NOTICE

Confidentiality

Response to Request for Qualifications and Proposals for Sewage Treatment Option

for

THE MUNICIPALITY OF IQALUIT

HILL
MURRAY
&
ASSOCIATES INC.

ENVIRONMENTAL
SYSTEMS ENGINEERS

March 19, 1998

Ian Mosher
Director, Engineering and Planning
Municipality of Iqaluit
P.O. Box 460
Iqaluit, NT
X0A 0H0

Dear Ian:

Re: Response to Request for Qualification and Proposals
Sewage Treatment Options

Please find enclosed eight (8) copies of HM&A's plans to provide the Municipality of Iqaluit with the highest level of treatment attainable. Membrane-Bioreactor technology offers the Municipality several distinct advantages including phasable, just-in-time infrastructure, treatment that easily exceeds the most stringent discharge criteria, the option for re-use and expandability within a foot print typically four times smaller than conventional secondary and several orders of magnitude smaller than lagoon systems.

HM&A installed two MBR systems in the Arctic in 1995 and continues to provide operations and maintenance support through our operating division, the Canadian Wastewater Corporation (CWC).

I would be pleased to arrange a visit for you or your staff to any of our facilities and look forward to hearing from you in the future.

Sincerely,

HILL, MURRAY & ASSOCIATES INC.

Trevor T. Hill, P.Eng.
President

Enclosures

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HILL
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&
ASSOCIATES INC.

ENVIRONMENTAL
SYSTEMS ENGINEERS

March 19, 1998

Our File: 08800-20/IQAL

Ian Mosher
Director, Planning and Engineering
Municipality of Iqaluit
P.O. Box 460
Iqaluit, N.W.T.
X0A 0H0

Dear Ian:

Re: Approval to Verify Information
Response to Request for Qualification and Proposal

This letter will authorize your staff to verify information included in this report. This authority exists only for the purposes of evaluation HM&A's proposal.

This authority shall expire 30 April 1998, or on the award of any contract to parties other than HM&A. Extensions may be granted on written request.

Sincerely yours,

HILL, MURRAY & ASSOCIATES INC.

Trevor T. Hill, P.Eng.
President

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HILL, MURRAY & ASSOCIATES INC.
Environmental Systems Engineers

Response to Request for Qualification and Proposal for Sewage Treatment Option

for

Water Reclamation Facility
for
The Municipality of Iqaluit

Prepared for

Ian Mosher, P.Eng.
Director, Engineering and Planning

March 18, 1998

Hill, Murray & Associates Inc. Suite 202, 780 Tolmie Avenue, Victoria, B.C. V8X 3W4
Phone: (250) 388-3930; Fax: (250) 388-3943

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Annexes

1 EXECUTIVE SUMMARY

This proposal is submitted to meet the opportunity to serve the needs of The Municipality to develop a long-term plan for the treatment of sewage generated by the Iqaluit community.

Our intention is meet or exceed the specification suggested in the Request for Qualification and Proposal. Hill, Murray & Associates has built many plants of the exact size suggested and as such detailed specifications are available - some of which have been enclosed. We have also taken the liberty to provide two options: One providing for immediate tertiary quality and a second providing a phase increase in quality in line with the changes in legislated discharge criteria.

Hill-Murray has developed many plants in the province of British Columbia and two in the Arctic which embody the concept of 'just-in-time' infrastructure. This concept relies on providing infrastructure as and when needed, in step with the expansion of the community.

Hill, Murray & Associates Inc. (HM&A) has provided herewith a comprehensive design and construction plan for an advanced Water Reclamation Facility, capable of treatment which easily exceeds the required discharge criteria for marine discharge and beneficial reuse applications. This proposal details both a facility for 2,000 m^3/day and a facility for unlimited expansion.

We further offer complete design, built, operate services. Our operations company, CWC - the Canadian Wastewater Corporation, currently operates nine plants in B.C. and two in the Arctic with six further plants under construction. CWC has a skilled staffed of Professional Engineers and certified operators and technicians ensuring that all plants may be operated under a performance contract - guaranteeing effluent quality and ensuring plant reliability 24 hours a day, 7 days a week. All plants are remotely operated and monitored from our corporate offices in Victoria.

1.1 Automated Operations

The plant is actively controlled by a Programmable Logic Controller that activates systems as required by the plant's sensors. An autodialer notifies CWC if the plant is not operating at peak performance. The control systems are accessed through a modem link, allowing the company's technicians to alter systems remotely.

1.2 Odourless Operation

The HM&A designed and built facility is an odour free process. The process, inclusive of sludge digestion which occurs in the bioreactor, is fully aerobic thereby assuring local residents of the elimination of odour.

1.3 Sludge Production

Due to long solid retention times (SRT's) and a high level of digestion within the bioreactor, sludge yield is typically less than one half of that normally seen in a conventional activated sludge process.

1.4 Redundancy

The facility features fully redundant operating modes. All process equipment necessary for operation has been duplicated within the bid. Should any single piece of equipment fail, the plant could run continuously at 100% capacity until such time as repairs may be effected.

1.5 Effluent Quality

Due to the positive barrier provided by the membranes, the plant produces consistently excellent effluent quality. The effluent is non-toxic to fish (see Bioassay results included in Annex D). Further, as membrane filtration occurs at the molecular level, viruses, bacteria and pathogens (coliform) are removed at the membrane surface. This allows for consistent coliform levels of 2.2 MPN or less.

1.6 Phasing

The technology is highly phasable. While the tendered price calls for a system, capable of treating 2,000 m^3/day in 1998 in steady-state, there exists the opportunity for more users to hook on; reducing per unit capital and O & M costs. It is recommended that a phased approach to infrastructure be considered; equipment supplied, and fitted if or when needed.

1.7 Guarantee

Hill, Murray & Associates Inc. and ZENON, the technology provider, offer the only effluent quality guarantee (see Annex F)available in the treatment of municipal wastewater. The facility produces consistently excellent effluent quality. Operation and Maintenance through the Canadian Wastewater Corporation, the operations arm of HM&A, guarantees this fail safe mode of operation for the entire life of the plant.

1.8 Northern Experience

Hill, Murray & Associates Inc. provided a fully recycling, wastewater treatment system in 1995 for the Department of National Defence in Cambridge Bay and Hall Beach that was especially designed for the high Arctic. The membrane and bioreactor components, transfer mains for sewage and recycled water, and other auxiliary equipment were designed, assemble and shipped to the site in less than seven weeks. The equipment was housed in Canadian-built containers that were designed for a harsh climate. Plants are controlled by a Programmable Logic Controller that activated systems as required by the plant's sensors. An autodialer notifies the plant is not operating at peak performance, the control system can be accessed through a modem link allowing the company's technicians to alter systems remotely. HM&A performed all project management and site supervision for the completion of this project.

1.9 Liability Insurance & Bonding

A copy of HM&A's current liability insurance coverage, including the terms of the coverage are included in Annex J, along with a copy of our Performance Bond and Labour and Material Payment Bond.

1.10 Plant Location

Membrane-bioreactor technology allows HM&A the flexibility of building a wastewater reclamation facility at any location, depending on the preferences of the Municipality of Iqaluit.

2 EXPERIENCE AND MANAGEMENT HISTORY

2.1 Corporate Profile

Hill, Murray & Associates Inc. (HM&A) is a "design-build" company providing economical tertiary quality wastewater treatment facilities. HM&A is at the forefront of advanced wastewater treatment technology, specializing in the use of technology in "turn-key" applications. There are currently over 100 wastewater systems of this type in service throughout North America, including the Arctic, treating all manner of wastewater constituents in all manner of conditions.

HM&A is a total service company, delivering the "whole product" to the client, including all aspects of the project, from permitting, through design and construction, to long term maintenance and monitoring. HM&A has a longstanding relationship with ZENON Environmental Inc. of Burlington, Ontario. This partnership offers the very best in membrane manufacturing, kinetic design and product support, combined with local representation, integration and project management. The technology has a proven track record demonstrated by many discharge permits for sensitive receiving environments from the B.C. Ministry of Environment, Lands and Parks, B.C. Ministry of Health, Government of the Northwest Territories and Environment Canada. By combining detailed technical understanding of the technology, strong design-build experience and appreciation for the administrative requirements of municipal and regional governments, HM&A offers economical, sustainable solutions to all clients. HM&A has excellent references from previous projects, and in 1997 won the Ministry of the Environment, Lands and Parks - Award of Excellence for our work in advanced treatment and water reuse (see Annex E for References).

2.2 Design Capability

HM&A has extensive work experience on design-build systems for municipal facilities, developers, ski resorts, the High Arctic and other remote sites. HM&A has proven its ability to supply all design, drawings, equipment lists and materials, project management and field co-ordination services necessary to complete the project.

HM&A's team consists of experienced and dedicated professionals, all working toward the client's goal of meeting the strictest permit limitations on discharge.

The Design Team consists of:

Robert A. Murray, P.Eng. - Director of Engineering

Mr. Murray has many years of design experience with advanced wastewater treatment systems. He has detailed understanding of plant kinetics, design requirements, control and instrumentation. Mr. Murray leads the HM&A design team.

Garth N. Nye - Project Manager

Mr. Nye brings to HM&A detailed understanding of mechanical systems and their integration into the design. A licensed Cross Connection Inspector, he has detailed experience in the management of construction processes.

Gary Jerzak - Engineering Manager

Mr. Jerzak has many years of construction management experience. He has complete understanding of client needs and requirements and drives down costs through tactical purchasing and facilitation.

Gary Griffiths - Design Coordinator

Mr. Griffiths provides CAD services and mechanical equipment specification services for the design team. He also provides interference item checks for the design layout.

In addition, HM&A's operations division, the Canadian Wastewater Corporation (CWC), provides on-going operations and maintenance management services for all our plants. Their mandate is to ensure all plants are in compliance with their permitted criteria, as well as providing expert knowledge and technical support. Through this team, any site staff will be provided with a full line of technical support for the completion of maintenance activities. Further, CWC will monitor biomass condition, equipment performance and effluent quality, instructing staff on any required action.

The Operations and Maintenance Team consists of:

Graham S. Symmonds, P.Eng. - Director of Operations

Mr. Symmonds provides advanced equipment and process monitoring services for all of our plants. He combines a detailed understanding of wastewater treatment plant operations, advanced control system knowledge and detailed experience in the application of machinery health monitoring techniques.

Denis J.N. Perreault - Facilities Manager

Mr. Perreault has over twenty years of experience in the operations and maintenance of wastewater treatment systems. He has comprehensive technical aptitude and performs set-to-work, performance monitoring, inspection and maintenance services.

Lorne Cowley - Utility Manager

Mr. Cowley has twenty years of experience in the electrical field combined with complete business management understanding. He provides liaison with customers and ensures their satisfaction.

2.3 Permitting

HM&A directs considerable effort to obtaining the required permits from the regulatory agencies. We have had marked success in this regard, providing permits for *all* our projects and plant installations. In many cases, we have resurrected permits from certain failure, and in record time. We accomplish this through direct facilitation of the permits, providing all documentation and information required by the regulatory agencies in a timely manner, as well as fostering a relationship with the Ministries that identify HM&A as experts in the implementation of a leading edge technology.

2.4 Equipment Supply

HM&A specifies and purchases all equipment and materials for the completion of the construction of our projects. This includes hands-on project management facilitation of the delivery of not only critical path items, but all equipment. HM&A has extensive lines of communication with all equipment suppliers, including extensive lines of credit, and in the case of advanced membrane filtration and sludge de-watering systems, retains exclusive representation agreements.

2.5 Construction of Works

HM&A will contract with various local contractors in addition to our construction team to ensure the construction of this facility is completed. All work will be completed to the applicable codes, and all workers will be insured by the Workers' Compensation Board (WCB). HM&A has a current registration with WCB NWT as a result of our on-going commitments in the North. On-site supervision will be provided by HM&A's Director of Engineering or Project Manager. Design and construction will be in accordance with the Canada Building, Plumbing and Electrical Codes, and the WCB Industrial Health and Safety Standards applicable to this industrial facility.

2.6 Commissioning

HM&A has extensive commissioning experience from our operating plants. We will provide all services needed to bring the plant to an operational state, including the provision of equipment-specific field service representatives as required. This work will be conducted under HM&A's operations division, Canadian Wastewater Corporation (CWC). We will provide all services needed to bring the plant to an operational state, including the provision of equipment-specific field service representatives as required.

2.7 Previous Treatment Facilities Experience

HM&A is a leader in the application of advanced technology for wastewater treatment (references are included in Annex E). We have designed and built 12 tertiary tertiary quality sewage treatment facilities in Canada; all of these plants are operated and maintained by Canadian Wastewater Corporation (CWC), the operations arm of Hill, Murray & Associates Inc. By employing advanced technology, HM&A offers powerful treatment capability, producing treatment to BOD < 10 mg/L, TSS < 10 mg/L, fecal coliform < 2.2 MPN/100 ml. Our innovative solutions have met the challenge at all points, providing developers, owners and regulatory officials with safe, reliable and consistent treatment.

Specific experience includes (see Annex H for details):

Design, supply, install and maintain treatment facilities for **North Warning Systems Sites CAM-M and FOX-M** (two complete systems, including infrastructure). Commissioned December 1995 - $750,000 (each) with a flow of 2,500 USgpd.

Design, supply, install and maintain treatment facilities for **Thetis Lake Trailer Park**. Commissioned August 1995 - $225,000 with a flow of 12,000 USgpd.

Design, supply, install and maintain treatment facilities for **Sooke Social Services Building**. Commissioned April 1996 - $85,000 with a flow of 1,000 USgpd.

Design, supply, install and maintain septage treatment facilities for **Burgoyne Bay,** Salt Spring Island. Commissioned Summer 1997 - $260,000 with a flow of 1,000 Igpd.

Design, supply, install and maintain treatment facilities for **Mt. Washington Ski Resort**. Commissioned November 1996 - $3,000,000 with a design flow of 500,000 USgpd.

Design, supply, install and maintain upgraded municipal facilities at **Ganges, Salt Spring Island**. Commissioned November 1996 - $730,000 with a flow of 90,000 Igpd.

Design, supply, install and maintain treatment facilities for **Kingfisher Oceanside Inn**, Courtenay, B.C. Commissioned June 1997 - $325,000 with a flow of 12,000 USgpd.

Design, supply, install and maintain treatment facilities for **Salt Spring Island Village Resort**. Commissioned September 1997 - $600,000 with a flow of 30,000 USgpd.

Design, supply, install and maintain treatment facilities for **Lake O'Hara Lodge,** Banff, Alberta. Commissioned July 1997 - $155,000 with a flow of 4,000 USgpd.

Design, supply, install and maintain treatment facilities for **Sooke Harbour House,** Sooke. Commissioned September 1997 - $275,000 with a flow of 5,000 USgpd.

Design, supply, install and maintain treatment facilities for **Huband Park Elementary School**, Courtenay, B.C. Design complete, permit in place. Construction began December 1997 - $270,000 with a flow of 4,000 USgpd.

Design, supply, install and maintain treatment facilities for **Powell River Water Reclamation Facility**, Powell River, B.C. Design complete, permit in place. Construction begins December 1997 - $4,950,000 with a flow of 1,000,000 Igpd.

Design, supply, install and maintain treatment facilities for **The Falls Golf and Country Club**, Chilliwack, B.C. Design complete, permit in place. Construction begins December 1997 - $485,000 with a flow of 25,000 Igpd.

2.8 "Turn-Key" Installations

Hill, Murray & Associates Inc. is uniquely positioned in the market to offer "Turn-Key" project implementation. Our experience with advanced treatment and recycling applications within Canada is significant as is our detailed knowledge of the Plumbing Code amendments which allow for dual plumbing

within buildings (potable and non-potable mains)[1]. We have extensive experience with equipment installation, and now operate several ZenoGEM systems within Canada.

3 EFFLUENT QUALITY GUARANTEE

HM&A offers the only treatment solution that results in treated water quality that exceeds the requirements for unrestricted re-use. The treated water from a ZenoGEM plant is guaranteed to meet the following:

	Guarantee	**Expected**
BOD_5	< 10 mg/L	< 5 mg/L
TSS	< 10 mg/L	< 1 mg/L
Fæcal Coliform	< 1000 MPN/100 mL (with disinfection via UV < 2.2 MPN/100 mL is easily achievable)	< 500 MPN/100 mL

Further, the reactor will be fitted with the required air to ensure complete nitrification of ammonia to nitrates and nitrites. Denitrification is available as an option.

4 WASTEWATER TREATMENT

4.1 General Process Description

Employing a membrane/bioreactor configuration, our systems are the compact answer to most sewage treatment and disposal problems detailed schematic and layouts are included in Annex A). The membranes provide a positive barrier between influent and effluent, ensuring excellent effluent quality, reducing the requirement for full-time operators and making the technology ideal for *sensitive receiving environments*. On-line system monitoring including auto-dialers and modem connections reinforce the automated, stand-alone concept. HM&A and equipment manufacturers fully guarantee the product and the process and will ensure that the effluent quality requirement is met.

By employing membranes, the solids concentration in the bioreactor can be substantially increased, further reducing the size of the system, improving biodegradation, and thereby dramatically decreasing sludge yield. Built-in redundancy and appropriate factors of safety enhance the operational availability of the plant. Routine operational checks and validations are well within the capability of custodial staff, as no detailed process

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[1] Hill, Murray & Associates drafted amendments to the British Columbia Plumbing Code in October 1994 specifying the technical requirements for dual water main applications within commercial and residential buildings. These amendments were approved and will be part of the British Columbia Plumbing Code to be issued in the spring of 1998.

knowledge is required. Support services, planned maintenance and system monitoring routines are designed to be complementary with the site's activities.

In general, the treatment system consists of the headworks, the treatment plant and the effluent disposal system. By using an engineered integration of proven, robust equipment, this facility will process sanitary waste to the highest standards possible. Treatment will be effected continuously in the bioreactor. The treated water (effluent) will be discharged to a ground disposal.

Membrane bioreactor facilities meet or exceed the most rigorous discharge criteria, resulting in the system being certified under NSF 41 (National Sanitation Foundation) and California's Administrative Code Title 22, the world standards for treated effluent reclamation and re-use. In many cases substantial water savings are achieved through wastewater re-use for toilet flushing or landscape irrigation. These systems are ideally suited for the treatment of high strength wastewater, producing superior quality effluent.

4.1.1 Headworks

The headworks in this facility will be fitted with an automated, PLC driven auger type trash removal unit capable of removing all inorganic material and ensuring all organics pass through to the reactor.

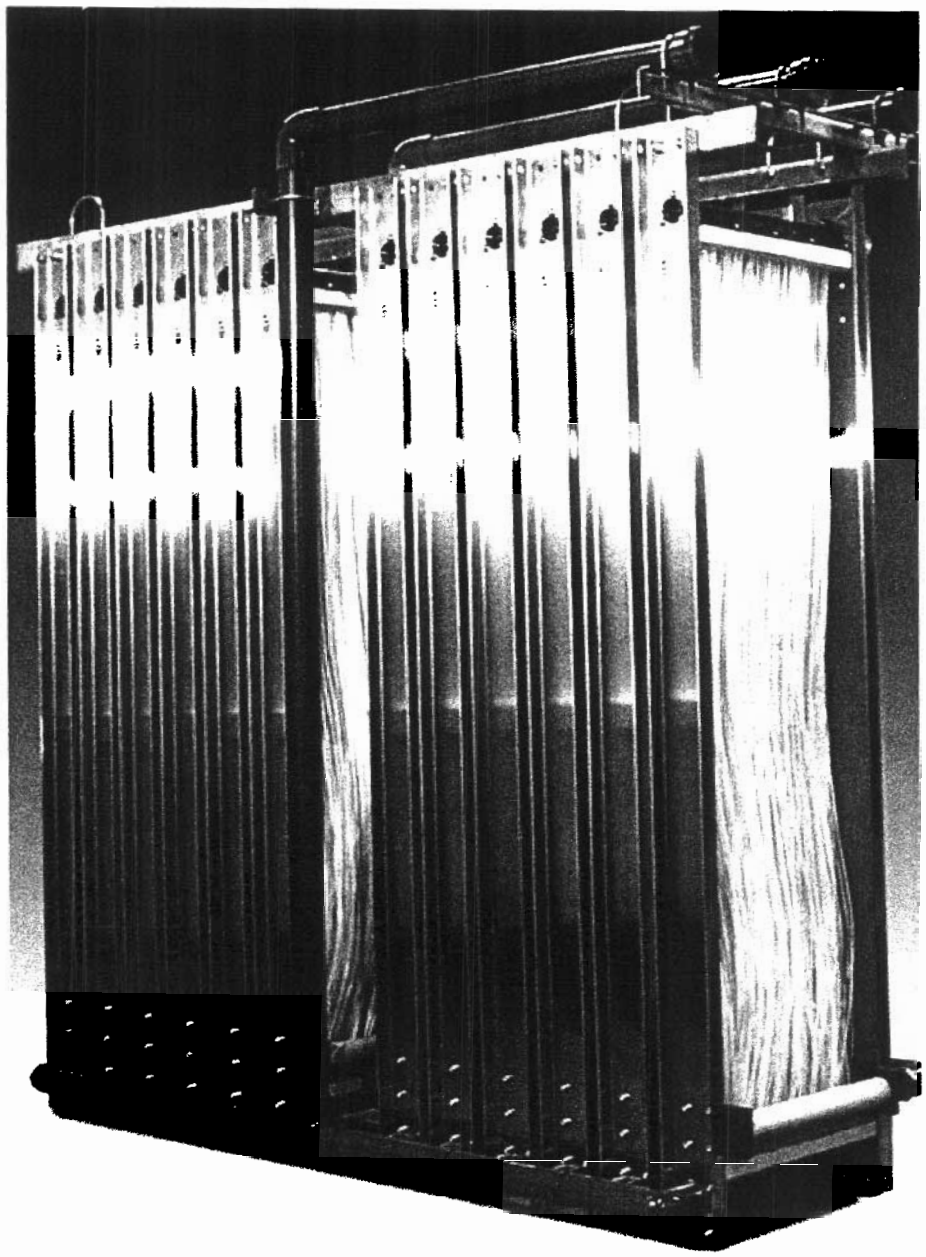


Figure 1: ZeeWeed™ Membranes - The Heart of the System

4.1.2 ZenoGEM Process

The ZenoGEM system is a patented process consisting of a suspended growth activated sludge system (biological reactor) integrated with a ZENON ultrafiltration membrane system (Annex I). Ultrafiltration utilizing the ZeeWeed (Figure 1) membranes is a vacuum-driven process in which the wastewater is drawn through the surface of a membrane capable of separating both insoluble materials (bacteria, colloids, suspended

solids, oils) and higher molecular weight soluble matter from the influent. As the membranes act as a physical barrier between the feed and the permeate (influent and effluent), effluent quality is consistently above the requirements of the legislated discharge criteria.[2]

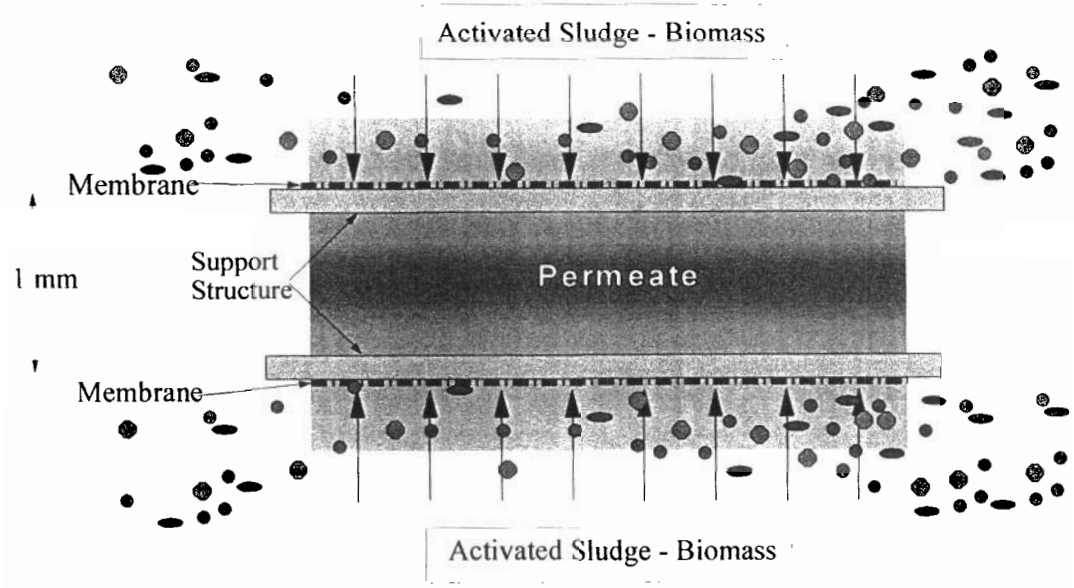


Figure 2:Hollow-Fibre Membrane Technology - An "Outside-In" Process

[2] The effluent quality (BOD_5 < 10 mg/L, TSS < 10 mg/L, Coliform < 1000 CFU/100 mL) will ensure that the environmental impact on the discharge area is minimized.

4.1.3 The Reduction or Elimination of Other Wastestreams

ZenoGEM achieves the highest effluent quality attainable. By treating the waste stream with the ZenoGEM system and biologically destroying the bulk of the organic contaminants in the bioreactor, a substantial increase in the efficiency of destruction is achieved. In fact, the ZenoGEM produces in the order of ***50%*** less sludge than conventional secondary treatment systems. Further, as ZenoGEM is a destruction technology, not a separation technology, real cost savings may be realized in the reduction or elimination of tertiary waste streams that normally require post-treatment processes.

The use of membranes also eliminates the requirement for chemical addition for the flocculation and coagulation of solids in the filtrate treatment systems. HM&A will install a sludge dewatering system consisting of a Fournier Rotary Press. This will render any sludge from the plant landfillable or compostable, with the filtrate being passed back to the ZenoGEM for further treatment. In effect, this completes the cycle of treatment: no additional wastestreams are generated from a plant with this configuration.

4.1.4 Flexibility

Better flexibility in the rate of upgrading reduces the risk of unused infrastructure. Population growths are affected by many factors, of which, very few are under our control. Building infrastructure that will not be used to capacity for its entire life, is costly. HM&A will upgrade the plant so that it is operated at full capacity, every year, maximizing infrastructure use.

