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Northern Wastewater Research

NTWWA

Northern Territories Water & Waste Association

Serving NWT & Nunavut

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Sampling in Grise Ford, Nunavut – photo courtesy of Rob Jamieson

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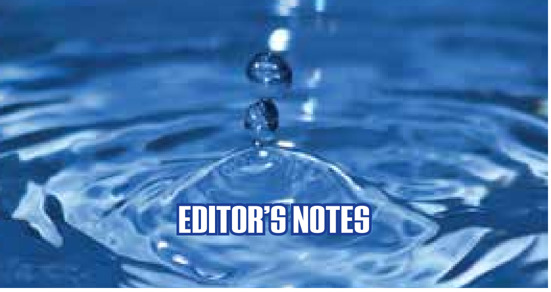

Editor's Notes
KEN JOHNSON

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Twenty five years ago, the Technical Studies program of the Department of Municipal and Community Affairs (MACA) of the Government of the Northwest Territories (GNWT) was still a fully funded program within the Department, and it was doing some good work. One of the benchmark documents of the program was the *Guidelines for Planning, Design, Operation and Maintenance of Sewage Lagoons in the NWT*. In 1990, I had just left the GNWT, and the responsibility I held for this program was inherited by Ron Kent, the founding father of the Northern Territories Water and Waste Association. Ron continued to manage the program for a couple of years until the financial priorities of MACA eliminated the funding for Technical Studies. Unfortunate as this was, it became the impetus for Ron to take matters into his own hands to pursue a technical platform for water and sanitation outside the influence of the GNWT, which ultimately became the NTWWA.

The loss of MACA's technical studies program created a gap in what had become a research related activity of the GNWT, which made use of the water and sanitation technical expertise of individuals such as Gary Heinke from the University of Toronto, and Dan Smith from the University of Alberta. This activity also provided research opportunities for a generation of graduate students from both the U of T and the U of A.

This gap has remained until the somewhat recent work by Fleming College as part of the legacy work of International Polar Year, and the work by Dalhousie University in partnership with the Government of Nunavut. Articles from both groups are highlighted in this edition of the Journal. In fact, the work by both of these institutes has advanced beyond the scope of MACA's Technical Studies program and brought a new generation of graduate students to the north. Several of these individuals are now employed by the Government of Nunavut.

For those of us who have maintained a keen interest in the research element of northern water and sanitation, these are exciting times. I would like to praise and thank the individuals and institutions who have supported and participated in this reignition of the water and sanitation research in the north. These individuals and institutions are providing a scientific basis for advancing the practical water and sanitation interests of the communities of the north, particularly Nunavut, which may be used as a reality check as the regulatory push from the Wastewater Systems Effluent Regulations (WSER) continues.

Iqaluit
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Northern Water: Keeping it Clean

FIRST ANNOUNCEMENT

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Iqaluit, Nunavut
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COME ONE, COME ALL water professionals to the NTWWA's Annual Conference and related events. The conference is the highlight of the year for water professionals across the north, which includes operators, engineers, technologists, suppliers, regulators, contractors, and administrators. The 2015 conference and workshop in Iqaluit will feature a conference with at least 20 technical presentations, and a two-day-long operator workshop.
We expect that once again the Great Northern Drinking Water Challenge will be a fun event, with communities competing for the trophy for the best water in the North.

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Operators earn Continuing Education Credits for attending the conference and the Operator s Workshop on November 23 and 24.

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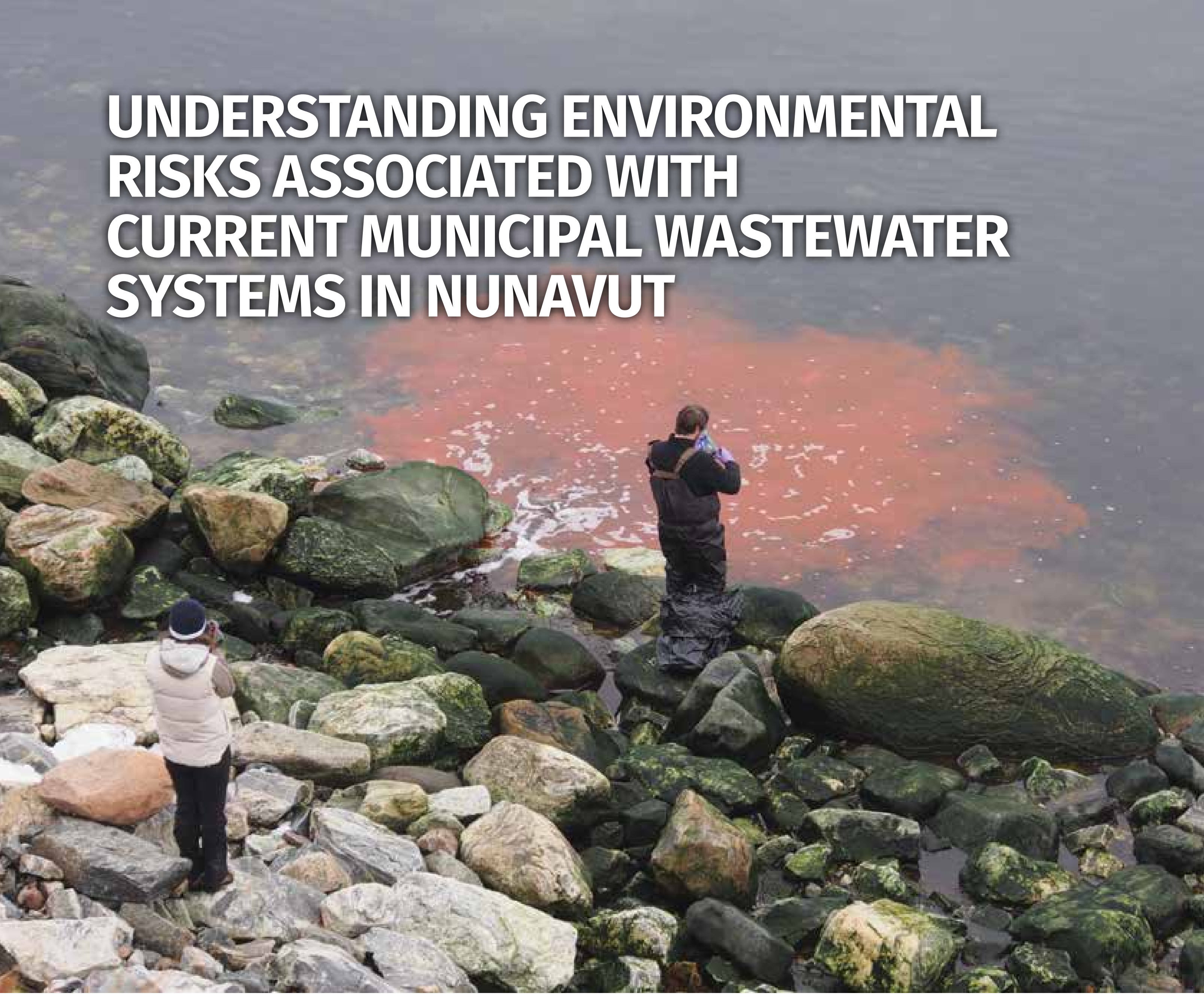
UNDERSTANDING ENVIRONMENTAL RISKS ASSOCIATED WITH CURRENT MUNICIPAL WASTEWATER SYSTEMS IN NUNAVUT



Dye tracer study conducted in Pond Inlet, Nunavut.

The Wastewater Systems Effluent Regulations (WSER) which have been implemented for the Southern regions of Canada include National Performance Standards (NPS) of 25 mg/L five day carbonaceous biochemical oxygen demand (CBOD5), 25 mg/L total suspended solids (TSS), and 1.25 mg/L unionized ammonia. These standards must be met by all municipal wastewater systems collecting, on average, greater than 100 m3/d. The primary stated goal of the WSER is to improve environmental and human health protection, and it has been assumed that the implementation of more stringent effluent quality standards will achieve this goal.

Within Nunavut, the typical effluent quality criteria that systems are currently required to meet are much higher than the WSER NPS (e.g., 120 mg/L BOD5, 180 mg/L TSS). Upgrading systems to meet the WSER would require considerable capital investment, and most likely a shift to the use of mechanical treatment plants, with associated increases in operation and maintenance requirements. The WSER recognize that the North is faced with unique circumstances and extreme conditions which affect wastewater treatment. As such, Nunavut and other Far North jurisdictions have been provided a window to investigate the effectiveness of Far North wastewater systems and what risks the effluent discharged poses to the receiving environment. Canada intends to implement performance standards for northern regions, but it is still unclear what level of treatment will be required of northern wastewater systems that will be captured by the WSER.

In 2010, the Government of Nunavut initiated a research project in conjunction with Dalhousie University. A major component of the municipal wastewater research program has focused on quantifying environmental impacts associated with current effluent discharges in Nunavut. Environmental Effects Monitoring (EEM) studies were completed in several communities in Nunavut, encompassing a range of community sizes, effluent

By Rob Jamieson, Kira Krumhansl, Wendy Krkosek, Mark Greenwood
Centre for Water Resources Studies, Dalhousie University,
and Justine Lywood, Government of Nunavut


Exposed tidal flat in Pangnirtung, Nunavut.


Benthic invertebrate sampling in Grise Fiord, Nunavut.

quality, and receiving water environments. The study sites included passive wastewater treatment systems that were intermittently decanted on an annual basis (Grise Fiord, Kugaaruk, Pond Inlet), and active treatment systems that have continuous discharges (Pangnirtung, Iqaluit). These studies included benthic invertebrate surveys, tracer studies to define how effluent mixes and disperses in receiving waters, and water quality monitoring.

Benthic invertebrate surveys were completed in all five communities. Benthic invertebrates are organisms that live on, or in, the sediments of aquatic systems. They are often used as biological indicators as they are easy to sample, have low mobility and are highly affected by their environment. The presence and absence of different benthic invertebrate species has been widely used to characterize the level of impact associated with sewage pollution. Within each community, samples were collected in the area where the effluent was discharged into the marine environment (impacted site), as well as in a comparable area that was not impacted by effluent discharges (reference site). For sites that did not have continuous discharges, sampling was conducted during decant events, which would represent worst-case scenarios in terms of exposure of benthic communities to wastewater effluent.

