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Notes to OSET-NTP Trial 12 Performance Certificate for AES-38 Treatment System

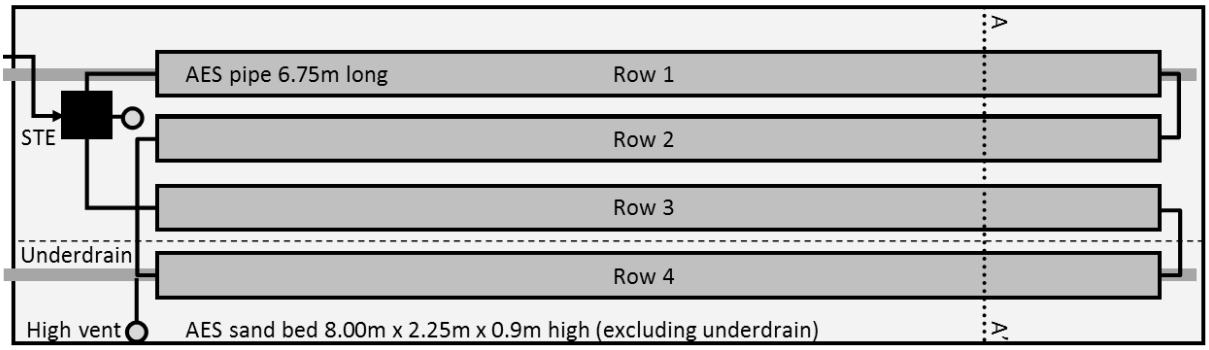
A more detailed review of the tested results is available from Environment Technology upon request.

Contents

1. AES (Advanced Enviro-septic) System Installed at OSET-NTP

The layout of the pipe rows in the AES bed was a Combination System, which combines a serial system layout with a parallel system layout. The two sub-systems were installed in parallel using a distribution box. Each sub-system consisted of two rows joined in series.

Figure 1. Schematic layout of AES-38 system tested in OSET-NTP Trial 12



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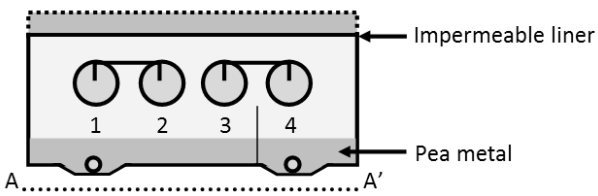


1. Impermeable top cover installed to prevent rainfall dilution affecting the test results. Most installations crown and grass the bed to shed rainfall. Field observations of an AES bed suggest that rainfall keeping a bed damp enhances biofilm growth/ maintenance.

2. Pea metal was placed over the total area of the bed to avoid additional treatment occurring as effluent moved sideways through the sand bed when accessing the underdrains. This was to ensure the performance reflected the performance of an unlined AES bed as closely as possible under test conditions. In practice, lined beds have a single underdrain, with pea metal around the underdrain only, as additional treatment is desirable.

Photo 1. AES bed during construction with the septic tank in the background

Photo 2. Distribution box during installation showing the two outlet ports at each side
The port on the far side of the box is used for the low vent. The hole with the yellow seal visible is the inlet port. The other pipework in the photo is the high vent manifold connecting rows 2 and 4.

Photo 3. **Distribution box in use**. The inlet has an 88 degree bend so that effluent from the septic tank discharges below the liquid level in the distribution box. This forms a water trap and prevents air from upstream of the distribution box from accessing the venting airflow. The two outlet ports have flow equalisers which have an offset orifice. These can be rotated to change the level of the orifice to enable the effluent flow to be split evenly between the two outlet ports.

Photo 4. Completed installation. The sides of the AES bed and sides and top of the septic tank were insulated to lessen the extremes of temperature associated with being above ground. The top of the AES bed had 100mm – 150mm of sand on top of the impermeable liner, and canvas over the sand to prevent the sand from blowing away.

An as-built plan is available from Environment Technology.

