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Lac des Mille Lacs First Nation

Bingwi Neyaashi Anishinaabek

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Research Report | Fall 2022

Water, Water can be Everywhere

Nation Rebuilding Series, Volume 9

By: Mateo Orrantia and Mercedes Labelle

northernpolicy.ca

NPI – Who We Are

Land Acknowledgement

NPI would like to acknowledge the First Peoples on whose traditional territories we live and work. NPI is grateful for the opportunity to have our offices located on these lands and thank all the generations of people who have taken care of this land.

Our main offices:

- Thunder Bay on Robinson-Superior Treaty territory and the land is the traditional territory of the Anishnaabeg and Fort William First Nation.
- Sudbury is on the Robinson-Huron Treaty territory and the land is the traditional territory of the Atikameksheng Anishnaabeg as well as Wahnapitae First Nation.
- Kirkland Lake is on the Robison-Huron Treaty territory and the land is the traditional territory of Cree, Ojibway, and Algonquin Peoples, as well as Beaverhouse First Nation.
- Each community is home to many diverse First Nations, Inuit, and Métis Peoples.

We recognize and appreciate the historic connection that Indigenous peoples have to these territories. We support their efforts to sustain and grow their nations. We also recognize the contributions that they have made in shaping and strengthening local communities, the province and the country as a whole.

This report was made possible in part through the support of the Donner Canadian Foundation and the Northern Ontario Heritage Fund Corporation. Northern Policy Institute expresses great appreciation for their generous support but emphasizes the following: The views expressed in this report are those of the author and do not necessarily reflect the opinions of the Institute, its Board of Directors, or its supporters. Quotation with appropriate credit is permissible.

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Editors: Dr. Robert Patrick and anon.

Published by Northern Policy Institute
874 Tungsten St.
Thunder Bay, Ontario P7B 6T6
ISBN: 978-1-990372-33-9

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Animbiigoo Zaagi'igan Anishinaabek

Our people have been present in these lands for time immemorial. Our ancestors were strong, independent people, as we are today, who moved with the seasons throughout a large area of land around Lake Nipigon. We governed ourselves using the traditional teachings we still teach our children today. Now, our community members widely scattered throughout many communities, the majority of which are located in northwestern Ontario in and around the shores of Lake Superior. We are unified by our connection to the environment, our commitment to our traditional values, and our respect for each other.

Bingwi Neyaashi Anishinaabek

The people of Bingwi Neyaashi Anishinaabek – formerly known as Sand Point First Nation – have been occupying the southeast shores of Lake Nipigon since time immemorial. Our community is dedicated to fostering a strong cultural identify, protecting Mother Earth, and to providing equal opportunities for all. Furthermore, our community vision is to grow Bingwi Neyaashi Anishinaabek's economy and become recognized as a sustainable and supportive community where businesses succeed, members thrive, and culture is celebrated.

Lac des Mille Lacs First Nation

The community of Lac des Mille Lacs First Nation is located in Northwestern Ontario, 135 km West of Thunder Bay, and encompasses roughly 5,000 HA of Mother Nature's most spectacular beauty. Our people have held and cared for our Lands and Traditional Territories since time immemorial. To fulfill our purpose and in our journey towards our vision, we, the Lac Des Mille Lacs First Nation are committed to rebuilding a strong sense of community following a holistic approach and inclusive processes for healthy community development.

Partners

Northern Policy Analytics

Northern Policy Analytics (NPA) is a community-inspired applied policy and research consulting firm based in the Yukon and Saskatchewan. Founded by Drs. Ken Coates and Greg Finnegan in response to rapidly changing conditions and opportunities in the Canadian North, NPA recognizes that Northern and Indigenous communities often experience poorer educational outcomes, higher unemployment rates, receive fewer public goods and services, and lack the economic stability needed to optimize community well-being and quality of life. Yet these communities are often located in direct proximity to some of Canada's most valuable natural resources, resulting in both opportunity and conflict.

We address both policy and economic development issues and strive to effectively bridge the gap between Indigenous communities and settler government agencies by supporting community and economic development planning, grant writing, facilitating meetings, and by supporting entrepreneurship and the development of businesses in the region. NPA also helps communities marshal the information and resources they require to improve community and economic outcomes, while mitigating the impacts of colonialism and the over-arching resource extraction sector that dominates the regional economy.

Northern Policy Institute

Northern Policy Institute is Northern Ontario's independent, evidence-driven think tank. We perform research, analyze data, and disseminate ideas. Our mission is to enhance Northern Ontario's capacity to take the lead position on socio-economic policy that impacts our communities, our province, our country, and our world.

We believe in partnership, collaboration, communication, and cooperation. Our team seeks to do inclusive research that involves broad engagement and delivers recommendations for specific, measurable action. Our success depends on our partnerships with other entities based in or passionate about Northern Ontario.

Our permanent offices are in Thunder Bay, Sudbury, and Kirkland Lake. During the summer months we have satellite offices in other regions of Northern Ontario staffed by teams of Experience North placements. These placements are university and college students working in your community on issues important to you and your neighbours.

About the Authors

Mateo Orrantia

Born and raised in Marathon, ON, Mateo is proud to call Northern Ontario home. Currently in his first year of medical school at NOSM U, Mateo tries to bring an interdisciplinary approach to problem-solving. A firm believer in a self-directed and diverse North, he wants to apply his experiences in research and grassroots activism to help foster stronger and more sustainable communities across Northern Ontario. After spending his last few summers working at Pukaskwa National Park, Mateo has become passionate about protecting the region's unparalleled natural resources. Unsure of where his future will take him - other than back to the North - Mateo has gotten involved with initiatives across disciplines, from Strength & Conditioning coaching, to literary research and student governance. When he's not working, Mateo enjoys strength training, reading, and exploring the outdoors (which usually results in a little too much bushwhacking).

Mercedes Labelle

Mercedes Labelle graduated from McGill University in 2020 with an Honours Bachelor of Political Science and Urban Systems. During her studies, she focused on Canadian politics and public policy processes, specifically researching the uneven distribution of benefits and services between urban and rural communities. Having grown up in Canada, the United States, and Spain, Mercedes is eager to return to Northern Ontario, where her family now resides. In her free time, Mercedes enjoys listening to podcasts, cooking, and reading.

Contributions by Lindsay Bain, Charles Cirtwill and Rachel Rizzuto.

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Executive Summary

In the context of water treatment facilities, the "basic build" approach has generally meant that technology designed in one context is assumed to be readily applicable in another. Without allowing for local cultural, economic, geographic, or environmental factors. The three case studies explored here suggest that this assumption is problematic, if not entirely wrong. Lytton First Nation, Keewaytinook Okimakanak (KO) Tribal Council, and the Town of Innisfil, all faced the challenge of aging infrastructure unable to meet the communities' needs. These needs included being able to provide clean drinking water and keeping up with projected community growth. Both Lytton and KO experienced periodic and long-term drinking water advisories due to inadequate, aging infrastructure and the lack of funding to operate a community water system. Through community discussions resulting in locally tailored designs, as well as training programs for local water treatment plant operators, drinking water advisories have almost been eliminated.

This paper identifies common problems with basic build infrastructure, and illuminates examples of successful and best practices in the First Nations and non-First Nations context. It is hoped these examples will allow First Nation communities to determine what infrastructure is best for their community.

The **best practices** identified through this case study analysis include:

- Design and construction of water-treatment plants that are specifically-suited to the needs, and scale, of the communities;
- Prioritizing the support and training of local water operators;
- Flexible designs that are conducive to future growth and modification of the system(s), such as a modular system; and,
- Extensive community participation to identify the current situation, needs, preferences, and other cultural aspects of the community.

The case studies also revealed that, when possible, the following things should be **avoided:**

- Water systems that rely too heavily on outside actors for installation, maintenance, and upgrades.
- Systems that are difficult for the community to use, and for the community to train residents to operate; and,
- Third-party project facilitators and operators, that take capacity-building opportunities away from community members.

