On-site Effluent Testing – Where to from Here – We can't sit Stool

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ABSTRACT

The On-site Effluent Treatment Testing Facility has been operating in Rotorua since 2005/06 and as the National Testing Facility managed by Water NZ since 2008/09. The testing facility enables systems to be compared against other systems for a range of parameters as well as nitrogen species, and compliance with the NZ standard for BOD and TSS. The facility also provides a period of greater than normal design flow to assess how the systems cope with fluctuating loads. The facility is set up to enable testing of up to 7 systems at one time.

Funding is currently via suppliers of the systems ($22,000 per system) and council funding partners ($1,500/TLA, $3,000/UA and $5,000/RC) who receive full detailed reports on the systems tested. Additional funding above these values has historically been provided by Auckland City Council, Bay of Plenty Regional Council and Rotorua District Council. Currently only 6 Regional Councils, 9 District Councils and 1 Unitary Authority exist as funding partners.

The number of plants tested within each trial has gone from the maximum of 7 (2005/06, 2006/07, 2012/13) to 4 in 2014/15, then to 3 currently being tested (2015/16) and only 3 booked in for the 2016/17 testing season. At the current numbers being tested, the facility is losing up to $18,000/year. The National Testing Facility cannot continue on this basis. Either suppliers need to be charged close to $30,000 per system tested, or additional Councils become funding partners, or the facility will fail to continue.

There is no statutory requirement for systems to be put through the OSET facility, or pass the AS/NZS1546.3:2008 requirements. A National Environmental Standard (NES) for on-site wastewater that may have provided the needed teeth for this was mooted a few years ago, but this never progressed. This paper provides some thoughts on how this needs to change in the future to prevent inadequate and inappropriate systems being installed – the so-called cowboys that ride into town with the "best system ever", flogging their horse and wares, causing mayhem, then leaving. The OSET facility and national testing facility needs buy-in from all Councils that consent on-site systems in their region/district.

The paper also provides results of the trials to date; an update of that presented by Mr Ian Gunn to the Water NZ conference in Hamilton in 2014, as well as problems encountered during the trials and initial results of a small-scale in-field assessment. This may be the last time the OSET results will be available to the public unless through Council funding partners.

The paper concludes with a few ideas of "where to from here" with regard to what is assessed for each system, in order to get more Council's on-board.

KEY WORDS

On-site, wastewater treatment, National Testing Facility, OSET

INTRODUCTION

The On-site Effluent Treatment (OSET) Testing Facility has been operating in Rotorua since 2005/06. The initial objective of the facility was to test the nitrogen reduction capabilities of the on-site systems for use in the Rotorua Lakes and Lake Taupo catchments for the Bay of Plenty Regional Council (BOPRC), Waikato Regional Council (WRC) and Rotorua District Council (RDC). BOPRC had set a requirement for total nitrogen (TN) discharges from on-site wastewater systems serving development around the Rotorua Lakes at 15 mg/L TN and WRC had a similar requirement for lakeside development around Lake Taupo, but at the limit of 25 mg/L TN (Gunn, 2014).

At that time, there were over 35 companies marketing on-site units throughout NZ, with many claiming to meet the nitrogen targets of BOPRC and WRC. The two councils considered that systems should verify their performance via performance trial. Thus the OSET testing facility was set up at the RDC wastewater treatment plant (WTP) to carry-out a nine-month trial. The testing facility currently has the capability to trial up to seven (7) units at once.

SWANS-SIG (the Small Wastewater and Natural Systems Special Interest Group of Water NZ) took over management of the trial facility in 2008/09 and changed some procedures so that it became the National Testing Facility. This changed the focus from nitrogen to the meeting of secondary effluent requirements of the New Zealand Standard AS/NZS1546.3:2008. Further information on the history of the OSET facility can be read in Gunn (2014).

FUNDING, REPORTING AND ISSUES GOING FORWARD

Funding is currently via both suppliers of the systems and grants from council funding partners. Suppliers currently pay $22,000/trial but this is programmed to increase in 2017 to $28,000/trial. Councils pay varying amounts depending on whether they are a District Council (DC), a Unitary Authority (UA) or Regional Council (RC), with payments of $1,500, $3,000 and $5,000 respectively. The cost to suppliers are to cover the direct cost of the trial, rental from RDC and laboratory expenses, and the council grants are to cover the nominal payments to the OSET–Partners Advisory Group (PAG) or the OSET-Management Audit Group (MAG) for technical management and auditing. Additional funding of more than the values above has historically been provided by Auckland City Council, Bay of Plenty Regional Council and Rotorua District Council.

Council funding partners receive full detailed reports on the systems tested. This includes detailing equipment breakdowns and the need for attendance by operators. It therefore allows them to compare results with all other systems tested and gives them the opportunity to set local rules over maintenance frequency for various systems, and to decide which systems are stable and suitable to meet the requirements of their District/Region. Historically they have also received a comparative report that compared all the systems in that trial. However, this report is no longer considered appropriate as it only compares units within that trial and not against all trials and will be discontinued in 2016.

Currently only 6 RCs (of 11) and 9 DCs (of 73) and 1 UA (out of 5) are funding partners. This provides $46,500/yr, which does not cover the cost of the technical manager, yet alone auditing and reporting costs. The management and auditing costs are relatively fixed regardless of the number of systems being trialled.

The number of plants tested within each trial has gone from the maximum of 7 (2005/06, 2006/07, 2012/13) to 4 in 2014/15, then to 3 currently being tested (2015/16) and only 3 booked in for the 2016/17 testing season. At the current numbers being tested, the facility is losing up to $18,000/year. The National Testing Facility cannot continue on this basis. Either suppliers need to be charged greater than $30,000 per unit tested, or **additional Councils need to become funding partners, or the facility will fail to continue.**

It is proposed that future results that are put on the Water NZ Website will be limited to reporting what systems were tested and a list of all issues that occurred. It will not identify which systems failed the AS/NZS1546.3:2008 criteria or what their grading was or what issues they had during the test. Only Councils that are funding partners will receive this information. Councils that have on-site systems going in within their area need to join up as funding partners to receive trial information.