4.1.5 Inherent System Safety

The ZeeWeed membrane provides a fail-safe capability to the ZenoGEM system. Under no mode of failure is raw effluent discharged to the environment. Membrane based technology provides a physical separation based on molecular weight, eliminating the risk of carryover to the effluent (permeate). Also, if the membranes fail, it is in a mode that isolates flow as opposed to a by-pass mode. The simplicity of the system also allows for an increased amount of remote process control. Each system is monitored by a PLC alarm circuit providing notification of alarm conditions to site custodial staff, HM&A and the manufacturer.

Additionally, the ZenoGEM system is able to handle spikes and irregular waste stream constituents, both by volume and concentration, without risk of losing control of effluent flow or quality.

4.1.6 Odour and Aesthetics

Conventional plants can often produce odour. This is very significant in the proximity of new developments when sales are paramount or when the facility must be located next to a residential or commercial area. The membrane bioreactor is an aerobic process which eliminates odour, giving the developer comfort now, and the residents quality of life in the future. In addition, the treatment facility is completely enclosed in a building that complements the local architecture. No odour as well as attractive facilities ensure that neighbours are unaffected by the presence of the water reclamation facility. See Annex A for an example of aesthetically conceived water reclamation facility designs.

4.1.7 Space Advantage

Conventional style treatment systems are typically land intensive, as they must provide adequate tankage such that the biological component of the treatment remains stable, while the hydraulic component is kept at low enough velocities to ensure settling. These two components of wastewater treatment are referred to as Solids Retention Time (SRT) and Hydraulic Retention Time (HRT). In gravity-reliant treatment technologies these two parameters are coupled together. A conventional plant must therefore be designed to ensure a long HRT (in the order of 24 hours) to ensure settling and flocculation of the solids, resulting in large process tanks.

The ZenoGEM process does not rely on gravity for settling of solids, decoupling the traditional connection between SRT and HRT. As the membranes provide a physical barrier and are permeable to only low molecular weight molecules. The solids, organics, viruses and bacteria, are contained in the bioreactor, while allowing the hydraulic phase (the water, or treated effluent) to be continuously removed from the system. This ability allows the bioreactor to be run at a much greater concentration of solids and allows for a much longer retention of solids, while allowing the aqueous phase to pass, minimizing the tankage requirements.

4.1.8 Control, Monitoring and Instrumentation

The ZenoGEM® system is ideally suited for stand-alone and automated applications. The system is inherently safe due to the positive barrier provided by the membranes and the system's ability to withstand spikes in both hydraulic and biological loadings without the loss of effluent quality. As a result, the systems are readily automated.

Operation of the system will be controlled by a Programmable Logic Controller, which will control all equipment on-site (local H-O-A switches will be included near all pumps and blowers to provide for manual isolation).

Due to the high level of automation, the systems are easily monitored. An autodialer will sense any failure of fitted equipment or any alarm condition. This unit will notify CWC staff via a pager system. At CWC offices in Victoria, our technicians will log onto the system via a modem integrated with the PLC. From this position, we are able to determine the exact alarm condition. Most alarm conditions can be rectified through logical restructuring of the PLC ladder logic. In the event that this is not the case, a technician will be dispatched to the site to rectify the problem.

Substantial system redundancy and bufferage will ensure that the system will continue to function in the event of a failure of a primary system.

4.2 Summary of Benefits

The net benefits of the ZenoGEM system operating parameters are:

- phased approach to building infrastructure;
- odourless process;
- a greatly reduced system size;
- a much greater concentration of biomass;
- 50% less sludge produced;
- greatly improved resistance to spikes or "non-conventional wastestreams";
- guaranteed effluent quality;
- effluent stream independent of influent rate and concentration; and,
- a highly reliable system in all operating conditions.

5 MUNICIPALITY OF IQALUIT

The Municipality of Iqaluit is in a growth phase. With the designation of Iqaluit as the Capital of Nunavut, it is anticipated that the local population will increase, as will the commercial and business opportunities in the area. Already the commercial and cultural centre, and transportation hub in the Eastern Arctic, Iqaluit will now be in a position to serve the entire Nunavut region. As a result of this anticipated growth, Iqaluit is a prime candidate for the infusion of "just-in-time" infrastructure by employing HM&A's nodal expansion community concept.

Northern communities are typically very remote and in most cases are poorly serviced from what southerners would consider essential amenities: Sewer and Water. Additionally, the lack of infrastructure, the dispersed nature of rural communities and a minimal tax base usually precludes the option of municipal scale treatment facilities. In addition, most communities suffer from very short building seasons, limited access a lack of skilled operators.

5.1 Discharge Criteria

The Municipality of Iqaluit discharge permit currently allows the discharge of effluent meeting a BOD/TSS of 120/180 mg/L. This level of discharge will be mandated as unacceptable in the near future. It is expected that the Municipality will be expected to meet a limit of 30/35 mg/L, requiring a minimum of secondary treatment. As the effluent is discharged to a marine outfall, a real requirement for complete nitrification exists to eliminate any toxic effects on the receiving environment. In addition, meeting the fecal coliform criteria without disinfection will eliminate the toxic effects of chlorine on the marine ecosystem.

5.2 Conventional Arctic Treatment

The primary method of sewage treatment in the north begins with collection from individual houses and facilities via sewage trucks, followed by discharge into a lagoon for treatment. The effluent quality from these lagoons is very dependent on the time of year and the influent constituents. Typically they discharge a higher level of contaminants in the spring and gradually improve over the summer period (a result of the interruption of the treatment process during the winter freeze-up period). During this freeze-up period, almost no natural disinfection occurs and the biological degradation of solids comes to a standstill. In the high arctic, where the length of the summer season is very short, adequate treatment is rarely achieved, with possible contamination of groundwater supplies. These facts make the operation of lagoon systems highly variable and land intensive propositions.

In order to address these shortcomings, a system is required that addresses these problems, specifically one that:

- provides compact treatment in easily transportable components;
- is easily automated, fail safe and requires minimal attention;
- provides high quality effluent to allow for ease of discharge and to protect the arctic environment; and,
- provides the opportunity to conserve other resources.

Hill, Murray & Associates Inc. has pioneered the introduction of containerized wastewater recycling systems into the arctic, and installed two fully recycling systems at NWS sites LSS CAM Main (Cambridge Bay, NWT) and LSS FOX Main (Hall Beach, NWT) in 1995. These plants have been in service for 30 months and have provided excellent and reliable treatment.

5.3 Advanced Treatment

MBR technology offers the only treatment solution that results in treated water quality that exceeds the requirements for unrestricted re-use. As such, much of the treated water produced by the treatment plant is re-introduced into buildings as a water source for flush water, industrial purposes or other non-potable applications.

These systems provide tertiary quality treatment in a compact arctic ready configuration. Employing a membrane/bioreactor configuration, our systems are the compact answer to complex sewage treatment and disposal problems. The membranes provide a positive barrier between influent and effluent, ensuring excellent effluent quality, reducing the requirement for on-site operators, and allowing the treatment system to be fully automated. These factors make the technology ideal for *turn-key* installations. On-line system monitoring including auto-dialers and modem connections reinforce the turn-key, stand-alone concept.

By employing membranes, the solids concentration in the bioreactor can be substantially increased, further reducing the size of the system, and improving biodegradation, thereby dramatically decreasing sludge yield. Built in redundancy and appropriate factors of safety enhance the operational availability of the plant. Highly automated systems mean that no detailed process knowledge is required on-site, making the plants easy to operate and maintain.

5.4 Opportunity for Conservation and Sustainability

MBR technology offers its own stand-alone energy conservation possibilities, most notably a reduction in potable water consumption. This has substantial energy effects, especially in communities where fresh water is produced by melting ice and snow. We have completed a very successful BC 21 Power Smart campaign focusing on the benefits of harnessing the new commodity of "recycled water".

This is a unique opportunity for northern communities to enhance the living conditions and protect the fragile Arctic environment. For the first time, the ability to actively treat sewage in an economical and environmentally sound manner is within the reach of Arctic communities.

5.5 Just-in-Time Infrastructure

MBR technology provided by HM&A provides many distinct advantages for expanding communities. Through a phased approach, the municipality can provide the wastewater treatment services to meet the current needs and expand in a predictable and efficient manner when (and only if) the population growth meets the expected curve.

The overall scale of the plants is much reduced, allowing a unique phasing capability, reducing high up-front capital costs. Also, it allows the treatment systems to immediately operate at their optimum parameters, rather than requiring several years to achieve steady state.

5.6 Conceptual Design

Option 1: Full Tertiary Quality Immediately

Effluent Quality:	BOD	< 10 mg/L
	TSS	< 10 mg/L

It is anticipated the Iqaluit Water Reclamation Facility will begin as a phasable WRF-NEC-5000 plant. The hydraulic and biological design flow meets the needs of the community for today's flow. In this phase, the following equipment is provided:

- Process Equipment for 2000 m^3/day
  - Aeration Module
  - Permeation Module
- Modular tankage
  - Equalization Module
  - Process Modules
- Aesthetic building
- Vacuum Truck Receiving Station Module
- Trash Removal (Screenings) Module

In addition, all necessary Arctic HVAC is provided.

To reduce costs, all modular equipment will be fabricated and shipped via barge to the site. Infrastructure upgrades are based on actual flows and are also shipped as modular units consisting of the appropriate volume of tankage and process equipment. Other modules include:

- Sludge Pressing Module
- Recycled Water Module
- Emergency Power Generation Module

Option 2: Phased Tertiary - Blended Effluent Option

Effluent Quality MBR	BOD	< 10 /mg/L
	TSS	< 10/mg/L
Effluent Quality Microscreen	BOD	< 40 mg/L (40% removal on Lagoon Discharge - 80 mg/L)
	TSS	< 30 mg/L (60% removal on Lagoon Discharge - 70 mg/L)
Blended Effluent Quality	BOD	< 25 mg/L
	TSS	< 20 mg/L

As a lower cost option, the Municipality has the option of meeting the discharge criteria by employing HM&A's Dilution Strategy. In this option, design flow would be initially set for the sewered flow (with trucked wastewater still going to the lagoon). The inclusion of a microscreen at the lagoon discharge will reduce effluent to levels that meet when blended with allowing dilution by MBR treated water. This strategy was employed at our Westview Water Reclamation Facility in Powell River, BC. A paper detailing this strategy is included in Annex K.

As with Option 1, all components are modular in construction.

With Option 2, the Municipality can achieve the goals of full tertiary quality in a phased approach: meeting the forthcoming discharge criteria, and phasing treatment capacity to full tertiary in a controlled manner. Option 2 is easily phasable into Option 1.

Costs for design/build and operations are included in Annexes B and C along with conceptual layouts. The costs are based on our understanding of the project and site conditions and are subject to summer site inspection.

5.7 Financing

The Municipality of Iqaluit, through the introduction of just-in-time infrastructure, can capitalize expansion of the plant through the administration of DCCs or Development Cost Charges (DCCs) or hook-up fees to new customers. In this way, expansion is funded only by the additional development, rather than assessing the entire tax base.

In addition, HM&A has the backing of financial partners and is capable of providing a complete Design/Build/Own/Operate solution. A letter of financial stability has been included in Annex G.

6 OPERATIONS AND MAINTENANCE

As with any mechanical system, maintenance is required to ensure that the plant is operating at its required availability. HM&A requires that a comprehensive planned maintenance program be established and conducted by a qualified, authorized service agent in order to offer the effluent quality and equipment guarantees. HM&A's operations arm, the Canadian Wastewater Corporation (CWC) performs this service. Corrective maintenance, when required, must also be conducted by an authorized service agent. Equipment specified in the treatment plant has been chosen not only on the basis of its ability to meet the performance requirements of the plant, but also in consideration of minimizing maintenance.

All our systems are highly automated, with built-in alarm channels and annunciators that notify our staff in the event of any problems. Also, the process is, by definition, operator-independent due to the positive filtration achieved by the membranes.

6.1 Provision of Maintenance Services

CWC will perform maintenance management and supervisory services. These services are intended to ensure that the plants are operating in a manner that is both compliant with the discharge requirements and within sound operating ranges. Specifically, CWC will provide the following:

- ✓ Data analysis and review
- ✓ Technical support
- ✓ Response to alarm conditions
- ✓ On-line monitoring of PLC alarms
- ✓ On-site effluent testing
- ✓ Biomass monitoring
- ✓ Membrane performance monitoring
- ✓ Operator's Manual amendment and control
- ✓ Provision of walk-through tours to new facilities maintenance technicians/site staff
- ✓ Assessment of spares status
- ✓ Reviewing the state of the plant and making recommendations to the Owner for improvement
- ✓ PLC maintenance and alteration
- ✓ Refinement of the treatment process, including alteration of pumping cycles
- ✓ Provision of expert knowledge services for wastewater treatment and maintenance issues (including the introduction of advanced equipment health monitoring techniques to the sites)

The provision of services to the site are classified into three categories: operations; maintenance management; and advanced command, control, communications and information systems.

6.2 Operations Management

CWC will manage the operation of the plant, including the following:

- ▸ Determination of sludge wasting intervals
- ▸ Determination of appropriate energy conservation measures
- ▸ Commissioning and refinement of control algorithms
- ▸ Evaluation of process parameters
- ▸ Determination of action required to return process to nominal state after any upset condition
- ▸ Determination and implementation of membrane cleaning regimes and rotation schedules

The operation of the plant will be effected through a close-controlled PLC-driven logic base. In the main, the plant will operate in an automated state and no direct operator intervention into the process is required.

6.3 Maintenance Management

Maintenance management refers to the assumption of responsibility for ensuring the plant maintains the required state of operational availability. In the performance of this task, CWC staff will ensure that the machinery in the plant is subjected to the appropriate level of maintenance. Maintenance at the plant is based on a combined time-based/condition-based philosophy. The delineation between the two is determined on the

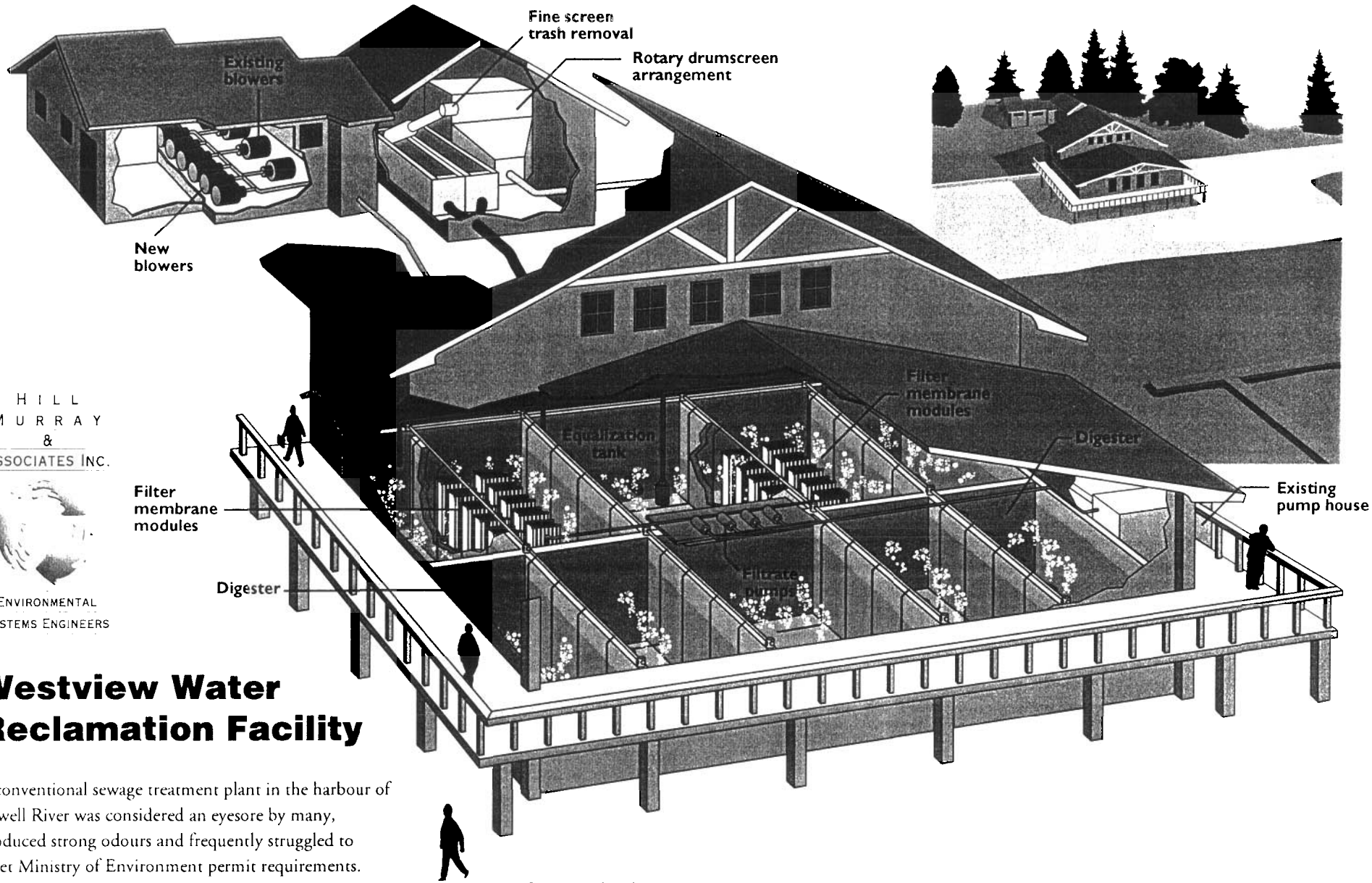
basis of capital cost, expected reliability, expected hazard-rate, and implications of failure. Similarly, equipment is designated as RxR (repair by replacement) or RxO (repair by overhaul).

In addition, CWC provides technical support activities for the plant, evaluating and implementing changes in protocols.

6.4 Command, Control, Communication and Information (C_3I) Technologies

In order to effectively manage the operation of the plant remotely, CWC employs a powerful suite of man-machine interface software, remote imaging, active process and plant control and advanced communications technologies. This control suite, supplementary to the control logic for the operation of the plant allows for immediate notification of any alarm conditions, ensures that CWC staff can verify any operating condition at the plant and allows for alteration of control logic as well as recovery from any abnormal condition.

This suite has been developed by CWC to ensure that the operating state of any portion of the plant can be confirmed, altered or queried 24 hours per day, seven days a week. This system allows for immediate response to any problem and in most cases negates any requirement for the on-site operator or CWC staff to visit the plant.



HILL
MURRAY
&
ASSOCIATES INC.

ENVIRONMENTAL
SYSTEMS ENGINEERS

Westview Water Reclamation Facility

A conventional sewage treatment plant in the harbour of Powell River was considered an eyesore by many, produced strong odours and frequently struggled to meet Ministry of Environment permit requirements.

Hill, Murray & Associates proposed an affordable solution – a membrane-bioreactor system, to be installed in the existing tanks and buildings of the old plant. The new system will be clean and odourless and will produce treated water which exceeds Ministry of Environment regulations.

The facility will be housed in an attractive 1920s-style boathouse with a public walkway.

A key feature of the design of the water reclamation facility is flexibility. In the future, the plant can be expanded with additional membranes to accommodate increased sewage volumes within the existing tanks.

The 'just-in-time' concept for future upgrades of the plant means that capital costs for new equipment can be spread over a number of years and the impact on taxpayers is minimized. Upgrading this plant means there is no need to purchase more land, and most important, the high level of treatment of the discharge ensures that the fragile marine environment is protected.

Municipality of Iqaluit
Water Reclamation Facility

Option 1 - Full Tertiary Immediately

MBR Flow 2000 m^3/day

Item	Cost ($M)
Engineering/Design	1.5
Permitting	0.5
ZenoGEM Equipment	3.5
Fournier Press Equipment	0.5
Headworks Equipment	0.35
Headworks Tanks	0.25
Headworks Building (2000 ft^2)	0.25
Treatment Tanks	1.0
Treatment Building (10000 ft^2)	1.0
Civil Improvements	1.0
Mobilization & Shipping	0.5
Installation & Management	0.75
Commissioning	0.2
Sub-Total - Option 1	11.3
Recommended Contingency - may be reduced subject to site visit.	2.5

Subject to: Summer Site Visit
Errors & Ommissions Excepted

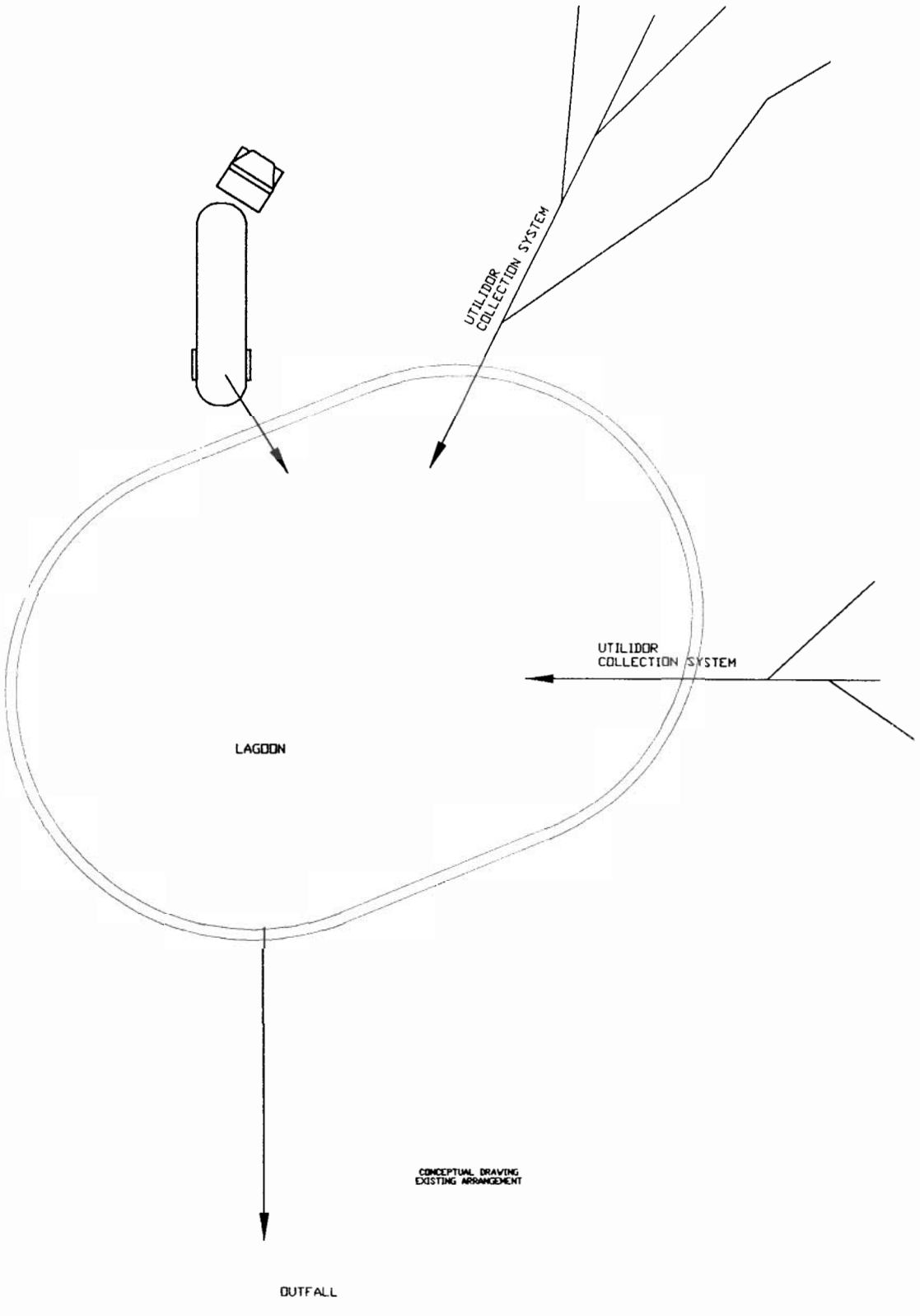
Option 2 - Minimum Budget Compliance
Phased Tertiary

MBR Flow 1000 m^3/day
Microscreen Flow 1000 m^3/day

Blended Flow 2000 m^3/day

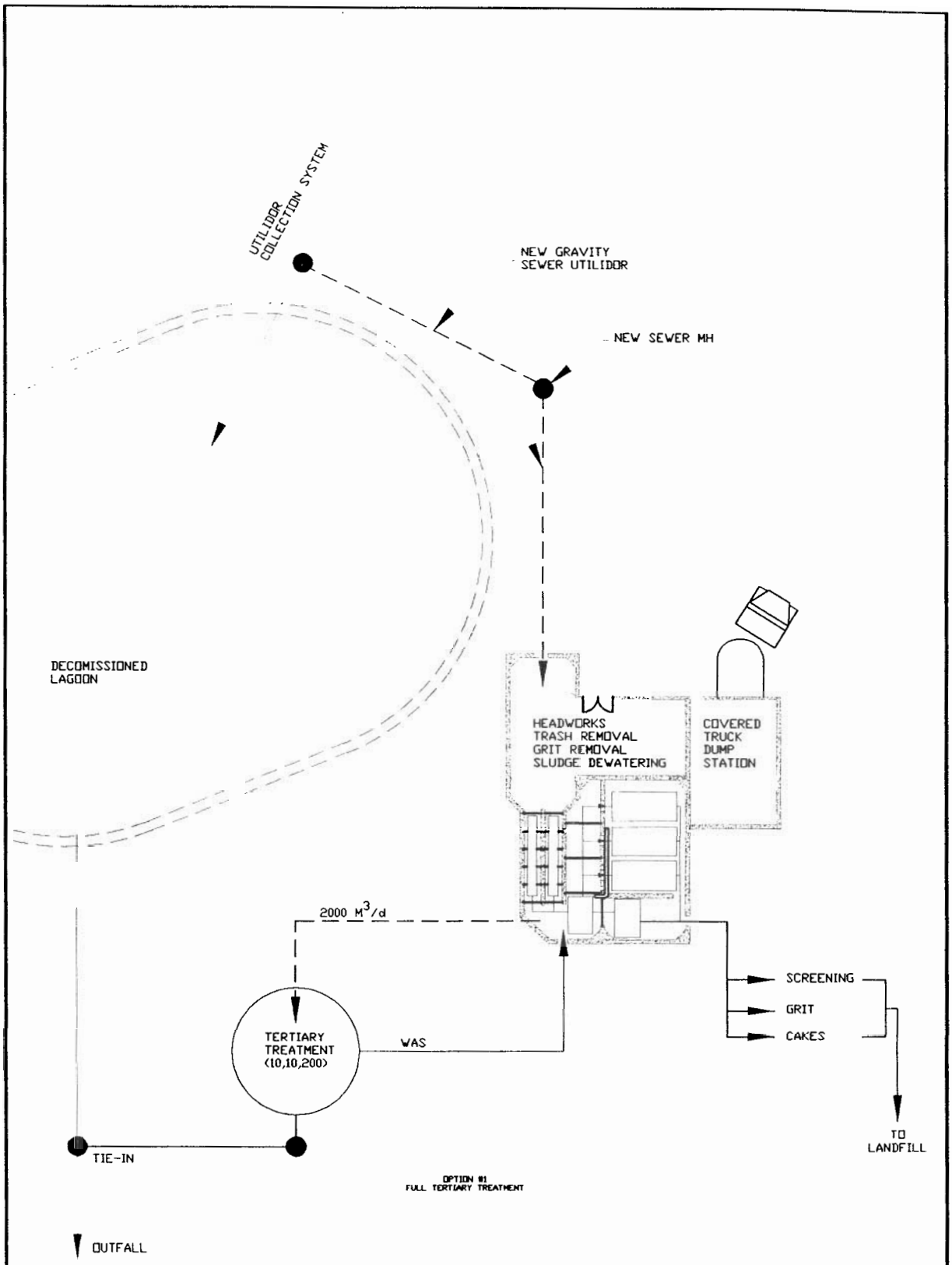
Item	Cost ($M)
Engineering/Design	0.8
Permitting	0.3
ZenoGEM Equipment	1.8
Drum Screen Equipment	0.15
Sludge Pressing Equipment	0.3
Headworks Equipment	0.1
Headworks Tanks	0.15
Headworks Building	0.15
Treatment Tanks	0.4
Treatment Building	0.4
Civil Improvements	0.5
Mobilization & Shipping	0.3
Installation & Management	0.45
Commissioning	0.15
Sub-Total - Option 2	5.95
Recommended Contingency - may be reduced subject to site visit.	1.0

Subject to: Summer Site Visit
Errors & Ommissions Excepted



Hill, Murray, & Associates, Inc.

