Communal-size sewage and leachate treatment using biofilters in process trains

The Waterloo Biofilter™ is a new type of free-draining aerobic trickling filter developed in Ontario for domestic sewage but has been applied to other larger scale flows such as small municipality and resort sewage, landfill leachate, and food processing wastewater.

The optimized physical properties of the plastic foam medium enable single-pass loading rates of 0.5-8 $m^3/m^2/d$ depending on filter bed depth, influent composition, solids content, and desired effluent quality and maintenance frequency. The medium combines high retention time, large open pores, concurrent aerobic and anaerobic reactions, and high surface area for higher performance and long-term low maintenance. This article describes results from larger wastewater installations with several pretreatment steps.

Municipal Wastewater, Saskatchewan

In Prince Albert, Saskatchewan, a 105 m^3/d flow of municipal and commercial-industrial wastewater is treated using the Proteus® coagulation system and Waterloo Biofilters. The facility was monitored by CETAC-West and is now operated by the City of Prince Albert. The Proteus system efficiently mixes alum with raw sewage to produce a sludge and a supernatant within a 20-minute residence time.

The sludge is thickened and processed off-site, and the supernatant with BOD=50-100, TSS=10-40, and TP<0.5 mg/L is normally passed through graded sand filters and is then sprayed onto the biofilters in sequence (**Figure 1**). (BOD refers to biochemical oxygen demand over 5 days.) The sand removes solids to TSS<2 mg/L, but removes only minimal BOD. Testing and monitoring was carried out from November 1995 to August 1996 using one 4.5 m^2 biofilter, at loading rates of 0.5-3.5 $m^3/m^2/d$, followed by the full flow through five biofilters from August 1996 to April 1997 (**Table 1**).

The wastewater is polished to BOD<10 mg/L by the biofilters at loading rates of 5-6 $m^3/m^2/d$ from August 1996 to early January 1997 (**Table 1**) and effluent quality is not affected by the cold temperatures of November to January compared to August to October. The higher loading rate of 6 $m^3/m^2/d$ in late December to early January increases BOD only slightly (9 mg/L), but the 8 $m^3/m^2/d$ test in January increases effluent BOD to 14 mg/L. The lower loading rates provided sustainable low-maintenance operation whereas the higher loading rate resulted in some biomat accumulation on the medium.

Table 1. CETAC (West) Monitoring Results of Proteus and Waterloo Biofilter Sewage System at Hazeldell Plant, Prince Albert, N. Saskatchewan (~105 m^3/d)

Dates of Monitoring 1996-97	Loading Rate $m^3/m^2/d$	Biofilter Influent TSS mg/L	n	Biofilter Influent BOD mg/L	n	Biofilter Effluent BOD mg/L	n
		sand filters					
August	5	<2		–		7.1	19
September	5	<2		–		7.7	19
October	5	<2		–		8.0	21
November	5	<2		–		6.5	17
December	5	<2		–		4.4	15
L Dec-E Jan	6	<2		–		8.8	9
Mid January	8	<2		–		14	8
		no sand filters					
L Jan-E Feb	8	31	2	79	2	21	5
E Feb-E Mar	5	21	8	83	9	18	23
M Mar-M Apr	6	21	12	61	12	19	28

n = number of analyses

Testing of the biofilters without sand filters followed until mid-April 1997. The Proteus supernatant contained BOD=69-83 and TSS=21-31 mg/L and the Waterloo Biofilter polished this to BOD=20 mg/L regardless of the 5-8 $m^3/m^2/d$ loading rate (**Table 1**). The higher quality BOD<10 mg/L was not attainable without the sand filters at these loading rates due to the higher solids content, but is adequate to meet the 25 mg/L BOD compliance for direct discharge after UV disinfection and saves considerable capital and operating cost.

Food Processing & Sewage Wastewater, Korea

In Seoul, Korea, a 350 m^3/d flow of food processing and sewage wastewater is being treated in two separate streams using sacrificial anode electrochemical coagulation pretreatment (Global Water Systems) followed by Waterloo Biofilters. The sludge is concentrated in a clarifier and the soluble organic superfluent is polished in the biofilters at design loading rates of ~8 $m^3/m^2/d$. After start-up in early October 1997 treating raw wastewater with BOD and TSS=200-300 m/gL, by November 1997 the EC coagulation effluent averaged BOD=68 mg/L and TSS=62 mg/L (n=2) and the Waterloo Biofilter polished this to BOD=16 mg/L and TSS=5 mg/L (n=2), within compliance limits.