There is currently no statutory requirement for systems to be put through the OSET testing facility, or pass the AS/NZS1546.3:2008 requirements. A NES for on-site wastewater that may have provided the needed teeth for this was mooted a few years ago, but this never progressed through parliament. The OSET-PAG consider that there should be a Central Government requirement to make all systems meet at least the AS/NZS1546.3:2008 requirements before being allowed to be installed in NZ. This will require the DCs and RCs to get involved and only provide consents/permits to those that have passed. Water NZ is currently discussing this with appropriate Ministers to see whether a watered down NES, or other arrangement with some teeth can be implemented to enforce this.

TESTING AND REPORTING PROCEDURE

Full details of the testing programme are provided in Gunn (2014). In summary, the AS/NZS1546.3:2008 and benchmark grading runs for 9 months from October in year 1 to July in year 2. Each unit receives 1,000 L/day of screened raw domestic wastewater in two doses of 500 L over 2 hours in the morning and 2 hours in the early evening. The testing timeline is a settling-in period (Weeks 1 to 8), test sampling from Week 9 with samples at six day intervals until Week 35. From Week 36 a high load trial comprising 5 days at 2,000 L/day returning to 1,000 L/day in Week 37 is used to evaluate high load effects on the treatment system for the final 3 weeks. The parameters monitored are BOD, TSS, TN, NH_4-N, NO_3-N, NO_2-N TP, Alkalinity, pH, Faecal Coliforms and power consumption.

To meet the secondary treatment performance requirements of AS/NZS1546.3:2008, the following criteria need to be met during Weeks 9 to 35:

- *When sampled and tested for biochemical oxygen demand (BOD_5) 90% of samples shall have a BOD_5 of less than or equal to 20 g/m^3 with no sample greater than 30 g/m^3.*
- *When sampled and tested for total suspended solids (TSS) 90% of samples shall have a TSS of less than or equal to 30 g/m^3 with no sample greater than 45 g/m^3.*

The benchmark grading period is weeks 23 – 35. Ratings are based on the median of the results and given a grade based on the rating system shown in Table 1. The green highlights are an example of an on-site system's performance. Table 2 provides the benchmarking of the systems tested to date. The results shown below the solid line are additional to those presented in Gunn (2014). Further details on the systems in Trials 1 – 8 can be found in Gunn

(2014) and on Trials 9 and 10 on the Water NZ website for funding partners. Care must be taken in using the results without reviewing the whole report, as some systems are designed for larger loads than typical domestic households, some systems required a number of operator visits to correct faults and some systems failed the AS/NZS1546.3:2008 criteria even though their grading results look acceptable. A column has been added to Table 2 noting whether operator input was required to keep the system running as designed for Trials 9 and 10 only. As these systems are designed to be put in the ground and to operate unattended, with service visits only 1 - 3 times/year, any input by operators (shown by an X) is disappointing.

Table 1. Example rating for an On-site System over the Benchmarking period

Indicator Parameters	**Median**	**Std Dev**	**Rating**	**Rating System**				
				A+	***A***	***B***	***C***	***D***
BOD (mg/L)	*5*	*3.5*	*A*	*<5*	*<10*	*<20*	*<30*	*≥30*
TSS (mg/L)	*8*	*4.6*	*A*	*<5*	*<10*	*<20*	*<30*	*≥30*
Total Nitrogen (mg/L)	*40.7*	*2.5*	*D*	*<5*	*<15*	*<25*	*<30*	*≥30*
NH_4- Nitrogen (mg/L)	*17*	*3.7*	*C*	*<1*	*<5*	*<10*	*<20*	*≥20*
Total phosphorus (mg/L)	*4.2*	*0.4*	*B*	*<1*	*<2*	*<5*	*<7*	*≥7*
Faecal Coliforms (cfu/100 mL)	*163,000*	*80,900*	*D*	*<10*	*<200*	*$<10^4$*	*$<10^5$*	*$\geq 10^5$*
Energy (kWh/d) (mean)	*0.2*	*0.05*	*A*	*0*	*<1*	*<2*	*<5*	*≥5*

Table 2: Benchmark Ratings to Date

Unit	**BOD5**	**TSS**	**TN**	**NH_4-N**	**TP**	**FC**	**Energy**	**Operator Input**
Biocycle	B	C	C	C	C	D	C	
Oasis	A+	A+	A	A+	B	C	B	
Maxi-Treat	A+	A	A	A+	B	C	D	
Humes	A+	A	A	A	B	D	D	
Hynds	A+	A	A	A+	B	C	B	
NovaClear	A+	A+	C	A	B	A+	C	
Econo-Treat	A+	A+	A	A	B	C	B	
Devan	A	B	D	A	B	C	B	
Airtech	A	B	B	A	B	C	C	
AdvanTex	A+	A+	A	A+	B	C	A	
AWTS-NI	A+	A+	A	A+	B	C	C	
Quantum	A	A+	C	C	B	C	B	
Klaro	A+	A	D	A+	B	B	A	
Aqua-nova	A+	B	D	A	B	D	C	
Aqua-nova NR	A	B	D	B	B	C	C	
TechTreat	A	B	B	C	B	C	C	
BIOROCK	A+	A	D	C	B	C	A	
Findlater	A+	A+	D	A+	B	B	C	
Super-Treat	A+	C	B	B	B	C	D	
EcoSewerage	A	A+	B	C	B	C	A	
Trial 9								
CleanStream TXR-1	A+	A+	D	A	B	C	A	X
Biocycle 8000	B	C	D	D	B	D	B	X
BioKube Venus	A	C	D	A	B	C	A	X
Devan Integra S-15	B	A	D	D	B	C	A	X
Biolytix BioPod	A	B	D	C	B	D	A	

RX Plastics Airtech 9000	A	A	B	B	B	C	B	
Trial 10								
Ecocycle Fusion	A	A	D	C	B	D	A	X
Oasis Series 2000L	A+	A+	B	A+	B	C	B	
Wright Protec 10000	A	B	D	C	B	C	B	X

A graphical depiction of the results are provided in Annexure A at the end of this paper. These have been provided by Mr Ian Gunn. The graphs provide an overall rating, energy use, nitrogen reduction preformance and standard deviation. The graphs use the same colour scheme as Figure 1 below.