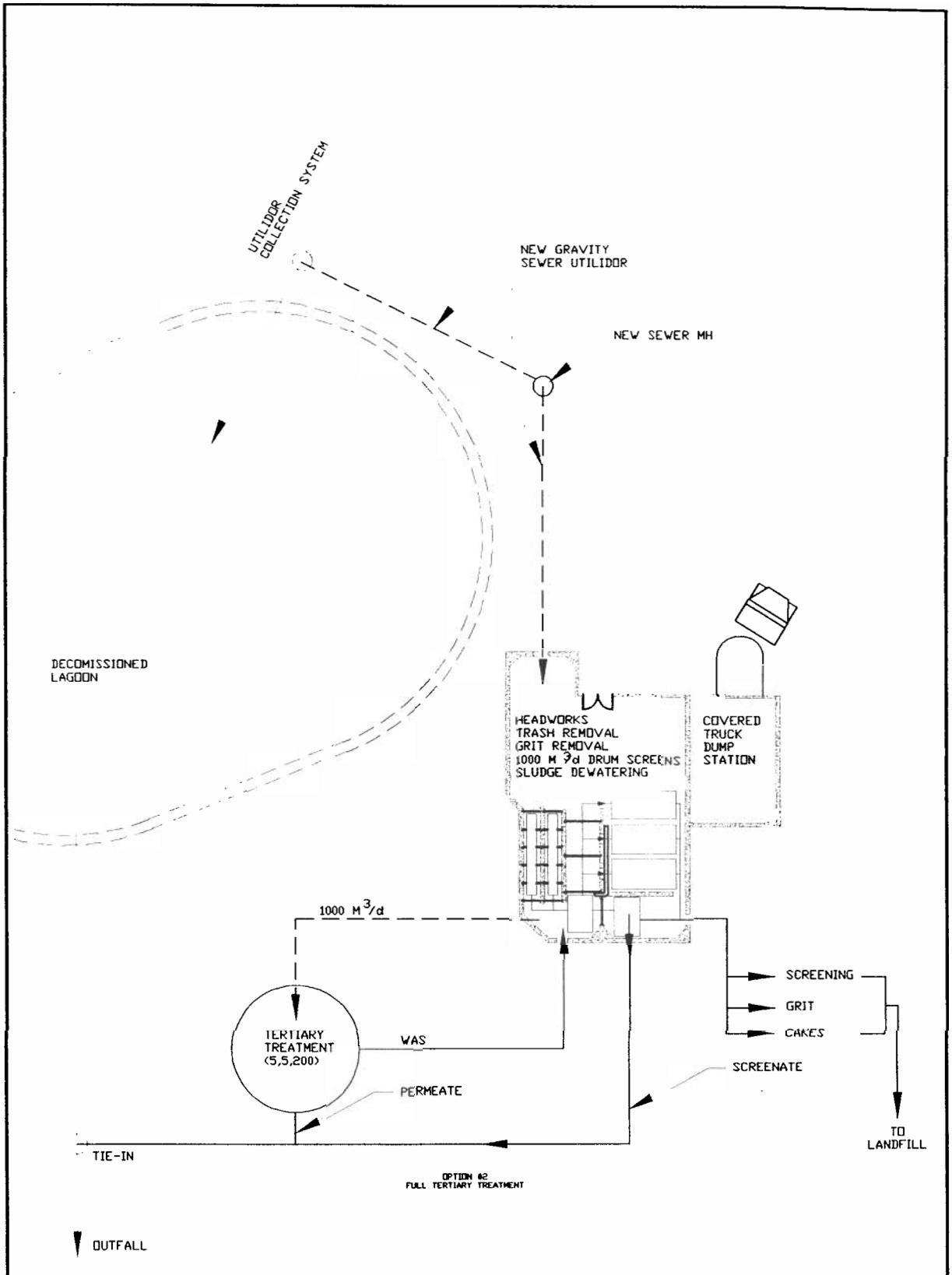
DESIGNED: RAH	APPROVED: RAH	CONCEPTUAL DRAWING IQALUIT, N.W.T.	SHEET G1
DRAWN: LAM	PROJECT NO. N/A		
FILE: 93000-26/BLOCKS		EXISTING ARRANGEMENT	OF 3 SHEETS
CHECKED: GDG	DATE: 19/03/1998		



OPTION #1
FULL TERTIARY TREATMENT

Hill, Murray, & Associates, Inc.

DESIGNED: RAH	APPROVED: RAH	CONCEPTUAL DRAWING IQALUIT, N.W.T.	SHEET G2
DRAWN: LAM	PROJECT NO. N/A		
FILE: 35000-26/BLOCKS		PROPOSED CHANGES-OPTION #1	OF 3 SHEETS
CHECKED: GDG	DATE: 19/03/1996		



OPTION #2
FULL TERTIARY TREATMENT

Hill, Murray, & Associates, Inc.

DESIGNED: RAM	APPROVED: RAM	CONCEPTUAL DRAWING IQALUIT, N.W.T.	SHEET G3
DRAWN: LAM	PROJECT NO. N/A		
FILE: 35008-20/BLOCKS		PROPOSED CHANGES-OPTION #2	OF 3 SHEETS
CHECKED: GDG	DATE: 19/03/1998		

Estimated Operating Costs - Iqaluit Water Reclamation Facility

Errors & Ommissions Excepted

Year	Estimated Annual Increase in Population	Total Dwelling Units Annual	Total Dwelling Units Accum	Total Sewage Flows Igpd	Membrane Replacement Costs Annual Change	Labour	Power Cost	Chemicals	Sludge	Local Overhead & Admin	Monitoring & Mngment Fees	Total Operating Costs Actual	Total Operating Costs NPV	Monthly Actual Operating Costs/D.U.	Monthly NPV Operating NPV
1998	4,538	2,269	2,269	399,824	59,707	75,000	587,763	6,645	261,779	75,000	111,941	1,172,835	1,172,835	43.07	43.07
1999	4,690	76	2,345	413,251	61,712	75,000	602,209	6,700	270,570	75,000	112,342	1,198,534	1,175,033	42.59	41.75
2000	4,848	79	2,424	427,129	63,785	75,000	617,010	6,757	279,657	75,000	112,757	1,224,965	1,177,398	42.11	40.48
2001	5,011	81	2,505	441,472	65,927	75,000	632,175	6,816	289,048	75,000	113,185	1,252,151	1,179,930	41.65	39.25
2002	5,179	84	2,589	456,298	68,140	75,000	647,713	6,877	298,755	75,000	113,628	1,280,114	1,182,627	41.20	38.06
2003	5,353	87	2,676	471,621	70,429	75,000	663,633	6,940	308,788	75,000	114,086	1,308,875	1,185,488	40.75	36.91
2004	5,533	90	2,766	487,459	72,794	75,000	679,943	7,005	319,157	75,000	114,559	1,338,459	1,188,513	40.32	35.80
2005	5,718	93	2,859	503,829	75,239	75,000	626,990	7,073	329,875	75,000	115,048	1,299,224	1,131,053	37.87	32.96
2006	5,911	96	2,955	520,749	77,765	75,000	642,400	7,142	340,953	75,000	115,553	1,328,814	1,134,130	37.47	31.98
2007	6,109	99	3,054	538,237	80,377	75,000	731,321	7,214	352,403	75,000	116,075	1,432,391	1,198,561	39.08	32.70
2008	6,314	103	3,157	556,312	83,076	75,000	749,296	7,289	364,238	75,000	116,615	1,465,513	1,202,231	38.68	31.73
2009	6,526	106	3,263	574,994	85,866	75,000	767,712	7,366	376,469	75,000	117,173	1,499,586	1,206,062	38.30	30.80
2010	6,745	110	3,373	594,303	88,749	75,000	786,581	7,445	389,112	75,000	117,750	1,534,638	1,210,051	37.92	29.90
2011	6,972	113	3,486	614,261	91,730	75,000	805,914	7,527	402,179	75,000	118,346	1,570,696	1,214,199	37.55	29.03
2012	7,206	117	3,603	634,890	94,810	75,000	825,722	7,612	415,685	75,000	118,962	1,607,792	1,218,505	37.19	28.18
2013	7,448	121	3,724	656,211	97,994	75,000	846,017	7,700	429,645	75,000	119,599	1,645,954	1,222,968	36.83	27.37
2014	7,698	125	3,849	678,247	101,285	75,000	866,810	7,790	444,073	75,000	120,257	1,685,216	1,227,589	36.49	26.58
2015	7,957	129	3,978	701,024	104,686	75,000	888,115	7,884	458,986	75,000	120,937	1,725,609	1,232,365	36.15	25.81
2016	8,224	134	4,112	724,566	108,202	75,000	909,943	7,981	474,400	75,000	121,640	1,767,166	1,237,298	35.81	25.08
2017	8,500	138	4,250	748,899	111,836	75,000	932,308	8,081	490,331	75,000	122,367	1,809,923	1,242,387	35.49	24.36

JB LABS
827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

DATE. April 30, 1997

JOB NO: JB 1750
LR NO: 23704

SAMPLING DATE: See Below
SAMPLING AGENT. Perrault

CLIENT: Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

The sample(s) submitted by the agent have been tested as requested and we report as follows:

SAMPLE Sample # 1: Mt.Washington STP - Effluent Apr 23/97
Sample # 2: Mt.Washington STP - Mixed Liquor

			Sample 1		Sample 2
Tot Suspended Solids	mg/L		< 1	1	4400
BOD_5	mg/L		< 5		
Phosphorus, Total	mg/L	P	0.155		
Nitrite	mg/L	N	0.005		
Nitrate	mg/L	N	16.8		
Ammonia	mg/L	N	0.11		
T.Kjeldahl Nitrogen	mg/L	N	0.61		
Faecal Coliform	CFU/100ml		< 1		
Fixed Susp.Solids	mg/L				3240
Volatile Susp Solids	mg/L			1	1160

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc.
Barbara M. Klassen, B.Sc.

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service; and/or "Standard Methods/Water and Wastewater", American Public Health Association.

JB LABS

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

RECEIVED
MAR [illegible] 1997
[illegible] Associates Inc

DATE February 26, 1997

JOB NO JB 1750
LR NO 23351

SAMPLING DATE See Below
SAMPLING AGENT D. Perrault

The sample(s) submitted by the Agent have been tested as requested and we report as follows

CLIENT Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE Sample # 1: Mt. Washington Effluent Feb 20/97
Sample # 2: Mt. Washington Bioreactor Cell #1
Sample # 3: Mt. Washington Bioreactor Cell #2

		Sample 1	Sample 2	Sample 3
Tot Suspended Solids	mg/L	< 1	12,300	10,200
BOD$_5$	mg/L	< 5		
Faecal Coliform	CFU/100ml	< 1		
Fixed Susp.Solids	mg/L		1,800	1,500
Volatile Susp Solids	mg/L		10,500	8,700

less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M Sc
Barbara M. Klassen, B Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues" Chemistry Laboratory Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

IRC
Integrated Resource Consultants Inc.

CLIENT CONFIDENTIAL

Suite 160
14480 River Road
Richmond, BC
Canada V6V 1L4
Tel. (604) 278-7714
Fax (604) 278-7741
e-mail: IRC@mindlink.bc.ca

FAX

TO: Graham - Hill, Murray & Associates

FROM: Marian Zazzi

IRC Integrated Resource Consultants Inc.

RECEIVED
JAN 20 1997
Hill, Murray & Associates Inc

NUMBER OF PAGES, INCLUDING THIS PAGE: 1

DATE: 20 January 1997

BIOASSAY UPDATE:

SAMPLE NAME:	Mt. Washington Permeate
SAMPLE DATE:	12 January 1997
DATE RECEIVED:	14 January 1997
ANALYSIS:	96 HOUR RAINBOW TROUT TOXICITY
96 HOUR UPDATE:	100% TROUT ALIVE IN 100% CONCENTRATION The 96 Hour LC50 was greater than 100%

The LC_{50} is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality. Results are calculated using the method described by Stephan (Methods for calculating an LC_{50} in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The test method followed was as per "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" EPS 1/RM/13, 1990, amended May 1996.

Please call should you have any questions
Full report to follow in the mail

TOTAL P.01

North Island Laboratories

#3-9946 Kilpatrick Avenue, Courtenay, B.C. V9N 7S7

Tel: 338-7786 Fax: 338-7553

RECEIVED

JAN 2 4 1997

Hill, Murray & Associates

Report To: Graham Symmons
Graham Symmons
Hill Murray & Associates
202-780 Tolmie Ave

Sample Number: 1840-01
Date Reported: 1/17/97
Date Received: 1/8/97 13:58
Date Collected: 1/8/97

Collected by: Graham Symmons
Source: Waste Water Tmt Plant
Sample point: New

Water Analysis Results

Parameter	Result	Units
Ammonia		
Ammonia (N)	0.011	mg/L
BOD,TSS,Fecal Coliforms		
5 day BOD	< 5	mg/L
Total Suspended Solids	< 1	mg/l
Fecal Coliforms	< 1	CFU/100mL
Nitrate		
Nitrate (N)	35.5	mg/L
Nitrite		
Nitrite (N)	0.284	mg/L
Total Kjeldahl Nitrogen		
TKN (mg/L)	0.80	mg/L
Total phosphate		
Total Phosphate (P)	0.148	mg/L

IRC
Integrated Resource Consultants Inc.

CLIENT CONFIDENTIAL

Suite 160
14480 River Road
Richmond, BC
Canada V6V 1L4
Tel. (604) 278-7714
Fax (604) 278-7741
e-mail. IRC@mindlink.bc.ca

FAX

TO: Graham - Hill, Murray & Associates

FROM: Marian Zazzi

IRC Integrated Resource Consultants Inc.

NUMBER OF PAGES, INCLUDING THIS PAGE: 1

DATE: 30 DEC. 1996

BIOASSAY UPDATE:

SAMPLE NAME:	Mt. Washington Permeate
SAMPLE DATE:	19 DEC. 1996
DATE RECEIVED:	23 DEC. 1996
ANALYSIS:	96 HOUR RAINBOW TROUT TOXICITY
96 HOUR UPDATE:	100% TROUT ALIVE IN 100% CONCENTRATION The 96 Hour LC50 was greater than 100%

The LC_{50} is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality Results are calculated using the method described by Stephan (Methods for calculating an LC_{50} in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The test method followed was as per "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" EPS 1/RM/13, 1990, amended May 1996.

Please call should you have any questions
Full report to follow in the mail

TOTAL P.01

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel. (250) 385-6112
Fax: (250) 382-6364

RECEIVED
DEC 06 1996

(1)

DATE December 5, 1996

JOB NO JB 1750
LR NO 22920

SAMPLING DATE Nov 26/96
SAMPLING AGENT Perreault

The sample(s) submitted by the agent have been tested as requested and we report as follows

CLIENT Hill, Murray & Associates
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE Sample # 1: Mt. Washington Resort STP - Startup Nov 26/96

			Sample 1
Tot Suspended Solids	mg/L	<	1
BOD_5	mg/L	<	5
Phosphorus, Total	mg/L P		1.39
Nitrite	mg/L N		0.34
Nitrate	mg/L N		11.7
Ammonia	mg/L N		0.12
T.Kjeldahl Nitrogen	mg/L N		0.43
Faecal Coliform	CFU/100ml	<	1

(2) Fib

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc.
Barbara M. Klassen, B.Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel (250) 385-6112
Fax: (250) 382-6364

RECEIVED
APR 28 1997
Hill, Murray & Associates Inc.

DATE: April 21, 1997

JOB NO. JB 1750
LR NO 23650

SAMPLING DATE. See Below
SAMPLING AGENT Client

The sample(s) submitted by the agent have been tested as requested and we report as follows

CLIENT: Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE. Sample # 1: Thetis Lake Campground: Effluent Apr 16/97
Sample # 2: Thetis Lake Campground: Biomass

			Sample 1	Sample 2
Tot Suspended Solids	mg/L	<	1	7800
BOD_5	mg/L	<	5	
Faecal Coliform	CFU/100ml	<	1	
Fixed Susp.Solids	mg/L			950
Volatile Susp Solids	mg/L			6850

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc
Barbara M. Klassen, B.Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

RECEIVED
MAR 03 1997
Hill, Murray & Associates Inc.

DATE February 24, 1997

JOB NO: JB 1750
LR NO: 23337

CLIENT
Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B. C.
V8X 3W4

Attn: Graham Symmons

SAMPLING DATE: Feb 18/97
SAMPLING AGENT: D.Perreault

The sample(s) submitted by the agent have been tested as requested and we report as follows

SAMPLE

Sample # 1: Thetis Lake: Effluent Feb 18/97
Sample # 2: Thetis Lake: Mixed Liquor

		Sample 1	Sample 2
Total Suspended Solids	mg/L	< 1	11,600
BOD_5	mg/L	< 5	
Faecal Coliform	CFU/100mL	< 1	
Fixed Suspended Solids	mg/L		1,510
Volatile Suspended Solids	mg/L		10,090
Phosphorus, Total	mg/L P		121

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc
Barbara M. Klassen, B.Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

DATE: January 20, 1997

JOB NO. JB 1750
LR NO: 23125

SAMPLING DATE: See Below
SAMPLING AGENT: Client

The sample(s) submitted by the agent have been tested as requested and we report as follows:

CLIENT Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE Sample # 1: Thetis Lake STP: Effluent Jan 13/97
Sample # 2: Thetis Lake STP: Biomass

		Sample 1	Sample 2
Tot Suspended Solids	mg/L	< 1	19,400
BOD_5	mg/L	< 5	
Faecal Coliform	CFU/100ml	5	
Volatile Susp Solids	mg/L		17,000

[illegible] & Associates INC.
PAYMENT AUTHORIZATION
This item is approved for payment
by:_____
Date Goods Received:_____
Account:_____Sub-Account:_____
Project No._____P.O. No:_____
Billable:_____Non-Billable:_____
[illegible]_____Issued Date:_____

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc
Barbara M. Klassen, B.Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

DATE October 15, 1996

JOB NO: JB 1750
LR NO: 22630

SAMPLING DATE: See Below
SAMPLING AGENT: Client

The sample(s) submitted by the agent have been tested as requested and we report as follows:

CLIENT: Hill, Murray & Associates
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE: Sample # 1: Thetis Lake Campground - Plant Effluent Oct 8/96
Sample # 2: Thetis Lake Campground - Eff After Filt
Sample # 3: Thetis Lake Campground - Biomass

		Sample 1	Sample 2	Sample 3
Tot Suspended Solids	mg/L	< 1		9650
BOD_5	mg/L	< 5		
Faecal Coliform	CFU/100ml		< 1	
Fixed Susp.Solids	mg/L			1280
Volatile Susp Solids	mg/L			8370

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M Sc
Barbara M. Klassen, B Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

JB LABS

(1)

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APR 18 1996

Hill, Murray & Associates Inc.

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (604) 385-6112
Fax: (604) 382-6364

DATE: April 17, 1996

JOB NO. JB 1750
LR NO: 21627

SAMPLING DATE: See Below
SAMPLING AGENT: Client

The sample(s) submitted by the agent have been tested as requested and we report as follows:

CLIENT Hill, Murray & Associates
#1 - 1131 Collinson St.
Victoria, B.C.
V8V 3C2

Attn: Graham Symmonds

SAMPLE
Sample # 1: Membrane Discharge - Thetis Lake Apr 12/96
Sample # 2: Bio-reactor mixed liquor
Sample # 3: Discharge to field

		Sample 1	Sample 2	Sample 3
Tot Suspended Solids	mg/L	< 1	8520	
BOD_5	mg/L	< 5		
Fixed Susp.Solids	mg/L		1100	
Volatile Susp Solids	mg/L		7420	
Faecal Coliform	CFU/100ml			< 10

(2) [illegible] Thetis Lk Lab [illegible]

< = less than

John E Evanoff, M Sc
Barbara M Klassen, B Sc

JB Laboratories Ltd.
water/wastewaters

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

JB LABS

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (604) 385-6112
Fax: (604) 382-6364

(1)

RECEIVED

APR 0 2 1996

Hill, Murray & Associates Inc.

DATE: April 1, 1996

JOB NO: JB 1750
LR NO: 21521

SAMPLING DATE: See Below
SAMPLING AGENT: Client

The sample(s) submitted by the agent have been tested as requested and we report as follows.

CLIENT: Hill, Murray & Associates
#1 - 1131 Collinson St.
Victoria, B.C.
V8V 3C2

Attn: Graham Symmonds

SAMPLE:
Sample # 1: Thetis Lake - Membrane Bank #1 Mar 25/96
Sample # 2: Thetis Lake - Membrane Bank #2
Sample # 3: Thetis Lake - Membrane Chamber
Sample # 4: Thetis Lake - Chlor. Ring Inlet

		Sample 1	Sample 2	Sample 3	Sample 4
Tot Suspended Solids	mg/L	< 1	1	6100	
BOD_5	mg/L	< 5	5		
Faecal Coliform	CFU/100ml				10

(2) Trev
Rob
Mary

File in Thetis Maintenance file please.

B.

< = less than

John E. Evanoff, M Sc
Barbara M. Klassen, B Sc

JB Laboratories Ltd.
water/wastewaters

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

(1)

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (604) 385-6112
Fax: (604) 382-6364

DATE: January 16, 1996

JOB NO: JB 1750
LR NO. 21411

SAMPLING DATE: See Below

CLIENT: Hill, Murray & Associates
#1 - 1131 Collinson St.
Victoria, B.C.
V8V 3C2

SAMPLING AGENT: Client

The sample(s) submitted by the agent have been tested as requested and we report as follows

Attn: Graham Symmonds

RECEIVED
JAN 2 3 1996
Hill, Murray & Associates Inc.

SAMPLE: Sample # 1: Thetis Lake - Aeration Jan 8/96
Sample # 2: Thetis Lake - Membrane Discharge

		Sample 1	Sample 2
Tot Suspended Solids	mg/L	8700	5
BOD_5	mg/L		< 5
Faecal Coliform	CFU/100ml		< 10

(2) Mary
File Please
H.

