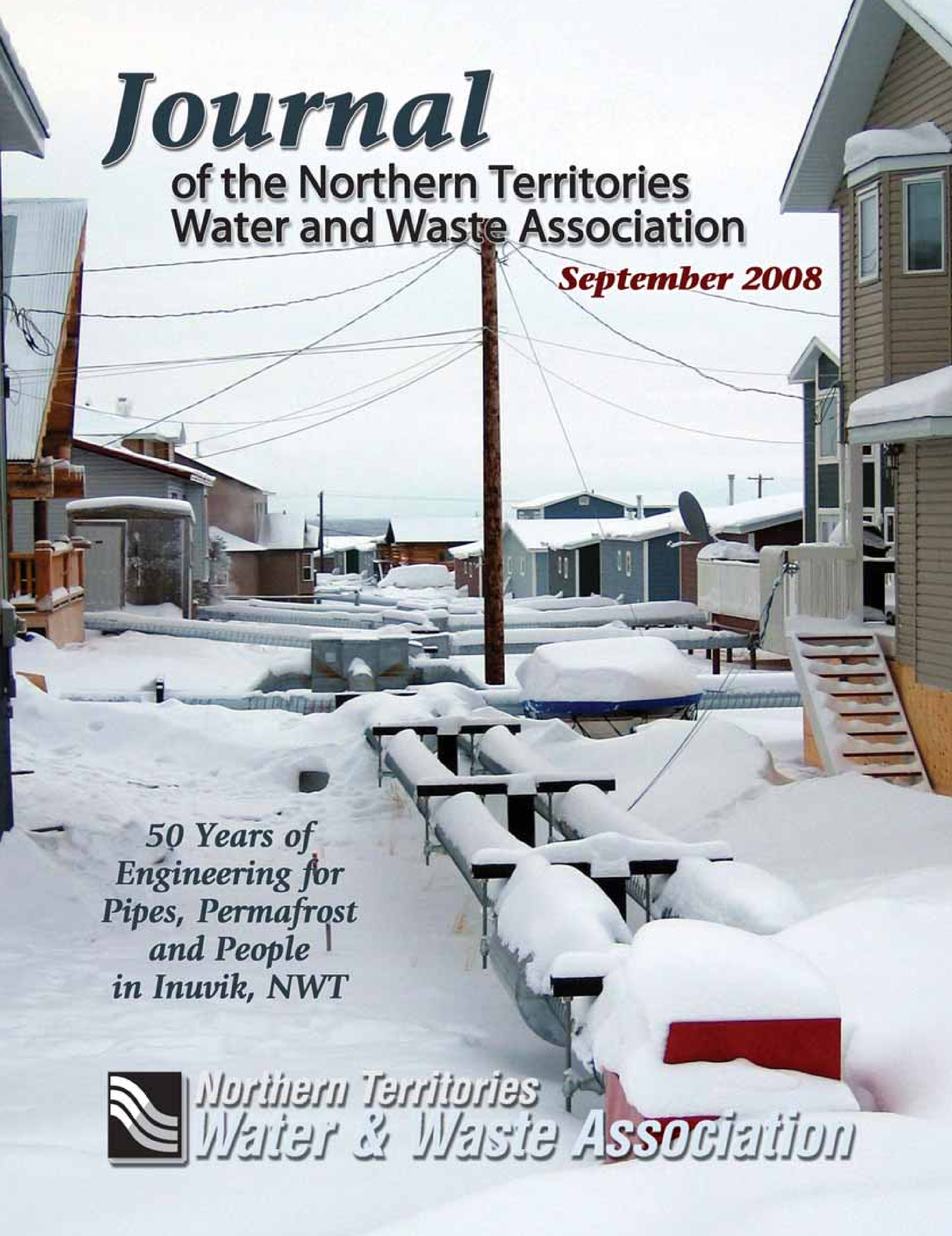

Journal

of the Northern Territories Water and Waste Association

September 2008

50 Years of Engineering for Pipes, Permafrost and People in Inuvik, NWT

Northern Territories Water & Waste Association

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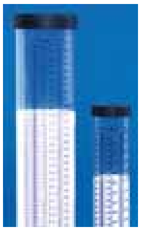

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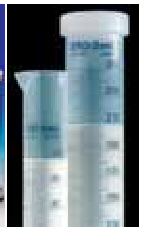

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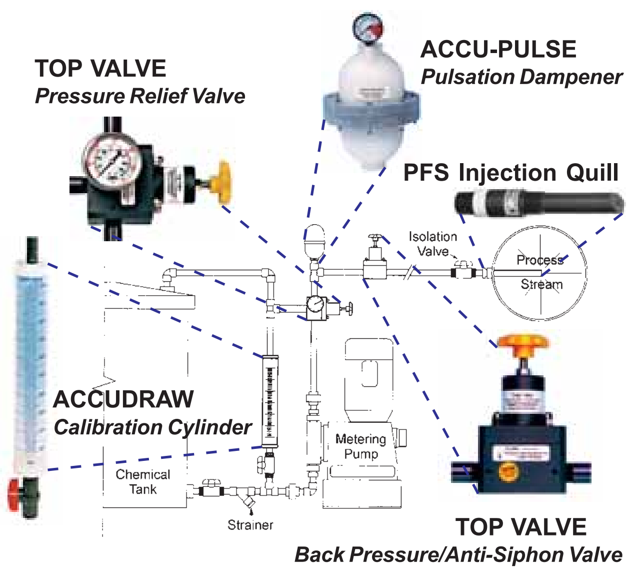

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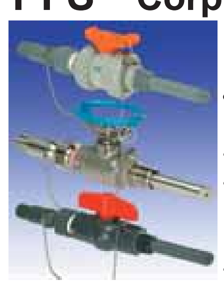

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Northern Territories Water & Waste Association Journal

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FIRST ANNOUNCEMENT

Annual Conference, Trade Show & Workshop
Norman Wells, NWT, November 1, 2 & 3

THEME: *Water: Education, Operations and Preservation*

The NTWWA's Annual Conference has become the highlight of the year, not only for the Association members, but also the water and waste management sector across the north, which includes engineers, technologists, suppliers, regulators, contractors, administrators, and operators. The 2008 conference and workshop in Norman Wells will feature a conference with 20 exceptional technical presentations, and a day-long operator workshop.

We are planning for the 2008 Great Northern Drinking Water Challenge. In 2007, the Town of Norman Wells was the winner of the third annual event, and Sean Austman-Kunkel happily received the drinking water cup. Sean will be anticipating a "hometown" advantage as he competes for the cup again this year.

TRADE SHOW
The conference will feature exhibits with many products and services, and companies and product representatives who know what works in the north.

CONTINUING EDUCATION CREDITS AND OPERATOR WORKSHOP
Water Treatment Plant Operators can earn 1 Continuing Education Credit for attending the conference and the Operator Workshop on November 3. The workshop will feature "hands-on" sessions with great practical information for Operators.

REGISTRATION

***Registration is now available, so visit* www.ntwwa.com *or call* 867.873.4325**

THE LINK BETWEEN SOVEREIGNTY AND INFRASTRUCTURE IN THE CANADIAN NORTH

The ongoing ramblings of the Government of Canada on northern sovereignty are a welcome change to the complete absence and neglect that northern Canada has received over these past many years. However, the Prime Minister may be missing the "iceberg" in regard to what efforts will in fact sustain and enforce Canada's sovereignty over the far northern reaches of North America.

The rhetoric "use it or lose it" appears to be the catch phrase with token efforts of military exercises, tours, and mapping, which may only serve southern politicians and southern commerce, but not northern Canadians in general. I would suggest that this phrase be replaced by "home sweet home" as a means of not only capturing the imagination and support of all Canadians, but as a statement that the lands and waters that countries such as the United States, Russia and Denmark are encroaching upon are in fact the home of Canadians. The world, and in fact southern Canada, should be constantly reminded that Canadians are living on Ellesmere Island in the community of Grise Fiord, and on Banks Island in the community of Sachs Harbour. Northern Canada is "home sweet home" for residents of these and other communities.

By Ken Johnson,
NTWWA Journal, Technical Editor

If I were a mediator at a World Court hearing testimony about land ownership, I would certainly give more weight to the argument that this land is home to Canadians rather than that this land is territory we intend to use for industrial development. If it is just ours to use for development, and it is so big, why can't we share it?

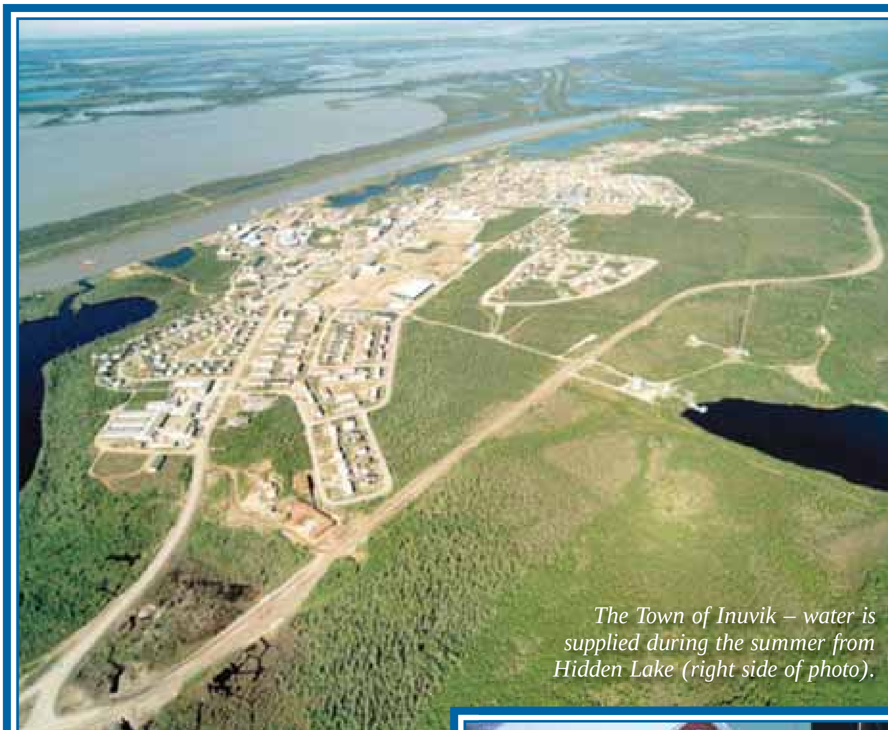
With the establishment and maintenance of any home, infrastructure (water, sewer, roads, and buildings) is an essential part of that home.

Infrastructure is particularly significant to the north because an interruption of services may in some cases be a matter of life and death, as opposed to an inconvenience farther south. Community infrastructure in the north has made steady improvements over the past 50 years since the first "modern" system was commissioned in Inuvik. Community infrastructure is taken for granted in the south; however, in the north, hauling fresh water in buckets and sewage in plastic bags are recent memories, particularly for those living in smaller communities.