This study produced some very interesting results, providing valuable information on the relative impact that small northern community wastewater systems currently have on the environment. Of important consideration for the development of northern effluent performance standards is the research finding that the volume of wastewater discharged and the assimilative capacity of the receiving environment have a large influence on the magnitude of environmental impacts. The impact of effluent on

benthic invertebrate communities was much more pronounced in Iqaluit as compared to the smaller communities. The larger volume and lower quality of effluent discharged to Koojesse Inlet has resulted in sediment anoxia, and the complete absence of benthic invertebrates for a distance of 500 metres from the discharge location.

In the smaller communities (i.e., Grise Fiord, Kugaaruk, Pond Inlet, and Pangnirtung) however, only minor differences in benthic invertebrate communities between impacted sites and reference sites were detected. These differences typically only existed within 50 to 150 metres of the effluent discharge location. In general, within this range, the effluent produced a mild enrichment effect, with small or non-significant changes in invertebrate abundance and diversity. It was also interesting that the quality of effluent in these four small communities varied considerably, but the receiving water impacts were similar, illustrating that the volume of effluent has the largest influence on environmental health of the factors considered. The results from the benthic invertebrate studies are described in detail in Krumhansl et al. (2015). Tracer studies and water quality monitoring conducted at three of the sites (Pangnirtung, Pond Inlet, Kugaaruk) corroborated the benthic invertebrate results, demonstrating rapid dilution of effluent within the receiving water environments. The largest spatial extents of impact were seen in locations that had large tidal ranges (i.e., Pangnirtung) where effluent was discharged onto exposed tidal flats.

These research results should be carefully considered in the development of northern effluent performance standards. The reality for Nunavut is there exists unique wide-ranging terrain, climate, and socioeconomic challenges that shape wastewater treatment in the Territory. Establishment of stringent minimum performance standards will likely require a shift to active mechanical treatment, which will create a tremendous financial and operational burden for small, remote communities, while producing marginal improvements in environmental health given the small impacts that currently exist. The Government of Nunavut-Dalhousie wastewater research project will conclude in December 2015. A series of final reports, including the results from this work, can be obtained from the Government of Nunavut in early 2016 by contacting the Manager of Infrastructure Research, Community and Government Services.

REFERENCES

Krumhansl, K., Krkosek, W., Greenwood, M., Ragush, C., Schmidt, J., Grant, J., Barrell, J., Lu, L., Lam, B., Gagnon, G., and Jamieson, R. 2015. Assessment of arctic community wastewater impacts on marine benthic invertebrates. Environmental Science and Technology. 49(2): 760-766.

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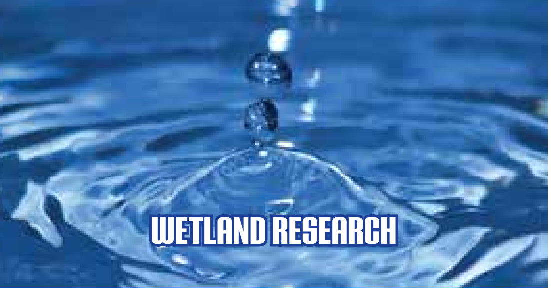

PAULATUK, NUNAVUT – WETLAND MANAGEMENT

Figure 1: Aerial view of Paulatuk treatment wetland delineating wetland boundaries and flow directions (see top right of photograph). The wetland extend approximately 350 m from the facultative lake to the ocean.

The management and treatment of municipal wastewater effluents is challenging in Canada's Far North. The harsh climate, remoteness and economic realities of northern communities can limit the treatment options that are available. In 2009, the Canadian Council of Ministers of the Environment (CCME) released the final draft of the Canada-wide Strategy for the Management of Municipal Wastewater Effluent, which details regulatory changes to be implemented through the Canadian Fisheries Act. However, the federal government recognized that conditions in portions of Canada's Far North (Nunavut, Northwest Territories, and regions located north of the 54th parallel in Quebec and Newfoundland and Labrador) are unique and as such performance standards in the Far North should reflect that uniqueness.

In many communities of the Far North, raw wastewater is hauled to wastewater lagoons (waste stabilization ponds) or facultative lakes, which are in most communities the primary method of treatment. The rate of microbial oxidation within the lagoons and lakes is typically slow due to the cold temperatures of the north, which often accelerates the rate of sludge accumulation. Over time, an increase in sludge can reduce the holding capacity of the lagoon meaning

By Gordon Balch, and Brent Wootton,
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Colin Yates, Waterloo Summit Centre for the Environment,
University of Waterloo, Huntsville, ON

that it may be necessary to decant the effluent before the desired treatment targets are achieved. In most communities, natural tundra wetlands exist immediately downstream of the lagoons. These wetlands are natural depressions supporting tundra vegetation or in some cases areas where native tundra species have grown in response to the nutrients released in the treated municipal effluents. In either case, most treatment facilities (lagoons, facultative lakes) discharge the treated municipal effluents into a "natural" wetland.

Although these natural wetlands are not and never were considered to be part of the treatment system, many have wondered if they provide additional treatment benefit, and thus may provide a unique treatment option for these remote communities. Constructed wetlands (e.g., intentionally engineered wetlands) have been used for decades in more temperate regions as a viable treatment method for a wide range of wastewater sources such as municipal effluents and wastewaters from the mining and agricultural sectors. The biological treatment processes are analogous to biological treatment processes used in larger municipal wastewater treatment plants utilizing activated sludge or fixed film bioreactors.

Although the biological treatment processes operative in natural tundra wetlands are similar to the processes in constructed wetlands, many operational and site specific conditions are different which could significantly impact treatment efficiency and limit the overall treatment benefit. For example, the tundra wetlands freeze solid for several months of the year during which time no treatment occurs. Many have questioned if the wetland have the ability to adequately treat a large inflow of wastewater during early spring when the accumulation of frozen effluents started to melt. In response to these and other questions the Centre for Alternative Wastewater Treatment (CAWT) began a four year study to assess the treatment potential of tundra wetlands in 13 northern communities within the Northwest Territories and Nunavut. Funding for this work was provided by the Canadian International Polar Year program and from Environment Canada. Additional funds from the Royal Bank of Canada – Blue Water Project helped to consolidate the study findings into a tundra treatment wetlands guidance document which can be downloaded at cawt.ca. The

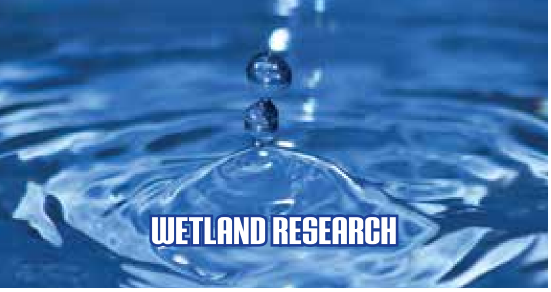


Figure 2: A view of the natural tundra wetland in Paulatuk downstream of Dead Lake (facultative lake).

CAWT is an applied researcher centre located at Fleming College, Lindsay, Ontario dedicated to wastewater treatment.

Paulatuk is a small isolated community of a few hundred people located in the Northwest Territories and one of the CAWT study sites investigated in 2009. The municipality of Paulatuk, NT discharges approximately 12,500 cubic metres of raw sewage per year into a facultative lake (locally named Dead Lake) which has an estimated volume of approximately 103,000 cubic metres. Daily outflow from the lake to the wetland approximates the volume of municipal effluent discharged into the lake, which averages about 34 cubic metres per day. The wetland, as shown in Figure 1, is approximately five hectares in size with a length of around 350 metres. The wet-sedge tundra is dominated by species of Carex and Poa with willow (Salix spp.) found in the drier upland boundary areas (Figure 2).

The wastewater generated by the community of Paulatuk received primary treatment from the large facultative lake (Dead Lake). As a result, the strength of the wastewater entering the Paulatuk wetland in 2009 exhibited an average concentration of 40 mg cBOD5 per litre, 3.2 mg total ammonia nitrogen (as N) per litre and 2.4 mg total phosphorus per litre. Effluent concentrations exiting the wetland were reduced to 2 mg cBOD5 per litre, while the concentration of total ammonia nitrogen was reduced to below the detection limits of 0.02 mg/L and total phosphorus to 0.04 mg/L. The augmentative wastewater treatment provided by the Paulatuk wetland along with most other wetlands studied by the CAWT demonstrates the added treatment benefits that these areas can provide.

Findings from the CAWT study indicate that natural tundra wetlands provide a passive, low cost, low maintenance option for the enhanced treatment of municipal effluents. The study also suggests that these natural wetlands could contribute significantly to a viable wastewater strategy for the Far North by formally recognizing the benefits provided by the natural wetlands in a hybridized treatment process that included both the lagoon systems plus the natural wetland. The guidance document generated by the CAWT provides modeling tools that can be used to predict treatment performance of the wetland receiving treated effluents from lagoon systems and provide guidance to maximize the treatment potential of the hybridized lagoon/wetland system. More about the how the SubWet 2.0 model can be used as a management tool for the lagoon/wetland hybridized system can be found in the companion article of this issue of this journal.

WATER LICENCE COMPLIANCE SAMPLING IN GJOA HAVEN, NUNAVUT

The Government of Nunavut has been assisting the communities of the Kitikmeot with the sampling required for water licence compliance. The drinking water testing for E. coli tests has been able to make use of the environmental mini-lab in Cambridge Bay, which is a facility managed by the GN Department of Health and Environment. The availability of this laboratory has helped the communities manage the timing issues with shipping samples south. However, we do not yet have the capability for testing of sewage samples due to the availability of the appropriate equipment and human resources in Cambridge Bay. Sewage samples are still sent to the Taiga Lab in Yellowknife. Given the proximity of the Kitikmeot Region to Yellowknife and the direct flights, we are managing to complete the expected level of monitoring, and the sampling results from the past two years (2013 and 2014) are demonstrating these improvements.

There are many challenges associated with the sampling itself, the shipment of sampling, and ultimately the regulatory requirements for wastewater monitoring in north. However, the experience with applying good techniques and attention to detail has been helpful in minimizing the problems associated with these issues.