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M Sc
Barbara M. Klassen, B Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

Ministry of Social Services Building 6868 West Coast Rd						
Date	Total Daily Flow	Flow to Field	Recycle Ratio	Permeate Analytical		
				BOD	TSS	FC
17-Apr-96				<5	<1	<1
22-Apr-96				<5	<1	<10
24-Apr-96				<5	<1	<10
26-Apr-96				<5	<1	<10
29-Apr-96				<5	<1	1
01-May-96				<5	2	<1
03-May-96				<5	2	<1
06-May-96				<5	<1	<1
08-May-96				<5	3	<1
10-May-96	152			<5	2	<1
13-May-96				<5	<1	<1
15-May-96				<5	2	<1
17-May-96				<5	<1	<1
21-May-96	162			<5	<1	<1
24-May-96	231			<5	<1	<1
24-May-96						
27-May-96				<5	<1	<1
30-May-96	223					
03-Jun-96	155			<5	<1	<1
11-Jun-96	218			<5	<1	<1
13-Jun-96	257					
20-Jun-96	214	38	82%	<5	<1	<1
24-Jun-96	183	22	88%			
26-Jun-96	244	16	93%	<5	<1	<1
27-Jun-96	655	48	93%			
03-Jul-96	172	8	95%			
09-Jul-96	283	24	92%	<5	<1	<1
10-Jul-96	546	47	91%			
15-Jul-96	325	8	97%			
16-Jul-96	316	0	100%			
19-Jul-96	403	16	96%			
21-Jul-96	211	0	100%			
30-Jul-96	266	14	95%	<5	<1	<1
31-Jul-96	169	0	100%			
01-Aug-96	510	0	100%			
02-Aug-96	136	47	65%			
03-Aug-96	672	0	100%			
06-Aug-96	223	29	87%			
07-Aug-96	228	4	98%			
08-Aug-96	214	0	100%			
09-Aug-96	286	49	83%			
11-Aug-96	124	0	100%			
12-Aug-96	115	0	100%			
13-Aug-96	199	0	100%	<5	<1	<1
14-Aug-96	154	45	71%			
15-Aug-96	152	0	100%			
20-Aug-96	194	19	90%			
21-Aug-96	166	49	70%			
22-Aug-96	256	0	100%			
23-Aug-96	131	42	68%			
26-Aug-96	139	0	100%			
27-Aug-96	521	90	83%	<5	<1	<1
28-Aug-96	194	46	76%			
29-Aug-96	198	0	100%			
30-Aug-96	365	43	88%			
03-Sep-96	179	0	100%			
04-Sep-96	278	0	100%			
05-Sep-96	406	45	89%			
06-Sep-96	390	0	100%			
09-Sep-96	279	0	100%	<5	<1	<1
13-Sep-96	310	21	93%		<1	
16-Sep-96	384	0	100%			
24-Sep-96	311	16	95%	<5	<1	<1
29-Sep-96	381	18	95%			
01-Oct-96	237	0	100%			
03-Oct-96	454	44	90%			
07-Oct-96	271	0	100%			
08-Oct-96	289	43	85%	<5	<1	<1
15-Oct-96	368	6	98%			
23-Oct-96	339	20	94%			

01-Nov-96	303	10	97%			
05-Nov-96	254	22	91%		3	<1
11-Nov-96	203	15	93%			
15-Nov-96	237	11	95%			
20-Nov-96	244	26	90%			
28-Nov-96	276	20	93%			
02-Dec-96	185	10	94%			
09-Dec-96	164	18	89%			
10-Dec-96	328	130	60%			
16-Dec-96	181	15	92%	<5	<1	1
24-Dec-96	169	21	87%			
09-Jan-97	60	19	68%			
13-Jan-97	49	11	77%			
18-Jan-97	154	44	72%			
03-Feb-97	84	22	74%			
06-Feb-97	162	30	82%			
17-Feb-97	65	16	76%			
18-Feb-97	159	88	45%	<5	<1	1
24-Feb-97	64	21	67%			
25-Feb-97	130	93	29%			
27-Feb-97	119	38	68%			
03-Mar-97	163	43	74%			
04-Mar-97	369	44	88%			
10-Mar-97	121	44	63%			
14-Mar-97	213	33	85%			
17-Mar-97	60	14	77%	<5	<1	1
23-Mar-97	71	29	59%			
27-Mar-97	205	33	84%			
08-Apr-97	70	14	80%			
15-Apr-97	161	19	88%			
16-Apr-97				<5	<1	1
21-Apr-97	83	22	73%			
05-May-97	131	11	92%			
15-May-97	134	126	6%			
26-May-97	65	12	81%			
27-May-97	88	0	100%	<5	<1	1
28-May-97	226	0	100%			
29-May-97	293	88	70%			
02-Jun-97	141	10	93%			
05-Jun-97	101	15	85%			
06-Jun-97	549	39	93%			
10-Jun-97	213	0	100%			
17-Jun-97	81	18	77%			
02-Jul-97	73	12	84%			
07-Jul-97				<5	<1	1
08-Jul-97	50	14	71%			
18-Jul-97	90	17	81%			
23-Jul-97	127	8	94%			
30-Jul-97	162		100%			
08-Aug-97	59	11	82%	<5	<1	1
21-Aug-97	75	9	87%			
02-Sep-97	140	7	95%			
09-Sep-97	59	18	69%			
19-Sep-97	542	16	97%			
22-Sep-97	68	25	63%			
24-Sep-97	31	0	100%			
29-Sep-97	156	24	85%			
30-Sep-97	282	0	100%			
07-Oct-97	83	12	86%	1	<1	1
16-Oct-97	97	9	91%			
17-Oct-97	776	37	95%			
22-Oct-97	85	9	90%			
28-Oct-97	94	7	92%			
29-Oct-97	412	37	91%			
30-Oct-97	197	43	78%			
04-Nov-97	66	16	76%			
20-Nov-97	83	16	81%			
25-Nov-97	94	16	83%			
26-Nov-97	138	85	39%	<5	<1	1
27-Nov-97	0	0				
28-Nov-97	117	39	67%			
07-Dec-97	89	22	75%			
10-Dec-97	76	13	82%			
12-Dec-97	91	21	77%			

Average Flow to Field 23 USG

CYCLE-LET

ENHANCED NITROGEN REMOVAL

The enclosed laboratory data is from one of several Cycle-Let facilities in New Jersey which is currently being run in an enhanced nitrogen removal mode. Through internal recirculation, pH control and a final polishing denitrification filter (where necessary) we can consistently achieve an effluent of less than 10 mg/l total nitrogen.

Zenon Municipal Systems Inc.
P.O. Box 1285, Ann Arbor, MI 48106 Telephone: (313) 769-9574 (800) 443-3006 Fax: (313) 761-7842

ZENON

EFFLUENT NITROGEN MONITORING

WILMAD			
Ave Flow	739 gpd		
Peak Flow	3250 gpd		
Date	NO3-N	NH3-N	Total
8/20/91	4.80	0.54	5.34
9/6/91	8.80	0.14	8.94
9/11/91	0.24	0.08	0.32
9/13/91	7.80	0.23	8.03
9/20/91	0.65	0.83	1.48
9/30/91	2.5	0.31	2.81
10/7/91	6.00	0.06	6.06
10/15/91	5.00	0.06	5.06
12/10/91	0.1	0.39	0.49
3/19/92	0.73	0.56	1.29
3/25/92	0.14	0.20	0.34
4/2/92	1.90	0.14	2.04
5/7/92	0.63	0.20	0.83
6/2/92	0.03	1.09	1.12
7/9/92	0.10	0.20	0.30
8/6/92	3.90	0.80	4.70
9/8/92	0.04	0.47	0.51
10/27/92	0.04	0.31	0.35
11/3/92	0.04	0.18	0.22
12/1/92	1.64	0.44	2.08
1/7/93	1.00	0.54	1.54
2/23/93	1.31	0.06	1.37
3/2/93	0.86	1.44	2.30
4/20/93	3.89	1.75	5.64
5/4/93	1.38	0.34	1.72
6/10/93	0.13	0.30	0.43
7/12/93	2.05	0.02	2.07
8/11/93	0.94	0.10	1.04
9/7/93	0.13	0.01	0.14
10/7/93	0.58	0.24	0.82
11/11/93	4.05	0.01	4.06
12/15/93	0.62	0.80	1.42
1/6/94	0.15	0.24	0.39
2/4/94	0.52	0.61	1.13
3/1/94	0.16	0.88	1.04
AVERAGE	1.80	0.42	2.21

FMI			
Ave Flow	232 gpd		
Peak Flow	550 gpd		
Date	NO3-N	NH3-N	Total
1/10/92	5.8	0.3	6.10
1/17/92	5	0.2	5.20
1/19/92	5.6	0.5	6.10
3/5/92	5.9	0.3	6.20
4/9/92	6	0.3	6.30
5/20/92	0.1	0.2	0.30
6/1/92	3	0.27	3.27
6/8/92	0.5	0.2	0.70
7/13/92	0.5	0.2	0.70
8/3/92	0.5	7.97	8.47
9/8/93	0.58	2	2.58
10/6/92	2.87	0.2	3.07
11/5/92	5.68	0.2	5.88
12/22/92	0.5	0.2	0.70
1/4/93	0.5	0.44	0.94
2/2/93	2.83	0.68	3.51
3/1/93	2.01	0.2	2.21
4/5/93	1.7	0.39	2.09
5/10/93	0.5	0.2	0.70
6/8/93	0.5	0.2	0.70
7/6/93	1.91	0.2	2.11
9/15/93	2.03	0.0	2.03
10/11/93	2.87	0	2.87
11/8/93	3.1	0	3.10
12/8/93	3.78	0	3.78
1/17/94	4.2	0	4.20
2/10/94	0	0	0.00
AVERAGE	2.54	0.57	3.10

TRAP ROCK			
Ave Flow	720 gpd		
Peak Flow	1700 gpd		
Date	NO3-N	NH3-N	Total
2/27/92	0.1	0.09	0.19
4/1/92	0.1	0.1	0.20
4/10/92	0.1	0.2	0.30
4/15/92	0.1	0.2	0.30
5/6/92	0.1	0.15	0.25
5/11/92	0.1	0.33	0.43
6/1/92	2	0.2	2.20
6/30/92	0.1	0.27	0.37
7/7/92	0.11	0.24	0.35
7/29/92	0.1	0.3	0.40
10/9/92	9.5	0.16	9.66
11/3/92	2	0.2	2.20
12/11/92	3.7	0.2	3.90
1/5/93	2.9	0.29	3.19
2/8/93	2	0.25	2.25
3/2/93	3.3	0.2	3.50
4/5/93	3.6	0.2	3.80
5/3/93	2.5	0.22	2.72
6/16/93	0.56	0.84	1.40
7/6/93	3.7	0.2	3.90
8/3/93	4.9	0.2	5.10
9/10/93	3.6	0.2	3.80
10/5/93	2.7	0.2	2.90
11/9/24	3.6	0.2	3.80
12/8/93	4	0.2	4.20
1/12/94	4.7	0.2	4.90
2/11/94	3	0.2	3.20
3/8/94	3.2	0.42	3.62
AVERAGE	2.37	0.24	2.61

Zenon Municipal Systems Inc.
P.O. Box 1285, Ann Arbor, MI 48106 Telephone: (313) 769-9574 (800) 443-3006 Fax: (313) 761-7842

TCI/UAGC			
Ave Flow	1147 gpd		
Peak Flow	2800 gpd		
Date	NO3-N	NH3-N	Total
4/20/93	4.62	0.95	5.57
5/4/93	3.42	0.20	3.62
6/8/93	2.87	0.20	3.07
7/6/93	0.5	0.2	0.70
8/4/93	1.50	0.00	1.50
8/10/93	4.30	0.51	4.81
9/8/93	1.25	2.42	3.67
10/12/93	0.91	8.71	9.62
11/18/93	4.32	0	4.32
12/7/93	2.62	0	2.62
1/20/94	2.06	0	2.06
2/9/94	1.72	0	1.72
3/1/94	3.56	0	3.56
AVERAGE	2.59	1.01	3.60

ARAMIS			
Ave Flow	1501 gpd		
Peak Flow	1800 gpd		
Date	NO3-N	NH3-N	Total
6/14/93	1	0.7	1.70
7/6/93	14.2	1.76	15.96
7/27/93	3.64	0	3.64
8/4/93	1.84	0	1.84
9/8/93	1.62	0	1.62
10/5/93	3.05	0	3.05
11/16/93	4.56	0	4.56
12/7/93	2.72	0	2.72
1/28/94	2.68	0	2.68
2/9/94	2.68	0	2.68
3/1/94	1.22	0	1.22
AVERAGE	3.56	0.22	3.79

GATEWAY/MANALPAN			
Ave Flow	3032 gpd		
Peak Flow	5100 gpd		
Date	NO3-N	NH3-N	Total
9/20/93	0.8	0.5	1.30
9/30/93	2	trace	2.00
10/11/93	2	2.5	4.50
10/18/93	2	0	2.00
10/24/93	2	trace	2.00
11/8/93	1.95	0.2	2.15
12/1/93	3.01	0.2	3.21
1/10/94	2.15	0.2	2.35
2/9/94	1.72	0	1.72
3/11/94	2.21	0.2	2.41
AVERAGE	1.98	0.48	2.36

Zenon Municipal Systems Inc.
P.O. Box 1285, Ann Arbor, MI 48106 Telephone: (313) 769-9574 (800) 443-3006 Fax: (313) 761-7842

IRC
Integrated Resource Consultants Inc.

CLIENT CONFIDENTIAL

Suite 160
14480 River Road
Richmond, BC
Canada V6V 1L4
Tel. (604) 278-7714
Fax (604) 278-7741
e-mail: IRC@mindlink.bc.ca

RECEIVED
JAN 20 1997
Hill, Murray & Associates Inc

FAX

TO: Graham - Hill, Murray & Associates

FROM: Marian Zazzi

IRC Integrated Resource Consultants Inc.

NUMBER OF PAGES, INCLUDING THIS PAGE: 1

DATE: 20 January 1997

BIOASSAY UPDATE:

SAMPLE NAME:	Mt. Washington Permeate
SAMPLE DATE:	12 January 1997
DATE RECEIVED:	14 January 1997
ANALYSIS:	96 HOUR RAINBOW TROUT TOXICITY
96 HOUR UPDATE:	100% TROUT ALIVE IN 100% CONCENTRATION The 96 Hour LC50 was greater than 100%

The LC_{50} is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality. Results are calculated using the method described by Stephan (Methods for calculating an LC_{50} in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The test method followed was as per "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" BPS 1/RM/13, 1990, amended May 1996.

Please call should you have any questions
Full report to follow in the mail

TOTAL P.01

North Island Laboratories

#3-2946 Kilpatrick Avenue, Courtenay, B C V9N 7S7 Tel 338-7786 Fax 338-7553

Report To: Graham Symmons
Graham Symmons
Hill Murray & Associates
202-780 Tolmie Ave

Sample Number: 1840-01
Date Reported: 1/17/97
Date Received: 1/8/97 13:58
Date Collected: 1/8/97

Collected by: Graham Symmons
Source: Waste Water Tmt Plant
Sample point: New

Water Analysis Results

Parameter	Result	Units
Ammonia		
Ammonia (N)	0.011	mg/L
BOD,TSS,Fecal Coliforms		
5 day BOD	< 5	mg/L
Total Suspended Solids	< 1	mg/L
Fecal Coliforms	< 1	CFU/100mL
Nitrate		
Nitrate (N)	35.5	mg/L
Nitrite		
Nitrite (N)	0.284	mg/L
Total Kjeldahl Nitrogen		
TKN (mg/L)	0.80	mg/L
Total phosphate		
Total Phosphate (P)	0.148	mg/L

IRC
Integrated Resource Consultants Inc.

CLIENT CONFIDENTIAL

Suite 160
14480 River Road
Richmond, BC
Canada V6V 1L4
Tel. (604) 278-7714
Fax (604) 278-7741
e-mail IRC@mindlink.bc.ca

FAX

TO: Graham - Hill, Murray & Associates

FROM: Marian Zazzi

IRC Integrated Resource Consultants Inc.

NUMBER OF PAGES, INCLUDING THIS PAGE: 1

DATE: 30 DEC. 1996

BIOASSAY UPDATE:

SAMPLE NAME:	Mt. Washington Permeate
SAMPLE DATE:	19 DEC. 1996
DATE RECEIVED:	23 DEC. 1996
ANALYSIS:	96 HOUR RAINBOW TROUT TOXICITY
96 HOUR UPDATE:	100% TROUT ALIVE IN 100% CONCENTRATION The 96 Hour LC50 was greater than 100%

The LC_{50} is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality. Results are calculated using the method described by Stephan (Methods for calculating an LC_{50} in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The test method followed was as per "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" EPS 1/RM/13, 1990, amended May 1996.

Please call should you have any questions
Full report to follow in the mail

TOTAL P.01

JB LABS
827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

RECEIVED
DEC 06 1996

(1)

DATE December 5, 1996

JOB NO. JB 1750
LR NO. 22920

SAMPLING DATE Nov 26/96
SAMPLING AGENT Perreault

The sample(s) submitted by the agent have been tested as requested and we report as follows

CLIENT Hill, Murray & Associates
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE Sample # 1: Mt. Washington Resort STP - Startup Nov 26/96

			Sample 1
Tot Suspended Solids	mg/L	<	1
BOD_5	mg/L	<	5
Phosphorus, Total	mg/L P		1.39
Nitrite	mg/L N		0.34
Nitrate	mg/L N		11.7
Ammonia	mg/L N		0.12
T.Kjeldahl Nitrogen	mg/L N		0.43
Faecal Coliform	CFU/100ml	<	1

(2) Fib
Mt Wash. STP Startup

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M.Sc
Barbara M. Klassen, B.Sc.

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
Tel: (250) 385-6112
Fax: (250) 382-6364

RECEIVED
APR 28 1997
Hill, Murray & Associates Inc.

DATE: April 21, 1997

JOB NO. JB 1750
LR NO. 23650

SAMPLING DATE. See Below
SAMPLING AGENT. Client

The sample(s) submitted by the agent have been tested as requested and we report as follows

Fig Thetis Lk Lab Result.

CLIENT: Canadian Wastewater Corp.
#202, 780 Tolmie Avenue
Victoria, B.C.
V8X 3W4

Attn: Graham Symmons

SAMPLE: Sample # 1: Thetis Lake Campground: Effluent Apr 16/97
Sample # 2: Thetis Lake Campground: Biomass

		Sample 1	Sample 2
Tot Suspended Solids	mg/L	< 1	7800
BOD_5	mg/L	< 5	
Faecal Coliform	CFU/100ml	< 1	
Fixed Susp.Solids	mg/L		950
Volatile Susp Solids	mg/L		6850

< = less than

JB Laboratories Ltd.
water/wastewaters

John E. Evanoff, M Sc
Barbara M Klassen, B Sc

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/Water and Wastewater", American Public Health Association

REFERENCES

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V2P 4P1

☞ Mr. Jim McFarland — Ph: (250) 360-3085
Manager of Operations
Capital Regional District
524 Yates Street
P.O. Box 1000
Victoria, B.C.
V8W 2S6

☞ Mr. George Stewart — Ph: (250) 334-5724
Owner
Mt. Washington Ski Resort Ltd.
P.O. Box 3069
Courtenay, B.C.
V9N 5N3

☞ Mrs. Frederique Philip — Ph: (250) 642-3421
Owner
Sooke Harbour House
1528 Whiffen Spit Road, R.R.4
Sooke, B.C.
V0S 1N0

☞ Mr. Richard Helm — Ph: (613) 995-2398
Directorate Aerospace Equipment
Canada National Defence
R & CS 2-3-4
National Defence Headquarters
M Gen George R. Pearkes Building
Ottawa, Ontario
K1A 0K2

INSTALLATION and AUXILIARY/ANCILLARY EQUIPMENT LIMITED WARRANTY

The Treatment Process is warranted by Zenon Municipal Systems for effluent quality. The auxiliary and ancillary equipment designed, specified and/or installed by Hill, Murray & Associates Inc. is warranted for a period of twelve months from the date of commissioning. This includes equipment from the sewage collection point upstream of the Plant, the transfer system to the Plant, and the effluent discharge from the Plant up to and including the effluent sump and pump. This warranty is *supplemental* to the Process Equipment Warranty and the effluent quality guarantee. If the associated ancillary and auxiliary equipment designed, specified and/or installed by Hill, Murray and Associates Inc. do not function properly, Hill, Murray and Associates Inc. will repair or replace it, at its option, including labour to remove and install, shipping, duties or tariffs. If the equipment is damaged by misuse, abuse, alteration or modification or circumstances beyond the control of Hill, Murray and Associates Inc., or if sustained flows are in excess of the design flow or the equipment is not operated according to the operating specifications, Hill, Murray and Associates Inc. assumes no responsibility for repair, replacement or performance. Repair or replacement is Hill, Murray and Associates Inc. only obligation under the warranty. Hill, Murray and Associates Inc. will not be responsible for any consequential, or incidental damages resulting from the sale, use, or improper functioning of this equipment.

Offered by:

_____ Date: _____

_____

Hill, Murray & Associates Inc.

Accepted by:

_____ Date: _____

_____

Cycle-Let®
WASTEWATER SYSTEM
LIMITED WARRANTY

The Cycle-Let® Wastewater System is warranted to function and meet effluent parameters specified provided that a service contract with an authorized service agent is in place. If the Cycle-Let® equipment does not function properly, Zenon Municipal Systems Inc. will repair or replace it at its option. If the equipment is damaged by misuse, abuse, alteration or modification, or if sustained flows are in excess of the design flow or circumstances beyond the control Zenon Municipal Systems Inc., or the system is not operated according to the operating specifications, Zenon Municipal Systems Inc. assumes no responsibility for repair, replacement or performance. Repair or replacement is Zenon Municipal Systems Inc. only obligation under the warranty. Zenon Municipal Systems Inc. will not be responsible for any consequential, or incidental damages resulting from the sale, use, or improper functioning of this equipment.

Influent: BOD_5 = 250 mg/L
TSS = 250 mg/L

Effluent: BOD_5 < 5 mg/L
TSS < 5 mg/L
Total Coliform < 2.2 MPN/100 mL

Approved by:

Accepted by:

Zenon Municipal Systems Inc.

Zenon Municipal Systems Inc.
P.O. Box 1285, Ann Arbor, MI 48106 Telephone: (313) 769-9574 (800) 443-3006 Fax: (313) 761-7842

ROYAL BANK

Royal Bank of Canada
Greater Victoria Business Banking Centre
2nd Floor, 707 Fort Street
Victoria, B.C., V8W 3G3

Transit #08030
Phone: (250) 356-4517 Fax: (250) 356-4583
E-Mail: john.mccannel@royalbank.com

March 19, 1998

Municipality of Iqaluit
P.O. Box 460
Iqaluit, N.W.T.
X0A 0H0

Dear Sirs:

We are pleased to advise that based on our experience to date, we consider the firm of Hill, Murray and Associates Inc. responsible for a project of the size you are presently considering.

At present, Hill, Murray & Associates Inc. have lines of credit established, and all dealings with our office have been conducted in a satisfactory manner.

We trust this is the information you require however, should you require anything further, please don't hesitate to contact the writer.

Yours truly,

J.A. (John) McCannel
Senior Account Manager
Business Banking

HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

SOOKE OFFICE BUILDING

PROJECT:
British Columbia Buildings Corporation
Ministry of Social Services
Sooke, BC

APPLICATION:
Fully recycling, wastewater treatment plant

CAPACITY:
1000 imperial gallons per day (IGPD)

INSTALLED:
December 1995 - April 1996

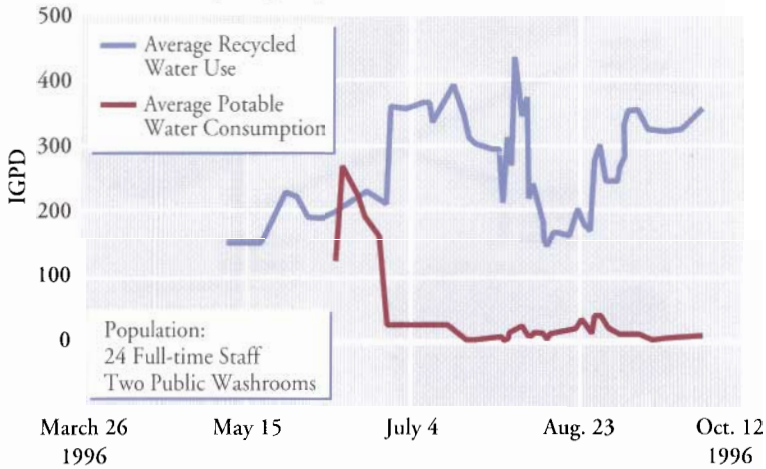
COMMISSIONED:
April 1996

PROBLEM:
There are no sewers in the area so the building required a disposal field for the sewage generated by office workers and the public. The 10,000 ft^2 building needed a standard septic field of 400 feet of disposal pipe. A large parking lot and small overall lot size meant that there was insufficient space to install a standard field.

SOLUTION:
The developer and Hill, Murray & Associates provided a fully recycling, tertiary-quality, wastewater treatment facility. The discharge to the field was reduced to an average of 18 gallons per day and the disposal field consisted of only 17 feet of pipe. The treatment system is housed in a 400 ft^2 maintenance room in the basement of the building.

SOOKE SOCIAL SERVICES BUILDING

Canada's First Fully Recycling Building



Zenon's ZenoGem™ technology has reduced potable water consumption in the building to **only 18 gallons per day** from 400 gallons per day. This results in an annual **saving of 60,000 gallons** of potable water.

Effluent quality is consistently very high. The disposal field is not part of the treatment process, but merely acts as a hydraulic absorber for the treated water.

over ...

TREATMENT:

The wastewater is collected from sinks and toilets in a trash trap and pumped to a bioreactor. The bioreactor aerobically converts ammonia to nitrates and nitrites producing ideal conditions for microbial breakdown of the sewage. Fully aerobic conditions eliminate all odours.

Water in the sewage is drawn off in a process known as ultrafiltration. No bacteria, viruses, helminths or other water-borne pathogens can pass through these molecular filters. The water is prepared for reuse by a carbon filter and ultraviolet sterilization.

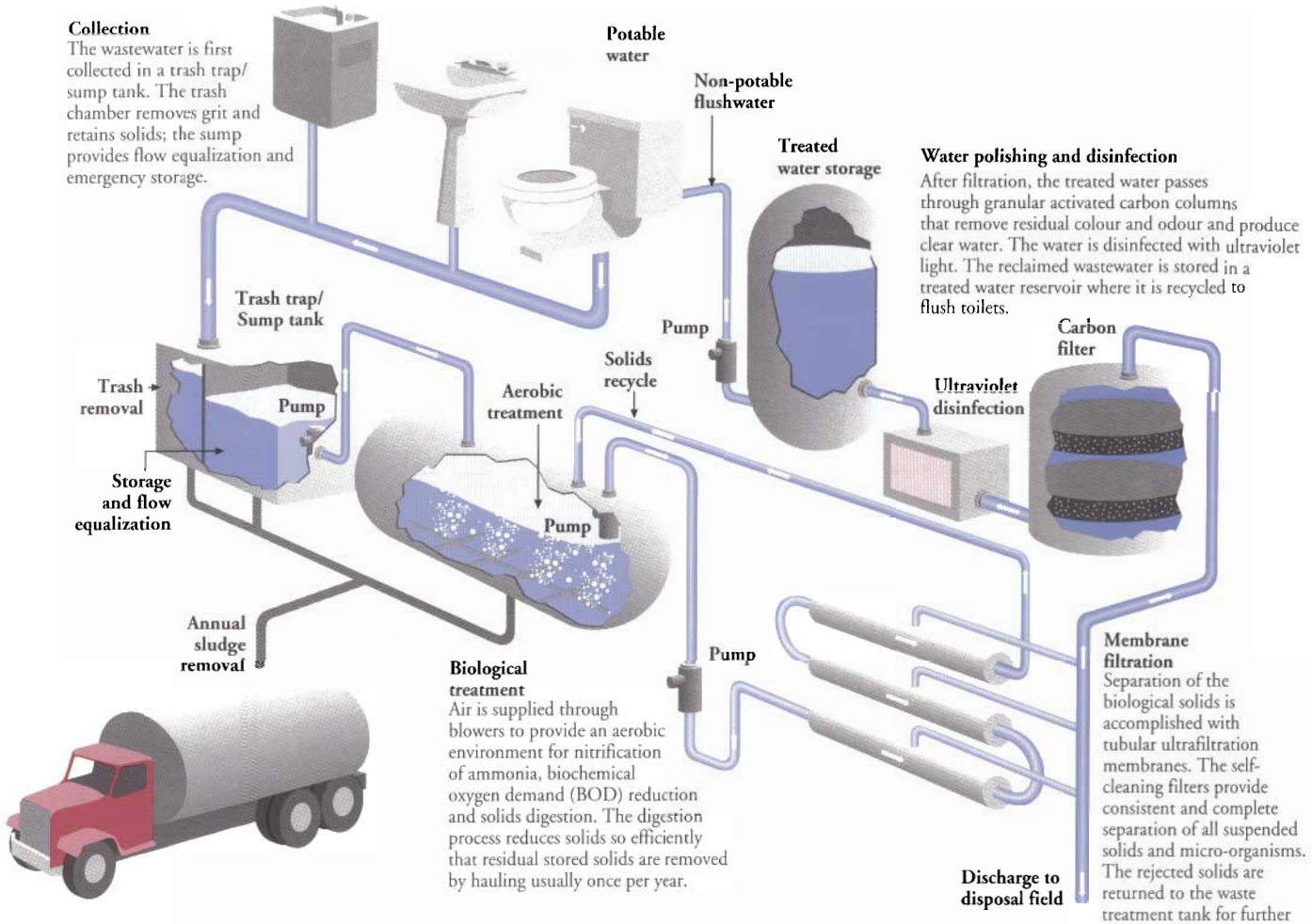
MONITORING:

The plant is actively controlled by a Programmable Logic Controller. The control system can also be accessed through a modem link, allowing technicians to alter systems remotely to ensure peak performance. The plant is monitored 24 hours a day and seven days a week.

