APPENDIX B

An Assessment of Alternative Sanitary Sewage Treatment Technologies, Holyrood, NL

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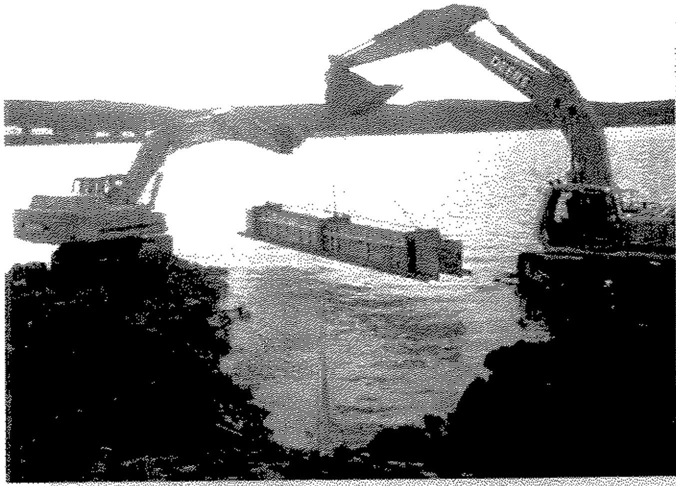
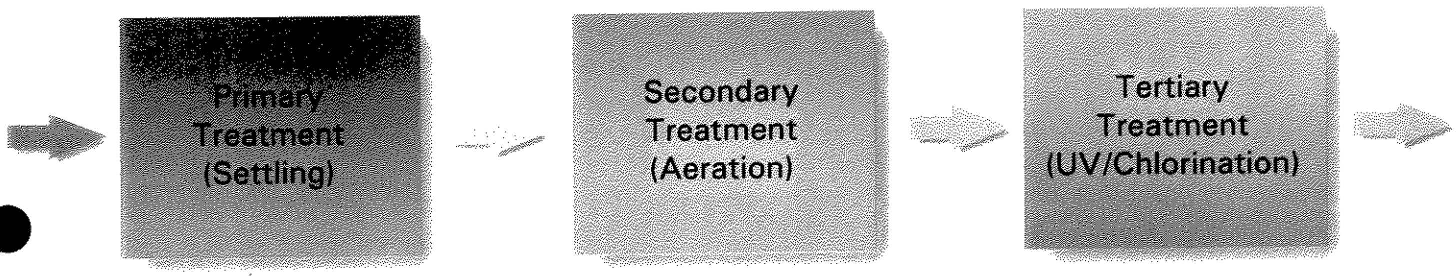
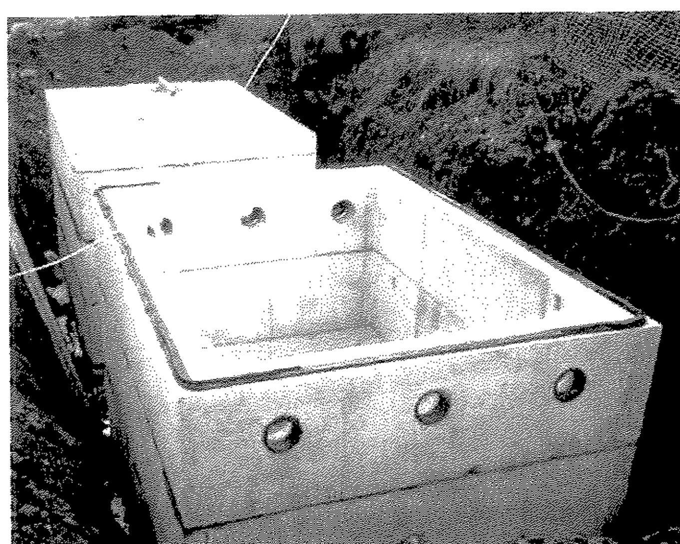


Town of Holyrood Country Path Road



An Assessment of Alternative Sanitary Sewage Treatment Technologies



BAE ◆ NEWPLAN GROUP

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Abbreviations and Nomenclature

AFS - Advanced Fluid Systems

BMS - Butler Manufacturing Services

BOD - Biochemical Oxygen Demand

CMT - Construction Management Technologies

FRP - Fibre Reinforced Polyester

GRP - Glass Reinforced Polyester

PLC - Programmable Logical Controller

PVC - Poly Vinyl Chloride

RBC - Rotating Biological Contactor

SBR - Sequencing Batch Reactor

SHT - Sludge Holding Tank

SS - Suspended Solids

m - Metre(s)

mm - Millimetre(s)

m^2 - Square Metre(s)

m^3 - Cubic Metre(s)

rpm - Rotations per minute

DEFINITIONS

Activated Sludge
- A flocculent microbial mass produced when sewage is aerated.

