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# The Community-Led Approach: A Holistic Methodology to Addressing Rural Drinking Water Advisories in Samson Cree Nation

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# The Community-Led Approach: A Holistic Methodology to Addressing Rural Drinking Water Advisories in Samson Cree Nation

by

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# Abstract

Drinking Water Advisories (DWAs) affect Indigenous Communities across Canada, with focus being given to specific problems impacting centralized systems. This thesis explores the largely undocumented rural systems context and how wastewater systems must be considered in tandem. In partnership with Samson Cree Nation, through Indigenous Research Methodologies like Two-Eyed Seeing this thesis presents research that investigated the community's approach to solving drinking water concerns. Using deductive thematic analysis, the qualitative data was used to evaluate the benefits and challenges of a community-led approach and to quantify the impact that DWAs have on Samson Cree Nation residents. Historical data and onsite inspection data was evaluated to define the extent of DWA's, the condition of rural servicing infrastructure, and the impact of existing regulation and water governance practices. Findings indicated that the community-led approach allowed the Nation to advocate and articulate issues specific to the Nation and develop solutions that reflected the community's unique needs. Quantitative data showed that 15% of homes were under a Boil Water Advisory and up to 50% of homes under Do Not Consume orders. A majority of rural water and septic systems were beyond their expected life and 70% of septic systems had failed and been converted to a 'shoot-out' septic waste system, within close proximity to a house and/or well. Considering the prevalence of DWAs, the issue extends beyond merely physical condition. The existing regulations and funding policies are outdated and counter to long-term solutions. Within Samson Cree Nation, the lack of clear regulation and quality control has created uncertainties and inconsistencies. Specifically, in the lack of monitoring and regulation surrounding construction. Minimal operation and maintenance have resulted in failing infrastructure and general distrust across the Nation both in individual systems and the Nations capacity to address concerns. Other issues identified by interviewees included the Nations' lack of capacity and awareness about rural water issues. Overall, the success of the Nation-led approach highlights the importance of Indigenous-led partnership and collaboration. However, to obtain long-term solutions for DWAs, the regulations and policies that govern must be adapted to minimize the prevalence of short-term band-aid solutions.

# Preface

My work with Samson Cree Nation began before I ever finalized a research project. Rather it started as an interest in their *nîpiy* committee and the work they were doing. This relationship-building focus lent towards a thesis that reflected the needs and desires of the community, rather than an academic obligation. Hence, a common theme throughout my thesis is a community approach rather than typical westernized engineering. This meant incorporating social and cultural components, ideas and impacts to supplement the technical pieces for a more holistic picture.

While this thesis is my original work, the project was completed in collaboration with Nation staff, Maskwacîs Health Services and Urban Systems Ltd. This partnership between the Nation, academia and industry brought people to the table who were all working towards a common goal. With various individuals contributing in unique and necessary ways we were better able to identify and address drinking water advisories in Samson Cree Nation. The internal project team helped bring this project to fruition and would not have been possible otherwise and as such, my research reflects a very collaborative effort.

Having been raised in Calgary and attending both undergrad and postgrad at the University of Calgary, my experience and knowledge of the community was minimal. I will never pretend to have the lived experience of the members living on reserve nor fully understand the implications as a result of our differences. However, I always tried to bring an unbiased perspective to my research and if not unbiased, then at least understanding. I was able to spend many days on reserve over the two years I was involved with Samson Cree Nation, and I am forever grateful to have participated in community events and had chances to have one-on-one conversations with members. I feel it important to recognize the opportunities I was awarded through my research, while acknowledging the unique perspective each individual researcher brings to his or her research.

# Acknowledgments

Looking back to when I started my masters, I could never have guessed how many people there would be to thank for helping and supporting me throughout the process. I have had the opportunity to pursue an area I am passionate about, while making many meaningful friendships along the way.

First to my parents, for whom always encouraged lifelong learning and finding a path I am passionate about. I could not have done this without your support. I greatly appreciate the many long conversations and advice you have given me through this process. As well as the rest of my family and friends, who were my cheerleaders and always there to celebrate every accomplishment.

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Next to everyone at Samson Cree Nation, including *nîpiy* committee members, Nation staff and residents, who welcomed me into the community and made this project possible. I want to thank the *nîpiy* committee for giving this project direction and letting me be a part of such an amazing group of people.

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# 1.0 Introduction

Water is a fundamental component of the earth and is essential to the existence and functioning of all living things. It is present in the air as water vapor, in the ground as soil moisture and in aquifers as groundwater. In short, water is connected to nearly every aspect of life on earth, and it plays a critical role in the health and wellbeing of all living things. Water connects us, it is what makes us up as individuals and allows us to stay alive (Anderson et al., 2013). Beyond that, it is widely believed and understood in many Indigenous cultures that water is not only alive, 'but also sentient - having consciousness' (Anderson et al., 2013). Access to clean water is not only a fundamental human right but an obligation to a shared responsibility in environmental health (Andorra et al., 2022). Given Canada's abundance of freshwater, it is surprising that we still face water-related issues. As of 2008, 100 percent of urban residents and 99 percent of rural residents in Canada have access to improved drinking water and sanitation (Boyd, 2011). However, with two-thirds of First Nations communities experiencing at least one long-term Drinking Water Advisory (DWA) between 2004 and 2014 we see the bleak reality (Palmater, 2019). Not only do water issues exist persist, but Indigenous communities are disproportionally effected, with First Nations homes ninety times more likely to be without running water (Boyd, 2011).

In recent years, Indigenous communities have garnered media attention due to lack of access to potable water and poor infrastructure. In 2015, the Federal Government pledged to end all long-term drinking water advisories by 2021. While the project remains ongoing; $5.2 billion has been invested since 2015 to lift 120 long-term drinking water advisories, though 32 DWA's are still in effect across 28 communities (G. of C. I. S. Canada, 2021). However, opinions vary on whether this is sufficient given both the delay of completion and the lack of inclusion of small water systems. With over 630 Indigenous Nations in Canada, many of which are located in rural areas, decentralized systems must be included when considering access to clean water and the quality of life in Indigenous communities (G. of C. Canada, 2022).

Looking further into rural systems, it is important to consider how wastewater servicing should be considered in tandem within water systems. As a small scale system, the most effective risk prevention to water quality concerns is source water protection, which can be significantly impacted by wastewater management (Walters et al., 2012). A decentralized water and wastewater system consists of potable water and wastewater management that includes collection, treatment and distribution through each system. Indigenous Services Canada (ISC) defines decentralized systems as a "group or groups of band-managed (as opposed to individually-managed) on-site water or wastewater systems" (Canada;, 2010).

This definition underpins many decisions, including the determination of allowable funding, and operations and maintenance provided by ISC.

Holistic approaches are needed to address and identify the cause and effect of long-term drinking water advisories. Holistic is defined as "belief that the parts of something are interconnected and can be explained only by reference to the whole" (Oxford Languages, n.d.). In the context of water management, this means that we cannot only look at water servicing itself, but rather everything that touch's and interacts with water. Water quality concerns are not solely attributed to infrastructure but involve all levels of water management including operation and maintenance practices, governing regulation and funding models. Meaningful solutions must be community-led, particularly in Indigenous communities who share a demography that sets them apart from the rest of Canada (J. P. White et al., 2000). Focusing exclusively on technical solutions, minimizes social and local context regarding water perception and community impact that is necessary for meaningful community solutions (Baird et al., 2015). Failure to incorporate traditional knowledge and Indigenous perspective with technical management has led to the restriction of successful water management (Irvine et al., 2020). Improved rural servicing requires incorporating the community impact of DWAs with improved infrastructure for water and wastewater systems, financial resources, in-community capacity growth and relationship building (Irvine et al., 2020).

## 1.1 Background

According to a report by the Office of the Auditor General of Canada, as of March 2021, there were 101 Indigenous communities in Canada (out of 630) that were under a DWA (O. of the A. G. of C. Government of Canada, 2021, p. 3). Many of these advisories have been in place for years, and some have been in place for decades. This means that the water in these communities is not safe to drink, and residents must boil or otherwise treat their water before using it. In Canada, there are three types of DWAs (G. of C. I. S. Canada, 2018b):

1. Boil Water Advisory (BWA) – Water can be boiled for safe consumption
2. Do Not Consume (DNC) – Water should not be consumed under any circumstance but can be used for washing or bathing
3. Do Not Use (DNU) – Water should not be used under any circumstance

BWA's use E. coli or Total Coliforms to indicate the presence of disease-causing bacteria, viruses or parasites (G. of C. I. S. Canada, 2018b). DNC's can indicate any number of contaminates, with common sources being metals, nitrates, or anions (H. Canada, 2015a). Similarly, DNU orders may indicate the presence of various contaminates in higher concentration or the presence of toxins or radioactive material (H. Canada, 2015a).

In addition to the challenges related to drinking water, many Indigenous communities in Canada also face challenges with their wastewater systems. This can include inadequate sewage treatment, inadequate infrastructure for collecting and treating wastewater, and a need for trained personnel to operate and maintain these systems (Islam & Yuan, 2018). These issues can lead to environmental degradation and public health risks for the community. The Federal Government has committed funding to support these efforts, and various organizations are working with Indigenous communities to design and implement solutions that are appropriate for the specific needs and cultural context (G. of C. I. S. Canada, 2018a).

### 1.1.1 What Is a Decentralized System?

A decentralized water and wastewater system consists of potable water and wastewater management that includes collection, treatment and distribution through each system. ISC defines decentralized systems as a “group or groups of band-managed (as opposed to individually-managed) on-site water or wastewater systems” (Canada;, 2010). This definition determines allowable funding, operations and maintenance provided by ISC.

In Canada, decentralized water systems typically include groundwater wells or cisterns. Cisterns are large water reservoirs that are routinely filled through truck delivery. Typically constructed with plastic, cisterns may be located inside or outside of the house and run-in conjunction with pumps to distribute through the home (Government of Manitoba, 2014). Groundwater wells access water from the local aquifers. In Alberta, this typically means drawing from bedrock aquifers as a majority of wells utilize a deeper water source (84%) as compared to the unconsolidated aquifers (16%) (P. S. and P. C. Government of Canada, 2014). Bedrocks aquifers are a preferred water source as they typically have better water quality and consistent yield (P. S. and P. C. Government of Canada, 2014). This is because unconsolidated aquifers are unconfined, meaning they can be polluted by surface water (P. S. and P. C. Government of Canada, 2014).

Decentralized wastewater systems in Canada typically utilize holding tanks, septic tanks, septic fields, lagoons and shoot-outs (Islam & Yuan, 2018). Similar to cisterns, holding tanks work by collecting the septic waste in polyethylene tanks for storage (*Alberta Private Sewage Systems Standard of Practice*, 2021). This needs to be routinely pumped out and disposed by a vac truck. A septic tank is a large water-tight container composed of fiberglass, plastic or concrete that is located underground (Cameron et al., 2009). The tank is connected through an inlet and outlet pipe that collects wastewater from the household, typically by gravity or pumps (Cameron et al., 2009). Inside the tank, three layers are formed from the collection of wastewaters. The top layer is composed mainly of oils and grease, called "scum" (US EPA, 2018). The middle layer contains the wastewater and waste particles (US EPA, 2018). The bottom layer consists of heavier particles, called "sludge"(US EPA, 2018). It contains a large population of anaerobic

bacteria that breakdown organic material from the wastewater. An effective septic tank holds sewage long enough for most solids to settle and become broken down from the bacteria (G. of C. I. S. Canada, 2020b). The remaining solids and liquid discharged into a septic field (US EPA, 2018). Septic fields, otherwise known as disposal fields, drain fields, leach fields or leachate beds are a series of lateral pipes that distribute the semi treated waste beneath the ground surface where it infiltrates as it makes its way through the water course (Cameron et al., 2009). Pollutants such as pathogens, metals and chemicals are filtered out. Lagoons are less common than the previous systems for individual use, but typically work by collecting septic waste from the home and storing it in a pond like structure. Sludge waste must be dredged from the lagoon every 20-30 years to maintain storage volume (Lipetzky, n.d.).

Open discharge and shoot-outs are terminologies that can be used interchangeably, as they both refer to a household sewage disposal method where effluent from a septic tank is discharged onto the ground surface. Open discharge systems are highly regulated across Canada, with many provinces banning the use of them altogether (*Alberta Private Sewage Systems Standard of Practice*, 2021; Government of Manitoba, 2003; Government of Saskatchewan, 2011; Ministry of Health, 2014). Regulations for open discharge require minimal treatment before discharge when compared to other systems. Whereas a shoot-out is a failed septic system that releases untreated, or minimally treated, wastewater effluent to a ground level surface (Baijius & Patrick, 2019). Households that have failed leachate beds (septic fields) usually have septic shoot-outs. The term “shoot-out” is used primarily in a Canadian context, more specifically for First Nation communities where shoot-outs are most common. Septic systems are used primarily in rural communities that lack access to municipal wastewater treatment infrastructure. Surface discharge systems and shoot-outs release wastewater effluent that may contain contaminants such as pathogens, metals and chemicals (Baijius & Patrick, 2019). These contents discharging to water sources can cause harm to the environment and to human health (Baijius & Patrick, 2019). For the purpose of this paper the term open discharge and shoot-out will be used interchangeably, as both pose a significant risk to water contamination and human health. Figure 1 below illustrates a typical decentralized system utilizing a groundwater well and septic tank with surface discharge, and a photo of a shoot-out.

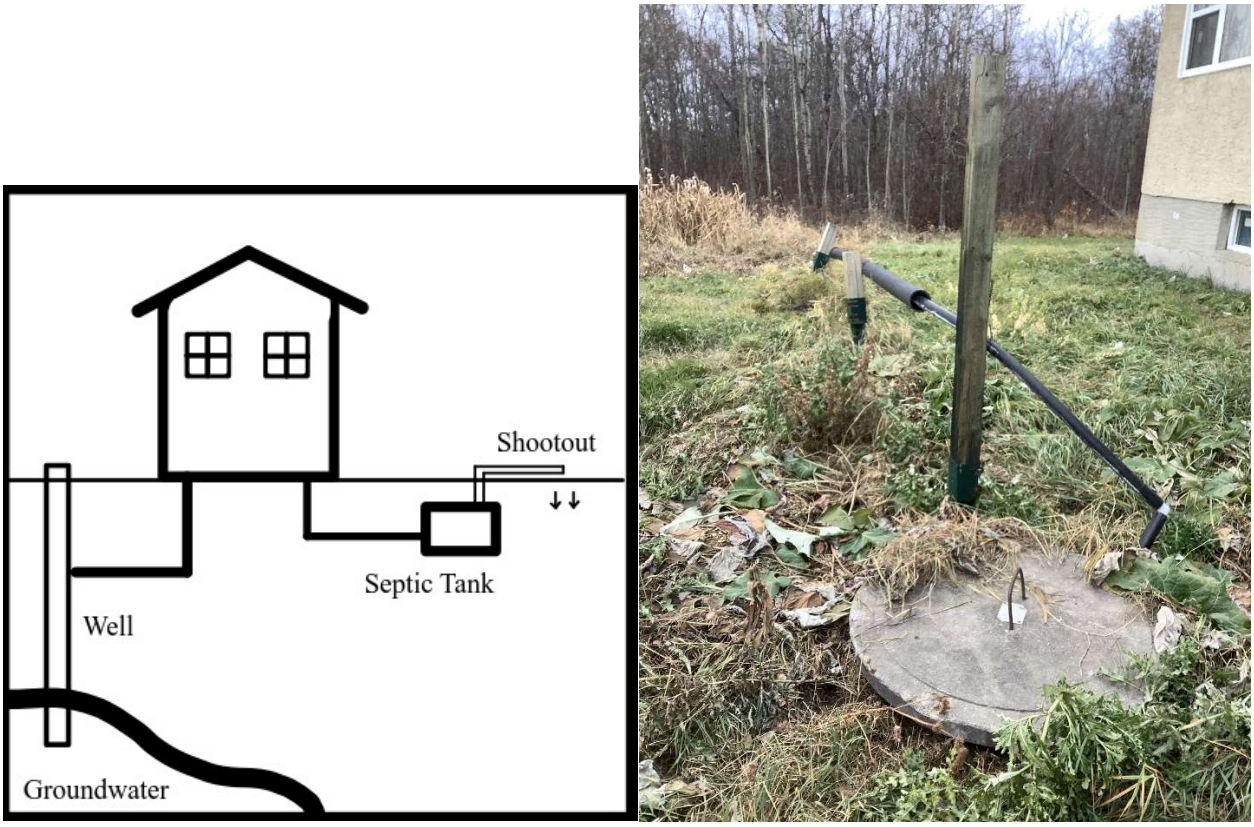


Figure 1: Typical Decentralized System and Photo of a Shoot-out

### 1.1.2 Decentralized System Regulatory Considerations

In non-Indigenous communities, water and wastewater systems are typically managed by the municipality and regulated by the provincial government. In Indigenous communities, Indigenous Services Canada (ISC) and Health Canada work together with the community to provide services according to federal policy and guidelines (G. of C. I. S. Canada, 2011a). Health Canada "works in partnership with First Nations communities to ensure drinking water quality monitoring programs are in place in communities South of 60°, as per the Guidelines for Canadian Drinking Water Quality" (G. of C. I. S. Canada, 2011a). This includes programs for testing water quality, capacity building and community-based education. Environment Canada regulates the degree of treatment and effluent quality of wastewater discharged to receiving waters, and provides advice and technical expertise on federal legislation requirements (G. of C. I. S. Canada, 2011a). Indigenous and Northern Affairs Canada (INAC), recently renamed under ISC, is responsible for providing regulation and protocols on water and wastewater systems to support Indigenous communities.

The Federal Government dictates that all new water and wastewater systems comply with:

- "The relevant sections of the National Building Code standards;
- the Guidelines for Canadian Drinking Water Quality, Health Canada;
- the Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments, Environment Canada;
- the Protocol for Decentralized Water and Wastewater Systems in First Nations Communities, Indian and Northern Affairs Canada;
- the Protocol for Centralized Wastewater Systems in First Nations Communities, Indian and Northern Affairs Canada; and
- Provincial/Territorial guidelines and regulations except where they are less stringent than those of the federal government." (G. of C. I. S. Canada, 2011a)

These documents define requirements for construction, management and operation of water and wastewater systems.

### 1.1.3 Funding for Decentralized Systems

In 2015, the Federal Government pledged to end all long-term drinking water advisories by 2021 (Water Is Life, 2022). The Federal Government defines long-term advisories as those that have been in place over a year (G. of C. I. S. Canada, 2018b). While the project remains ongoing; 120 long-term drinking water advisories lifted (across the 630 First Nations communities across Canada), 200 short-term drinking advisories prevented and $5.2 billion invested since 2015 are clear victories for Indigenous communities (G. of C. I. S. Canada, 2021). However, opinions vary on whether this is sufficient given the delay of completion and whether this fully covers on-site water servicing concerns. A key point being how wastewater servicing must be considered in tandem with water systems (McFarlane & Harris, 2018).

Though water and wastewater systems are inherently linked, given the proximity to each other, the current condition, quantity and management of these systems is largely unknown (McFarlane & Harris, 2018). Few attempts have been made to acknowledge and engage in interdisciplinary conversations around the cause, challenges and governance of small drinking water systems (McFarlane & Harris, 2018). If we are to understand the unique challenges, we cannot consider them independently. A 2005 report compiled by the Assembly of First Nations highlighted that "…wastewater management, particularly sewage, is especially problematic for First Nations. This problem is not just about how others dispose of their sewage and how this affects our lands and waters, but how inadequate our own wastewater systems are on our reserves. … 75% of the 740 water treatment systems on reserves and 70%

of the 462 wastewater treatment systems on reserves posed a medium-to-high risk to drinking water and wastewater quality" (AFN, 2005).

