Ainley GROUP
CONSULTING ENGINEERS & PLANNERS

Project Case Study

Maintenance and Monitoring of Ottawa's First Biofilter

Background

In July 2000, the City of Ottawa authorized the Ainley Group (in association with other consulting firms) to monitor and maintain the Glen Cairn biofilter. The purpose of the program was to monitor, operate and maintain the biofilter and to record the various conditions within the Glen Cairn Trunk Sewer to aid in the design of the permanent biofilter.

The location of the Glen Cairn Trunk Sewer is shown in *Figure 1*. At its upstream end, the Glen Cairn Trunk Sewer receives flows from three forcemains and a gravity sewer. One of these forcemains, the Richmond forcemain, is approximately 14km long. Due to its length and long retention time, the sewage in the Richmond forcemain becomes anaerobic and produces hydrogen sulphide (H_2S). Where the three forcemains enter at the top end of the Glen Cairn Trunk Sewer, the high turbulence of the flow in the manhole releases large amounts of H_2S gas. At the downstream end, the Glen Cairn Trunk Sewer discharges into the Tri-Township Collector Sewer. This sewer, constructed in 1998, is composed of 1200-mm dia. concrete pipe. Approximately 2680 metres of the upstream portion is lined with 'T-Lock' as a protection against corrosion, while the remaining downstream 820 metre section is unlined. Less than two years after construction, corrosion was evident in the unlined portion.

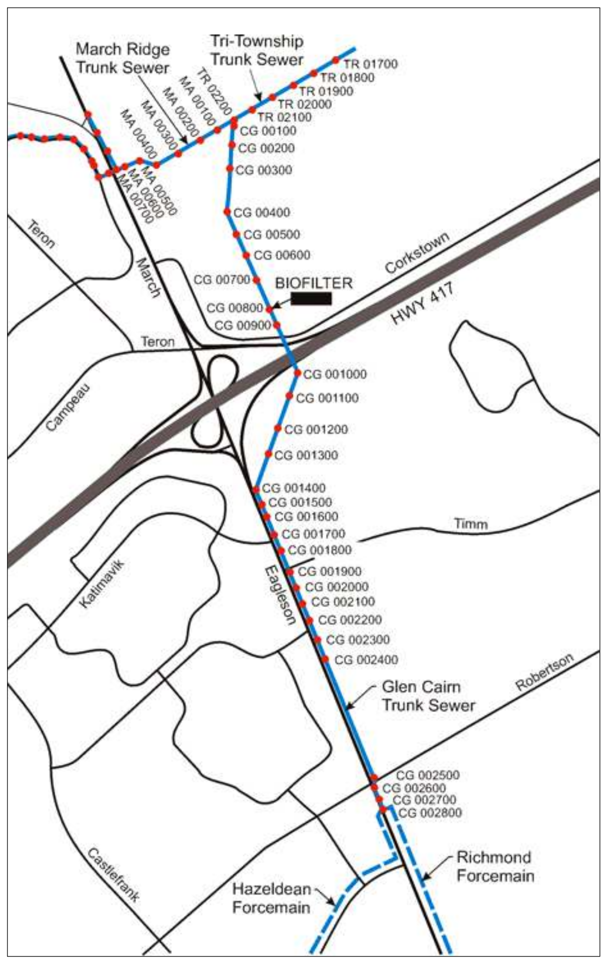

Figure 1 – Glen Cairn Trunk Sewer location

Sanitary sewer corrosion is usually caused by a biological process that frequently occurs in sewage collection systems. Aerobic bacteria (Thiobacillus), which commonly colonize crowns, walls and other surfaces above the waterline in wastewater pipe systems and structures, have the ability to consume hydrogen sulphide gas and oxidize it to sulphuric acid. This process takes place where there is an adequate supply of hydrogen sulphide gas (>1.0 ppm), high relative humidity, carbon dioxide and oxygen. The sulphuric acid then corrodes the concrete.

Since there was no existing data of a biofilter operating in a climate as cold as Ottawa, the pilot installation was needed to determine if a permanent facility could control the odour and corrosion in the Glen Cairn Trunk Sewer and still function during the winter months. Additionally, the pilot biofilter could be constructed quickly and inexpensively and the collected data would be used to refine the design of the permanent facility

The pilot biofilter bed in the middle of winter

The Project

For a period of two months in 2000 and 2001, the Ainley Group conducted continuous flow monitoring in the Glen Cairn Sewer, upstream and downstream of the biofilter. The purpose of this monitoring was to determine the air-split upstream and downstream of the biofilter and to determine if the biofilter was able to dry the crown of the pipe. The monitoring program consisted of installing depth/velocity monitors in the liquid flow and air-velocity meters in the middle of the 'unwetted' area of the pipe. With this data, the airflow and sewer flow upstream and downstream of the biofilter was calculated to determine the airflow split. Differential pressure, humidity, temperature and H_2S monitoring was also conducted at numerous locations in the Glen Cairn Sewer. Using the same data, a mass balance was carried out which led to the conclusion that the probability of drying the crown of the pipe was low, due to the high humidity in the Ottawa area.