2. Treatment quality during start-up/ media development

Environment Technology requested additional testing of BOD, TSS and FC during the media development phase of Trial 12, Weeks 1-8. Treatment quality achieved during this time was cBOD ≤ 10mg/L and TSS ≤ 20mg/L, well within secondary treatment quality requirements of cBOD5 ≤20mg/L; TSS ≤30mg/L

Table 1. Additional testing results AES-38, OSET-NTP Trial 12, Weeks 1-8

	5 Day Biological Oxygen Demand $cBOD_5$ (mg/L)	Total Suspended Solids TSS (mg/L)	Faecal Coliforms FC (CFU/100ml)
Week 1	2	20	480,000
Week 2	10	16	215,000
Week 3	3	12	160,000
Week 4	4	8	38,000
Week 5	6	8	166,700
Week 5	6	15	84,000
Week 6	3	12	not tested
Week 7	2	9	not tested
Week 8	2	7	not tested

The system tested in Trial 12 had two underdrains. A lined AES bed would usually have just one underdrain, however in this installation one second row – Row 4 – was isolated to enable samples to be collected from this row only in order to quantify ‘worst case’ treatment quality. In practice it proved difficult to collect a sample from this underdrain as volumes were low. The collection vessel was left in place overnight in order to collect enough liquid for testing. The results from this testing showed BOD unchanged while the results for TSS were similar to the results from weeks 1-8; elevated but all results <21mg/L, well within secondary treatment quality requirements of cBOD5 ≤20mg/L; TSS ≤30mg/L. After the trial the flow equalisers in the distribution box required a slight adjustment to even the split. The low volumes discharged from row 4 may have been due to the distribution box split favouring rows 1 and 2 over rows 3 and 4, or may reflect the usual situation where the last row or rows in a system receive less effluent. TSS was elevated while BOD remained at <2mg/L which suggests that the TSS was of inorganic origin, and likely to be caused by residual silt in the sand being washed out as the sand surrounding rows 2 and 4 received effluent for the first time. Environment Technology recommends watering AES lined beds during installation and removing any silt that collects in the pump/ dosing chamber prior to connection to pressure compensating dripper lines.

Table 2. Additional testing results AES-38, OSET-NTP Trial 12, rows 1-3 underdrain and row 4 underdrain testing, Weeks 24 and 36

AES-38, OSET-NTP Trial 12 additional testing	5 Day Biological Oxygen Demand $cBOD_5$ (mg/L)	Total Suspended Solids TSS (mg/L)	Faecal Coliforms FC (CFU/100ml)
Sample collected from main underdrain (rows 1-3) 5/4/17 Week 24	<2	6	21,600
Sample collected from isolated underdrain (row 4) 7/4/17 Week 24	<2	21	10
Sample collected from isolated underdrain (row 4) 29/6/17 Week 36; day 2 of 5 day overload period	<2	9	1,200

3. Septic tank effluent quality

Samples were also collected from an access point between the septic tank and AES bed.

Table 3. Septic tank effluent test results, weeks 24 and 29

AES-38, OSET-NTP Trial 12 additional testing	5 Day Biological Oxygen Demand $cBOD_5$ (mg/L)	Total Suspended Solids TSS (mg/L)	Faecal Coliforms (CFU)
Septic Tank effluent 5/4/17 Week 24	71	31	1,240,000
Septic Tank effluent 8/5/17 Week 29	59	32	not tested

4. Emergency storage

Emergency storage was assessed at 1929L, or 46 hours. This was calculated using the pore space in the lower 150mm of sand in the bed, and the storage volume in the underdrains and pea metal, and pump chamber. Tested results of systems with only 150mm of sand beneath the bed returned secondary treatment quality, which justified allowing the bottom 150mm of the sand bed being used for emergency storage. Effluent could back up in the AES bed a further 300mm - until the AES pipes are half full of liquid – without restricting airflow through the bed. If emergency storage is calculated using this additional space the total emergency storage volume is 3946L or 3.9 days.

While it is noted in the performance certificate that removal of the pump chamber would reduce the emergency storage volume by 318L Environment Technology notes that removal of the pump chamber would also remove any reason to have emergency storage, as the system would then be completely passive. Removal of the pump chamber would occur if the pump was replaced by a Flout chamber, or an unlined AES bed - with dispersal of effluent through the base of the bed - was installed.