## 1.2 Research Context

Samson Cree Nation, an Indigenous community located within Treaty 6, has long dealt with drinking water concerns having previously been under a long-term DWA. With over 6300 members living on reserve and over 780 rural homes, issues with water extend beyond the townsite and continuously impact those living in rural areas of the Nation. Over the last decade, the Nation has taken an alternative approach to water quality solutions and adapted community-led solutions to better articulate the problem and find long-term solutions.

Understanding and addressing water quality concerns in Samson Cree Nation began many years before my involvement, and one could argue many years before anyone sat at a formal table discussing water issues in Indigenous communities. As it is the original Peoples who have lived experience, who have passed stories down from generation to generation, that truly began the discussion.

The importance and value of water as a life-giving element created the foundation of the *nîpiy* committee in Samson Cree Nation. *nîpiy*, which is Cree for water, began in 2013. The committee was established to bring likeminded individuals together to manage, protect, and enhance water resources to achieve water governance and sovereignty (*nîpiy*, 2020). In 2020 a water roadmap was developed by the committee, in which *nîpiy* identified evaluating and addressing rural drinking water issues as a key objective. This was to be done in conjunction with prioritizing public education and engagement.

Working directly with the Nation, this project began through building relationships. I joined the committee in 2020 and was able to experience perspective firsthand on the day-to-day challenges and the vision *nîpiy* is working towards. Following my involvement with the committee, this project was envisioned to help the Nation understand rural drinking water advisories on a quantitative and qualitative basis.

In 2021, the *nîpiy* committee was awarded funding from Indigenous Services Canada (ISC) through the First Nation Infrastructure Fund Program to address drinking water concerns in Samson Cree Nation. Following contract award, a team was put together consisting of Nation members (operators and staff), the local health authority (Maskwacîs Health Services), Consultants (Urban Systems Ltd.) and Academics (University of Calgary). The team was to direct and manage the *'Priority DWA Project'* and provide updates to *nîpiy*. My role was to provide support to technical and social related findings, document the community lead approach and communicate back to leadership.

## 1.3 Research Goal and Objectives

The aim of this research is twofold:

1. Document and evaluate Samson Cree Nations community-led approach to Drinking Water Advisories through the *'Priority DWA Project'*.
    - As the first of its kind funded through ISC in Alberta, the Nation is looking to understand the challenges and benefits of the process. Findings from this research will be used to inform the *nîpiy* committee and Nation leadership for usage in the execution of future projects. Outcomes from the community involvement will also be used to guide community engagement methods.
2. Understand the cause and effect of Drinking Water Advisories in Samson Cree Nation, including physical, social and culture impacts.
    - Findings may be used by the Nation to articulate concerns at provincial and federal levels as the Nation advocates for changes in funding, policy and regulation. Community feedback may also be used to build education and awareness through the Nation as the Nation strives to improve community wellbeing.

## 1.4 Thesis Outline

This thesis explores the perception of decentralized water and wastewater systems in Indigenous communities and how our understanding of water management has created issues in regards to DWA's. The literature review focuses on the current state of decentralized water and wastewater systems in Canada, with a focus in Alberta, and looks at how water governance has influenced the current status of on reserve servicing. The subsequent sections will outline the research done to evaluate the community-led approach for DWAs in Samson Cree Nation and identify the causes for rural DWA's throughout the Nation. This includes an evaluation of the Nations operation and maintenance (O&M) procedures, governing regulatory standards and funding formulas impacting water governance and subsequently water quality. Lastly, this research will articulate the larger community impact DWA's have caused to residents and the larger community. Section 6 provides a summary of research completed, as well as recommendations for future work.

As research completed in conjunction with Samson Cree Nation through a community-led process, the research was very collaborative. As such, the findings herein reflect both my own contribution and the work of members from Samson Cree Nation and key team members. This has not been explicitly separated through my thesis as I think it disservices the collaborative approach. For clarity, my own contribution is as follows:

- Collection of quantitative data from onsite inspection
- Analysis of quantitative data presented in results
- Execution and analysis of qualitative data from one-on-one interviews and two group engagement sessions

It is important to note, various words are used to categorize Indigenous peoples in the context of this thesis. The term Indigenous is used for broad generalizations, First Nations when specific to First Nations groups, and Aboriginal in reference to policy and/or historic programs.

# 2.0 Literature Review

This literature review explores our understanding of the existing condition of decentralized water and wastewater systems in Indigenous communities and looks at the regulation and policy in charge of ensuring its continued operation. Too often drinking water systems are explored in isolation from the larger political, economic and social context (McFarlane & Harris, 2018). With primary focus in Alberta, the literature review tries to understand the cause and implications of Alberta's unique challenges in rural water and wastewater servicing, including the usage of "shoot-outs". With little available research on rural water and wastewater management on reserve, the extend of challenges is largely unknown. As we move toward reconciliation, it becomes our duty to support in closing the knowledge gap. Specifically, the gap between what we know about rural wastewater servicing issues and the impact on water servicing. This literature review looks to identify the gaps by compiling relevant material and discussing how existing regulation, policy and management have extrapolated the issue. Recommendations will be made for future studies on how to fill the gap.

## 2.1 Methodology

A scoping review using the Arksey and O'Malley framework with advancements from Pham at al. was followed (Arksey & O'Malley, 2005; Pham et al., 2014). This included defining the research question; developing a search strategy of relevant articles and article selection; data characterization; and reporting. While defined as linear steps, this was an iterative process that involved re-evaluation throughout to ensure a comprehensive assessment. The primary intent of this review is to look at the broader challenges within the existing systems and identify gaps in literature. Hence, it was decided that a scoping review was preferred over a traditional systematic review. The scoping review process is better at reviewing a broader scope of evidence and highlighting the gaps in the research.

### 2.1.1 Research Question

The scoping review looked at the questions: How does existing regulation, policy and management impact existing rural water and wastewater servicing in Indigenous communities? How does the current framework for understanding decentralized systems extrapolate current issues? And what gaps in the literature are evident?

### 2.1.2 Search Strategy and Article Selection

The search strategy was to use grey literature from relevant government and technical reports and supplement the information with relevant published articles. Given the lack of available articles on decentralized water and wastewater systems in Canada, it was impractical to only rely on peer reviewed

journal articles and thesis's. A comprehensive review was completed on the electronic databases; Scorpus and Web of Science. Table 1 outlines the keywords used in the search strategy.

Table 1: Key Words (with synonyms) Used for Scoping Review

| Search Term | Synonyms |
|---|---|
| Water | water OR "drinking water" OR "water quality" OR "potable water" OR wastewater OR effluent OR "septic discharge" OR sanitary |
| Indigenous Communities | "Indigenous communit*" OR "Aboriginal communit*" OR "First Nations communit*" OR Indigenous OR "First Nations" OR aboriginal |
| Canada | Canada OR Canad* |

When water and wastewater were considered as separate search criteria and decentralized was added, the two databases only produced 14 available sources. Hence, broader terms were chosen to allow for a larger selection during screening. The second criterion was the timeframe of publication. Focus was given on articles published in the last 10 years (2011 to 2022). Only English documents were selected. A multistage approach was taken where articles were selected and then cited sources within the existing article were explored for relevant material. Articles were manually screened by checking their titles and abstracts for identified keywords.

The primary search yielded 1528 articles. 478 were removed as duplicates and 353 were removed as being outside of the relevant date range (2011-2022). 635 articles were removed after the title and abstract screening. Three records were added after hand searching. 66 full-text articles were screened for eligibility, of which 51 articles were excluded due to the study design or outcomes not meeting the inclusion criteria. A final 14 articles were selected for this review. An additional 13 grey literature sources from government reporting were included to provide context around policy, regulation and funding for a total of 27. The process is illustrated in Figure 2 as a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Moher et al., 2009).

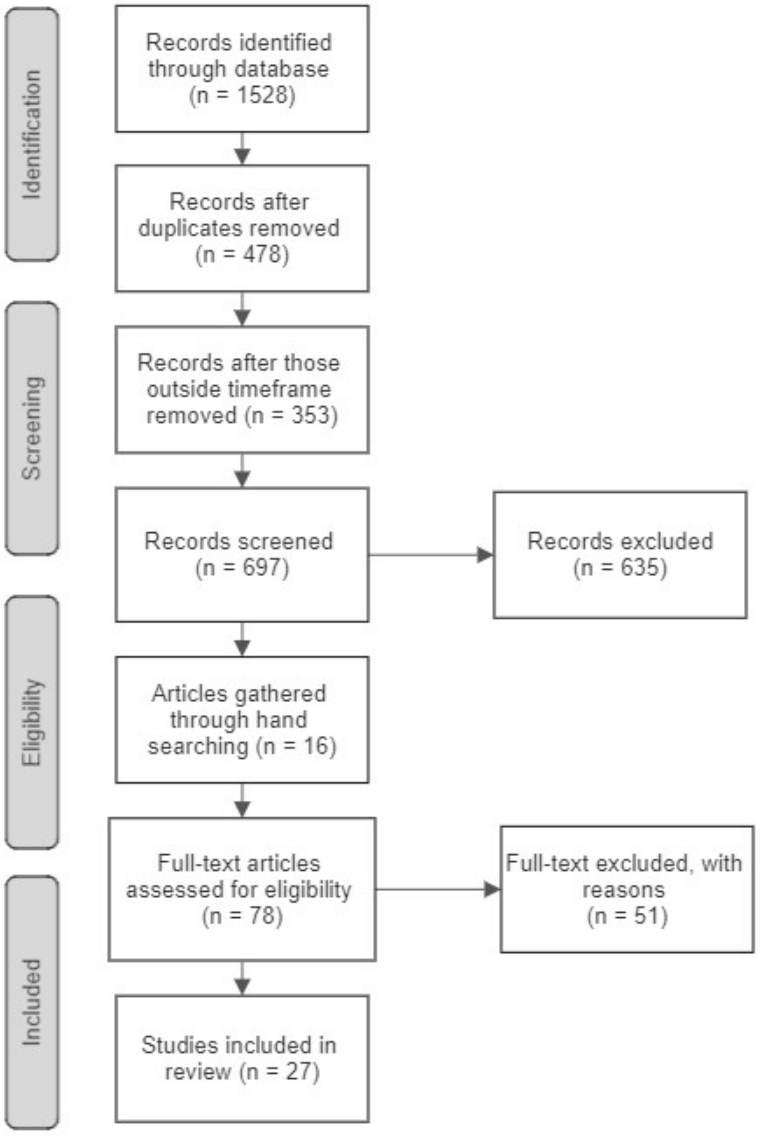


Figure 2: PRISMA Flow Diagram Showing the Review and Article Selection Process

### 2.1.3 Data Characterization and Reporting

Data was sorted based on Author, Title, Date and themes. Based on the article theme it was compared to similar papers and reported based on the following sections: Quantity and Condition of Decentralized Systems, Governing Regulations, and Funding Policies and Financial Implications. A summary of characteristics and publication type is shown in Table 2 below.

Table 2: Summary of Data Characterization for Scoped Articles

| Characteristic | Number (n=27) | Percentage |
|---|---|---|
| Theme | | |
| Quantity | 8 | 30% |
| Condition | 11 | 41% |
| Governing Regulation | 19 | 70% |
| Funding Policies and Financial Implications | 12 | 44% |
| Publication Type | | |
| Journal Article | 12 | 45% |
| Book Chapter | 2 | 7% |
| Government Document | 13 | 48% |

## 2.2 Literature Review Findings

The scoped articles were organized based on the publication topic, method, purpose, publication year, location and data type. General attributes of the selected articles are summarized in Table 3. Government guidelines, policy and regulation are not summarized in the table but are considered key contributors to the development of this paper and will be referenced herein.

Table 3: Summary of Articles in Scoping Review

| # | Study | Topic | Site | Method | Data Type | Summary of Intent |
|---|---|---|---|---|---|---|
| 1 | (Baijius & Patrick, 2019) | "We Don't Drink the Water Here": The Reproduction of Undrinkable Water for First Nations in Canada | Six First Nation communities located in the Canadian prairie region | Case Study | Primary data | How colonial practices of the government continue to cause a lack of clean drinking water and inadequate household sanitation. To address these issues greater focus must be put on First Nations water governance capacity and structure |
| 2 | (Boyd, 2011) Hand chosen | No Taps, No Toilets: First Nations and the Constitutional Right to Water in Canada | Indigenous Communities across Canada | Case study and review of legal framework. | Secondary data and grey literature | The adverse health effects associated with inadequate water infrastructure and how the right to water is a constitutional right. Looks at the legal framework for water governances and the progress made in water access. |
| 3 | (Daley et al., 2015) | Water systems, sanitation, and public health risks in remote communities: Inuit resident perspectives | Remote Arctic Aboriginal community | Case study | Primary qualitative data. | Case study to look at the condition of water and wastewater sanitation systems and the overarching impact within the community. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | from the Canadian Arctic | | | | |
| 4 | (Dunn et al., 2014) Hand chosen | Drinking Water Quality Guidelines across Canadian provinces and territories: Jurisdictional variation in the context of decentralized water governance | Canada's 13 jurisdictions | Content review and discrepancy analysis | Grey literature | Review of the variation across Canada regarding the approach to water governance |
| 5 | (Islam & Yuan, 2018) | First Nations wastewater treatment systems in Canada: Challenges and opportunities | First Nations across Canada | Content review and progress analysis. | Secondary data and grey literature. | Evaluate current water and wastewater systems on First Nations and evaluate it against the Canadian Action Plan. Look at the progress, improvement opportunities, financial conditions and provide recommendations. |
| 6 | (Bradford et al., 2017) | Indigenizing Water Governance in Canada | Indigenous communities across Canada | Book Chapter: Case study and review of water governance framework. | Secondary data and grey literature | Give historical, social and political context to the water-related governance challenges facing Indigenous peoples of Canada. |
| 7 | (Mccullough & Farahbakhsh, 2012) | Square Peg, Round Hole: First Nations Drinking Water Infrastructure and Federal Policies, Programs, and Processes | First Nations technical staff in Ontario | Case study and review of policy framework. | Primary data | Analysis of the policies, programs and processes that contribute to drinking water advisories and piped-water infrastructure gaps. |
| 8 | (Morrison et al., 2015) | Quantifiable progress of the First Nations Water Management Strategy, 2001–2013: Ready for regulation? | Policy, reports and regulation pertaining to Indigenous Communities | Review of water governance policy, plans and reports. | Secondary data and grey literature | An analysis of federal policies regarding drinking water on First Nations lands, based on an evidence-based critical analysis. This includes looking at progress reports and commissioned assessments. |
| 9 | (J. White et al., 2012) | Water and Indigenous Peoples: Canada's Paradox \| The International Indigenous Policy Journal | Northern First Nation communities | Qualitative interview and review of policy. | Primary qualitative data | Quantify the gap between funding and improving water infrastructure and look at what's creating drinking water issues, proposed remedies, and policy implications. With a focus on the legacy of colonization. |
| 10 | (Renzetti & Dupont, | Canadian drinking water policy: jurisdictional variation | Canadian provinces and territories | Review of water governance | Grey literature | Reviews to Canadas approach to water governance including |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2016) - Hand chosen | in the context of decentralized water governance (Dunn – hand chosen) | | | | regulations, policies, practices and institutions. |
| 11 | (Black & McBean, 2017b) | Indigenous water, Indigenous voice–a national water strategy for Canada's Indigenous communities | Indigenous and non-Indigenous representatives from across Canada | Case study with qualitative interviews | Primary qualitative data | Looking at the necessity of an Indigenous water strategy that involves legislation, jurisdiction and regulation; funding; technical components; and policy and governance as key areas. |
| 12 | (Lucier et al., 2020) | "Is there anything good about a water advisory?": an exploration of the consequences of drinking water advisories in an Indigenous community | Wauzhushk Onigum First Nation | Qualitative interview and impact of DWA's on community | Primary data | Explore the impacts of drinking water advisories on communities and provide considerations for water quality management. |
| 13 | (Thompson et al., 2017) | A decade of drinking water advisories: Historical evidence of frequency, duration and causes | 1526 advisories issued in 776 First Nations | Review of drinking water advisories across Canada | Secondary data | Understand historical trends of drinking water advisories in terms of location, source type, system size and operator certification and the correspondence to policy and funding. |
| 14 | (McFarlane & Harris, 2018) | Small systems, big challenges: Review of small drinking water system governance | academic literature published between 1990 and 2016 on the governance of small drinking water systems in industrialized countries | Publication review | Secondary data | Review of small drinking water systems and existing research available with a focus on infrastructure, governance and next steps in research. |

Themes arising from the scoping review included the poor state of the water and wastewater infrastructure on Indigenous reserves and the discrepancies and variation of regulation seen across Canada. There was also a general consensus of inadequate and ineffective funding causing issues with infrastructure, operation and maintenance. These observations will be discussed in more detail in the following sections.

### 2.2.1 Quantity and Condition of Decentralized Systems

Thirteen (13) articles commented on the disproportional number of Indigenous communities impacted by poor infrastructure and lack of access to adequate clean drinking water. Four (4) studies commented on the insufficient wastewater management. However, only three (3) studies had data on the quantity and condition of decentralized servicing systems, with only one (1) in relation to wastewater servicing. Except for the referenced 2011 federal reporting, as discussed below, each example pertained to a specific Nation indicating a lack of understanding across the provincial context regarding overall conditions and quantities of rural water and wastewater servicing.

On behalf of the Department of Indian and Northern Affairs Canada (INAC), Neegan Burnside completed an assessment of water and wastewater systems across Canada. This included looking at the centralized and decentralized water and wastewater systems. Neegan Burnside defined decentralized as any system servicing less than 5 homes. Five percent (5%) of decentralized systems were investigated onsite of roughly 40,000 First Nation homes serviced by individual systems across Canada. Looking at the specific levels of service being provided within Alberta, Table 4 and Table 5 indicate the breakdown of services for water and wastewater, respectively.

Table 4: Water Service Provision Breakdown in Alberta (P. S. and P. C. Government of Canada, 2011)

| Level of Service | Proportion of Service |
|---|---|
| Piped | 38% |
| Truck Delivery | 31% |
| Individual Wells | 31% |
| No Water Service | 13 homes |

Table 5: Wastewater Service Provision Breakdown in Alberta (P. S. and P. C. Government of Canada, 2011)

| Level of Service | Proportion of Service |
|---|---|
| Piped | 32% |
| Truck Haul | 11% |
| Shoot-outs and Individual Septic's | 57% (of which 42% have surface discharge (G. of C. I. S. Canada, 2011b)) |
| No Wastewater Service | 79 homes |

Considering the implications of servicing in Alberta, there are over 14,500 homes in 54 individual First Nation communities (P. S. and P. C. Government of Canada, 2011). This could mean upwards of 5000 homes are serviced by individual wells. Extrapolating the average of septic systems with surface discharge (42%), the number of First Nation homes experiencing surface discharge would be upward of 8,000 homes.

With only four (4) articles of those screened addressing water and wastewater together, there is little within academic literature that incorporates the community perspective of inadequate wastewater servicing. Past areas of study include regulatory framework gaps, organizational capacity challenges, infrastructure gaps, and control, authority, and community demands (Baijius & Patrick, 2019; Boyd, 2011; Daley et al., 2015; Islam & Yuan, 2018). With limited data on the condition of decentralized water and wastewater systems, our greatest indicator of condition in Alberta is the frequent usage of shoot-outs and the risks they pose to human health due to the discharge of raw sewage in close proximity to the homes (P. S. and P. C. Government of Canada, 2011). Given no federal reporting has been conducted since 2011, the "out of site out of mind" mentality has ruled (Ramlogan, 2019). Likely leading to higher degrees of failure and poor levels of service (McFarlane & Harris, 2018).

