BOINZ CONFERENCE 2008

ON-SITE SEWAGE SYSTEMS
TREATMENT QUALITY AND APPROPRIATE METHODS OF DISPOSAL

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Summary

Many Councils and design professionals trust the claims made by manufacturers of "secondary" sewage treatment systems.

However an extensive testing programme of on-site systems in Hawkes Bay has revealed that:

- only 33% of systems tested actually produced secondary treated effluent (BOD_5 20 g/m3)
- the average effluent quality of the treatment systems that failed to meet this standard was no better than effluent from a filtered septic tank.

Manufacturers claim effluent from a treatment system can safely be discharged through irrigation tubing. However the test results show that 67% of systems are actually producing filtered septic tank effluent. It would be more appropriate to discharge effluent from these systems into septic tank soakage trenches.

This paper discusses:

- secondary sewage treatment system design and performance
- effluent distribution practises

The paper suggests procedures that Councils can put in place to protect public health by ensuring that sewage treatment systems actually produce secondary treated effluent.

Background

It is estimated that up to 20% of houses in New Zealand are not connected to a public sewage system and have on-site sewage systems. On these properties the sewage must be disposed of on-site and must **NOT:**

- Pond on the surface
- Flow into a stream or aquifer
- Flow into a neighbouring property or roadside drain

As a general rule, for successful effluent disposal the effluent must be "dosed" into the ground at a rate the soil can absorb and treat.

On-site systems consist of either Primary (septic tank) treatment or Secondary sewage treatment systems. With primary treatment up to 40% of the treatment is achieved in the septic tank with the remaining treatment being provided by exposure of the effluent to in-ground organisms in the soakage trenches.

Primary and Secondary Treatment

In secondary treatment systems the in-ground organisms, which provide additional treatment in the soakage trenches, are replicated in separate chambers to provide secondary treatment within the treatment plant prior to effluent discharge.
[Note: All liquid from a septic tank or secondary treatment system is referred to as effluent, irrespective of quality.]

Methods of Effluent Disposal

Primary treated effluent is pumped (evenly dosed) into Low Pressure Effluent Dosing (LPED) trenches. [Note: While historically, gravity-fed trenches have been used for septic tank effluent disposal, this method of disposal is not "even" or in balance with the soil's ability to absorb and treat and this can result in premature creeping failure.]

Secondary treated effluent can be pumped into LPED trenches or directly into drip line irrigation tubing. However, as drip line tubing was originally developed for precise water irrigation of plants, drip line irrigation can only safely be used for the disposal of secondary treated effluent.

Drip line should <u>NOT</u> be used for primary treated effluent or for effluent from sewage treatment systems that do not produce secondary treated effluent.

Secondary treated effluent is defined in the Standard (AS/NZS 1547:2000) as BOD_5:20, TSS:30 g/m^3
[BOD_5 stands for Biochemical Oxygen Demand and TSS stands for Total Suspended Solids.]

BOD_5 – Biochemical Oxygen Demand

BOD_5 stands for Biochemical Oxygen Demand. In general terms BOD_5 is a measure of the amount of oxygen required to fully treat a pollutant. The lower the BOD_5 figure, the higher the degree of treatment.

For example:
- septic tank influent (sewage) from a house has a BOD_5 of around 350 g/m3
- primary (septic tank) effluent from a septic tank has a BOD_5 of around 250g/m3
- filtered septic tank effluent has a BOD_5 of around 120 g/m3
- secondary treated effluent has a BOD_5 of 20g/m3 as defined in the Standard. (figures from TP 58)

Instantaneous Failure of Dripline

If the effluent quality is not of secondary treated standard or better, "instantaneous" failure can occur immediately adjacent to each emitter. If the effluent quality is such that it requires additional treatment, and it draws more oxygen from the soil than is readily available to obtain that treatment, then the soil immediately around each emitter will become anaerobic.