TREATED WATER QUALITY

	BOD mg/L	TSS mg/L	FC MPN/100 ml
Influent Levels	600	600	1,000,000
Permitted Levels	5	5	2.2
Day 1	<5	1	<1
Day 2	<5	2	<1
Day 3	<5	1	<1
Week 2	<5	2	<1
Week 3	<5	1	<1
Week 4	<5	1	<1
Month 2	<5	1	<1
Month 3	<5	1	<1
Month 4	<5	1	<1
Month 5	<5	<1	<1
Month 6	<5	<1	<1

SOOKE SOCIAL SERVICES BUILDING WASTEWATER SYSTEM:



BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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Email: hma@islandnet.com

HILL MURRAY & ASSOCIATES INC.

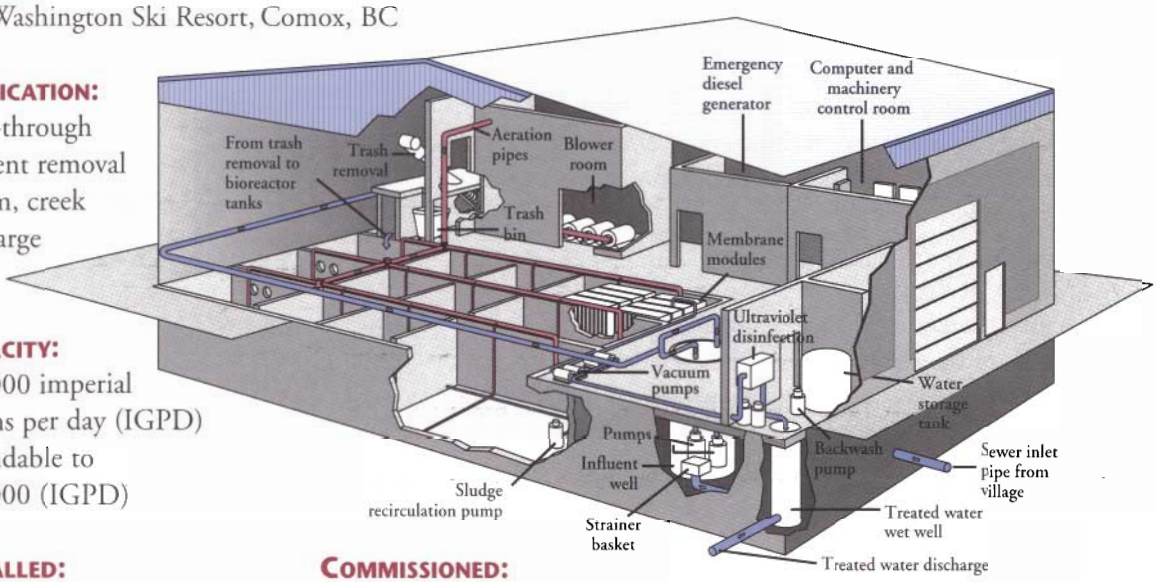
SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

MT. WASHINGTON SKI RESORT

PROJECT:
Mt. Washington Ski Resort, Comox, BC

APPLICATION:
Flow-through nutrient removal system, creek discharge



CAPACITY:
120,000 imperial gallons per day (IGPD) expandable to 500,000 (IGPD)

INSTALLED:
August - November 1996

COMMISSIONED:
November 1996

PROBLEM:
The existing sewage treatment plant for Mt. Washington's 445 chalets and condominiums and other facilities, was operating at capacity. The mountain's effluent discharge was directed into nearby Piggott Creek. The provincial Ministry of Environment required very low nutrient levels in the effluent to ensure that fish populations in the creek were not adversely affected.

The ski resort was planning a major expansion and required a sewage treatment facility that could handle larger volumes while still meeting environmental regulations.

SOLUTION:
Hill, Murray & Associates designed a new wastewater treatment facility housed in a small building a short distance away from the resort area. The building incorporates biological treatment and membrane filtration using Zenon's ZenoGem™ technology, as well as the mechanical and support systems required to operate and maintain a large facility.

The system treats wastewater to near drinking water quality. Nutrient levels are markedly reduced ensuring the treated wastewater easily meets strict Ministry of Environment regulations for fish-bearing streams.

TREATMENT:
Treatment is accomplished using hollow-fibre membranes deployed in a bioreactor that reduces nutrients, in particular phosphorus, to very low levels (less than 0.1 mg/L). The sewage treatment building contains a diesel generator for back-up power and an automatic trash removal and bagging system.

EFFLUENT QUALITY

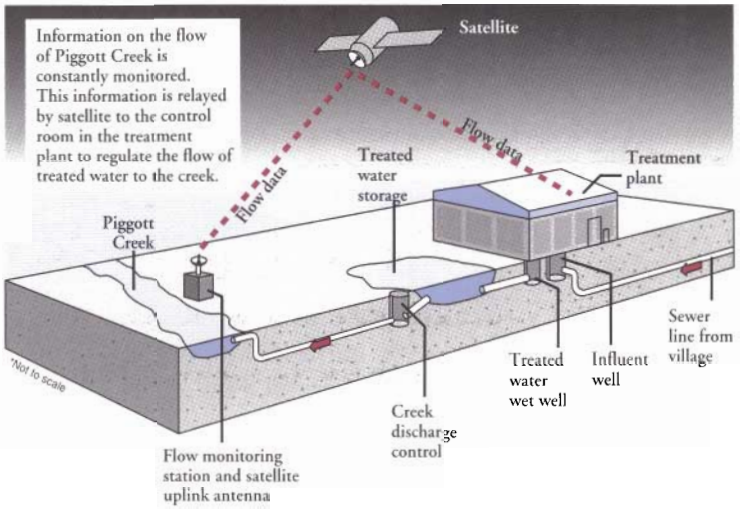
Parameter	New Permitted Limit	New Advanced Treatment Plant Level
BOD_5 (mg/L)	<10	<10
TSS (mg/L)	<10	<10
Phosphorus (mg/L)	<0.5	0.1
Toxicity	Non Toxic	Non-Toxic (BioAssay)
FC (MPN/100 mL)	<10	<10
Temp °C	Temperature Diffuser Required	Ambient
Turbidity	Not Specified	<0.2 NTU
pH	Not Specified	6.2 - 7.2

over ...

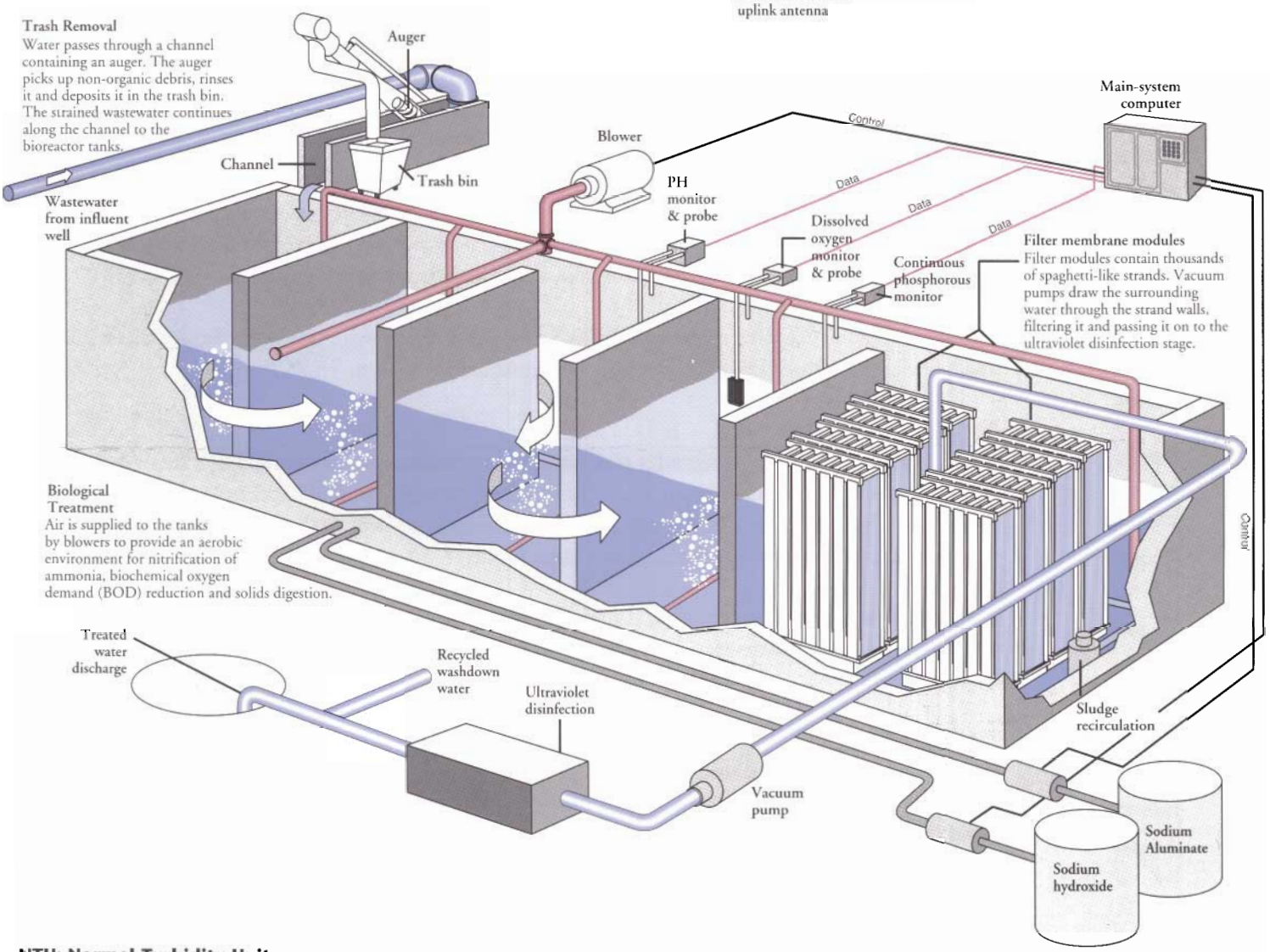
MONITORING:

The plant is actively controlled by a Programmable Logic Controller that activates systems as required by the plant's sensors. An autodialer notifies Hill, Murray if the plant is not operating at peak performance. The control system can also be accessed through a modem link, allowing the company's technicians to alter systems remotely. The plant is monitored 24 hours a day, seven days a week.

The flow of Piggott Creek is constantly monitored and the information is relayed by satellite to the instrument controls of the treatment plant in order to regulate the flow of treated wastewater to the creek.



MT. WASHINGTON SKI RESORT SYSTEM:



NTU: Normal Turbidity Units

BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

BURGOYNE BAY SEPTAGE FACILITY

PROJECT:
Capital Regional District
Burgoyne Bay Septage Facility
Saltspring Island, BC

APPLICATION:
Septage de-watering facility

CAPACITY:
400 gal/hour

INSTALLED:
September 1996

COMMISSIONED:
September 1996

PROBLEM:
The Burgoyne Bay Septage Facility had used a lagoon system to remove water from the septage. The plan was to allow the liquid to percolate through the lagoon bottom and compost the dried septage.

However, a high water table meant the lagoons failed to percolate and the septage was too wet to compost. The lagoons were closed and septage was hauled to another facility at considerable cost to the residents of Saltspring Island.

SOLUTION:
Hill, Murray & Associates established a de-watering facility. This highly efficient system produces septage cakes of greater than 40 per cent dryness, ready for composting.

While the cakes would ideally be composted on-site, their lower weight means low trucking costs if hauling is required.

At the heart of the innovative facility is a 12"-diameter rotary press, manufactured by Les Industries Fournier of Quebec. The Fournier press has been used in a number of de-watering applications in Quebec and has a history of excellent performance on septage and sewage sludges.

The sealed unit operates at a very low speed and is nearly odourless. Operating costs are low because the process runs automatically. The press takes up very little floor space, and is inexpensive to maintain.

over ...

TREATMENT:

The septage is pumped from area septic tanks and hauled to Burgoyne Bay where it is screened to remove non-biodegradable materials such as plastic. The septage is put in a 10,000 gallon storage tank and is continuously mixed.

EFFLUENT QUALITY

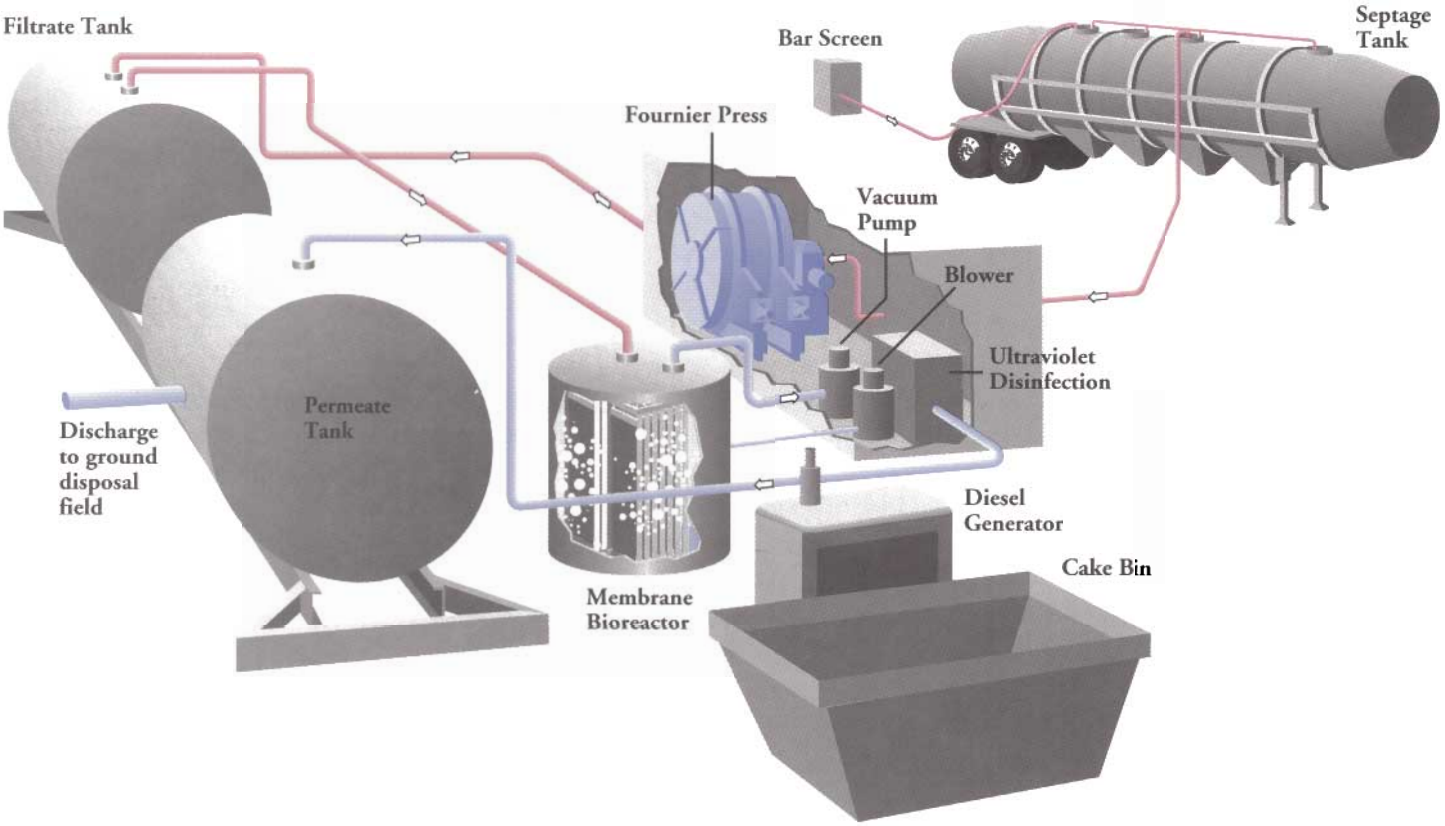
	Septage	Cake	Filtration	Treated Water
BOD_5 (mg/L)	10,000	–	<1,000	<10
TSS (mg/L)	20,000	–	<1,000	<10
FC (MPN/100 mL)	10,000,000	–	10,000,000	<1
Dryness	1 - 2.5%	>40%	–	–

The septage is fed into the Fournier rotary press where drag forces from a rotating channel push the liquid through filter elements and compress the solids. The 12"-diameter press can process 300 gallons an hour (larger models are available). As the sludge cake is formed, it is further compressed. A large percentage of the water is squeezed out of the sludge, resulting in a very dry cake.

The liquid is pumped into another storage tank where Zenon's ZenoGem™ membrane bioreactor treats the filtrate removing suspended solids and organics. The treated water can be reused or disposed of in a conventional field. The cakes are stored temporarily and can be composted or disposed of at a landfill site.

MONITORING:

The press only functions when an operator is present. More permanent septage facilities would use a variety of automatic features, including remote monitoring to ensure peak performance.



BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

GANGES POLLUTION CONTROL CENTRE UPGRADE

PROJECT:
Capital Regional District
Ganges Pollution Control Centre
Saltspring Island, BC

APPLICATION:
Sewage treatment plant upgrade

CAPACITY:
90,000 imperial gallons per day
expandable to 300,000 (IGPD)

INSTALLED:
November 1996 - January 1997

COMMISSIONED:
December 1996

PROBLEM:
The Capital Regional District (CRD) operates a sewage treatment plant to serve the growing community of Ganges on Saltspring Island. CRD needed to upgrade the facility which was reaching its maximum capacity. The plant had to be designed to handle future increases in sewage volume and minimize the impact on the marine environment where the outfall is located.

Simple expansion was difficult, as the small site is very close to the town's stores, businesses and restaurants, and little additional land is available.

SOLUTION:
Hill, Murray & Associates' unique solution was to convert the plant to a membrane-bioreactor system which uses the existing tanks and buildings. This technology increased the facility's capacity and improved the effectiveness of the treatment.

This approach offered considerable cost savings, as many of the components for upgrading the facility were already in place and no costly sewer extensions were required. Reduced maintenance and sludge disposal requirements mean lower operating costs.

The capacity of the plant can be further expanded in phases over time, to match actual demand as the community grows — just-in-time infrastructure. Additional membranes are added to the tanks as they are needed. Taxpayers pay for what they need right now; they don't finance facilities which they may or may not need sometime in the future.

The upgraded Ganges facility easily exceeds Ministry of Environment requirements for a marine outfall. Moreover, the quality of the treated water remains constant despite daily and seasonal fluctuations in sewage volume.

over ...

TREATMENT:

Two existing tanks on the site were retrofitted with a ZenoGem™ membrane-bioreactor system. This technology, developed by Zenon Environmental, a leading Canadian environmental technology firm, has a proven 20-year track record at installations across North America.

Unlike conventional sewage treatment, where solids settle by gravity and then liquids flow off the surface, the Zenon process uses membranes to retain solids and the liquid is pulled through the membranes with vacuum pumps. The Zenon process treats significantly more sewage in the same size of tank.

EFFLUENT QUALITY

Parameter	New Permitted Limit	New Advanced Treatment Plant Level
BOD_5 (mg/L)	<25	<10
TSS (mg/L)	<25	<10
Toxicity	Non Toxic	Non-Toxic (BioAssay)
FC (MPN/100 mL)	<1000	<100 (no disinfection)
Turbidity	Not Specified	<0.2 NTU

Before the upgrade, the plant at Ganges could treat about 90,000 imperial gallons of sewage per day. Incremental upgrades — adding more membranes to the tanks — will allow the plant to treat at least 300,000 IGPD, giving the community more than 25 years of sewage treatment.

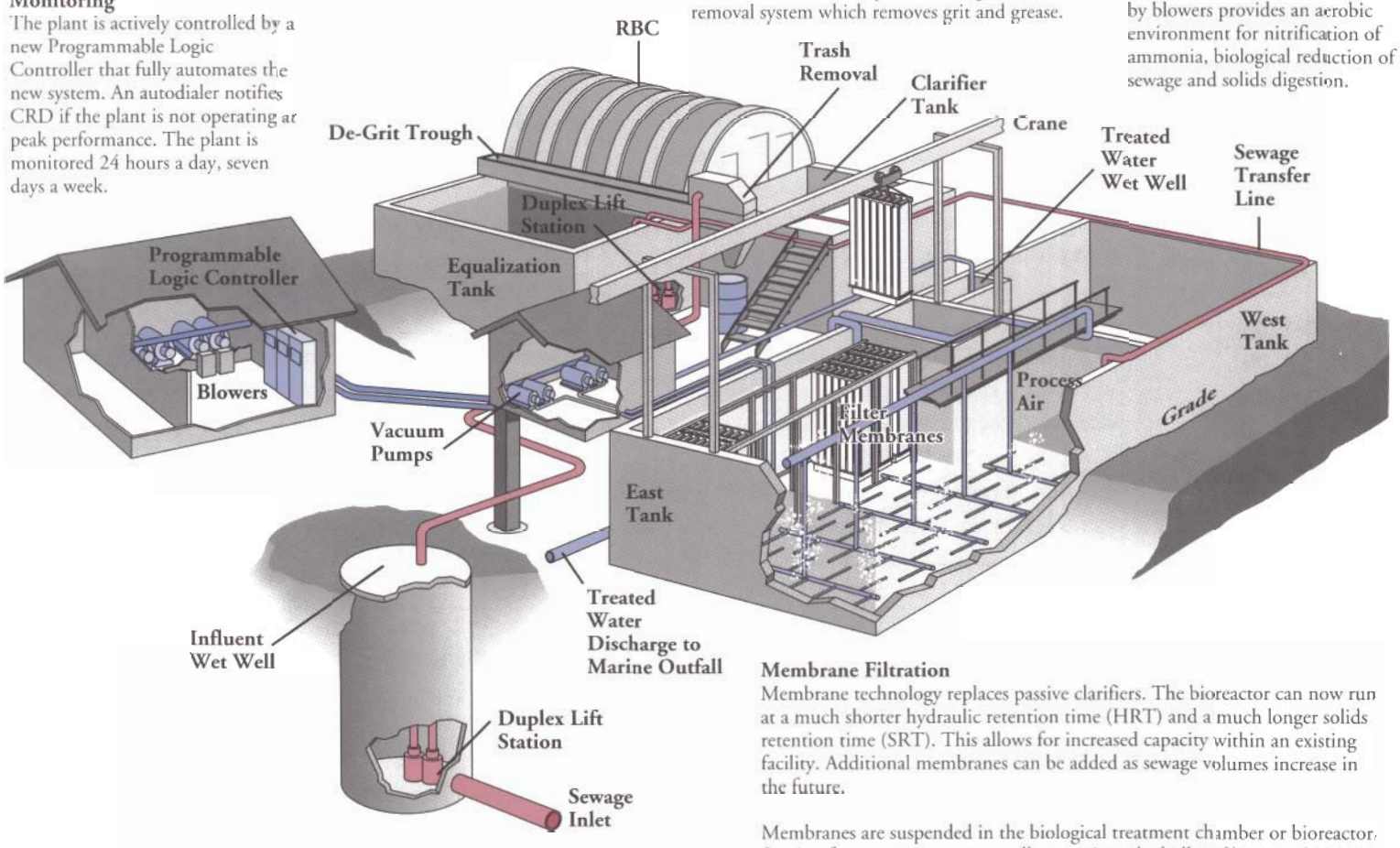
MONITORING:

The plant is actively controlled by a Programmable Logic Controller. The plant is monitored 24 hours a day, seven days a week to ensure peak performance.

Monitoring
The plant is actively controlled by a new Programmable Logic Controller that fully automates the new system. An autodialer notifies CRD if the plant is not operating at peak performance. The plant is monitored 24 hours a day, seven days a week.

Pre-Treatment
The wastewater is first passed through a trash removal system which removes grit and grease.

Biological Treatment
The existing treatment tank is used with the addition of an enhanced air supply. Air supplied by blowers provides an aerobic environment for nitrification of ammonia, biological reduction of sewage and solids digestion.



Membrane Filtration
Membrane technology replaces passive clarifiers. The bioreactor can now run at a much shorter hydraulic retention time (HRT) and a much longer solids retention time (SRT). This allows for increased capacity within an existing facility. Additional membranes can be added as sewage volumes increase in the future.

Membranes are suspended in the biological treatment chamber or bioreactor. Suction from vacuum pumps pulls water into the hollow fibre membranes which act as a barrier to solids and pathogens. The treated water proceeds to the wet well and then to the marine outfall.