Federal documents have identified rural septic systems as a risk to source water protection (G. of C. I. S. Canada, 2020a; P. S. and P. C. Government of Canada, 2014). Consideration has risen across the Canadian prairies where shoot-outs are prevalent. According to a study done on six first Nations communities across Treaty 4, Treaty 5, Treaty 6 and Treaty 7, septic shoot-outs were defined as a high risk issue in 2/3rds of communities, the second most frequent risk to source water (Baijius & Patrick, 2019). This is due to groundwater contamination that only gets worse during seasonal flooding. A study done by Patrick, 2018, outlined septic shoot-outs as one of 11 primary concerns that pose a threat to drinking water in First Nation Communities located in the Canadian Prairies.

A case study completed in Pikangikum, Ontario showed how water and wastewater challenges persist even after poor conditions are noted by the general public. Reports from 2006 noted that 95% of homes do not have access to running water or indoor plumbing and have consistent observations of water contamination (Boyd, 2011). Two public health inspectors noted "The most basic of twentieth century (i.e. last century) health supporting water/sewage infrastructures are not available to Pikangikum First Nation residents. This includes (but is not limited to) housing, air/water/soil contamination control and regulation, drinking/water provision and sewage disposal" (Boyd, 2011). This came when inspectors observed residents using buckets to gather water from the local lake (where raw sewage commonly entered due to overflow from the nearby overburdened septic systems). The attention persisted until 2007 when Indian Affairs pledged $9.7 million for new water and wastewater systems (Boyd, 2011). However,

prior to 2018 when the community was given support from ISC through the long-term water advisories project, the provincial and federal governments had failed to uphold their original pledge. Up until 2018, the community garnered support from third parties to equip homes with clean water and waste water removal facilities (*Habitat for Humanity Canada | Clean Drinking Water in Pikangikum*, n.d.; *Pikangikum First Nations*, n.d.).

Looking locally, Little Buffalo, a Lubicon Cree First Nation in Alberta has historical issues with no running water and contaminated local sources. The community gained attention in 1990 when the UN ruled that Canada was violating the basic human rights of the Lubicon First Nation (*Lubicon Lake Band v. Canada, Communication No. 167/1984 (26 March 1990), U.N. Doc. Supp. No. 40 (A/45/40) at 1 (1990).*, n.d.). At the time, Canada argued that Lubicons are not a people but only "a thinly scattered minority group living in the midst of a more numerous population grouping" (OHRC, 2007). With back-and-forth dialogue through the United Nations, Canada and Lubicon have been at a standstill over land claims that ultimately affect the people and necessary services (Boyd, 2011). Last reported in 2013, the province stepped in to provide trailers with water tanks and septic systems after concerns over internal misuse of money rose and water and wastewater servicing issues continued to persist (Stewart, 2014). With only a band aid solution considered over 30 years, this calls to question how we simply ignore humanitarian issues when institutional disputes occur. Canada's reluctance to acknowledge Indigenous peoples right at the table impacts a community's ability to move forward (Boyd, 2011).

A case study of a remote Arctic Inuit community credited geographical location, underfunding, limited economic ventures and impractical design solutions for the growing water and sanitation issue in Nunavut (Daley et al., 2015). The community, Coral Harbor, also noted that incomplete monitoring and record-keeping increased water and wastewater challenges (Daley et al., 2015). With informants pointing out "The [Health Canada] Drinking Water Quality Guidelines are [available as a resource] but Nunavut is struggling with that. Typically, [our communities] are not filtering the water, just chlorinating it. The water sources … typically have good bacteriological results. But there is no general chemistry or metal scan done on the samples. Also, a lot of concern comes from the fact that they are handling the water a lot. They are putting it in trucks and then trucking it to individual homes" (Daley et al., 2015).

These examples highlight the lack of knowledge around the condition and assessment of water and wastewater services in Indigenous communities. Many Nations are unable to upgrade their systems, nor can they sufficiently manage it in the first place, due to lack of financial and human capacity (Dziegielewski & Bik, 2004). Because the Nation falls outside of federal funding formulas, regardless of condition, they are left with little to no support for issues that may affect the community physically, mentally and spiritually (O'Gorman, 2021). The differences between Indigenous and non-Indigenous

communities indicates a larger problem around jurisdictional variation (Renzetti & Dupont, 2016). If an Indigenous community can be beside a non-Indigenous municipality, how can one live without quality control and monitoring, while the other provides consistent and reliable access to proper water and wastewater servicing. It must also be acknowledged that Canada cannot simply push Indigenous communities to follow a westernized servicing approach to densify living conditions (Bateman, 2022). This is a traditional way of life and not for Canada to disregard based on the differences of day-to-day life (Boyd, 2011). There needs to be collaboration to define solutions that reflects the Nations unique needs (Black & McBean, 2017b). Looking at the unique situation of arctic communities, solutions must reflect the natural conditions which may mean additional monitoring and control for decentralized systems (Daley et al., 2015). With little to no direction provided in federal regulation, these needs often get forgotten as the communities are not set up in a way to create and implement processes without outside support.

### 2.2.2 Governing Regulations for Decentralized Systems

Within decentralized systems, ISC refers to the *Protocol for Decentralized Water and Wastewater Systems in First Nations Communities* to provide "minimum standards and codes that must be followed for the design, construction, operation and maintenance of on-site water and wastewater systems" for any infrastructure to be funded by the department (Canada;, 2010). In Alberta, the primary service method for decentralized systems are individual wells and shoot-out/septic tanks for water and wastewater, respectively (G. of C. I. S. Canada, 2011c). The protocol defines general requirements for the design, construction, installation and management of wells and septic tanks. Though additional requirements cite conformance with provincial, municipal, or local-authority standards or regulations. As for open discharge, no specific requirements are included within the protocol besides local regulation until the "CSA B65 – National Installation Standard for Decentralized Wastewater Systems" is developed.

Given the intricate relationship between ISC, Health Canada, and Environment Canada, as well as the lack of necessary physical, financial, technical, and organizational assistance from federal agencies, Indigenous communities often experience uncertainty, inconsistency, and a breakdown of systems (Bradford et al., 2017). The misalignment in governance, regulation and policy continues to create a grey zone of confusion (Renzetti & Dupont, 2016). All other municipalities are managed by provincial and territorial governments, whereas the Federal government provides regulation for reserve lands that often references local regulation in the protocol, which for rural communities can vary significantly (Dunn et al., 2014). With various regulations to consider, it can create confusion around whether a specific standard or policy exists at a federal level when there are multiple documents all discussing the same system. One major gap is the quality control and inspection of new rural systems (Dunn et al., 2014).

Within local legislation it is common for municipalities to provide inspection or at least regulatory requirements for contractors to follow. However, on reserve, policies and frameworks are managed federally so risk of contractor non-compliance increases as the process becomes a "grey area" over who will take responsibility. As reported by the Auditor General of Canada, "…First Nations communities did not benefit from a level of drinking water protection comparable to that available to people living off reserves because provincial legislation and regulations are not applied on reserves. Consequently, First Nations communities did not have a regulatory regime to govern drinking water" (Lui, 2011).

In a study on the jurisdictional differences between regulatory approaches for drinking water standards, Dunn, Bakker and Harris found that issues on reserves are not the same as those that affect rural systems but instead due to governance pathways and expectations (Dunn et al., 2014). That the current federal systems "have left many of these reserve communities as falling between the cracks, given lack of provincial involvement and investment" (Dunn et al., 2014). Variable access to resources becomes a major risk to an already failing system that would require significant governance reform in the immediate future (Dunn et al., 2014). Unfortunately, the risk of variable conditions across provinces creating unequal conditions seems to have come to fruition based on the most recent federal assessment (Canada, 2011).

Within Alberta, all private wastewater management systems must follow the *Alberta Private Sewage Systems Standard of Practice 2021*. Within this standard, an open discharge is considered as "a system designed to discharge effluent to the ground surface to accomplish evaporation and absorption of the effluent into the soil as a method of treatment." (*Alberta Private Sewage Systems Standard of Practice*, 2021).The standard of practice specifies that open discharge systems must follow specific material and constructions requirements and must not be installed on a quarter section where there are more than 4 homes subdivided (*Alberta Private Sewage Systems Standard of Practice*, 2021). Open discharge systems are also required to have minimum separation distances to wells, water bodies, buildings and property lines. Where property lines do not exist, such as reserves, the system must maintain minimum separation of 180m (*Alberta Private Sewage Systems Standard of Practice*, 2021). Given the high percentage of shoot-outs recorded, this indicates that current practices may be exceeding provincial guidelines (Canada, 2011b). This poses a risk to both the natural aquifer and surface waters that feed the individual wells (Baijius & Patrick, 2019).

If we look at the provinces with similar quantities of shoot-outs, we can compare regulations to hypothesize cause and effect. The regions with the next highest quantity of recorded shoot-outs exist in Saskatchewan and Manitoba, with 40% and 15% of individual wastewater systems discharging to surface, respectively (G. of C. I. S. Canada, 2011b) In Manitoba, these systems are considered "sewage ejector(s)" and are similarly regulated, mandating specific area requirements, separation distances and soil

parameters (Government of Manitoba, 2003). The most obvious difference being that each property using this system must have a minimum area of 4 hectares, rather than a specified amount per quarter section. Saskatchewan looks to have the least specific regulation regarding shoot-outs and only indicates minimum separation distances between infrastructure, which are less than the other prairie provinces (Government of Saskatchewan, 2011). Saskatchewan doesn't indicate any maximum density regulations.

Alternatively, British Columbia only has 3% of systems discharge to surface. BC's regulations dictate that septic tanks that discharge directly to surface water are no longer permitted (*Sewerage System Standard Practice Manual Version 3 - Volume 2*, 2021). This begs the question of why the prairies allow such systems in the first place, when most of Canada considers them a human health risk. Additionally, when such systems are so strictly regulated then why does it account for over 20% of septic management in Indigenous communities (G. of C. I. S. Canada, 2011b). ISC specifically created the Indigenous Services Environmental Public Health program to provide guidance and technical advice for central and decentralized wastewater systems, as well as work with Indigenous Communities to develops standards, guidelines and protocols. However, it seems that the ongoing issue of adequate treatment methods is far from being addressed (G. of C. I. S. Canada, 2020a). Islam and Yuan argue that along with funding, improvements must be made to discharge limits and new programs and policies must be brought into Canada to improve rural servicing.

### 2.2.3 Funding Policies for Water and Wastewater Systems

The responsibility to providing funding for water infrastructure to First Nations is shared by ISC (previously INAC), Health Canada (HC), and Environment Canada (EC) (Bradford et al., 2017; Islam & Yuan, 2018; Morrison et al., 2015).

ISC is the primary party responsible for allocating funding for water and wastewater projects to Indigenous communities across Canada. As of March 2022, $2.68 billion dollars has been invested since 2016 in centralized water and wastewater servicing (G. of C. I. S. Canada, 2018a). ISC indicates that ongoing funding for band-managed on-site water or wastewater systems are available so long as the *Protocol for Decentralized Water and Wastewater Systems in First Nations Communities* requirements for design, installation, operation, maintenance and monitoring are in continuous compliance (Canada;, 2010). To be in compliance with ISC funding requirements, Indigenous communities must also meet level of service standards set out by the Government of Canada *Water and Wastewater Policy and Level of Services Standards (Corporate Manual System).* Within the Corporate Manual System, wells and drinking water treatment units that provide potable water for individual residences and are centrally managed on-site systems, are considered 'Level 1' services (G. of C. I. S. Canada, 2011a). Levels of service ranging from 1-3 provide water provision for basic usage and human consumption, but do not

provide water for community services. Similarly, septic tanks and disposal fields that are centrally managed on-site waste treatment systems are considered level 1, the lowest level of service for waste management (G. of C. I. S. Canada, 2011a). It is important to note that ISC will not consider reconstruction of centrally managed on-site systems as eligible for funding (Canada;, 2010). Privately-owned or individually-managed on-site water or wastewater systems are also excluded within ISC funding guidelines (Canada;, 2010).

For operation and maintenance, ISC dictates that funding is subject to approval under the *Operation and Maintenance – ISC Level of Service Standard, Corporate Manual System.* ISC funding system defines eligible asset's based on a "Net Funding Requirement" (NFR), which defines the percentage that will be covered by ISC based on the Gross Funding Requirement (GFR) required to maintain the system to "accepted standards" (Government of Canada; Indigenous Services, 2022). Within this document, water supply/treatment and wastewater treatment/disposal are included under the building asset category with an NFR factor of 1, meaning they are eligible for 100% funding for operation and maintenance. This classification has created a loophole in the regulation, as individual systems can be classified as individually managed by ISC given they are supporting individual residents. If we look at how the operation and maintenance policy may be interpreted with the protocol, communities could argue that individual well and septic systems that are 'centrally' managed by the Nation may be eligible for operation and maintenance funding (Government of Canada; Indigenous Services, 2022). Given that a majority of rural systems are band responsibility, not the responsibility of the resident. However, in action this doesn't seem to be the case and it becomes the responsibility of the Nation to provide basic servicing without funding support from ISC.

Beyond having to prove funding eligibility, to obtain annual funding Nations must:

- "Establish a Maintenance Management Plan (MMP),
- Develop Capacity through Maintenance Management Reviews and Training Plans, and,
- Establish a Review Process for Maintenance Management Reports." (Government of Canada; Indigenous Services, 2022)

All funded assets must receive consistent satisfactory ratings through the ARCS inspection or the annual inspection completed by the Nation. All Nations must also be in compliance with health and safety maintenance projects as determined by ACRS (Government of Canada; Indigenous Services, 2022). Without sufficient funding to prepare policies and procedures, nor capacity to initiate, many Nations may miss out on annual funding (Alcantara et al., 2020). Compounded by ISC's requirement to be in

"continuous compliance", the one chance approach may eliminate opportunities for Nations to receive funding.

ISC allocation methodology indicates that O&M funding is a subsidy towards total costs and that Nations "are expected to make up any difference in funding through user fees or other sources" (Government of Canada; Indigenous Services, 2022). While a '1 NFR ratio' indicates "full" funding, this assumes (incorrectly) that all O&M funding models currently in place are sufficient to ensure acceptable operation (Lukawiecki, 2018). In practice, Nations across Canada must subsidize O&M costs even for "fully" funded assets (T. M. Vogel et al., 2018). However, to First Nations water is seen as a spiritual resource and should be available to all members without charge (Lukawiecki, 2018). Along with challenging geographical locations and limited economic ventures without subsidy, Nation's may fail to meet acceptable standards of monitoring, condition and maintenance. Restricting them from receiving any funding in the future for a particular asset (Government of Canada; Indigenous Services, 2022).

The current funding formulas reference O&M costs from Toronto (T. 1991- Vogel, 2019). While the manual indicates a remoteness index to address rural communities, each province and territory has different economies and requirements which may lead to large discrepancies in funding amounts (T. 1991- Vogel, 2019). Requiring Nations to fund above average amounts due to inadequate funding formulas is unethical (T. 1991- Vogel, 2019).

While some communities have sufficient economic development to meet band contribution requirements for O&M funding, the reality shows that the ISC standardized funding model approach disservices Indigenous Communities (Mccullough & Farahbakhsh, 2012). Often communities limited economies are "incompatible with the principle of user-fees" (Mccullough & Farahbakhsh, 2012). The one solution approach further broadens the discrepancies faced between communities, but places blame back on the very same people for not keeping up. The central management approach mandates rigid funding periods that support shelf ready projects as the Federal Government rushes to spend the previous year's budget allowance (Lukawiecki, 2018). Working on the federal government's fiscal year, this means funds must be dispersed and spent by March 31$^{st}$. Typically, Nations are notified of funding amounts in late summer and capital is distributed in Fall, with additional funding becoming available through Winter. This pushes Nations into restricting design and construction timelines, where aggregate performance is praised (Mccullough & Farahbakhsh, 2012). In addition to winter construction impacting workmanship, the whole system lends towards poor quality and reactive designs rather than proactive solutions. The reliance on yearly based funding models block Nations from useful community planning (Lukawiecki, 2018). With no guarantee of future momentum and a system that changes priorities based on government leadership, Nations are being held back from proactive and long-term solutions. Alternatively, Nations

with sufficient capital may front end the project through design in order to capture the "loose" capital available later in the fiscal year, favoring the high-capacity communities (Mccullough & Farahbakhsh, 2012).

Funding structures are set up to award work to the lowest bidder (Canada, 2017). This puts Indigenous communities at risk for low quality work and delayed spending (Mccullough & Farahbakhsh, 2012). McCullough and Farahbakhsh label this the "frugality principle" in which ISC favors frugal decisions, actions and institutional direction. This cost-savings mentality does not necessarily mean value-maximization, which ultimately has negative impacts on the Nation who have to manage the future system (Mccullough & Farahbakhsh, 2012).

When looking to address the issues of shoot-outs and source water contamination, the national assessment recommended extending piped servicing for water and wastewater to meet future development needs. This was the most cost-effective solution (P. S. and P. C. Government of Canada, 2011). This assumed that future development would follow typical westernized approaches of subdivided land development. This "solution" is not only harmful to Indigenous cultural but completely disregards the value and perspective of traditional knowledge (Bateman, 2022). It also forces communities to make hard decisions when faced with the choice between maintaining their historical way of life or gaining access to reliable water and wastewater servicing (Bateman, 2022).

### 2.2.4 Political Considerations

Access to reliable drinking water should be an inherent right to all Canadians. So much so that "boil water advisories are not even mentioned in the Calls to Action because they shouldn't need to be: clean water is a basic human right that non-Indigenous people in Canada are able to take for granted" (Jewelland & Mosby, 2021). Canada's unwillingness to participate in the United Nations General Assembly in 2010, marking water as a human right, may explain Canada's inaction on the issues across the country (Boyd, 2011). That's not even to mention shoot-outs, where studies have pointed towards significant impacts to physical health due to contamination of source water. This included gastrointestinal infections, skin infections, lice infestations, urinary tract infections and eye/ear infections that all lead to detrimental impacts to the mental and social health of the community (Boyd, 2011).

A case study looking at the root cause of water challenges faced by Indigenous Communities from a political ecology lens argued that the issue be considered a 'political' problem, rather than a 'water' problem (Baijius & Patrick, 2019). Routing from the Indian Act, the current institutions and laws "perpetuate settler colonialism, reproducing the social relations and inequalities that are at the root of many 'water problems' (Baijius & Patrick, 2019). Jerry P. White et.al, 2012, further define how

colonization has impacted community capacity, both in legislation and discrimination. The article calls to questions "why would there be a difference from similar sized non-Aboriginal communities, including those that are remote?" (J. White et al., 2012). This brings up a good point in how the current living conditions within Indigenous communities have perpetuated the stereotype that issues arise due to dis-interest or inaction from Indigenous peoples. However, having historically been excluded from decision making, the resulting federally run structure is outdated, inefficient and inappropriate to meet community needs (Baijius & Patrick, 2019).