Aeration
- The process of mechanically supplying oxygen to waste.

Aerobic Reaction
- a reaction whereby molecular oxygen is present.

Anaerobic Reaction
- a reaction where no oxygen is present.

Anoxic Reaction
- A reaction whereby only bound oxygen is present.

Biochemical Oxygen Demand
- The amount of dissolved oxygen consumed by a microbial action when a sample of wastewater is incubated for a designated amount of time and temperature, usually for 5 days at 20° Celsius and referred to as BOD5. It is an indirect measurement of the polluting load of organic waste.

Biomass
- A microbial mass that forms as microorganisms attach to the solid surface area of a fixed film reactor.

De-nitrification
- An anoxic process following aerobic reactions whereby heterotrophic bacteria convert nitrates to odourless nitrogen gas.

Effluent
- Treated water leaving a wastewater treatment system.

Fixed Film Reactor
- Provides a solid surface area (media) for micro-organisms to attach to and then feed on the organic matter as the media is alternately submerged in liquid and presented to the atmosphere for oxygen consumption.

Influent
- Wastewater entering a wastewater treatment system.

Mixed Liquor
- Wastewater that has been mixed typically by means of mechanical aeration.

Nitrification
- An aerobic process whereby autotrophic bacteria convert the nitrogen in organic compounds to nitrates following the oxidation of carbonaceous material by heterotrophic bacteria.

Pathogenic Microrganisms
- A pathogen is an agent that causes an infection in a living host resulting in the growth of microorganisms in the host. Pathogenic Microrganisms carry pathogens.

Primary Treatment
- The first stage of a treatment process whereby the majority of suspended solids are removed from raw sewage usually in a primary settlement tank.

Secondary Treatment
- The second stage of the treatment process whereby microorganisms utilize oxygen and feed off the organic material present in the wastewater to form a biomass which is settled in the form of sludge.

Septic Tank
- A type of settlement tank in which the sludge is retained for a sufficient time to allow the organic matter to undergo anaerobic decomposition.

Suspended Solids
- a measure of the solids in suspension in liquids, normally expressed in mg/L or parts per million (p.p.m).

Tertiary Treatment
- The third stage of a treatment process, sometimes referred to as polishing, whereby effluent undergoes advanced treatment. Nitrification, disinfection by chlorination or U.V. lamps, and phosphorus removal are examples of this type of treatment.

1.0 INTRODUCTION

On April 24, 2001, the Town of Holyrood engaged the BAE◆NEWPLAN Group Limited to undertake a sewage treatment study for Country Path Road located in the Town of Holyrood. The project is a study of various sewage treatment processes suitable for treating the wastewater from the residential houses on Country Path Road and discharging the effluent produced into North Arm River, a nearby salmon habitat or into nearby wetlands. The study outlines the treatment processes available, a budget estimate for each treatment process and BAE◆Newplan's recommendations.

2.0 STUDY BACKGROUND

Country Path Road consists of 23 residential houses which are spread out into small clusters along the 3100 meter road. The pattern of development that has evolved on Country Path Road has resulted in three main areas of population. The first area consists of 8 homes approximately 700 meters from the Conception Bay Highway. The remaining two areas consists 6 homes in each located approximately 1660 meters from the Conception Bay Highway. Three remaining homes are relatively isolated and spread out over the last 750 meters of Country Path Road.

On August 21, 1998, a preliminary estimate for a conventional gravity sewer was compiled to service the first 20 homes on Country Path Road in the amount of \$1,660,000. This estimate equated to \$83,000 per home which was not feasible and an investigation into alternative methods for servicing was required.

3.0 THE EVOLUTION OF SANITARY SEWAGE TREATMENT

In the early 1800's society realized that the disposal of human waste was a growing concern for populated areas. Scientists quickly determined that the most economical and natural way to reduce the volume of human waste was to biodegrade the organic pollutants. Processes evolved in the late 1800's which involved aerating the waste to speed up the reaction. In general, the reaction researched was the addition of ample volumes of oxygen to the waste so that large populations of micro-organisms could form and digest the organic portion of the waste. As sewage treatment became an area of specialization and process designers evolved, two main treatment philosophies developed which are known today as:

1. Fixed Film.
2. Suspended Growth or Activated Sludge.

In a fixed film process a media such as sheets of rigid plastic are rotated through the waste such that typically 40% -50% of the media is submerged at any given time. The micro-organisms form on the media and consume oxygen and waste as they are repeatedly rotated through the waste. This process is known as a flow through process, as waste is permitted to enter the treatment plant on a continuous basis and at varying rates. These treatment plants were eventually named Rotating Biological Contractors or RBC's.