BOD: Biochemical Oxygen Demand - mg/L
TSS: Total Suspended Solids - mg/L
FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

THETIS LAKE TRAILER PARK

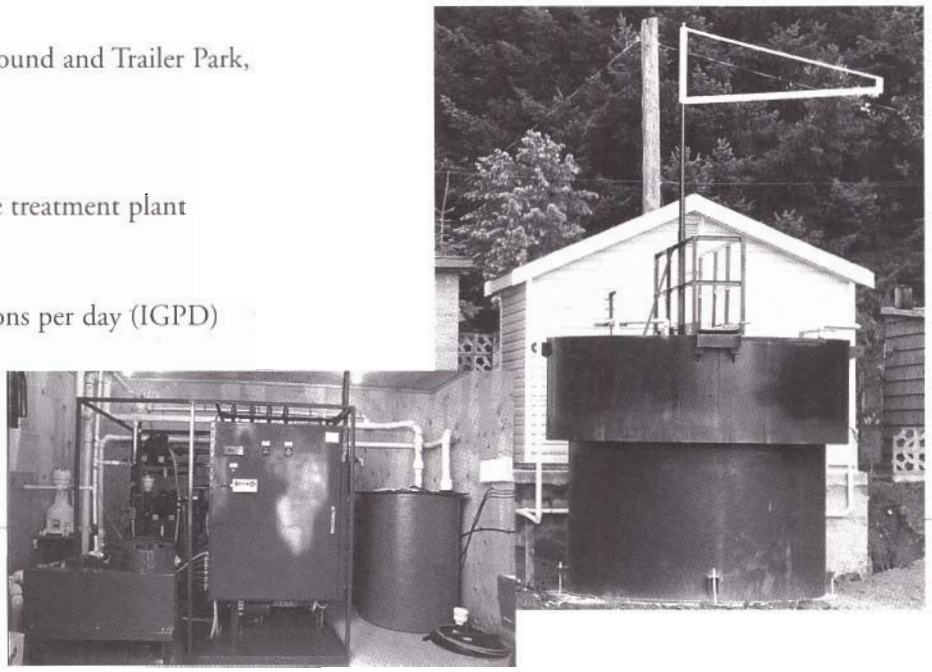
PROJECT:
Thetis Lake Campground and Trailer Park,
Victoria, BC

APPLICATION:
Flow-through sewage treatment plant

CAPACITY:
10,000 imperial gallons per day (IGPD)

INSTALLED:
July - August 1995

COMMISSIONED:
August 1995



PROBLEM:
The park contains 21 permanent mobile homes, 40 full-service trailer and RV hook-ups, and camping sites with shared washroom facilities. The septic system failed and health authorities prohibited further discharge to the disposal field. Owners of the park were forced to pump and haul 6,000 gallons of sewage a day.

SOLUTION:
Hill, Murray & Associates designed and installed a sewage transfer system, treatment tank and effluent disposal field. Most of the equipment is housed in a small building near the park office. The treatment tank is located beside the building and the disposal field is in an adjacent forested area.

The sewage treatment plant has been operating since August 1995. The quality of the treated wastewater is excellent and always meets or exceeds permit levels set by health authorities.

TREATMENT:
Sewage is collected in a sump and transferred to the waste-treatment tank with macerating pumps. The sewage is aerated in a two-chambered tank which ensures sufficient capacity during peak season.

The treated water is filtered through hollow fibre membranes, Zenon's ZenoGem™ technology. An adequate supply of air and an activated sludge process lead to biological reduction of the solids. The water is disinfected using ultraviolet light.

TREATED WATER QUALITY

	BOD mg/L	TSS mg/L	FC MPN/100 ml
August 1995	<5	1	<5
November 1995	<5	2	<5
February 1996	<5	1	<5
May 1996	<5	1	<5
August 1996	<5	2	<5
November 1996	<5	1	<5

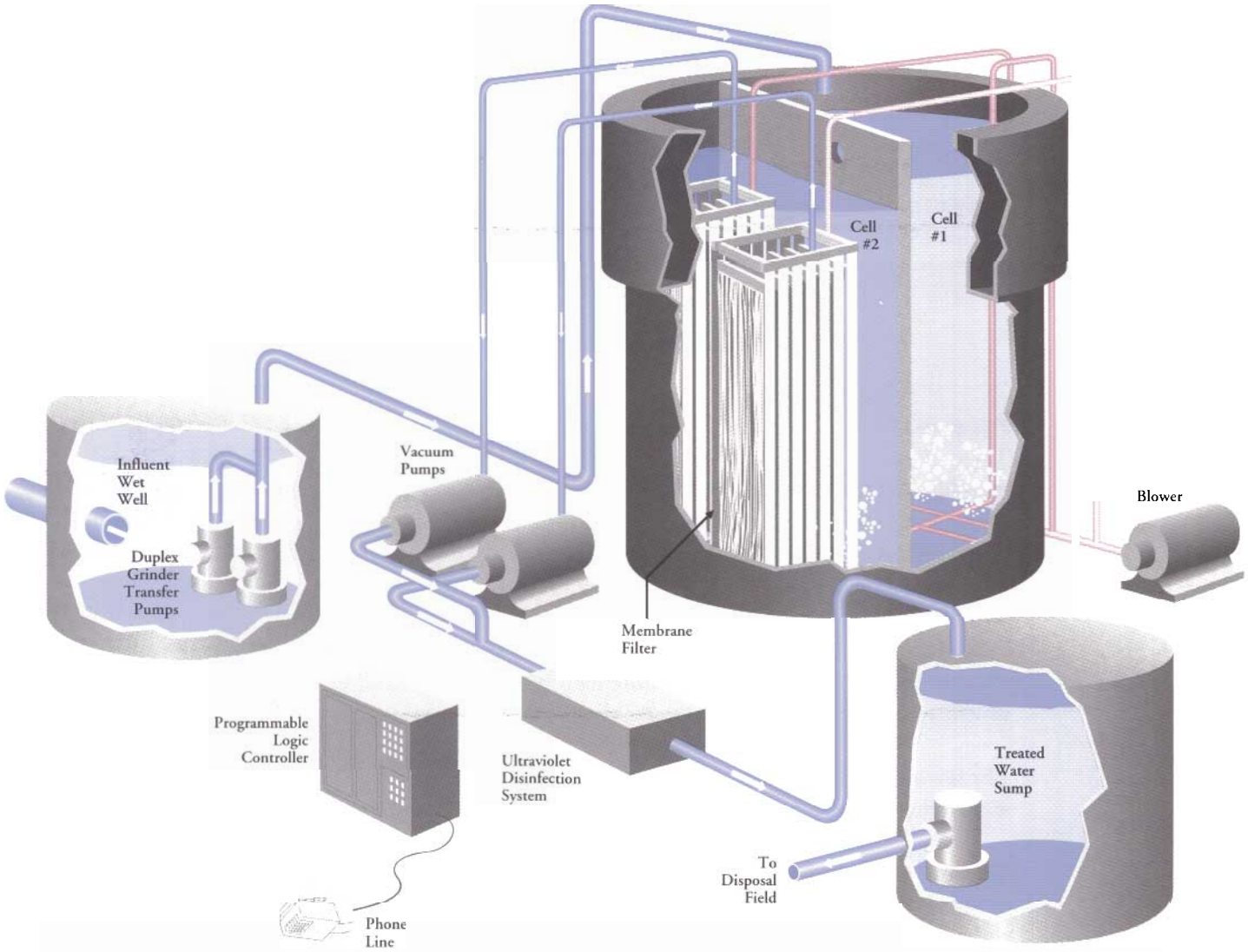
Treated water produced by the plant is pumped into a disposal system that uses a unique "surface infiltrator" developed by Hill, Murray. The surface infiltrator allows discharge in areas where conventional field construction would be prohibitively expensive or difficult.

over ...

MONITORING:

The plant is actively controlled by a Programmable Logic Controller that activates systems as required by the plant's sensors. An autodialer notifies Hill, Murray if the plant is not operating at peak performance. The control system can also be accessed through a modem link, allowing the company's technicians to alter systems remotely. The plant is monitored 24 hours a day, seven days a week.

THETIS LAKE TRAILOR PARK SEWAGE TREATMENT PLANT:



BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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Email: hma@islandnet.com

HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

SMALL RESORTS

PROJECT:
Sooke Harbour House,
Sooke, BC

Kingfisher Oceanside Inn
Courtenay, BC

APPLICATION:
Fully recycling, wastewater treatment plant

CAPACITY:
6,000 imperial gallons per day (IGPD)/
10,000 IGPD

INSTALLED:
Sooke Harbour House: July-September 1997
Kingfisher Oceanside Inn: April-June 1997

COMMISSIONED:
Sooke Harbour House: September 1997
Kingfisher Oceanside Inn: June 1997

PROBLEM:
The owners of Sooke Harbour House, a world-renowned inn on the west coast of Vancouver Island, were told by the Ministry of Health that there was a problem with their septic system. The owners planned to expand the inn and they needed a wastewater system that would protect the fragile marine environment, which was such an integral part of the inn's popularity. The beautiful buildings and grounds at the inn are also part of its attraction, so it was important that a wastewater facility not be an eyesore.

Similarly, Kingfisher Oceanside Inn, a seaside resort on the east coast of Vancouver Island, was expanding and the owners were worried that an already failing septic system combined with a high water table might pollute the adjacent shoreline. Land was at a premium, so a wastewater facility would have to make efficient use of space. The owners were also concerned that the facility blend in with its surroundings.

SOLUTION:
Hill, Murray & Associates designed and built fully recycling, tertiary-quality wastewater treatment facilities for both Sooke Harbour House and Kingfisher Oceanside Inn. The heart of the treatment process is a Zenon ZenoGem™ membrane-bioreactor housed in an unobtrusive 15 foot by 24 foot building. Most of the wastewater handling equipment is located underground.

The new accomodations at both inns were built with the required additional plumbing so that treated water can be reused in toilets and urinals. Sooke Harbour House also uses the recycled water to irrigate large gardens and lawns.

Recycling water results in a marked reduction in water consumption and a decrease in the volume of wastewater discharged to the disposal fields. Hence, the fields are considerably smaller than conventional sewage treatment systems. Effluent quality is consistently very high at both locations.

The capacity of the water reclamation facilities can be increased in phases over time, to accommodate further expansion of the inns and increased volumes of wastewater.

over ...

Treatment:

In both installations, the wastewater from showers, sinks, and toilets is collected in a trash trap and pumped into the membrane-bioreactor. Blowers supply air for the efficient microbial breakdown of the waste. The Zenon process uses vacuum pumps that pull the liquid through the membranes, leaving solids and water-borne pathogens behind. The water is prepared for reuse by passing it through a carbon filter and ultraviolet sterilizer.

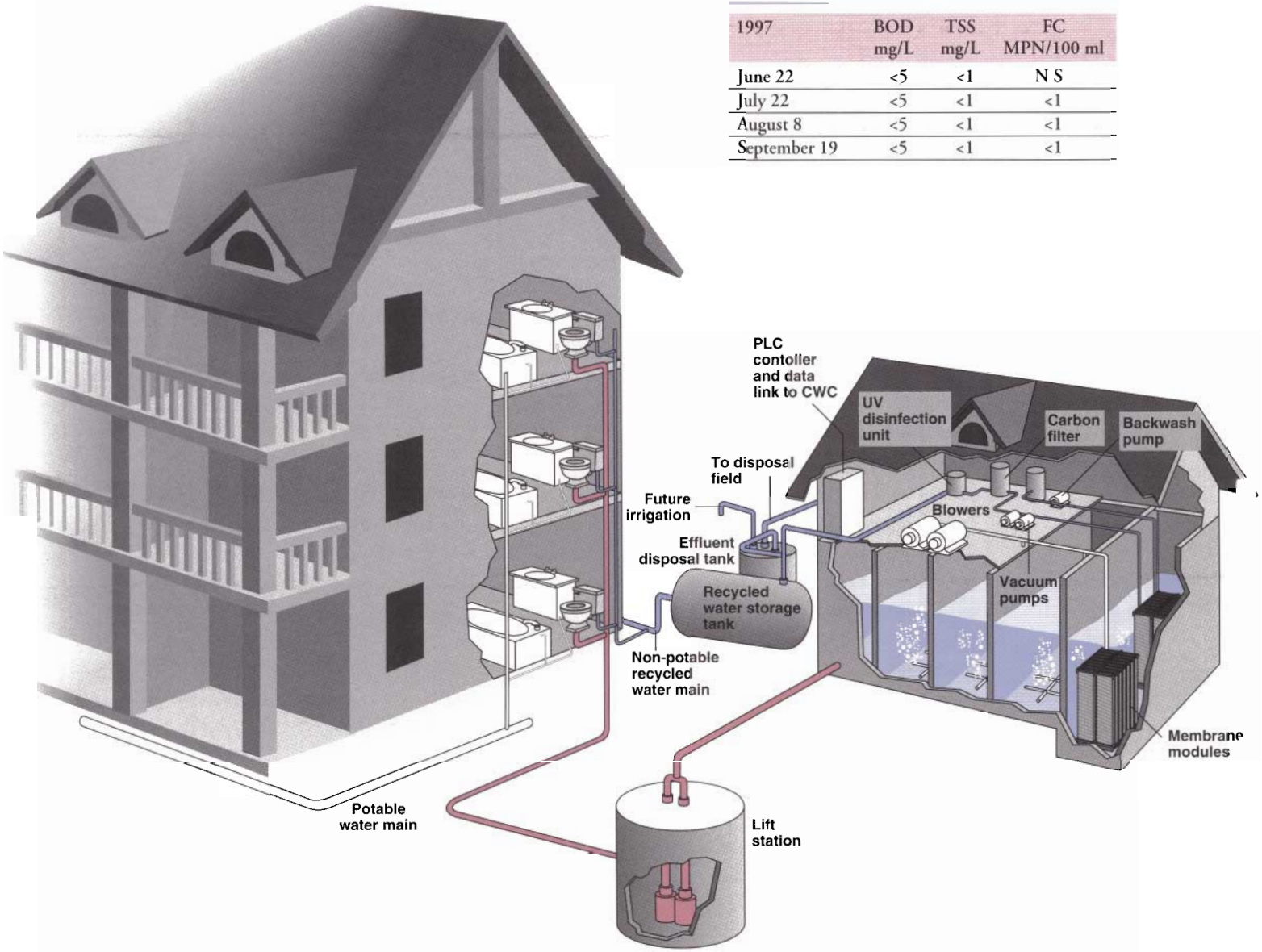
Monitoring:

Both facilities are actively controlled by a Programmable Logic Controller. The plants are operated, maintained and monitored by the Canadian Wastewater Corporation (CWC), a utility company and subsidiary of Hill, Murray & Associates.

Kingfisher Oceanside Inn:

Treated Water Quality

1997	BOD mg/L	TSS mg/L	FC MPN/100 ml
June 22	<5	<1	N S
July 22	<5	<1	<1
August 8	<5	<1	<1
September 19	<5	<1	<1



BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

Suite 202 • 780 Tolmie Avenue • Victoria • British Columbia • Canada • V8X 3W4 • Telephone: 250-388-3930 • Facsimile: 250-388-3943
Email: hma@islandnet.com

HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

SALT SPRING ISLAND VILLAGE RESORT

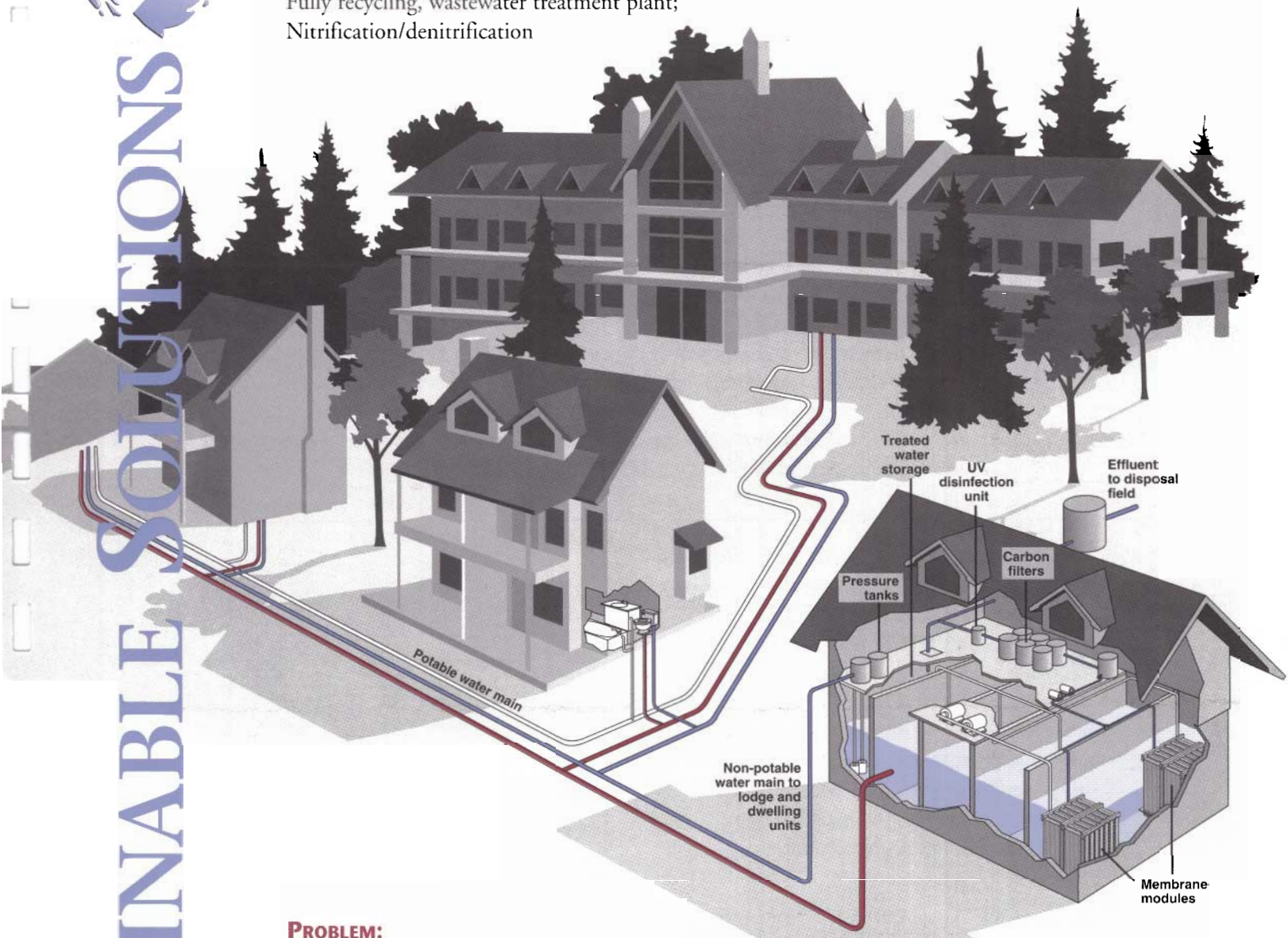
PROJECT:
Salt Spring Island Village Resort
Saltspring Island, BC

CAPACITY:
30,000 imperial gallons per day (IGPD)

INSTALLED:
Summer 1997

COMMISSIONED:
Summer 1997

APPLICATION:
Fully recycling, wastewater treatment plant;
Nitrification/denitrification



PROBLEM:
Salt Spring Island Village Resort is the largest resort of its kind in British Columbia's southern Gulf Islands. The resort features a main lodge and 123 cabins spread over 36 acres. The owners recognized that conserving ground water and minimizing the impact of wastewater on a high water table and nearby Bullock Lake would be a major challenge. Saltspring Island has also been plagued with severe water shortages.

SOLUTION:
A revolutionary new approach to wastewater treatment for residential and resort developments was designed and built by Hill, Murray & Associates. Sewage from each of the units and the lodge is pumped to a central facility where it is treated. The treated water is then pumped via a non-potable

over ...

water main back to the lodge and 60 of the housekeeping units to be reused in the toilets and urinals. Treated water is also used to irrigate the grounds. Surplus treated water that is not recycled, is discharged to a disposal field. In total, 36 per cent of the water is recycled representing 4.2 million gallons of potable water conserved annually.

Hill, Murray & Associates played a key role in revising British Columbia's plumbing code to allow for dual water mains in commercial and residential buildings. The lodge and the 60 housekeeping units are plumbed with a dual water main in accordance with an amendment to the code.

Salt Spring Island Village Resort is the first resort/residential development in Canada with two sets of water mains in the streets. The resort sets a new precedent for water conservation in areas with limited water supplies.

Recycling water results in a marked reduction in water consumption and a decrease in the volume of wastewater discharged to the disposal field. Hence, the field is smaller and requires considerably less drainage pipe than with conventional sewage treatment systems.

Effluent quality is extremely consistent. Actual quality produced by the facility easily exceeds the stringent standards for beneficial reuse set by the Ministry of Environment, Lands and Parks.

The capacity of the water reclamation facility can be increased in phases over time, to accommodate further expansion of the resort and increased volumes of wastewater.

TREATMENT:

Wastewater from showers, sinks, and toilets in the housekeeping units and the main lodge is collected in trash traps and pumped to the treatment facility which uses Zenon's ZenoGem™ membrane-bioreactor technology. Blowers supply air for the efficient microbial breakdown of the waste. Vacuum pumps pull the liquid through membranes, leaving solids and water-borne pathogens behind. The water is prepared for reuse by passing it through a carbon filter and ultraviolet sterilizer.

TREATED WATER QUALITY

Parameter		Influent	Treated Water
BOD (mg/L)		250	<5
TSS (mg/L)		250	<5
FC (MPN/100ml)		10^4- 10^5	<2.2
Nitrogen:	Total	40	<4.5
	Ammonia	25	~0.01
	Nitrates	0	<4
	Nitrites	0	~0.02
	Organic	15	~0.4
TKN (ammonia + organic)		40	~0.4

MONITORING:

The facility is actively controlled by a Programmable Logic Controller. This plant is operated, maintained and monitored by the Canadian Wastewater Corporation, a utility company and subsidiary of Hill, Murray & Associates.

BOD: Biochemical Oxygen Demand - mg/L

TSS: Total Suspended Solids - mg/L

FC: Faecal Coliform measured as MPN - Most Probable Number of Pathogens in 100ml sample

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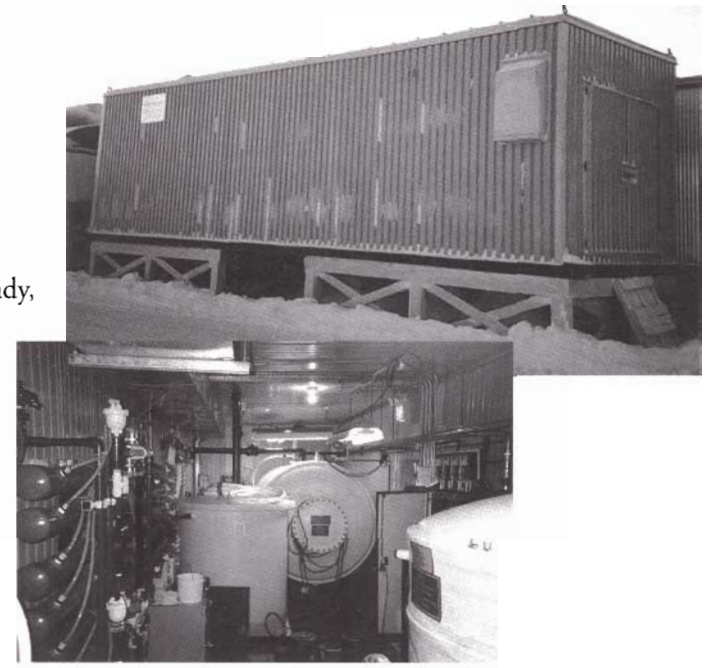
HILL MURRAY & ASSOCIATES INC.

SUSTAINABLE SOLUTIONS

ENVIRONMENTAL SYSTEMS ENGINEERS

HIGH ARCTIC RADAR SITES

PROJECT:
North Warning System
Long Range Radar Sites,
CAM-M and FOX-M
Department of National Defence
Cambridge Bay and Hall Beach, NWT



APPLICATION:
Fully recycling, pre-assembled, Arctic-ready, wastewater treatment systems

CAPACITY:
2,500 imperial gallons per day (IGPD)

INSTALLED:
October - November 1995

COMMISSIONED:
December 1995

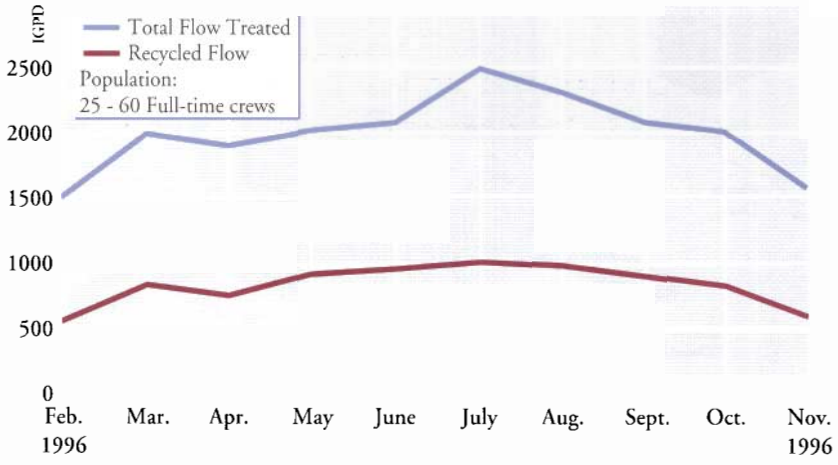
PROBLEM:
Sewage treatment at these high-Arctic sites originally involved dumping raw sewage directly onto the tundra. As part of the Department of National Defence's commitment to the environmentally sound disposal of waste, DND searched for a technology that would minimize the impact of discharges to the fragile Arctic ecosystem. DND was also interested in reducing the operating and maintenance costs of supplying fresh water in the winter.

SOLUTION:
Hill, Murray & Associates provided a fully recycling, wastewater treatment system that was especially designed for the high Arctic. The membrane and bioreactor components, transfer mains for sewage and recycled water, and other auxiliary equipment were designed, assembled and shipped to the site in less than seven weeks. The equipment was housed in Canadian-built containers that were designed for a harsh climate.

Hill, Murray designed all the auxiliary systems including recycled water main, sewage transfer main, and an Arctic-hardened effluent disposal system. As general contractor, the company tendered the installation contract and provided on-site direction for the installation and start-up of the system.

HIGH ARCTIC

First Recycling Plants in the Arctic



Total water consumption at the sites has been reduced to 1500 from 2500 gallons a day, **saving over 300,000 gallons of potable water annually**. The treated water that is now discharged has a minimal effect on the environment. The plants have been in compliance since they were commissioned.

over ...

Treatment:

Wastewater is collected from showers, urinals, toilets, cafeteria and cleaning facilities in collection tanks located throughout the site. A sensor automatically causes the transfer of wastewater to the bioreactor where it undergoes complete aerobic treatment. The wastewater is then filtered through tubular membranes (Zenon's ZenoGem™ technology) resulting in treated water that can be reused in toilets and urinals.