Anaerobic conditions (in the absence of air) are the same as those found in a septic tank. As a result the soil around each emitter can become overloaded, often resulting in pools of anaerobic (septic tank) effluent around each emitter. Dripline is often laid in backyards and play areas and instantaneous failure of dripline can present a significant heath hazard to children. Children usually play at ground level and below and do not always wash their hands when they should.

Therefore disposal of effluent to dripline should only be used for secondary sewage treatment systems whose effluent conforms with the quality required by the Standard. If that Standard cannot be guaranteed then the effluent should be disposed of to LPED effluent soakage trenches.

Secondary Sewage Treatment Process

To be successful the secondary sewage treatment process must be aerobic (in the presence of air). The primary treated effluent, from the anaerobic (septic tank) process must be exposed to sufficient organisms, over sufficient time, to break down the primary treated effluent and treat it to secondary effluent quality as defined in AS/NZS 1547:2000.

The system process must be in balance at all times in order to treat the effluent to the required quality. **On-site test results and years of anecdotal evidence show that the majority of treatment systems, and the treatment processes used, do not adequately treat peak and fluctuating sewage flows.**

These varying flows are common in holiday homes, schools, camp grounds, community halls and marae. When a sewage treatment system is subjected to peak and fluctuating loads, and the treatment process is not in balance, the resulting effluent quality can be no better than effluent from a filtered septic tank.

Conclusions

- It would appear to me that the majority of off-the-shelf sewage treatment systems are not adequately designed or tested before being released onto the market
- It would also appear that Council approval processes are not sufficiently robust to detect these deficient treatment systems before they are installed.

Council Test Data Reveals High Failure Rate for On-Site Sewage Treatment Systems

The Hawkes Bay Regional Council (HBRC) have been conducting an extensive compliance monitoring programme of sewage treatment systems since 2001.
The test data from 132 test samples taken between 2001-2003 revealed that:

- 67%[(1)] of sewage treatment systems were not producing secondary treated effluent
- the average effluent quality of these systems was no better than effluent from a filtered septic tank

The monitoring programme set up in 2001 required consent holders to provide at least one "grab" sample test per year and forward the results to the Hawkes Bay Regional Council. Council noted[(4)] that the results obtained from the monitoring showed that many systems were not meeting Council consent conditions or the manufacturers' own performance claims.

A further report published in On-Site NewZ in 2004[(2)] noted that there had been a considerable reduction in compliance that year. The report went on to state that, *"The majority of systems sampled are aerated wastewater treatment units servicing a mixture of permanent dwellings and holiday homes. All systems had been serviced six monthly. Overloading of the system may be a reason for non-compliance for some holiday homes…, or it may simply be the shock loading from intermittent use."*
It would appear to me that some of the system designs are not robust enough to cater for these conditions and that the cheaper systems are producing the worst results.

This report[(3)] stated that the HBRC had been working with the local on-site sewage treatment industry since 2001, via the Sewage On-site (SOS) group. This group was of the opinion that the information on system performance should be provided to the public so they can make informed decisions on what sewage system to install.

A letter from HBRC to members of the SOS group[(4)] stated that the results of the tests were being made available to the consent holders and system manufacturers. It went on to state that, "*Only four types of systems[(5)] had a sufficient number of systems in place to provide reliable data for the statistical*

analysis". These manufacturers are referred to in this paper as systems A, B, C and D and this information is taken from Appendix 1.

The test result data distributed at the SOS meeting in January 2004[6] revealed that only 33% of the 75 systems tested actually produced secondary treated effluent with respect to BOD_5.

Of the systems failing to meet the Standard effluent BOD_5 quality (67% of those tested), the average BOD_5 test result was **104**g/m^3 [7]. For comparison purposes promotional material from a New Zealand septic tank effluent filter manufacturer[8] claims that their effluent filter produces an effluent quality of BOD_5 **90**g/m^3 from a septic tank or primary chamber of their sewage treatment system.

Further information released in April[9] showed that the rate of failure to produce secondary treated effluent with respect to BOD_5 had increased from 44% of systems in 2001 to 50% of systems in 2002 to 86% of systems in 2003.