The suspended growth process operates in a batch cycle in which the influent is retained in an equalization basin for a predetermined period of time, typically 3 – 4 hours, and then it is transferred to a reactor basin where oxygen is mechanically circulated or diffused through the waste. In this process the large population of micro-organisms are formed in suspension within the volume of waste retained in the reactor basin. The aeration cycle lasts for approximately 90 minutes before the mechanical aerators are turned off and the waste is permitted to settle for approximately one hour. After the settle period has expired, then the clear supernatant at the top of the reactor basin is decanted and discharged.

For decades this process was studied in theory only and although it was deemed to be the superior process, suspended growth systems were not constructed until the early 1900's. This was due to the large amount of the operator attention required to operate the batch cycle process. The process was referred to as a Sequential Batch Reactor or SBR.

The development of Programmable Logic Controllers or PLC's in the late 1970's took the operator attention out of SBR's and in the early 1980's there was an influx of SBR's into the American sewage treatment marketplace. Over the past 20 years, process designers have altered and refined both the RBC and the SBR technologies while others have developed hybrid designs using the philosophies of both processes. This has resulted in a competitive and efficient marketplace with society and the environment being the beneficiaries.

4.0 RESEARCH STRATEGY

An internet search of existing technologies and a review of literature compiled by BAE◆Newplan and SNC Lavalin on sewage treatment processes was conducted. At least one company representing each treatment process was presented with a pre-determined list of influent and effluent characteristics and requested to submit a preliminary process design including capital, operational and maintenance costs.

For the purpose of requesting a budget estimate, average daily flow and peak flow calculations were calculated for the largest cluster of homes (12) with consideration of future development, for a total of 20 houses used in the calculation. Each home, was assumed to have a population of three people using an estimated 450 litres of wastewater per day. It was also noted that the 20 homes could be treated as 3 separate areas. The process designers for the mechanically driven RBC and SBR processes indicated that this would not be a economically viable option for their systems. Therefore only the non-mechanical processes were requested to submit quotations on this scenario.

Based on this information and the regulatory requirements as published in the "Environmental Control Water and Sewer Regulations" the following specifications were compiled for this study:

	Single System	3 Systems each
Average Daily Flow	28.8 m /day	28.8 m /day
Peak 3 hour Flow	1.1 L/s	0.5 L/s
Peak 4 hour flow	1.0 L/s	0.4 L/s

Influent Data	Amount
BOD	200 mg/L
SS	200 mg/L
Fats, oils and grease	50 mg/L
Phosphorous	*
TKN	*
NH3-N	*

* To be estimated by process designer

Effluent Data	**Amount**
BOD	20 mg/L
SS	30 mg/L
Fats, oils and grease	15 mg/L
PH Level	5.5-9.0
TKN	10 mg/L
NH3-N	2 mg/L
P2 O5	1mg/L
Total Coliform	1000/100 mL
Faecal Coliform	200/100 mL
Chlorine	1 mg/L where applicable

TABLE 1 Influent and Effluent Parameters

Effluent testing has proven that SBR's have nitrogen and phosphorus removal inherent in their design. RBC's can be modified or enlarged to provide the same level of treatment and for the purposes of this report both processes were provided with the same effluent guidelines to ensure a fair comparison. As a result of these design parameters this report assumes that all processes proposed are technically equivalent and will produce a similar quality effluent.

Some other constraints placed on the process designers were the provision of a sludge retention time of four months and the requirement of effluent disinfection. The four month sludge retention time ensures that the sludge pumping truck or "honey truck" can be provided with a full 750 to 1000 gallon load every trip for a maximum of three trips per year. The requirement for effluent disinfection is essential to complete the process. This treatment plant will discharge into a fish habitat and the disinfection system should provide 99.99% kill of all coliform and more importantly all pathogenic bacteria. A secondary process cannot provide this level of treatment without disinfection.

Once a contact person was established for each treatment method, they were then provided with the influent and effluent criteria via e-mail and requested to submit a proposal. Personal interviews and telephone interviews with knowledgeable technical personnel were also conducted where possible.

5.0 THE COMPANIES AND THEIR PROCESS DESCRIPTION

5.1 General

Construction Management Technologies Inc. (CMT), Premier Tech Environment Ltd., CMS Group, Bioflo Inc., ABL Environmental Consultant's Ltd., ABYDOZ, Eco Process and Equipment Inc., Hydro-Logic Environmental and P.J. Hannah Equipment Sales Corp. were among the companies that submitted a budget estimate for their proposed sewage treatment plant(s) to BAE◆NEWPLAN group for the purposes of this study. Some companies promoted as many as 4 different sewage treatment processes in which case the process designers were requested to indicate which process was most suited for this application and the reasons why.