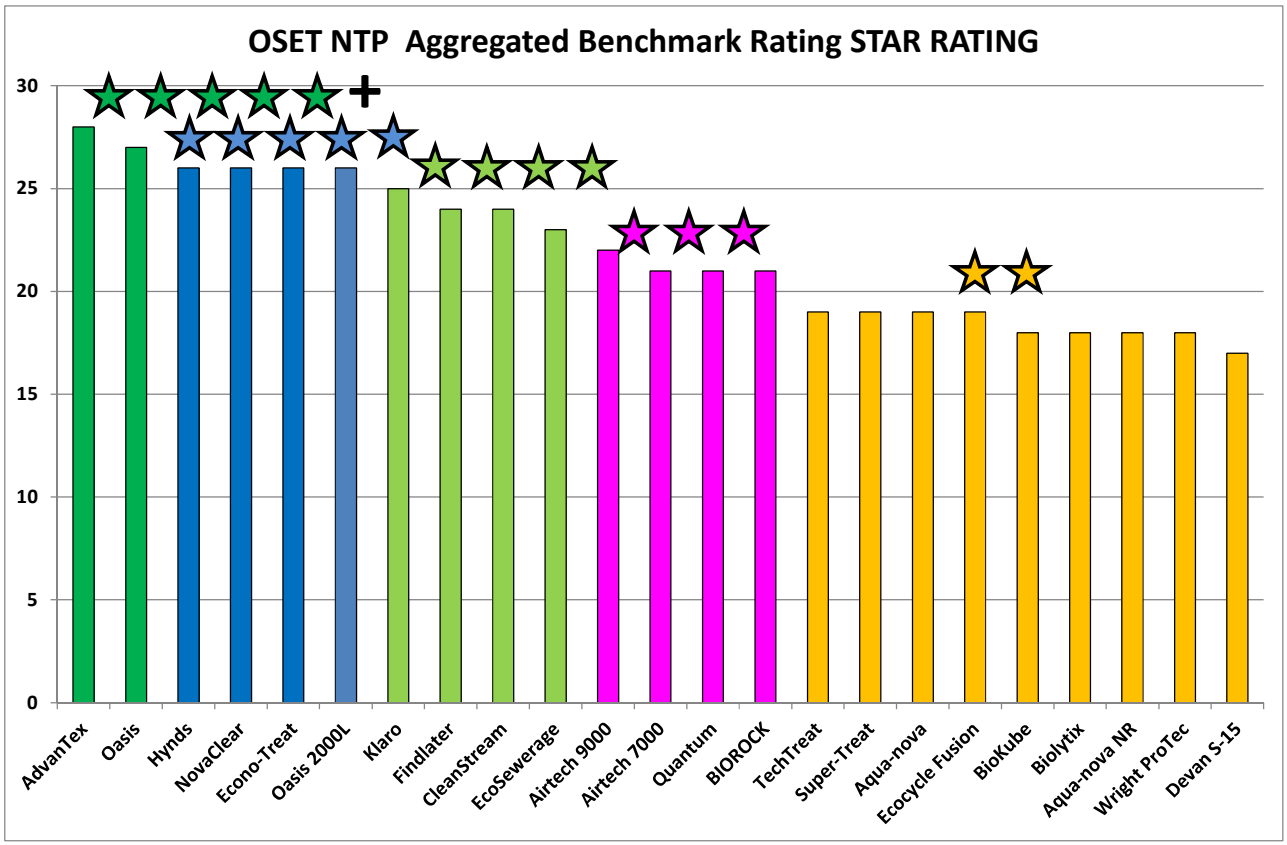


Figure. 1. Aggregated Benchmark Rating (from Gunn, 2016)

FOOD FOR THOUGHT

On-site systems should continue to be designed to reduce BOD and TSS to allow sustainable discharge into soil without clogging as promoted by AS/NZS1547:2012. Systems have tended to get too complex in order to alter nitrogen species and reduce total nitrogen loading. This has resulted in systems that are no longer simple and require much more input from operators.

As shown in Table 2 above, the level of on-site system componentry failure at the OSET testing facility is alarming, with most systems requiring some attendance to address issues, such as; blocked filters, pump failures, wiring configuration errors. This is particularly so, as one would consider that the system being installed at the OSET testing facility would be under strict quality control. So what is happening in the real world? The old adage of KISS (keep it simple stupid) is true here. As will be further discussed by Mr Andy Dakers of ecoEng at the On-site Workshop (2016), the focus needs to remain on the protection of public health and not on nitrogen apart from in specific nitrogen sensitive areas.