The photos show wastewater sampling for sewage and solid waste runoff in Gjoa Haven with the hamlet staff and some of the sampling techniques used in the Kitikmeot Region for sewage and solid waste effluents. The sign in the photo identifies the water licence testing compliance point recorded in the water licence.

Notes and photos from Shah Alam, Municipal Planning Engineer,
Community and Government Services,
Government of Nunavut, Cambridge Bay

Dye tracer test in the Coral Harbour, NU wetland (June 15, 2011).

DEFINING THE ROLE OF TUNDRA WETLAND TREATMENT AREAS IN MUNICIPAL WASTEWATER MANAGEMENT IN NUNAVUT

Tundra wetland treatment area in Kugaaruk, NU (September 11, 2012).

Wetlands have often been referred to as "nature's kidney" because they can possess the ability to naturally attenuate contaminants. Some of the water quality improvement processes that can occur in wetlands include filtration, settling, off-gassing, UV disinfection, and microbial degradation. Seventeen of the 25 communities in Nunavut treat municipal wastewater with a lagoon (either an engineered wastewater stabilization pond or a natural pond) in combination with a tundra wetland treatment area. These wetlands are important components of Nunavut wastewater management systems, providing further treatment prior to discharge into marine and freshwater receiving environments.

Studies dating as far back as the 1970s have recognized the treatment potential of these arctic wetland treatment areas.

By Jenny Hayward, Rob Jamieson,
Centre for Water Resources Studies, Dalhousie University,
and Justine Lywood,
Government of Nunavut

However, until the past couple of years, little was known about the mechanisms contributing to treatment in arctic wetland areas. Furthermore, quantitative estimation of their potential treatment performance, and therefore inclusion into the regulatory process, was challenging due to a lack of information on parameters used within common engineering design tools. Dalhousie University and the Community and Government Services department of the Government of Nunavut initiated a study from 2011 to 2013 to fill in these knowledge gaps.

The tundra wetlands that receive primary treated effluent from lagoons are unique in that they are typically not engineered or "constructed" treatment wetlands. Their location and structure are largely determined by the natural landscape and the manner by which effluent is discharged into the wetlands. The boundaries of these systems are more difficult to define than constructed wetlands, as they are connected to the surrounding hydrological landscape. Therefore the characteristics of tundra wetland treatment areas are closely tied to the physical attributes of the landscape. In some cases, the act of discharge of effluent onto the tundra creates a wetland area that was not previously present. Despite their natural attributes, the tundra wetland treatment areas that receive effluent are distinctly different from natural tundra wetlands. These differences include their hydrological characteristics, biogeochemistry, nutrient availability, and vegetation.

The Dalhousie University studies focused on three tundra wetland treatment areas in Nunavut: Coral Harbour, Kugaaruk, and Grise Fiord. The Coral Harbour wastewater stabilization pond has permeable berms, therefore the wetland receives effluent at an uncontrolled rate throughout the treatment season spanning from mid-June to mid-September (Hayward et al., 2014). Whereas, the Kugaaruk and Grise Fiord waste stabilization pond have impermeable berms, therefore the systems have a controlled decant of effluent over a period of a few days to about a week. These studies involved detailed site-specific characterization of the physical, hydraulic, hydrological, and hydrogeological environments of each system and an assessment of the treatment performance.

Physical measurements involved topographic and vegetation surveys. Flow rates

Flow and water quality measurement in the Coral Harbour, NU wetland (June 20, 2011).

were measured at key points in the wetlands, especially at the inlets and outlets. Hydraulic tracer tests were conducted, which involves the injection of a non-reactive solute into the wetland at the inlet stream, and measuring the concentration over time, at a point downstream. This measurement allows for determination of key hydraulic parameters of the wetlands. Tracer tests were essential to determine the wetted areas available for treatment and the hydraulic retention times (HRT)—which is the average amount of time water spends in the wetland. Delineations of the wetland and watershed were performed based on the vegetation and topographic surveys. Water quality samples were collected from the inlet, outlet and intermediate sample points, and tested for an array of wastewater parameters (CBOD5, TSS, TAN, E. coli, pH, dissolved oxygen, etc.).

Favorable treatment performance was observed in the Coral Harbour and Kugaaruk tundra wetland treatment areas, where both systems reduced concentrations of the wetland influent CBOD5 by greater than 80 per cent. Contrastingly, the Grise Fiord wetland treatment area did not perform as well, with an average concentration reduction of the wetland influent BOD5 of 40 per cent. There were important differences between the three wetlands, in terms of their hydraulics and hydrology, that helped bring context to the treatment performance results. For example, the Coral Harbour wetland had seasonal changes in hydraulic loading rates and treatment performance. The worst case in treatment occurred during the spring when there were high flows coming into the wetland.

The watershed setting of each wetland was different and helped to explain the differences in treatment performance. The Kugaaruk wetland does not have significant

This study demonstrated that this type of model can successfully be used to assess potential treatment performance of tundra wetland areas.

external hydrologic contributions, because it has a very small watershed. However, the Grise Fiord does have significant dilution (20 to 40 per cent dilution measured) due to upstream external hydrologic contributions from a much larger watershed. The large contributing watershed area contributed to the short HRT observed and poor overall performance in Grise Fiord.

A tanks-in-series model (e.g. P-k-C*) with first order treatment rate kinetics is an industry standard modeling technique that is used to represent performance in treatment wetlands. Conceptually, this type of model represents the hydraulics in a wetland as a series of continuously mixed tank reactors. This type of model was modified by Hayward and Jamieson (2015) to represent the treatment rate constants and hydraulics in the Coral Harbour wetland. The modifications were necessary to account for the hydrological differences between constructed and tundra wetland treatment areas. Rate constants are used in wastewater system engineering to quantify how fast different contaminants are added to, or sequestered from the waste stream. The rate constants derived for the wetland were variable, but comparable to low range values derived from hundreds of other treatment wetlands in warmer climates.

This study demonstrated that this type of model can successfully be used to assess potential treatment performance of tundra wetland areas. The modeling approach can be parameterized with data collected from site-specific studies and used to estimate the treatment potential of wetland areas. Site-specific assessments of each individual site are recommended as a best management practice in order to reduce uncertainty in performance expectations. The assessment process should also place special consideration on the potential for seasonal changes in flow and performance.

Tundra wetland treatment areas play an important role in northern wastewater management by providing further treatment to primary treated effluent. The Government of Nunavut-Dalhousie wastewater research project will conclude in December 2015. A series of final reports, including the results from this work, can be obtained from the Government of Nunavut in early 2016 by contacting the Manager of Infrastructure Research, Community and Government Services. These upcoming publications will: (i) summarize the findings from the Dalhousie studies, and (ii) address design guidelines for tundra wetland treatment areas.

REFERENCES

Hayward, J. & Jamieson, R. 2015. Derivation of treatment rate constants for an arctic tundra wetland receiving primary treated municipal wastewater. Ecol. Eng. 82, 165-174. http://dx.doi.org/10.1016/j.ecoleng.2015.04.086

Hayward, J., Jamieson, R., Boutilier, L., Goulden, T., & Lam, B. 2014. Treatment performance assessment and hydrological characterization of an arctic tundra wetland receiving primary treated municipal wastewater. Ecol. Eng. 73, 786-797. http://dx.doi.org/10.1016/j.ecoleng.2014.09.107

ALASKA WATER AND SEWER CHALLENGE

In Alaska, the palette of existing water and sanitation systems includes washeterias and central water points, individual well and in-ground systems, water and sewer truck or trailer haul systems, and piped water and sewer systems. All of these systems operate on a user-pay principle with no operating subsidies, which is contrary to the operation of water and sanitation systems in the Canadian north.

Washeterias and central watering points are treated drinking water sources delivered to a single service connection and people must use their own containers to collect drinking water. The complementary sewage system to this water supply system is the honey bucket. Individual wells and septic systems make use of the favourable in-situ soil conditions where favourable ground conditions prevail. Trailer haul systems which are a scaled down version of a truck haul system, and utilize four-wheel all-terrain vehicles (summer) and snowmobiles (winter) to pull specially designed trailer-mounted water or sewage containers. A favourable aspect of the trailer haul system is that the pumping system uses vacuum cleaner motors.

Piped water and sewer systems is the standard service level in Alaska, which provides centralized water and sewage treatment with the piped distribution of water and piped collection of sewage.

The absence of in-home access to safe drinking water and sewage disposal is a documented cause of high disease rates, including severe skin infections and respiratory illnesses. Several recent Alaskan studies found that a lack of in-home piped water service is associated with higher incidence of respiratory tract and skin infections among rural Alaska natives.

Conventional, community-wide piped systems and truck haul systems are increasingly expensive to construct, maintain and replace. The available capital funding cannot meet the demand for new systems and rehabilitation of aging systems, which is estimated to be $750 million. As well, many communities cannot afford the high operation and maintenance costs associated with piped or haul systems. These emerging realities have prompted Alaska to embark on a significant program to develop and implement decentralized water and sanitation systems. This program has advanced under the name of the Alaska Water and Sewer Challenge.

The Alaska Department of Environmental Conservation's (DEC), Village Safe Water Program has retained six prospective companies to design, create and test an all-in-one water and sewer system. The competition for the prospective companies was unusual because it did not employ the typical request for proposals, but rather an expression of interest, which includes funding for the research and ultimately the development of a technology to the tune of over $20 million (US). The final six companies, out of an initial 18 that applied in the initial phase, have advanced to the competition's second phase, which will end with proposal presentations sometime in 2015.

From phase 2, a shortlist of three companies will be funded for testing and product development, with a winner chosen and possibly manufacturing new systems in the next four to six years.

More than 4,700 rural Alaska homes lack running water and sewage systems. The goal of the program isn't just to find a way for everyone in rural areas to have access to safe water. Large central pipe and truck systems,

By Ken Johnson, P.Eng., Planner, Engineer and Historian
Stantec Consulting

in use in most Alaska villages, are expensive to build and maintain for a community as a whole. It is hoped that whatever comes from the Alaska Water and Sewer Challenge will also be advanced to replace those systems.

The program's goal is a secure, safe source of at least 55 litres of running water per person, per day, that will cost no more than $135 per month for a home to run and maintain. Wastewater management has to be included into the design of the system and the system is meant to be fitted to individual houses, avoiding centralized water and wastewater management.