Napier-Reid Ltd., Fluidyne Inc. and Biogreen (Nfld) Ltd. were also contacted for the purposes of this study but proposals were never received.

Aerated lagoons and oxidation ditches are not specialized treatment processes and have been included in this study by the BAE◆Newplan Group Limited.

5.2 Construction Management Technologies

Construction Management Technologies (CMT) located in Mount Pearl, Newfoundland represents Butler Manufacturing Services (BMS) in Ireland. Butler Manufacturing Services has just recently developed a new product called the Sludgemiser. It is a revolutionary new package sewage treatment plant capable of treating sewage and destroying sludge all in one unit. The system is not yet in production and therefore we were unable to obtain a budget estimate in time for this study. The Sludgemiser is expected to go into production within the next year.

Another product that BMS has designed is a pre-fabricated packaged sewage plant known as the Blivet. CMT has provided BAE◆Newplan with a budget estimate for this treatment plant.

5.2.1 The Blivet

The proposed model that CMT has suggested is the Blivet 1500. The treatment process is as follows:

The BMS Blivet utilizes primary settlement, aerobic treatment, final settlement, and sludge storage stages in its treatment process. The proposed unit has dimensions of approximately 6.0m x 2.3m x 3.0m.

The main component in this system is the BMS Aerotor where aerobic treatment takes place. The Aerotor is a patented BMS product and is defined as a fixed film reactor with an active aeration element. It is made up of sections of drums consisting of a series of glass reinforced plastic (GRP) vanes, mounted in parallel, which radiate in a spiral formation from a horizontal shaft. This creates a surface area for biomass growth to take place. Also, motion of the spiral formation as it rotates creates active aeration of the liquid allowing the growth of suspended micro-organisms. Thus, the Aerotor acts as both a fixed film reactor (ie: RBC) and an activated sludge system. The Aerotor rotates at approximately 6 revolutions/minute which is faster then a typical RBC and this design factor allows for a self-cleansing feature in the Aerotor.

The Aerotor alone is not capable of treating raw sewage, and so the BMS Blivet has included a primary settling tank into the package system. The use of Lamellar or parallel plates for enhanced settlement of solids is incorporated into the design of the Blivet. Once raw sewage is treated in the primary settling tank, the influent then passes through the Aerotor for further treatment. This treatment is carried out as the effluent is drawn in through holes in the drum periphery, passing through the series of maze-like surfaces. As the influent passes over the bacterial surfaces, in addition to being mixed with air, the waste is treated by processes similar to both filter media/RBC (Passive contact) and activated sludge (Active Aeration) methods discussed above.

Due to the arrangement of the Aerotor into separate compartments, the effluent makes contact with all the media before passing to the next stage, helping to eliminate by-passing of the effluent through the unit. During high flow the level tends to increase in the primary settling tank causing the forward pump rate to increase due to a longer contact with the rotor inlet ports thereby creating a balancing effect. However, if the flow exceeds design levels – a 375mm back-up level – the Aerotor will be by-passed.

Further treatment takes place in a final settling tank after leaving the Aerotor. The liquid leaving the Aerotor is higher than the level it enters with a net head gain of 375mm caused by the rotating motion of the rotor, which in itself acts as a pump. This results in a gravity discharge which eliminates the need for extra pumping equipment which is often required to return a portion of the treated supernatant to the primary settling tank.

The complete BMS Blivet system, composed of a primary settling tank, BMS Aerotor, and final settling tank, can be packaged as a complete unit in a standard sized container for shipping purposes. A maximum rotor diameter of 1.6m is used. The small ratio of the rotor diameter to the total rotor surface area is the main reason the unit can be made so compact. The units are generally 1/3 smaller than a RBC equivalent.

A UV chamber would have to be added to this unit for disinfection purposes. Also, in the treatment of NH3-N, CMT has recommended either using a separate Aerotor after the Blivet, or over sizing the Blivet by 1/3 which would require a Blivet 2000 model. This model is sized at 7.1m x 2.3m x 3.0m and will be used for the purpose of this report.

The unit may be freestanding mounted on a solid base above ground, or buried, without a concrete surround, up to the deck level (2.3 m). Removal and relocation of the unit is possible as concrete encasement is not required. The units have a modular capability, as they can be placed parallel, or in series which makes future expansion both easy and economical.

The BMS Blivet has been in production since 1992. The first installation of the unit in Newfoundland & Labrador has recently taken place in Bishop Falls.

5.3 Premier Tech Environnement Ltd.

Premier Tech Environment Ltd., located in Quebec, has two products namely the Ecoflo Biofilter and the Rotofix for which they have submitted budget estimates for the purpose of this study. These products are only for secondary treatment and therefore other treatments are required to produce an effluent that meets the specifications, for a conventional three-phase process. Estimated costs of all other necessary equipment has been included. The proposed packaged plants are outlined below.