A number of Regional Councils in their Plans are requiring land use activities, generally farming, to meet nitrogen leaching criteria in sensitive areas, e.g. 18 kg N/ha/yr. This is significantly difficult for the more intensive farming practices to meet (dairying and cropping). A brief summary of the Dakers assessment on N leaching (ecoEng, 2015a) from on-site systems follows below. Numbers may differ slightly from the ecoEng Report but the overall picture is similar:

- 3-Bedroom house, with design based on 5 people, giving a hydraulic load of 1,000 L/d;
- Average occupancy 2.7 permanent FTEs;
- Nitrogen from a D Grade on-site system (40 mg/L) is 7.5 kg/yr; and
- Leaching from a LPED 2A sand trench is predicted at 3.4 kg TN/yr and from a 250 m^2 drip field of 2.5 kg N/yr.

The 18 kg N/ha/yr leaching would represent the equivalent of 5 houses/ha with LPED or 7 houses/ha with drip field discharge. Allowing for roading, this gives 1,600 m^2 and 1,200 m^2 lot sizes respectively. These are considered very small lot sizes for areas requiring on-site systems, with many plans requiring land areas greater than 1 ha for on-site systems.

So as pointed out by Mr Dakers, is nitrogen from on-site systems really that critical? Or should we be returning the focus to public health, with an emphasis on nutrients only in areas that are very nitrogen sensitive.

WHERE TO FROM HERE – STOP GOING THROUGH THE MOTIONS

Possible Additions to the OSET Assessment

The OSET-MAG also are considering including the wider system set-up and operation in the assessment. This would include an audit on the installation, general comments on equipment type and likely plant reliability and the management/ operation manual. The OSET report would then provide a grading for these aspects of the system. This has come about as there have been a number of incidences during the OSET trial where filters or valves have become blocked or partially blocked by bits of plastic residue (drill curls, etc.) left over from the installation. Installers that do not keep pipe ends clean, remove all residue, or do not flush their system prior to start-up would end up with a low grade. As the assessment criteria would be outlined in the testing procedure, it is certainly believed that it would result in installers lifting their game.

The OSET-MAG also consider that if operation and management manuals are assessed, then suppliers will put more thought into timing and tasks undertaken during inspections, e.g. a system operating in an extended aeration mode and producing a lot of sludge may require more frequent inspection and sludge removal than a non-aerated system.

There is also concern within the OSET-MAG that as the systems get more complex and concentrate on nitrification and denitrification, a lot more sludge is produced. Many systems have waste activated sludge returning to the front end of the system rather than a separate wasted sludge tank. This impacts on sludge age and can result in poor sludge settling that might not show up within the OSET trial period.

Further discussion of the whole package of On-site Wastewater Management Service (OWMS) is given in Dakers and Potts (2015).

Strand 2 – Field Assessment

The difficulty in establishing Strand 2 (field assessment) of the OSET assessment is well understood. This is due to the variability in the field regarding people per unit, diets, water use, cleaning chemicals used, antibiotics and drug use and the lack in number of similar systems in order to give a statistically robust result.

Oasis kindly offered to undertake a field assessment of some of their Oasis 2000 systems in the Canterbury area to see what the issues were and if it would be easy to roll out on a national scale. Although the trial results are confidential to Oasis, they have provided permission for me to share the results and issues faced. The information has been take from a report presented by Mr Andrew Dakers to the OSET-MAG (ecoEng, 2015b).

Oasis approached 15 homeowners based on likeliness of wanting to be involved. In the end, due to lack of response, 7 sites were monitored with population ranging from 2 to 5 people per household and two households with occupants on antibiotics. There were a number of issues encountered with the automated monitoring/communication systems provided by OSET-NTP.

Oasis put in a lot of time and it was clear from their comments that the programme requires a dedicated manager with good communication skills to liaise with the land owners. The obvious problems were:

1. Obtaining buy in and co-operation of the property occupants;
2. Reliable connection for the remote outpost units; and
3. Dedicated technical manager/co-ordinator for the Strand 2 trial

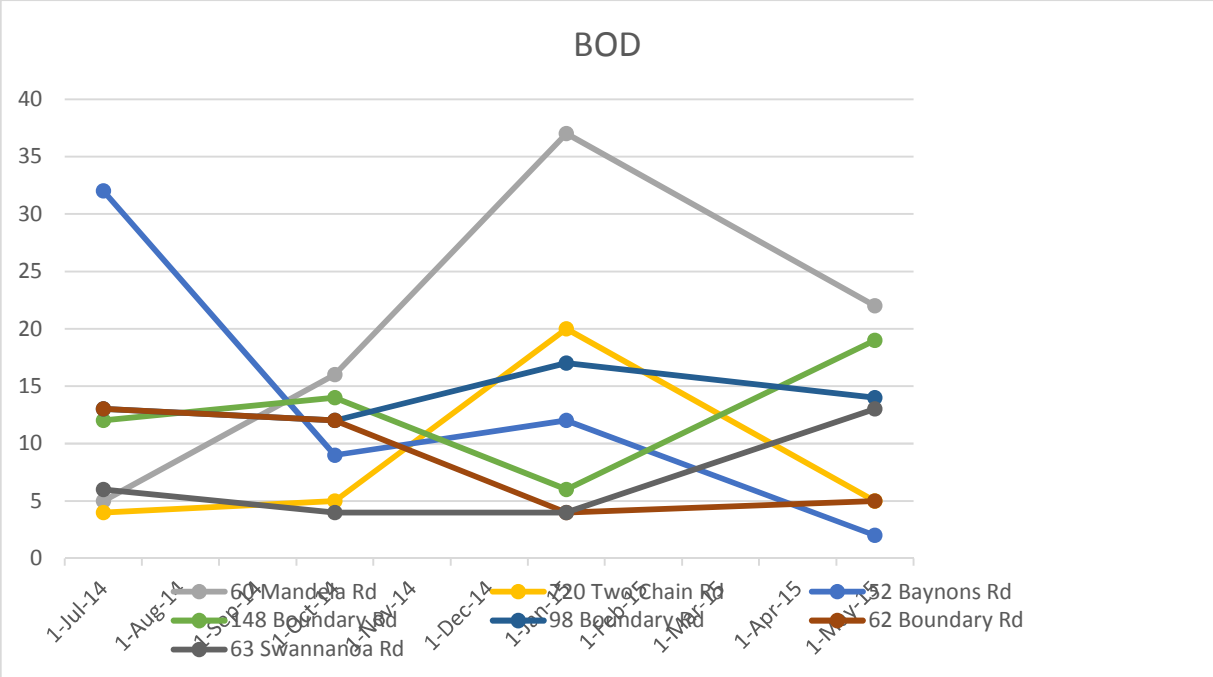


Figure. 2. BOD results from Field Testing (units mg/L)