There remains a deliberate reluctance to invest time and money in community infrastructure to appropriately serve northern communities. This absence of time and money occurs in the regulatory environment imposed upon the north, which may ultimately dictate some of the infrastructure, as well as the infrastructure that is actually constructed.

The Prime Minister is currently taking a backward approach in taking advantage of the link between sovereignty and infrastructure, suggesting that commerce comes first and infrastructure comes second. This was reported during the Prime Minister's August tour of the NWT and Yukon, with statements that road and port infrastructure won't come until the $16 billion Mackenzie Valley natural gas pipeline is built. I suspect that the politicians in the United States, Russia and Denmark are giving this position a unanimous "thumbs up".

FIFTY YEARS OF ENGINEERING FOR PIPES, PERMAFROST & PEOPLE OF INUVIK, NWT



The Town of Inuvik – water is supplied during the summer from Hidden Lake (right side of photo).

Celebrating its fiftieth anniversary in 2008, the Town of Inuvik is Canada's largest community north of the Arctic Circle, and has a unique history as the first completely "engineered" northern community. According to some, there has never been a Canadian town so "pondered, proposed, projected, planned, prepared and plotted" as East-3, which was its original site identification back in the 1950's. Inuvik was planned and engineered by the Canadian government in the late 1950's to replace the flood-prone Aklavik as the region's administrative centre. Canadian Prime Minister John G. Diefenbaker dedicated Inuvik as, "The first community north of the Arctic Circle built to provide the facilities of a southern Canadian town. It was designed not only as a base for development and administration, but as a centre to bring education, medical care and new opportunity to the people of the western Arctic."

The site for Inuvik was chosen for its elevation above the Mackenzie River flood zone, abundant gravel deposits, ample space for an airport, freshwater lakes and navigable waters. The community sits on a broad terrace between the East Channel of the Mackenzie River and the upland that forms the present-day Mackenzie Delta's eastern boundary.

Inuvik's long, very cold winters, permafrost, and great distance from sources of supply continue to challenge engi-

New utilidor construction in Inuvik.

By Ken Johnson, MCIP, P.Eng.,
Senior Planner and Engineer, Earth Tech Canada

neers. Inuvik depends on southern sources for supplies and materials of all sorts, with the exception of drinking water. The built environment of Inuvik must contend with the permafrost and the extreme cold for buildings, water, sewer, roads and drainage; each of these elements requires unique design and construction considerations.

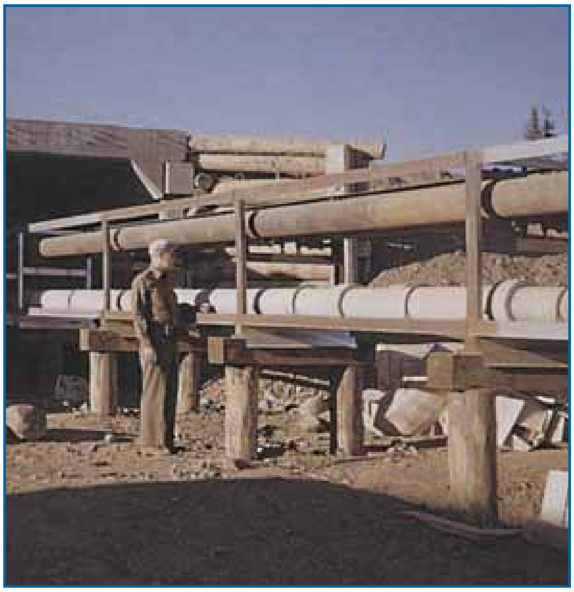
The permafrost ground below Inuvik is "ice rich", which means that when it partially melts, the ground may settle by hundreds of millimetres as it fills the voids left by the melting ice. This magnitude of settlement can cause major structural damage to buildings and pipes. The heat from houses, and water and sewer pipes may also melt permafrost, therefore all of the buildings and pipes in Inuvik are built on piles to provide a "thermal break" between the building and the ground.

The water and sewer mains, referred to collectively as the "utilidor", run along a dedicated right-of-way along the back of each lot along with the power poles that service each building; the cost of installing these services is over $50,000 per lot. The service connections exit above ground from each building and resemble a large "metal centipede" as they connect to the water and sewer mains. Road crossings of the utilidor create another challenge because the road must literally bridge the utilidor, at a cost of nearly $50,000.

Inuvik's utilidor was originally constructed in one single enclosed conduit supported on wood piles; the utilidor originally included a dedicated pipe carrying high temperature hot water for buildings and freeze protection of the water and sewer mains. The high temperature hot water system was eventually taken out of service, and the utilidor structure has been undergoing incremental replacement.

Inuvik's methods of development access and site preparation have also adapted to the extreme conditions. Roads are built above the natural grade, with embankments thick enough to provide an insulating layer to minimize permafrost melting. Road grades and building lots are never excavated for pre-grading purposes to avoid the effects of continuing thaw settlement, which can continue for several years in the developed or disturbed areas. Building lots are often filled to provide grading for drainage and a drivable access for construction vehicles, as well as to reduce thaw settlement. Drainage runs in ditches on the surface, except where it passes through culverts under roads.

Inuvik originally developed with a reasonably compact and efficient downtown



Left – Construction of original Inuvik utilidor in the 1950's (photo by Jack Grainge). Right – Some segments of the original utilidor are still visible.

business core just east of the East Channel. Primary and secondary schools were located on large blocks of land between the downtown core and surrounding residential areas. A large regional hospital was sited at the south end of the townsite. The residential areas radiate outward from the central core area, and there is a considerable amount of undeveloped space between the current margins of developed residential districts and the perimeter collector road.

New residential housing in Inuvik has taken on a southern look, but the occasional new house maintains a very northern flair. Inuvik acts as its own developer of serviced land for townsite expansion, undertaking both financing and administrative work itself in order to supply serviced lots at the lowest cost reasonably achievable.

The Town of Inuvik continues to anticipate the economic growth associated with the proposed Mackenzie Gas Pipeline. The pipeline may open another chapter for the community, and will present some very interesting challenges for engineers, not only on the pipeline itself, but also for the engineering of community expansion for "pipes, permafrost, and people."

POTABLE WATER RESERVOIR CLEAN, AND REPAIR IN JEAN MARIE, NWT

Jean Marie River is a First Nations community located in the Deh Cho region of the NWT. Jean Marie is a pretty little community with a population of approximately 72 people. It is located at the confluence of the Mackenzie and Jean Marie Rivers at 61°32'N and 120°38'W – 302 air kilometres southwest of Yellowknife and 63 kilometres east of Fort Simpson.

The Jean Marie River reservoir was constructed in 1995 with an anticipated design life of 20 years. Twenty years is a long time for a structure that sits in the ground with no cover, open to the elements, filled with water that goes up and down, and freezes and thaws every year. The reservoir was built in the shape of an overturned pyramid. The depth of the reservoir is 6.4 meters, with a total volume of approximately 7,400 cubic meters. The

Near empty reservoir with sediment accumulation in bottom.

By Malcolm McPhail, Municipal Works Officer, Government of the NWT
& Dennis Buboire, Capital Planning and Works, Government of the NWT

Above – Empty reservoir with damaged intake filter.
Right – Reservoir fill line.

reservoir is lined with a 2.5 mm thick high density polyethylene (HDPE) liner.

In the fall of 2007 a cleaning, inspection, and repair project was initiated to coincide with the seasonal filling of the reservoir. It was a dirty job, but it had to be done.

We suspected there could be a leak or two that we'd have to deal with. The "T" shaped water intake filter was also bent from last season's ice pressure, so this was one obvious repair. As the water level dropped, the weight of the ice had bent the filter. We were nearing the end of September and the reservoir was about one-third full. The water was nice and clear, and it was easy to see accumulated grunge on the liner.

We began the process by putting together the fill line, which consisted of 12.2 metre long sections of rigid 150 m diameter HDPE pipe. The fill line was hooked up to the truck fill arm and reservoir water was pumped through the pipe

Accessing reservoir after snowfall.

to clean the line. We were not sure what may have gotten in the line from it laying around between fills, and thought this was a good process instead of just dumping the water into the drainage ditch.

Draining and cleaning the reservoir took 3 to 6 staff about 10 days. The time could have been reduced by a few days, but a couple of overnight snowfalls slowed the process. Walking in the reservoir was slippery enough with just water on the liner's surface, but the snow made it hazardous and sometimes comical. More than one of us skidded down the slope on our butts! You could not go down or up the liner without a safety rope attached to your person.

Once we had the reservoir empty, we had to affect a temporary repair to the filter – time did not allow us to repair the filter to its original design specification.

We also had two small tears in the liner at the base of the filter. As with the filter, we could not locate any qualified contractors in a timely manner, so we performed temporary repairs by stitching the liner together using plastic ties and covering the stitching with a patch of spare liner

From left to right: Rip in reservoir liner; stitching of reservoir liner to repair rip; final covering of reservoir liner repair.

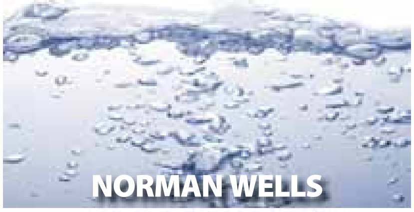


material. The patch was secured with potable water compatible glue, and further fastened with screws.

Prior to the fill, everyone's water tanks were topped up, and the fire pumper and two potable water backup tanks in the community garage were filled. Residents were asked to conserve water while the process was taking place. The community ended up hauling water from the Town of Hay River as our supply ran out before the reservoir was back in service.

For approximately thirty days following the fill, we had a great deal of trouble meeting the free chlorine levels. The chlorine pump could not meet demand. Readings fluctuated all over the map. We ended up adding chlorine by hand into the water truck. High turbidly levels surprised us as well. All readings from Jean Marie River raw water were acceptable before filling the reservoir.

All is now well with the water supply in Jean Marie River – until the next cleaning and inspection.



PLC INSTALLATION IN NORMAN WELLS, NORTHWEST TERRITORIES

In 2004, the Town of Norman Wells' water treatment plant (WTP) initiated the process of updating its Programmable Logic Controller (PLC); the existing unit was outdated and difficult to operate. There were often "ghost" alarms, which caused a lot of extra call-outs and frustration. Every time the alarm dialer sent out an alarm after normal operating hours, it was not known whether it was a real emergency or not; this required a lot of inspection and troubleshooting. The old PLC consisted of thousands of contacts and solenoids, which were the industry standard when the unit was installed.

The process of bringing Norman Wells' senior administration onside with the importance of the problem was probably the hardest part of the whole process. Firstly, it had to be proven that there actually was a problem. The plant still functioned and the majority of the processes and alarms were unaffected most of the time. It was very difficult to prove that the alarm call-outs are, in fact, false alarms; to the senior administration, it just looked like business as usual.