5.3.1 The Ecoflo Biofilter

This Ecoflo system consists of a filter using specially treated peat moss and is encased in a fiberglass shell. The raw sewage will first enter a septic tank with a minimum effective capacity equal to 1.5 the maximum daily flow. Three EFT-080 effluent filters would be used in the septic tank to capture solids with a diameter greater or equal to 1/16".

A holding/retention tank with a minimum effective capacity of $5m^3$/ day will be used as a pumping station for dosing the Biofilters. Three submersible pumps are installed in the tank for the simultaneous dosing of the Ecoflo biofilters that are installed in parallel on the same site. Dosing is used to direct the wastewater to the Ecoflo Biofilters at regular intervals which is controlled by a PLC and provides a constant wastewater flow.

The pumped effluent enters 30 of the Ecoflo Peat-Based Biofiltration systems, which are separated into three clusters of ten biofilters each, by equally distributing the flow from the 3 alternating pumps through a flow divider. The wastewater is then cleansed as it percolates through the peat bed.

For surface water disposal, as required, the 30 biofilters would be installed on an evacuation zone which includes an impermeable pad (synthetic liner) protected by geotextile and 200mm of crushed stone containing 100mm perforated pipes to collect the treated waste water. The surface required for the installation of each cluster of ten biofilters is 125 m^2 for a total of 375 m^2. Each cluster can be connected to a forced aeration system working with three electric fans installed in manholes to control odor.

As a final treatment, the effluent would be sent to a U.V. disinfection unit, before being discharged.

5.3.2 The Rotofix

A complete treatment process would require the raw sewage to enter a septic tank in order to remove non-biodegradable matter, before being released to an equalization basin and then to the RotoFix. This primary treatment phase requires three EFT-080 septic tank effluent filters and a minimum effective capacity equal to 1.5 the maximum daily flow.

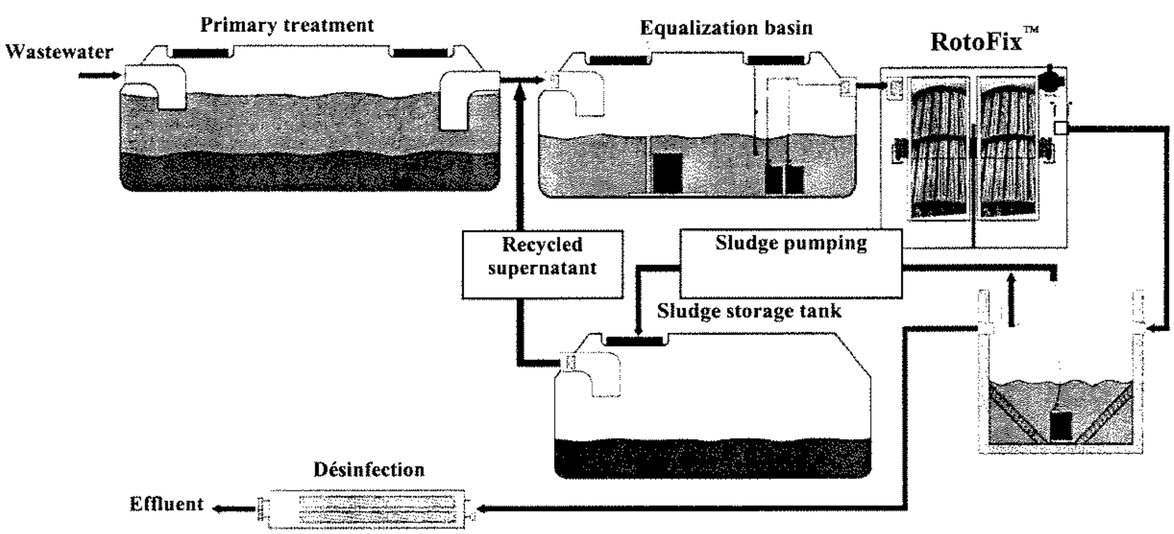
An aerated storage (equalization) tank with an effective working capacity of 9.5 m^3, located at the effluent of the septic tank, contains one mechanical aerator and two submersible pumps to feed the RotoFix units. The aerator and the feeding pumps are controlled by a control panel manufactured by Premier Tech.