It would appear to me from the test results in Appendix 1 that:
- the average BOD_5 produced by system A is **112**g/m^3 (48 tests)
- the average BOD_5 produced by system B is **75**g/m^3 (34 tests)
- the average BOD_5 produced by system C is **41**g/m^3 (9 tests)
- the average BOD_5 produced by system D is **34**g/m^3 (25 tests).

Note: the AS/NZS 1547:2000 Standard for BOD_5 is **20**g/m^3

It would also appear to me that:
- system A exceeded the standard BOD_5 level in 87% of tests
- system B exceeded the standard BOD_5 level in 55% of tests
- system C exceeded the standard BOD_5 level in 67% of tests
- system D exceeded the standard BOD_5 level in 52% of tests.

While aeration has been identified as the treatment process in the majority of systems, manufacturers of plastic, zeolite and foam treatment media systems have also been sampled in the Hawkes Bay Regional Council monitoring programme. These test results have been sent to the manufacturers involved.

It would appear to me that some manufacturers, despite having Council test data showing that their systems failed to meet consent and/or AS/NZS 1547:2000 standards, continue to promote their systems as producing secondary treated effluent.

Verify Manufacturers' Claims

It would appear to me that some manufacturers make claims regarding the performance of their systems that are not supported by operating data obtained in the field.

For example:

- System 'A' has an engineer's letter of support
- System 'A' has been awarded an environmental award by a Regional Council
- System 'A' make a primary (septic) tank **filter**, used in the primary chamber of their treatment plants, and claim BOD_5 **90** treatment
- System 'A's "secondary" treatment plant's **effluent**, using this filter, averages BOD_5 **112** (from 48 tests on 29 systems 2001-2003)

While it should be noted that individual on-site tests (from grab samples) are not scientific, and that some poor performances could be the result of system misuse, it would appear to me that the treatment

processes used in some systems are not sufficiently robust to avoid poor system performance that can occur under normal household operation, e.g. the arrival of guests or extra loads of weekend washing.

Potential Council Liability
[Note: this section is intended as a discussion item for BOINZ members at the conference]

Given the high failure rate of some system processes, and the potential threat to public health, the following questions could be asked of Councils and Council officers in the event of a significant outbreak of water borne disease originating from the discharge of partially treated effluent.

- If a Council approves a secondary sewage treatment system without due diligence could it be held partially liable for future system failures and any subsequent health issues?

- Could a Council hold its officers responsible for the failure of systems that its Council officers have approved?

- Is it possible that the current high failure rate of domestic secondary sewage treatment systems could be the forerunner of a similar scenario to the "Leaky Building" issue?

The "leaky building" issue has resulted in considerable financial impact and related stress issues on those affected. It would appear to me that the high failure rate of "secondary" sewage treatment systems and "treated" effluent disposal where children play (back yards, schools, campgrounds etc) presents a significant potential for serious health issues. These health issues could, in extreme circumstances, be fatal.

Questions to Ask Manufacturers

Council officers would be well advised to draw up a check list of questions and require written answers from system manufacturers before granting approval to both new and existing sewage treatment systems.

The following questions would be appropriate to ask:

- Who designed the sewage treatment system?

- What sewage treatment engineering qualifications do they have?

- Can they demonstrate a track record in robust sewage treatment engineering design?

- Does the system produce secondary treated effluent (as defined in AS/NZS 1547:2000) under typical household conditions?

- What testing of the sewage system has been carried out? (Note: It can take up to 3 years for the primary chamber of a treatment system to reach full toxic loading and results declared before this time can be premature and misleading)

- How many systems have been tested? (Note: A single or small number of grab samples, especially if taken less than 3 years after installation, is only an indication and may not be representative or conclusive. Is it worth taking a risk on a single, or even a small handful of tests?

- Has the system design been modified since the testing and if so why? (Note: Although it is to be expected that a system will be upgraded from time to time, be cautious of 'new' treatment media or frequent upgrades as this could be due to failure of existing designs.)

