US EPA Environmental Technology Initiative

Onsite Wastewater Technology Testing Report

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The Massachusetts Alternative Septic System Test Center (MASSTC) is operated by the Barnstable County Department of

1. Technology description

General

The Waterloo Biofilter® belongs to a broad class of treatment units called trickling filters. When used in denitrifying systems, the filters are generally configured so as to return a portion of the filtrate to the septic tank, while the remaining portion flows forward to a soil absorption system.

Components

As installed and tested at MASSTC the technology consisted of a 1,500 gallon concrete septic tank, a 20-in diameter pump chamber and a Waterloo Biofilter. As Tested, a cylindrical, plastic mesh basket containing man-made fibers was suspended in the septic tank liquid. One Zabel model A100 effluent filter was fitted to the septic tank outlet tee. The pump chamber was Zabel cylindrical 50-ga

a free-draining condition. The pressure manifold atop the filter must be self-draining to prevent freezing. Above ground wooden enclosure installations should consider treatment for carpenter ants and burrowing insects. An approved effluent tee filter should be installed in the septic tank. Above-ground units can have varying heights of the containment structure exposed above grad

Design and permitting costs vary with the site conditions.

Electric usage

Average electric usage by the three units was 2.43 kW per day per unit or about $.27 per day at $.10 per kW; monthly this comes to $7.20 per month, and $86.20 per year. By comparison with other technologies at MASSTC, this electric cost is the lowest cost of the technologies tested at MASSTC (generally $8-$30 /month).

Maintenance

Massachusetts requires that all alternative technologies have a service contract in force for the life of the installation. Costs for this service vary but are approximately $400 per year. The service includes inspection of pumps, alarms, controls, fan, effluent filter, and

The technologies were sampled at two-week intervals. During each sampling event, technology influent wastewater was sampled at the common dosing channel. Technology effluent was sampled at the distribution box. Influent wastewater and technology effluent were sampled using automated samplers, programmed to obtain fifteen flow-weighted samples composited over a twenty four hour period. Initiation of the individual samples was timed with a delay, to the influent wastewater dosing schedule for each technology.

Composite samples were kept refrigerated at 4 degrees centigrade either by ice packed in the sampler or by use of a refrigerated sampler. Upon completion of the sampling schedule samples were processed at the MASSTC. Analysis for pH and specific conductance were conducted at MAASTC during sample processing. Subsamples for BOD_5 and fecal coliform were sent to the Barnstable County Department of Health and the Environment laboratory. Subsamples for nitrogen and phosphorus analysis: ammonium (NH_4), nitrate plus nitrite (NO_x), dissolved organic nitrogen, (DON), particulate organic nitrogen (PON), alkalinity, orthophosphate (PO_4), total suspended solids (TSS) and total phosphorus (TP); were sent to the School for Marine Science University of Massachusetts, Dartmouth (SMAST).

5. Contaminant Removal Performance Summary for the Waterloo Biofilter®

Note: Technologies were allowed a start-up period, when measures of removal performance would be excluded from the test period. We define the start-up period as ending when the technology attains effluent levels below 30 mg/l BOD_5; 30 mg/l TSS; and 19 mg/l TN. These levels are performance thresholds for alternative systems set by MA DEP.

The data from all three units from the second sampling event attained levels below 30/30/19 mg/l, so that only the first sample event was excluded under the start-up period rules.

Biochemical Oxygen Demand ($BOD_{5)}$ removal

BOD_5 measured in the technology effluent averaged 9.3 mg/l (median, 8.0 mg/l) over the monitoring period, versus 175 mg/l for influent wastewater, representing a removal rate of 95 per cent (Table 1, Appendix 1 & 2)). Measurements exceeded the threshold 30 mg/l level only 2% of the time (3 samples out of 124 taken). Standard deviation, reflection of the variability of the performance was relatively low; an indication that the technology was able to provide good removal performance consistently over the testing period.

Table 1. Biochemical Oxygen Demand (5-day) removal performance of the Waterloo Biofilter® system during testing at the Massachusetts Alternative Septic System Test Center - June 1999- June 2001.