The RotoFix system proposed will consist of two stages working in parallel. The two units are 1.8m in diameter by 1.4m in length. The RotoFix is a type of rotating biological contactor. It consists of elongated PVC media with multiple internal blades. Numerous media profiles up to 1.5 m long are radially arranged around a horizontal shaft and secured by end plates and a central plate of polymer to form a rotor assembly. The rotors are mounted on a stainless steel drive shaft and are submerged about 55% into a concrete tank to allow bacterial growth on the surface of the media to alternately come into contact with the wastewater and the atmospheric oxygen. Each rotor rotates at 2-6 rpm and is driven by a low-power motor and a stainless steel wire wound around the central plate. The wastewater carried by the rotors cascades over the length of the media tubes and then spills out the ends to be recycled in the RotoFix tank. The unit also utilizes aeration in its process. Captured air is released from the tube chambers, as the rotors are submerged, allowing additional tank aeration. The bacteria that feed on the carbonaceous material in the wastewater forms a biofilm, 0-3 mm thick, on the surface of the media, as the rotors circulate through both the wastewater and the ambient air.

After treatment in the RotoFix system, the effluent flows by gravity into a sedimentation tank with an effective working capacity of 10.5 m^3. This tank will be equipped with a scum and sludge activation system used to transport the sludge into a sludge storage tank with an effective capacity of 9.5 m^3. Sludge is also recycled from the sludge storage tank to the equalization basin as required.

Units for phosphorus removal (chemical precipitation by the addition of aluminium) and UV disinfection will also be added as part of the entire treatment process. A schematic diagram of the entire process is shown below in Figure 1.

FIGURE 1. The Rotofix Process Schematic



5.4 CMS Group – The ROTORDISK

CMS Group, located in Ontario, has submitted a budget estimate for a packaged sewage treatment plant which incorporates one of their products known as the ROTORDISK. The plant uses RBC technology to remove pollutants from wastewater. It is a multi-staged, fixed steel baffle RBC. The ROTORDISK sewage treatment process is as follows:

The ROTODISK plant combines primary settling, biological oxidation, final settling, and sludge storage in one integrated system. In order to meet specifications a chlorination disinfection unit must be added to the system. The entire system is placed in an aluminium tank, equipped with a motor, mixer, pump and flow meter with a strip chart recorder. This tank, including the cover, will require approximately 23 m^3 of concrete for installation purposes.

The ROTORDISK itself would consist of disks made from 3/8" grid extruded medium density polyethylene material with U.V. light inhibitors. It is designed to prevent anaerobic conditions from developing. The grid pattern allows for oxygen transfer into the wastewater. The banks of biological support media are contained between rigid woven mat FRP endplates, supported by tension rods and polyethylene spacers. The shaft holds 663 m^2 of this media.

Wastewater flows into the ROTORZONE where the rotating disks are 40% immersed in the wastewater being treated. The ROTORZONE is made up of 4 sections complete with fixed ¼" steel plate flow control baffles. The film of biomass that forms on the media is alternately exposed to the waste in the water and the oxygen in the air.

The RBC module is designed to be installed in the primary clarifier which can accommodate long storage periods of sludge. This feature helps provide a continuous source of BOD to the ROTORDISK. The final stage of the ROTORDISK assembly is equipped with a patented oxygen recycle device that picks up the BOD, feeding the microbe population during low flow.

A one horse power motor would be used to drive the system and is designed for start-up conditions. Under a normal, balanced load, the motor draws less than 60% of its rated horsepower. A rotational alarm bell or light would also be supplied as part of the plant. An electrical control panel would be provided for operation. A SCADA ready system can be provided if requested. The unit can usually be shipped as a one-piece item.

5.5 Bioflo Inc. – The Bio-Fosse

A wastewater treatment system known as the Bio-Fosse has been developed and marketed by Bioflo Inc., in Quebec. For the purposes of this study Bioflo Inc. has submitted a budget estimate on their Bio-Fosse system. Estimated costs of all other necessary equipment are included, as the Bio-Fosse is only a secondary treatment system, and therefore other treatments are required to get an effluent that meets specifications, for a conventional three-phase process. Two estimates were given for the treatment plant. One for an all fibreglass tankage system and the other for a concrete tank based system. The proposed system is as follows:

The treatment plant will consist of a conventional septic tank for primary sedimentation and anaerobic digestion. This tank would have a minimum 27 hours residence time at an average daily flow, 2 compartments representing a 2:1 volumetric ratio, and a commercial quality septic tank filter.