Introduction

Successful infrastructure development goes hand-in-hand with economic and social success, and will be of utmost importance for Indigenous and non-Indigenous communities across Canada as they set their sights on recovery and prosperity in a post-COVID world. However, conversations around Indigenous water system development in Canada take place against a backdrop of failures largely fostered by the "basic build" approach to infrastructure funding and construction, often resulting in short- and long-term water advisories. Basic build infrastructure often follows a "blanket approach" to funding, design, and construction, without accounting for a community's unique needs and circumstances, which will be demonstrated by looking at cases from Neskantaga, Sandy Lake, and Hollow Water First Nations.

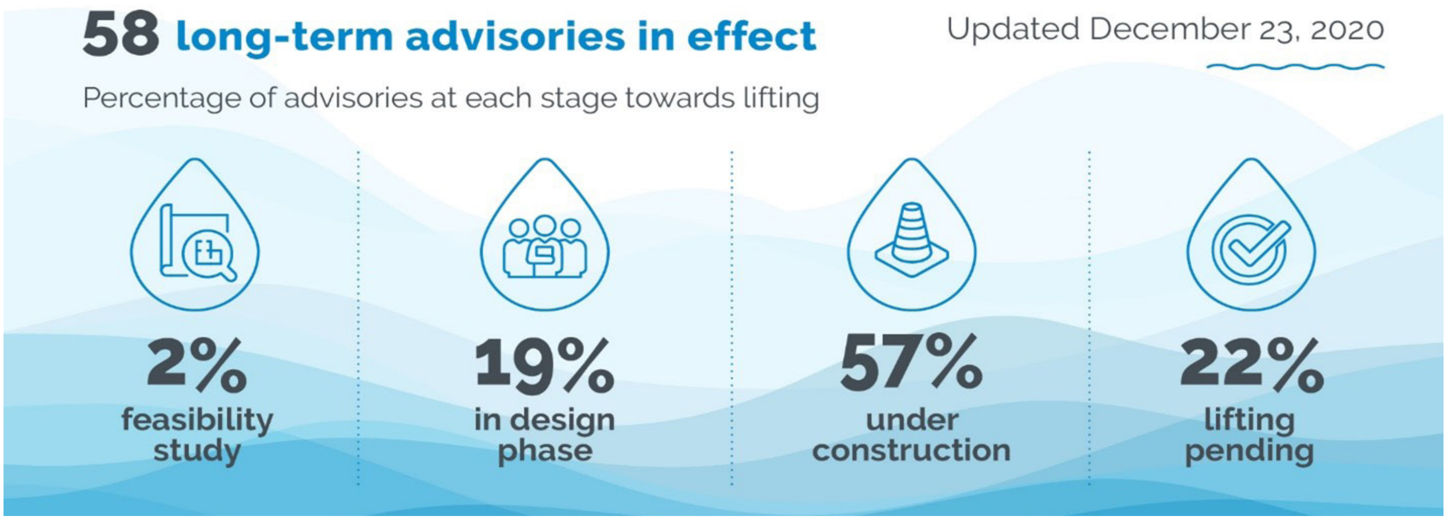
Although the basic build approach can sometimes allow for quicker infrastructure development with lower up-front costs, it often leads to negative project outcomes. The significant benefits associated with more innovative methods of design, on the other hand, far outweigh its disadvantages—emphasizing the importance to shift away from the historically-used basic build approach towards more innovative methods. With 58 long-term drinking water advisories currently in effect (Canada, 2020), the focus on new, innovative approaches is more crucial now than ever.

Reducing and/or Eliminating Boil Water Advisories

Basic build water infrastructure has largely failed First Nations communities, with many being under long-term boil water advisories. With the federal government announcing it would not meet its goal to eliminate all boil water advisories by March 2021, community-led innovative infrastructure is more crucial than ever.

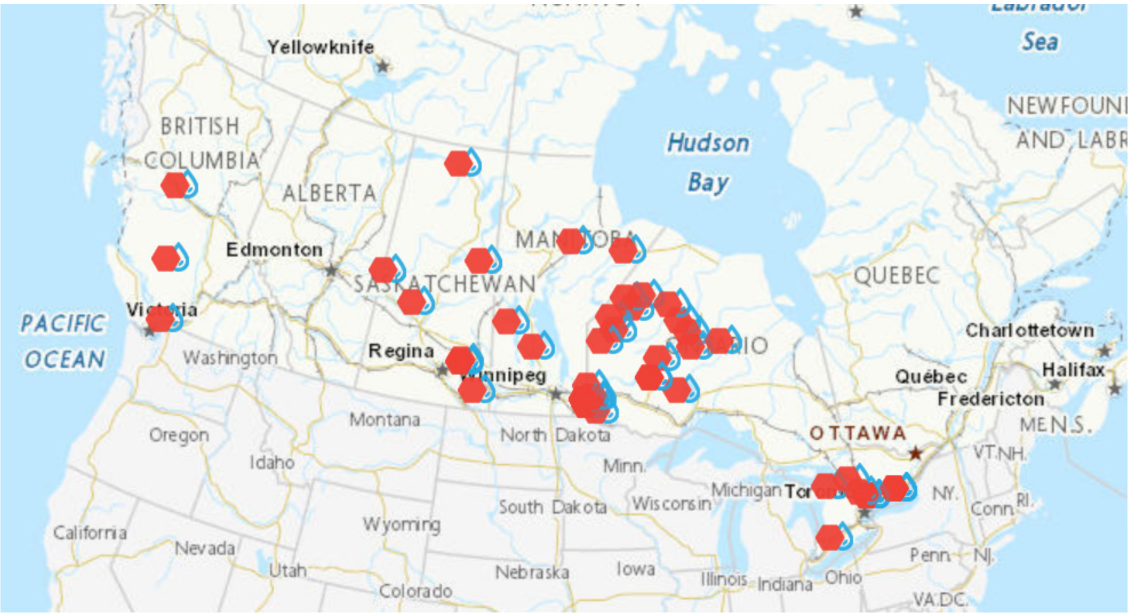
Failing to provide for a basic human right such as access to clean water has legal, ethical, and health implications and ought to be taken more seriously. One major limitation to the access of safe drinking water is the remote location of reservation communities and traditional lands (Bradford et al. 2016: 13). Without established safe water sources, communities become reliant on trucked-in water sources (where deliveries are uncertain in poor weather, situations of inadequate funding, or lack of personnel available) and local, raw water sources (lakes, wells, springs, opportunistic "bush" waters) (Bradford et al. 2016: 13). Some communities have access to under-funded potable water-dispensing units which communities tend to distrust, seemingly for good reasons, as investigations reported pathogens including bacteria (E. coli, etc.), viruses (Hepititis A), and protozoa (Cryptosporidium) in water samples (Bradford et al. 2016). Poor drinking water quality brings with it numerous potential health issues such as vulnerability to waterborne diseases, gastrointestinal infections, birth defects, skin problems (skin cancers and eczema), diabetes, obesity, mental stress, hypertension, kidney problems, heart and liver diseases, infant mortality, and others (Bradford et al. 2016: 2, 13). Prevalence rates of diabetes and obesity come from an increased reliance on sugary, carbonated drinks such as sodas as they are more cost-efficient than bottled water (price difference of approximately 15 cents) and are more readily available (Hanrahan et al. 2016: 278; Bradford et al. 2016: 13). High iron content and the existence of organic matter in local water sources sometimes leads parents to add sugary flavorings such as Kool-Aid to encourage children to drink water, though this is additionally problematic to diabetes rates and health concerns (Hanrahan et al. 2016: 278). Problems with water security in Indigenous communities are more extensive than simply the quality and accessibility of drinking water, but further extend to issues of wastewater and sewer management (Hanrahan et al. 2016: 273). Contamination becomes a very real concern during the water-retrieval process, especially for communities without a piped sewer system, as sanitation of buckets and transportation methods/ equipment may be insufficient (most notably when "clean water" and "waste" are transported in similar fashions) (Hanrahan et al. 2016: 273).