BOD (mg/l)	Replicate 1	Replicate 2	Replicate 3	Influent	Mean	%Removal
Average	9.7	8.9	9.1	174.5	9.3	94.7%
Median	9.0	7.5	8.0	162.0		
Standard Deviation	6.0	6.7	8.1	59.8		
Maximum	28.0	36.0	36.0	385.0		
Minimum	1.0	1.0	1.0	83.0		
Count	46	46	32	46		
Count> 30 mg/l	0	1	2			

The three maximum values occurred in May 2000. At that time, in all three units the baskets supporting the foam cube media tilted and slumped. This movement displaced the distribution manifold, causing some of the spray of septic tank effluent to miss the media column and hit the enclosure walls and short-circuit to the discharge point. Thus with each pressure dose, a portion of the technology effluent was not fully treated by the filter media, with resultant poorer effluent quality. Waterloo Biofilter® personnel repaired the baskets and subsequent samples show an improvement in the effluent quality (Appendix 1 &2) until the period January – March 2001 when levels rose above 20 mg/l. We interpret this decline as a seasonal effect: lower influent wastewater temperature and

ambient air temperature slow biological activity and thus degrade performance. Waterloo Biofilter now uses rigid baskets or bulk filter tanks to avoid problematic slumping.

Total Suspended Solids (TSS) removal.
Total Suspended Solids (TSS) measured in the technology effluent averaged 6.2 mg/l (median 4.0 mg/l) over the monitoring period, versus 160 mg/l for influent wastewater, representing a removal rate of 96 per cent (Table 2).). Measurements exceeded the threshold 30 mg/l level less than 2% of the time (2 out of 118 samples taken). Standard deviation, a reflection of the variability of the performance was relatively low, an indication that the technology was able to provide good removal performance consistently over the testing period.

Table 2. Total Suspended Solids (TSS) removal performance of the Waterloo Biofilter® system during testing at the Massachusetts Alternative Septic System Test Center - June 1999- June 2001.

TSS (mg/l)	Replicate 1	Replicate 2	Replicate 3	Influent	Mean	%Removal
Average	6.7	6.1	5.5	160	6.2	96.2%
Median	3.5	4.0	3.0	161		

Fecal Coliform Removal

Fecal coliform is often used as a surrogate measure of public health significance. Wastewater treatment systems that remove fecal coliform are thought to concurrently reduce the discharge of human pathogens. In general, the Waterloo Biofilter removed >99% of the fecal coliform in the influent (Table 4).

Table4. Fecal Coliform removal performance of the Waterloo Biofilter® system during testing at the Massachusetts Alternative Septic System Test Center. June 1999- June 2001.

Fecal Coliform CFU/100 ml	Replicate 1	Replicate 2	Replicate

recommend that checking and cleaning the effluent filter should normally be a part of the service/maintenance procedure.

Biofilter® Enclosure integrity

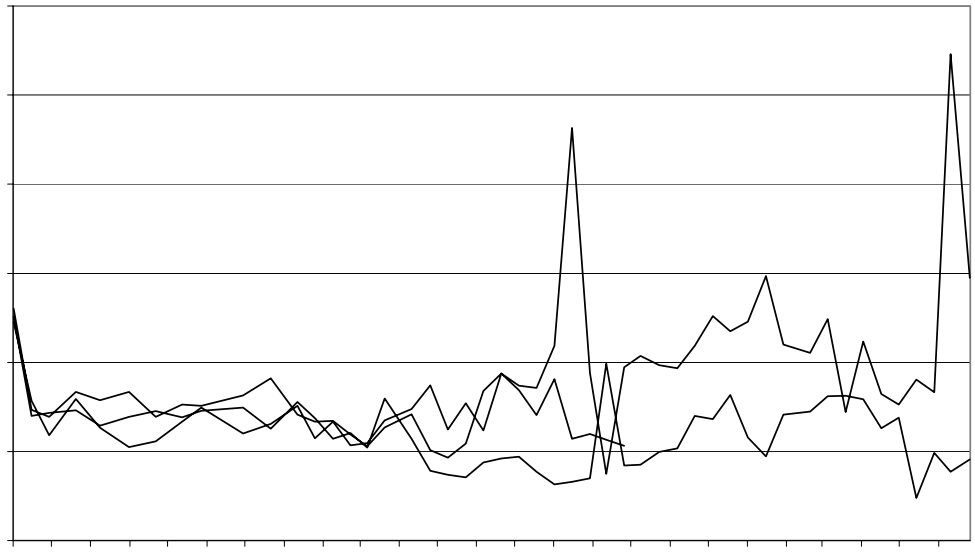
Enclosures were fitted with hinged wooden access covers. The hinge fasteners (screws) were inadequate to the stresses placed upon them and stripped out on Unit 1 (August 4, 2000).