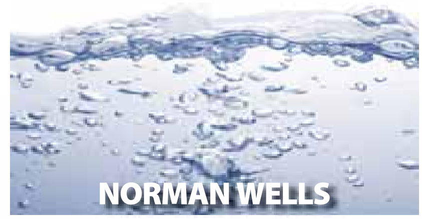
Secondly, the problem had to be researched. How much would it cost to fix the existing unit versus replacing it with more modern technology? Was fixing the existing unit even possible, and would it solve the problem? What was the new technology, and how hard would it be to install and calibrate to our existing system? How much of our existing equipment besides the PLC would have to be updated to accommodate a new system? Which companies would be able to help us complete these upgrades?

The Town engaged Earth Tech for some answers to these questions. The Town contacted Earth Tech's instrumentation specialist, Duncan Cook, and within the first hour of talking to him almost all of our questions were answered. It was quickly clarified that there was no benefit to fixing the existing system because it would cost a lot of money and couldn't be guaranteed to work properly in the end. It was decided that the Town would use new digital technology to solve our problem. Working with Earth Tech, with their industry knowledge and familiarity with the Norman Wells WTP, made the groundwork a lot easier and more efficient. The final piece of the planning puzzle was to secure the money required to complete the upgrades.

Norman Wells instrumentation improvements involved many, many, wires.

Once all these planning steps were complete, the actual work began. The new PLC has many more capabilities, and the Town is going to make an effort to take advantage of all of them. The Town installed magnetic flow meters with no moving parts, which saves a lot of operation and maintenance, as Norman Wells has high turbidity issues. This monitoring capability was directly wired into the PLC and is displayed on the touch screen monitor. Also, the Town installed on-line chlorine metering, and on-line turbidity monitoring for both of the plant filters as well as the raw water coming into the plant. Lastly, the Town installed a Scatter 7 turbidimeter, which has the ability to read turbidities of up to 1000 NTU. The new PLC has the ability to show all the readouts from our various instrumentation on an easy to read screen.

By Sean Austman-Kunkel
Utilities Manager, Town of Normal Wells



From left to right: Connecting the many wires for the instrumentation improvements was a time consuming exercise; on-line turbidity monitoring is a new feature of the instrumentation improvements; the monitoring capability shows up on a touch screen display.

Before the PLC came to Norman Wells for installation, electricians ran wires from all the applicable instruments, including flow meters, on-line instrumentation, pressure transmitters, temperature sensors, etc., so that they could be added to the PLC software. It took weeks worth of work to get the water plant ready for the installation of the new PLC.

The first few days of the installation process consisted of getting Duncan Cook familiar with our processes. Wires were followed back to their sources to make heads or tails of how everything worked, so that it would all work again with the new PLC. The installation was scheduled for 7 days, and ended up taking 12 days because of the work involved in troubleshooting. During the course of the 12 days, the team worked no less than 12 hours any given day, and there were a few 16 hour days.

The scariest part was when functions were turned to manual and the old PLC was cut out. Was it going to work? Were we going to be able to put it back together again? There were, thankfully, no huge problems that came up during this time.

The new PLC is much more user friendly, and it is programmable. There is a modem installed with the unit that allows it to be accessed from any remote location. The PLC has a touch screen monitor that shows all the flows, temperatures, turbidities, reservoir level, etc. It is so much more user friendly that it more than justifies the work that went into it. The PLC is set-up to have alarms for a lot more functions, which in the end greatly aids the water treatment plant operator to ensure, at all times, the quality of water and service to the community.

The new PLC has made the life for the operators much easier. With the simpler ability to change functions, settings, and much more, the Town has found a solution for many of the issues facing water treatment in the north. With the on-line ability of the new PLC, the plant conditions can be monitored from off-site. This allows better response to problems associated with water treatment. For example, if the chlorine pump goes down or the barrel runs dry, an alarm will alert the operator, or anyone it's programmed to contact, before the water itself runs out of chlorine residual. There is no end to the positive aspects of this new system, even though the Town will continue to iron out the wrinkles.

AERATED LAGOON UPGRADES FOR KAWAWACHIKAMACH, NORTHERN QUEBEC

The Naskapi community of Kawawachikamach, with a population of 580 people, is located at approximately 54° 51′ 50″ N, 66° 45′ 40″ W in northern Quebec near the mining community of Schefferville. The community is 1100 km northeast of Montreal and 1000 km south of Iqaluit. The average January temperature is -24°C and the average July temperature is 12°C.

As in other northern communities, the cold climate conditions present challenges to biologically based wastewater treatment systems. Long periods of very low air and water temperatures can reduce wastewater lagoon volumes through ice build-up, damage typical floating equipment, and slow biological treatment processes to a crawl.

It was important to provide a robust wastewater treatment system that can be operated by local personnel, since the community is isolated. It can be difficult and expensive to attract skilled wastewater treatment plant operators or to bring in contractors and replacement parts if repairs are needed. As a benefit to local development, a simple-to-operate wastewater treatment plant can provide employment for local workers without the need for extensive training.

The community had constructed a two celled lagoon in 1996 which was no longer meeting the required effluent standards. Difficult soil conditions meant that constructing winter storage cells would be prohibitively expensive. The existing surface aerators were not suitable to the cold northern climate and were prone to damage due to freezing into the ice. The entire system was in need of an upgrade.

The sewage lagoons are located 580 metres northwest of the edge of the community.

Treatment upgrade design

Nelson Environmental Inc. designed, supplied and installed the aeration system components for the facility. Equipment for the upgrade was shop assembled in Winnipeg, Manitoba to the greatest extent possible and shipped by rail to the community, allowing for easy installation.

A proprietary lagoon based wastewater treatment system was chosen for the Kawawachikamach upgrade because it met the requirements for a system with low maintenance needs, ease of operation, and tolerance of extremely cold climates. The two-cell, continuous discharge system includes primary and secondary fine bubble aerated cells. It was determined that, through a process equipment upgrade, the existing cells would be more than capable of providing sufficient treatment for the design flows expected by the community, eliminating the need for construction of a proposed third cell.

The design wastewater flow was 274 m3/day. The process design allowed for the loss of treatment volume by ice accumulations up to 1.2m thick. The system was designed to provide full secondary treatment to meet the limits of 25 mg/L of BOD in summer and 30 mg/L of BOD in winter. Provision was made for the system to be expanded to treat 400 m3/day without requiring new pond construction or dewatering of the existing ponds. A third

By Merle Kroeker, P.Eng.
Project Development Engineer, Nelson Environmental Inc.

The aeration system was installed with buried perimeter air distribution piping.

treatment cell may be added in the future if the growth of the community dictates that treatment capacity beyond 400 m3/day is required.

Equipment design

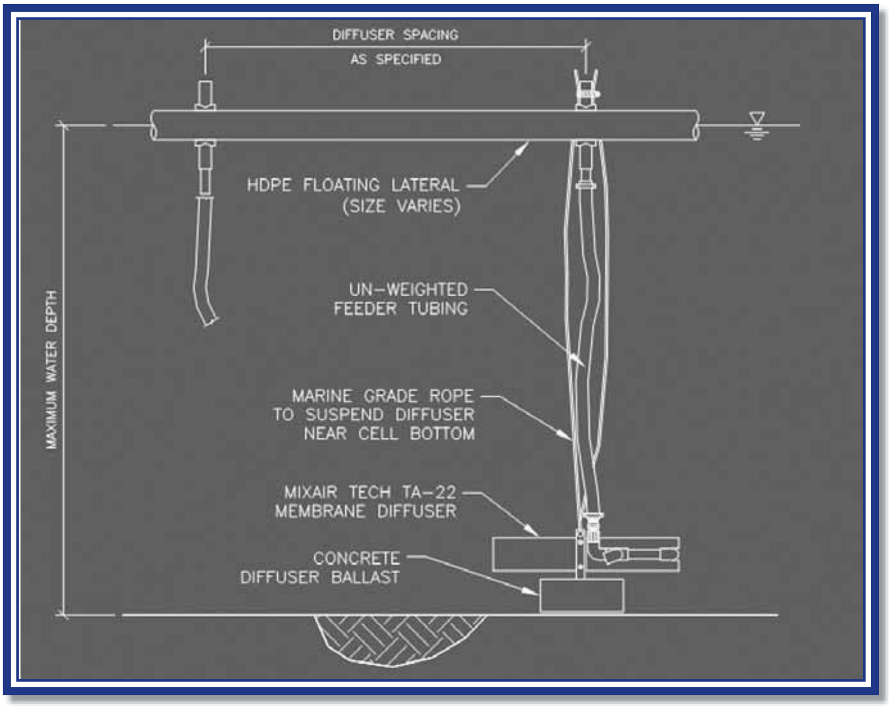
Floating high density polyethylene (HDPE) air supply laterals were chosen for this application, since with careful design, they can be frozen directly into the lagoon ice without sustaining damage or impairing their function. The tough HDPE material will not crack or

The aeration diffusers were individually ballasted and suspended below the floating laterals.

otherwise deteriorate even at temperatures of –40°C and direct exposure to UV radiation from the sun.

The floating HDPE laterals were secured against movement by self-adjusting tension assemblies. These units maintain tension on the header assemblies to resist wind action while adjusting automatically for thermal expansion, contraction of the pipe, and variations in water depth.

The aeration diffusers were individually ballasted and suspended below the floating laterals, ensuring a consistent diffuser depth regardless of sludge accumulation or uneven bottom contours. The self-supported tubular membrane diffusers have a 10 year design life. Independent testing has confirmed that the diffusers maintain the same high oxygen transfer efficiency at the end of the design life as when they are installed. The floating laterals allow for all aeration system maintenance to be performed from a light boat on the lagoon surface. No special barges or dewatering of the lagoons is required. Sludge can be removed from the system with all equipment left in place.



Drawing showing configuration of diffuser and ballast system.

Long periods of very low air and water temperatures can reduce wastewater lagoon volumes through ice build-up, damage typical floating equipment, and slow biological treatment processes to a crawl.

Future upgrade for ammonia removal

Eutrophication (nutrient enrichment) of waterways is one of the most serious water quality issues in North America. Wastewater treatment plants (WWTP) are one of the main point sources contributing to excessive nutrients (nitrogen and phosphorous) in lakes and rivers.

For large population centres, the trend has been to construct costly mechanical treatment plants. While this is a good practice for large flows, smaller communities (particularly those with existing lagoon infrastructure) struggle with not only the extreme capital costs, but more importantly, the excessive long term operation and maintenance costs of high intensity mechanical plants. Historically, lagoon based wastewater treatment systems have not been designed with nutrient reduction in mind. The extremely slow growth and respiration of nitrifying bacteria at typical lagoon effluent temperatures of 0.5° to 1.0°C, and the absence of suitable growth substrate for these bacteria, have made in-lagoon nitrification impractical.

Nelson Environmental has developed a proprietary submerged attached growth reactor for cold-climate ammonia-N removal. In the process, ammonia removal takes place within a compact aerated rock media bed installed after an aerated lagoon. The high surface area of the screened rock material facilitates the development of nitrifying bacteria during periods of warmer water temperatures. Large quantities of biomass are critical for maintaining treatment at very low water temperatures as the ammonia uptake of the bacteria slows due to a decreased metabolism.