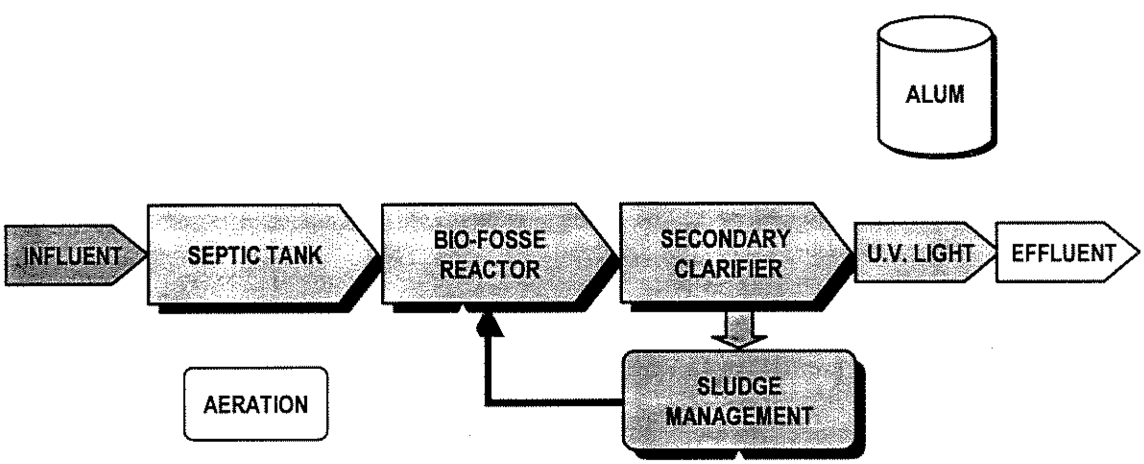
After the filter, the effluent is pumped to the secondary treatment phase which is made-up of two reservoirs. One is the Bio-Fosse fixed film reactor reservoir of approximately 9m x 3m x 2m, containing fine bubble membrane air diffusers and a wavy structured fixed film support called Biotex where biological treatment is carried out. This Biotex grid is installed vertically and appears as a succession of columns. The flow is then directed to the second reservoir; a secondary aerobic clarification unit, approximately 4m x 3m x 2m in size which is used to extract and concentrate the secondary sludge.

The treated water then passes to the tertiary treatment phase and the concentrated sludge is transferred to a sludge management reservoir, which provides for aerobic digestion and is capable of returning the clarified supernatant for treatment in the reactor. At regular intervals, the floating portion of the sludge is collected and returned to the inlet of the secondary chamber.

The tertiary treatment phase involves the removal of phosphorus by using precipitation with aluminium. The treated water may be disinfected by using either a chlorination process, or by treatment using U.V. light.

Figure 2 below shows the outlined treatment process:

Figure 2. The Brofosse Pricess Schematic



5.6 ABL Environmental

ABL Environmental Consultants Ltd. of Dartmouth, Nova Scotia design 4 sanitary sewage treatment processes namely:

1. Biopyramid Greenhouse Treatment System
2. ABL Lunenburg Process
3. Recirculating Sand Filter
4. Sequential Batch Reactor.

The Biopyramid Greenhouse Treatment System is a polishing stage of treatment, which is not applicable to this process. The ABL Lunenburg Process is a fixed film process that is still in the company's refinement stage and was not quoted due to the remoteness of this project from their central office. The remaining Sand Filter and SBR process were deemed to be applicable to this application and quotations were provided.

5.6.1 Recirculating Sand Filter

Waste water discharges into two 15,900 litre septic tanks in series, each equipped with an effluent screen. Effluent from the last septic tank is discharged into a re-circulation tank and a filter feed pump delivers wastewater to sand filter beds. Two 7.3m x 12.2m sand filter beds are required. Perforated pipes distribute the wastewater over the surface of the filter.

The wastewater then flows by gravity through the filter and is collected in perforated pipes at the end of the filter. The filtered water then flows through a splitter valve and the flow is split into an effluent stream to a chlorine contact chamber and a recycled stream back to the recirculation tank. The effluent stream is injected with sodium hypochlorite, through a 22 watt chemical dosing pump then discharged into the chlorine contact chamber for final treatment before being discharged. The recycled stream mixes with the re-circulation tank prior to being discharged into the filter bed for another pass.

5.6.2 SBR Treatment Plant

The SBR treatment plant is made up of a fibreglass tank with internal baffles, which provide separate chambers (tanks) for the various functions to be carried out in the treatment process. First, the wastewater is discharged into an aerated influent equalization tank where it is then pumped to one of two SBR tanks where biological treatment and clarification processes are carried out. Following settling, the supernatant from the SBR tanks is decanted to a Chlorine Contact Chamber for disinfection. The waste sludge is discharged into an aerated Sludge Holding Tank. The operation of the plant is automatic and regulated by a control panel.

ABL will provide a computer and software which is capable of recording and trending all preset system parameters and controlling the operation of the plant. This information can be communicated anywhere in the world through telephone lines.

All critical elements of the plant are backed up by duplicate stand-by equipment. Also, all the tanks, except the chlorine contact chamber, are aerated.