At the biofilter, various parameters have been monitored since the fall of 2000. The following schematic of the biofilter (*Figure 2*) shows the monitoring locations.

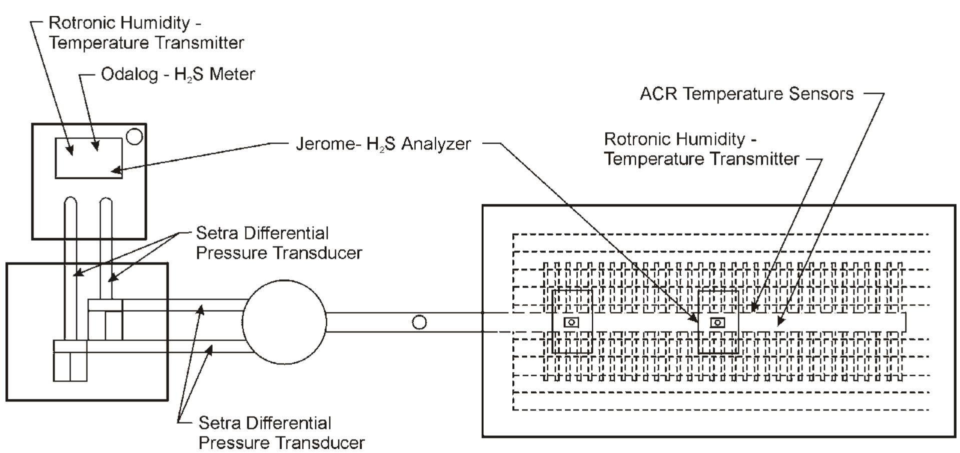

Figure 2 – Monitoring locations at the biofilter

Some of the instrumentation used in the monitoring program included:

- **Odalog Hydrogen Sulphide Meter:** Fabricated by App-Tek International, this unit (*Figure 3*) monitors the levels of H_2S in the GC 800 (intake of biofilter).
- **Jerome 631-X Hydrogen Sulpfide Analyzer:** This unit, made by Arizona Instrument Corporation, measures the extremely low concentration (normally <0.05 ppm) of hydrogen sulphide from the bed (*Figure 4*).
- **Rotronic Humidity-Temperature Transmitter (Model FT2C-D):** Fabricated by Rotronic Instrument Corporation, this unit is used to measure the humidity and temperature of the air in the sewer (*Figure 5*).

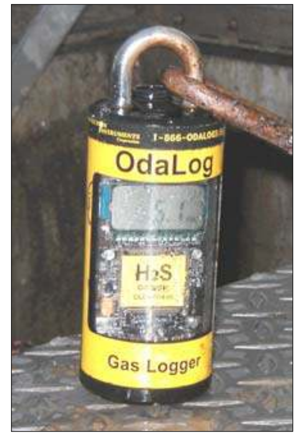

Figure 3 - Odalog Data Logger

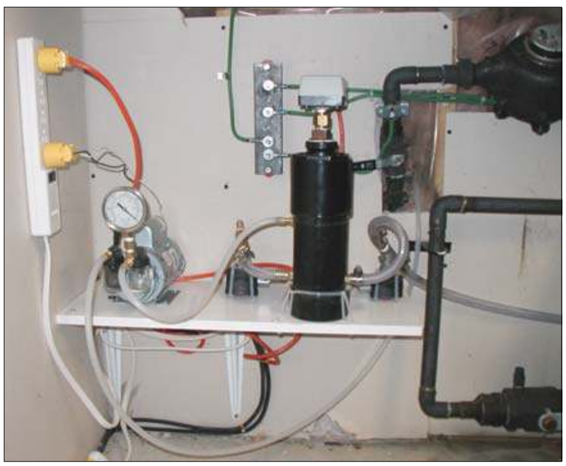
Figure 4 - Jerome 631-X Analyzer Set-Up

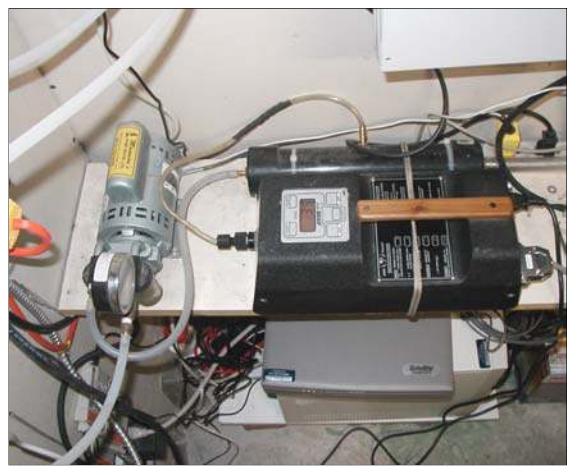
Figure 5 – Rotronic Temperature/Humidity Transmitter (incoming sewer air)