It is not anticipated that a "brand-new" technology will emerge from the competition. What is anticipated is that a linking of existing technologies will emerge that assembles potable water storage and delivery with conservation and wastewater management into one complete decentralized system capable of operating cost effectively in a cold region.

The partnerships retained in the phase 2 of the project are:

- Tetra Tech, a partnership of engineering firms and universities in Alberta, Canada, and Sydney, Australia.
- Lifewater Engineering Co., a Fairbanks-based company working with the University of Alaska Fairbanks' Cold Climate Housing Research Center, Campwater Industries, and AppTech Solutions.
- The University of Alaska Anchorage, with a large team including partners from the University of Colorado Boulder, University of Southern California, University of North Carolina and the Alaska Native Tribal Health Consortium.
- Dowl HKM Alaska, a large national engineering firm with offices throughout Alaska.
- Cowater Alaska, a decentralized water and wastewater speciality company that has partnered with Zender Environmental Health and Research Group and Garness Engineering.
- Summit Consulting Services, an Alaska engineering company that has partnered with facilitation firm Agnew-Beck Consulting.

The Alaska Water and Sewer Challenge is being managed by a working group consisting of DEC, the Environmental Protection Agency, the U.S. Department of Agriculture and Rural Development, Indian Health Service, the Arctic Research Commission, and the Tanana Chiefs Conference.

Stay tuned for updates in this program.

COLD WASTEWATER LAGOONS AND SAGR: A MATCH MADE IN CANADA

Every year, Canadians dump over 150 billion litres of untreated and undertreated wastewater directly into our waterways. Collected in one place, this would cover the whole city of Yellowknife to over a metre deep! Responding to this ongoing environmental concern, in 2012 the Canadian Government created the country's first national standards for wastewater treatment, the *Wastewater Systems Effluent Regulations (WSER)*.

WSER has left most Canadian wastewater lagoons non-compliant, and that hits the rural areas and smaller municipalities common to northern Canada the hardest. But in Misipawistik Cree Nation, located on the northwestern shore of Lake Winnipeg, they don't worry about WSER anymore, thanks to some good Canadian ingenuity.

How the rules have changed the wastewater game

Ammonia limits and tougher $CBOD_5$ limits are the main difference between WSER and earlier provincial discharge licenses (CBOD5 is short for "carbonaceous biochemical oxygen demand). Specifically, the new rules cap the amount of un-ionized ammonia (NH3) that can be discharged into fish-bearing waterways. NH_3 is toxic to fish even at low levels compared to its cousin NH_{4+} (also common in wastewater). But as water's pH and temperature increases, the less-toxic NH_{4+} turns into the more toxic NH_3. The same water that is safe in winter could kill fish in summer, and so seasonal ammonia discharge limits are common.

The result of these rule changes are significant. While many lagoon facilities meet the CBOD5 and total suspended solids (TSS) levels specified in their old permits, they now exceed these ammonia toxicity limits and find themselves out of compliance.

Misipawistik SAGR provides low operation and maintenance, while producing excellent nutrient removal.

How to get ammonia out (and why that's tougher here in the North)

Certain types of bacteria naturally consume ammonia and turn it into nitrates, a process known as "nitrification." But these bacteria like three things: warmth, a surface to grow on, and less food for competing bacteria (meaning $CBOD_5$ levels must be below 25 mg/L).

In a typical northern-Canadian lagoon, these conditions are in short supply. By the point in the treatment process where CBOD5 levels are low enough, there just isn't the warmth or real estate left for enough nitrification to occur, so the effluent water remains toxic from the ammonia.

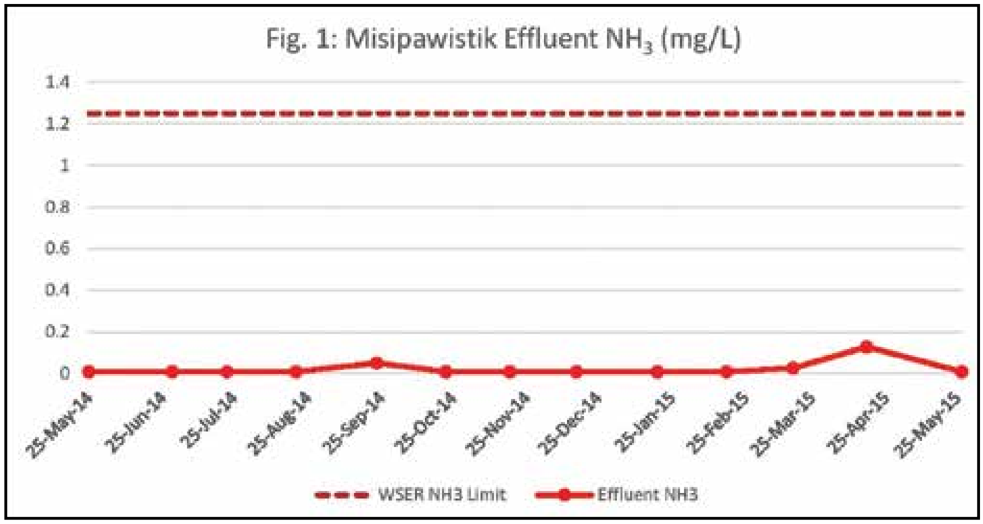
Fortunately, science and engineering has the answer. Winnipeg-based Nelson Environmental has developed a nitrification solution that works with existing lagoon-based treatment facilities in the water below the frozen surface. In some of the coldest populated areas of North America, inserting a Submerged Attached Growth Reactor (SAGR) into the process after a lagoon has been proven to provide full nitrification as well as partial disinfection.

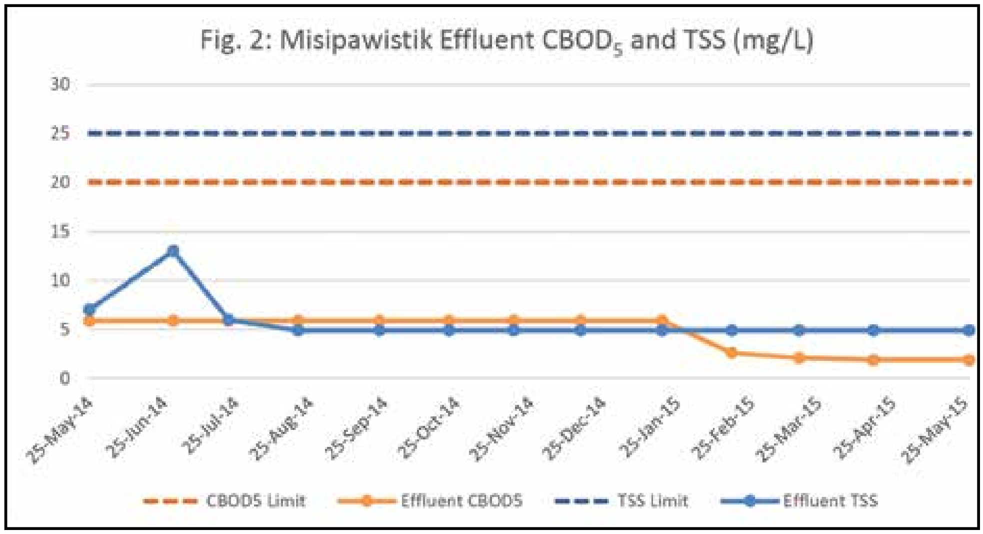
By Martin Hildebrand and Philip Wiebe,
Nelson Environmental

How a SAGR works in five sentences

The SAGR works by distributing the primary or secondary lagoon's effluent across an aerated aggregate stone bed, which offers ample real estate for nitrifying bacteria to call home. This consistently reduces ammonia to less than 1 mg/L despite the lagoons being covered in ice for the long winter.

The SAGR is designed to be forgiving, handling a wide range of water qualities without issue. If the lagoon has exceeded its original design loads and flows, a SAGR can further polish the influent water in addition to the nitrification. Even in water colder than 0.5°C, it drops $CBOD_5$ and TSS levels to less than half the WSER-allowed levels, and by significantly (99 per cent-plus) reducing Fecal Coliform and E. Coli it can eliminate the need for further disinfection.





The Misipawistik conundrum

Treating wastewater in small communities in Canada's north is challenging for more reasons than just the climate. There is only so

Treating wastewater in small communities in Canada's north is challenging for more reasons than just the climate.

much capital funding for upgrades, and since communities are often located in remote areas, it can be difficult to keep up basic levels of operator training and local expertise.

Misipawistik Cree Nation faced these challenges and more. Not only was its existing two-cell facultative lagoon already not WSER-compliant when it discharged seasonally, but a booming population meant they needed more capacity, and soon!

Designed by AECOM and Nelson Environmental, construction on the improvements began in the fall of 2013. Alum dosing was installed at the front end of the system to remove phosphorus, which would settle out in the first lagoon (which stayed facultative). Nelson Environmental installed OPTAER® fine bubble aeration into the second lagoon to take more CBOD5 and TSS out. Two SAGR beds were installed at the end of the system to provide year-round nitrification (and further scrub CBOD5/TSS).

How well did it work?

Water quality stats show the upgraded system operating on targets. The toxic ammonia levels are consistently one-tenth of the WSER limit, and $CBOD_5$ and TSS levels have also remained well below their caps (see Fig. 1 and 2).

But perhaps the most impressive part of the SAGR solution is what it takes to hit these targets, or better yet, what it doesn't take. It doesn't take moving parts beyond the blowers supplying oxygen to the process. It doesn't take sludge- and solids-removal, as they are digested internally. This means it doesn't take more than very basic operator training, and actually operating the Misipawistik facility doesn't takes much time either (less than 30 minutes per day for visual inspections and maintenance).