5.7 Eco Process and Equipment Inc. – The OxiSequencer

A wastewater treatment system know as the OxiSequencer, has been developed and marketed by Eco Process and Equipment Inc. and they have submitted a budget estimate on their system for the purpose of this report. The system operates as follows:

The OxiSequencer concept is based on operating two sequencing batch reactors (SBR) in series. The first reactor is called a BioSeperator, which includes several compartments and serves as an equalization tank and an anaerobic sludge digester. The second reactor is called a BioSequencer and operates under an engineered sequence.

The BioSeperator, equipped with 4 level floats, is designed for a hydraulic detention time of approximately two days at average flow with a top water level volume of 5.4 m x 5.4 m x 2.75 m during peak flow. A dry pit pump is required to transfer the supernatant to the BioSequencer. A duplicate stand-by transfer pump is also supplied for back-up purposes.

Aeration is provided to the BioSequencer reactor by a coarse bubble system model ECO OMEGA. Two positive displacement blowers would be provided to supply air to the SBR. One blower will operate, while one is used as a stand-by unit. The Biosequencer is also equipped with level floats. The top water level dimensions required for this reactor during peak flow conditions is 3.4m x 1.7m x 5.06m.

A decanter, model ECO SyphonCanter, would be provided to remove the clear supernatant from the SBR and allow it to flow by gravity to the receiving waters. Before entering the receiving waters the decanted water will flow to a U.V. disinfection system.

One submersible pump would be provided to transfer excess sludge from the BioSequencer to the BioSeperator. The sludge would be collected in settled form through a uniform sludge collector.

A control panel including programmable timers and relays will be provided for operation of the equipment.

5.8 Hydro-Logic Environmental

Hydro-Logic Environmental Ltd., located in Ontario, represents two products namely the CASS SBR and the Schreiber BioReel for which they have submitted budget estimates for the purpose of this study.

5.8.1 CASS SBR

The CASS SBR treatment system that Hydro-Logic has proposed consists of a steel tank with internal dimensions of 3.6m x 3.5m x 3.5m, which is sectioned into one process basin and one sludge holding basin. An inlet pumping station with a volume of 4 m^3, to hold the influent during the decant period, would also be required and can be provided as part of the package plant tank if necessary. The proposed system operates as follows:

A repeated sequence of aeration and non-aeration is used to provide aerobic, anoxic and anaerobic process conditions. The CASS reactor basin is divided by baffle walls into three sections; Zone 1: Selector, Zone 2: Secondary Aeration, Zone 3: Main Aeration. These zones are in approximate proportions of 5%, 10%, and 85% respectively.

Each zone operates on a time-based sequence. This interrupted batch feed method is made up of a repeated cycles of fill-aeration, fill-settle, and decant periods. During the fill-aeration period, influent is received into the basin through the selector zone and at the same time the air is turned on in the aeration zones. Complete mix-reaction conditions occur in Zone 3 during this variable volume operational period.

The fill-settle period refers to the first part of the air-off phase when quiescent settling occurs in Zone 3. This solids-liquid separation causes the biomass to settle as a blanket on the basin floor leaving a clear supernatant to be decanted during the next period of the air off phase.

During this decant period the influent withdrawal is interrupted and stored in the pump well. This interrupted flow prevents any possibility of short-circuiting and effluent deterioration. The decanter trough is situated above the top water level for both the previous aeration and settling periods to prevent accidental discharge of mixed liquor SS. When the decant period starts the decanter travels at a fast speed until a level indicator float switch on the decanter detects interaction with the liquid level. The decanter then proceeds at a design rate of travel, producing a constant rate of discharge of treated effluent from the basin until it reaches a designated water level whereby the decanter returns back to its initial position and the entire cycle is repeated.

Sludge biomass is continuously recycled from the zone 3 to the zone 1 selector in order to remove readily available soluble substrate by favoring the growth of floc-forming microorganisms. The sludge return rate causes an approximate daily cycling of biomass in the main aeration zone through the selector zone. The selector is self-regulating for any load condition and operates under anoxic and anaerobic reaction conditions during non-aerated periods. The use of stored carbon sources for denitrification and phosphorus removal eliminates the need to oxidize the associated BOD, and allows the CASS reactor basin to be approximately 20-30% smaller than the typical SBR systems.

The CASS SBR uses a dissolved oxygen sensor to measure changes in biomass oxygen demand and proportionally adjusts the aeration intensity so that excessive dissolved oxygen concentrations are prevented and valuable energy is not wasted.

The budget estimate did not include the cost of a disinfection unit and so typical UV costs will be assumed for the estimate.

In Canada, the CASS SBR has been installed in Ontario, New Brunswick, Nova Scotia and Newfoundland (Hibernia).