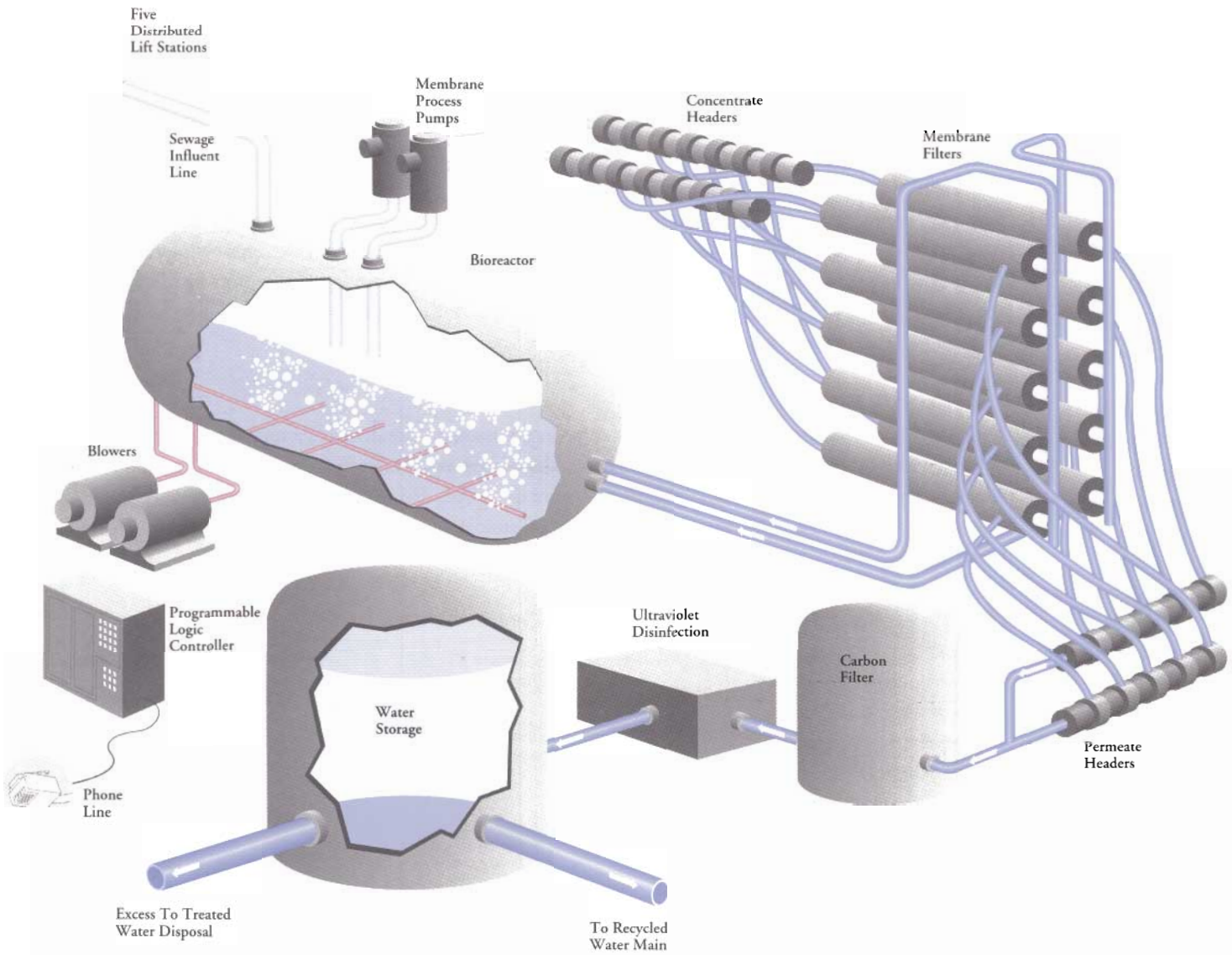
Treated Water Quality

	BOD mg/L	TSS mg/L	FC MPN/100 ml
February 1996	<5	1	<1
March 1996	<5	2	<1
April 1996	<5	1	<1
May 1996	<5	1	<1
June 1996	<5	2	<1
July 1996	<5	1	<1
August 1996	<5	1	<1
September 1996	<5	1	<1
October 1996	<5	2	<1
Novemebr 1996	<5	1	<1

Monitoring:

The plant is actively controlled by a Programmable Logic Controller that activates systems as required by the plant's sensors. An autodialer notifies Hill, Murray if the plant is not operating at peak performance. The control system can also be accessed through a modem link, allowing the company's technicians to alter systems remotely. This feature is vital when the nearest technical support centre is more than 4,000 km away! The plant is monitored 24 hours a day, seven days a week.

High Arctic Radar Site Wastewater System:



BOD: Biochemical Oxygen Demand - mg/L

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HILL MURRAY & ASSOCIATES INC.

WASTEWATER EXCHANGE

"It's reassuring to know that good business is also good for the environment."

- Trevor Hill, President, Hill, Murray & Associates

HILL, MURRAY WINS PRESTIGIOUS AWARD

Visions West/Province of B.C.

Trevor Hill and Rob Murray (centre) accept the Minister's Environmental Award from the Honourable Cathy McGregor (right) and Garde Gardom (left).

Hill, Murray & Associates has received a 1997 Minister's Environmental Award for its contribution to the protection of B.C.'s environment. The award, which is in the business or industry category, was presented to President Trevor Hill and Director of Engineering Rob Murray by the Minister of Environment, Lands and Parks, Cathy McGregor.

More than 200 nominations were considered for the awards. Hill, Murray was one of only 10 organizations and individuals selected by the Minister.

"We're giving special recognition to these British Columbians for their outstanding commitment, the results they've achieved, and the example they've set for others," said Minister McGregor.

The award recipients were honoured at a ceremony at Government House in Victoria with Lieutenant-Governor Garde Gardom and McGregor. Formal congratulations were also extended from the legislative assembly.

FOCUS ON RESORTS: PROTECTING PRISTINE ENVIRONMENTS

Many of BC's finest resorts are located in ecologically sensitive areas and their development or expansion must be carried out very carefully. Hill, Murray & Associates has met the challenges of wastewater reclamation and reuse in a growing number of resort projects, some of which are highlighted in this issue.

The company's approach is unique — water is conserved by reclaiming treated water from sewage and reusing it; modular technology can be added to existing tanks and buildings to process increased volumes of sewage; capital costs can be spread over long periods of time; and effluent quality is excellent, exceeding government regulations and protecting the receiving environment.

ENVIRONMENTAL SYSTEMS ENGINEERS

Wastewater Exchange is published three times a year by Hill, Murray & Associates, a Victoria-based, Canadian-owned company that specializes in advanced wastewater treatment and water reclamation and reuse.

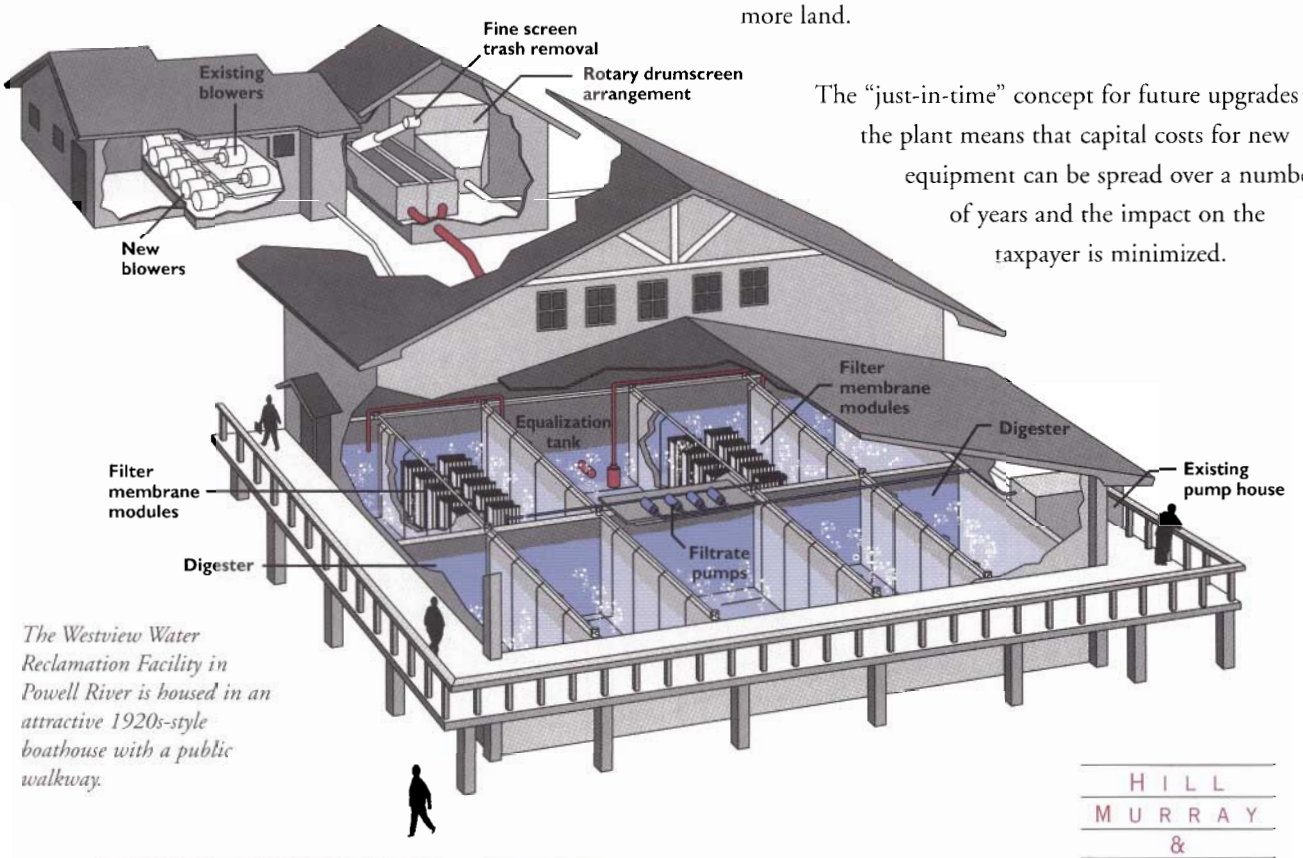
BREATHING NEW LIFE INTO AN OLD PLANT

A conventional sewage treatment plant in the harbour of Powell River was considered an eyesore by many, produced strong odours, and frequently failed to meet Ministry of Environment permit requirements.

Hill, Murray & Associates proposed an affordable solution — a membrane-bioreactor system that is installed in the existing tanks and buildings of the old plant. The Westview Water Reclamation Facility is clean and odourless and produces treated water that exceeds government regulations and protects the fragile marine environment. And it's all housed in an attractive building that fits in with the harbour setting.

Flexibility is a key feature of the design of the new facility. The plant can be expanded with additional membranes to accommodate increased sewage volumes within existing tanks. And there is no need to purchase more land.

The "just-in-time" concept for future upgrades of the plant means that capital costs for new equipment can be spread over a number of years and the impact on the taxpayer is minimized.



The Westview Water Reclamation Facility in Powell River is housed in an attractive 1920s-style boathouse with a public walkway.

Glenn Kerr, Hill, Murray & Associates' new Business Manager.

SERVING OUR CLIENTS BETTER

Hill, Murray & Associates welcomes a new addition to its team — Business Manager Glenn Kerr. Glenn brings six years of public relations and business management experience to the company. He plays a key role in the sales support side of the company, in addition to managing the administrative and customer service apects of the business.

HILL MURRAY & ASSOCIATES INC.

ENVIRONMENTAL SYSTEMS ENGINEERS

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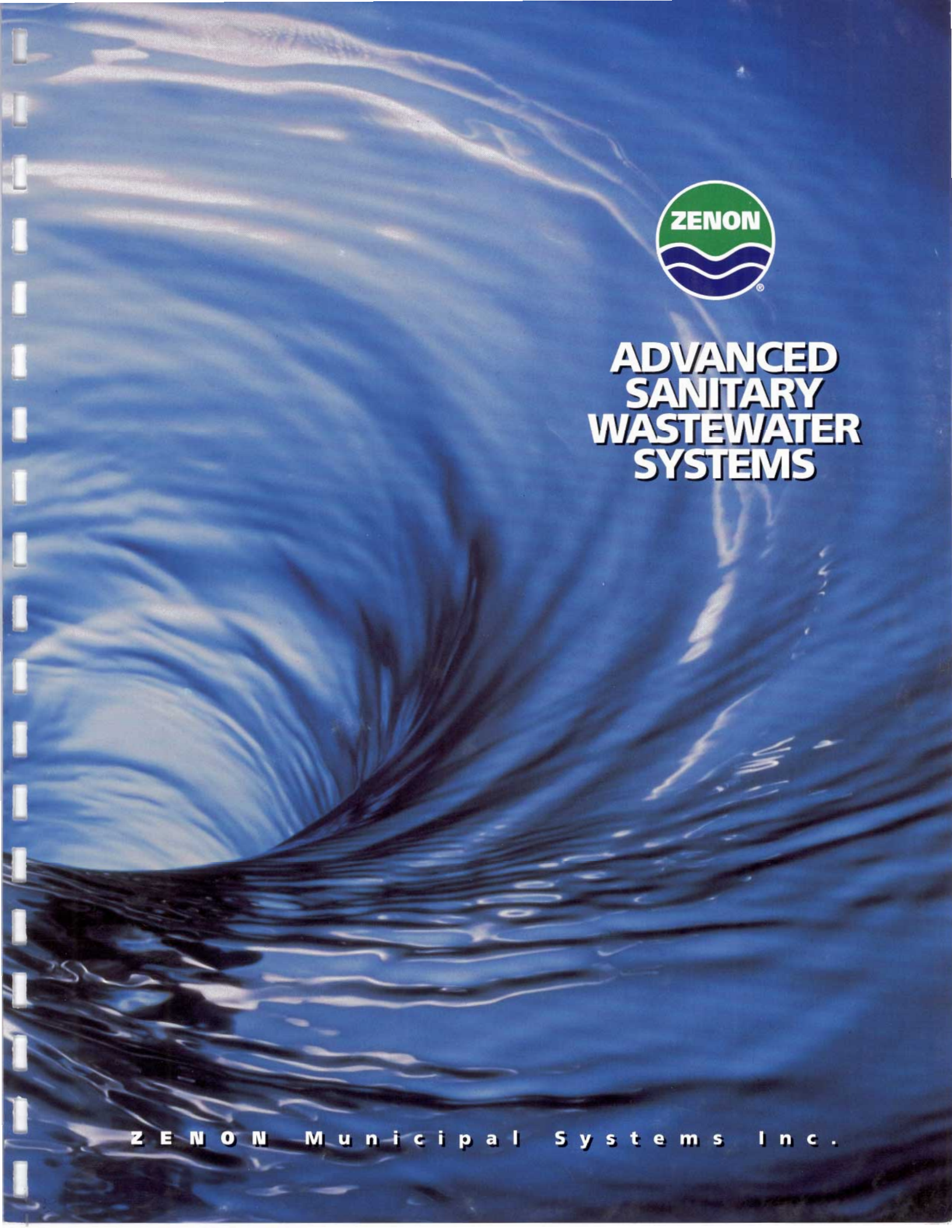


ADVANCED SANITARY WASTEWATER SYSTEMS

ZENON Municipal Systems Inc.

ZENON

ADVANCED SANITARY WASTEWATER SYSTEMS

Zenon Municipal Systems (ZMS) is the leading manufacturer of advanced sanitary wastewater treatment and reclamation systems. Since 1974, engineers, architects, developers, government officials and Fortune 500 Corporations have relied on Zenon systems. We've earned our reputation for reliability and excellent performance.

When we started in 1974, we began with the belief that water was a precious commodity, and that someday, sanitary effluent would be recycled throughout the world. We initially developed our Cycle-Let™ systems to recycle flush water in remote locations. Over time, our patented technologies and their applications have continued to evolve. Today, we handle virtually every type of sanitary wastewater, and we are still providing proven, cost-effective and unique biological solutions to meet our customers increasingly stringent effluent requirements.

As the leader in the manufacture and operation of sanitary wastewater systems for water recycling, ZMS has developed the systems engineering and field operations capability to deal with demanding sanitary wastewater problems.

THE INNOVATIVE ZENOGEM™ TECHNOLOGY IS THE HEART OF OUR SYSTEMS

This technology is based on the unique combination of bio-oxidation and membrane separation.

Bio-oxidation is needed to oxidize the organic matter to the feed. Membranes ensure that the substance and bacteria are retained in the system as long as necessary for essentially complete oxidation to carbon dioxide and water.

Unlike conventional systems, where operational changes can cause bacteria loss, the ZenoGem™ system is stable to feedwater changes and sludge production is less. The membrane separator ensures a consistently high effluent quality.

For unrestricted recycle wastewater use, the ZenoGem™ system can polish the effluent further. This modified ZenoGem™ system - known as the Cycle-Let™ system - is designed to handle even the most challenging water reuse application.

RECYCLED WATER QUALITY	
BOD	<5 mg/l
SUSPENDED SOLIDS	<5 mg/l
NITROGEN REMOVAL	85-90%
TURBIDITY	<2 NTU
TOTAL COLIFORM	≤ 2.2/100 ml

BENEFITS - APPLICATIONS - UPGRADES

THE BENEFITS

ZMS advanced sanitary wastewater treatment systems offer many benefits over conventional technology.

ECONOMICAL:

- Minimal or no use of chemicals
- Low sludge production
- Highly efficient biological process
- Low energy requirements
- Low operator maintenance
- Compact in size, with easy site integration

SANTA MONICA, CALIFORNIA

RELIABLE:

- Resistant to process upsets
- Consistently meets the effluent quality
- Automated operation
- Few process control parameters

Your plant benefits from effluent quality which minimizes your risk of permit violations and possible fines.

THE APPLICATIONS

Our systems are designed for conventional municipal and commercial sanitary wastewater application, including:

- Multi-family developments,
- Planned unit developments,
- Community systems,
- Onsite sanitary wastewater treatment applications.

Engineers commonly choose our system when:

- Water needs to be recycled,
- Tertiary effluent quality is required,
- Space is tight,
- Providing full-time operators is costly,
- Sludge disposal is expensive.

AUSTIN, TEXAS

UPGRADING EXISTING SYSTEMS

We can also upgrade existing municipal, community and commercial sanitary wastewater systems which:

- Are out of compliance with discharge parameter limitations
- Need more advanced treatment (tertiary BOD_5 and TSS, nitrification, denitrification, phosphorus removal)
- Need additional capacity

LA PLATA, MARYLAND

If you would like a cost-effective method to upgrade your existing facilities, Zenon can help you replace some or all of the existing clarifiers with membrane systems, and operate existing biological reactors at much higher MLSS. The ZenoGem™ process will enable the existing reactors to be operated at flows more than three times higher than conventional capacity. The efficiency of the upgraded plant will reduce sludge production rates, reduce operator maintenance, and reduce disinfection costs due to the consistent tertiary quality effluent.

ZENON

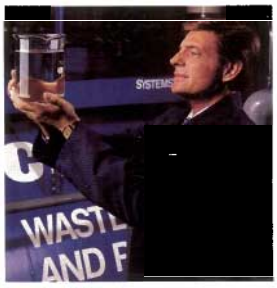
ADVANCED SANITARY WASTEWATER SYSTEMS

INCREMENTAL EXPANSION

All Zenon systems - whether new or upgrades - can be expanded incrementally as appropriate. Our plants can be built for today's capacity with built-in capability for easy incremental expansion as the population increases, and municipalities obtain the added tax incentives to pay for increased sewage treatment.

SERVICE

With ZMS, you can obtain either, or both, of the ZenoGem™ and the Cycle-Let™ systems under a wastewater management service agreement. This service provides frequent plant inspections and monitoring to meet state and local reporting requirements.



In addition, it provides:

- complete routine maintenance,
- emergency service,
- parts replacement,
- annual maintenance, using trained technicians and licensed operators.

ZMS operates many of its systems.

CERTIFICATION / APPROVALS

ROSELAND, NEW JERSEY

ZenoGem™ and/or Cycle-Let™ systems have been approved in many U.S. states, including: California (under Title 22 for unrestricted irrigation); New Jersey (Wastewater Recycling General NJPDES Permit); Texas; New York; Michigan; Massachusetts; Ohio; Pennsylvania, etc. In addition, Cycle-Let™ has been through comprehensive testing by the National Sanitation Foundation and has been certified NSF Standard No. 41.

PRINCETON, NEW JERSEY

ZENON Municipal Systems Inc.

P.O. Box 1285, Ann Arbor, Michigan 48106
Phone: 1-800-443-3006 or 313-769-9574 Fax: 313-761-7842
Amsterdam • Budapest • Chicago • Edmonton • Detroit • Milan
Montreal • New Jersey • Norfolk • Toronto • Vancouver

Printed in USA

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X 1780-20/Bond

Jardine Insurance Service Canada Inc.

Certificate of Insurance

☐ **Vancouver** 16th Floor, 1111 West Georgia Street, Vancouver, B.C. Canada V6E 4G2 Telephone: (604) 682-4211 Facsimile: (604) 682-3520
☒ **Victoria** 202-3045 Douglas Street, Victoria, B.C. Canada V8T 4N2 Telephone: (250) 388-4416 Facsimile: (250) 388-9926
☐ **Calgary** Suite 2810, 144 - 4th Avenue S.W., Calgary, Alberta Canada T2P 3N4 Telephone: (403) 264-8600 Facsimile: (403) 264-8608
☐ **Edmonton** Suite 505, 10104 - 103rd Avenue., Edmonton, Alberta Canada T5J 0H8 Telephone: (403) 421-7188 Facsimile: (403) 421-7717

Certificate No.: 2409

Certificate Holder: The Corporation of the District of Powell River,
6910 Duncan Street.
Powell River, BC V8A 1V4

Description: Westview Water Reclamation Facility Upgrade

Name of Insured: HILL, MURRAY & ASSOCIATES INC.

This is to certify that the policies of insurance listed below have been issued to the insured named above for the policy period indicated, notwithstanding any requirement, term or condition of any contract or other document with respect to which this certificate may be issued or may pertain. The insurance afforded by the policies described herein is subject to all the terms, exclusions and conditions of such policies. Limits shown may have been or may be reduced by paid claims/expenses.

Schedule of Insurance

Type of Insurance	Company and Policy Number	Policy Dates		Limit of Liability/Amount
General Liability Including Non-Owned Auto Liability	Axa Pacific 1253019	Effective Expiry	22-Oct-97 1-Jul-98	Bodily Injury and Property Damage $3,000,000.00 Inclusive $3,000,000.00 Aggregate with respect to Products/Completed Operations
Builders Risk/ Installation Floater	Axa Pacific TBA	Effective Expiry	22-Oct-97 22-May-98	$5,200,000.00 Site $500,000.00 Other Location $25,000.00 Transit
Property In Transit	Hartford IC128473	Effective Expiry	20-Sep-97 20-Sep-98	500,000.00 Limit of Liability any one vehicle or occurrence.
Other Boiler & Mahinery	Axa Pacific TBA	Effective Expiry	22-Oct-97 22-May-98	3,000,000.00 Limit of Liability 1,000.00 Deductible

Jardine Insurance Services Canada Inc.

Per _____ Signed P.N. Pringle, AIIC

Dated October 23, 1997

MP4-92 Insurance & Surety Bonds/Business Life Insurance

Continued

Certificate of Insurance 2409

Particulars of Insurance

General Liability

☒	Premises Property and Operations	☐	Exclusions pertaining to Blasting, Collapse, Underpinning, deleted as follows:
☒	Products and Completed Operations	☒	Owner as Additional Insured see below
☒	Blanket Contractual (all written agreements)	☒	Provides Coverage for Claims arising from Use of Machinery and Equipment attached to licensed construction machinery on Project Site
☒	Owners and Contractors Protective	☒	30 Days Notice of Cancellation or Material Change
☒	Occurrence Bodily Injury and Property Damage	☐	Wrap up Liability Insurance
☒	Broad Form Property Damage	☐	Completed Operations Insurance Provided for _____ months after completion of Project
☒	Contingent Employers Liability	☒	Professional Liability Exclusion
☒	Personal Injury	☒	Deductible—$2,500.00
☒	Employees as Additional Insured	x	Subrogation waived against anyone insured hereunder.
☒	Cross Liability		
☒	Pollution Exclusion		
☐	Tenants Fire Legal Liability		

Builders Risk/Installation Floater

☒	"All Risk" Form	☒	Deductibles—10% Earthquake, $10,000. Flood, $2,500. All other losses
☒	Flood Included	☒	Named Insured: Hill, Murray & Associates Inc. & Distirct of Powell River
☒	Earthquake Included	☒	Additional Named Insured: Subcontractors and all others having an insurable interest in the work.
☒	Excludes Faulty Workmanship, Faulty Construction or Faulty Design but not loss resulting therefrom.	☐	
☒	Covers Transit by Land	☐	
☐	Covers Boiler Explosion during Installation, Temporary Operation and Testing		
☒	Covers Owner as Additional Named Insured see below		
☒	Grants Permission for Occupancy prior to completion		
☒	Waiver of Subrogation Against Named Insureds		
☒	30 Days Notice of Cancellation or Material Change		

Property

x	"All Risk" Form	☒	Additional Named Insureds: District of Powell River and Subcontractors and all others having an insurance interest in the work.
☐	Fire and Extended Coverages Form	☐	
☒	Flood Included	☐	
☒	Earthquake Included	☐	
☒	Replacement Cost	☐	
☐	Coinsurance—_____		
☒	Deductible—$1,000.00		

☒ Indicates that the coverage is included where a Policy is listed on the front of this certificate.

Effective: October 22, 1997

General Liability: Named Insureds: Hill, Murray & Associates Inc. and District of Powell River
Unnamed Insureds: Subcontractors, Owner's Representative and the Contractor's Consultants.

Boiler and Machinery Insurance: Named Insureds: Hill, Murrary & Associates Inc. and District of Powell River
Additional Named Insureds: Subcontractors and all others having an insurable interest in the work.

Terms and Conditions

This certificate is issued for convenience only. All of the terms and conditions of the Policies referred to are contained in the original document which are not modified or amended by this Certificate. With respect to Liability Insurance Coverages, where an Aggregate limit applies, the Certificate Holder is advised that the limit shown may apply to products/completed operations or projects other than shown in this certificate and the limit may be reduced by Claims/Expenses Paid.