So despite all the factors working against northern communities (a climate that works against traditional ammonia removal, remote locations that make it difficult to bring in and train skilled operators, not to mention infrastructure that is rapidly being obsoleted or overwhelmed) Misipawistik Cree Nation now has a system that meets the most stringent federal effluent requirements with a low-tech, environmentally-responsible process. It seems Canada has a chance to solve its 150 billion-litre problem after all, and it can start with one northern lagoon at a time!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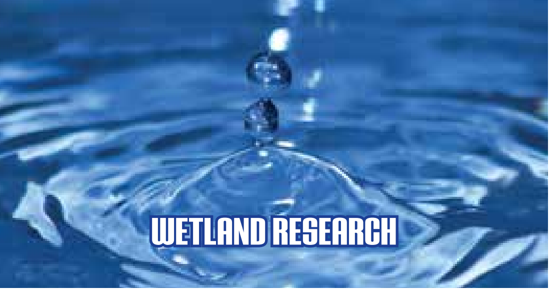

CHESTERFIELD INLET WETLAND MODELING

In 2008, the Centre for Alternative Wastewater Treatment (CAWT) began a four-year study to assess the efficacy of utilizing natural tundra wetlands to treat municipal effluents generated by remote isolated communities of the far north. The four-year study was funded by the Canada International Polar Year program, Environment Canada and the Royal Bank of Canada – Blue Water Project and was in response to CCME's Canada-wide Strategy for the Management of Municipal Wastewater Effluent and recognition that conditions in Canada's Far North are unique and that the strategy should reflect the uniqueness of these communities. The CAWT study demonstrated that most of the 13 tundra wetlands examined are providing significant levels of treatment beyond that achieved by the existing treatment facilities (e.g. lagoons) operated by the municipality. One of the outcomes of the study was the modification of an existing wetland model, which now can be used to predict the effluent treatment performance of natural tundra wetlands receiving municipal effluents.

The SubWet 2.0 model can be used by wastewater practitioners to help predict the treatment performance of natural tundra wetlands when lagoon wastewaters are released via intentional decants or unintentional exfiltration at different times of the year (e.g. different temperatures). It is believed that the SubWet 2.0 model can help practitioners better manage effluent releases to maximize the treatment benefits afforded by downstream tundra wetlands and in doing so ensuring the greatest treatment available. This model was originally developed by the United Nations Environment Programme-Division of Technology, Industry and Economics-International Environmental Technology Centre (UNEP-DTIE-IETC). The CAWT worked in collaboration with UNEP-DTIE-IETC and Sven Jørgensen (the originator of the model) to develop SubWet 2.0; a new version to accommodate temperate and cold climatic conditions including summer Arctic and temperate winter conditions. The model employs 25 differential process equations and 16 parameters (e.g. rate coefficients, such as the temperature coefficient of nitrification). Comparison of the SubWet 2.0 simulations to the actual measured data gathered by the CAWT has demonstrated that SubWet simulated concentrations are generally within 25 per cent of the measured values. Figure 1 is a screen shot of the Design window where initial input values are entered.

Figure 1. An overview of the initial Design window for SubWet 2.0 showing the initial input parameters for the Chesterfield Inlet tundra wetland.

The following is intended to illustrate how SubWet 2.0 can be used by wastewater managers to better assess how management activities can be maximized to achieve desired wastewater treatment targets. The data used in these examples was generated from the natural tundra wetland that treats municipal effluents generated by Chesterfield Inlet, NU during the 2009 CAWT site investigation. In 2009, municipal wastewater was discharged to a shallow,

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Centre for Alternative Wastewater Treatment (CAWT), Fleming College Lindsay, ON
Colin Yates, Waterloo Summit Centre for the Environment,
University of Waterloo, Huntsville

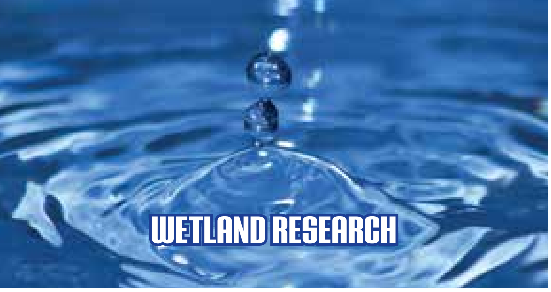
Figure 2. Aerial view of Chesterfield Inlet treatment wetland (2009) delineating wetland boundaries and flow directions.

low-volume depression at the upstream end of the wetland (Figure 2). Wastewater parameters entering the wetland were predictably high with average concentrations of 207 mg/L cBOD5; 29.5 mg/L total ammonia nitrogen (TAN as N); 5.49 mg/L total phosphorus (TP). Despite the high strength of the wastewater, the Chesterfield Inlet wetland was able to reduce these parameters to the averaged concentrations of 10.5 mg/L cBOD5; 1.1 mg/L TAN and 0.4 mg/L TP.

Three scenarios are presented below to help illustrate the potential of SubWet 2.0 as a predictive tool. All examples are based on the 2009 data, which was collected prior to the installation of a new waste stabilization pond in 2010 to better treat the municipal effluent.

Scenario 1: Predicting the influence of pre-treatment on wetland performance

In this example, we examine how wetland performance can be enhanced by pre-treatment of the municipal wastewater prior to release into the wetland. In this hypothetical example, if pre-treatment reduced cBOD5 from 207 to 40 mg/L and TAN from 29.5 to 3.2 mg/L and TP from 5.49 to 2.45 mg/L, SubWet predicts that the concentrations exiting the Chesterfield wetland would be reduced to 5 mg/L cBOD5, 0.1 mg/L TAN and 0.5 mg/L TP. With this level of pre-treatment, SubWet also predicts that the volume of wastewater entering the wetland could be increased from the 2009 value of 36 m3/d to 180 m3/d while still achieving an effluent quality exiting the wetland of 17 mg/



Seasonal temperature differences can impact the treatment processes occurring within the wetland.

LcBOD5, 0.6 mg/L TAN and 1 mg/L TP.

Scenario 2: Predicting the influence of temperature on treatment wetland treatment performance.

This example illustrates how seasonal temperature differences can impact the treatment processes occurring within the wetland. Temperature could be one factor that a wastewater manager may want to consider when releasing effluents to the wetland in the early spring versus warmer periods. In 2009, the average temperature at the time of survey was 7.5°C. Under this temperature, cBOD5 was reduced from 207 to 10.5 mg/Land TAN from 29.5 to 1.1 mg/L and TP from 5.49 to 0.4 mg/L. If the average temperature was reduced from 7.5°C to 3°C, SubWet predicts that the concentrations exiting the wetland would increase to 15.3 mg/L cBOD5 and 1.7 mg/L TAN. TP would not change since it is not microbally mediated and thus temperature has less of an influence.

Scenario 3: Predicting the influence of a reduction in the size of the wetland

Currently the size of the Chesterfield Wetland is approximately five hectares. If the wetland were reduced in size by road construction or some other activity, then SubWet can be used to predict the loss of treatment capacity. In this example, the Chesterfield Inlet is hypothetically reduced by 35 per cent. With this size reduction, SubWet predicts that treatment efficiency would be reduced. The predicted change in wastewater parameters from inlet to outlet of the wetland would be cBOD5 from 207 to 21 mg/L and TAN from 29.5 to 0.54 mg/L and TP from 5.49 to 0.61 mg/L.

The above scenarios are intended to illustrate how lagoon managers can use SubWet 2.0 to help determine what operational conditions (e.g. effluent strength, volume, temperature) regarding the release of effluents from lagoon systems to natural tundra wetlands provides the maximal treatment performance in a hybridized lagoon / wetland treatment system.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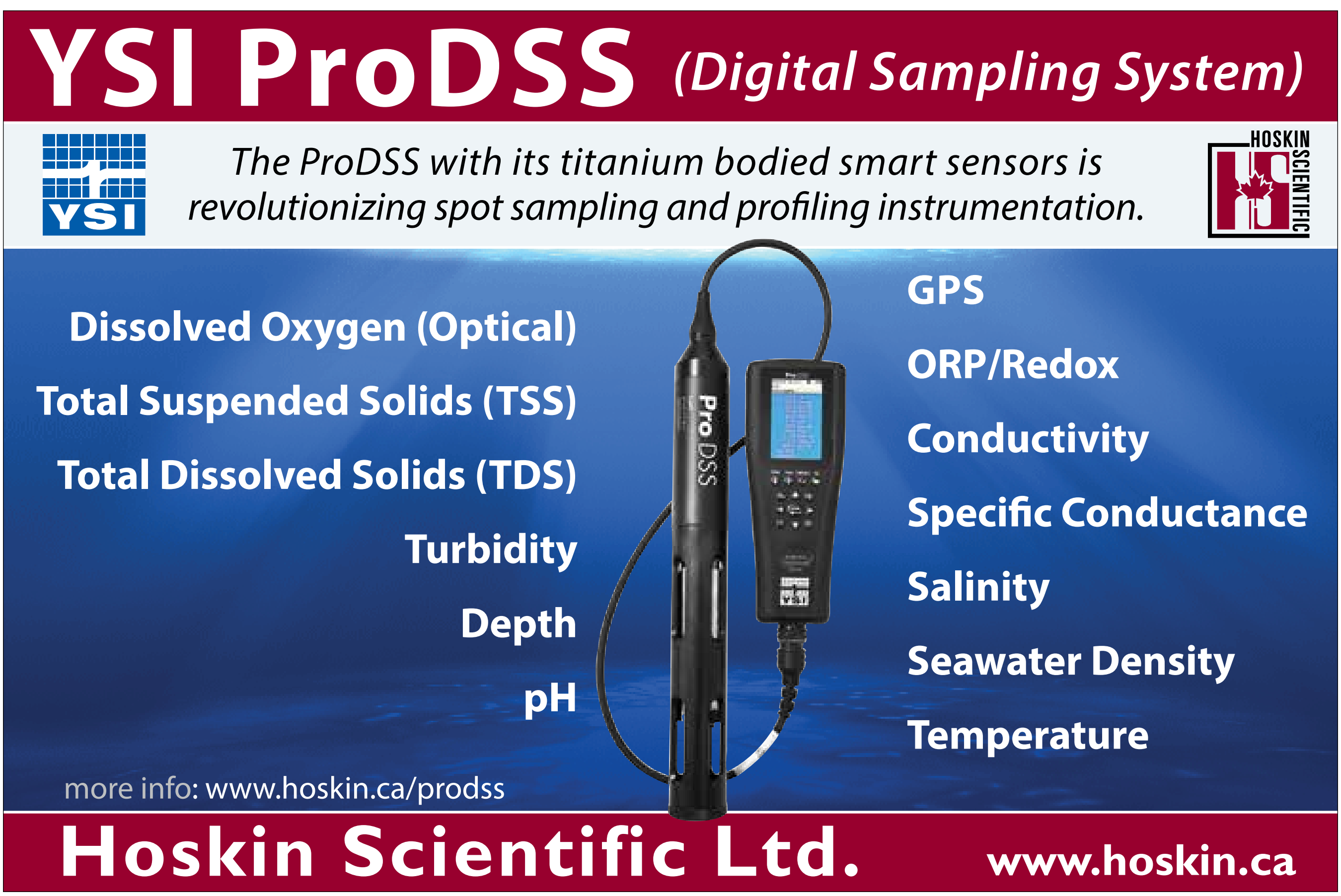
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THE CHALLENGES WITH MECHANICAL WASTEWATER SYSTEMS IN THE FAR NORTH

Iqaluit wastewater treatment plant.