Figure 1: Long-Term Boil Water Advisories, as of December 2020



Source: Canada, 2020

Figure 2: Current Long-Term Drinking Water Advisories (n=58), December 2020



Source: Canada, 2020

The Basic Build Approach

Federal policy for water infrastructure provision on reserve was first articulated in a 1977 memorandum to Cabinet that proposed providing First Nations communities with infrastructure equal to that of non-First Nations communities (McCullough & Farahbakhsh, 2012). It was after this that we saw most on-reserve water systems be built—only five of Ontario's on-reserve systems are more than 30 years old today (Klasing, 2016). Shortly after that commitment, Indigenous and Northern Affairs Canada (INAC)[1] would take on the oversight of water infrastructure delivery to First Nations communities across Canada, becoming the central cog of a very complex set of policies, programs, and procedures (McCullough & Farahbakhsh, 2012). INAC is constrained by federal budget priorities and spending choices. It is also bound by accounting rules largely designed to track spending as opposed to measure outcomes. This restricts INAC's ability to 'think outside the box' to respond to technical challenges. Though the Ministry is directly responsible to the federal government, the Canadian public, and the auditor general, it is not directly accountable to First Nations in the same way (McCullough & Farahbakhsh, 2012). This accountability to a standard set of rules, guidelines, formulas, and criteria severely limits INAC's ability to create systems that are adaptable to local Indigenous contexts (McCullough & Farahbakhsh, 2012). Moreover, INAC consistently gravitates towards frugality in its actions—historically favoring cost-savings over value-maximization (McCullough & Farahbakhsh, 2012). This results in lower target standards, front-end cost evaluations, and limited project assessment and evaluation scopes (McCullough & Farahbakhsh, 2012).

From this, it is evident how a 'basic build' approach for Indigenous water infrastructure has historically emerged: the complex nexus of policies and procedures that water infrastructure development has been managed through has encouraged an approach that favours standardized 'one size fits all' systems, and seeks to deliver those as quickly and cheaply as possible, to meet annual budget requirements.

Neskantaga First Nation, Ontario

Neskantaga First Nation is a small northern Ontario First Nation with approximately 350 members living on reserve (AANDC, 2019). In 1991, a new water treatment plant was built on the reserve by outside contractors (Russel, 2020). This water treatment plant was only successful for a few years. As soon as 1995, a boil water advisory was issued in the community, citing overly high chlorine levels in the distribution lines—a result of flawed design and operator and maintenance issues, according to INAC (Penner, 2016). It was also found that the slow sand and sodium hypochlorite filtration system used by the treatment plant was wholly inadequate for local climate conditions (Penner, 2016). Water operators in the community do not have the appropriate training to operate the system as it is built, signaling that it was not designed with local contexts in mind (Klasing, 2016). These issues are compounded by further physical design flaws: pipes often break due to cold winters and significant spring thaws (Klasing, 2016). That same boil water advisory instituted in 1995 is still in place today, marking over 25 years without safe drinking water in the community.

Throughout this time, INAC has spent over $50,000 a year on providing bottled water to the community, and has funded a small, reverse-osmosis unit in the community that allows residents to fill their water jugs at a centralized location (Penner, 2016). Despite being installed in 2009 as a temporary measure, it has since served as the main source for non-bottled potable water on reserve, as the development of the communities' new treatment plant—started the same year—still has not been completed (Penner, 2016).

Currently, work has progressed on the water system, but there is mistrust by community members about the water quality, even if tests show the water quality has improved. According to Chief Chris Moonias, "The community people will not trust the water…I know that for a fact because when we were in Thunder Bay[2], they drank bottled water when we were there and that's one of the biggest things. We need to work on the trauma that they faced over 25 years — the mental health aspects, to start building that trust with our nation members that we have clean drinking water" (Akin, 2020).

[1] At the time, also Aboriginal Affairs and Northern Development Canada (AANDC). Currently Indigenous Services Canada (ISC)

[2] Community members were evacuated to Thunder Bay when water flow to homes via plumbing stopped (Porter, 2020).

Sandy Lake First Nation, Ontario

Sandy Lake First Nation is a remote fly-in community in northwestern Ontario, home to approximately 3,000 members. The community's water treatment plant was built in 1991—a "package" Graver Monoplant filtration system; it requires chemicals to remove particulates from the water and chlorine to kill pathogens (Cassels et al, 2001). However, it is not designed to be able to kill protozoa, like giardia, that may be present in the "high-risk" surface water (Cassels et al, 2001). That being said, for at least ten years post-construction, water quality was not a great concern in the community. Although, it was noted that the plant had difficulty in providing enough water to the community due to difficulty of operation and a lack of optimization for local conditions (Cassels et al, 2001). Less than 80 percent of homes in the community are connected to the system (Cassels et al, 2001)

This plant also carries significant operation and maintenance burdens. Due to its reliance on chemicals for decontamination and the remote location of the community, the First Nation is dependent on a one-month window every year to ship the necessary compounds for water disinfection—if there are unforeseen weather conditions, or a miscalculation of needs from the First Nation, it could become extremely difficult to obtain the chemicals needed (Cassels et al, 2001). The plant is somewhat difficult to operate, and many of the operators felt as though they needed additional training to be able to maximize the value of the plant to the community (Cassels et al, 2001).

A boil water advisory was put in place in the community in 2002, 11 years after the treatment plant was constructed. The advisory was put in place due to the realization that the plant did not have adequate disinfection capabilities to address the contaminants found in the local source water, as well as a lack of operational capacity and training to operate the facility (Tooley, 2018). This advisory is still in place today.

Hollow Water First Nation, Manitoba

Hollow Water First Nation is a small Anishinaabe (Ojibway) First Nation located on the Eastern Shore of Lake Winnipeg, and as of 2016 had a population of approximately 580 (2016 Census). In 2016, Hollow Water First Nation was placed on a boil water advisory after dealing with ongoing breakdowns at the water treatment plant. After $9 million dollars of investment into the treatment facility was made by the Federal Government, water is still unusable to many community members since the upgrades did not include money for piping to nearly 50 homes (Hobson and Burns-Pieper, 2021). This has left many community members to continue being reliant on getting water supply from cisterns, which are large tanks for holding water. The supply of water to the tanks does not come from a water main, rather it is trucked to the tank and filled once every week or two. Although this method is cheaper, the tanks do not provide enough water for average usage, so rationing is still required, and cisterns pose much higher risk of contamination, as toxins can leech into the tank if not properly maintained (Blunt and Hobson, 2021).

Many of these tanks are over 30 years old and have had very limited maintenance or cleanings over the years. The responsibility for cleaning the tanks in many cases falls to the band or the individual resident, however, funding and training are not available. Therefore the clean water put into these dirty tanks can be dangerous to drink. The boil water advisory was able to be formally lifted in 2018 because of safe results produced at the treatment plant, but do not account for the decentralized system of the water in cisterns. Therefore, satisfying the Federal Government's objectives of formally ending the boil water advisor appears sufficient on paper, this basic build approach to water treatment has not met the needs of the community and still poses severe health risks to many community members (Hobson and Burns-Pieper, 2021).

This has left community members who are still on the cistern system reliant on bottled water. Bottled water also lacks accessibility, often requiring community members to travel approximately two and a half hours by car to Winnipeg, Manitoba to obtain safe drinking water (Hobson and Burns-Pieper, 2021). Beyond safe drinking water, many of the community members have cited skin conditions that have developed from using water from the cisterns to bath or wash hands in. Similarly, recent studies have shown that cisterns are high risk for bacterial contamination, resulting in higher spread of viral and bacterial infections, other diseases, and stomach cancer (Blunt and Hobson, 2021).

Although the water that is piped and treated at the new treatment facility is safer than the water previously was, there is a deep mistrust in the government, and many individuals are still worried about the quality of the water. Hollow Water First Nation Chief Larry Barker describes the cisterns as a Band-Aid solution (Hobson and Burns-Pieper). The use of 30-year-old cisterns is a decision that was made to deliver water as quickly and cheaply as possible, regardless of the continuity and safety of the larger water system.