- Is the secondary treatment process completed within the treatment chamber before being pumped to the disposal field? (Note: At least one treatment system has a return pipe from the irrigation line back into the treatment chamber where 75% or the effluent is returned for 'further treatment'. As up to 25% of the effluent is discharged into the soil after only one treatment cycle the question could be asked: "Is this a septic tank or a secondary sewage treatment system?")

- Is the treatment process timer-controlled or is the sewage treated at the same rate it is received? (Note: As sewage is produced at varying rates, for instance first thing in the morning, sewage systems that try to treat fluctuating volumes on demand can produce corresponding varying treatment quality levels)

- Are their reliable, independent, engineer or Council tests and reviews of the system? If the system has credibility then a number of engineers and Councils should be prepared to state their confidence, in writing, that they have tested and/or approved the system. (These letters may also help in spreading responsibility if the system later fails to produce secondary treated effluent.)

- **Write to the Engineers and Councils directly asking them to state what testing and verification process they have undertaken prior to their granting approval and do they still stand behind their approval of the system?** (Note: Also check that the system, and treatment media, they have tested or approved is the same as that being currently marketed)

If the manufacturer is unwilling, or unable, to provide satisfactory answers to these questions, then it could be an indication that the sewage system may not reliably produce secondary treated effluent as required. If this is the case, Council officers could ask themselves "Should they, or their Council, take the risk?

APPENDIX 1

Appendix A: Raw data collection from Hawkes Bay Monitoring Programme (2001-2003).

(Note: Results exceeding AS/NZS 1547:2000 (BOD_5 20g/m^3) standard for secondary sewage treatment are coloured in red)

Owners	Manufacturer *	BOD - 2003	BOD 2002	BOD 2001	Holiday Areas?
Unconfined Aquifer					
Bostock	GT 8000 PRF	18			
Bowyer	Enviroflow	160	64	260	
CCL Bins	Biocycle	26	28	78	
Corbans Not SH 50	Oasis	19	1		
Dykes	GT 5000	160	160		
Edmonds Farm Trust	GT 5000	130		75	
Graham	Enviroflow	7	10	9	
Graham	Gould	68	190	138	
Hall	Biocycle	35	44		
HB & BC Aero Club	Biocycle	91			
Helliwell	Enviroflow	240	53	14	
Jag	Septech	24	52		
McKay	GT 8000 PRF	260	340	294	
Newton Forrest	Biocycle	31	2.5	0.6	
Rust Moody	Domus	30		2	
Smith B	Jet	5	9	56	
Villa Maria SH50	Biocycle	4	19	6	
Well Oiled	Biocycle	25	18	6	
White	Enviroflow	140			
Ham	Jet		39	38	
Donnelly	Enviroflow	3	260		
East Clive					
Cowan	Enviroflow	25	26		
Dodds	Gould	200			
Jones	GT 8000	130	170		
Tinsley	Enviroflow	68	20	120	
Waimarama					
Arinin Tu	Enviroflow	71			Y
Duncan	GT 8000	37	10		Y
Edmonds G & S	Biocycle	100	16	3.6	Y
Flowers	GT 5000	73	160	92	Y
Greesson & Petersen	GT 5000	47			Y
Hutton	GT 8000 RPF	33			Y
Hazelwood MW & CE	Enviroflow	20	4		Y
Hazelwood MW & CE	GT 8000	220	16		Y
HDC Waimarama	Enviroflow	380	1	9	Y
Kilmester	GT 8000	88	7		Y
Nash	GT 8000	190	68		Y
Percy & Ruddle	GT 8000	28	2		Y
Smith R	GT 8000	87			Y
Sweet	GT 5000	120			Y
Te Whaiti	Septech	68			Y
Verhoevan	GT 8000	54	120	78	Y