A 10,000 gpd demonstration plant has been constructed in Manitoba. The facility has shown that ammonia levels below 1 mg/l can be achieved at wastewater temperatures of 0.5°C over a sustained period if combined with a well designed secondary treatment lagoon system. The system is stable, having the ability to develop new biomass to accommodate fluctuations in influent loading.

The facility at Kawawachikamach has been designed to allow for the addition of an ammonia removal process, should ammonia removal be required in the future. The demonstrated cold water treatment ability of the process and the compact footprint, combined with low maintenance requirements makes this tertiary treatment process suitable for remote communities with harsh climates.

Summary

Through careful design, aerated lagoons are ideal to meet the wastewater treatment requirements of remote northern climates. They are robust, provide excellent treatment, and are easy to maintain without specialized training requirements.

A MEASURE AND PROCESS FOR IMPROVING HUMAN EXCRETA DISPOSAL PRACTICE IN RURAL ALASKA VILLAGES

Figure 1. Causal Loop Diagram

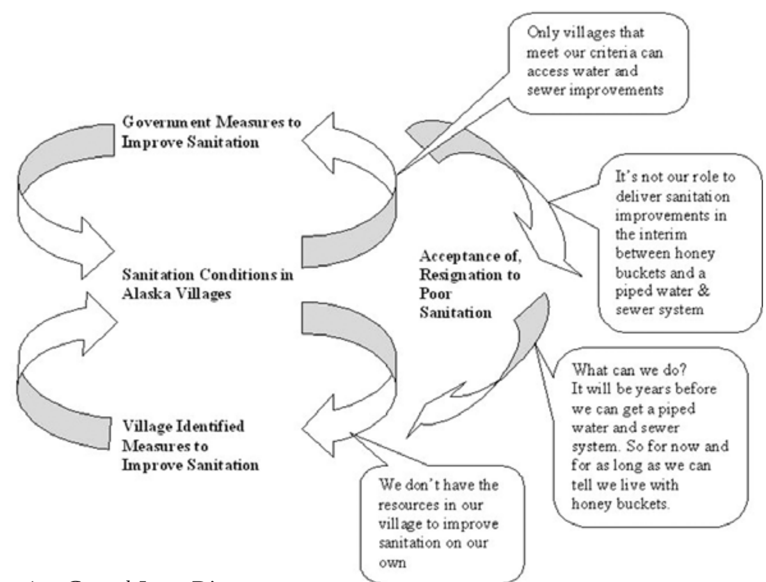


Figure 1 – Causal Loop Diagram.

Background

Permanent settlements in rural Alaska developed largely based on the establishment of trading centers, churches and schools. As the nomadic indigenous people became settled in permanent villages the need to address sanitation issues related to population concentration became evident. For decades factors such as remoteness, geography, permafrost, and cost have presented a challenge to villages and service providers in achieving sanitation improvements. The state and federal government continue to work with tribal and city governments to fulfill their responsibility to protect human health through the provision of safe water and adequate sanitation to villages in rural Alaska.

Approximately 15 - 20% of rural Alaska households still lack piped water and sewer or an equivalent system. "Honey buckets" (5 gallon plastic buckets) are used for human excreta (sewage waste) collection, transport and disposal. A wide gap exists in villages through out Alaska between the highest level of sewage disposal practice (piped water and sewer) and the lowest level of sewage disposal practice (honey buckets), and there are few resources to address health threats at the lowest levels.

The problem

Why are there limited resources to improve human excreta disposal in rural Alaska villages in the interim between the use of honey buckets and the delivery of piped water and sewer?

The federal and state water and sewer service providers are the gate keepers for villages to access improved systems. Gatekeepers are defined as, "individuals who have the authority to make decisions that will affect the mobility of others. They…(decide) daily whether to open the gate and let people through or keep them out" *(Scollon and Scollon)*. The water and sewer service providers define the village capacity required to gain water and sewer improvements, as well as what type of improvements can be funded.

People in rural Alaska living without proper sanitation want water and sewer improvements for a number of reasons, including improved health status and convenience. There are, however, many cultural, social, and economic concerns that strain the available human and financial resources of the villages. In villages where poor sanitation conditions persist and resources are limited, it is possible for people to lose sight of the associated public health threat and to perceive poor sanitation as part of the background.

The reasons for the identified problem are complex, but two beliefs prevail – the resignation of the water and sewer service providers that they are doing all they can within existing constraints, and

By Joseph Sarcone,
Rural Sanitation Coordinator, USEPA, State of Alaska

Figure 2 – Draft Sanitation Practice Index.

In villages where poor sanitation conditions persist and resources are limited, it is possible for people to lose sight of the associated public health threat and to perceive poor sanitation as part of the background.

Figure 2 — *Draft Sanitation Practice Index* — Metric: Person Contact with Human Waste

	HOUSE		TRANSPORT		DISPOSAL ***
10	Honey bucket* and easily cleanable surfaces (smooth walls and floors; for example vinyl flooring)	10	Honey bucket bins with with vacuum pumper unit service (when temperatures permit)	10	Sewage Lagoon more than .25 miles from nearest house
9		9		9	
8		8		8	
7		7	Honey bucket hoppers with honey bucket haul trailer service	7	
6		6		6	Sewage Lagoon Less than .25 mile from nearest house
5		5	Honey buckets with vacuum pumper unit collection at each house's honey bucket	5	Honey bucket bunker (well maintained)
4		4	Honey buckets with household collection service by honey bucket worker using 4 wheeler with a trailer or a snow machine with a sled.	4	Honey bucket waste and solid waste dumped together more than .25 miles from village
3		3		3	
2		2		2	
1	Honey bucket and not easy to clean surfaces (porous floors, walls, e.g., unpainted plywood)	1	Self haul honey bucket using a 4 wheeler or snow machine, this includes **	1	Honey bucket waste and solid waste dumped together less than .25 miles of village
0		0		0	Dumping all around (beach and slough) or poorly maintained honey bucket bunkers

* Honey bucket liners and disinfectants (e.g., Pine Sol) are often used. There are advantages and disadvantages to these practices. Based on this, the index does not assign a value to them.

** Honey bucket disposal to 35 - 50 gal containers at each household with self haul using a 4 wheeler with a trailer or a snow machine with a sled

*** Subtract 2 points for poor drainage in and around disposal site and transportation route

House Points ______
Transport Points ______
Disposal Points ______
TOTAL

Honey buckets awaiting disposal.

the acceptance of the villages that there is little they can do to change things. The dynamic system described is presented in the language of Systems Thinking in Figure 1, Causal Loop Diagram.

Goals and process

A goal has been identified to reduce human exposure to disease through implementation of improved sanitation in rural Alaska villages. This is responding to the health problem in rural Alaska households that lack piped water and sewer where exposure to human excreta increases the risk of infection from disease.

The objective, by December 31, 2010, is to reduce exposure to disease associated with these practices by 50% of baseline in villages that primarily use honey buckets for human excreta collection, transport and disposal. The determinant will be the number and frequency of person contact points with human excreta in collection, transport and disposal resulting in exposure to disease.

The process activities will include:

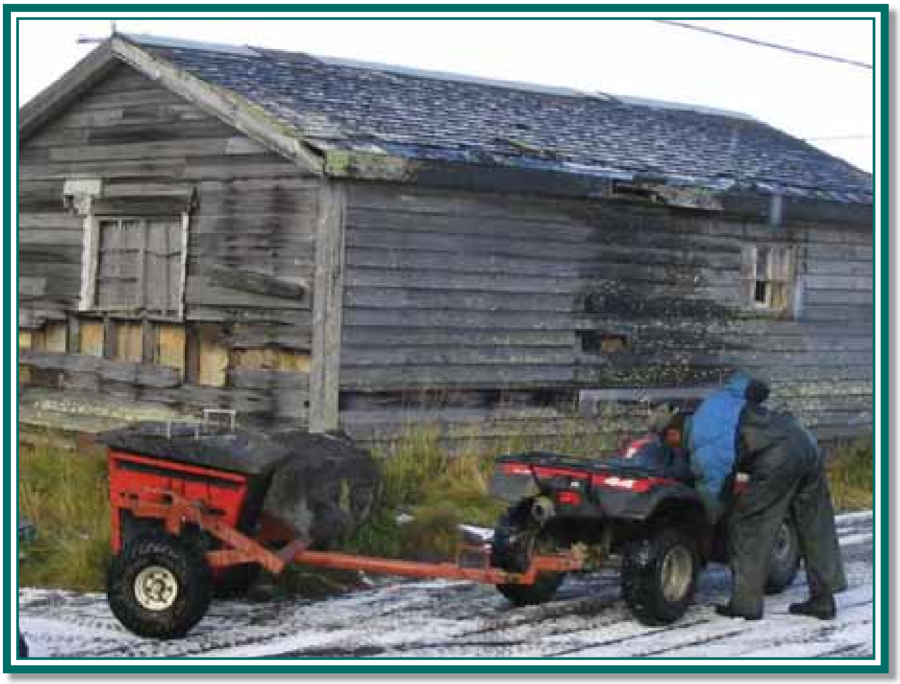
- Developing a metric for human excreta disposal practices in the use of honey buckets (See Figure 2 – Draft Sanitation Practice Index).
- Developing and implementing a questionnaire to elicit information from villages regarding sanitation practices, including general levels of concern, perceived barriers to improvements, and possible solutions for improvement.
- Implementing a participatory process with villages to identify community based measures to improve sanitation in the use of honey buckets.
- Establishing a coalition of service providers to make resources available for implementation of community based measures to improve sanitation using honey buckets.

The Sanitation Practice Index serves two purposes. For the village it tells the story (on one page) of what can be done to achieve sanitation practices that are more protective of the health of the people in the village. For the environmental health service providers it serves as a valuable tool to measure an environmental public health outcome (reduced exposure to human excreta) related to the use of honey buckets.

The idea of the Sanitation Index as a tool to measure environmental public health status has been applied in two other areas. A Water Haul Index has been drafted and uses as a measure the potential for pathogen introduction to water transported and stored in homes in villages. The scoring is based on four variables: water source, method of transport, in-house storage, and in-house disinfection. In addition, a waste burning index has been developed. The Waste Burning Index uses the measure of potential for inhalation exposure associated with various solid waste burning practices in villages. The four variables that are scored include: separation of waste, type of burn unit, distance of burning from homes, and operation of burn unit.

Process milestones

- December 1, 2008 – complete sanitation practice questionnaires with 50% of the villages;



Honey bucket haul trailer and all-terrain vehicle.

- December 1, 2008 – work with 50% of the villages to determine a sanitation practice index score for each village – the index score will reflect the number and frequency of potential person contact points with human excreta in collection, transport and disposal for each village;
- April 15, 2009 – work with 10% of the villages to identify community based measures to improve sanitation in the interim between the use of honey buckets and the implementation of a piped water and sewer services – two pilot project villages will begin to implement their measures;
- September 15, 2009 – partnerships between villages and service providers will fund implementation of community based measures in 10% of the villages;
- December 31, 2010 – complete questionnaires in all of the villages and identify community-based measures – all of the villages will begin or continue to implement their measures with the assistance of service providers.

