforce of 150 people. During the off-season the maintenance workforce can number up to 300 people. In the early 1990's a new gravity septic tank soakage system was installed.

This involved a large in ground septic tank, distribution manhole and a number of soakage lines approximately 1 metre deep. Within 4 years of its installation effluent backup was becoming a problem and the original designer suggested extending or duplicating the soakage trenches. I was asked to comment on this proposal and, if necessary, come up with an alternative solution.

I could see no advantage in extending or duplicating the existing trenches, which due to the creeping failure rate associated with gravity trenches, would only delay the day when the new trenches would also fail. The septic tank, although being a good size of 30,000 litres, was buried 800mm deep with no inspection or cleaning access. In addition the tank had a solid baffle wall approximately 75% down the tank which resulted in the scum layer breaking up as it flowed over the wall.

My recommendation to LNZ was to:

- Alter the layout of the septic tank by removing the baffle wall completely

- Adding 4 manhole access points to allow inspection and cleaning access. The tank pumper would also have access to cut the crust up prior to pumping out.
- Install a large commercial effluent filter in place of the outlet junction.
- Install a pump chamber with timer controlled alternating pumps (to provide a back up pump and keep it operational) to pump to the disposal field.
- Install a 4-sector LPED field of shallow disposal trenches similar to that at Flat Hills.

This job demonstrated to me the advantages of dose loaded LPED disposal over traditional gravity soakage trenches.

Usage 300 people @ 30 l/p/day = 9000 litres per day
Disposal area 4 sectors each with 6 x 22 metre trenches @ 1.5 metres – total area 792m2
DLR = 11.3 litres per metre per day

FLEMINGTON SCHOOL AND COMMUNITY HALL – (Approx cost $25,000) – Project Manager for Min of Education

The Flemington community, approximately half way to the East Coast from Waipukarau, proposed to relocate a community hall (150 people capacity) along side the local school (100 pupils) to serve the school and community.

As the school septic tank flowed into a nearby drainage area which drained into the local creek, a new sewage system had to be designed. The Ministry of Education approached me after the local plumber's on-site septic tank disposal system was rejected by the District Council.

The water usage figures are as follows:

- Flemington School 100 pupils and staff (@ 30 litres per person 3000 litres per day
- Community Hall 150 people capacity (@ 20 litres per person 3000 litres per day

The greatest loading would occur during school/community events, i.e. calf day, sports day, end of year functions etc. so the system hds to be able to handle (or store) this combined load. Design considerations included the wastewater usage, the fact that schoolchildren can and will play anywhere, usually at ground level or below, and the school/hall had no surplus land on site for effluent land application.

With regard to sewage treatment I designed a 25,000 litre septic tank to service the school and hall. The treatment was by an Innoflow intermittent 'Protec' sand contactor sized to treat up to 3500 litres per day. In the event of a hall function the peak load would be stored in the septic tank and treated progressively during the week or during the weekend when the school was closed.

The school had permission from the farmer on whose land the swamp was situated, to continue the discharge provided the effluent quality was improved. The School undertook the legal requirements and I designed the conversion of the swamp to a wetland by restricting the outflow into the stream and planting generous numbers of flaxes and kahikitea in addition to the existing vegetation. This area has always been fenced off from stock.

The reason behind the selection of the Innoflow 'Protec' sand contactor is that it is backed by 20 years of research and development and has a verifiable discharge quality of BOD:TSS of 5:5. This figure has been confirmed by the Regional Council monitoring programme.

Wetlands 1200 m2
Maximum daily volume = 3500 litres per day
DLR = 2.9 mm/m2/day

TE TIKANGA MARAE: - (Approx cost $25,000 compared with $75,000 for AWTS)

The marae were upgrading their kitchen facilities and the existing kitchen had been demolished. When the Council inspector called to inspect part of the works he had enquired where the sewage went. After a short inspection the answer was discovered in a nearby creek.

The Council ordered a stop work until a satisfactory wastewater design was received. The Marae obtained an estimate from a local aerated treatment plant manufacturer for $75,000.

The marae had allocated all its available funds to the upgrade and did not have the estimated $75,000 available for the aerated sewage system. But it also had no kitchen facilities and, with a stop work in place on the project, if the marae had been asked to host a tangi the results would have been embarrassing for the relatives and the marae.

In considering a design I had the following limitations (not including the financial matter- although this was still a consideration)

- The flat land around the marae was used for car parking, gatherings and children's play areas.
- The land became semi-saturated during wet weather.
- The steeply sloping ground containing a pine plantation was too steep for septic tank effluent or LPED trenches.

The marae wastewater volume was 25,000 litres over 4 days with a peak daily flow of 11,000 litres. The design I selected was to increase the septic tank storage to hold the peak wastewater volume produced over the entire 4 day period, and treat to a very high quality over an extended period after the tangi had finished. This design required:

- 2 x 25,000 litre septic tanks to store the wastewater peak load.
- An Orenco high head pump vault (timer controlled) fitted in the second tank.
- A 20 square metre Innoflow 'Protec' sand contactor.
- A treated effluent pumping chamber.
- Effluent disposal requiring 500 metres of Raam irrigation tubing, laid 100mm deep, spaced 3 metres apart (the trees prevented closer spacing) in the pine plantation. The Design Loading Rate (DLR) is 1.3mm per square metre per day which takes into account the soil (100mm topsoil-mulch overlaying heavy clay) and the steep slope.

This system was installed for $25,000 which was a considerable saving on the $75,000 for the aerated plant estimated originally.

This system has been operating for one year and a sample taken from the treated effluent tank gave results of: BOD/TSS 2:2.mg/m3. I would stress that although this is only a single grab sample after only 1 year of operation, the Protec sand contactor has a 20 year history of verified test data showing the average treated effluent quality of BOD:TSS of 5:5.

2000 litres per day treated – pumped into 500 metres of Raam spaced 3 metres apart.
DLR = 1.3 metres per m2 per day

CONCLUSION

Timer controlled LPED systems extend the effluent quality and distribution of septic tank systems to a higher level and this process should be the minimum requirement for septic tank systems.

Where existing facilities produce short duration peak loads, the storage and gradual treatment and disposal of the filtered or treated effluent is a viable option.

The LPED systems mentioned in this paper can have secondary treatment plants added without having to redo any of the existing septic tank or LPED installation.