The consistent performance of wastewater treatment in the far north of Canada, in general, remains an elusive objective and a frustration for engineers, communities, senior governments and regulators.

Most northern communities utilize sewage retention (ponds with periodic discharge), and overall these systems perform well because of the simple technology. Exceptions to the application of sewage retention have emerged due to site specific conditions that generally exclude their application because of topographic conditions, where terrain is too rough for the construction of a lagoon, or land use issues, where proximity to other development restricts the siting of a lagoon.

Mechanical sewage treatment systems have been applied to the situations where lagoon systems cannot be applied. However, mechanical systems have experienced a variety of challenges that question the sustainability of these type of systems in the far north.

Only three communities in Nunavut – Rankin Inlet, Pangnirtung, and Iqaluit – use mechanical sewage systems. The system in Rankin Inlet is preliminary treatment to remove large solids by screening. The system in Pangnirtung is secondary treatment, which originally used a rotating biological contactor. The system in Iqaluit has preliminary and primary treatment for the removal of solids by screening. Although designs for secondary treatment systems have been completed in Rankin Inlet and Iqaluit, construction of the advanced systems has not yet been authorized. All of these mechanical systems have significant operating challenges.

Only three communities in the Northwest Territories and the Yukon –

By Glenn Prosko, Senior Project Manager, Stantec Consulting,
and David Lycon, Senior Process Engineer, Stantec Consulting

Fort Simpson, NWT; Carmacks, Yukon; and Dawson City, Yukon – use mechanical sewage treatment systems. All of these facilities are secondary treatment systems with a disinfection process.

Fort Simpson advanced a project for improvements to their wastewater treatment in the early 1990s with a building, and a treatment process using drum screens. A design/build proposal in 1997 advanced the move to secondary treatment, which abandoned the drum screens in favour of a physical/chemical process. The system was commissioned in 2002, but it has experienced constant performance issues.

Dawson had been planning to construct an SBR facility in 2002, but the annual operation and maintenance estimate of $600,000 halted the project. A new project emerged for an aerated lagoon just south of the community, but unfortunately, this project stopped dead in its tracks in 2008 because of the lagoon's proximity to a residential subdivision. The Yukon Government then decided to advance a design/build proposal for a mechanical system, and a design/build contract for $25 million was awarded to a contractor in 2009 applying the Vertreat process (deep-shaft technology). The facility was commissioned in 2012, but has performance issues.

The original Carmacks WWTP was commissioned in 1975, and the facility operated successfully for 35 years. A design/build request for proposal for a new facility was issued in 2005 for new a mechanical system, and this project was ultimately advanced in several stages. The facility has operated reasonably well since it was commissioned in 2009.

Regardless of the community and the wastewater process, the natural environment in the north influences community access for construction, operation and maintenance, with weather extremes, and highly variable weather at times. This factor prevails whether a community has an all-weather road, or if the year-round access is limited to aircraft and relying on the annual sealift for the majority of the community resupply.

The climate in northern communities is extremely cold, with an average daily mean temperature of less than zero degrees centigrade for most of the far north. This propensity for cold means that all built infrastructure must be designed and con-

Operation and maintenance success of facilities in the far north has been suggested to be the ultimate indication of a project's success.

structed for protection against freezing, and in some cases be designed and constructed with provisions for thawing if the facility freezes.

There are generally great distances between the individual Northern communities themselves, and between the communities and major centres farther south. In Nunavut, for example, none of the communities have all-weather road access and rely solely on year-round access by air, and resupply during the sealift period between late July and mid-October.

The design and construction of a mechanical WWTP in the far north should follow the well-established procedures and practices; however, these procedures and practices are frequently misunderstood or poorly managed, and the end result are facilities that do not perform. The selection of a WWTP process for the north should be carefully executed because the north is not an appropriate testing realm for new technologies or technologies that do not have a "track record" of performance.

In designing a facility, the consulting resources applied should have the appropriate northern experience and expertise in all of the technical disciplines associated with a WWTP, which include wastewater process, structural, geotechnical, heating and ventilation, electrical, and instrumentation and controls. In the same way, the contractor experience applied to a WWTP should have the appropriate northern experience. Without this experience, the contractor will ultimately encounter problems at some point in the project.

The administration of the construction contract for a WWTP must have the resources in place to provide comprehensive contract monitoring, reporting, and responses from beginning to end of a WWTP project in the north. Without this dedicated resource, a project will deviate from the project objectives and may not recover.

Operation and maintenance success of facilities in the far north has been suggested to be the ultimate indication of a project's success. Operation and maintenance creates a legacy for community, which may last a generation (25 years), equating to the anticipated design life of a mechanical WWTP.

The operation and maintenance itself, along with the operation and maintenance documentation and the operation and maintenance training, are distinct aspects of the overall operation and maintenance of a WWTP. Operation and maintenance considerations of a facility should begin at the same time as the process design, involving resources with operation and maintenance experience; these considerations should be revisited throughout the design process.

Mechanical WWTPs have experienced many challenges in their application in the far north; however, they do offer the opportunity to reduce the influence of the natural environment. In considering a mechanical WWTP, the multitude of factors associated with the design, construction, operation and maintenance of these systems in the far north must be fully considered. The experienced technical disciplines must also be fully engaged for the duration of the project.

The consideration of operation and maintenance of a WWTP – and the engagement of the local human resources to be responsible for the operation and maintenance – cannot be over emphasized. A WWTP is a community legacy that will last a generation and significantly impact the human and financial resources of the community.

Each and every project in the north is unique, so ultimately there is no "recipe"" for success; however, with the communication of project experiences, the potential list of things that can go wrong when a project is underway may be greatly reduced.

THE SOCIAL CONTEXT OF WASTEWATER MANAGEMENT IN REMOTE COMMUNITIES

Kugluktuk sewage lagoon.

The remote areas of Canada constitute as much as 45 per cent of the country's land mass, including the regions of the Yukon, Northwest Territories, Nunavut, Nunavik (northern Quebec), and Nunatsiavut (northern Labrador). This vast region is populated by a mere 100,000 people occupying 90 communities, for an average population of 1,100 per community. In fact, the communities of Whitehorse (24,000), Yellowknife (19,000) and Iqaluit (7,000) account for about half of the population, making the average population, more realistically, fewer than 600 people per community. Developing and sustaining infrastructure in these small remote communities has always been influenced by a variety of technical, financial, administrative, operational, and regulatory factors.

Over the past decade, the complexity of these factors has increased substantially, with changes to available financial resources, administrative structures, operational responsibilities, and regulatory environments. Many of these changes have increased the overall complexity of infrastructure development and sustainability in remote communities, particularly at the community level. Many communities are finding the demands of these complexities to be well beyond their financial and administrative resources, and, as a consequence, are placing themselves in very undesirable situations with regard to community funding and regulatory compliance. The challenges associated with wastewater management in remote communities occur in the areas of science, applied science and social science.

Science of Wastewater Management

The science of modern wastewater treatment systems can be described by a number of unit processes, each of which provides an increasingly higher quality of sewage effluent by applying various physical, chemical and biological actions. The unit processes include preliminary treatment, primary treatment, secondary treatment, tertiary treatment, disinfection, and residuals management.

Applied Science of Wastewater Management

Applied science is the process of taking the science and applying it to specific applications. Thinking "outside the box" is necessary for applied science in remote communities in response to the challenges of extreme cold, very limited access, extraordinary costs, and scant resources. These are a few of the routine challenges that engineers, suppliers and contractors must face in designing and constructing wastewater treatment facilities for remote areas.

The applied science, or engineering, of wastewater systems in remote communities should follow the key principle of appropriate technology. This principle has been applied inconsistently to projects in remote communities, and, consequently, a significant number of projects are not meeting the performance expectations of the communities, or the regulatory authorities. Appropriate technology suggests that, whatever process is being applied for wastewater treatment, it must consider the biophysical context of the project site,

By Ken Johnson, Planner and Engineer, Stantec Consulting

which includes location, climate, landforms, and possibly the native vegetation.

Cold weather and distance are the two major factors in the consideration of appropriate technology. Although engineering designs may take into account measures to prevent wastewater facilities from freezing, it is also prudent to design the means to thaw a facility in the event it does freeze. In fact, it may be appropriate to say that it is not a matter of if the facility freezes, but when it freezes. Remote communities, by definition, are located at a great distance from what would be considered the "normal" amenities available to a community. Consequently, the resources available for routine operation and maintenance may not be available at the facility site, and mobilizing them may be not be possible for days, or more, and may cost extraordinary amounts of money. Appropriate technology for wastewater treatment in remote locations can make use of the extensive cold. One example is the concentration of sewage biosolids through the freeze-thaw process, and subsequent composting through the limited summer months.

Social Science of Wastewater Management

Although the science and applied science of wastewater treatment need more attention, at least some work has been done on these factors over the past several decades. In contrast, the social science of wastewater management in remote communities has been virtually ignored. Even the term "social science" may not be all-encompassing enough to apply to "all the other stuff" associated with wastewater management in remote communities, but it is a start. Social science associated with wastewater management in remote communities presents a multitude of challenges, including administrative, financial, and human resources issues.

Any remote community, regardless of size, has the need for a fully funded, fully staffed and fully trained community administration, but this is seldom seen. Administrative challenges include multiple levels of government, limited resources and changing rules. There may be several levels of local government representing the aboriginal community, as well as the non-aboriginal community, plus the territorial government, and land claims by the aboriginal community. The federal government may have several departments working independently to represent their own mandates.