By monitoring H_2S in the system, the concentration exiting the biofilter bed provides insight on how the biofilter bed performs during the different seasons. It was found that, as the outside temperature drops, the concentration of H_2S in the system drops. The efficiency of the biofilter was lower but, since H_2S concentrations in the system are low during the winter months, lower removal efficiency could be acceptable.

Typical data collected during the winter, spring and summer is shown in *Table 1*. As can be seen from the incoming H_2S data, the average level during the winter months was 0.53 ppm with a peak of 44 ppm. The spring data indicated an average of 0.52 pm with a peak of 11.7 ppm. Similarly, the summer data averaged 7.0 ppm with a peak of 94.9 ppm. During the winter months, wastewater in Ottawa drops to an average minimum temperature of 4^0C. During the summer months the sewage temperature can rise to a maximum of approximately 22^0C. The information presented in *Figure 6* shows the incoming and outgoing H_2S concentrations during the winter season.

Table 1: Pilot Biofilter Seasonal Performance (ppm)

Sample Location	Winter (Jan. 20-28 '01)		Spring (May 5-12 '01)		Summer (June 17-21 '01)	
	Average	Peak	Average	Peak	Average	Peak
Incoming (GT 0800)	0.53	44.00	5.02	11.70	7.00	94.90
Outgoing (on bed)	0.19	0.44	0.07	0.48	0.04	0.43
Removal Efficiency %	64.2%	99.0%	98.6%	95.9%	99.4%	99.5%