Conclusions

All villages in Alaska fall along a continuum (of capability) to manage, operate, and maintain services and infrastructure. Some villages have greater capability and some less capability. For most villages this is a dynamic continuum. Changes in variables such as leadership, personnel, and local economy can result in immediate, and dramatic movement along the continuum in either direction.

The approach in working with villages acknowledges the community dynamics. The approach is based on the following reasoning: 1) capability can be built starting at any point along the continuum; 2) the best place to start is at a point the village identifies; and, 3) a village identified starting point is more likely to lead to a sustainable outcome. *(Sarcone and Miller, ANHB, O&M Demonstration Project Final Report, 2000)*

Images courtesy of Simone Sebalo and Lynn Zender, Zender Environmental Health and Research Group.

THE RAVEN RECYCLES IN WHITEHORSE, YUKON

Raven Recycling building.

Introduction

Solid waste management continues to be a challenge for communities across the north and the south. Certainly, while landfill burning is a distant memory for southern communities, it remains a common practice in the north. Incremental improvements to open burning are being made with the application of burning vessels in the Yukon (See article in NTWWA Journal, 2006), and selected burning in the NWT and Nunavut. Environmental legislation is pushing communities to stop burning altogether; however, this legislation has not been complimented with significant alternatives for waste management, such as recycling.

One significant success story for recycling in the north has been Raven Recycling in the Yukon. This "grass-roots" organization has grown from simple beginnings in 1989 as the Recycling Committee of the Yukon Conservation Society to an independent private enterprise with almost 20 employees. Things have changed a lot since then, such as the introduction of beverage container legislation in the Yukon in 1995. Raven now accepts over 30 different commodities to be recycled. Acting from their mandate to divert waste from the landfills of the Yukon, Raven ensures that any surplus funds from recycling profitable commodities (such as aluminum) are spent on recycling items that lose money (such as magazines).

The Raven Recycling Society is the central recycler in the Yukon Territory for household and commercial waste, while there are currently 19 recycling depots and 3 material processors in the Yukon.

Limited recycling success in Nunavut and growing success in the NWT

Recycling in Nunavut has been initiated

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Senior Planner and Engineer, Earth Tech Canada

with limited success over the past decade. In 2005, the City of Iqaluit pulled the plug on Nunavut's only door-to-door recycling program, and replaced it with a voluntary system. Only a fraction of the city's total annual garbage collection, about 60 out of an annual total of 6,000 tonnes, ended up in the blue bags and plastic boxes used to separate recyclable materials. The recyclables cost the city $7,800 a tonne to get rid of, which is more than 35 times higher than the cost of $200 a tonne to dispose of trash at the dump.

Other communities across Nunavut are making efforts to divert waste for recycling, however this is a slow process and will ultimately depend upon assistance from senior government to be sustainable.

In the Northwest Territories, as of the end of 2007, residents had turned in more than 50 million beverage containers for recycling since a beverage container return program was established in 2005, following the enactment of beverage container legislation in 2005. This program results in 82 per cent of all beverage cans and bottles sold being recycled, putting the territory's recycling rate on par with other Canadian jurisdictions.


Raven Recycling drop off.

The Raven keeps some beverage recycling entirely local

In the beginning, the Raven's Pop Can Depot was run entirely by volunteers. A single penny refund was given only on pop-cans, with the funds coming from the committee member's own pockets. Raven essentially set the stage for the beverage container legislation, which did not follow until 1995.

Consider the recycling of an empty Yukon beer bottle. Some of the domestic beer bottles that are brought into Raven for the ten cent refund end up just three blocks away at the brewmeisters of the Yukon Brewing Company Ltd. Here, the bottles are washed, sterilized and refilled with brews such as Arctic Red, Yukon Gold and Chilkoot Lager. Bottles surplus to Yukon Brewing's requirements are shipped to southern breweries for reuse.

Aluminum from beer and pop cans is reused on this continent, thanks to the large aluminum company Alcan. Raven bales all the pop and beer cans dropped off for refunds into small compact blocks.

Other recycling and recycling initiatives

Raven purchases the ABCS's of scrap metal. These letters stand for aluminium, brass, copper and stainless steel. Recyclers bring their aluminium, copper, brass and stainless steel to Raven Recycling, where they are paid a price by weight of material.

Plastics, such as yogurt tubs and margarine containers, get shipped straight to processors in the lower mainland of British Columbia. There, the plastics are ground into small sizes, decontaminated, washed, pelletized and blended with other plastics to make whatever recipe the eventual purchaser wants.

Paper gets shipped to brokers in the lower mainland of British Columbia. The paper brokers shop around until they can find the best price for Raven's paper. Recently, all of the bales of paper that Raven has sent south to the brokers have ended up in the People's Republic of China. It is used in their mills to make new paper products.

The future of the Raven

The future of the Raven looks very bright, with their revenue funds spent on research, consulting, public and school education programs, and advising various levels of government about the benefits of waste Reduction, Reuse and Recycling.

Established recycling initiatives of Raven, such as the corporate "PaperSave" pickup program, are continuously re-evaluated to improve the efficiency and quality of paper recycling in the Yukon.

An interesting quirk of the recycling trade is that the Raven is one of the territory's largest bulk exporters. In 2002, Raven shipped the equivalent of 464 semi trailers worth of loose recyclables outside the ter-

Raven Recycling operating yard.

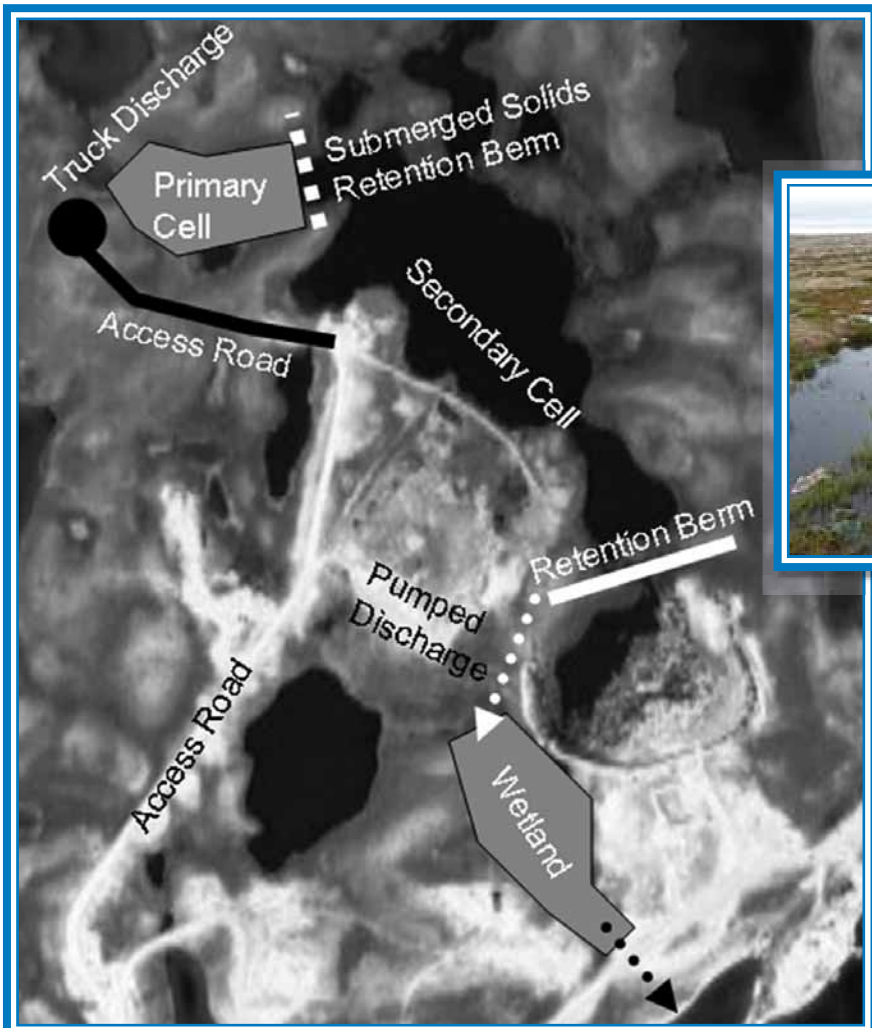
Raven Recycling swap area.

ritory for recycling and reuse; in 2005 the shipments were equivalent to 578 semi trailer loads.

Throughout the years, Raven has established the viability of recycling, and continues to be the groundbreaker in accepting and processing new and different recyclable items.

The future of the Raven looks very bright, with their revenue funds spent on research, consulting, public and school education programs, and advising various levels of government about the benefits of waste Reduction, Reuse and Recycling.

WETLAND PLANNING STUDY, CAMBRIDGE BAY, NUNAVUT



Left: proposed Cambridge Bay lagoon configuration.
Below: existing wetland vegetation in Cambridge Bay.

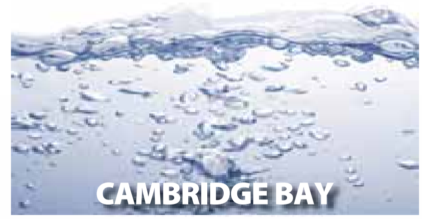
Introduction

Cambridge Bay, Nunavut has been planning for upgrades to their sewage lagoon systems, which will include a wetland area. As part of the design stage, a wetland planning report was prepared to estimate the effluent water quality improvement that an engineered wetland project would achieve.

The study provides a unique look at wetland water treatment in cold climates. Treatment in a wetland is generally the result of a number of processes, such as settling, filtration, and bacterial action. These processes are aided by the presence of wetland vegetation, which is expected to be relatively sparse at the Cambridge Bay wetland due to the northern climate; however, such vegetation does now exist in the depression ponds within the proposed wetland footprint. Some of these processes (mainly biological) occur much more slowly in cold temperatures, and the calculated water quality improvement was based on information and models from more southern climates. However, it is possible to predict the biological treatment efficiency of the Cambridge Bay wetland by applying temperature coefficients and predicting very low rates for biological processes compared to rates used in warmer climates.

Proposed lagoon and wetland system

In 2005, the sewage treatment facilities at Cambridge Bay consisted of three natural lagoons with a total capacity of 71,800 m3, and a limited wetland area. The Government of Nunavut realized that this existing sewage treatment system would not meet the needs of the projected population in 2020, and decided to investigate potential improvements to the lagoon system. Earth Tech Canada was retained for this planning related work.