Owners	Manufacturer *	BOD - 2003	BOD 2002	BOD 2001	Holiday Areas?
Mahia & Mahanga					Y
Firth	GT 8000	141			Y
Hinks	Fibrecon	38			Y
Keenan	Oasis	72			Y
Lawson	Biocycle	110			Y
Mahia Boating & Fish	Enviroflow	36			Y
Meredith	Enviroflow	36			Y
Preedy	Enviroflow	40			Y
Riddell	Aqua Blue	220			Y
Steed	Oasis	130			Y
Taylor	GT 8000 - PRF	73			Y
Whaanga	Oasis	36			Y
Haumoana					
Barnes	Enviroflow	110	5	17	
Gilbert	Biocycle	39			
HDC Haumoana	GT 8000	190			
Jackson	Enviroflow	51			
Te Awanga					
Bell	GT 8000	62			
Clarke	Oasis	27			
Giblin	GT 8000	110	290		
Parker Je & O	GT 8000	89			
Webb	GT 8000	110	5		
Wickcliffe Trust	AX-10	5			
Williams	GT 8000	52	47		
Other					
Cairns	Oasis	2			
Cook	Biocycle	48		16	
Haynes & Smith	Biocycle	69	15	12	
Jack	AX-10	19			
Kuiumdjain	Enviroflow	170	10		
Redman	GT 5000	43			
Wilson	Oasis	32	46		
Nagal	Gould		160		
Wood	Enviroflow		19	9	
Campbell B	Sand Filter (EMS)			15	
Ellis K	GT 8000			120	
JoMarsa Partnership	Innoflow			5	

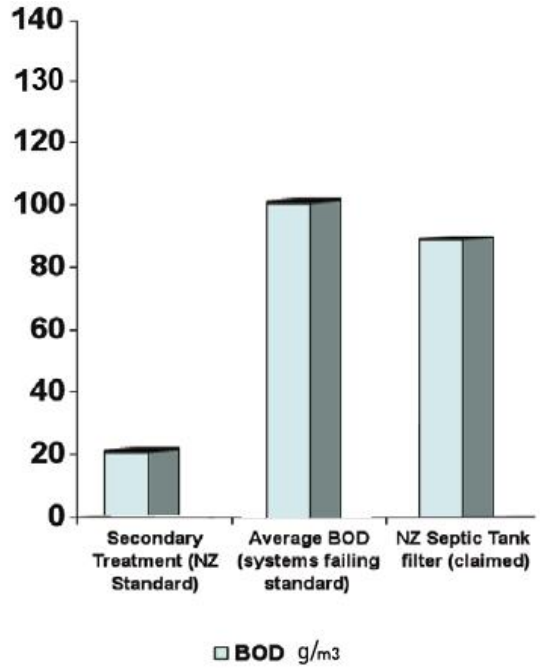
It would appear to me that two questions are appropriate to ask in respect to the results above:

- What level of treatment should on-site sewage treatment systems achieve under normal operating conditions before they are approved as secondary sewage treatment systems?
- Should effluent discharged from a sewage treatment system, that does not meet the appropriate requirements of the Standard (AS/NZS 1547:2000), be discharged to dripline irrigation tubing or septic tank Low Pressure Effluent Dosing (LPED) trenches?

APPENDIX 2

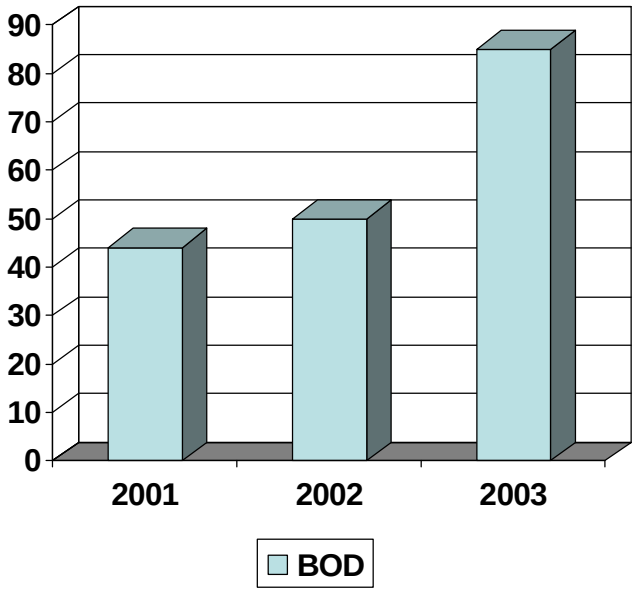
The following three graphs and text are from a Power Point presentation to the Land Treatment Collective national conference (2006) and are based on the test data above. The full results (2001-2003), including the manufacturers, are listed in Appendix 1 above.