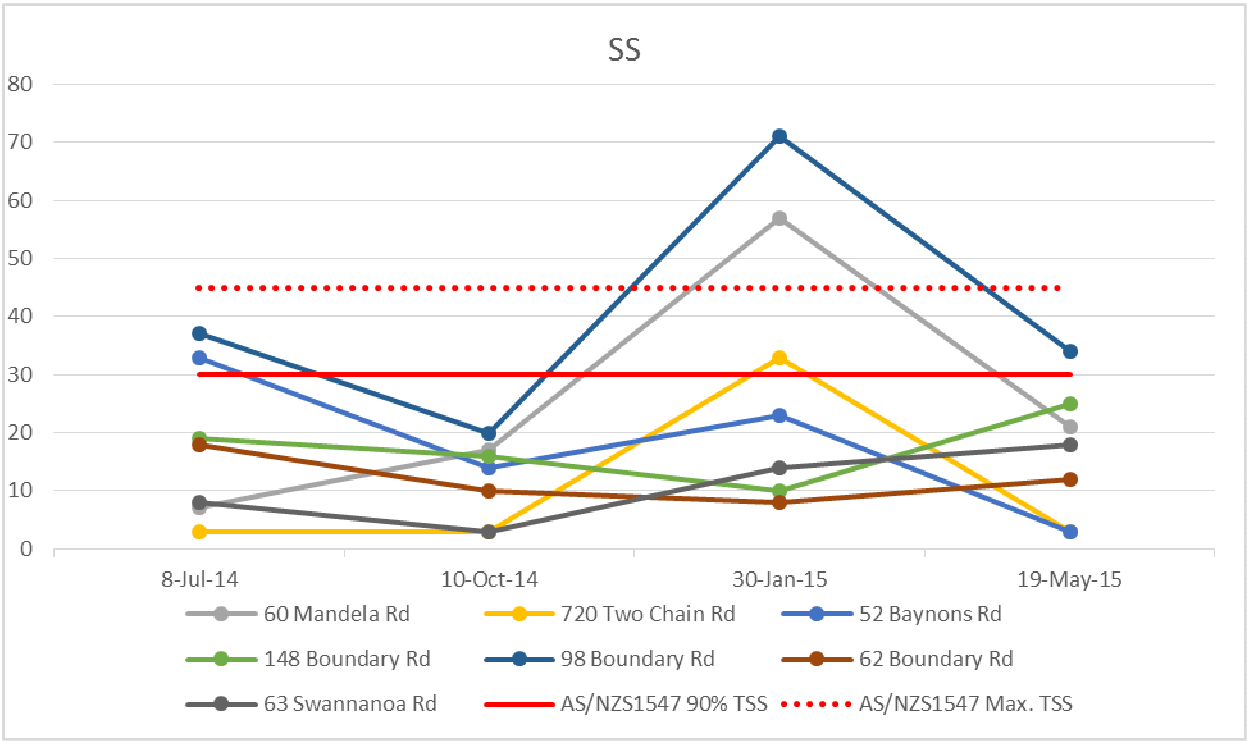


Figure. 3. TSS results from Field Testing (units mg/L)

Although the results of the field testing are variable, they generally fit within the expected range for BOD and TSS but with the odd outlier. BOD means were 7 – 20 mg/L with a range of 4 – 37 mg/L, and TSS means of 10 – 40 mg/L with a range of 3 – 71 mg/L. The results for the 7 sites are shown in Figures 2 and 3. Of note is the jump in concentration of most samples collected on 30th January 2015, indicating perhaps a different person undertaking the sampling.

If Strand 2 is to be rolled out across NZ, we need to reflect on what Strand 2 is going to require to be a rigorous and sound programme and how effectively it will serve the needs and wider interests of the end users, regulators and industry.

At this stage the OSET-MAG consider Stand 2 too difficult and believe the focus should be on improving Stand 1.

SUMMARY AND CONCLUSIONS

The OSET testing facility has assessed 30 on-site units over the last 9 years. Grading varies considerably, however, most units perform well for BOD and TSS reduction, with 25 of the 30 units passing the AS/NZS1546.3:2008 performance criteria. This is not surprising as this is what on-site systems were primarily designed to do in order to allow discharge into soil without blocking soil pores.

On-site systems should continue to be designed to reduce BOD and TSS to allow sustainable discharge into soil. The old adage of KISS (keep it simple stupid) is true here with systems having become more complex in the last decade order to try and reduce nitrogen. The focus needs to remain on the protection of public health – keeping the discharge below ground level and away from people. In some cases, this may result in advanced primary systems being more appropriate to use than secondary systems.

The OSET trials have highlighted the unreliability of many of the advanced secondary on-site systems. They have not managed to operate through the trial period without faults having needed to be fixed. As these systems are designed to be put in the ground and to generally operate unattended, with infrequent service visits, any input by operators to keep the system working is extremely disapointing. To counter this, the OSET-MAG also considering including in the assessment of the wider system set-up and operation. This would include an audit on the installation, general comments on equipment type and likely plant reliability and the management/ operation manual. The OSET report would then provide a grading for these aspects of the system. OSET-MAG would like feedback from you in the On-site Workshop as to whether you also think this is important.