Outcomes

A 2011 federal study found that 73 per cent of all First Nations water treatment plants in Canada were either at medium or high risk of failure (Simeone & Troniak, 2012). We can see that the "basic build" approach often leads to water treatment systems that are not well-suited to local contexts, which creates multiple barriers to long-lasting clean water for communities. First, plants can be ill-suited to identify and treat the specific contaminant concerns of each locality and respond to local climates (Bradford et al, 2018), as evidenced in the Sandy Lake example. Second, the treatment plants may be dependent on treatment methods that present significant logistical challenges to communities. Surely, a treatment plant dependent on chemicals that must be shipped in during a one-month window cannot be the best option for a remote community like Sandy Lake. Reliance on external factors (i.e. delivery of decontamination chemicals) for clean water additionally hinders a community's autonomy and self-reliance. Finally, the treatment plants may not be adequate for community demographics. There are many communities, like Grassy Narrows, Sandy Lake, and Six Nations of The Grand River, who have not been able to connect all of their homes to the local water treatment plant, due to the plant having inadequate capacity or presenting significant post-installation connection challenges (Klasing, 2016). Fortunately, movement has been made in all three communities in recent years (see Chattha, 2019, Chattha, 2020, and Indigenous Services Canada, 2021). For example, Grassy Narrows' water treatment system was upgraded, and two wells were replaced that were connected to the main treatment system (Chattha, 2020).

Treatment plants designed along this typical approach also present significant challenges for local operators. Some of these systems are complex to operate and maintain, and local operators do not have the appropriate training. Water operators in many First Nations communities desire additional training and upgrading, they often have no backup operators, receive less pay than their municipal counter-part while working long hours, and are often under-supported by local governance due to financial concerns in many First Nations. As such, water treatment systems that are not suited to local water quality conditions have been located in many First Nation communities. These systems then challenge the best water quality operators to produce safe drinking water. These water treatment systems then experience breakdowns, high cost of maintenance and repair often leading to system failure. The basic build approach, due to its focus on cost-savings, and a standardized but outdated water treatment system, is not able to address the variability of source water quality across Canada as well as operational capacity issues alongside the development of the physical infrastructure (Cassels et al, 2001), which, as we will see, is an important element of water infrastructure development for Indigenous groups.

Finally, water treatment systems may be culturally inappropriate for local communities. Though this is not captured in the examples above, current systems have been identified as not being value-sensitive or responsive to local concerns (Bradford et al, 2018). For example, in Lytton First Nation—an innovative case study example we will examine later on in the paper—community members identified an aversion to the chlorine taste in the water that resulted from their old water treatment plant (RES'EAU, 2016). This is but a small example of the ways in which a treatment plant can be inappropriate for local values and cultural factors. Without a common understanding of the cultural knowledge, culturally inappropriate water program proposals and communication barriers have prevented access to safe drinking water in prospective communities (Bradford et al. 2016: 13).

For many Indigenous communities, water is considered "a gift from the Creator, the lifeblood of Mother Earth and a spiritual resource that must be respected and kept clean" (Bradford et al. 2016: 2). Water is sacred, is a necessity for life, and is built into subsistence ways of life and traditional activities for Indigenous peoples; without access to clean water "all life will perish" (Turner 2012). The reliance on trucked in, bottled water becomes problematic for reasons beyond health, economic, or accessibility considerations. Indigenous teachings speak to water as providing "for both the hydration of the body, and giving 'spirit' in each drink," leading some community members to ponder: "since anything wrapped in plastic dies … Are we feeding our people dead water?" (Bradford et al. 2016: 13).

Such concerns may explain the growing popularity of Biological Reverse Osmosis (IBROM) systems by SAPPHIRE and other companies. These are very popular now on the prairies and elsewhere. While the systems have a high capital cost, they have very low operational costs. More critically, they employ few chemicals and require limited maintenance.

Maintenance is not only a question of local skills. Regular maintenance interruptions affect other aspects of the community as well. Persistent boil water advisories or even regular system "downtime" take time and energy away from largely elder generations in communities which could otherwise be spent socializing, engaging in spirituality, teaching, and practicing cultural traditions. Transmitting knowledge that is otherwise at risk of being lost (Lucier et al. 2020: 9). Such concerns can play a key role in undermining a sense of ownership over local treatment plants, which in turn influences the upkeep and maintenance that the treatment plant receives (Bradford et al, 2018).

It is not clear that the basic build approach is the most cost-effective method of approaching water infrastructure, either. Though it is true that in many cases it is able to keep up-front costs low, the costs that it will incur over its lifetime through maintenance, repair, and replacement can be significant (Penner, 2016). First Nations communities are responsible for 20 per cent of the costs for infrastructure, maintenance, and operations, along with water safety monitoring and ensuring trained operators are present (Bradford et al. 2016: 1). This leads to issues of education, training, and retention. It is difficult to retain personnel from external locations once they're trained or to recruit personnel to complete training due to the remote location, operators reluctantly being on-call every day, limited support personnel (depending on the community), and fears of making mistakes with complex water systems (Bradford et al. 2016: 13). More needs to be done to allow Indigenous communities to become self-sustaining. Providing access to safe water sources is imperative, though investing in developmental interests such as education, financial planning, and community literacy programs would further assist communities with being able to plan, implement, and maintain services for the future. As will be discussed later in this paper, there are instances where taking an innovative approach to water infrastructure development was less expensive up-front than taking the basic build approach.

Case Studies: Water Infrastructure Innovation in Practice

Lytton First Nation, British Columbia: Modular, Small-Scale Water Filtration Plant[3]

Project Overview

Community Specifics: Lytton has approximately 1,000 members living in 56 micro-communities, or small reserves, across 14,161 acres along the Fraser and Thompson Rivers. Some reserves only contain between two to four inhabitants.

Challenges: The reserves are serviced by ten separate water systems, many of which are under periodic water advisories because of aging infrastructures or contamination.

Solution: Innovative, small-scale water treatment plant at one of Lytton's reserves, Nickeyeah. Nickeyeah only has six inhabitants.

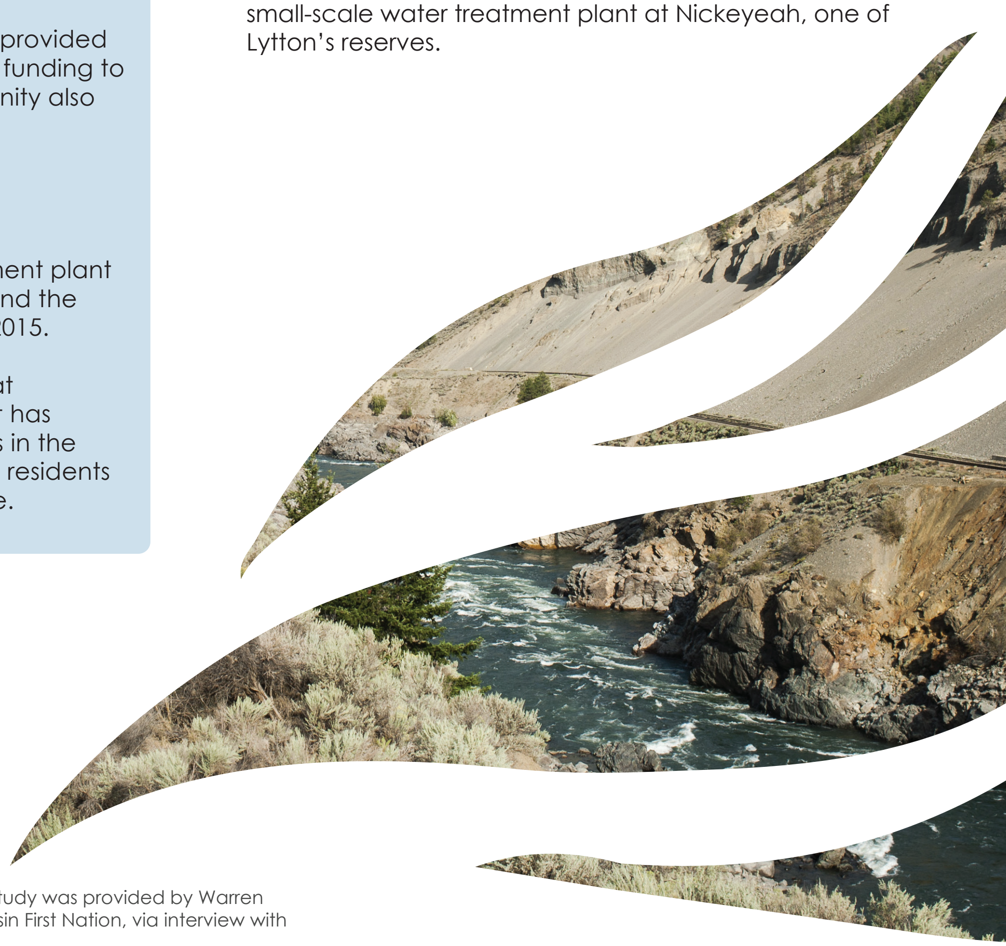
Funding sources: The federal government provided the majority of the funding, also providing funding to UBC's lab, RES'EAU WaterNet. The community also contributed monies.