Council Tests of Secondary Treatment Systems in Hawke's Bay



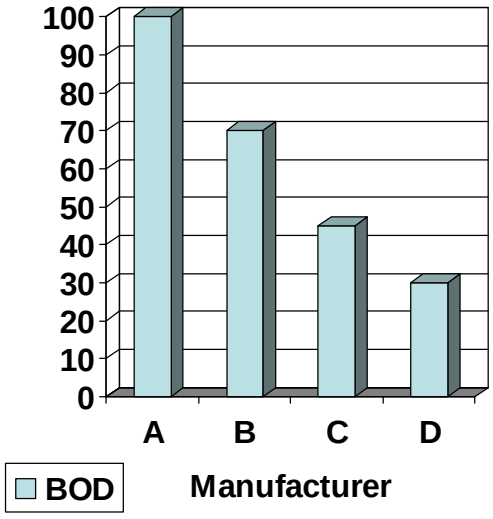
- Only 33% produce secondary treated effluent
- Average BOD of failed systems (BOD 104) was worse than a filtered septic tank
- Not suitable for dripline disposal

Increasing Rate of Failure in HB Council Monitoring Programme



- Rate of failure increased from
- 44% in 2001
- 50% in 2002
- 85% in 2003
- Fragile systems only get worse.
- Cheaper systems producing worst results.

High Failure of Systems Revealed in HB Monitoring



- A: avg BOD 112 (48 tests)
  - Exceed std in 87% tests
- B: avg BOD 75 (34 tests)
  - Exceed std in 55% tests
- C: avg BOD 41 (9 tests)
  - Exceed std in 66% tests
- D: avg BOD 34 (25 tests)
  - Exceed std in 52% tests

Note: The system manufacturers can be identified from the table of test data (Appendix 1)

Potential Instantaneous Loading Rate Failure of Dripline

- Effluent concentrated around each emitter
- Primary treated effluent would overload soil
- High BOD loading causes anaerobic conditions
- High TSS clogs emitters
- Failure (septic) around each emitter

ARTICLE REFERENCES

1. Calculated from test data results in Appendix 1.

2. On-site NewZ – January 2002. Contribution by Ian Gunn.

3. On-Site NewZ – January 2004 contribution by Helen Codlin, Hawkes Bay Regional Council.

4. Compliance Monitoring Report Analysis, dated 8 April 2004, from Helen Codlin, Manager Environmental Regulation, Hawkes Bay Regional Council to members of the Sewage On-site group.

5. Compliance Monitoring Report Analysis, dated 8 April 2004, from Helen Codlin, Manager Environmental Regulation, Hawkes Bay Regional Council to members of the Sewage On-site Group. Copies available from HBRC, Private Bag 6066, Napier.

6. Packaged Treatment Plants, 2003/2004 Sample Analysis Results. Hawkes Bay Regional Council circular presented at the January 2004 meeting of the Sewage On-site group. Copies available from HBRC.

7. Packaged Treatment Plants, 2003/2004 Sample Analysis Results. Hawkes Bay Regional Council circular presented at the January 2004 meeting of the Sewage On-site group. Copies available from HBRC.

8. GT 150 effluent filter manufactured by Gould GT Systems. Performance as stated in company promotional brochure of BOD:TSS 90:25g/m^3

9. On-Site Wastewater Discharges – Analysis BOD Monitoring Data, by Barry Zong Bo Hu, Environmental Regulation Section, Hawkes Bay Regional Council, dated March 2004. Copies available from HBRC.