In addition to the on-site national testing programme, the facility has also been used to assess larger commercial units and has been utilised for research and development. It is a very valuable asset to the on-site and small wastewater community.

Currently only 16 councils out of 89 are funding partners. OSET-MAG want the information on systems to be freely available but as with most things, if it is not paid for, then it is not treated as valuable. The OSET facility needs further funding support. The on-site community need to lobby local Regional and District Councils to provide the support needed, so that there is greater access to the results and so that the most appropriate systems are going into areas where they are needed.

REFERENCES

Dakers, A., Potts, R. 2015. Where to with OSET Strands Discussion Paper. *Memorandum presented to the OSET Partners Advisory Group on On-site Wastewater Management Service (OWMS).*

ecoEng. 2015a. Assessment of the relative nitrogen risks from an OWMS. Technical Information Note.

ecoEng. 2015b. Oasis Strand 2 Interim Results and Report to MAG. *Confidential Report to OSET Management Audit Group.*

Gunn, I. 2014. Performance Testing of On-site Domestic Wastewater Treatment Units – the On-site Effluent Treatment National Testing Programme. *Water NZ Conference Proceedings 2014.*

Gunn, I. 2016. Performance Ranking of On-site Domestic Wastewater Treatment Plants – Update, OSET NTP Trials 3 to 10 (2007 to 2015). *On-Site NewZ Blog 2016.* www.onsitenewz.wordpress.com

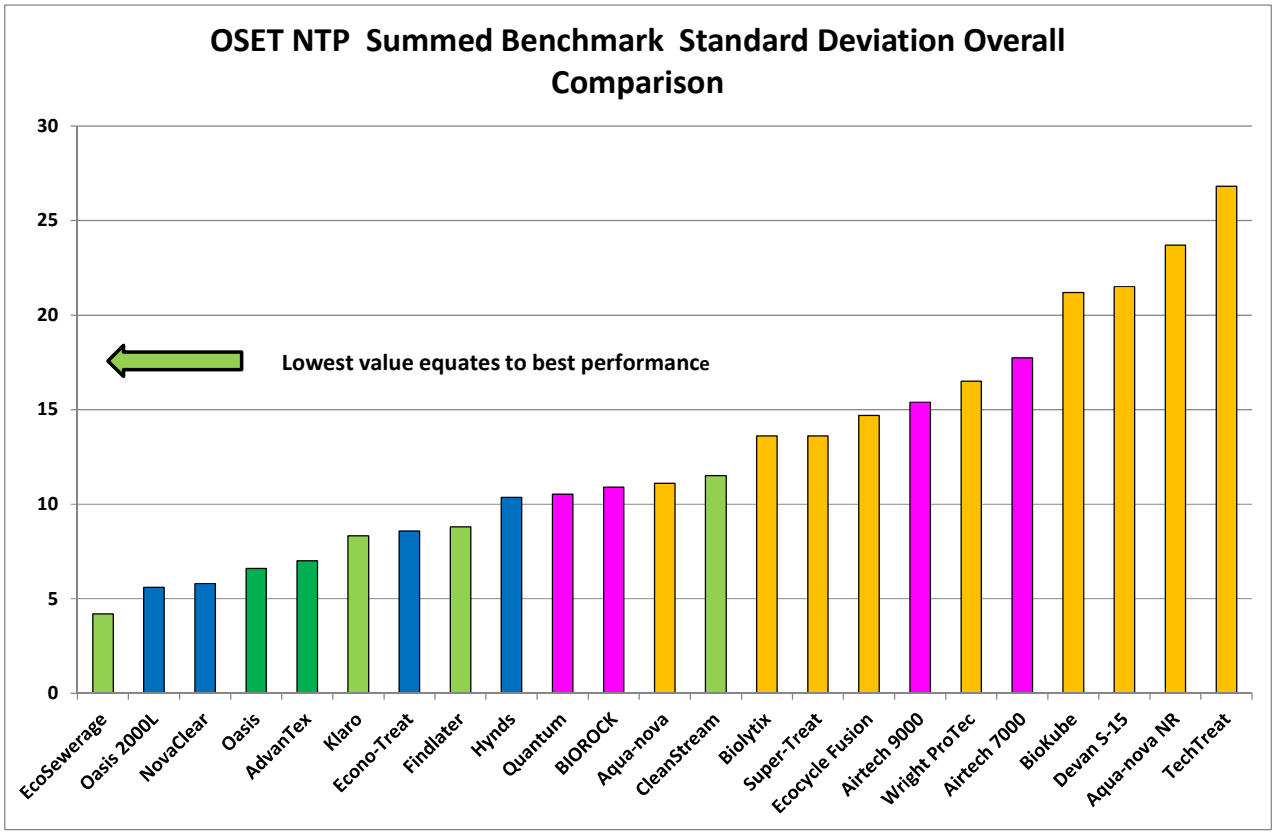
Hedgland, R. 2015 (March). Water NZ. On-site Effluent Treatment National Testing Programme Collective Results Review Trial 9 – November 2013 to July 2014.