In some communities, there may be six or more levels of government. The devolution of responsibilities has continued for several decades in response to demands for autonomy from some communities, as well as the downsizing of territorial governments. This devolution process has had varying degrees of success. For instance, a recent chapter in the Northwest Territories is the so-called "New Deal", which was implemented in 2007 and provides block funding to all communities. Some communities are seizing the opportunity, while others are overwhelmed. In spite of the best-conceived and comprehensive introduction possible, the New Deal will fail in some communities.

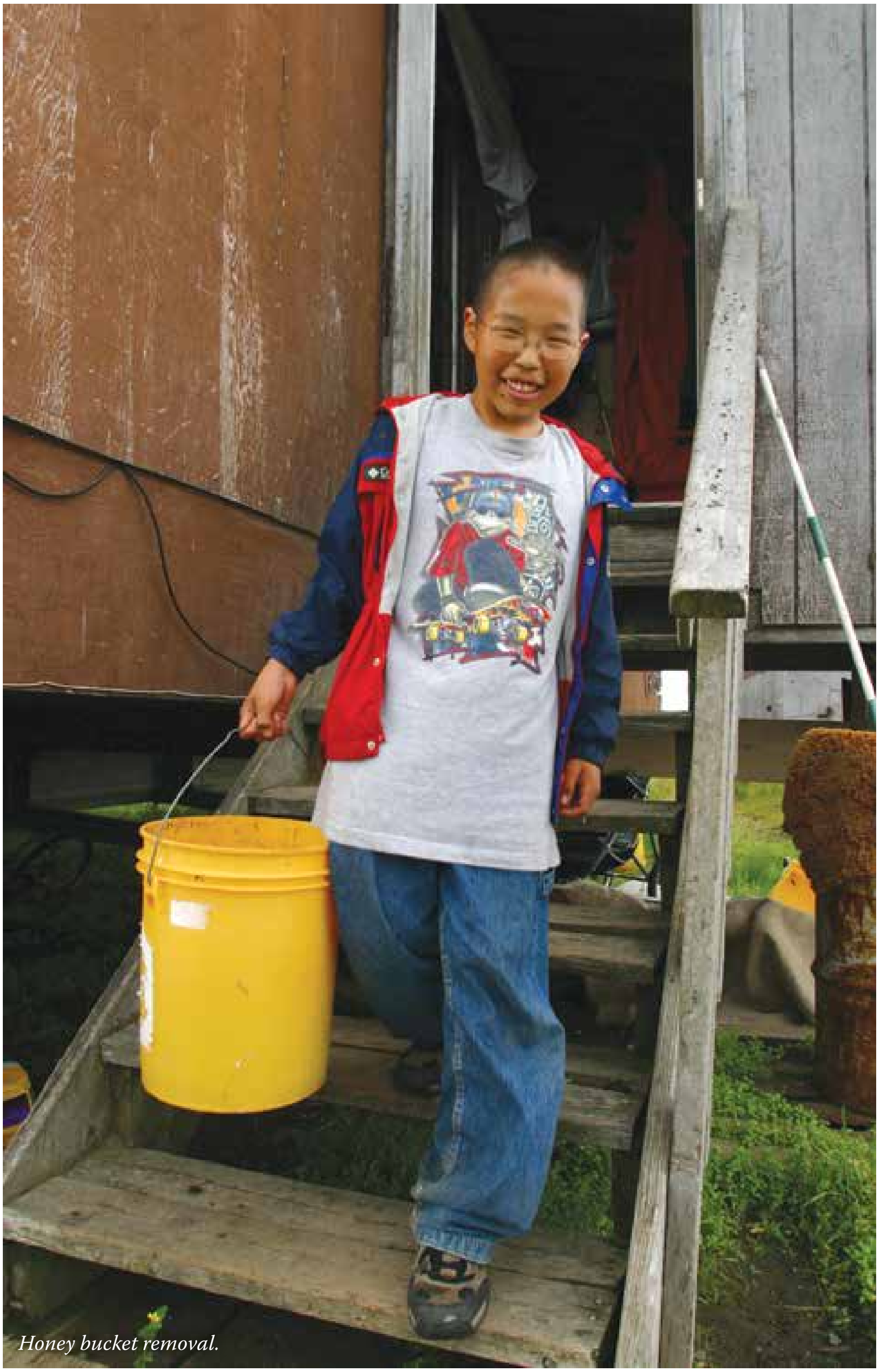
Financial challenges include financial management, capital funding, and operation and maintenance funding. Financial management is a challenge for any community, and represents a continuing challenge for many remote communities. Every remote community has a community budget that is proportionately larger than would normally be expected in a southern context. Management of this budget requires skill and training that many communities do not possess. Funds from senior governments for capital, operations and maintenance have diminished significantly over the past decade, and communities are being encouraged to be more self-sufficient financially. Human resources issues may be the most challenging aspect of the social science of wastewater management. People represent a very dynamic environment that has been plagued with a chronic lack of resources for hiring, training, and retaining.

New Technologies

Lagoons have been the sewage treatment process of choice for most remote communities, because of their cost-effectiveness and simplicity of operation, and the abundance of space that is available to most communities. This situation has been changing over the past decade as regulators have lobbied water boards and pressured communities to improve effluent quality by applying conventional "southern" mechanical technologies. This evolution has had mixed results, with mechanical systems operating in the NWT/Nunavut communities of Fort Simpson, Rankin Inlet, Iqaluit and Pangnirtung.

Although it may be said that these systems are generally operating in compliance with the water licence parameters, the communities are faced with sustaining these processes with limited financial and human resources. New challenges are emerging because of demands for managing the significant biosolids waste stream produced by these waste treatment processes. The ecosystems of the remote regions of Canada are unique and fragile, and must be protected; therefore, wastewater treatment is needed. Public health must also be protected, and wastewater treatment must serve this purpose as well. To date, however, the protective measures for these ecosystems and public health have not been developed, or implemented, based on the necessary science, applied science and social science information.

COMMUNITY WATER AND SANITATION POLICY IN THE NORTH – A HISTORY


Honey bucket removal.

By the 1960s, only seven communities in the NWT were partially served by piped water and sewage services, including Fort Smith, Hay River, Yellowknife, Fort Simpson, Norman Wells, Inuvik and Iqaluit (then Frobisher Bay).

Nevertheless, by the end of the '60s, the level of water and sanitation services in the north continued to be poor, marked by inadequate water quality and quantities, unsanitary wastewater collection and waste disposal practices, and infrastructure exacerbated by minimal indoor plumbing in houses and other buildings in the community.

The need for better services was obvious from the health statistics related to poor water and sanitation conditions in NWT communities. In the period 1970 to 1973, 25 people died of gastrointestinal diseases, and it was reasoned that gastrointestinal diseases are typically caused by poor sanitation conditions. Some 3,500 cases of gastrointestinal disease were reported in 1971 and 5,000 in 1970.

NWT communities also experienced high incidence of infant mortality, hepatitis and bacillary dysentery, which are attributable, in part, to poor water and sanitation services. Sanitation related diseases were up to 40 times more common in the NWT than in the rest of Canada.

The NWT Water and Sanitation Policy

It was clear that major investments in water and sanitation infrastructure were required. Some funding had been made available for improvements in the larger communities; services in the 50

Edited from an article by
Vern Christensen, Former Deputy Minister,
Municipal and Community Affairs, GNWT

An annual reassessment of capital funding needs was completed in each community in consultation with local community governments. These needs were then prioritized in terms of the relative needs in other NWT communities and the overall NWT Government's capital plan.

smaller communities were limited to non-existent. Water was delivered by truck to households at $5 per month while sewage and garbage pick-up was provided free. Delivery capacity, water quality and quantity, waste disposal facilities and the housing stock to receive these services was very inadequate.

A greater political awareness of the conditions in NWT communities came with the move of the NWT Government to Yellowknife from Ottawa in 1967. By 1973, the NWT Government had made it a priority to develop a comprehensive new policy to address the growing crisis of poor water and sanitation services in NWT communities. The advent of the new (1970) federal Northern Inland Waters Act also increased the urgency to improve community sewage and garbage disposal facilities.

This policy required sustained funding for the Policy to be effective. The policy was eventually approved in 1974, and the first year of capital funding was included in the 1975/76 GNWT budget in the amount of $4 million. Operating costs still needed to be obtained from within normal program funding, but this was still a major milestone toward significant improvements in community water and sanitation services across the NWT.

Capital Planning, Budgets and Priorities

With a new and funded policy in place, one of the first tasks to be implemented was the development of a comprehensive inventory and assessment of water and sanitation infrastructure in each NWT community, including housing, road and local drainage conditions. While population health data was relatively accessible, data regarding as built conditions for infrastructure was limited and unreliable.

In the summer 1976 through to spring 1977, GNWT staff visited the communities in each Region of the NWT and documented local infrastructure and related conditions. This data was critical to determine where minimum service levels were not being met and where highest needs for water and sanitation service facilities improvements were.

With the acceleration of community water and sanitation improvements, the accuracy and comprehensiveness of planning information improved significantly. An annual reassessment of capital funding needs was completed in each community in consultation with local community governments. These needs were then prioritized in terms of the relative needs in other NWT communities and the overall NWT Government's capital plan.

In general terms, the safe delivery of sufficient potable and collection of sewage and garbage waste was the highest priority for infrastructure improvement. The assurance of sustainable and quality water sources was the next priority with a consideration of bacteriological, chemical and esthetic water qualities. Sewage treatment and solid waste facilities improvement fell into the third priority involving the safe location of sewage outfalls and waste treatment facilities that were adequate to protect the environment. This general ranking of priorities was influenced by related considerations such as the risk of spread of disease, the population directly affected, significance of environmental impacts, and cost.

Signs of Improvement

Considerable improvement in service levels were achieved by the early 1980s. A 1982 report on the status of water and sanitation facilities concluded that there had been considerable improvement in the acceptability of water and sanitation facilities in NWT communities since 1973. The 1982 status report indicated that NWT communities were "approximately 70 per cent toward attaining overall acceptability of water and sanitation services." A 70 per cent acceptability in terms of overall water and sanitation service levels was a significant improvement achieved in a relatively short period of time; however, there were many communities remaining in which facilities and services were still inferior. In the 30-plus years since the status report, improvements in community water and sanitation systems have continued, and a milestone was reached in 2014 with the completion of a project to provide a water treatment facility in each and every community of the Northwest Territories.