Cost: $500,000.

Project length: The design process took approximately one year. The water treatment plant was built off-site in the winter of 2014-15, and the project was finished and installed in April 2015.

Outcomes: A modular treatment plant that was quick and easy to maintain. The plant has succeeded in ending boil water advisories in the small Nickeyeah community, and allowed residents to safely drink from the tap for the first time.

Lytton First Nation in British Columbia has approximately 1,000 members living in small reserves, called "microcommunities" by some, scattered along the Fraser and Thompson Rivers (Fontaine, 2017). The community is made up of 56 reserves, spread over 14,161 acres (Nadeem et al, 2018). These diverse reserves are serviced by ten separate water systems, many of which are under periodic water advisories because of aging infrastructure or contamination (Fontaine, 2017). With some reserves only containing two to four inhabitants, it can be exceedingly difficult to receive funding for infrastructure upgrades from the government, as they often consider them too small to receive capital infrastructure funding (UBC Applied Science, 2020). In 2015, the First Nation collaborated with the University of British Columbia's (UBC) lab, RES'EAU-WaterNet, to build an innovative, small-scale water treatment plant at Nickeyeah, one of Lytton's reserves.



[3] Unless otherwise indicated, information about this case study was provided by Warren Brown, Operations and Maintenance Manager at Tl'kemtsin First Nation, via interview with the authors in June 2020.

Initial Stages

When the old facility at Nickeyeah Creek could no longer provide safe water to the nearby houses, Lytton First Nation submitted an upgrade proposal to INAC (Nadeem et al, 2018). However, the project was rejected for not being "cost effective": an engineering firm had quoted the project at $1.3 million, which the government decided was far too much for a facility that only serviced six houses (Nadeem et al, 2018). Instead, INAC facilitated a partnership between RES'EAU-WaterNET, a UBC lab funded by IC-IMPACTS, specializing in solving water issues, and Lytton First Nation's then-water operator Jim Brown. Together, they were to work on an innovative solution for the community (Nadeem et al, 2018). All three parties—the community, RES'EAU, and the federal government—worked together to fund the project. In the end, the majority of the funding came from the federal government, who also provided funding to RES'EAU.

Design and Construction Process

RES'EAU placed an enormous emphasis on designing a water system that was specifically tailored to the community's needs. This resulted in the design process taking approximately a year, the lengthy amount of time being due to the extensive levels of communication and innovative nature of the project (Nadeem et al, 2018). From the beginning, RES'EAU made sure to place the community water operators at the centre of the project, incorporating local water knowledge at the earliest project stages (RES'EAU, 2016). Water operators and community leadership were able to express their needs, wants and capabilities. Facilitated by trust between the community, leadership, and water operators, the water operators were able to champion the project to the community, and help achieve community acceptance.

After initial talks with operators and leadership, RES'EAU then went to individual homes in the community with questionnaires about water needs, current situations, etc. They made it a point to learn stories from the community about water, and told the community that they would be kept in the loop throughout the project. RES'EAU used a community circle approach to the design, holding meetings with community members and contractors to get as much participation and community input into the design as possible—this included not only talking circles but also interviews with important community leaders, like elders (RES'EAU, 2016). Through this, community members were able to set the main goals of the system—improved water treatment and intake (RES'EAU, 2016). For example, many people in the community expressed that they did not like the chlorinated taste that resulted from the treatment process of the old facility, thus one priority was to figure out a treatment system that mitigated this issue (Visser Sales Corp., 2015). Throughout the project, RES'EAU created a youth film program for local youth to document the project—allowing them to get involved and interested in local water systems (RES'EAU, 2015). The film project involved documenting the project processes and recording community perspectives on the affair.

Once the community input phase was completed, there was a lot of back-and-forth with community water operators on some of the more technical aspects of the plant, allowing them to pick a system that they felt worked best and what they felt most comfortable with. Due to Lytton First Nation's spread-out nature, water operators need to drive long distances, up to 140 kilometers between water stations, to complete a check of all their systems. Therefore, they needed something that was quick and easy to maintain. Operators were also fully trained on the system, to ensure that it would be a sustainable solution, and not something that would fail as soon as the RES'EAU presence decreased.

The plant was made in a modular fashion, and was completely assembled offsite then packaged into a shipping container. This helped to avoid the complications and delays that can occur with construction projects in more remote areas, such as on reserves. Other private partners, in addition to RES'EAU, like BI Pure Water worked closely with the then-Aboriginal Affairs and Northern Development Canada (AANDC) during the design and rollout of the plant, to help ensure it met budgetary requirements (Visser Sales Corp., 2015). The project was finished and installed in April of 2015, and the community held a ceremony to celebrate the opening of the plant. In total, the project was completed for $500,000 (Nadeem et al, 2018).

Design Elements

The treatment plant is located near its Nickeyeah Creek water source, one that was identified and tested in co-operation with community members (Fontaine, 2017). The plant's main features are its tailored size and ease-of-use—the entirety of it fits in a shipping container. Historically, a main issue with water plants in Indigenous communities is that the government has prescribed a standardized, high operation and maintenance systems to communities that are far too large and complicated for the limited training and pay rate offered to small Indigenous communities (Corpuz-Bosshart, 2018). This plant, however, is tailored to the six houses it serves, and extended dialogue with water operators helped ensure that the system was within their capacity to operate.

The plant is designed to make 19L/min of water, with a maximum demand of 27 cubic metres per day (Visser Sales Corp., 2015). To treat the water, the system uses pre-filtration, UV disinfection, and chlorine disinfection—as selected by the community water operator (Visser Sales Corp., 2015). The pre-filtration process is accomplished through six different filters, which require a simple swap-out or cleaning occasionally when indicated by pressure monitors located before and after each filter (Visser Sales Corp., 2015). Ultraviolet light treatments can be monitored by the controller, and the disinfecting lamps only need changing approximately once a year (Visser Sales Corp., 2015). Finally, the chlorine disinfection is flow-paced and conducted by an injection system. For this process, only the chlorine tank levels and the control panel need to be monitored by the water operators (Visser Sales Corp., 2015). This all results in a system that can be quickly checked by the water operators that need to drive over a hundred kilometres a day and monitor multiple systems, and meets the needs and water preferences of the community it serves.

Project Completion and Outcomes

Admittedly, there were some initial challenges to get used to the new systems and innovative technologies, but it has performed very well since then. There has also been some work to maintain the system, and small adjustments have been made to the system by the community water operators to better fit the changing operator and community needs. These changes were made through ongoing communication with RES'EAU, who have ensured the system was easy to adapt as needed. To ensure that the system was functioning well, RES'EAU remained involved, testing the water multiple times and helping monitor the system for an entire year to see how it performed through the season (Corpuz-Bosshart, 2018). It has succeeded in ending boil water advisories in the small Nickeyeah community and allowed residents to safely drink from the tap for the first time since the 1990s (Nadeem et al., 2018; Admin, 2016).

In addition to improving the material conditions of Nickeyeah residents, it has also had the effect of increasing pride among community members. It has allowed the opportunity for community leaders to showcase their work in the project to other First Nations, positioning themselves as an innovative, capable community. Water operator Warren Brown has also been offering tours to local schools and First Nations of their systems, showcasing to the youth their own community and helping build pride and interest in water systems.