5. Service requirement – once every 6.25 years

Sludge accumulation for six persons discharging 1000L/d is estimated as 80L/p/y. A septic tank should be pumped out when the tank is 2/3 full of sludge. The 5000L septic tank used had an operating capacity of 4500L therefore pump out should occur when 3000L of sludge has accumulated. At 6x 80L/y = 480L/y for 6 persons the service interval for this system is 3000L/ 480L/y = 6.25 years.

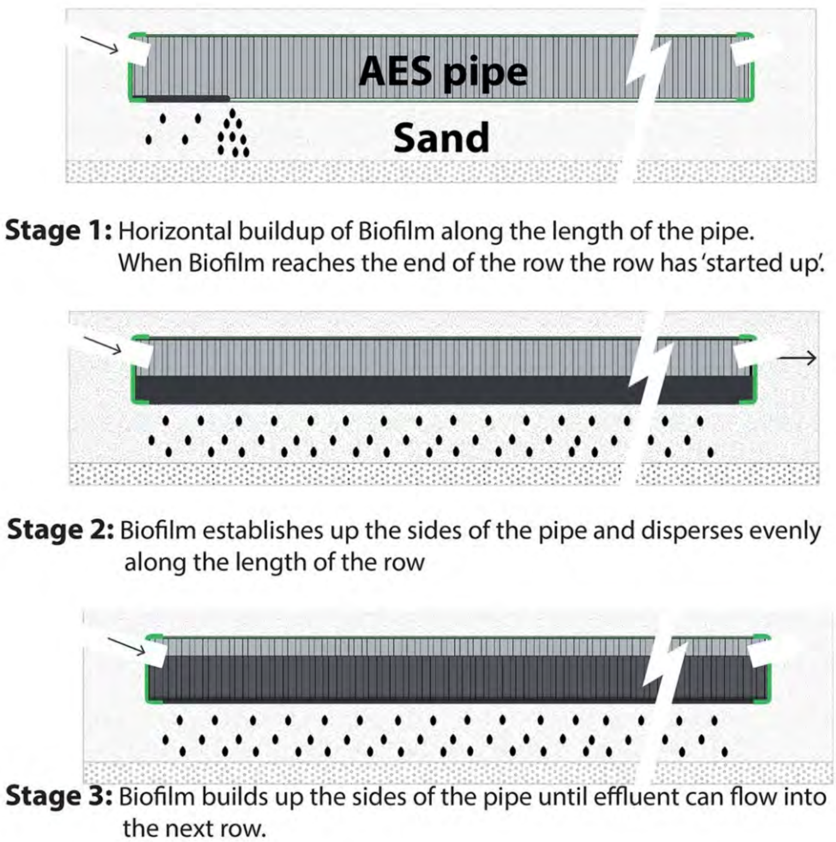
6. Power consumption

The discharge pump and high level alarm were the only electrical components, and required in this installation as the testing facility collection tanks were set up with a 3m head. It is therefore not possible to achieve an A+ rating for energy for this trial, although the benchmarking results table suggests this is possible. The power used – 0.1 kWh/d – would cost around $9.13/ year at $0.25/kWh. The pump is used on demand only - if the system is not in use, for example when the occupants of a house are on holiday, there would be no power used. The majority of AES installations are installed as unlined beds and therefore require no power at all.

7. Overflow to subsequent rows of AES pipes

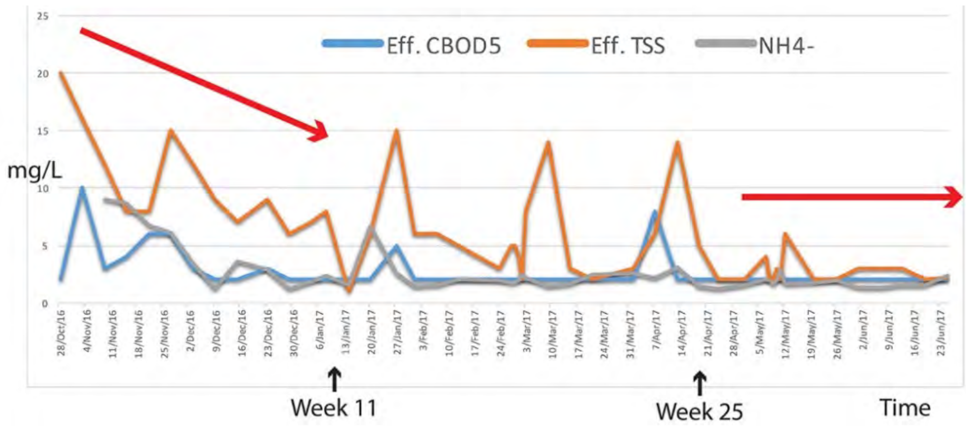
As overflow into and discharge – albeit in low volumes – through row 4 occurred, this is evidence that rows 1 and 3 had started up, as shown in stage 2 of Figure 2 below. It is assumed that overflow into row 2 also occurred. Biofilm growth in rows 1 and 3 reduces the permeability which results in the liquid level rising until flow through the raised connectors - 100mm PVC pipework - occurs.