2014 NTWWA Vice-President's Report

ARLEN FOSTER

Thank you to everyone who attended the 2014 annual conference, which took place in Yellowknife this last November. We had a great conference in Yellowknife, with over 130 people attending and more than 18 tradeshow booths! The event was not only well attended but extremely well received, as numerous attendees commented on the positive experience. We were blessed to have board members from WCW (Western Canada Water Association), travel to Yellowknife and take part in meetings as well as the conference. This attendance continues to help further the NTWWA's ongoing growth, as well as our participation as a constituent organization of the WCW. We continue to highlight that this annual conference and tradeshow remains the best network and educational format for all northerners and southerners alike. Thank you for continuing to support and expand this event with us!

In 2015, the NTWWA will be hosting the annual conference in Iqaluit, Nunavut and is excited to continue our success of reaching northern leaders including water and wastewater professionals. We are working through the conference details and scheduling presentations that will be informative and interesting for all. Please come and take part in this event with us. I would like to thank everyone in advance who are volunteering their time to help make the 2015 conference come together.

I anticipate that you will enjoy our annual Journal, and that it will share information you find valuable and informative. It is another example of how the NTWWA aims to share knowledge and experience with all members and the general public. As always, Ken Johnson deserves our appreciation and thanks for pulling all the pieces together and developing the Journal on our behalf. Ken continues to be a big support to the NTWWA amidst his own busy work and personal schedules. Also, thanks to Jennifer Spencer, our Executive Director, and Pearl Benyk, our Administrator, for their ongoing efforts – we would not be able to do this without the both of you.

Last but not least, I would like to thank all those who provide financial support to our association and encourage your ongoing participation in this matter. Without the water professionals across the north, the industry folk, the two territorial governments, the Government of Canada, as well as the constituent organizations of Western Canada Water, we would not be able to succeed the way we do!

2014 NTWWA Executive Director's Report

JENNIFER SPENCER-HAZENBERG

The 2015 NTWWA Annual Conference, Trade Show, and Operator's Workshop will be hosted in Iqaluit, Nunavut November 20th to 24th. The theme for this year's conference is "Northern Water: Keeping it Clean". The conference program will include approximately 20 technical presentations, and the conference will be followed by a two-day Operators Workshop. Before the conference, the Solid Waste Association of North America (SWANA) will be hosting a two-day workshop on Landfill Operator Basics.

The NTWWA provides a very worthwhile and interesting opportunity for those working in the northern field of water and waste, and others who are concerned about these vital services, to meet, network and hear about the projects others have been working on during the past year. If you are a northern water or waste professional, mark your calendars and join us at the annual event to share ideas and learn about northern water and waste challenges and solutions.

Last year the Annual Conference, Trade Show and Operators Workshop, in Yellowknife, was a huge success, with approximately 130 delegates. Thanks to those operators who sat on the Operator's Panel and shared their experiences. A big thank you to Pearl Benyk for all the hard work coordinating the logistics of the 2014 NTWWA annual event. The delegates, presenters and trade show participants are key to the success of the annual event, so thank you very much for your participation.

Since 2005, the NTWWA has been hosting a friendly drinking water competition for the water treatment plant operators who attend the conference. If you want to take home the trophy and bragging rights, remember your H2O in 2015!

The board tries to maintain diverse representation and currently consists of water treatment plant operators, consultants with expertise in the areas of water and waste, a water and waste industry representative, and government employees. If you are interested in becoming a board member, please step forward at the Annual General Meeting held following the conference.

This is my third year as Executive Director of the NTWWA, and I want to thank the NTWWA board of directors for their support. I would especially like to thank Pearl Benyk for all of her help in keeping the organization running smoothly. Every year we say goodbye to dedicated members and welcome newcomers, 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 all of the new board members, thanks for volunteering your time; we are excited about the new experiences, knowledge and ideas you bring. Special thanks are due for the efforts of the President, Bill Westwell, the Past President, Alan Harris, the Journal editor Ken Johnson, and our administrator Pearl Benyk.

I look forward to you joining us in Iqaluit.

– CALL FOR ARTICLES –

2016 edition of the NTWWA Journal – the theme of the 2016 edition will be "Aging Northern Infrastructure".

Contact Ken Johnson if you want to prepare an article.
ken.johnson@cryofront.com
780-984-9085

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MARK YOUR CALENDAR!

The 2016 conference of the Northern Territories Water and Waste Association is scheduled for the middle of November, 2016 in Yellowknife.

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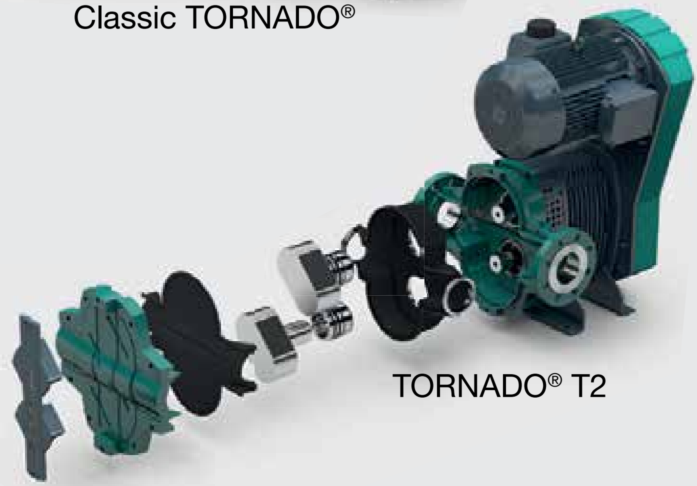

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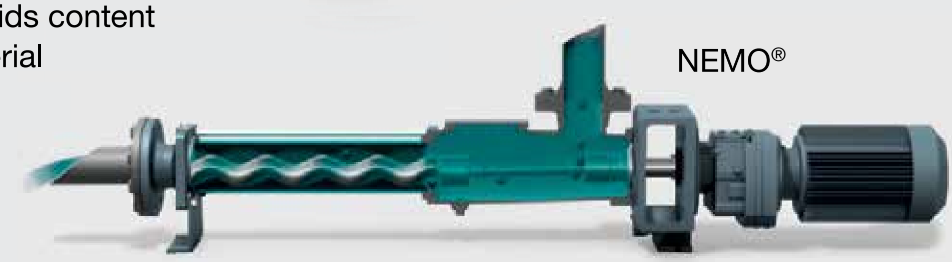

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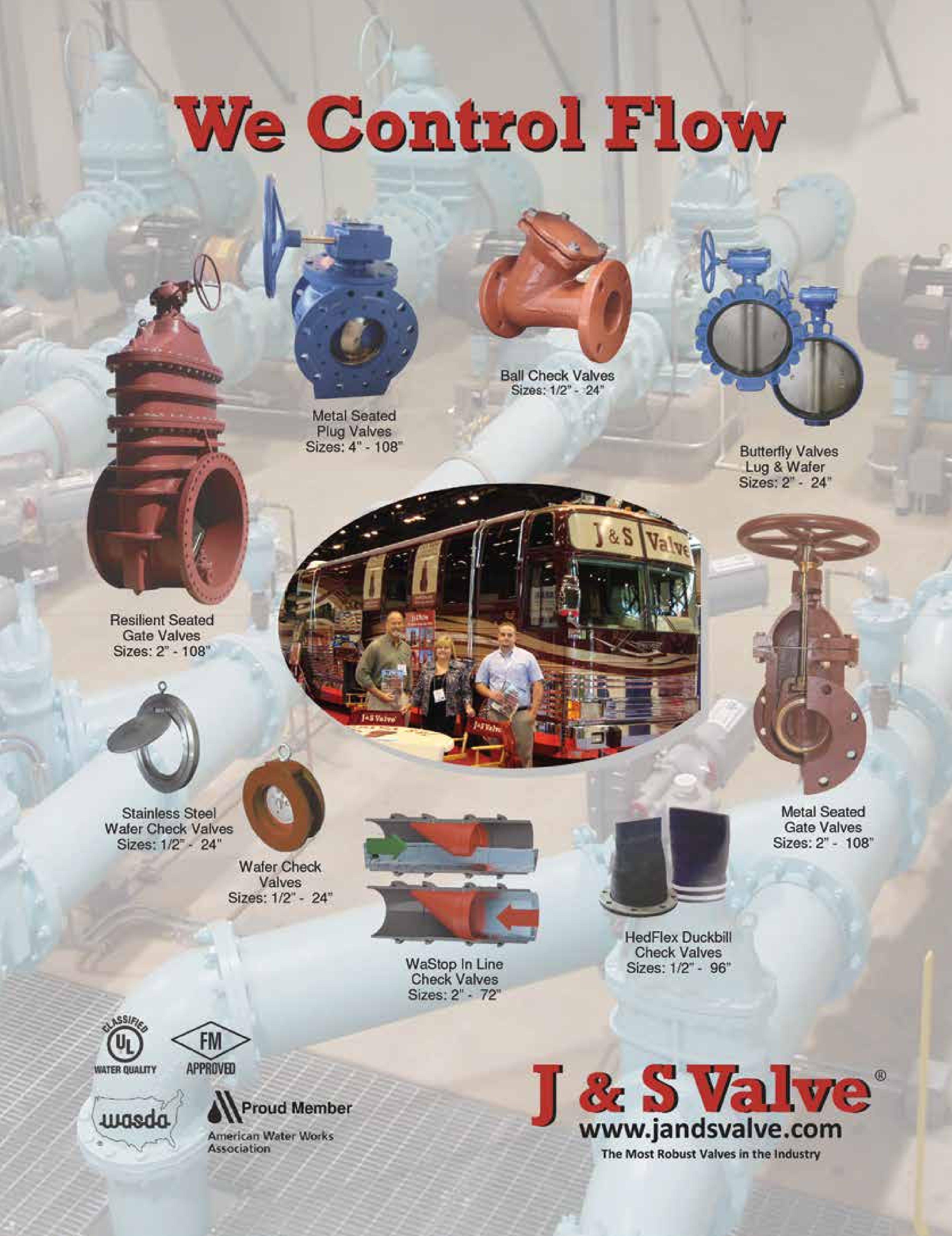
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