RES'EAU stayed in contact with the community long after the project was complete, and is still in communication with the water operators to this day. They assist with presentations to schools and other groups, as well as help the operators if they have any problems or questions about the system. This is seen by the operators as a massive improvement over the typical situation, where they are left to fend for themselves after a water system is built. The ongoing relationship, as previously mentioned, has made it easier for operators to fix and adapt the system as required.

However, project outcomes were not perfect. RES'EAU felt as though they had done a good job of community engagement, but at the end of the project, they found that some of the community had been left out and not all of their concerns were taken into account. The timing of the work had interrupted local water availability temporarily, preventing local gardens from being planted on time. Further, some members of the wider community had not been made aware of the project, or received only limited information about it (RES'EAU, 2016). This led to some community members feeling dissatisfied or frustrated with the project (RES'EAU, 2015). This all occurred because the RES'EAU team acted on the assumption that the community council had the resources to be able to keep everyone informed and, in the loop, though in reality the council wasn't able to (RES'EAU, 2016).

The project was also able to motivate further water infrastructure innovation in the community. After the initial Nickeyeah project was completed with great success, RES'EAU and Lytton initiated another project: the installation of point-of-entry water treatment systems in the basements of five community homes. In accordance with the community-led development practices of the previous project and improved practices following community recommendations, RES'EAU worked with community members and water operators to design and install five fridge-sized treatment systems in community homes, at a cost of approximately $7,000 per household (Corpuz-Bosshart, 2018). The systems deliver over 400L a day per person, pumping in water from the nearby creek and using simple filters and UV irradiation to ensure water safety (Corpuz-Bosshart, 2018). Beginning operation in November 2016, they succeeded in lifting water advisories two months later with little in the way of issues since (Corpuz-Bosshart, 2018). The continuation of this partnership was made possible by the previous collaboration and community participation in the initial water treatment infrastructure project.

Keewaytinook Okimakanak Tribal Council, Ontario: Safe Water Project [4]

Project Overview

Community Specifics: The Keewaytinook Okimakanak (KO) Tribal Council is the Chiefs Council serving the northern and western Ontario First Nations of Deer Lake, Fort Severn, Keewaywin, McDowell Lake, North Spirit Lake, and Poplar Hill with a total population of 2,415 according to 2016 census data (Statistics Canada 2018).

Challenges: The communities have no road access and have dealt with long- and short-term boil water advisories due to issues with their water systems and infrastructure.

Solution: Creation of the Safe Water Project that incorporates 24/7 remote monitoring technology, operator support, and an operator certification program.

Funding sources: Federal government - Indigenous and Northern Affairs Canada.

Cost: INAC provided $1.3 million for the Project in the initial five communities. In the fall of 2016, the federal government contributed another $4 million to expand the project to 14 other northern Ontario communities.

Project length: Started in May 2015 and is ongoing.

Outcomes: The project has been very successful at reducing, and sometimes eliminating, boil water advisories in its partner communities. While it has not been able to completely eliminate boil water advisories in its member communities, it has been able to greatly reduce their duration and frequency to safely drink from the tap for the first time.

The Keewaytinook Okimakanak (KO) Tribal Council is the Chiefs Council serving the northern and western Ontario First Nations of Deer Lake, Fort Severn, Keewaywin, McDowell Lake, North Spirit Lake, and Poplar Hill. All of these communities have no road access and have dealt with boil water advisories, some long- and some short-term, due to issues with their water systems and infrastructure (Porter, 2016). In response, the KO Chiefs Tribal Council implemented a program, called the Safe Water Project, that incorporates 24/7 remote monitoring technology, operator support, and an operator certification program.

[4] Unless otherwise indicated, information about this case study was provided to the authors via interview with Barry Strachan, Manager of Water and Wastewater Operations at Keewaytinook Okimakanak, Ontario, July 3, 2020.

Initial Stages

This project is not the first time that this idea was attempted to be put into motion. The federal government originally rejected this program idea in 2004 in favour of its own program that brought in third-party operators from outside the communities (Kelly, 2016). The government program ultimately failed and was abandoned in 2015. Barry Strachan, who works as the Manager of Water and Wastewater Operations at KO, thinks that the program failed because there was no capacity being built through the program, and because of the presence of a third-party, communities did not feel a sense of urgency or ownership about their water issues. The presence of a third party was thus not conducive to long-term, sustainable success (Kelly, 2016).

The idea initially came to Barry Strachan through his 26 years of experience working in Keewaytinook Okimakanak communities and his intimate experience with their water issues. He also wanted to avoid a piecemeal approach to water infrastructure, where lobbying for many individual things was placing a significant administrative and managerial burden on the communities' leadership.

He started off by approaching Indigenous Services Canada for funding, which initially did not work out. He then embarked on a year-long journey of lobbying at all levels of government to have funding provided for it as a pilot project. Barry lobbied up to a federal minister level, with no success. Realizing that additional help was needed, he turned to the KO Chiefs to help in his efforts. Eventually, they were able to secure federal funding. The government helped connect them with Airborne Underwater Geophysical Signals (AUG) in Toronto to design the monitoring system (Kelly, 2016).

Design and Construction Process

Much of the project design was the fruit of Barry Strachan's experience working with water systems and water systems operators within the KO tribal council area for over 20 years—using his connections and experience to help bring together the operators and the supports (Kelly, 2016). The training aspect was designed with the realities of prospective First Nations water operators in mind, as will be explained in the subsequent section. The main aspect that needed "designing" was the water monitoring system. This system was made by AUG in collaboration with the communities participating in the project. Water operators and project champions alike were able to hold a meaningful dialogue with AUG in order to modify the AUG monitoring system and its software such that it was more compatible with the community's needs. They were also able to help choose where the system would be installed, so that it would protect the community's most vulnerable areas (AUG Signals, 2015).

Design Elements

The Safe Water Project involves three main elements: the monitoring system, the operator supports, and the operator training.

The monitoring system is a customized version of AUG's TRITON-Intelligent Water Surveillance Unit (AUG Signals, 2015). The units are installed at strategic locations selected by community members like schools, community centres, and treatment plants (AUG Signals, 2016), to minimize the scale and health consequences of issues with each water system. They monitor water quality 24/7, with tests every ten seconds and reports generated every two minutes. If contaminants are detected, the system can issue a warning via email or by text message directly to operator's cellphones. It also allows the water quality to be monitored remotely by logging onto a computer from anywhere and observing the quality virtually (Tenenhouse, 2015). Beforehand, people used to have to perform manual testing and wait through lengthy delays for testing results. Samples often have to be sent outside of the community for testing, which greatly delays results (Tenenhouse, 2015). Sometimes, precautionary boil water advisories needed to be put in place while waiting for tests. This system allows for this problem to be almost completely circumvented.

The second aspect of the project are the water operator supports. Being an operator in remote communities can be a difficult and thankless job, due to the level of responsibility that you have and the fact that there are usually only one or two operators in a community; the external support is important so that community water operators feel empowered to succeed. The water operators in the communities have access to industry supervisors for support, mentorship, and guidance to bolster their chances of success while pursuing their certification (Kelly, 2016). If they ever need assistance, they have around-the-clock access to two technicians located in Dryden. If an operator sends an alert out, the details of the problem are automatically sent to the support technicians via cellphone (Wilson, 2015). This helps ensure that there are ongoing supports for the operators to not only help them achieve their certification, but to help ensure that they are successful afterwards. Newly certified operators have been found to be much more successful upon returning to work if they had access to support and guidance upon returning to their communities (Marchand, 2016).

The whole project is dependent on certifying the operators. Operators, through the program, get officially certified by the province of Ontario and can then work anywhere in Canada, except for Quebec (Wilson, 2015). For a long time, operators have lacked the necessary academic background to be able to adequately manage water systems and deal with issues that might arise (Wilson, 2015). Importantly, operators are allowed to pursue multiple levels of certification, if they wish to progress in their learning or take on more responsibilities (Wilson, 2015). The training has both an in-class and field learning aspect, with the in-class learning taking place at the KO Centre of Excellence in Dryden. The Centre offers courses with amount of time spent in-class, to minimize the cost of the program, and help minimize the expenses incurred by having to travel to Dryden to take the course. If needed, courses can also be delivered off-site, to be more accessible to the communities (Keewaytinook, 2007). The Centre also employs multiple First Nations instructors. During this time, they have access to supervisors to help them achieve their certifications (Kelly, 2016).