Figure 2. Biofilm build up in AES pipes



When the AES-38 results from weeks 1 – 35 of Trial 12 are plotted on a graph there are three phases. During phase one treatment quality improves while the biofilm establishes along the length of the row. In phase two treatment quality becomes more stable after the biofilm has developed along the length of the row, and the row has started up. Biofilm continues to establish up the sides of the pipes. After Week 25 the treatment quality is very stable suggesting a third phase - equilibrium - has been reached – the biofilm growth is limited only by the influent nutrients, and is sufficient to slow the movement/ maximise the treatment of all the influent.

Figure 3. Trends in AES-38 OSET-NTP Trial 12, Weeks 1 – 35



The erratic TSS values in the second phase may have been due to silt in the sand around rows 2 and 4, and silt in the row 4 underdrain being washed out as effluent first reached rows 2 and 4.

8. High load assessment phase

In Week 36 the system received 2000L/d for five consecutive days and thereafter received the normal 1000L/d. Samples were collected on Days 1, 9 and 17 (Weeks 37-39) after the five days of high load. BOD and TSS were slightly elevated for the first two samples only, though still <5.2mg/L. Total nitrogen (TN) was unaffected.

Table 4. Test results high load three week recovery phase.

Parameter	1,000 L/day [Mean of 16 results (Weeks 23 to 35) prior to High Flows]	1,000 L/day [Week 37 - Recovery after high flows in Week 36]	1,000 L/day [Week 38 - Recovery after high flows in Week 36]	1,000 L/day [Week 39 - Recovery after high flows in Week 36]
BOD5	2.4 mg/L	3.9mg/L	2.1 mg/L	2 mg/L
TSS	3.8mg/L	4.6 mg/L	5.2 mg/L	2 mg/L
TN	38 mg/L	36 mg/L	42 mg/L	43 mg/L

9. Research and development phase – further nitrogen reduction

On the completion of Trial 12 the AES-38 system was reconfigured to enable recirculation of the treated effluent back through the anaerobic septic tank and AES bed, in order to enhance nitrogen reduction. The reconfigured system, an AES-38 R, ran for 11 weeks and achieved TN <10mg/L. The system is taking part in OSET-NTP Trial 13, 2017-18.

Photo 5. Pipe network inside the septic tank through which treated effluent can be recirculated

Table 5. TN, BOD and TSS results, Trial 12 research and development phase, Weeks 41 – 51

	R&D phase Weeks 41 - 51
BOD_5 (mg/L) [Mean of 3 samples]	**2**
TSS (mg/L) [Mean of 5 samples]	**7.5**
TN (mg/L) [Mean of 7 samples]	**9.5**

The slightly elevated TSS is again attributed to residual silt in the sand being washed out as rows 2 and 4 received more effluent. Septic tank effluent tested in Week 43 returned a low TSS result of 22mg/L, while final effluent TSS improved from 15mg/L in Week 43, to 5mg/L in Week 50. Final effluent BOD was consistently low at 2mg/L which also supports the inorganic/ silt origin of the elevated TSS in the final effluent during this phase.

10. AES-38 R and UV disinfection in OSET-NTP Trial 13

A Salcor 3G UV unit has been installed on the AES-38 R system undergoing testing in Trial 13. The treated effluent gravity flows through this unit before being discharged. Power flow ratings are being recorded both with and without the UV unit in use. Trial 13 finishes in August 2018.