Bonds arranged by **Jardine Rolfe Limited**
For Enquiries about this Bond see Reverse Sr

1988-201 Bond
X Powell River

OF NORTH AMERICA

RECEIVED
NOV 20 1997

ORIGINAL

810 400 BURRARD STREET, BOX 57, VANCOUVER, B.C. V6C 3A6
TELEPHONE (604) 687 7688 FAX (604) 687 8886

No. VS6006020

PERFORMANCE BOND

Hill, Murray & Associates Inc.

KNOW ALL MEN BY THESE PRESENTS THAT **HILL MURRAY AND ASSOCIATES INC.** as Principal, hereinafter called the Principal, and **THE GUARANTEE COMPANY OF NORTH AMERICA** a corporation created and existing under the laws of Canada and duly authorized to transact the business of Suretyship in Canada as Surety, hereinafter called the Surety, are held and firmly bound unto **DISTRICT OF POWELL RIVER** as Obligee, hereinafter called the Obligee, in the amount of **ONE MILLION ONE HUNDRED EIGHTY-FIVE THOUSAND & 00/100** Dollars (**$1,185,000.00**) lawful money of Canada, for the payment of which sum, well and truly to be made, the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a written contract with the Obligee, dated the **12th** day of **September, 1997** for

WESTVIEW WASTEWATER PLANT UPGRADE,.

in accordance with the Contract Documents submitted therefore which are by reference made part hereof and are hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Principal shall promptly and faithfully perform the Contract then this obligation shall be null and void; otherwise it shall remain in full force and effect.

Whenever the Principal shall be, and declared by the Obligee to be, in default under the Contract, the Obligee having performed the Obligee's obligations thereunder, the Surety may promptly remedy the default, or shall promptly

(1) complete the Contract in accordance with its terms and conditions:

(2) obtain a bid or bids for submission to the Obligee for completing the Contract in accordance with its terms and conditions, and upon determination by the Obligee and the Surety of the lowest responsible bidder, arrange for a contract between such bidder and the Obligee and make available as work progresses (even though there should be a default, or a succession of defaults, under the contract or contracts of completion, arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term "balance of the Contract price", as used in this paragraph, shall mean the total amount payable by the Obligee to the Principal under the Contract, less the amount properly paid by the Obligee to the Principal.

Any Suit under this Bond must be instituted before the expiration of two (2) years from the date on which final payment under the Contract falls due.

The Surety shall not be liable for a greater sum than the specified penalty of this Bond.

No right of action shall accrue on this Bond, to or for the use of, any person or corporation other than the Obligee named herein, or the heirs, executors, administrators or successors of the Obligee.

It is a further condition of this Bond that under no circumstances shall the Surety be liable under this Bond for any liability, relating directly or indirectly, to:

- engineering or design;
- liquidated damages of any kind, including but not limited to those for delays and for failure to meet performance, omissions or pollution levels;
- any guarantee or warranty relating to environmental protection or to pollution of any nature (including omissions), and;
- plant performance and any guarantee relating thereto.

It is specifically understood and agreed that the Surety shall not be liable for any of the Principal's work under the Contract for events occurring or discovered more than one (I) year after the date of substantial completion of the Principal's work under the Contract, notwithstanding anything to the contrary expressed within the Contract.

THE GUARANTEE COMPANY
OF NORTH AMERICA

810 400 BURRARD STREET, BOX 57, VANCOUVER, B.C. V6C 3A6
TELEPHONE (604) 687 7688 FAX (604) 687 8861

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond this **19th** day of **November, 1997.**

SIGNED and SEALED
In the presence of

HILL MURRARY AND ASSOCIATES INC.

Witness as to Principal

Principal

THE GUARANTEE COMPANY OF NORTH AMERICA

Gordon Selman Attorney-in-Fact

Bonds arranged by

Jardine Rolfe Limited

Vancouver 16th Floor, 1111 W. Georgia Street,
Vancouver, British Columbia, Canada V6E 4G2
Telephone: (604) 682-4211
Fax (604) 682-7496

Victoria 202-3045 Douglas Street,
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Edmonton Terrace Place, 490-4445 Calgary Trail S.
Edmonton, Alberta, Canada T6H 5R7
Telephone (403) 438-0250
Fax (403) 438-3230

Bonds arranged by **Jardine Rolfe Limited**
For Enquiries about this Bond see Reverse Side

1780-20 Bond
X Powell River

THE GUARANTEE COMPANY OF NORTH AMERICA

ORIGINAL

RECEIVED
NOV 20 1997

810 400 BURRARD STREET, BOX 57, VANCOUVER B.C. V6C 3A6
TELEPHONE (604) 687 7688 FAX (604) 687 8861

No. **VS6006020**

Hill, Murray & Associates Inc.

LABOUR AND MATERIAL PAYMENT BOND
(Trustee Form)

NOTE: This Bond is issued simultaneously with another Bond in favour of the Obligee conditioned for the full and faithful performance of the Contract.

KNOW ALL MEN BY THESE PRESENTS THAT **HILL MURRARY AND ASSOCIATES INC.** as Principal, hereinafter called the Principal, and THE GUARANTEE COMPANY OF NORTH AMERICA a corporation created and existing under the laws of Canada and duly authorized to transact the business of Suretyship in Canada as Surety, hereinafter called the Surety are, subject to the conditions hereinafter contained, held and firmly bound unto **DISTRICT OF POWERLL RIVER** as Trustee, hereinafter called the Obligee, for the use and benefit of the Claimants, their and each of their heirs, executors, administrators, successors and assigns, in the amount of **ONE MILLION ONE HUNDRED EIGHTY-FIVE THOUSAND & 00/100** dollars **($1,185,000.00)** of lawful money of Canada for the payment of which sum well and truly to be made the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a written contract with the Obligee, dated the **12th day of September, 1997** for **WESTVIEW WASTEWATER PLANT UPGRADE.**

which Contract Documents are by reference made a part hereof, and are herinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if the Principal shall make payment to all Claimants for all labour and material used or reasonably required for use in the performance of the Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

(1) A Claimant for the purpose of this Bond is defined as one having a direct contract with the Principal for labour, material, or both, used or reasonably required for use in the performance of the Contract, labour and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment directly applicable to the Contract provided that a person, firm or corporation who rents equipment to the Principal to be used in the performance of the Contract under a contract which provides that all or any part of the rent is to be applied towards the purchase price thereof, shall only be a Claimant to the extent of the prevailing industrial rental value of such equipment for the period during which the equipment was used in the performance of the Contact. The prevailing industrial rental value of equipment shall be determined, insofar as it is practical to do so, in accordance with and in the manner provided for in the latest revised edition of the publication of the Canadian Construction Association titled "Rental Rates on Contractors Equipment" published prior to the period during which the equipment was used in the performance of the Contract.

(2) The Principal and the Surety, hereby jointly and severally agree with the Obligee, as Trustee, that every Claimant who has not been paid as provided for under the terms of his contract with the Principal, before the expiration of a period of ninety (90) days after the date on which the last of such Claimant's work or labour was done or performed or materials were furnished by such Claimant, may as a beneficiary of the trust herein provided for, sue on this Bond, prosecute the suit to final judgment for such sum or sums as may be justly due to such Claimant under the terms of his contract with the Principal and have execution thereon. Provided that the Obligee is not obliged to do or take any act, action or proceeding against the Surety on behalf of the Claimants, or any of them, to enforce the provisions of the Bond. If any act, action or proceeding is taken either in the name of the Obligee or by joining the Obligee as a party to such proceeding, then such act, action or proceeding, shall be taken on the understanding and basis that the Claimants or any of them who take such act, action or proceeding shall indemnify and save harmless against all costs, charges and expenses or liabilities incurred thereon and any loss or damage resulting to the Obligee by reason thereof. Provided still further that, subject to the foregoing terms and conditions, the Claimants, or any of them, may use the name of the Obligee to sue on and enforce the provisions of this Bond.

810 400 BURRARD STREET, BOX 57, VANCOUVER, B.C. V6C 3A6
TELEPHONE (604) 687-7688 FAX (604) 687-8861

(3) No suit or action shall be commenced hereunder by any Claimant:

(a) unless such Claimant shall have given written notice within the time limits hereinafter set forth to each of the Principal, the Surety and the Obligee, stating with substantial accuracy the amount claimed. Such notice shall be served by mailing the same by registered mail to the Principal, the Surety and the Obligee, at any place where an office is regularly maintained for the transaction of business by such persons or served in any manner in which legal process may be served in the Province or other part of Canada in which the subject matter of the Contract is located. Such notice shall be given

(1) in respect of any claim for the amount or any portion thereof, required to be held back from the Claimant by the Principal, under either the terms of the Claimant's contract with the Principal, or under the Mechanics' Liens Legislation applicable to the Claimant's contract with the Principal, whichever is the greater, within one hundred and twenty (120) days after such Claimant should have been paid in full under the Claimant's contract with the Principal;

(2) in respect of any claim other than for the holdback, or portion thereof, referred to above, within one hundred and twenty (120) days after the date upon which such Claimant did, or performed, the last of the work or labour or furnished the last of the materials for which such claim is made, under the Claimant's contract with the Principal;

(b) after the expiration of one (1) year following the date on which the Principal ceased work on the Contract, including work performed under the guarantees provided in the Contract;

(c) other than in a Court of competent jurisdiction in the Province or District of Canada in which the subject matter of the Contract, or any part thereof, is situated and not elsewhere, and the parties hereto agree to submit to the jurisdiction of such Court.

(4) The Surety agrees not to take advantage of Article 1959 of the Civil Code of the Province of Quebec in the event that, by an act or an omission of a Claimant, the Surety can no longer be subrogated in the rights, hypothecs and privileges of Said Claimant.

(5) Any material change in the contract between the Principal and the Obligee shall not prejudice the rights or interest of any Claimant under this Bond, who is not instrumental in bringing about or has not caused such change.

(6) The amount of this Bond shall be reduced by, and to the extent of any payment or payments made in good faith, and in accordance with the provisions hereof, inclusive of the payment by the Surety of Mechanics' Liens which may be filed of record against the subject matter of the Contract, whether or not claim for the amount of such lien be presented under and against this Bond.

(7) The Surety shall not be liable for a greater sum than the specified penalty of this Bond.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond this **19th** day of **November, 1997.**

SIGNED and SEALED
In the presence of

HILL MURRAY AND ASSOCIATES INC.

_____
Witness as to Principal

_____
Principal

THE GUARANTEE COMPANY OF NORTH AMERICA

_____
Gordon Selman

_____
Attorney-in-fact

Endorsed by: - R.A.I.C. - A.C.E.C. - C.C.A. - E.I.C. - C.S.C.
L7B - (11-77)

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Fax: (403) 438-3230

HILL, MURRAY & ASSOCIATES INC.

ENVIRONMENTAL SYSTEMS ENGINEERS

Meeting the Draft Municipal Sewage Regulation
Standards for Discharge to Water for Combined Sewer Overflow Conditions through the Combination of Membrane-Bioreactor and Micro-Screen Technology

February 25, 1998

Suite #202 - 780 Tolmie Ave, Victoria, British Columbia CANADA V8X 3W4
(250) 388-3930 FAX: (250) 388-3943

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1.0 Introduction

Many municipal wastewater treatment plants suffer excessive peaking flows due to infiltration and inflow (I&I). In many cases, these peaking flows can exceed the treatment capacity of the plant by many times, resulting in discharges of raw, unscreened influent or carryover from the treatment process to the receiving environment. The nature of these discharges can result in non-compliance with permit regulations.

The sewage collection infrastructure at a municipal site is typically of varying ages and in various stages of serviceability. In addition, there are usually unauthorized (or in the case of Combined Sewer Overflows, or CSO, authorized or accepted) connections of the storm sewer to the sanitary sewer. Typically, the costs associated with repairing and maintaining the collection system are staggering, as are the costs of upgrading an existing or building a new treatment facility to treat the I&I problem. As a result, an effective means of treating the full flow to the permit levels is required.

2.0 The Draft Regulation

The BC Ministry of Environment has undertaken a comprehensive re-write of the sewage discharge regulation to address advances in technology and increased environmental concern over sewage discharges. Included in the new assessment is the realization that many municipalities are faced with a CSO condition, which could require significant investment in capital dollars to address a problem which could require 10 years for successful resolution. As a result, the draft regulation recognizes the need for a stepped approach to treatment in these conditions of high infiltration and inflow (I&I). For applications in open marine waters, the following criteria are applied:

Flows < 2.0 ADWF	Treatment Required: Secondary BOD_5 < 45 mg/L TSS < 45 mg/L
Flows > 2.0 ADWF	Treatment Required: Primary (may be interpreted as) BOD_5 < 130 mg/L TSS < 130 mg/L

This paper will show that through the selection of a treatment system that provides an exceptionally high level of treatment, I&I flows can be managed through screening, dilution and mixing: allowing I&I flows to be superimposed on the treated volume or "base" flow. In this way, "peaking" flows can be handled without sacrificing total flow quality. The key, then, is to provide a dilution medium of sufficient quality to meet permit requirements during peak flows. Membrane Bioreactor (MBR) technology offers great advantage in this regard.

Provided the base flow can consistently meet very high treated water quality, the concept of treatment by screening and dilution can be an effective means of dealing with exceptionally high peaking factors.

3.0 Concept of Operations

In order to effectively employ a screening and dilution operational philosophy, the following are required:

A highly renovated "base" flow (base flows are up to 2.0 x ADWF)
A means of screening the peak flows to remove a portion of TSS and particulate BOD
A means of controlling the flows to meet the required permit levels.

By employing MBR technology for the base flow, the first requirement is easily met (MBRs consistently

produce exceptionally high effluent quality: BOD < 5 mg/L, TSS < 5 mg/L and act as the ideal base for an effective dilution strategy).

The second criteria can be established through a raw sewage screening mechanism whose mesh size provides for the proper removal of contaminants. The thrid aspect is simplya means of controlling flows to ensure compliance with regulations (i.e. treatment to 2.0 ADWF).

4.0 Pilot Unit Set Up

In order to meet the screening or polishing requirement, a pilot operation was initiated to determine the effect of micro-screening on influent raw wastewater, and to determine if any adverse operational effects were encountered. For the trial, the micro-screen was supplied by PRA Manufacturing Ltd. While numerous tests had been performed by PRA and other firms on various influent wastestreams, there was concern over the ability of the screens to handle raw wastewater of the constituent level expected in a typical municipal plant (BOD/TSS ~ 170 mg/L). Other concerns were whether the particle size encountered in raw wastewater would cause permanent fouling of the mesh screens. In addition, the background data required to determine the flow capacity of micro screens in raw wastewater did not exist.

PRA's pilot micro screen was installed at CRD's Central Saanich Wastewater Treatment Plant on 9-10 October 1997. This unit is supplied at the following specifications:

Mesh Area 5 ft^2
The screen size for the pilot unit was 20µ.

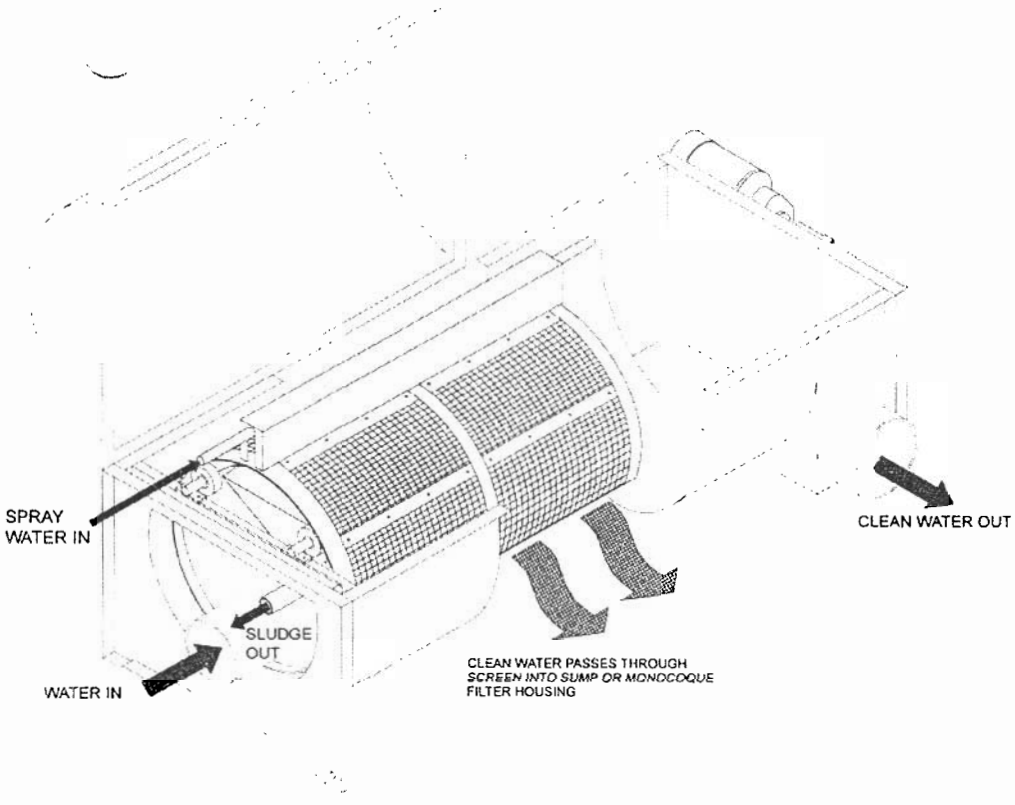
The system was installed to receive wastewater from the treatment module #2 flow splitter via a Sensus turbine flow meter. Both screenings and screened wastewater were discharged back to the treatment module #2.

Pilot Installation of PRA Micro-Screen

4.1 Basic Operation

The micro screen acts as a continuous filtering mechanism for suspended solids in the raw wastewater (see figure 1). The meshing material is located around the circumference of the drum. The raw wastewater flows into the unit through a fitting that directs the water to the interior of the drum. As the wastewater enters, it flows through the mesh and the mesh traps suspended solids. As the mesh gets progressively more fouled, the water level in the drum rises, activating a float switch. This float switch activates the drum rotation and the washwater spray solenoid valve, which operate for a preset period of time or until the liquid level is below the float switch. As the drum rotates, the screen carries solids collected by the lower portion of the screen. The solids built up on the screen are washed onto a tray assembly and discharged from the side of the unit, leaving the mesh clean to collect more solids from the wastewater. Filtered water leaves the unit from the bottom of the annulus surrounding the drum mechanism. After a preset time, the drum stops rotating and the wash water is isolated. Once the level in the micro screen again trips the float, the process is repeated.

Any flows that exceed the capacity of the unit spill over the top of the unit and are directly discharged. The sealing elements for the drum are rubber seals bearing against the drum assembly.



Schematic of Micro-Screen - Figure 1

4.2 Operational Data

During the Central Saanich trial, the pilot micro screen was operated at an influent flow of approximately 170 L/min. The flow varied from 193 L/min at the start of a cycle (when the drum was clean) to 164 L/min as the screen was blocked off. The screen consistently began rotating as the influent flow reduced to 170 L/min.

In order to assess the effectiveness of the treatment provided by the micro screen, an analytical sampling regime was instituted to determine the constituent reduction. Samples were taken at various intervals from the system and at various points in the separation process. These samples were analyzed at JB Laboratories in Victoria.

The following lab data was collected for the trial:

Date	Parameter	Influent	Effluent	% Reduction
10 Oct 97	BOD	250	150	40%
	TSS	176	70	60%
15 Oct 97 - 100% Washwater	BOD	210	130	38%
	TSS	204	84	59%
15 Oct 97 - 10% Washwater	BOD	260	144	45%
	TSS	208	83	60%
15 Oct 97 - 10% Washwater	BOD	206	142	31%
	TSS	196	74	62%

All BOD & TSS results in mg/L

The results show a significant level of BOD and TSS reduction (38% and 60% respectively).

In addition, TSS samples from the screenings discharge were taken as were TSS samples from the internal drum area:

Screenings	Sample #1	3150 mg/L
	Sample #2	3010 mg/L
Drum Liquid	Sample #1	322 mg/L
	Sample #2	256 mg/L

These analytical results show that the solids were in fact being captured by the screen and discharged from the unit (rather than simply collecting in the drum).

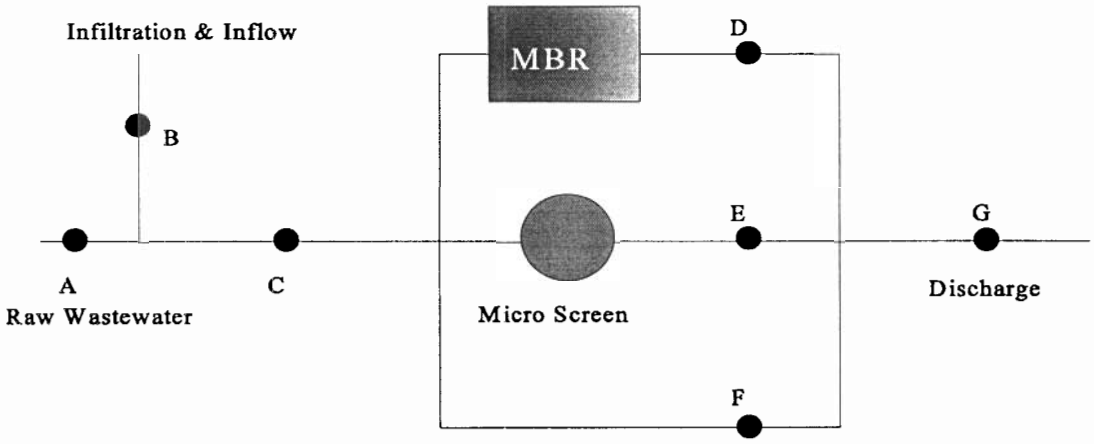
4.3 Operations

The PRA Micro Screen operated without difficulty after commissioning. The unit was operated in automatic mode for the duration of the trial. No significant fouling of the mesh surfaces was encountered, nor was there any bypassing of raw wastewater to the discharge. It is anticipated that the unit can operate unmanned, except for routine operational checks consistent with other machinery.

5.0 Effect of the Application of MBR and Micro Screen Technology to the I&I-Limited Municipal Plant

In order to assess the suitability for the combination of MBR and micro screen technologies to meet the needs of treating I&I in a municipal application, a model was developed to determine the treated water quality at all points in the treatment process and at all flow rates.

For the purposes of this model, a plant was schematically modeled as shown:



Schematic Model of Plant - Figure 2

In order to run the model, the following parameters were input:

Influent (Point A)	BOD	170 mg/L
	TSS	170 mg/L
	Flow	Variable Peak flow: 3000 m^3/day
Infiltration & Inflow (Point B)	BOD	30 mg/L
	TSS	30 mg/L
	Flow	Variable Peak Flow: 26000 m^3/day
MBR Discharge (Point C)	BOD	5 mg/L
	TSS	5 mg/L
	Peak Treatment Capacity	7500 m^3/day
Micro Screen Discharge (Point E)	BOD	38% reduction
	TSS	60% reduction
	Peak Treatment Capacity	6500 m^3/day

Using the data collected from this trial, and applying a mass balance to each point, the constituent components of the discharge can be predicted:

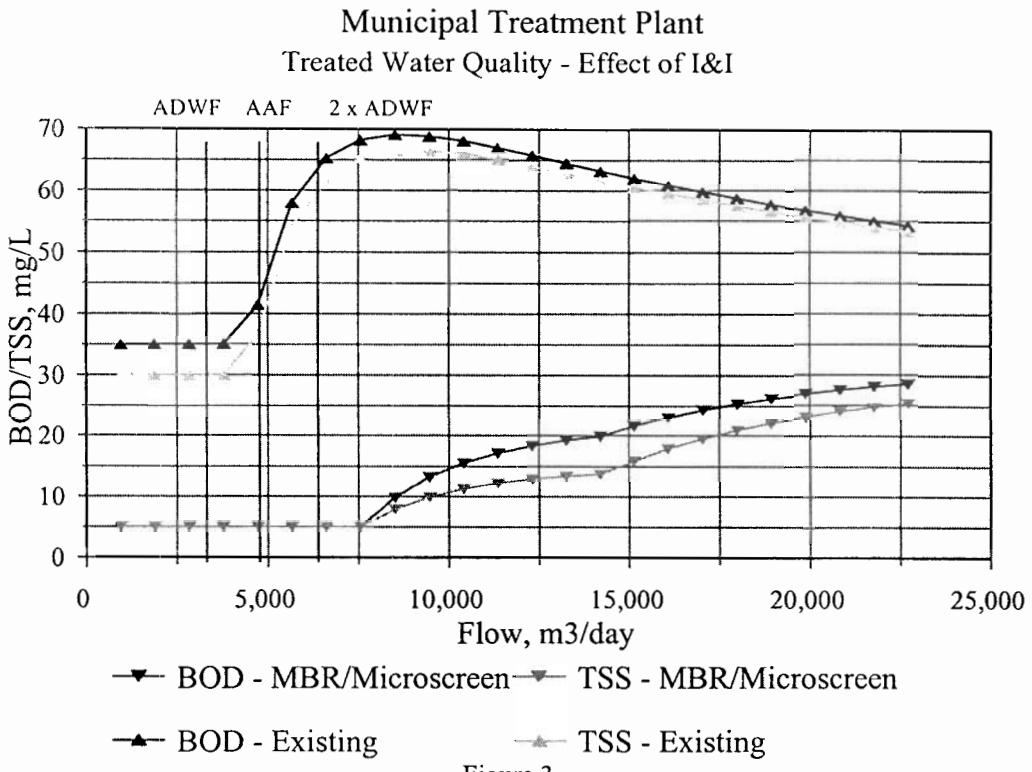


Figure 3

In this analysis, the sewage flow was assumed to peak at the ADWF, with the remainder of the flow being composed of I&I (at BOD/TSS of 30/30 mg/L). Superimposed on this analysis is the expected results from operating an existing plant (assuming the same flows, and a nominal treatment ability of BOD/TSS of 35/30 mg/L to a design capacity of 4500 m^3/day.

6.0 Conclusions

The combination of MBR and Micro-Screen technologies offers significant improvements to the level of treatment provided in extreme peaking events and allows for the extension of the "treatment envelope" to include I&I flows. The micro screen is very effective in reducing the influent BOD and TSS, effecting an average 38% removal of influent BOD and 60% removal of influent TSS.

The application of a treatment/screening/dilution philosophy is a valid method of meeting the requirements of the new regulation, provided a high quality treated water source is used as the base flow.