A major point across recent studies have been the lasting damage due to residential schools. By taking children from homes and forcing assimilation and other forms of abuse, the Canadian government effectively broke the chain of knowledge between generations (J. White et al., 2012). Removing culturally significant teachings and storytelling's, and forcing westernized approach's, Indigenous communities were left with "reduced levels of human capital and expertise to deal with the complex technological and environmental issues around safe water" (J. White et al., 2012). With inadequate capacity to manage issues and handle financial burdens the systems have been set-up to fail (J. White et al., 2003; J. P. White et al., 2000). On top of this, many other community issues are inheritances of created dependency and attempted forced assimilation (J. White et al., 2012). Jerry P. White et al. argued how relationship dependency, lack of capacity and failing conditions have left First Nations' communities have almost no economic or political power to make meaningful change.

### Limitations

Limitations within this scoping review include: 1) the usage of less published material from scientific spaces given the lack of applicable material on the conjoining impact of decentralized water and wastewater systems, 2) lack of specific case studies in Alberta and, 3) lack of an Alberta context and how it relates to federal regulations.

## 2.3 Conclusion & Future Studies

Access to safe drinking water and wastewater sanitation are internationally recognized as basic public health principles and necessary for sustaining human life (World Health Organization, 2013). While the conversation around centralized drinking water advisories grows, the gap in readily accessible data regarding decentralized water and wastewater systems remains, specifically the growing issue of shoot-outs in the prairies and rural drinking water quality. Indigenous peoples living on reserve are 90 times more likely to have no access to clean water in comparison to other Canadians (Boyd, 2011; Eggertson, 2006). Boil water advisories have also been reported to have physical, financial and time impacts (Lucier et al., 2020).

This literature review looked at identifying gaps in research regarding our understanding of how the wastewater systems affect water quality concerns in rural areas. As well as how policy, regulation and funding have perpetuated inadequate decentralized servicing conditions in Indigenous communities. A pool of 1528 articles was narrowed to 27 relevant sources. Many of the articles made reference to the failing conditions and the lack of sufficient O&M capacity to maintain water systems on Indigenous reserves (Dziegielewski & Bik, 2004; Hanrahan et al., 2015; Islam & Yuan, 2018; McFarlane & Harris, 2018). Challenges included the funding framework, variation across federal regulation in design and management, and the institutions related to the management and provision of drinking water (Alcantara et al., 2020; Dunn et al., 2014; T. 1991- Vogel, 2019). Although there was the impression that wastewater servicing impacts the community, the extend was unknown. Further, most of the articles did not describe the need to acknowledge them together in the context of infrastructure condition, regulation, and policy modification to find suitable long-term solutions.

Findings within this literature review indicate a multitude of areas for future research to begin closing the gap. This includes:

1. Technical limitations
    - General conditions of decentralized water and wastewater systems, specifically the growing issue of shoot-outs in the prairies and rural drinking water advisories
2. Funding structures
    - Funding limitations for rural water and wastewater servicing in regard to infrastructure, O&M and water governance and how decentralized systems are being considered.
    - How the funding formulas are set up to encourage inadequate infrastructure (frugality principle).
3. Policy conflicts
    - Variation between Indigenous Nations and the quality control and inspection of new/ existing rural systems.
    - Recommendations on how policy and regulation should be adjusted to create consistency within rural systems.

## 2.4 Summary

Through this scoping review, chosen articles highlighted the lack of a holistic understanding within rural water and wastewater servicing. This must be a priority if Canada is to uphold the UN's declaration for the treatment of Indigenous peoples (Jewelland & Mosby, 2021; United Nations, 2007). The issues are known and lived by our Indigenous neighbors and Canada need to reject the narrative that without "proof" the government remains ignorant to the challenges and health risks. Until every government is at the same table making decisions, it will be community members suffering with inadequate water and wastewater servicing. An inherent right we should all acknowledge, address and uphold.

# 3.0 Methodology

The methodology for this research was developed in partnership with the *nîpiy* committee of Samson Cree Nation. As a community-led approach, the priority for this research was to uphold *nîpiy*'s ideals and work in partnership to document the method and create community solutions. The research process was inspired by the Two-Eyed seeing approach, in which Western and Indigenous ways of knowing can come together to solve problems (Wright et al., 2019). The *nîpiy* committee at its foundation practices this approach by bringing together Nation members, industry experts and academia to address water related issues. The process was to be iterative and collaborative with monthly touch base points with the *nîpiy* committee. A key requirement was that the process upheld *nîpiy*'s guiding principles. This included:

- "Uphold Cree understandings of water.
- Practice sovereignty by leading decision-making in the interests of Samson Cree Nation and its membership, and their right to clean water.
- Promote responsible environmental stewardship.
- Leverage community resourcefulness to support innovative thinking toward achieving and maintaining reliable water delivery.
- Implement operational efficiencies to provide high quality and reliable service to the community.
- Foster approaches that build capacity in the community."(*nîpiy*, 2020)

Using the Two-Eyed approach as the basis, specific methodology for quantitative and qualitative collection and analysis was developed. Reference to the seven principles, storytelling and the liliology framework work to support the Two-Eyed approach. To uphold *nîpiy*'s goals, all processes herein were developed to reflect feedback, opinions and recommendations from *nîpiy* members. While not always "definable", this research is cognizant of interactions had on the Nation regarding the findings and/or other Nation related issues. Water touches every part of life and to provide truthful and meaningful contribution, the larger picture needs to be acknowledged.

As its foundation, this research followed a community-based approach in partnership with the *nîpiy* committee with inspiration from the research framework discussed below.

## 3.1 Research Framework

This research aimed to assist the Nation and acknowledge the failures of westernized engineering and lack of Indigenous involvement in conventional engineering processes. As non-Indigenous researchers working and collaborating with Indigenous communities, building capacity and having continuous self-reflection are necessary. A part of research is understanding that there is always more to learn, this is especially important when working in spaces where individuals have different experiences, values, perspectives and/or beliefs. This research provided opportunities for respectful collaboration that empowers communities with interrelated approaches. This involved iterations of the processes, approaches and conclusions drawn herein. To lead this research and ensure it is both meaningful and ethical, the seven principles as identified by Archibald are referenced:

- Respect – Through recognizing and incorporating Indigenous Knowledge in the research process this research shows respect to the Indigenous individuals and communities involved.
- Responsibility – Acknowledging the importance and incorporating Indigenous knowledge shows the due responsibility required as a researcher.
- Reverence – Working to showcase Indigenous knowledge and highlight the importance in engineering practice shows reverence to traditional culture and practices.
- Reciprocity – Balancing Indigenous knowledge with westernized engineering by working together rather than apart shows reciprocity and works towards solutions with mutual benefits.
- Holism – Understanding and incorporating the intimate connection between the physical, social, emotional and spiritual health through the combination of Indigenous knowledge with westernized engineering reflects the ideals of holism.
- Interrelatedness – Working in hand with holism, this research reflects the principle of interrelatedness by striving to understand the unique nuances within Indigenous research through collaboration and acknowledgment that we as researchers are merely students within this space seeking to broaden our understanding by incorporating multiple areas of knowledge.
- Synergy – Through cooperation and partnership, this research promotes the synergy between Indigenous knowledge teachings and westernized engineering (Archibald, 2008).

Along with the Two-Eyed approach, this research follows the ideals and concepts of liliology. As a decolonizing framework that aims to create ethical spaces for research within academia (Xiiem et al., 2019), the methodologies and objectives herein reflects the goal of merging ideologies. As defined by liliology, only in the space between westernized knowledge and Indigenous knowing's can we pursue transformational research (Xiiem et al., 2019). To follow these practices as a researcher, you must strive to understand the interrelatedness of the world around us and conduct research 'with' Indigenous

communities not ‘on’ Indigenous communities. This means ensuring the research is culturally appropriate and addresses the following issues as defined in Decolonizing Research: Indigenous Storywork as Methodology:

- Community Approval/ access
- Reciprocity and feedback to participants/ community
- Awareness of local issue
- Awareness of local ethics and approval of requirements (if required)
- Consent
- Archiving material
- Indigenous cultural and intellectual property rights (Xiiem et al., 2019)

This upholds the protocols defined by the Assembly of First Nations (AFN) as it illustrates consent, awareness, integrity, disclosure and empowerment (*First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge*, n.d.).

Lastly, this research referenced the storytelling circle methodology as defined by Baskin. This meant pursuing research with direct community involvement that built reciprocal relationships in pursuit of self-determination, decolonization and measurable benefit for the Nation (Baskin, 2005). This methodology worked alongside the Two-Eyed approach by promoting synergy between the collaboration of ideas. Westernized ideology is not conducive to Indigenous communities and has to be merged with Indigenous knowledge as a part of the storytelling circle methodology (Baskin, 2005). A key point in Baskin’s research commented on who should be completing the research. Non-Indigenous researchers cannot speak to the personal hardships experienced by each unique individual, especially within the topic of Nation impacts due to Drinking Water Advisories. The indispensable truth is that as a researcher, it is our maintained responsibility to work with First Nations to ensure the process, data collection and objectives are cognitive of our role as a non-Indigenous person.

The Two-Eyed seeing approach, liliology and storytelling methodology furthered the 7 principles by promoting holistic approaches. This included incorporating the stories of historical context, community members and knowledge keepers. The chosen methodology was not meant to eliminate the Eurocentric worldviews but rather make space at the table for Indigenous individuals to share their wisdom in a way that is mutually beneficial.

## 3.2 Ethical Research Standards

Ethics approval from the University of Calgary Conjoint Faculties Research Ethics Board (IRISS) was received in December 2021, prior to conducting interviews or group engagement sessions. The ethics approval process was awarded by the IRISS office based on the submitted sample questions, potential risks posed to study participants, and the continuous and informed consent process for use with interviewees.

To ensure this research upheld ethical methods and standards through execution it followed the guidelines defined by the Assembly of First Nations in the First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge. This requires researchers to conscientiously address themselves to the following questions (*First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge*, n.d.):

- Are there perspectives on the subject of inquiry that are distinctively Aboriginal?

Yes, interviews and group sessions will be held with Indigenous members within the Nation of focus or key members in the *'Priority DWA Project'*.

- What Aboriginal sources are appropriate to shed light on those perspectives?

To support this research, the following sources are referenced:

  - Indigenous Storywork: Educating the Heart, Mind, Body, and Spirit (Archibald, 2008)
  - STORYTELLING CIRCLES: Reflections of Aboriginal Protocols in Research (Baskin, 2005)
  - Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together Indigenous and mainstream knowledges and ways of knowing (Wright et al., 2019)
  - Working with Indigenous Knowledge a Guide for Researchers(Grenier & Centre (Canada), 1998)
  - Dismantling the Divide Between Indigenous and Scientific Knowledge. Development and Change (Agrawal, 1995)

These are used to guide the research and meaningfully incorporate Indigenous teachings. Through these references we can ensure there is a reciprocal understanding between participants that promotes respect and responsibility.

- Is proficiency in an Aboriginal language required to explore these perspectives and sources?

No, in this research all participants are English speakers. The only consideration is key words or concepts to note in language as a part of cultural importance, which can be reflected as needed in the research findings. It is important to note that the exclusion of traditional language, in this case Cree, can impact the understanding as some participants primarily use Cree during interviews. This can impact the findings as translations may not be available or suitable in conversion to English.

- Are there particular protocols or approaches required to access the relevant knowledge?

This was understood as research proceeded and clarified with community representatives prior to engagement to ensure proper protocol and gratitude was upheld. This included showing thanks through the form of tobacco, proper address of chief and council or nation Elders and participating in ceremony.

- Does Aboriginal knowledge challenge in any way assumptions brought to the subject from previous research?

This research is not in direct challenge of previous research studies but rather the historical organization of western engineering. Furthermore, it is less of a challenge of only one can be right but rather a collaboration to create a space that promotes respect through reciprocal relationships.

- How will Aboriginal knowledge or perspectives portrayed in research products be validated? Consent.

To ensure proper consent is achieved, this research will adhere to the following Aboriginal Knowledge Protocol (*First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge*, n.d.):

    - Ownership, Control, Access and Possession (OCAP) – All data and knowledge obtained is owned and controlled by the Nation. OCAP certification has been completed in preparation for the research. OCAP ensures the research is reciprocal and respects the time and commitments made by participants.
    - Informed Consent – To ensure the research is honest and open, all use and interpretation of the data will be openly communicated with the Nation.
    - Partnership – Further to the liliology framework, all research will be undertaken in partnership with Indigenous communities.
    - Academic Integrity – As a researcher, you cannot claim that any Indigenous teachings shared as your own thoughts or ideas.
    - Disclosure – As a researcher, you have a responsibility to disclose that the ideas presented are in collaboration and reflect the work completed in partnership.

- Equity and Benefit Sharing – As mandated by the 7 principals, all research must be reciprocal and benefit all parties involved.
- Empowerment – All Indigenous knowledge should be used to empower Indigenous communities.

## 3.3 Community-led Approach Process

Community-led approaches are not new, but rather a growing method in the Indigenous landscape for the assertion of Indigenous sovereignty and jurisdiction. Wilson et al. define community-based monitoring in Indigenous communities as a method for generating useful data and having meaningful decision-making, which illustrate governance based on stewardship, kinship and responsibility. Arsenault et al. define community based Indigenous research as methods that prioritize community concerns and ways of knowing. Regardless of the wording used, at its core community-led processes are projects developed and executed by community, for community.

Many First Nations find themselves in precarious positions as they have inherited generations of pre-determined and prescribed "solutions" that have failed to acknowledge or observe their rights and equality in Nation-to-Nation and government-to-government relations. In recent years, a community-led approach framework has been gaining traction given its success at tackling community-specific solutions. Key principles include balancing western and Indigenous ways of knowing, protecting Indigenous rights and providing opportunity for Indigenous communities to participate fully in decision making (Black & McBean, 2017a). Looking at an example of the Southern Inuit Island community of Black Tickle, who found success in a community based multi-disciplinary project to understand and address long-term water insecurity (Hanrahan et al., 2015). Their approach included "qualitative and quantitative methods including key informant interviews, focus groups, a census, a literature review, water testing, and an engineering site visit" (Hanrahan et al., 2015). The alternative approach allowed the Nation to identify the community impact of water scarcity and better aim solutions to Nation priorities. Similarly, an Indigenous-led water quality monitoring program in the Yukon River Basin used community based monitoring to better inform internal and external decision-making processes (Wilson et al., 2018).

### 3.3.1 *nîpiy* Committee-Led Approach

To address drinking water advisories, Samson Cree Nation focused on a solutions-based approach, one that leveraged relationships within its *nîpiy* committee, partners and funders. The process for the *'Priority DWA Project'* was as follows:

1. Formulation
    a. Problem Identification
    b. Team Formation
    c. Leadership Support
2. Planning
    a. Identify Objectives
    b. Analysis Background Data
    c. Develop Prioritization List
    d. Preliminary Site Inspection
3. Execution
    a. Onsite Work
    b. Community Communication
    c. Capacity Building
    d. Re-evaluation

The following sections will describe in more detail each step undertaken by the Nation to formulate, plan and execute the project. The boundaries are defined from project identification to execution. As the community-led process was developed and implemented by the *nîpiy* committee, this Section does not reflect the researchers own process development but rather observations and findings regarding the approach taken for the *'Priority DWA Project'*. This was used to evaluate the method.

#### *3.3.1.1 Formulation*

The first step taken by Samson Cree Nation in the planning process was to identify a need or opportunity within the community. In the context of the *'Priority DWA Project'*, formulation began with the initiation of the *nîpiy* committee. As defined by *nîpiy*'s vision statement:

> *"Samson Cree Nation nîpiy Committee recognizes the importance and value of water as a life giving element and works to ensure access to safe and sustainable water to current and future generations by honoring natural laws, cultural practices and traditions, acknowledging and using best practices, and conforming to current and future advancements in the preservation of water."* (*nîpiy*, 2020)

Through the *nîpiy* committee, Samson Cree Nation was able to create a space to meaningfully discuss and consider water related issues in the Nation. Specific milestones through formulation are discussed below.

Problem Identification

Once the need was identified, the next step was to develop a clear vision and set of goals for the project. This helped to guide the planning process and ensure that the project is focused and aligned with the community's priorities.

The *nîpiy* committee meets monthly to discuss current events and concerns regarding water in the Nation. In 2020, the water roadmap helped to create dialog around the areas of focus and goals for each. This was a key milestone for the committee that transitioned the group from theoretical to measurable goals. Issues with Drinking Water Advisories has been a long-standing issue in the Nation. The Nation recently joined the First Nations Drinking Water Class Action that entitles individuals and communities to compensation for those subject to a DWA that lasted at least one year between November 20, 1995, and June 20, 2021 (Barry, n.d.). With the formulation of the roadmap, *nîpiy* members were able to come together and clearly articulate how to begin addressing the problem together. Prior to this, Nation members had been building relationships with funding agencies and advocating on behalf of Samson Cree Nation. All to set the stage so that when Samson Cree Nation presented the problem and solution, the history of understanding and trust was already developed.

As a part of problem identification, the Nation advocated and acquired funding from ISC.

Team Formation

Once the problem was identified, a project team was identified to develop solutions. This included Nation members, Industry Experts and Academia. All members were identified by *nîpiy* committee members as individuals who could meaningfully participate in the community-led approach. Collaboration between team members had to address current and emerging governance challenges in regards to water and ensure any assumptions held by non-Indigenous and Indigenous peoples were reconciled (von der Porten & de Loe, 2013).

From September 2021 to September 2022, various Nation members, *nîpiy* committee members, Nation departments, Urban Systems Ltd. (Urban), Maskwacîs Health Services (MHS) and the University of Calgary participated in project delivery and execution of the *'Priority DWA Project'*.

*Key Personnel*

As the name suggests, community-led projects require dedicated members. The boundary for this analysis began at the identification of need. However, it should be noted that a lot of work was done prior to the

start of the *'Priority DWA Project'* to build understanding and capacity at the community level to a point where problem identification is even possible. Much of this work was done with support of the *nîpiy* committee. The exclusion of this from the analysis is not to disregard the work taken to get to a place of self-sufficiency in an area with little to no support, but rather acknowledge that as researchers we cannot begin to comprehend the long-term involvement required.

Nation personnel are vital team members to the project execution and long-term success. For a successful approach, their role in the project must not be limited to knowledge input but rather involvement and impact made at each stage (Wilson et al., 2018). Nation personnel provide a bridge between technical expertise and community involvement; help guide the decision-making process and can be instrumental in incorporating local resources during execution for a more holistic approach. Even before formulation, these individuals are gaining knowledge and building relationships in areas they care about to one day articulate the problem and involve other community members to move the project forward. The *'Priority DWA Project'* in Samson Cree Nation was no different. *nîpiy* committee members from the Nation have been working in or around water for years. Once the problem was articulated, many became key team members that lead objective and priority meetings, public communication, and project management.

Leadership Support

As a community driven project, leadership support was critical to ensuring the needs and priorities of the community are met. Activities included:

- Leveraging current team members in office to bridge connection
- Reporting back on project initiation, objectives and results as the project progresses

Project decisions were completed with the approval of Chief and Council; thus it was imperative that leadership understood the project to make educated decisions and recommendations.

#### *3.3.1.2 Planning*

The next step was to develop a detailed project plan that outlines the specific activities, resources, and timelines for the project. This included a clear set of objectives and milestones, as well as a plan for how the *'Priority DWA Project'* will be implemented, managed, and evaluated.

Identify Objectives

With the problem identified, key objectives and priorities as defined by the Nation were used to clarify the scope of the *'Priority DWA Project'.* To do so multiple project review meetings were held with:

- Nation Departments
    - Housing
    - Public Works
    - Water/ Wastewater
- Maskwacîs Health Services (local health authority)
- Urban Systems (Consultant)
- University of Calgary (Academia)

During these meeting, the team identified:

- Key attributes for prioritization
- Relevant background needed to execute the project
- Challenges and risks the project may face

Having multiple perspectives and primary representation from Nation members allowed for the objectives and prioritization criteria to reflect the Nation's needs more accurately.