Fishing Resort, Trailer Park, Ontario

On Rice Lake in Ontario, a 35-cottage fishing resort with measured 30 m^3/d flow is treated using 40 m^3 septic tank pretreatment, equalization tank, and a shallow bed, 36 m^2 biofilter loaded at ~0.8 $m^3/m^2/d$ since early 1995. Disposal is solely by 120 m of shallow pressure trenches over the existing failed tile bed, the second of its type in Ontario. The wastewater is strong and greasy because of the fried fish diet of the occupants and because of low-flow showers and toilets in the cottages. Monitored by the conservation authority for 3 summers, the septic tank averages BOD=221, TSS=528, and TKN=125 mg/L (n=13). The biofilter effluent averages BOD=23, TSS=5, and TKN=17 mg/L (n=13). The existing septic system had been ponding on the surface every year for 20 years before the biofilter was installed, but has not ponded at all since its inception.

Near Leamington on Lake Erie, wastewater from a 310-unit trailer park is pretreated in septic tanks and three conventional gravel tile beds set in heavy clay with underdrains to surface discharge. Peak underdrain effluent flow was measured at 52 m^3/d, but ac-

[1]Waterloo Biofilter Systems
[2]Manz and Associates Engineering
[3]Batu Enviro-Tek Inc.
[4]Henderson Paddon Environmental

tual peaks go as high as 80 m^3/d due to infiltration into the tile beds. Since early 1996, the effluent has been treated in an enclosed 26 m^3 biofilter building at a design loading rate of 2.0 $m^3/m^2/d$ (actual is up to 3.0 $m^3/m^2/d$) and produces an effluent of BOD=5 and TSS<5 mg/L (n=2) in a single pass. The biofilter effluent is disposed of in 275 m of shallow pressure trenches set in a thin layer of sand above the heavy clay.

School & Health Unit, Ontario

A 20 m^2 biofilter services a 20 m^3/d design flow from a health unit and a 300-student school on a Mohawk Native Territory since early 1996. The raw sewage is pretreated with 40 m^3 septic tanks with effluent filters and with a biofilter loaded at 1.0 $m^3/m^2/d$ in a single pass. However, uncontrolled infiltration into the system close to source has resulted in loading rates many times that design rate, but without, however, any hydraulic overload or treatment problems to the biofilter. The high quality biofilter effluent averages BOD<2, TSS<2, and TKN<1 mg/L (n=4) and is subsequently treated by an ultra-membrane filter for pathogens before direct discharge to an infiltrative lagoon on fractured limestone bedrock.

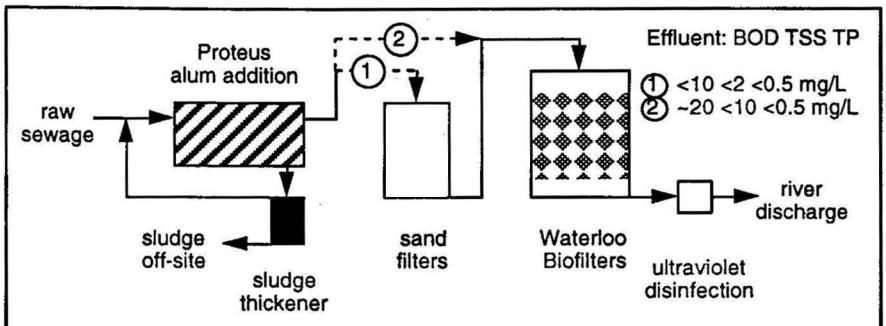

Figure 1. Flow Diagram for Proteus–Waterloo Sewage Treatment, Hazeldell Plant, Prince Albert, Saskatchewan (105 m^3/day)

Landfill Leachate, Ontario

Following successful treatment in the laboratory and several years performance of a smaller pilot plant in Owen Sound, a major biofilter installation was constructed in Simcoe County in collaboration with the MOEE to treat 16 m^3/d of landfill leachate, with a goal to disposing of the leachate on site. The unit consists of 3 concrete tanks serving as a rougher biofilter (design loading of 0.5 $m^3/m^2/d$) and 2 tanks serving as a polisher to treat the rougher effluent (design loading of 0.7 $m^3/m^2/d$). Pretreatment is the landfill itself.

The unit started up in mid-1996 and polisher effluent quality now is generally in the 5-40 mg/L range for BOD, down from 100-1500 mg/L in the raw leachate. Poor performance due to cold leachate (down to 0°C) and massive pumping from one cell to the treatment train have now been alleviated. A Telesafe data collection system allows temperatures, pump on-off cycles, alarms, and flow rates to be reviewed remotely, with operational parameters changed remotely. This monitoring device is found to be very desirable for an isolated location such as a landfill.