Project Completion and Outcomes

Since its inception, the project has been very successful at reducing, and sometimes eliminating, boil water advisories in its partner communities. From 2005-2015, Deer Lake, Fort Severn, and Poplar Hill had all spent close to 1,000 days on boil water advisories, which were able to be ended thanks to this project (Wilson, 2015). While it has not been able to completely eliminate boil water advisories in all member communities, it has been able to greatly reduce their duration and frequency. Permanent elimination of boil water advisories may not be a realistic goal for this project, as some of these advisories require large infrastructure investments/changes to fix, which is outside the scope of the Safe Water Project.

The success of this project was recognized by the federal government in the fall of 2016, when they contributed $4 million to expanding the project to 14 other northern Ontario communities (AUG Signals, 2016). The expansion was deemed somewhat successful, though connecting all of the communities to a single hub proved to be too much, and so many of the expansion communities have carried on with the main idea of the project, the tripartite approach, albeit with different operations hubs that better fit their unique needs.

The project has been able to significantly increase capacity within its partner communities for water infrastructure maintenance and operations. At the start of the project, there was only one certified water operator among the five communities and their five treatment plans. Now, there are seven qualified, certified, operators for the five treatment plants—a vast improvement. This has been done, in part, through significant youth outreach efforts that highlight the need and importance of water operators within the communities and try to get youth interested and involved in water systems. Those who have gone through the program report feeling an increased sense of pride and purpose, as well as an increased sense of responsibility and ownership towards their community's water infrastructure—a feeling that extends beyond the water operators to the community chiefs and councils as well.

At times, the project runs into issues in the communities due to an overdependence on the assistance hubs, though these issues are fairly minor and not overly common. Creating capacity and taking care of their own issues has helped the KO Chiefs Council become more self-sufficient in the eyes of the government, which facilitates further improvements and approvals for funding, from the perspective of those involved with operations with the group. KO has since received more approvals for improvements, new studies, and upgrades to infrastructure in their communities. It has helped empower the community towards self-direction and decolonization by helping it lessen its dependence on government programs and assistance.

Town of Innisfil, Ontario: Upgraded Municipal Water Treatment Plant

Project Overview

Community Specifics: Innisfil has a population of 43,326, which is rapidly increasing due to its close proximity to Toronto, Ontario.

Challenges: The previous water filtration plant was expensive to upkeep, and was not able to keep up with the new residential developments the city was experiencing.

Solution: Upgrade of current municipal water treatment facility to a two-stage FiberFlex™ ultrafiltration (UF) membrane system.

Funding sources: Self-funded by the Town of Innisfil.

Cost: Not Specified.

Project length: Commissioned in September 2018 and completed before December 2018.

Outcomes: Technical and commercial flexibility that occupied the previously-existing small footprint available, with the ability to expand the system to meet growing needs. The benefits of membrane ultrafiltration include being simple to automate, compact, environmentally friendly, consistent, and not reliant on chemicals.

In 2018, H2O Innovation was commissioned to upgrade the Town of Innisfil's water treatment facility. Innisfil is located on Lake Simcoe, approximately 80 kilometers north of Toronto. The Town's population was approximately 43,326 in 2021. In recent years, given the growth of surrounding areas such as Barrie and the Greater Toronto Area, Innisfil has seen an increase in residential developments. Previously, Innisfil's water treatment system used conventional clarifier and media filter treatment units, relying on a sand filtration process. The impurities in the water from Lake Simcoe would build up in the sand filters, requiring them to be cleaned approximately three times per day; that process alone cost the Town about $2,000 per day (Ramsay, 2019). Along with being expensive, these units were not sufficient in keeping up with the Town's growth, and in turn, the higher water demand that was felt in recent years (H2O Innovation, 2019 1). Thus, Innisfil looked to upgrade their facilities to allow for future growth and cost savings.

Initial Stages

H2O Innovation was founded in Quebec in 2000. Soon after, the company expanded to offices in British Columbia and Ontario. The company's three main pillars of operations include: water technologies and services, specialty products, and operations and maintenance (H2O Innovation, n.d.). H2O Innovation has experience with multiple system applications for drinking water filtration. Formerly used technologies include reverse osmosis and nanofiltration (RO/NF), ultrafiltration and microfiltration (UF/MF), conventional media filtration, and UV or chemical disinfection (ibid).[5]

Through the engagement process, Innisfil identified the priorities for the new water treatment project. The Town identified the requirement of "a compact footprint, high recovery, cold water compatibility to handle Canadian winters and minimal disruption to the existing plant's treatment operations" (H2O Innovation, 2019 1). After discussion and evaluation of the community needs, a two-stage FiberFlex™ ultrafiltration (UF) membrane system was ultimately selected for the community. Innisfil's water and wastewater company, InnServices Utilities Inc., preferred the modular ultrafiltration treatment over conventional technologies (Ramsay, 2019). The project delivery model followed a "Design-Bid-Build" strategy, where the owner - Innisfil and InnServices – bids the design and construction of the project to separate firms.

Design and Construction Process

The FiberFlex™ membrane ultrafiltration system was selected due to its ability to fit in the small footprint available in the pre-existing environment, as well as allowing the owner technical and commercial flexibility for the facility. As the retrofit revolved around modular aspects, a methodological construction process was used to strategically allow treatment operations to continue throughout; the water treatment plant did not experience treatment disruptions during construction (H2O Innovation, 2019, 1).

The ultrafiltration membrane racks and control systems were assembled completely off-site at the H2O Innovation manufacturing facility, where they were also tested. The off-site assembly allows minimal installation labour and time required for on-site system start-up (H2O Innovation, 2019 2). This model would work well in remote, Far North environments where construction seasons are short, or when there is a short timeframe for on-site construction. Innisfil's Lakeshore Water Treatment Plant was able to fully maintain treatment operations while the retrofit was underway.

[5] Other water systems are emerging in the field that are also worth consideration. For example, see Appendix A for information about the Integrated Biological Reverse Osmosis systems by SAPPHIRE and other companies.

Design Elements

Membrane filtration is the preferred system for treating wastewater, seawater, and surface water due to its high-quality filtrate. A membrane is a thin material layer which separates substances when a force pushes liquid through it. The filtration rejects microorganisms, like bacteria, and suspended solids greater than the pore size, contaminants typically resulting in elevated turbidity – the cloudiness or haziness in water caused by individual particles – less than 0.1 NTU (H2O Innovation, 2017, 1). Membrane filtration's four modes of operations are as follows[6]:

1. Filtration;
2. Backpulse (i.e. backwash);
3. Cleaning-in-place (CIP); and,
4. Membrane integrity testing (ibid).

Ultrafiltration is a variety of membrane filtration. Hydrostatic pressure pushes the water against a semi-permeable membrane, trapping solids and solutes high in molecular weight, while the water and low molecular weight passes through the membrane (Crystal Quest, n.d.). To further contribute to the innovative nature of the project, H2O Innovation developed an ultrafiltration skid - FiberFlex™ - to accommodate several module types. This development allowed the Town further flexibility when repurchasing, updating, or expanding their modules; they were not limited to only one company whose products were compatible. The benefits of membrane ultrafiltration include being simple to automate, compact, environmentally friendly, consistent, and not reliant on chemicals (Crystal Quest, n.d.).

Project Completion and Outcomes

The system design accounted for the community's growing population by designing it with the capacity to accommodate up to 22.5 MGD[7] (85 MLD[8]) in the future (H20 Innovation, 2019, 1). The FiberFlex™ ultrafiltration system gives the Town flexibility, as the system is designed to fit with different modules from multiple membrane manufacturers. This gives the Town multiple options when looking at maintenance, replacement, and expansion options moving forward.