Analysis Background Data

Water and wastewater infrastructure data was used to evaluated rural servicing in the Nation. Available data was compiled from the Nation and the local health authority, including water testing results, condition and quantity data, and relevant community plans and reports. Analyzing the background data set up the basis for decision making on prioritizing homes and developing construction solutions. It also helped to identify data gaps withing rural water and wastewater servicing in the Nation.

Develop Prioritization List

Comparing the defined key attributes identified at the beginning of the planning process to the compiled data, a prioritization list was created. The prioritization list selected which homes would be addressed within the *'Priority DWA Project'* based on the priorities identified by the Nation. The project could only focus on 30 homes of the 131 homes under a DWA in the Nation. This was due to available funding granted to the Nation from ISC. To ensure community objectives and perspectives are maintained, the prioritization list and criteria were then re-evaluated following a prioritization review meeting to identify any discrepancies or missing pieces. The prioritization review meetings were held between the internal

project team and relevant Nation staff. This was an iterative process where the prioritization list was updated as needed.

If possible, Nation personnel pre-visited the homes to confirm the houses are still in service prior to selection.

Figure 3 below illustrates the prioritization process taken within the planning step.

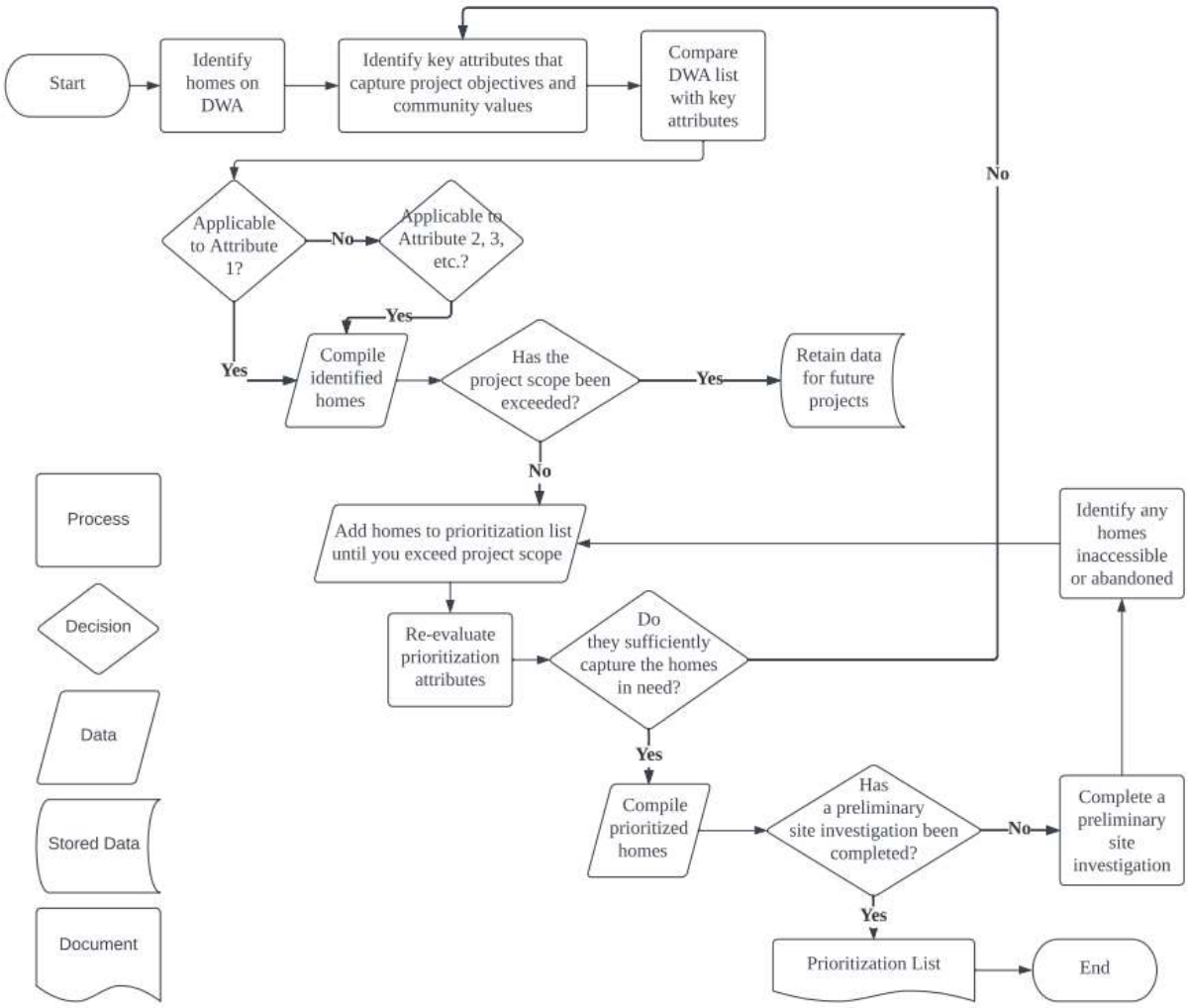


Figure 3: Prioritization Process for the Priority Boil Water Advisory Project

Preliminary Site Inspection

Once priority homes were selected, a small group of the project team completed preliminary inspections prior to construction to review:

- Visual condition assessment of the water well, septic system and ground conditions.
- Well yield test to understand depth, pumping capacity and water recovery.

The purpose was to confirm existing data with current conditions, communicate with residents and evaluate solutions on a case-by-case basis.

#### *3.3.1.3 Execution*

Onsite Work

To address rural drinking water advisories in Samson Cree Nation, various options were compared with technical experts and Nation staff to identify a suitable solution. Based on preliminary investigations, the following recommendations were made for the prioritized homes:

- Replace all water systems older than 25 years
- Address contamination pathways
    - Replace/Repair septic systems to reduce surface contamination
    - Regrade site away from well to reduce surface contamination
- Complete water quality testing following installation to identify contaminates in the aquifer or internal system
    - Confirm if additional flushing, chlorination or treatment would be required to meet the Guidelines for Canadian Drinking Water Quality. Flushing and re-chlorination was completed as required until no E. coli or total coliforms were present.

Once onsite construction was completed Maskwacîs Health Services completed bacteriological testing to update or rescind the DWA for each home.

Community Communication

Through the process, Nation personnel communicated with residents during and following construction. Bringing awareness to Nation members allowed the team to educate residents of what the project was, why it was important, how homes were selected and the Nations long-term vision to provide safe and clean drinking water to all residents.

Capacity Building

To build long-term success, capacity building and training was built into the process. This included knowledge sharing between team members and onsite training during inspections between technical

experts and Nation operators. The training focused on how to complete visual inspections, what to look for and how to perform water yield tests. Through construction the team focused on creating opportunities for Nation staff and operators to manage and execute the project independently.

Re-evaluation

Re-evaluation of the *'Priority DWA Project'* was identified as a key step in future phases or projects led by the Nation. In part, this research communicates lessons learned back to *nîpiy* and leadership. In addition, 'lessons-learned meetings' were scheduled with the *nîpiy* committee and with Federal funding agencies to discuss the challenges, benefits and roadblocks for the future.

## 3.4 Quantitative Data

Quantitative data was collected as a part of this research to help the Nation understand the extent and impact of Drinking Water Advisories in Samson Cree Nation.

### 3.4.1 Data Collection

Quantitative data was collected from Nation infrastructure records, government studies, local public health authority water testing results and onsite data collection, as described herein.

#### *3.4.1.1 Nation Data*

Nation data was collected from public works, the housing department and water and wastewater operating staff. Information included:

- Engineering studies regarding rural servicing
- Home and occupant information
- Operation and maintenance plans

#### *3.4.1.2 Maskwacîs Health Services*

Maskwacîs Health Services (MHS) is the local health authority that manages the unique physical, social, and cultural health needs of Samson Cree Nation, Ermineskin, Louis Bull and Montana First Nations (*About Us | Maskwacîs Health*, n.d.). As one of their mandates, MHS is responsible for water testing and issuing Drinking Water Advisories (DWA) in all 4 Nations. Data was collected directly from MHS with approval from Samson Cree Nation. This included:

- Number of DWA's
- Duration of DWA's
- Location of DWA's
- Comprehensive water testing results

#### *3.4.1.3 First Nations Technical Services Advisory Group (TSAG)*

Information was acquired from TSAG's GIS database with approval from Samson Cree Nation. This included:

- Number of wells
- Number of septic systems
- Types of septic systems
- Location

#### *3.4.1.4 Onsite Inspection*

Onsite visual inspections were conducted on 30 rural homes in Samson Cree Nation to understand existing conditions and compare Nation data with noted conditions. Collected data included:

- Type of System
- Infrastructure Condition
- Site Conditions

Visual inspects were completed with Nation staff as a part of the *'Priority DWA Project'*.

### 3.4.2 Data Analysis

After data acquisition, data was imported into Microsoft Excel to analyze and organize the findings.

## 3.5 Qualitative Data

Qualitative data was collected to understand the benefits and challenges of the community-led approach, as well as the perception of water in Samson Cree Nation and how it relates to Drinking Water Advisories. This was a value-added piece from the researcher to engage community and provide Samson Cree Nation with tangible results to leverage in future decision making. As the preliminary objective was to address DWA's, the interviews and engagement sessions provide a way to bring this research back to Samson Cree Nation members. Ethics approval was granted in December 2021 from IRISS, prior to conducting interviews or group engagement sessions.

### 3.5.1 Data Collection

Qualitative data was collected through face-to-face interviews and group engagement sessions. As defined by Yin, key informants were used as an effective method of qualitative data collection. This section discusses key considerations and the process taken for data collection and analysis through interviews and group engagement sessions.

#### *3.5.1.1 Key Informants*

Finding participants for evaluating the community let approach verse understanding DWA's in Samson Cree Nation was completed differently. Each method will be defined below.

Participants for Evaluating the Community-led Approach

To capture the community-led process, participants were identified as key team members involved with the *'Priority DWA Project'*. As a process evaluation, participants needed to be involved or familiar with the method, objectives and results of the project. Interviewees included representation from Nation and non-nation members. This ensured that data was captured from individuals with experience in westernized engineering processes as well as traditional knowledge. All participants are *nîpiy* members. Table 6 provides a breakdown of organizations from which the 6 key informants were drawn.

Table 6: Organizational Breakdown of Key Informants Evaluating the Community-led Approach

| Association Type | # Of Representatives |
|---|---|
| Leadership | 1 |
| Nation Staff | 3 |
| Industry Expert | 1 |
| Local Health Authority | 1 |

Participants for Understanding Drinking Water Advisories

To identify participants, *nîpiy* members and community leadership were contracted to inquire for interest. All interviews and/or group sessions were completed on a volunteer basis. Through the process, researchers continuously visited the community to build personal relationships beyond that of academia requirements. As researchers we can forget that there is more to reciprocal partnerships than just the end report, it is about building connections that are open and honest.

Once initial participants were identified, the "snowball" sampling technique was used to capture a larger sample size. Snowballing refers to reaching out to a given individual who reaches out to someone they know with relevant experience and so on (Atkinson & Flint, 2001). Individuals were then able to contact the researcher directly to participate. Since there is a broad range of people who represent water interests in Samson Cree Nation the snowball technique was the most effective way to contact individuals. The initial group of contacts identified through relationships and existing research provided a diverse base for the snowball sampling.

Eighteen (18) representatives included representation from various Nation departments, *nîpiy* committee members, knowledge keepers and users of decentralized water and wastewater systems in Samson Cree Nation. Table 7 provides a breakdown of organizations from which the 18 key informants were drawn.

Table 7: Organizational Breakdown of Key Informants Involved in Evaluating Drinking Water Advisories

| Association Type | # Of Representatives | # Of *Nîpiy* Members |
|---|---|---|
| Nation Resident | 11 | 5 |
| Nation Leadership | 1 | 1 |
| Nation Operator | 4 | 4 |
| Industry Expert | 1 | 1 |
| Local Health Authority | 1 | 1 |

All interactions with Indigenous members followed local protocol for knowledge sharing and participation in research. This meant ensuring informed consent and following the principles of OCAP, as discussed in Section 3.2.

#### *3.5.1.2 Question Templates*

Question templates were developed using a mixture of structured questions and biased discussion, see Appendix A. A separate question template was developed for:

- Interviews regarding the Community-led Approach
- Group session with *nîpiy* members
- Group session with residents

This followed an interrelated approach that promoted various ideologies and perspectives, while capturing necessary data for the research objectives. Questions included yes/no responses, as well as open ended discussion questions directed at the main themes of this research. Discussion based interactions gave recipients the freedom to expand upon their own experiences. Thus, allowing participants to express their opinions in a reciprocal manner. This ensured the research covered all concerns, not just the ones we as researchers think are the problem. Incorporating alternative perspectives keeps the research responsible to its participants. A key benefit of the interviews and group sessions was the ability to gain insight from organic discussions and collect in depth opinions on the challenges and benefits. Given the high impact to community, it was critical to capture the broad community perspective when reporting back to the *nîpiy* committee and leadership.

Interview Template

While the interview template (see Appendix A) was used at the beginning of all interviews, questions were adapted as needed for each key informant to maintain relevant conversation that reflected the participants specific experience and knowledge. This ensured that discussions included emerging topics and themes.

Group Engagement Session Template

The group sessions were used to understand the impact of DWA's in Samson Cree Nation. Similar to the interview process, group engagement session questions (see Appendix A) were adapted based on who was in attendance. With a group of individuals, it can be hard to confirm in which direction the discussion will lead. As this process was done in partnership with *nîpiy* to benefit the Nation, having flexibility during sessions was necessary to ensure all participants felt safe to share and validated in their opinions.

#### *3.5.1.3 Interview Process*

Face to face interviews were completed by going directly to the reserve and talking to community members. If the interviewee did not live on-reserve, another suitable location was identified prior to the interview. A total of 6 one-on-one interviews were conducted. During in-person interviews, permission was given by the interviewee to record the conversation using a digital voice recorder and notetaking. The length of time of interviews ranged from 15 to 45 minutes. During this research, multiple people were consulted on the process and impact of Drinking Water Advisories in Samson Cree Nation. Many of whom declined to provide on-the-record interviews. This was typically because participants did not want their answers recorded or felt that more organic conversations could be had without devices. These conversations, although not included in this thesis, provided valuable insight that guided the researchers understanding of the topic, thus influencing the research process.

#### *3.5.1.4 Group Engagement Session Process*

Two group engagement sessions were held on reserve with audio and graphic recording as a qualitative data collection process. During both sessions, verbal permission was granted for digital voice recording, visual recording and notes. The first session was 1.5 hours long and was held with *nîpiy* committee members. The second session was 1.5 hours long and comprised of Nation Elders and residents. The session with residents involved those with stories and knowledge surrounding water but did not include any people that work or manage water from a leadership level. This was to ensure a variety of perspectives and understandings were captured through both engagement sessions. It was ensured that all participants gave continuous consent and if at any point the community or individuals wished to withhold their participation, this was respected.

### 3.5.2 Data Analysis

All information was disclosed to participants, including the topic of the research, intent, how the findings would be used and when. This is to maintain academic integrity and responsibility within this research. All data remained anonymous and unbiased, unless requested otherwise. Data storage was encrypted to protect each response and use "blind" analysis during review. This meant that prior to any analysis, names or identifying characteristics were removed within each response. The only time in which personal information was used was if both parties agreed that it is mutually beneficial.

Deductive Thematic Analysis (described below) was used to review qualitative data. Deductive Thematic Analysis (TA) was chosen over inductive TA because existing concepts and understandings were used in this research to develop codes and themes. A general understanding was already held within the Nation regarding DWA's. Hence, the data was analyzed with existing concepts to better refine and categorize the responses.

As the one-on-one interviews had more structured discussions, the conventional deductive TA process was followed. As for the group sessions, the discussions were much broader and did not always follow a specific "script". As a result, general thoughts and opinions were observed and categorized without generating specific codes. Following the completion of each group session, a thorough account was made of the discussions and impressions. This was used to re-evaluate the discussion and generate themes for the data. Additionally, qualitative data was used to provide context to the research and give perspective using direct quotes within the report.

#### *3.5.2.1 Thematic Analysis*

Thematic analysis is a method for researchers to identify common themes, ideas and patterns as the major component within the results. This followed a narrative analysis through a six-stage process (Barnes, 2021a; Smith, 2015):

Familiarization

Familiarization includes transcribing the interview data in an easy-to-understand format. This step also includes taking initial notes and beginning the analysis by collecting preliminary thought and overall perspectives. This was done following the completion of each interview.

Coding

Coding includes defining "codes" that will be used to identify content and categorize the participants answer in such a way that we can correlate the feedback between participants. This is completed by going through the data set and highlighting sections based on the defined codes.

#### Generating Themes

Once all codes had been defined and quantified, broad themes and patterns were generated based on the codes and number of responses correlating to each one. This was an iterative process in which the codes were revised if they are too broad or if there is uncertainty about which theme each code falls within.

#### Reviewing Themes

Once all the codes were categorized based on an overarching theme, opinion or pattern, the themes were reviewed to ensure they are useful and accurate. This includes ensuring they are meaningful and truthful representations of the data collected.

#### Defining and Naming Themes

Using the final list, the themes were defined and named. This means defining in detail what each theme means and correlating how it helps us understand the data. These short form names should be easily recognizable and understood.

#### Writing a Thematic Analysis

The last step in thematic analysis involves writing up the overall analysis. This was incorporated within writing the overall research report.

## 3.6 Summary

The Two-Eyed methodology was used as the primary framework to guide this research. Influence from the seven principles, liliology and the storytelling methodology supported the process. The process undertaken by the Nation to deliver the *'Priority DWA Project'* was outlined and evaluated. Ensuring the research upheld the AFN's Aboriginal Knowledge Protocol, quantitative and qualitative data was collected using the principles of OCAP. Quantitative data was collected from the Nation and evaluated using excel. Qualitative data was collected through one-on-one interviews and group engagement sessions and evaluated using deductive Thematic Analysis. Collected data is used in the following sections to evaluate the community-led process and define the impact drinking water advisories have on the communities physical, mental and spiritual health.

# 4.0 Experimental Results

This Section looks at the effectiveness of the community-led process (*Priority DWA Project'*) executed by the *nîpiy* committee, as well as quantitative and qualitative results obtained regarding Drinking Water Advisories in Samson Cree Nation.

## 4.1 Community-led Process

Beginning in Fall 2021, the *'Priority DWA Project'* aimed to address DWA's in Samson Cree Nation 137, 137A and Pigeon Lake 138A to provide Nation members with long-term, reliable access to safe drinking water. The project addressed 34 homes, 28 under BWA and 6 under DNC. The 34 selected homes were chosen based on a prioritization process, as discussed in Section 3.3.1. Priorities identified by the Nation included:

- Elders
- Residents living with disability
- Children
- Condition of Infrastructure

A breakdown of project outcomes is summarized in Table 8 below.

Table 8: Summary of the Outcomes following Completion of the Priority Rural Drinking Water Advisories Project

| Outcome | # Of Homes |
|---|---|
| Homes Addressed | 34 (28 BWA and 6 DNC) |
| Removed from BWA | 27 |
| Removed from DNC | 1 |
| Placed Under DNC Following Construction* | 14 |

*Houses placed on DNC due to high levels of Fluoride

### 4.1.1 Qualitative Analysis of the Community-led Approach

As described in Section 3.5.2, thematic analysis was used to analyze qualitative data. This Section will focus on the one-on-on interviews conducted with key personnel to evaluate the community-led approach.