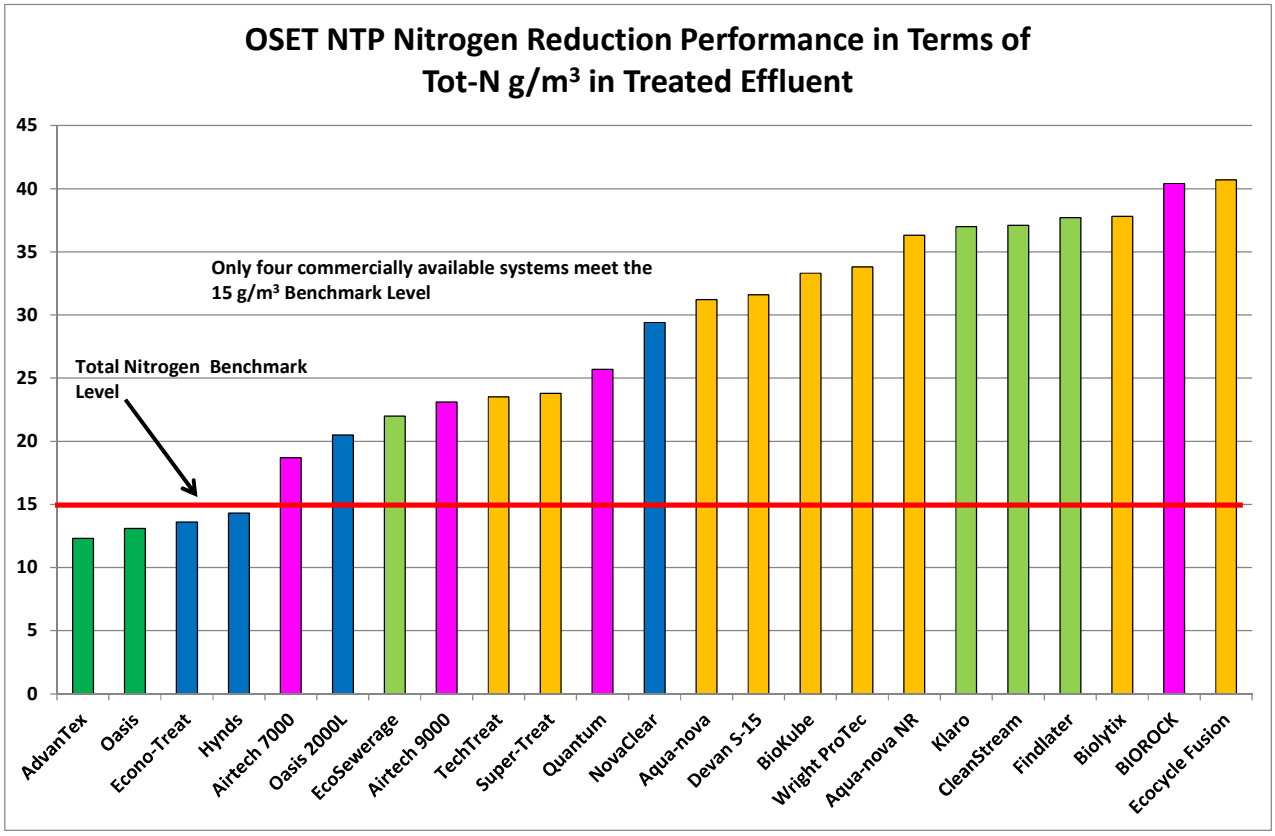
Hedgland, R. 2015 (November). Water NZ. On-site Effluent Treatment National Testing Programme Collective Results Review Trial 10 – November 2014 to July 2015.