Noise

The primary source of noise from the system is the sound of water being sprayed upon the filter media. Noise levels were measured on 2/27/00 using a quest Model 2700 Sound Level Meter calibrated by factor on 2/23/00 (NIST Traceable) using slow response and A weighting. Levels were recorded 20 feet from the unit 4 feet above grade. Recorded levels averaged 38.9 db. Some of the sound measured was contributed by an adjacent technology. These levels were equivalent to background levels at the test site at the time of measurement.

Ease of maintenance

Components which may require maintenance, such as the pump, the fan, the filter media, the spray heads and spray manifold and the effluent filter were relatively easy to access for servicing with one exception. The Biofilter® unit access cover was heavy because of its size, and had to be propped open with a stick or other object, and due to its weight presented a hazard to the service person. Waterloo Biofilter now uses smaller, lighter-weight covers with large hinges secured by bolts to address these problems.



APPENDIX 2

Tables of All Wastewater Constituents Monitored in Conjunction with Testing

Waterloo Biofilter®

Technology Vendor
Waterloo Biofilter Systems, Inc.
P.O. Box 400
143 Dennis Street
Rockwood, ON N0B 2K0 Canada
Tel: 519-856-0757

Location	Date	pH	Alkalinity (mgl)	BOD5 (mg/l)	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	PON (mg/l)	Total Nitrogen (mg/l)	POC (mg/l)	PO_4 (mg/l)	TP (mg/l)	Sp Cond (uS)	TSS (mgl)
DC WEST	6/9/99	7.30	205.0	108	1.9E+06	0.5	27.0	0.10	6.5	34.1	64.6	3.4	5.3	518	135
DC WEST	6/23/99	7.39	192.0	145	4.2E+06	2.4	30.8	0.03	8.0	41.2	63.8	3.9	5.5	485	142
DC WEST	7/7/99	7.21	171.0	210	8.4E+06	1.0	23.1	0.03	11.2	35.3	97.0	3.9	5.0	418	
DC WEST	7/21/99	7.24	190.0	136	1.0E+04	1.4	26.7	0.08	6.4	34.4	63.1	3.7	5.4	503	141
DC WEST	8/11/99	7.31	185.0	140	4.4E+06	0.5	31.6	0.13	10.3	42.5	95.3	4.2	6.1	573	215
DC WEST	8/30/99	7.28	172.0	110	3.1E+06	1.6	24.7	0.06	5.0	31.3	43.7	3.7	4.8	516	91
DC WEST	9/22/99	7.47	195.0	172	3.4E+06	0.3	35.9	0.00	10.1						