To begin analysis, transcriptions of every interview was produced. The generated codes were inputted into the software NVivo to review and categorize every interview. Codes were generated before reviewing the interviews based on the interpretation of important components and knowledge of existing

theoretical concepts, as prescribed by the deductive method (Smith, 2015). The codes were sorted into categories to further organize results. The categories and codes are summarized in Table 9 below.

Table 9: Codes Used to Categorize one-on-one Interviews

| Category | Code |
|---|---|
| Infrastructure | [Condition] |
| Administration | [Management] OR [Funding] OR [Trust] |
| Procedure | [Process] OR [Nation-Led] OR [Time] OR [Collaboration] |
| Education | [Education] OR [Awareness] OR [Communication] |

Using the defined codes, data was coded accordingly. This involved looking at each individual question and identifying common responses among participants. Once common responses were identified, they were categorized under specific codes and quantified. It should be noted that some participants had more than one answer for each question, hence for some questions the count is greater than six. The quantified count was based on the number of participants who had similar responses. This was an iterative process that involved re-evaluating the codes to ensure they were relevant to the research and useful in correlating responses. Once the codes were identified, a summary response of each question was created to reflect my interpretation of the general feedback for each question. The summary responses were used to identify the overarching themes of the qualitative data, as will be discussed at the end of this section. Table 10 through Table 18 summarize common responses for each question and the correlation to each code identified through the response review. A summary of Question 1 is shown in the table below.

Table 10: Summary of Responses and Respective Codes for One-on-one Interviews - Question 1

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 1. From your understanding, what was the intent of the project? | - Address long standing issues (x2)<br>- Address BWA's (x4)<br>- Create better water quality (x1)<br>- Understand the larger issue (x3) | [Condition] [Awareness] | The *'Priority DWA Project'* aimed to address long standing water issues in the Nation while working towards identifying the bigger problem to find long-term solutions. |

As shown in Table 10, two thirds of participants identified addressing the Boil Water Advisories as the primary intent. With half of participants also indicating the importance of understanding the larger issue

of water challenges in the Nation. Using the common responses, the codes condition and awareness were associated. Using the common responses and codes, a summary response was generated. The summary response was used to create the common themes at the end of this section. A summary of Question 2 is shown in the table below.

Table 11:Summary of Responses and Respective Codes for One-on-one Interviews - Question 2

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 2. Do you think the team achieved this? | - Yes (x3)<br>- Picture is larger and more complex (x1)<br>- Mostly (x1)<br>- Went above and beyond (x1) | [Process] [Time] | The Nation has begun to address drinking water issues in the context of this project but the journey to solving the problem in a sustainable way has only just begun. |

As shown in Table 11, a majority of participants deemed the project a success. The only concern being to fully address drinking water issues in Samson Cree Nation a more comprehensive solution is required. Responses correlated with process and time coding. Using the common responses and codes, a summary response was generated. This was used to create common themes at the end of this section. A summary of Question 3 is shown in the table below.

Table 12: Summary of Responses and Respective Codes for One-on-one Interviews - Question 3

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 3. If you could describe the process in a few sentences, what would be the main components to complete the project? | - Considering the long-term solutions (x2)<br>- Understand and address water quality challenges (x3)<br>- Collaborate with different organizations and develop mutually beneficial relationships (x3)<br>- Communication between groups and within community (x2) | [Trust] [Time] [Condition] [Funding] [Collaboration] [Nation-Led] [Communication] | The process involved understanding the long-term water quality issues and developing a collaborative process between community, industry and fundings agencies to address them at a Nation level. This is achieved through transparent communication. |

As shown in Table 12, half of participants described the process as addressing the drinking water advisories with many sharing that building relationships and trust as a key point in the process. Trust between outside organizations and community members. Responses correlated with trust, time, condition, funding, collaboration, Nation-led and communication coding. Using the common responses and codes, a summary response was generated. This was used to create common themes at the end of this section. A summary of Question 4 is shown in the table below.

Table 13:Summary of Responses and Respective Codes for One-on-one Interviews - Question 4

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 4. In your opinion, what worked well in regard to the process? | - Collaboration (x3)<br>- Communication between organizations (x4)<br>- Articulating the problem (x3)<br>- Collecting data (x3)<br>- Trust Building (x1)<br>- Focus on trying to take action (x1)<br>- Taking a unique approach (x1)<br>- Having it Nation-led (x1) | [Collaboration] [Nation-Led] [Communication] [Trust] | The process worked because the Nation was able to articulate the problem and lead the decision and solution making process. Collaboration and communication helped to build trust, which can be leveraged to move forward in the future. |

As shown in Table 13, half of participants identified articulating the problem and collecting data as successful steps in the process. Other positive steps included building trust, having the project being Nation-led and a focus on implementing a take action approach. Overall, there was a diverse response among participants regarding what went well through the process. Responses correlated with collaboration, Nation-led communication and trust coding. Using the common responses and codes, a summary response was generated. This was used to create common themes at the end of this section. A summary of Question 5 is shown in the table below.

Table 14: Summary of Responses and Respective Codes for One-on-one Interviews - Question 5

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 5. If the project were to go forward again, how should the process be adjusted? I.e., What were some of the lessons learned? | - Better communication with residents (x6) | [Communication] [Trust] [Awareness] [Education] | In future phases of the work, the Nation needs to communicate earlier and more effectively with residents. This includes communicating the end goal the Nation sees and how this is not the end all fix all, but rather a small part of a larger vision. |

As shown in Table 14, all participants responded that should the project proceed again the team needs to be better at communicating with residents through the process. Responses correlated with communication, trust, awareness and education coding. Using the common responses and codes, a summary response was generated. This was used to create common themes at the end of this section. A summary of Question 6 is shown in the table below.

Table 15: Summary of Responses and Respective Codes for One-on-one Interviews - Question 6

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 6. How did this project better achieve its objectives as a community-led project, rather than a typical westernized top-down approach? | - Nation has the capacity to identify the challenges (x3)<br>- More likely that the funding results in successful outcomes<br>- Solutions more suitable to the Nation (x2)<br>- More community integrated solutions and awareness from residents (x3)<br>- Nation led created trust between the team and residents (x1) | [Nation-led] [Funding] [Process] [Management] [Awareness] | The community-led approach allowed the Nation to better identify solutions, build capacity, and achieve successful outcomes for the Nation. Thus, building trust at the Nation level and Federal level. |

As shown in Table 15, when asked how the community-led process better achieved the project objectives one half of participants noted that it increased capacity to identify challenges. The other half of participants commented how the process brought in more community engagement and awareness. Responses correlated with Nation-led, funding, process, management, and awareness coding. Using the common responses and codes, a summary response was generated. This was used to create common themes at the end of this section. A summary of Question 7 is shown in the table below.

Table 16: Summary of Responses and Respective Codes for One-on-one Interviews - Question 7

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 7. How do you think this project benefited the community? | - Build Nation capacity (x1)<br>- Residents trusting the Nation to address water issues (x2)<br>- Increase awareness about rural water issues and the challenges (x6) | [Trust]<br>[Process]<br>[Time]<br>[Condition]<br>[Education]<br>[Awareness] | The *'Priority DWA Project'* allowed the Nation to spread awareness about rural water issues, while re-building trust between residents and Nation operations staff whose capacity grew through project execution. |

As shown in Table 16, all participants thought that the project benefited community by increasing awareness about rural water issues throughout Samson Cree Nation. Other benefits included building trust with Nation members and building Nation capacity. Using the common responses, the codes trust, process, time, condition, education and awareness were associated. Using the common responses and codes, a summary response was generated. The summary response was used to create the common themes at the end of this section. A summary of Question 8 is shown in the table below.

Table 17: Summary of Responses and Respective Codes for One-on-one Interviews - Question 8

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 8. Do you think there's anything preventing a project like this kind of going forward again? | - Funding (x4)<br>- Is what we are doing to address DWA's the best long-term sustainable solution for the Nation (x2)<br>- Residents not comfortable with the work (x1)<br>- If Nation team members leave, we lose all this information from the project (x1)<br>- Nation not invited to the table to discuss issues regarding the Nation (x1) | [Funding] [Time] [Education] [Awareness] [Management] [Communication] [Process] | The Nation sees funding as a major roadblock in future projects and must also consider long-term planning in data management and servicing strategies when considering how to move forward with rural water issues. |

As shown in Table 17, two thirds of participants identified funding as a roadblock to future projects. The next most common response (one third) was whether the project was selecting the best long-term solution for the Nation and how that may impact the longevity of future projects. Using the common responses, the codes condition and awareness were associated. Using the common responses and codes, a summary response was generated. The summary response was used to create the common themes at the end of this section. A summary of Question 9 is shown in the table below.

Table 18: Summary of Responses and Respective Codes for One-on-one Interviews - Question 9

| Question | Common Responses | Codes Identified | Summary Response |
|---|---|---|---|
| 9. How should Samson Cree Nation managed water and wastewater infrastructure in the future? | - Continue to build trust between the Nation and residents (x1)<br>- Create a space for everyone to respect and appreciate a holistic view of water – Indigenous and non-Indigenous (x1)<br>- Systems become more centralized, and the Nations operations team grows to reflect that (x1)<br>- Shift from reactive to proactive maintenance (x3)<br>- Nation has its own O&M team for wells and septic, less involvement from outside contractors (x2)<br>- Onus of the residents to complete basic O&M (x2)<br>- Better documentation (x1)<br>- Continue having residents living out in the country (x1) | [Education] [Awareness] [Management] [Trust] | Ideally, Samson Cree Nation would shift from reactive to proactive O&M by building capacity in the Nation and building a holistic understanding in water management throughout the community. |

As shown in Table 18, when asked how Samson Cree Nation should manage their water and wastewater infrastructure in the future the most common response was shifting to proactive maintenance. Other common responses included putting onus on the resident for operation and maintenance activities and having a Nation-led team to execute O&M activities. Using the common responses, the codes education, awareness, management, and trust were correlated. Using the common responses and codes, a summary response was generated. The summary response was used to create the common themes at the end of this section.

As discussed through this section, the common responses and respective codes were compiled and used to generate a summary response for each question. These are compiled and re-iterated below:

1. The *'Priority DWA Project'* aimed to address long standing water issues in the Nation while working towards identifying the bigger problem to find long-term solutions.
2. The Nation has begun to address drinking water issues in the context of this project but the journey to solving the problem in a sustainable way has only just begun.
3. The process involved understanding the long-term water quality issues and developing a collaborative process between community, industry and fundings agencies to address them at a Nation level. This is achieved through transparent communication.
4. The process worked because the Nation was able to articulate the problem and lead the decision and solution making process. Collaboration and communication helped to build trust, which can be leveraged to move forward in the future.
5. In future phases of the work, the Nation needs to communicate earlier and more effectively with residents. This includes communicating the end goal the Nation sees and how this is not the end all fix all, but rather a small part of a larger vision.
6. The community-led approach allowed the Nation to better identify solutions, build capacity, and achieve successful outcomes for the Nation. Thus, building trust at the Nation level and Federal level.
7. The *'Priority DWA Project'* allowed the Nation to spread awareness about rural water issues, while re-building trust between residents and Nation operations staff whose capacity grew through project execution.
8. The Nation sees funding as a major roadblock in future projects and must also consider long-term planning in data management and servicing strategies when considering how to move forward with rural water issues.
9. Ideally, Samson Cree Nation would shift from reactive to proactive O&M by building capacity in the Nation and building a holistic understanding in water management throughout the community.

Using the codes, components and summary responses above, general themes were created. These themes are easily identifiable conclusions used to understand the qualitative data in a readable format. Each theme is defined as a conclusion from the findings of the one-on-one interviews. The common themes were:

- **Poor Perception of Water:** Lack of trust from residents in the infrastructure and management of rural water and wastewater servicing.
- **Inadequate Funding:** Historical lack of funding has caused issues at all levels of infrastructure management including design, implementation and O&M and is a major risk to future solutions.
- **Beneficial Process:** The community-led approach has been generally successful for the Nation in providing suitable solutions.
- **Collaboration Takes Work:** Long term solutions take time, collaboration, open communication and trust.
- **Need for Education and Awareness:** Desire at community and member level to expand education and awareness of water related issues.

These themes were similarly reflected in the graphic recordings for the group engagement sessions as illustrated in Figure 10 and Figure 11 in Section 5.4.

## 4.2 Drinking Water Advisories

Concerns around water quality in rural households have been felt by Nation members for decades. In 2010, the National Assessment of First Nations Water and Wastewater Systems documented concerns related to drinking water advisories and poor water quality for rural households in Samson Cree Nation. The study showed that almost every well that was sampled for chemical analysis exceeded the Guidelines for Canadian Drinking Water Quality (GCDWQ). Table 19 below shows a summary of the results from the study completed on Samson Cree Nation.

Table 19: Private Water Well Results from 2010 National Assessment of First Nations Water and Wastewater Systems-Samson Cree Nation (G. of C. I. S. Canada, 2010)

| Parameter | Value |
|---|---|
| Number of Wells Sampled | 48 |
| Quality Concerns | 95% |
| Fluoride* | 26 |
| Coliforms DST* | 5 |

*Full chemical testing was included in the reporting. This table only summarizes results that exceed the GCDWQ.

This was a continuous trend according to data documented by Neegan Burnside in 2002. While inspections of private dwellings did not occur, the report commented that private wells posed the greatest risk to public health (G. of C. I. S. Canada, 2002).

Research by masters' students from the University of Alberta between 2012-2014 further documented concerns related to rural water quantity and quality in the Nation (Hnidan, 2014; Mah, 2014). Mah noted that 23% of water systems had systemic contamination and another 12% had acute contamination, with 10% never having been sampled. Water sampling programs from 2002-2003 completed chemical water sampling on 646 of the 730 private wells in Samson Cree Nation. Results found many household wells exceeded the allowable concentration for Fluoride, Iron, Manganese, Sodium and Total Dissolved Solids according to the GCDWQ (Mah, 2014).

### 4.2.1 Testing Procedure

Maskwacîs Health Services, the local Public Health Authority, is responsible for annual testing of the Nation's household wells to verify the water is safe for human consumption. Annual testing comprises of bacteriological contamination testing using the enzyme substrate technology (Rompré et al., 2002). This type of testing measures the presence or absence of Total Coliform and/or E. coli. Upon request MHS also preforms chemical testing. MHS is responsible for issuing Drinking Water Advisories on reserve. During this process MHS will deliver paper copies to residents notifying them of the advisory and send the test results to the Nation digitally. As defined by the Federal Government, drinking water advisories fall under one of three categories (G. of C. I. S. Canada, 2018b):

1. Boil Water Advisory (BWA)
2. Do Not Consume (DNC)
3. Do Not Use (DNU)

Table 20 below list the number of tests completed by MHS over the last 5 years (Maskwacîs Health Services, 2021)

Table 20: Number of Water Quality Tests Completed by MHS in the Last Five Years

| Year | 2020-2021 | 2019-2020 | 2018-2019 | 2017-2018 | 2016-2017 |
|---|---|---|---|---|---|
| Number of Homes Sampled for Bacteriological Testing | 80* | 225* | 359 | 459 | 381 |
| Number of Homes Sampled for Chemical Water Testing | 0* | 0* | 0 | 6 | 1 |

*Less Sampling occurred due to COVID-19

Upon the issue of a BWA in Samson Cree Nation, MHS will typically shock chlorinate the well and sample the well again for TC of E. coli. Shock chlorinating is used to remove bacteria and prevent poor water aesthetic from smell, taste or color (Government of Alberta, 2019). Shock chlorination typically involves adding liquid chlorine to the well in high concentrations, then allowing the chlorine to sit in the lines for 8-48 hours (Government of Alberta, 2019). Afterwards, the line is flushed to bring the chlorine levels back down to acceptable standards. Wells must test negative twice consecutively before it is taken off of BWA. In cases where the sample comes back positive, MHS staff will perform further investigation to determine the source of contamination. It should be noted that shock chlorination is not in MHS's mandate and performed given the lack of capacity within Samson Cree Nation operation staff. Shock chlorination is also not a catch all solution and can create additional problems. Some residents reported that they didn't want to shock chlorinate their well because other wells in the area that had been shocked were damaged afterwards.

Results indicate that current testing practices do not meet Provincial and Federal guidelines, as literature recommends:

Government of Canada recommends (H. Canada, 2019).

- Testing for bacteriological contaminates twice a year
- Testing for comprehensive water quality every two year

Government of Alberta recommends (Government of Alberta, 2019):

- Shock chlorinating your well once per year, when lab tests show coliform bacteria in your well water, following contamination by flood water or change in water clarity, color or taste, after any repair work is done on the well, pump or distribution system, and immediately following installation of a new well

Ideally, the Nation would shock chlorinate the wells while MHS provided bacteriological testing and comprehensive testing to all homes. However, the Nation and MHS indicated they do not receive sufficient funding to achieve provincial and federal standards for testing and maintenance. Prior to the start of MHS, no water quality testing was completed within the Nation with the exception of infrequent federal reporting.

### 4.2.2 Quantity

In September 2021, Maskwacîs Health Services reported that there were 131 Samson Cree Nation member homes on active BWA and/or DNC orders (Maskwacîs Health Services, 2021). No DNU orders are currently in place. This represents roughly 15% of all homes in the Nation, though it is generally understood that many homes do not receive water quality testing and/or haven't been tested in years indicating that the number may be much higher. This is a result of limited capacity within MHS or individuals refusing testing or being inaccessible during testing hours. Figure 4 shows all houses on a DWA within Samson Cree Nation prior to the project start.