Though this case study is not from a First Nations community, many of the successful practices are transferable. For example, the off-site construction and testing allows the water filtration system to be installed quickly on-site, which would help mitigate the effects of a short construction season in some Far North communities. In addition, the compactness of the system allows it to easily be retrofitted to existing plants, or erected if the community does not yet have one. Finally, the universality provided by the FiberFlex™ technology allows communities to expand to meet growing needs, without being limited by few compatible options.

[6] See Appendix B for more details
[7] Million gallons per day
[8] Million litres per day

Advantages of Innovative Water Infrastructure Design

Reducing and/or Eliminating Boil Water Advisories

Innovative water system infrastructure has succeeding in reducing, and sometimes eliminating, boil water advisories in the KO partner communities and Lytton First Nation. Lytton faced periodic drinking water advisories before switching over to an innovative infrastructure solution. In KO partner communities, boil water advisories were not completely eliminated in all communities, but the water systems project was able to greatly reduce the duration and frequency of the occurrences. The KO Safe Water Project's success in mitigating boil water advisories was acknowledged by the federal government, whom later contributed millions of funding monies to expanding the project in other northern Ontario First Nations.

Improved Operations and Maintenance Capabilities

Innovative systems also increase the capacity of system operators. New technology allows water quality to be monitored around-the-clock in Keewaytinook Okimakanak, meaning contaminants can be detected immediately and monitored remotely. This is a large advancement compared to the days it took to get samples back from manual testing, often because these samples have to be sent out of the community.

Water operators are also supported 24/7 by industry supervisors for support, mentorship, and guidance, both during and after obtaining their certification. The availability of these certifications builds capacity and creates jobs in the community, while also decreasing the need for external oversight of the water systems. Additionally, having water operators from the community increases sense of urgency and ownership over projects, while also building capacity and furthering autonomy.

Through the successful Safe Water Project, multiple members throughout the community became certified water operators, increasing operations and maintenance capabilities. Also, the more members of a community actively involved in upkeep of the systems, the greater the sense of responsibility and ownership is felt throughout.

Increased Future Opportunities

Additionally, the replacement of outdated infrastructure with new, innovative solutions might inspire communities to continue down that path. After a successful water treatment project in Lytton, the community and its partner, RES'EAU, continued on to install point-of-entry systems in five other homes. The successful initial partnership laid the groundwork for more projects moving forward. In the case of KO, the successful water project proved their management capacity to the federal government, which facilitated more funding for new infrastructure projects, feasibility studies, and improvements.

Innisfil, a town projecting significant growth in the coming years, now has the capacity to keep up with the steadily growing population numbers. Previously, its water filtration system was costly and capacity was limited. Now, with the innovative water system's increased capacity, paired with FiberFlex™, the community has multiple opportunities for future expansion.

Disadvantages of Innovative Water Infrastructure Design

Extended Project Timelines

Due to extensive community meetings, paired with additional research to tailor infrastructure to community specifications, design processes can be longer than those for basic build projects. Additionally, involving multiple project champions, as done in the Lytton project, means more voices are at the table. Meaningfully taking all suggestions into consideration takes time.

Successful Practices

Community Outreach and Education Initiatives

As seen in the case studies, community outreach and education initiatives have been successful in fostering community acceptance for the innovative infrastructure projects. In Lytton, the organization spearheading the new water system went door-to-door to learn more about the community and their water needs. RES'EAU kept the community well-involved throughout the design and construction processes. Additionally, RES'EAU launched a youth film program, encouraging them to document the processes and record community perspectives. KO also prioritized engaging and educating the youth on the new systems, as well as encouraging community members to get water operator certifications. Though community outreach was largely successful, it is difficult to hear from every member of the community. Thus, there were some members who were either unaware of the project, or felt as though their concerns were not heard. Regardless, through thorough outreach and education initiatives, organizations should aim to interact with as many residents as possible.

Community-Led Design

Community-led design is a process stemming from community outreach and engagement. Having the community set the project priorities helps ensure widespread acceptance of the infrastructure projects. For example, if Lytton was given a new water system without discussions, the system could rely heavily on chlorine to filter the water, leaving a chlorine taste. But, members of the community have a strong aversion to the chlorinated taste of water, which began during the usage of their former system. In addition, Lytton's spread-out nature was accounted for in the system design and operations training. Simplistic designs are also advocated for by community members. Systems that are overly large and/or complicated can be difficult to maintain, especially for smaller communities. Community-led design mitigates the potential uptake challenges. Community-led design results in systems tailored for that specific community, bypassing one-size-fits-all basic build infrastructure. Specificities within projects are an advantage of innovative infrastructure, which results from the successful practice of community-led design.

Community-led design in Keewaytinook Okimakanak was spearheaded in large part by a community member with experience working with water systems within the KO Tribal Council area, Barry Strachen. With Barry as the project champion, a system was designed that supported operators, instead of relying on external, third-party operators. Communities were heavily involved in discussions with Airborne Underwater Geophysical Signals (AUG), who were in turn responsive to the feedback received. For example, the monitoring system units were installed at locations identified by community members. Community-led design can occur when the project partners are willing to meaningfully collaborate and consider feedback.

Finally, the Innisfil project was successful due to identification of the community's needs. What resulted was a cost-saving system with potential for expansion. In addition, service disruption was avoided by assembling the systems off-site, allowing for a smoother process.

Partnerships

Ongoing communication between project partners served to benefit the communities in which infrastructure was being built. In addition, following the completion of the project, partnerships would remain. For instance, RES'EAU monitored the water system in Lytton for an entire year, post-completion, to see how it preformed throughout the season. In fact, RES'EAU still maintains contact with the community. The ongoing relationship helps the water operators fix and maintain the system as needed; they can reach out whenever a problem or question arises.

In addition, strategic partnerships can help ease administrative burdens, such as applying for project funding. After the KO project champion faced multiple funding rejections from different levels of government, he formally partnered with the KO Chiefs to pursue more avenues. Eventually, the team secured federal funding and were connected with a water system organization out of Toronto to design their project.

Conclusion

Often, best practices, such as specifically tailored design and comprehensive community engagement, can lengthen project timelines, the above case studies show these practices are essential when updating community water practices and infrastructure. Basic build infrastructure projects are not conducive to long-term growth or success; specifically tailored designs must be sought through community participation, and training community members in the construction, installation, and maintenance of the new facilities should be prioritized. As demonstrated above, community-led design through public meetings, local education initiatives, and long-term partnerships can increase the capacity of the communities, in terms on increasing local employment opportunities, reducing/eliminating water advisories, and keeping up with a community's projected growth. The long-term benefits of innovative water systems and operator capacity far outweigh partially longer timelines at the project onset.

Appendix – Integrated Biological Reverse Osmosis (IBROM)

Sources: Safe Water Drinking Team n.d., Sapphire Water International Corp, 2014.

One water treatment system worth noting is the IBROM approach. Sapphire Water, a division of Delco Water, developed a system that relies on three core processes: biological filtration, reverse osmosis membrane filtration, and pH adjustment. The Sapphire system especially popular in First Nations communities in Saskatchewan, but there are a few communities in Alberta that have implemented the system as well (20+ communities in total). Some of the technological and economic benefits include:

- Reduced dissolved gases removed such as Methane and Hydrogen Sulphide.
- No pre-treatment of chemicals is required.
- Reduced backwashing; and
- Reduced labour costs such as minimal operator interventions.

Appendix B - Membrane Filtration Modes of Operation

H20 Innovation – Ultrafiltration and Microfiltration

Source: H2O Innovation, 2017, 1

"In filtration, feed water is "pushed" through the membrane pores at low pressure where a portion of the filtered water or filtrate is stored for backpulsing and cleaning and the remaining filtrate continues to downstream processes or potable water storage. Backpulse is a reversal of filtrate flow to displace solids that have accumulated on the membrane surface and flows to drain. Backpulse frequency is based on the feedwater quality, typically every 20-60 minutes. Cleaning is done to remove materials that are not removed with backpulse. Chemicals used for cleaning are typically, acids, bases and oxidants. Membrane Integrity testing (MIT) is done periodically to verify there are no leaks in the membrane that would otherwise allow bypass of feedwater and harmful microorganisms. MIT is performed by using pressurized air and monitoring the pressure decay rate."

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