By Robert H. Kadlec, PhD., P.E.,
Wetland Management Services, Chelsea, Michigan
Edited by Cortney McCracken, EIT, Earth Tech Canada

The proposed configuration for the future lagoon system includes primary and secondary retention lagoons with 120,000 m3 of storage volume, and constructed wetlands which will convey and further treat the water prior to discharge to the north arm of Cambridge Bay. The 2.93 ha wetland will be constructed by berming the flow path from the lagoons to the sea, and excavating existing land features as needed. Discharge from the lagoons will be continuous during the summer season of approximately three months duration. During this time, the 3 hectares of wetland in the flow path of the effluent (estimated to be at a mean depth of 30 cm) will provide about two weeks of detention in the wetland.

Wetland forecasting procedure

Constructed treatment wetland design generally involves three elements: hydrology and hydraulics; consideration of the pollutant and hydraulic loadings; and first order removal models. The Cambridge Bay forecasting calculations were implemented via spreadsheets on a desktop computer because of the level of detail required in the modeling procedure.

The first step in predicting the wetland performance was a seasonal water budget calculation to examine how much water is present at various points in the wetland. This procedure took into account variables such as rainfall, evaporation, and plant transpiration, as well as the inlet water flow.

The next step was a review of the influent contaminant loads based on data taken in prior years at the lagoon discharge point. The wastewater from the community is high strength due to restricted use of water; however, the water reaching the wetlands will have much lower contaminant concentrations as a result of the extended lagoon treatment. The contaminant removal achieved by the wetland was calculated using pollutant mass balances, which required the selection of removal rate coefficients for each contaminant.

Contaminant removal rate coefficients

SUSPENDED SOLIDS

A major function performed by wetland ecosystems is the removal of suspended sediments from water as it moves through the wetland. These removals are the end result of a complicated set of internal processes. Some of these processes, such as resuspension and "generation" of suspended material, may increase the suspended solids at any point in the wetland. Temperature has little effect on suspended solids wetland treatment. Accordingly, an estimated rate coefficient of 50 m/yr was chosen, which is sufficiently high to drive the wastewater TSS down close to the background value of 10 mg/L.

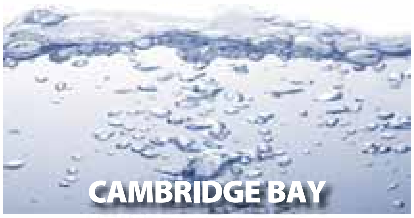


Table 1. Expected Water Quality Entering and Exiting the Engineered Wetland at Cambridge Bay After Lagoon Redevelopment

		CURRENT CONDITIONS		2025 CONDITIONS	
		From Lagoons	Wetland Outlet	From Lagoons	Wetland Outlet
TSS	mg/L	50	13	75	18
BOD	mg/L	30	9	50	16
TP	mg/L	2.5	2.1	2.5	2.2
Org-N	mg/L	5	3.1	5	3.5
NH4-N	mg/L	10	9	10	9
NOx-N	mg/L	0.5	2.7	0.5	2.2
TN	mg/L	15.5	14	15.5	15
TKN	mg/L	15	12	15	13
FC	#/100ml	1,000	70	1,000	100

CARBONACEOUS BIOCHEMICAL OXYGEN DEMAND

The Cambridge Bay wetland is expected to receive moderate incoming carbonaceous biochemical oxygen demand (CBOD5). As temperature effects have been found to be minimal, the rate coefficient was selected as 30 m/yr, which is the 40th percentile of the distribution across other wetlands. This rate coefficient is sufficiently high to drive the wastewater CBOD5 down to 9 mg/L under current conditions and 16 mg/L for future flows in 2025.

NITROGEN

There appears to be little or no temperature dependence of organic nitrogen k-values. However, ammonia nitrogen removal in Cambridge Bay is likely to be achieved primarily by microbes which are very temperature sensitive. Therefore, relatively low rate coefficients were selected for nitrogen processing. The result is that the Cambridge Bay wetland shows lower total nitrogen (TN) removals than the comparison database, which reflects more southerly, warmer conditions.

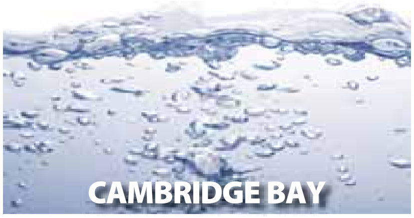
PHOSPHORUS

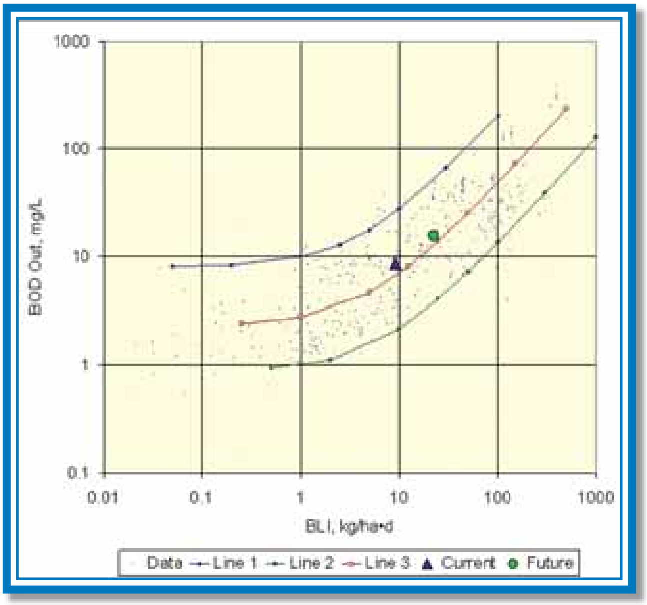
Phosphorus (P) is a nutrient required for plant growth. There are two direct effects of vegetation on phosphorus processing and removal in treatment wetlands: the plant growth cycle seasonally stores and releases P, thus providing a "flywheel" effect for a P removal time series; and new, stable plant residuals are created, which accrete in the wetland (these residuals contain phosphorus as part of their structure, and hence accretion represents a burial process for P).

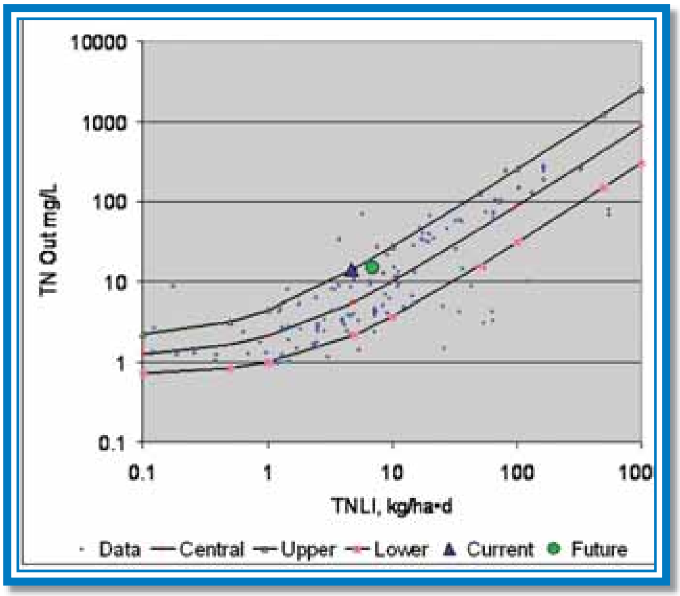
As most phosphorus removal is due to the burial of plant residuals, it is dependent on the size of the plant growth cycle, which is anticipated to be rather small for this far northern site. Accordingly, there will be a lower phosphorus removal at Cambridge Bay compared to southern wetland systems.

PATHOGENS

Wetlands have been found to reduce pathogen populations with varying, but significant, degrees of effectiveness. Bacteria in wetlands can be killed by ultraviolet radiation, consumed by nematodes, rotifers and protozoa, or removed along with particles in settling and trapping. Based on currently available treatment wetland data, pathogen removal is evidently not dependent on season or temperature.







Above: present and future BOD removal in Cambridge Bay compared with accumulated wetland performance data.
Right: present and future nitrogen removal in Cambridge Bay compared with accumulated wetland performance data.

Estimated wetland water quality improvements

The new wetland system in Cambridge Bay is expected to complement the proposed lagoon system and provide good effluent water quality improvement, especially for CBOD5 and total suspended solids (TSS). Despite Cambridge Bay's northern climate, CBOD5 and TSS removal are likely to be comparable to wetlands in other climatic regions, though nutrient removal will be less. Some removal of pathogenic organisms is anticipated, as there will be ample sunlight to promote UV disinfection in the wetland, as well as die-off due to cold temperatures. A two-log reduction (99%) is expected.

The forecasts for effluent water quality at the downstream end of the wetland are given in Table 1.

Conclusions

The water reaching the Cambridge Bay wetland will have been subjected to very long detention time in the proposed lagoon system, which will provide a good degree of wastewater treatment capability. The wetland will then allow further effluent water quality improvement, with particularly good results (results typical of southern treatment wetlands) predicted for CBOD5 and TSS removal.

COLD REGION MUNICIPAL WASTEWATER TREATMENT WORKSHOP, 2007

Indian and Northern Affairs Canada (INAC) is appreciative of the Northern Territories Water and Waste Association's (NTWWA) efforts to promote best practices in the design and operation of municipal water and waste treatment infrastructure. At the NTWWA Annual Conference, held in Iqaluit, Nunavut in November, 2007, the department hosted a cold region municipal wastewater treatment workshop. This workshop addressed the design and operation of sewage lagoons, baseline geotechnical and geothermal data collection and interpretation methods, the design and operation of treatment wetlands, and reviewed a case study of a sewage lagoon recently constructed in Carcross, Yukon. These topics were presented by experts in cold region municipal wastewater treatment. A cold region municipal wastewater treatment workshop was provided because it is important to promote healthy communities and responsible environmental stewardship in Canada's north.

Dr. Dan Smith presents information on the appropriateness of sewage lagoons in cold regions.

D. W. Smith of UMA Engineering Ltd. presented Lagoons in Cold Regions: Processes, Designs, and Operational Methods. This presentation discussed the appropriateness of sewage lagoons in cold regions, how wastewater is treated in a lagoon, and what should be considered when designing and operating a sewage lagoon. Smith described lagoons as being one or more wastewater holding areas designed to allow sufficient opportunity and time to permit physical, chemical, and biological processes to occur, leading to reductions in organic matter, inorganic matter, nutrients, and indicator and pathogenic micro-organisms. Sewage lagoons are complicated systems because of the many processes that take place to treat wastewater; though they are simple to operate and can produce acceptable wastewater effluent if basic design and operation principles are followed. Smith's recommendations are very useful and should be considered when designing and operating wastewater treatment lagoons in cold regions.

S. Aggarwal of Trow Associates Inc. and J. Oswell of Naviq Consulting Inc. presented Geotechnical and Geothermal Aspects of Sewage Lagoon Design and Construction in Permafrost Conditions. They emphasized that environmental site characteristics must be considered when designing sewage treatment systems. Aggarwal discussed the geotechnical aspects of selecting appropriate areas to construct sewage treatment facilities. Soil types, moisture content, and ground temperatures were addressed. Oswell discussed the value of geothermal models when designing a sewage lagoon. Geothermal modelling is an engineering tool that provides an estimate of thermal conditions over time. Through the collection and interpretation of surface temperature, geothermal gradient, and climate warming data, sewage lagoons can be properly designed.