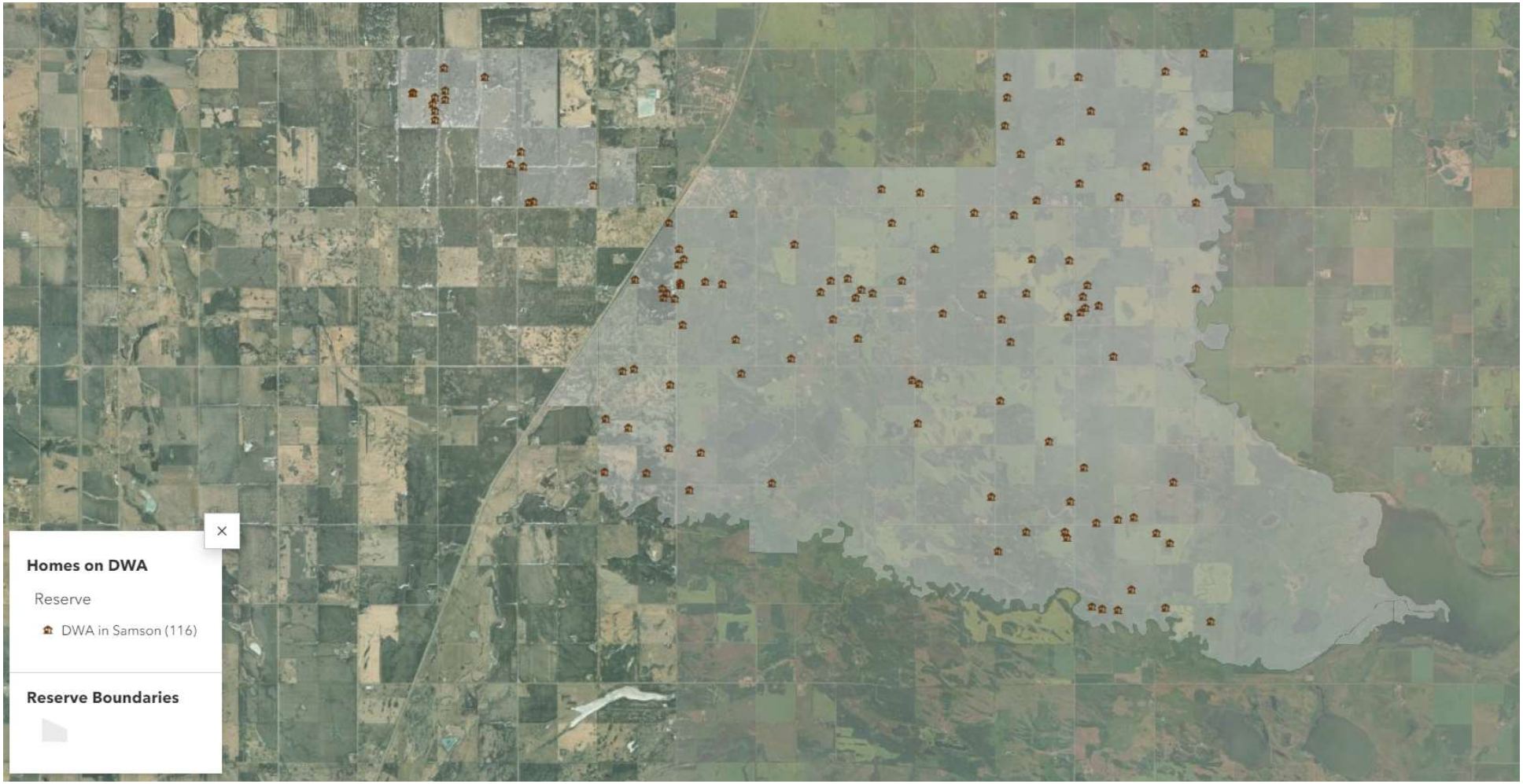


Figure 4: Map of Homes Under DWA in Samson Cree Nation (Samson Cree Nation, 2022)

Following the completion of the *'Priority DWA Project'* (from September 2021 to August 2022), Maskwacîs Health Services reported that there were 117 Samson Cree Nation member homes on an active DWA. The breakdown for this is shown in Table 21 below.

Table 21: Drinking Water Advisories in Effect Before and After the Completion of the *'Priority DWA Project'*

| Type Of Advisory | Before Completion | After Completion |
|---|---|---|
| Boil Water Advisory | 125 | 98 |
| Do Not Consume | 6 | 19 |
| Do Not Use | 0 | 0 |

Of the 19 DNCs in effect after completion of the *'Priority DWA Project'*, 14 were previously under BWA. Only one home that was under an DNC order before the project was removed from the list.

### 4.2.3 Length of Time

A common issue within the Nation was the prolonged time each home has been under a DWA. The Federal government defines long-term drinking water advisories as lasting greater than one year (G. of C. I. S. Canada, 2021). General reasons for long-term advisories include problematic treatments systems, poor source water quality, lack of training and damaged infrastructure (Murphy et al., 2015).

To understand the extent of long-term advisories within rural systems of Samson Cree Nation, data obtained from MHS was evaluated, including the DWA start date. Figure 5 below breakdowns the length of time each home has been under an advisory.

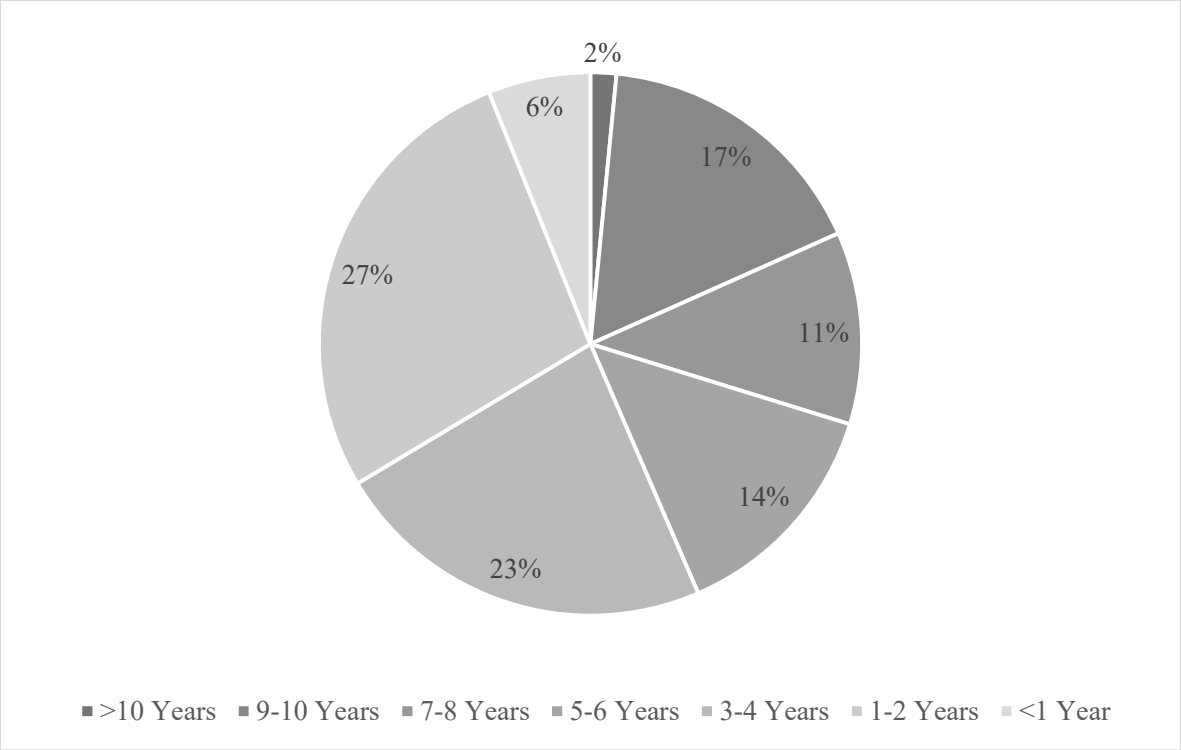


Figure 5: Length of Time on a Drinking Water Advisory in Samson Cree Nation

It should be noted that this is only for DWA's currently in place, as many homes frequently go on and off the list. Furthermore, when a house is taken off the list then put back on the start date for the DWA changes, hence many of the homes have likely been dealing with DWA's longer than the figure indicates.

### 4.2.4 Community Impact

Looking at the existing perception surrounding water and the impact of poor water quality leading to DWA's, residents were asked to think about one word that comes to mind when they think of water. Many spoke about concerns around water quality, the cultural connection people have to water and the treaty right to water. The response summary is illustrated in Figure 6.


Figure 6: Word Cloud Summary of Results to "What is One Word that Comes to Mind When you Think About Water?"

A major theme when evaluating community effects was the significant impact to traditional ways of life that has happened so quickly over the last 50 years. 100% of respondents from the group session with residents indicated that water in the Nation has rapidly degraded in quality.

Interviewees suggested that the causation for the rapid decline in water quality within Samson Cree Nation included oil & gas development, farming operations, refuse dumping from surrounding cattle farms, wastewater discharge from homes contaminating the water source and a lack of accountability in solving the water challenges. Respondents agreed that solutions take a lot of time and require us to hold people accountable to the issue and work together.

> *"You can't just point the finger at one person or one group, it takes all of us a concerted effort."*
>
> - Samson Cree Nation Resident

Though one resident had doubts that we could ever get back to pre-conditions. Even if we got everyone on the same page and had them care about the watershed, they argue that the damage done may be irreparable.

> *"Regardless of my way of thinking, regardless of your intentions, we can never go back to square one. The damage, it's destroyed."*
>
> - Samson Cree Nation Resident

This brings up an important topic around rebuilding confidence and trust within the community. Particularly regarding rural water quality and the presence of DWA's. The issue of trust within the Nation has long existed, with research from Mah in 2014 indicating 63% of residents in the Nation did not trust their well, 92% of which had previously been on a BWA. For those that did trust their well, only a quarter of participants had previously been under a BWA. Even with verified testing results, uncertainty remains and appears to persist where residents have experienced water quality issues.

## 4.3 Water Servicing

### 4.3.1 Water Servicing Regulation

As described under Section 2.2.2, reserves fall under Federal jurisdiction. Samson Cree Nation follows the *Protocol for Decentralized Water and Wastewater Systems in First Nations Communities*, which references applicable codes and standards for local-authority standards or regulations. Within Samson Cree Nation all water-well installation that is not specifically covered under the Protocol must comply with regulations defined under the Water Act, the Water (Ministerial) Regulation, and the Directive for Water Wells and Ground Source Heat Exchange Systems as per Province of Alberta requirements (*Water Act - Open Government*, n.d.; *Water (Ministerial) Regulation - Open Government*, n.d.; *Water Wells and Ground Source Heat Exchange Systems Directive - Open Government*, n.d.).

### 4.3.2 Onsite Servicing

There are roughly 1000 homes owned and operated by the Nation, 780 located in rural areas. All rural homes in the Nation are serviced by individual wells. Wells within the Nation were typically 120mm in diameter, though still occurring across Alberta, current construction favors a larger 165mm diameter (Kala Geosciences Ltd., 2021).

2002 desktop data obtained from the Nation's housing department was used to review well age in comparison to useful life. Typical useful life for a steel casing well is 25 years (Kala Geosciences Ltd., 2021). Data included well information for 501 wells, thought only 292 indicated a well completion date. Summary of results are shown is Table 22 below.

Table 22: Well Age of Individual Wells in Samson Cree Nation as of 2002

| Completion Date | Number of Wells | Age of Wells in 2002 | Age of Wells in 2022 | Proportion |
|---|---|---|---|---|
| 2002-1998 | 25 | <5 years | <25 years | 9% |
| 1997-1993 | 46 | 5-10 years | 25-30 years | 16% |
| 1992-1988 | 43 | 10-15 years | 30-35 years | 15% |
| 1987-1983 | 69 | 15-20 years | 35-40 years | 24% |
| 1982-1978 | 60 | 20-25 years | 40-45 years | 21% |
| 1977-1973 | 26 | 25-30 years | 45-50 years | 9% |
| 1972-1968 | 5 | 30-35 years | 50-55 years | 2% |
| 1967-1963 | 6 | 35-40 years | 55-60 years | 2% |
| 1962-prior | 12 | >40 years | >60 years | 4% |

Results indicate that of roughly 91% of wells in the Nation exceeded useful life with the average age being 37 years. In comparison to the 2010 report, where the average age of wells was 26 years, this appears to correlate even given the larger sample size in the Nations data.

Looking at provincial construction standards a majority of wells failed to meet the requirements, this included minimum well casing stick up height of 0.6m, thin wall casing without PVC liner and the absence of surface seals (Kala Geosciences Ltd., 2020).

In addition to the desktop review, thirty (30) homes were visited during October and November 2021 to collect visual condition assessments. Condition assessments were rated on a scale of 1-4 (See Appendix B for breakdown). Data from the visual condition inspection included:

- Number of Dormant or Abandoned Wells
- Well Condition
- Sources of Nearby Contamination

Results from the onsite inspection are summarized in Table 23 below.

Table 23: Summary Data from Onsite Visual Inspection of Well and Septic Systems

| House | Well Rating | # Of Dormant Wells | Sources of Contamination | Type of Septic System* | Septic Rating |
|---|---|---|---|---|---|
| 1 | 2 | 0 | Septic flowing towards wellhead (Presence of E. coli) | Shoot-out (AG) | 1 |
| 2 | 1 | 0 | Well cracked | Shoot-out (AG) | 1 |
| 3 | 3 | 0 | Historical Presence of E. coli | Shoot-out (AG) | 1 |
| 4 | 2 | 0 | Dented casing (Presence of E. coli) | Shoot-out (AG) | 1 |
| 5 | 2 | 0 | Partial blockage in well | Shoot-out (AG) | 1 |
| 6 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 1 |
| 7 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 1 |
| 8 | 3 | 0 | Septic sloping towards house | Shoot-out (AG) | 1 |
| 9 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 1 |
| 10 | 3 | 0 | DNC – unsealed cap | Shoot-out (AG) | 1 |
| 11 | 3 | 0 | DNC – unsealed cap | Shoot-out (AG) | 1 |
| 12 | 2 | 0 | Mouse nest in wellhead (Presence of E. coli) | Shoot-out (AG) | 1 |
| 13 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 2 |
| 14 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 2 |
| 15 | 2 | 0 | Casing threaded with another casing | Shoot-out (AG) | 2 |
| 16 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 2 |
| 17 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 1 |
| 18 | 3 | 1 | Unsealed cap | Shoot-out (AG) | 2 |
| 19 | 1 | 1 | DNC – black water | Shoot-out (AG) | 3 |
| 20 | 3 | 1 | Unsealed cap | Shoot-out (UG) | 2 |
| 21 | 3 | 0 | Old septic tanks still on property | Shoot-out (AG) | 3 |
| 22 | 3 | 0 | Unseal cap | Shoot-out (UG) | 1 |
| 23 | 3 | 0 | Unsealed cap | Shoot-out (AG) | 3 |
| 24 | 3 | 0 | Unsealed cap | Shoot-out (UG) | 3 |
| 25 | 3 | 0 | Unsealed cap | Shoot-out (UG) | 2 |
| 26 | 3 | 0 | Unsealed cap | Shoot-out (UG) | 3 |
| 27 | 2 | 0 | Presence of animal feces (historical presence of E. coli) | Septic Field | 4 |
| 28 | 3 | 1 | DNC – unsealed cap | Septic Field | 4 |
| 29 | 4 | 1 | DNC | Shoot-out (UG) | 3 |
| 30 | 4 | 0 | DNC – Leakage around septic tank notes | Shoot-out (UG) | 3 |

*AG refers to Above Ground and UG refers to Under Ground

Figure 7 below illustrate the breakdown of rankings assessed for water systems during onsite visual inspections.

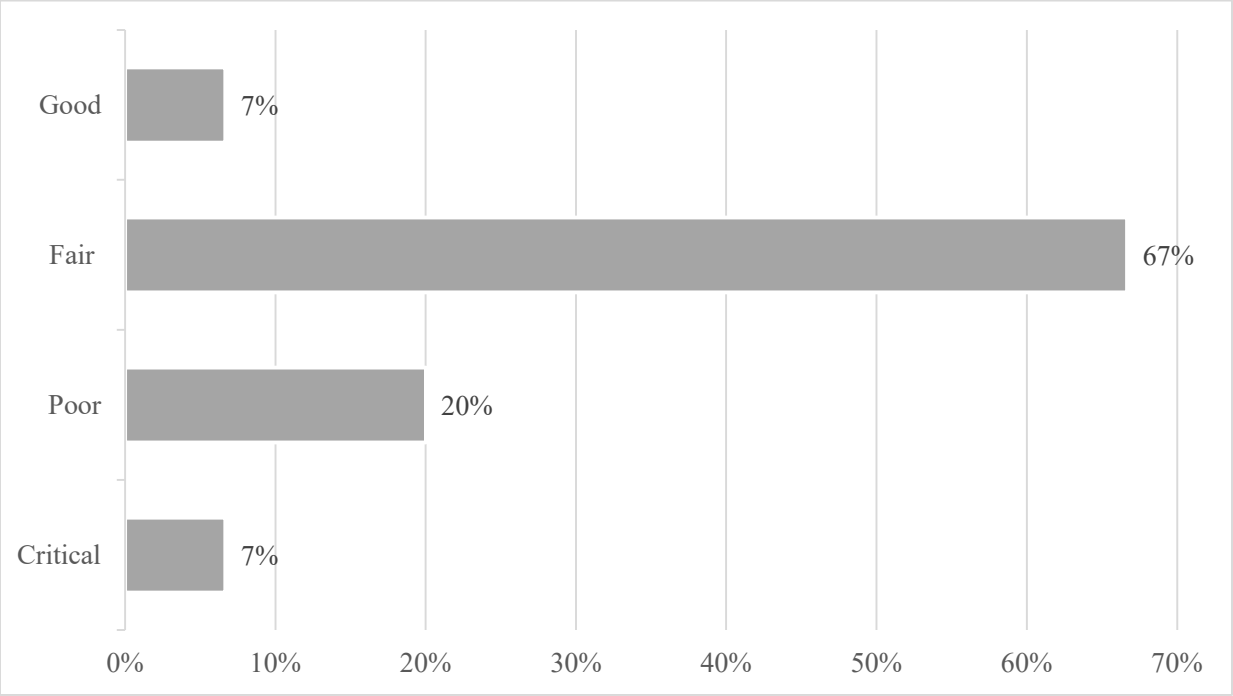


Figure 7: Well Inspection Rating Distribution

We can see a majority of wells are still operational but show issues of significant aging including corrosion, unsealed caps and unsealed electrical. There were also 5 homes that had dormant wells on the property, which represents just over 16% of the sample size. If we extrapolate that to the remaining 750 homes in the Nation, that could mean upwards of 125 abandoned wells require decommissioning in the Nation. This is consistent with data from the 2002 Neegan Burnside report that estimated between 100 and 180 private wells were either dormant or abandoned.

It was noted during inspections that most homes were built around the same time as the water and sewer systems and were found to have cracked foundations, failing plumbing and electrical systems. Some homes had signs of past water softeners or treatment systems, however residents indicated they had to be bypassed due to lack of funding to repair or replace them. All homes showed impacts of decades of hard water on appliances, fixtures, internal plumbing, sinks and bathtubs (i.e. rust colored staining & mineral buildup).

## 4.4 Wastewater Servicing

### 4.4.1 Wastewater Servicing Regulation

Within the *Protocol for Decentralized Water and Wastewater Systems in First Nations Communities* additional requirements for cite conformance must meet provincial, municipal, or local-authority standards or regulations. Within Alberta, the *Alberta Private Sewage Systems Standard of Practice 2021* is referenced.

In the context of this report, relevant regulation regarding treatment fields, septic tanks and surface discharge will be summarized as relevant information. Though many other decentralized treatment systems exist, as described in Section 1.1.1, only those listed are applicable to Samson Cree Nation.

#### *4.4.1.1 Septic Tanks*

Septic tanks use integral chambers to provide primary treatment to wastewater (*Alberta Private Sewage Systems Standard of Practice*, 2021). Relevant construction standards include:

I. Working capacity shall not be less that the expected daily peak wastewater volume
II. Opening and access points shall prevent infiltration and exfiltration of wastewater and groundwater
III. Minimum separation distance from a septic tank shall not be less than:
    a. 10m to a water well or water source
    b. 1m to a property line
    c. 1m to a building
IV. Septic tank access openings shall not be buried and be accessible for service and maintenance

#### *4.4.1.2 Treatment Fields*

Treatment fields are treatment to wastewater (*Alberta Private Sewage Systems Standard of Practice*, 2021). Relevant construction standards include:

I. Maximum effluent hydraulic loading rates are to be determined based on the texture and structure of the soil
II. Soil classification is to be coarse sand, medium sand, fine sand, loamy medium sand, or loamy coarse sand below the effluent infiltrative surface.
III. Minimum separation distance from any point for the lateral piping shall not be less than:
    a. 15m to a water well or water source
    b. 1.5m to a property line
    c. 10m to a building from a basement
    d. 1m to any building that does not have permanent foundation
    e. 5m to any building that has a permeant foundation but does not have a basement
    f. 5m to a septic tank

#### *4.4.1.3 Surface Discharge*

Withing the Standard of Practice, surface discharge (or open discharge) systems are allowable under the definition "a system designed to discharge effluent to the ground surface to accomplish evaporation and absorption of the effluent into the soil as a method of treatment" (*Alberta Private Sewage Systems Standard of Practice*, 2021). Relevant construction standards include:

I. No system to be used where soil classification is coarse sand, medium sand, fine sand, loamy medium sand, or loamy coarse sand within 1.5 m.
II. Effluent must be contained within the property
III. Design must minimum the pooling of effluent
IV. Minimum separation distances from the point of discharge shall not be less than:
    - 50m to a water well
    - 45m to a building
V. Where multiple open discharge systems exist, or where there are no property lines, the distance between outlets shall be a minimum of 180m

Standards will be evaluated with desktop and onsite visual inspection data in the Section below.