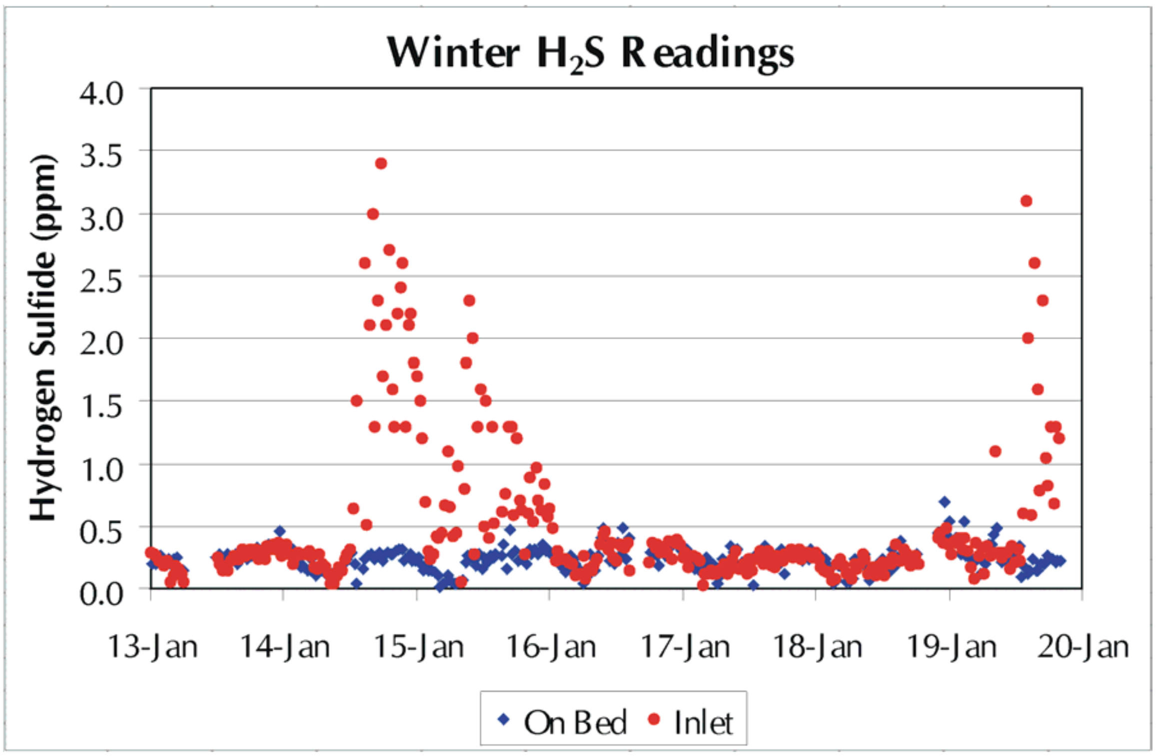

Figure 6 - Winter H_2S Reading on the Biofilter Bed and in the Inlet

The rate that bacteria break down H_2S in the biofilter bed has a direct relationship with the temperature of the biofilter bed; therefore, a better understanding of the ambient, incoming and bed temperature was needed. Based on the information collected by the Ainley Group, it was determined that the biofilter bed requires some heating during the winter months. A sample of the temperature data collected is presented in *Table 2*. During the fall season, the average temperature was noted to be 5.7^{0}C with a peak of 18.5^{0}C. Incoming sewer air had average and peak temperatures of 15.3^{0}C and 16.1^{0}C respectively, while the outgoing air on the bed had average and peak temperatures of 10.9^{0}C and 15.5^{0}C respectively. During the winter season, the average temperature was noted to be -5.5^{0}C with a peak of 11.5^{0}C. Incoming sewer air had average and peak temperatures of 8.8^{0}C and 10.3^{0}C respectively, while the outgoing air on the bed had average and peak temperatures of 5.3^{0}C and 11.0^{0}C respectively. During the summer season, the average temperature was noted to be 20.2°C with a peak of 37.5°C. Incoming sewer air had average and peak temperatures of 18.2°C and 20.0°C respectively, while the outgoing air on the bed had average and peak temperatures of 18.3°C and 22.0°C respectively. Currently the biofilter bed is being monitored for temperature at various depths. The ambient, incoming and average bed temperature for the summer of 2002 is presented graphically in *Figure 7*.

Table 2 - Temperature Monitoring

Sample Location	Fall (°C)		Winter (°C)		Summer (°C)	
	Average	Peak	Average	Peak	Average	Peak
Ambient[1]	5.7	18.5	-5.5	11.5	20.2	37.5
Incoming (GC 800)	15.3	16.1	8.8	10.3	18.2	20.0
Outgoing (on bed)	10.9	15.5	5.3	11.0	18.3	22.0

1 – Ambient temperature sensor in direct sunlight recorded values which may be higher than actual

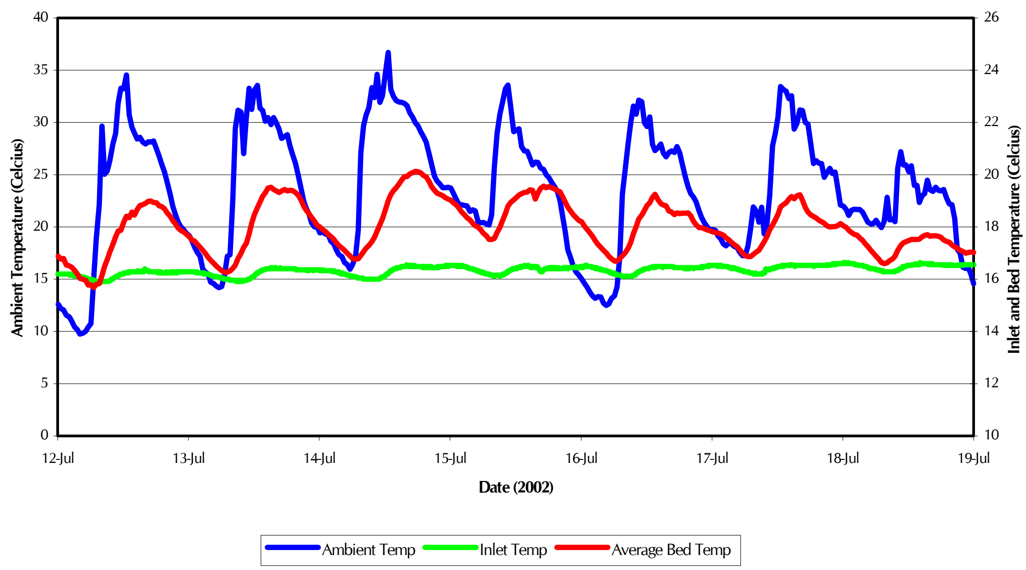

Figure 7 – Bed and Ambient Temperatures during Summer

Continual monitoring in the harsh environments of the sewer and the biofilter bed during all types of weather is a difficult task. Through this program, the Ainley Group was able to refine the sampling process that enabled the gathering of accurate and reliable data. The Ainley Group is a leader in this type of monitoring in the Ottawa area.