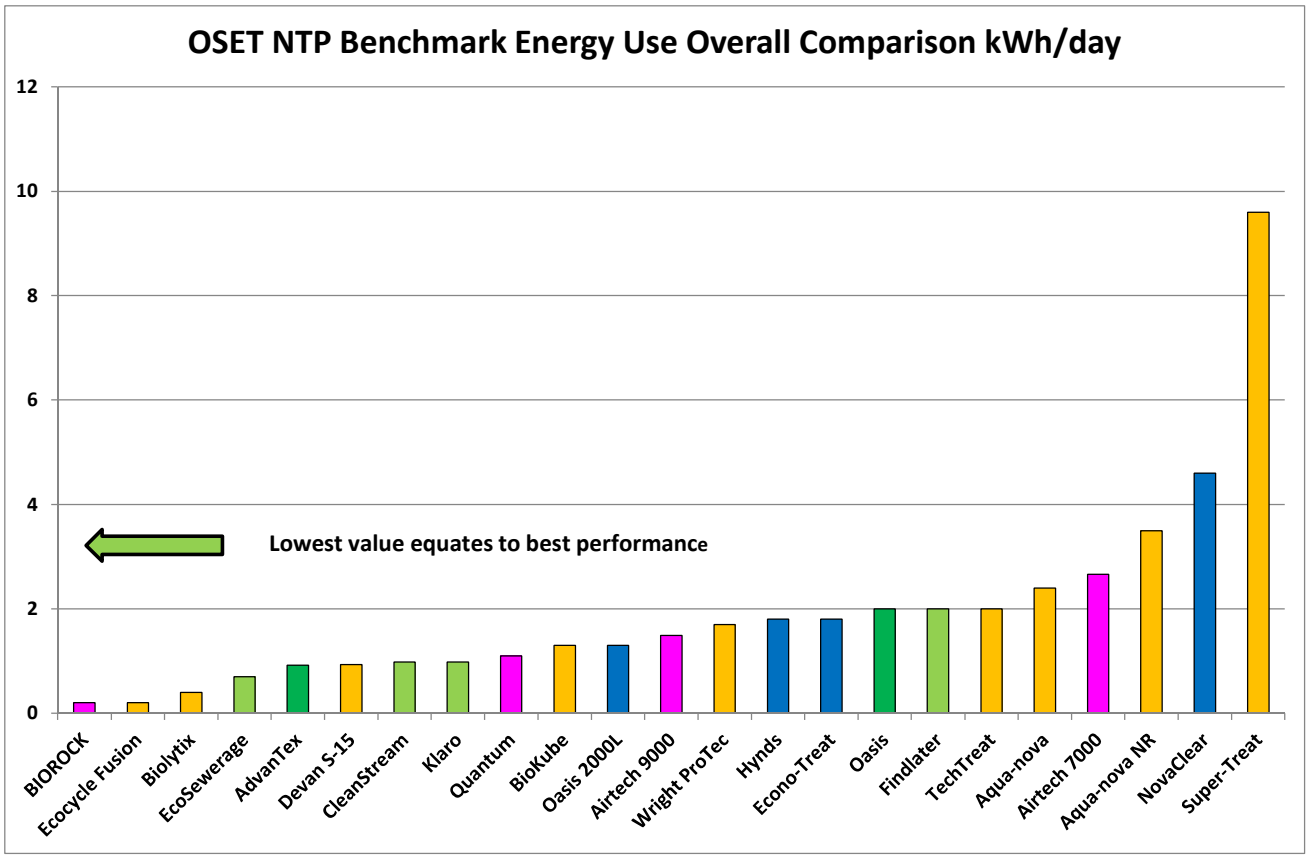
On-site Glossary

OWMS	On-site Wastewater Management Service
LPED	Low Pressure Effluent Dosing
OSET-PAG, -MAG, -NTP	On-Site Effluent Testing, Partners Advisory Group, Management Audit Group, National Testing Programme
SWANS-SIG	Small Wastewater and Natural Systems Special Interest Group
STEP	Sedimentation Tank Effluent Pumping

Annexure A: Further Graphs from Mr Ian Gunn On-Site NewZ Blog






OSET NTP Benchmark Energy Use Overall Comparison kWh/day
12
10
8
6
4
2
0
Lowest value equates to best performance
BIOROCK
Ecocycle Fusion
Biolytix
EcoSewerage
AdvanTex
Devan S-15
CleanStream
Klaro
Quantum
BioKube
Oasis 2000L
Airtech 9000
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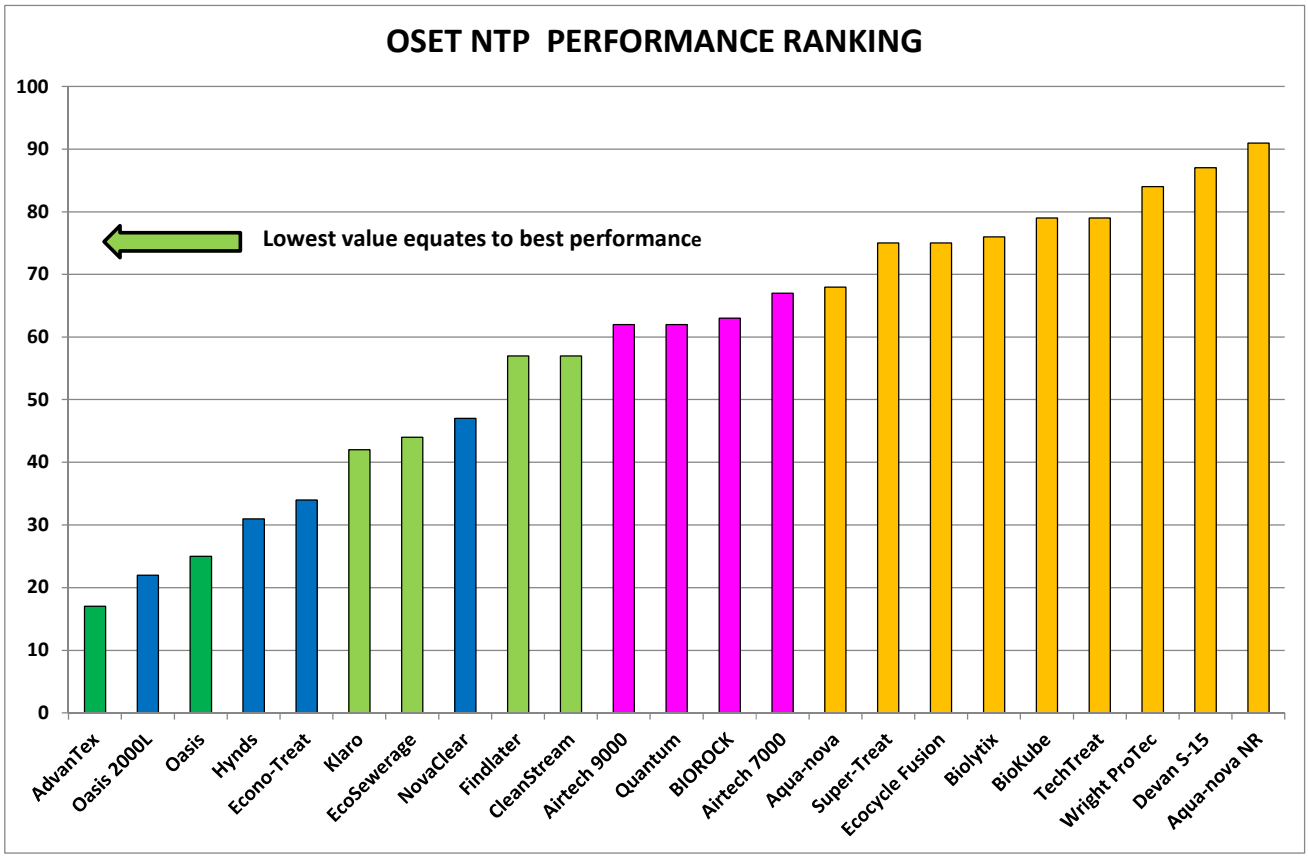
Aqua-nova
Airtech 7000
Aqua-nova NR
NovaClear
Super-Treat


OSET NTP PERFORMANCE RANKING
100
90
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Lowest value equates to best performance
AdvanTex
Oasis 2000L
Oasis
Hynds
Econo-Treat
Klaro
EcoSewerage
NovaClear
Findlater
CleanStream
Airtech 9000
Quantum
BIOROCK
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Super-Treat
Ecocycle Fusion
Biolytix
BioKube
TechTreat
Wright ProTec
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