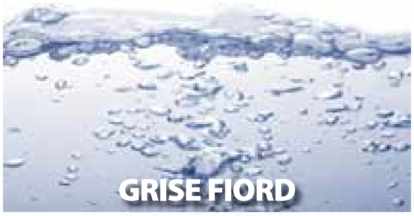
J. Higgins and M. Liner of Nunami Jacques Whitford presented Treatment Wetlands for Wastewater Treatment in the Arctic. Treatment wetlands are commonly included into the design of cold region

By David Abernathy, Indian and Northern Affairs
Water Resources Regional Coordinator,
Kitikmeot/Kivalliq Region, Nunavut

sewage treatment facilities. Much like lagoons, complex processes occur within treatment wetlands, though they are simple systems that provide effective sewage treatment when properly designed and operated. The operation of treatment wetlands is restricted to warmer periods, requiring wastewater to be stored in lagoons throughout freeze-up conditions. Certain aspects should be considered when constructing a treatment wetland, all of which relate to site conditions. Having adequate space, flat terrain with a minor slope, and existing vegetation is preferred. Once an appropriate site has been selected, berms should be constructed to evenly distribute the flow and maximize the treatment time. Treatment wetlands are one method of treating sewage, and when incorporated into a wastewater treatment system which includes a lagoon, they can provide excellent secondary treatment.

G. Bull of Gartner Lee Ltd. presented Northern Climate Sewage Lagoons – A Case Study. The design, construction, and operation of the Carcross, Yukon sewage lagoon was discussed. In 1998, the community of Carcross / Tagish First Nation and the Yukon Government decided to construct a lined lagoon system followed by a slow rate infiltration land application system. The aim of this system was to not directly release any sewage effluent to receiving surface waters. The design of this wastewater treatment system was based on the Alberta lagoon systems database, University of Alberta graduate student research, and selected lagoon models. The Carcross wastewater treatment system has an interesting design that incorporates both oxygen depleted (anaerobic) lagoons and long-term storage lagoons.

The Cold Climate Municipal Wastewater Treatment Workshop was a great opportunity to discuss best practices in municipal wastewater treatment infrastructure relevant to Canada's north. Excellent presentations on sewage lagoon design, baseline geotechnical and geothermal data interpretation, treatment wetland design, and a northern sewage lagoon case study were provided. Copies of these presentations and written abstracts are available on the NTWWA's 2007 Annual Conference Proceedings compact disk. Through research, communication, and best practices in cold region municipal wastewater treatment, we can support healthy communities and responsible environmental stewardship in Canada's north.



WATER SUPPLY CHALLENGES IN GRISE FIORD, NUNAVUT

Grise Fiord is Canada's most northern community at 76° 25' 08" North latitude, a mere 1500 kilometres from the North Pole. Grise Fiord must be differentiated from the weather stations and stations further north such as Eureka and Alert because it is the permanent home to 140 Canadians. Community infrastructure is tough to maintain at this latitude, and it was made "tougher" in spring of 2008, when residents of the community were forced to use icebergs as their potable water supply as they dealt with a severe water shortage.

Grise Fiord must replenish its water supply during a brief 3 week window in the summer when glacier melt flows sufficiently to fill several large tanks with capacity enough to supply the community for 12 months. The tanks must then be heated at considerable expense for almost 12 months. Coupled with a population base that is too small to absorb the same base infrastructure costs borne in other communities, Grise Fiord has some of the highest water costs in the country with a rate of approximately 4.5 cents per litre. The cost of water in Ottawa is approximately 0.1 cents per litre – water in Grise Fiord is about 45 times more expensive than Ottawa.

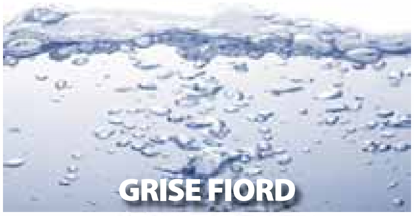
Location of water tanks and season water supply in Grise Fiord.

Harvesting ice blocks from iceberg using a loader.

This water shortage has happened to the community before in 1997, and 2000. In 1997 the Hamlet placed residents on half-rations of water in a bid to stretch dwindling supplies into midsummer. Conservation efforts began in April after the Hamlet's 5.9 million-litre reservoir was being depleted faster than usual. The second tank stood empty because the river froze at the end of the summer in 1996, before it could be filled.

Up to the late 1970's iceberg ice was the community's sole water supply from late September through June. At a community meeting in 1975 the community council was asked what water supply improvements they would like to see. The council replied, through an interpreter, that they would like some more of a certain tool that they had found in the school that they found to be ideal for harvesting chunks of ice off icebergs. Unfortunately the tool had been lost and they had no name for the device. After much discussion is was determined that the tool was a fire axe - the engineering consultant at the time, who was doing a water supply study, sent them two fire axes.

Thirty years later, the community was once again reverting to this "old technology" for an interim potable water supply. The community would normally have the two huge water tanks filled with glacial

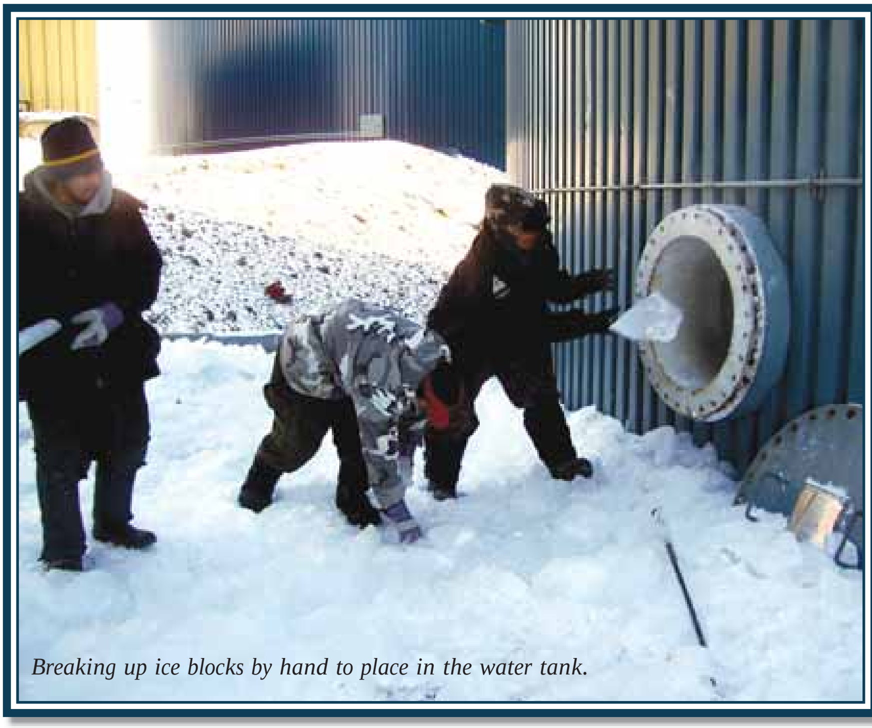


Loaders were used to break blocks from the iceberg and haul them into the community, where four people chipped them into smaller pieces and put them into the tanks. It was estimated that the essential endeavour would cost about $60,000.

Hauling ice blocks to community 6 kilometres away.

runoff to last them for 12 months from the tank filling in June of each year. Unfortunately maintenance work and a lack of rain in the summer of 2007 left the tanks under-filled.

Grise Fiord officials issued an advisory urging residents to conserve water, while a six-kilometre ice road was built to the Hamlet's new water source — a massive iceberg. Loaders were used to break



Breaking up ice blocks by hand to place in the water tank.

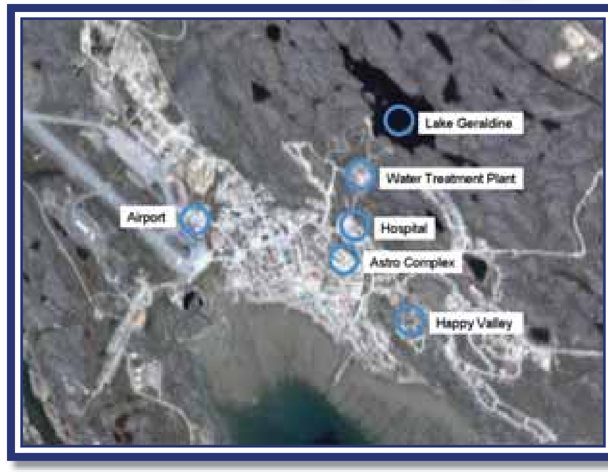
blocks from the iceberg and haul them into the community, where four people chipped them into smaller pieces and put them into the tanks. It was estimated that the essential endeavour would cost about $60,000.

The lack of water has also prompted residents to wonder what would happen should the problem recur. Climate change may become a factor in their situation, which they never foresaw a few years ago when we built these tanks. As well, the community may have to look for another source of water from other than the glacial runoff.

It is interesting to note that for some of the residents, iceberg water is the preferred source of potable water, particularly for making tea because of the absence of chemicals. Each autumn as the ocean freezes, icebergs become trapped in pack-ice three or four kilometres from the Hamlet. Blocks of fresh-water ice may be hacked away with an axe or chisel, and carried back to the settlement in qamutiks (sleds), towed behind snowmobiles. One qamutik-load equals about 410 litres of water.

THE DEVELOPMENT OF WATER AND SEWER INFRASTRUCTURE IN IQALUIT, NUNAVUT

THE RUSSIANS ARE COMING



Water and sewer infrastructure features in Iqaluit.

The oldest existing water supply infrastructure in Iqaluit dates from the early Cold War. Specifically, the water treatment plant and the Lake Geraldine water storage date from DEW Line era of the 1950's. In fact, the original drawings for these facilities carry the approval of the USAF.

The water treatment plant was constructed adjacent to the power plant that provided both electrical power and heat. The supply watermain was shared by the water and power plants, and cooling water from the power plant generators was returned to the lake. This shared intake arrangement assured flow in the supply main and tempered the influent water prior to treatment. Water was conveyed from the water treatment to connected users via a system of above ground utilidors and pipelines. The design and operating criteria of this era was "Heat 'er good and keep 'er flowing." Despite being the least favoured freeze prevention technique, bleeding remains the freeze prevention technique for limited portions of the water distribution system. Bleeds are also occasionally used by operating staff as a contingency technique to resolve localized problems, especially during mid-winter conditions.

Government moves to the North

The next substantial step in the evolution of the Iqaluit water system occurred in the mid 1960's when the Commissioner of the Northwest Territories moved from Ottawa to Yellowknife. This represented a relocation of administrative responsibility into the North, and the need for an administrative centre in Iqaluit. Around this time construction of the Astro Complex occurred which included apartments, a hotel, an office building, and some community services including a swimming pool and retail space. The water distribution system constructed to serve this complex drew its supply from an above-ground utilidor. Water was conveyed through above ground pipes, and into the high rise complex. The watermains were constructed using asbestos cement piping. The above ground portions were installed in sheet metal boxes, which were filled with vermiculite insulation.