Location	Date	pH	Alkalinity (mgl)	BOD5 (mg/l)	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	PON (mg/l)	Total Nitrogen (mg/l)	POC (mg/l)	PO_4 (mg/l)	TP (mg/l)	Sp Cond (uS)	TSS (mgl)
DC WEST QA	8/23/00	7.38	158.0	174	8.5E+06	6.5	24.4	0.04	11.5	42.5	139.3	3.2	4.9	650	272
DC WEST	9/6/00	7.50	144.0	160	4.9E+06	0.2	21.1	0.02	7.1	28.4	54.9	2.6	4.2	610	94
DC WEST	9/20/00	7.36	127.0	121	3.6E+06	2.6	21.4	0.00	9.7	33.7	86.7	3.0	5.3	544	188
DC WEST	10/3/00	7.24	139.0	203	7.1E+06	0.6	23.0	0.04	7.8	31.3	82.4	3.5	5.3	604	173
DC WEST QA	10/3/00	7.51	137.0	150	7.2E+06	0.4	25.7	0.02	8.6	34.6	86.7	3.7	5.3	608	184
DC WEST	10/17/00	7.09	189.0	90	8.1E+06	0.6	21.5	0.09	9.6	31.8	85.8	2.7	4.9	549	197
DC WEST	10/30/00	7.32	156.5	171	3.5E+06	3.6	21.1	0.08	8.1	32.9	80.3	2.9	3.4	463	165
DC WEST	11/14/00	7.29	163.5	153	1.3E+07	4.7	23.8	0.03	7.1	35.6	53.1	3.0	5.1	486	107
DC WEST	11/28/00	7.45	184.5	180	1.7E+07	3.8	24.5	0.01	6.6	34.9	65.0	3.2	4.8	538	133
DC WEST	12/12/00	7.57	183.5	152	1.3E+07	1.8	27.1	0.03	6.7	35.7	60.5	3.1	4.6	558	127
DC WEST QA	12/12/00	7.59	185.0	144	1.5E+07	0.3	27.2	0.04	6.0	33.5	52.3	3.3	4.4	565	112
DC WEST	1/9/01	7.56	180.0	160	1.0E+07	5.5	22.6	0.08	8.2	36.4	84.9	3.6	4.6	555	200
DC WEST	1/23/01	7.56	184.5	138	1.3E+06		27.1	0.05	7.1	34.3	69.9	3.6	4.9	514	123
DC WEST	2/6/01	7.53	179.5	109	5.1E+06	3.2	24.0	0.05	6.7	33.9	71.5	3.3	4.5	775	134
DC WEST	2/20/01	7.45	185.5	163	2.6E+06	5.5	23.5	0.05	7.5	36.5	74.2	3.5	4.9	526	164
DC WEST	3/13/01	7.43	169.5	114	3.0E+05	2.6	24.0	0.08	8.4	35.1	84.9	3.6	5.8	977	191
DC WEST QA	3/13/01	7.45	171.5	168	7.0E+05	2.9	24.0	0.08	8.4	35.4	85.0	3.6	5.7	993	191
DC WEST	3/27/01	7.48	177.5	115	1.9E+06	3.3	26.9	0.06	9.3	39.6	89.1	3.6	5.4	837	199
DC WEST	4/10/01	7.48	181.5	186	1.1E+06	4.1	24.9	0.05	7.8	36.9	72.3	3.9	5.0	501	152
DC WEST	4/24/01	7.54	195.0	205	4.0E+05	1.0	26.6	0.06	8.9	36.5	88.0	3.2	5.1	533	210
DC WEST	5/8/01	7.60	174.0	190	1.8E+06	1.8	25.3	0.07	7.3	34.4	77.0	3.0	5.1	514	156
DC WEST	5/22/01	7.46	173.0	157	9.0E+05	2.1	27.0	0.04	7.6	36.7	83.1	3.8	3.9	526	173
DC WEST	6/5/01	7.59	187.0	318	1.9E+06	1.0	28.1	0.10	8.8	38.0	87.4	3.3	4.5	507	200
DC WEST	6/19/01	7.46	183.5	260	3.8E+06	1.5	29.6	0.02	7.7	38.9	71.6	3.3		526	157
DC WEST QA	6/19/01	7.47	186.0	281	1.0E+07	1.6	29.8	0.06	7.9	39.3	72.2	3.2		508	164
DC WEST	7/2/01	7.27	185.0	263	5.2E+06	5.2	19.9	0.04	9.0	34.2	88.5	3.2	3.8	539	202
DC WEST	7/17/01	7.22	188.0	261	5.4E+06	1.7	25.3	0.06	12.6	39.7	148.8	3.3	6.1	515	288

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Location	Date	pH	Alkalinity (mgl)	BOD5 (mg/l)	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)

Location	Date	pH	Alkalinity (mgl)	BOD5 (mg/l)	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	PON (mg/l)	Total Nitrogen (mg/l)	POC (mg/l)	PO_4 (mg/l)	TP (mg/l)	Sp Cond (uS)
A2 DB	8/23/00	7.08	240.0	6.0	1.7E+04	1.4	0.4	19.						