The great innovation introduced during this phase of servicing was the concept of recirculation and reheating. The watermain was paralleled by a copper recirculation line. A recirculation pump

By Farrell McGovern, P.Eng.
Consulting Engineer

Above left: insulated high density polyethylene sewer mains – collapsed main on right and undamaged main on left. Right: various access vaults prior to installation.

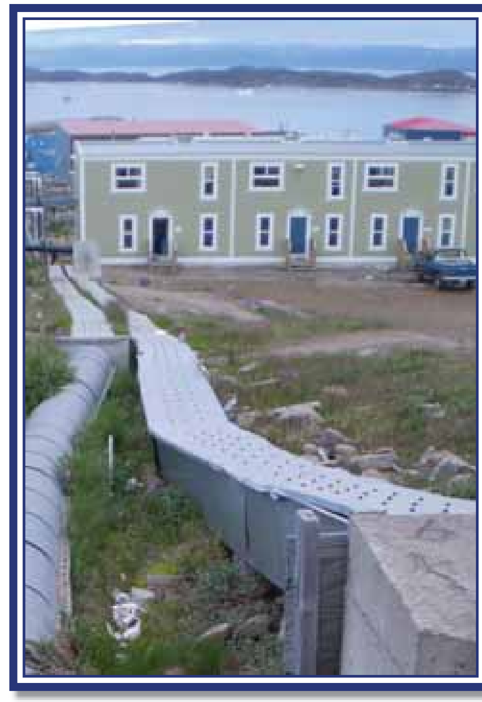
house was provided at the most remote point of the system, and a reheat and recirculation heating station was constructed. Much of this asbestos piping remains in service today. Portions of the copper recirculation piping have been replaced, but the recirculation and reheat arrangement remains substantially as installed.

Post Woodstock Iqaluit

The question of extension of the Iqaluit water distribution system was re-examined in the mid 1970's. Substantial residential growth had occurred both on the part of Housing Corporation and government staff housing. Four phases of extensions were constructed, bringing service to most of the lands south-east of the hospital. This servicing program represented the next great evolutionary step with the introduction of buried servicing. This innovation brought a host of benefits including the technical issue of avoidance of exposure to the extremes of wind and cold during winter conditions. The initial two phases included heated manholes and cross beams beneath the piping and manholes to mitigate the risk of thaw settlement. Buried installation was possible due to improved materials. Most notable among these was the use of piping that was pre-insulated with polyurethane. The later two phases represent the first use of pre-insulated high density polyethylene piping.

Beyond the innovations of improved materials and buried piping, the servicing of the 1970's recognized the merits of looping, especially as a means to facilitate circulation. As with all evolutionary processes, the later phases represent a better implementation of the concept of looping and circulation. A new reheat and recirculation station was provided near the hospital as a freeze prevention measure for the latter two phases of servicing installed in this era.

All of the fundamental concepts incorporated into the design of water systems in harsh climates were in place at the end of the 1970's. This includes buried high density polyethylene pre-insulated piping installed as a looped system with reheat and recirculation. The terminology of the business had also grown up.



Above ground water and sewer visible in Iqaluit today

The subsequent 30 years of engineering effort represent an era of continuing refinement and evolution.

A Municipal Utility

In the early 1980's the Iqaluit water system retained something of the nature of a government plumbing system. The system was in the ownership of the Government of the Northwest Territories. Almost all of its customers were agencies of various government bodies. In the early 1980's a series of discussions were initiated between the Government of the Northwest Territories and the Municipality. Ultimately an agreement was reached, and the Municipality assumed the ownership of the water and sewer system.

The mid 1980's represented a period of substantial extension of the piped water system. Servicing was extended from the area of the hospital towards the airport, into Happy Valley, and into the development area to the southwest along Apex Road. During the design of the servicing towards the Airport it was noted that there was no opportunity for looping. The selected solution was a recirculation main installed in parallel with the supply main. Recirculation and reheat was provided by equipment in the then Laundry (now Trigram) Building. During the design of Happy Valley it was recognized that designed arrangement of a supply and recirculation main substantially limited potential fire flow. In response a pressure reducing valve was installed at a second supply point. During normal conditions circulation was assured, while providing supply during unusual (fire) conditions.

The most substantial innovation of the 1980's was the introduction of the Access Vault as a replacement for manholes. These structures provided for better separation between servicing systems. Installation efficiency was sub-

stantially improved, and commissioning was less challenging as the vaults had been tested prior to shipment from the factory.

The 1990's and Beyond

The principle innovation of the 1990's was a change in engineering thinking regarding system layout. Looped systems became the preferred layout as opposed to supply mains with small diameter recirculation lines. The modest increase in cost was offset by a list of benefits including the opportunity to provide improved fire flow, and the improved redundancy of supply following the failure of individual segments of the system. In those instances where the street pattern was not conducive to a looped system, supply and return mains were provided that looped in and out of each dead end.

During the 1990's substantial effort was invested by the Municipality into the investigation of localized collapse of sanitary sewer piping. It was determined that greater burial depth (a minimum of 3 metres) would provide a more reliable environment from a thermal perspective. This moderately increased the depth of servicing installation, but also brought some improvement in the thermal environment surrounding the watermain. The watermains were now deep enough that seasonal temperature variations were small.

The Iqaluit water distribution system could have been characterized, at one time, as based upon well heated water flowing quickly through somewhat insulated above ground iron pipes. It can now be described using words like looped, buried pre-insulated high density polyethylene, factory manufactured access vaults and supported by recirculation and re-heat stations.

NTWWA 2008 President's Report

Sean Austman-Kunkel

Canada's North is one of the last "wild" areas in the world. Being as large as it is, with great sprawl between communities, the logistics of water and sewer treatment are paramount. With seasonal ordering and basic isolation, especially for much of the camp and rig water/sewer facilities, the goal of delivering clean drinking water and effective sewer treatment becomes all the more challenging.

With the ongoing challenges and ever changing regulations, water treatment in the North is a difficult endeavor. In the NWT we have a good ongoing training environment through MACA's School of Community Government. This helps to build our base of a trained and knowledgeable workforce. It also is the beginnings of networking in the north. The knowledge base is slowly growing here and the NTWWA is helping this along with our annual conference and operator's workshop.

Our conference allows people from all sectors of our industry and all corners of our country to share ideas and experiences. For a lot of the operators in the north, this is the one opportunity a year to really work through issues and have a plethora of information on which to draw. I, for one, really enjoy the ability to talk with all the operators and get some really useful hints and other information that simplifies a lot of the work that I do. The operator's workshop, which consists of practical instruction and tours, gives attendees the opportunity to see other treatment processes in action.

This is the 4th Annual NTWWA Journal, providing once again a chance for us to share our experiences over the last year with all of our loyal readers.

The 2007 NTWWA conference was held in Iqaluit. In case you are unfamiliar with the location, as I was when I traveled there, Iqaluit is located on Frobisher Bay on the SE corner of Ellsmere Island. Being the capital of Nunavut, Iqaluit is a bustling center with all amenities you would expect from a major North American city. With state of the art UV filtration in their water treatment plant, Iqaluit gave us all a glimpse of where our treatment processes are heading. Our keynote speech by Sheila Watt-Cloutier was very moving, giving all that attended an idea of the dramatic changes facing not only people in the eastern arctic, but soon the whole world. I for one was a great fan of the Traditional Throat Singers, which performed at our meet and greet.

I hope you enjoy reading this journal as much as we enjoyed producing it. I look forward to welcoming all of you to my home, Norman Wells, for the 2008 NTWWA Conference.

NTWWA 2008 Executive Director's Report

Olivia Lee

The NTWWA is pleased to release its 4th annual journal publication featuring articles relating to water, wastewater, solid waste, and water and wastewater infrastructure. The release of the Journal is one of the main goals and objectives of the Association and we hope that you find that it is interesting and informative.

The 2008 NTWWA Annual Conference, Trade Show, and Operator's Workshop, themed "Water: Education, Operation, Preservation" will be hosted in Norman Wells, Northwest Territories from November 1st to the 3rd. Water is the lifeline of all communities and the North is no exception. The water sources in the North are some of the most pristine in the world and we are all working to keep it that way, so mark your calendars and join us at the annual event to share ideas and learn about what is going on in the areas of water, wastewater, and solid waste in the North.

Last year the Annual Conference, Trade Show and Operators Workshop, held in Iqaluit, Nunavut, was a huge success with 97 delegates, including 10 trade show booths and 22 presenters. A big thanks to the City of Iqaluit, specifically Crystal Jones and Mike Bozzer, for all of their hard work coordinating the logistics of the 2007 NTWWA annual event. The delegates, presenters and trade show participants are what make the annual event such a success, so thank you for your participation. The Association has taken into consideration comments received from last year's participants and we are working to make the 2008 Conference an even bigger success.

Since 2005 the NTWWA has been hosting a friendly drinking water competition for the water treatment plant operators who attend the conference. The winner of the 2007 Drinking Water Competition was the Town of Norman Wells and they will be looking to hold on to that title at the upcoming conference, so all of you operators out there don't forget your water. After all, your community could be the next to take home the trophy.

I would like to take this opportunity to thank the NTWWA Board of Directors for keeping me on as the Executive Director again this year. I am grateful for the opportunity and experience. Every year we say goodbye to dedicated board members and welcome newcomers to the Board and this year is no exception. On behalf of the Board, I would like to thank all of the Board members that are leaving us for their dedication to bringing a northern perspective to the field of water and waste. To all of the new Board members, thanks for volunteering your time and efforts to the Board. We are excited to have new members with new experience, knowledge and ideas. Special thanks are due for the efforts of President Sean Austman-Kunkel, past President Heather Scott, the Journal's technical editor Ken Johnson, and our administrator Pearl Benyk.

I wish you all a wonderful read and hope to see you in Norman Wells.

WCWWA 2008 Director's Report

Ken Johnson

NTWWA members may have noticed a bit of a northern element appearing in some of the recent issues of the Western Canadian Water (WCW) magazine. The WCW editor has been encouraging the NTWWA to take an active role in the content of the magazine, and I have been responding by "recycling" articles from past issues of the Journal.

2008 marks a significant milestone for the WCWWA, with the celebration of 60 years of activity as an association – this is an outstanding achievement that all water and waste practitioners in the west and the north should be proud of. The 2008 conference in Regina will focus upon this achievement with a variety of historical presentations; the NTWWA is also taking an active role in the historical presentations with a conference presentation entitled "A Brief History of the Past 60 Years of Northern Water and Waste", submitted by yours truly.

You will notice that this issue of the Journal also has some historical content with the cover article on Inuvik, which is celebrating its 50th anniversary in 2008. Our role within the WCWWA continues to grow with continued participation in the WCWWA Board activities, and participation in the annual conference.

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