Location		pH	Alkalinity (mgl)	BOD5 (mg/l)	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	PON (mg/l)	Total Nitrogen (mg/l)		PO_4 (mg/l)	TP (mg/l)	Sp Cond (uS)	TSS (mgl)
A 3 DBOX															
	6/23/99	7.69	173.0	12.0	2.4E+05	0.0	20.7	2.8							

Location	Date	pH	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	Total Nitrogen (mg/l)	PO_4 (mg/l)	TDP (mg/l)	Sp Cond (uS)
A1 1FT	8/30/99	6.87	1.3E+04	0.5	0.0	13.3	13.8	4.6		420
A1 1FT	9/22/99	6.88		0.6	0.0	13.9	14.5	4.1		
A1 1FT	10/13/99	6.74	7.4E+03	0.0	0.3	13.5	13.8	4.1		
A1 1FT	11/3/99		6.0E+02	0.7	0.0	13.1	13.8	3.9		
A1 1FT	11/18/99	6.77	1.4E+03	0.5	0.1	14.1	14.8	4.1		
A1 1FT	12/21/99	6.75	3.4E+03	0.0	0.6	0.0	0.6	4.0		387
A1 1FT	1/12/00	6.74	2.8E+03	1.1	2.3	8.5	11.8	4.3		461
A1 1FT	2/2/00	6.68	1.0E+04	0.7	0.8	11.9	13.4	3.4		488
A1 1FT	2/16/00	6.60	1.0E+03	0.0	0.7	15.3	16.0	4.2		524
A1 1FT	3/1/00	6.74		1.0	1.1					

A1 5FT

Location	Date	pH	FC #/100 ml	

A2 1FT

Location	Date	pH	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	Total Nitrogen (mg/l)	PO_4 (mg/l)	TDP (mg/l)	Sp Cond (uS)
A2 1FT	9/20/00	6.90	5.0E+00	0.2	0.0	18.0	18.3	3.5	4.1	488
A2 1FT	10/3/00	6.85	3.0E+01	0.1	0.0	17.7	17.8	3.9	4.0	495
A2 1FT	10/17/00	6.75	1.0E+01	0.3	0.1	18.4	18.8	3.1		438
A2 1FT	10/30/00	6.74	2.0E+02	1.0	0.0	18.8	19.8	3.5	4.0	414
A2 1FT	11/14/00	6.59	5.0E+02	0.7	0.0	17.8	18.4	3.1		386
A2 1FT	11/28/00	6.66	1.3E+03	0.7	0.5	15.6	16.8	3.1		399
A2 1FT	12/12/00	6.53	8.0E+02							

A2 5FT

Location	Date	pH	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	Total Nitrogen (mg/l)	PO_4 (mg/l)
A2 5FT	6/5/01	6.32	5.0E+00	0.8	0.1	21.2	22.1	4.9
A2 5FT	6/19/01	6.23	1.0E+01	3.3	0.0	22.4	25.7	4.8
A2 5FT	7/2/01	6.36	5.0E+00	2.7	0.0	32.9	35.6	5.5
A2 5FT	7/17/01	6.01	5.0E+00	2.2	0.0	33.0	35.2	5.3

A3 1FT

Location	Date	pH	#/100 ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)

A3 2FT

Location	Date	pH	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	Total Nitrogen (mg/l)	PO_4 (mg/l)	TDP (mg/l)	Sp Cond (uS)
A3 2FT	6/14/00	7.47	1.0E+02	1.0	1.0	7.5	9.5	2.4	2.5	535
A3 2FT	9/6/00	6.97	5.0E+00	0.5	0.0	9.4	9.9	3.9	3.9	497
A3 2FT	11/28/00	7.19	2.2E+03	0.6	0.0	8.8	9.4	3.3	3.9	380

A3 5FT

Location	Date	pH	FC #/100 ml	DON (mg/l)	NH_4 (mg/l)	NO_x (mg/l)	Total Nitrogen (mg/l)	PO_4 (mg/l)	TDP (mg/l)	Sp Cond (uS)
A3 5FT	6/14/00	7.07	2.0E+02	0.2	0.0	10.4	10.6	3.3		456
A3 5FT	6/28/00	6.84	6.0E+01	0.3	0.0	10.0	10.3	4.6	4.6	439
A3 5FT	7/12/00		1.4E+02				0.0			
A3 5FT	9/6/00	6.86	1.0E+01	0.7	0.0	10.2	10.9	3.7	3.8	506
A3 5FT	9/20/00	6.97	5.0E+00	0.4	0.0	10.1	10.5	3.9	3.9	468
A3 5FT	10/3/00	7.18	5.0E+00	0.0	0.0	10.6	10.6	4.1	4.2	485
A3 5FT	10/17/00	7.28	5.0E+00	0.5	0.0	10.0	10.6	3.6		428
A3 5FT	10/30/00	6.95	5.0E+00	0.9						