### 4.4.2 Onsite Servicing

Nation housing relies on septic tanks to manage and treat wastewater effluent in individual homes. Septic tanks typically comprised of smaller single chamber precast concrete tanks having a volume of between

1,500-2,900 L. Recent reports indicate problems ranging from missing lids, broken side walls, tank settlement, heavy concrete spalling and degradation (Kala Geosciences Ltd., 2022). The staff indicated that historically, most discharge methods following a septic tank were installed as a single pipe dug below ground rather than a fully designed septic field. There is some minor confusion regarding what operators label each system, with underground shoot-outs and septic fields being used interchangeably. General consensus broke up the discharge into 3 methods:

1. Above ground (AG) shoot-out – failed underground system that was converted to discharge inadequately treated septic waste directly to surface
2. Underground (UG) shoot-out – discharges inadequately treated septic waste through a single pipe into the ground
3. Septic Field – discharges septic waster through a fully designed and constructed septic field for adequate treatment

Discussions with operators and members indicated that many systems are being converted into above ground (AG) shoot-outs. This has been done to stop septic waste backing up into the home. This was corroborated during the interview process, with residents commenting on the need for sewer field replacement and the common failure of existing systems.

Septic fields typically fail due to age, improper installation, unsuitable design or lack of maintenance (Lindbo et al., 2014). Limited recorded data was available regarding wastewater servicing within Samson Cree Nation. The most recent assessment from 2010 inspected 48 homes. Findings are summarized in Table 24 below.

Table 24: Onsite Wastewater Systems Inspection Data (reproduced from (G. of C. I. S. Canada, 2010))

| Parameter | Value | Proportion |
|---|---|---|
| Average Age | 27 | - |
| Surface Discharge (shoot-out) | 22 | 45% |
| Evidence of Odor | 27 | 56% |
| Evidence of Ponding | 7 | 14% |
| Operations Concerns | 30 | 62% |

Proximity of the shoot-out release point to the home was a common concern noted within the report (G. of C. I. S. Canada, 2010). Typical useful life for an onsite wastewater treatment system is 25 years (Kala Geosciences Ltd., 2021). Where onsite wastewater treatment systems are defined as any system that manages and/or treats wastewater, this includes septic tanks and soil-based effluent dispersal (*Alberta*

*Private Sewage Systems Standard of Practice*, 2021). Given that septic system replacement is atypical in the Nation, this indicates that a majority of systems exceed useful life.

Similar to Section 4.3.2, thirty (30) individual septic systems were assessed during a visual condition assessment. Data collection included:

- Type of System (i.e. shoot-out, septic field)
- Septic Condition - on a scale of 1-4 (See Appendix B for breakdown)
- Distance from Septic System to the Well (i.e. within allowable standards)
- Distance from Septic System to the House (i.e. within allowable standards)

Results from the onsite inspection are summarized in Table 23 in Section 4.3.2. Systems labeled as shoot-out (UG) where labeled as a shoot-out rather than a septic field based on feedback from Nation operating staff. The term "shoot-out" inherently refers to an inadequate treatment method and though single pipe discharge can be allowable under Alberta regulations under "open discharge", it became apparent following site investigations and conversations with residents that most of the existing wastewater systems were undersized and inadequately designed for the ultimate use. They were often sized for the number of bedrooms in a home, rather than the number of occupants. In many cases, the number of occupants in a home within the Nation exceeds typical design criteria used by septic tank contractors and suppliers (Kala Geosciences Ltd., 2021). Hence the naming convention used in this report. Unless specified it was assumed the septic systems were an "underground shoot-out" rather than a functional septic field. Houses with septic fields were confirmed by the resident as having constructed the system themselves.

Figure 8 below illustrate the breakdown of rankings assessed for septic systems during onsite visual inspections.

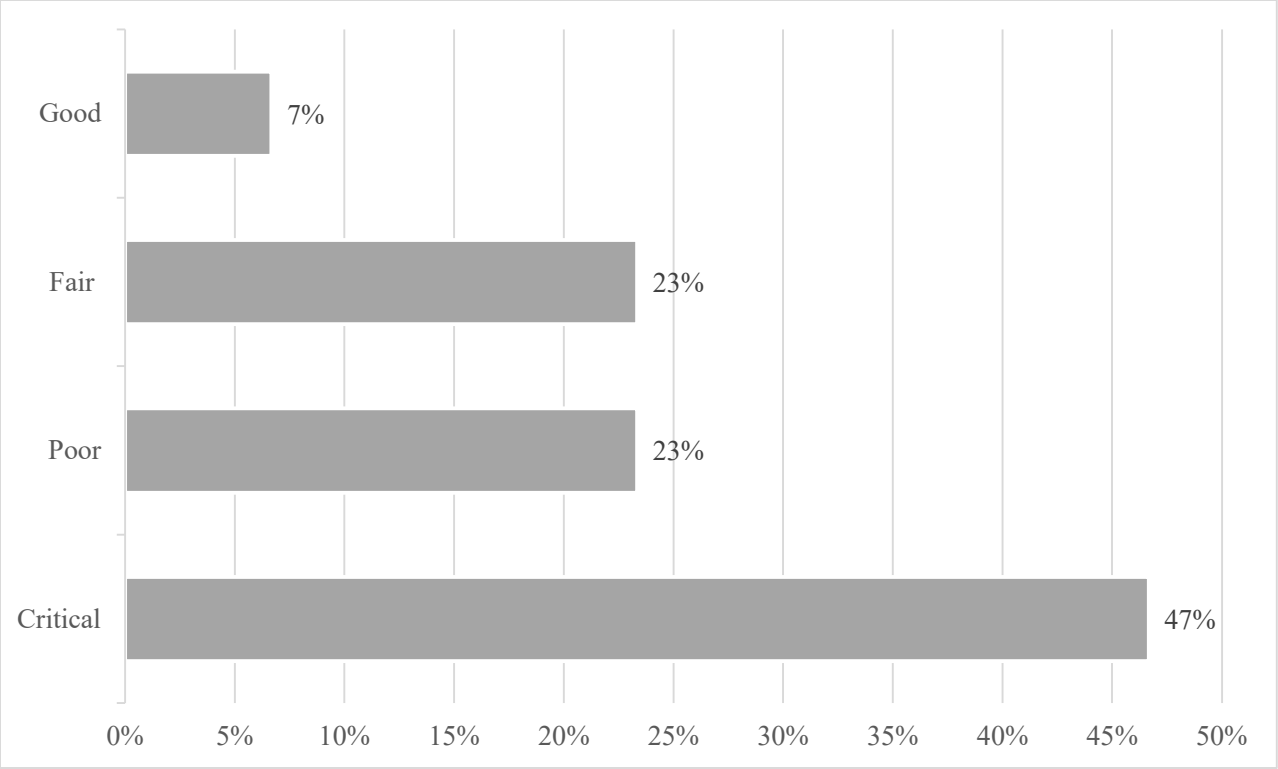


Figure 8: Septic Inspection Rating Distribution

Looking at the type of system, 70% of homes had above ground shoot-outs. These systems are a major health concern that require immediate attention. Hence, the proportion of poor to critical ratings. If we compare this to the 2010 National report for Samson Cree Nation shown in Table 24, we can see a discrepancy of 25% for surface discharge.

During inspection, many systems had evidence of an older underground septic system. According to Nation staff, these older systems likely failed due to a naturally high groundwater table. Many residents were forced to convert the old systems to an above ground shoot-out that commonly discharged close to the home and groundwater well. Percolation tests are typically required as part of a septic system design to verify that the preferred disposal method will suit the ground conditions. A percolation test measures the rate at which soil can accept and transport water in saturated flow conditions (Alberta Private Sewage Systems Standard of Practice, 2021). Nation staff were unable to confirm whether a percolation test was completed prior to install. In unsuitable conditions, wastewater will not absorb into the soil and rather pool on the surface (Alberta Private Sewage Systems Standard of Practice, 2021).

Existing systems in the Nation were generally in non-conformance when compared to the Alberta Private Sewage System Standard of Practice. Test pits taken as a part of the *'Priority DWA Project'* identified

soil classification as silty clay to clayey silty (CL-ML); acceptable by the standards (Kala Geosciences Ltd., 2021). However, based on the visual inspection, the distance separation between effluent discharge, the home and the well were non-confirming, as shown in Figure 9 below. With a minimum separation of 45m between open discharge and home dwellings, 85% of inspected homes are currently in non-compliance (*Alberta Private Sewage Systems Standard of Practice*, 2021).

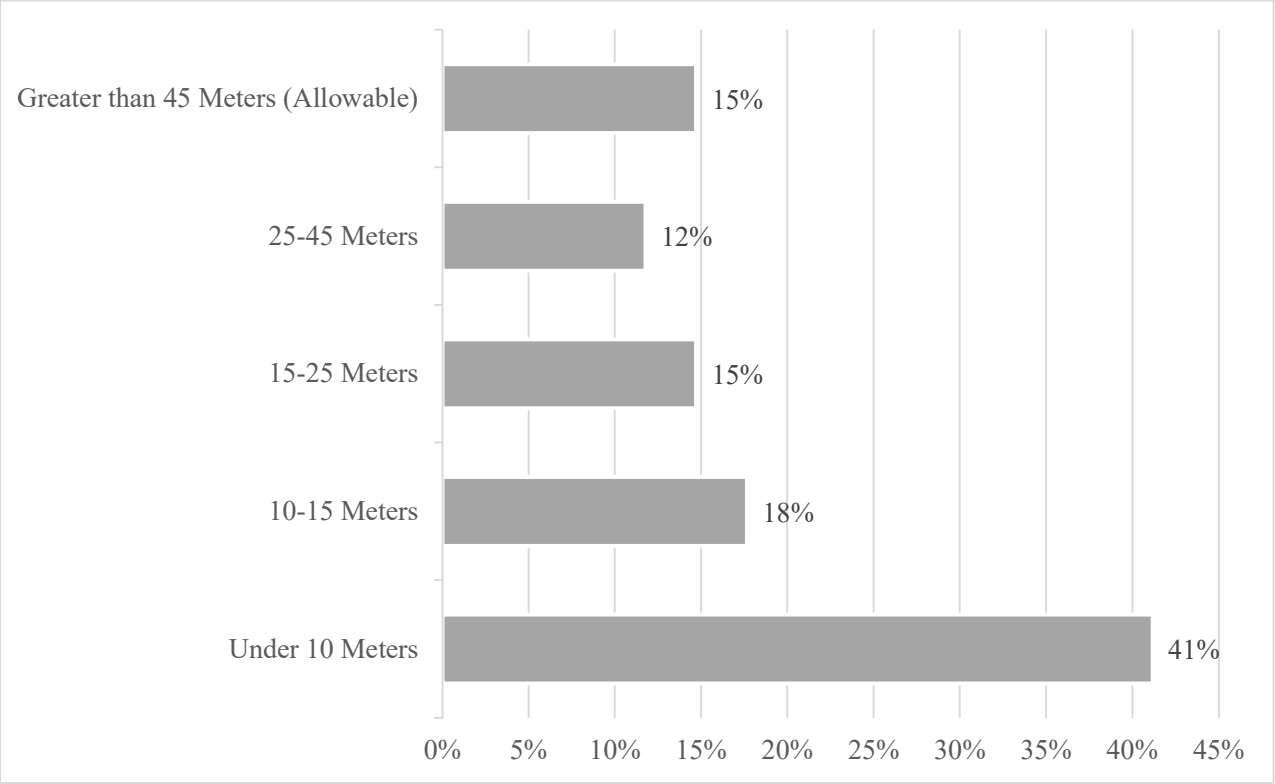


Figure 9: Comparison of Distance between Septic Discharge and House

Furthermore, homes with a converted shoot-out system due to a failed underground septic system had significant pooling noted. The Standard of Practice indicates an open discharge system should not be installed within a quarter section where more than 4 parcels have been subdivided (*Alberta Private Sewage Systems Standard of Practice*, 2021). Though sub-divided parcels do not exist within the reserve, SCN 137 and 137A comprises approximately 188 quarter sections of land. Of those, approximately 73 quarter sections have more than 4 homes currently in place. Though the Nation is in compliance with the standards, as the Nation's population continues to grow, further use of open discharge systems could have compounding negative effects on surface and groundwater quality. For multiple open discharge systems, a minimum separation of 180m must be maintained between outlets. This was unable to be confirmed with available data but was noted as a risk to the Nation.

### 4.4.3 Groundwater Management

Groundwater management was noted during onsite inspections as a concern to wastewater servicing. Nation personnel indicated during the planning process that many homes had groundwater management connected directly to the septic system, this approach is not a best practice and would increase the risk for sewer backup and contamination (Kala Geosciences Ltd., 2021). It was originally thought that many of the homes would have weeping tile systems tied into their septic tanks, this was later rejected based on site observations noted during the *'Priority DWA Project'* construction. However, there were a few houses with sump pumps that discharged to surface. Though it appears that groundwater management is not directly impacting water quality as a result of septic backups, it was noted that basement flooding, seepage, cracking foundation was commonly identified and still represents a health and property risk for the residents. In addition, the larger affects to aquifer health due to mismanaged groundwater and the correlation to Drinking Water Advisories was not evaluated within the scope of this project but should be considered in the Nations long-term planning.

## 4.5 Water Management

Water governance challenges are common within Indigenous communities (Bradford et al., 2017; Dunn et al., 2014; Murphy et al., 2015; von der Porten & de Loe, 2013). Bradford et al. accounted the lack of participation and influence at higher political tables regarding water protection, regulation and enforcement as reasons for the ongoing issue. Within Samson Cree Nation, water governance is a growing concern and priority for leadership and the *nîpiy* committee. Understanding water management in Samson Cree Nation has gained traction in the last few years as a way to aid discussions surrounding self-determination in the context of water governance. Currently water management occurs on a reactive basis in the Nation. With minimal capacity for proactive planning, systems are addressed on an as need basis based on level of priority. This Section will discuss operation and maintenance, regulation and policy applicable to the Nation. Section 5.3 will correlate results obtained regarding water management with the ongoing presence of Drinking Water Advisories in Samson Cree Nation and its relation to the larger picture of water governance.

### 4.5.1 Operation and Maintenance

The operation and maintenance of current rural systems is centrally managed. This means that the Nation is the primary responsible party that relies on specific groups for support. Each group has the following responsibilities:

#### *4.5.1.1 Samson Cree Nation (Housing & Trades)*

- Is responsible for operation and maintenance of all rural household groundwater wells and septic systems
- Does not perform water quality testing or shock chlorinating
- Hires contractors to install new wells and repair or replace septic systems that no longer function
- Operation and maintenance in Samson Cree Nation is reactionary and completed on an as needed basis
- Activities are limited due to zero funding available for rural water and wastewater operation and maintenance

#### *4.5.1.2 Samson Cree Nation Members*

- Are responsible to report any issues with their wells or septic systems to Samson Cree Nation Housing and follow guidance from Maskwacîs Health Services

#### *4.5.1.3 Maskwacîs Health Services*

- Attempts to perform testing for bacteriological 2 contaminants once per year for all rural households.
- Only tests for comprehensive water quality when a resident asks for it or if there is something obviously concerning with the water taste, appearance or odor. Testing limited due to available funding.
- Assists with shock chlorination for a rural household when lab tests show coliform bacteria in the well water. This lies outside of their work mandate. However, Maskwacîs Health Services provides assistance to residents as required.

### 4.5.2 Water and Wastewater Funding

Complex governing structures in Indigenous communities have long contributed to the lack of useful funding strategies (Morrison et al., 2015). In non-Indigenous communities, operation and maintenance (O&M) of water and wastewater systems is regulated by provincial governments and generally managed by the municipality (Walters et al., 2012). Municipalities use service fees for delivery and treatment and receive substantial funding from municipal and provincial governments to operate and maintain the system (Thompson et al., 2017). In contrast, Indigenous communities work with ISC and Health Canada to provide servicing to their members (Thompson et al., 2017) as a shared responsibility in accordance with federal guidelines and policy (Canada;, 2010). Indigenous communities are typically responsible for ensuring the design, construction, maintenance and operation of the system is in accordance (Thompson et al., 2017).

Samson Cree Nation receives funding for operation and maintenance through Indigenous Services Canada according to the Operation and Maintenance – ISC Level of Service Standard, Corporate Manual System (Government of Canada; Indigenous Services, 2022). The Nation currently receives $0 in funding for annual operation and maintenance of water and wastewater systems for rural households.

The Nation receives less than a thousand per home annually to operate and maintain the entire house. This includes internal and externals operation and maintenance such as plumbing, electrical, and structural concerns. Though not designated for water and wastewater servicing, the Nation will occasionally rely on their Public Works Department through this allowance to address resident concerns. Some sources indicate that a good rule of thumb for O&M is to allow for 1% of the purchase price. With house pricing between 150k-400k, the discrepancy is obvious (*How Much Should I Budget for Home Maintenance Costs?*, n.d.; *The Cost of Maintaining a Home*, n.d.).

During interviews with key personnel, 100% of interviewed participants commented on the lack of O&M, with 66% identifying funding as a roadblock preventing the Nation from providing adequate rural servicing.

## 4.6 Summary

To address DWA's in Samson Cree Nation, the *nîpiy* committee executed the *'Priority DWA Project'*. A community-led process that aimed to find a holistic solution to the drinking water quality concerns across the Nation. As of 2021, 131 Samson Cree Nation member homes had been on an active BWA and/or DNC orders. Following project completion, 117 DWA's remained. Though the project addressed 34 homes, 14 homes were placed under a DNC order following completion due to high levels of Fluoride. Findings from the one-on-one interviews identified the following themes when evaluating the community-led approach; 1) A poor perception of water across the Nation; 2) Existing funding is inadequate to ensure long-term success; 3) The process better met the community needs; 4) Collaboration takes work; and 5) There is a need for education and awareness regarding water related issues.

Looking at the Drinking Water Advisories through a technical lens, historical records and onsite inspection data indicated that 91% of wells in the Nation exceed useful life with 27% being in poor to critical condition. Looking at the septic, a majority of systems appeared to be beyond expected life with 70% being in poor to critical condition. 70% of inspected homes had an above ground shoot-out.

Water management in the Nation is reactive and handled on a triaged system that can only address failed systems. With limited capacity for operation and maintenance and inadequate funding for capital or operational activities, the existing rural servicing is deteriorating. The failing systems and water quality concerns are affecting residents physical and mental wellbeing.

Looking at the larger scope, it is apparent that current regulation, policy and funding structures are disadvantageous to Indigenous communities and must be adjusted to reflect the unique needs and culture of each Indigenous community.

# 5.0 Discussion

In the context of Canadian history, we have seen articles and headlines discussing Drinking Water Advisories and the growing crisis ("Safe Water for First Nations," 2019). However, the lack of adequate drinking water continues to plague Indigenous peoples across Canada. Forty-three years after the initial promise from the Federal government to provide safe drinking water and sanitary services the problem persists (Bateman, 2022). Even with Canada's commitment to ending long-term drinking water advisories, we are still only looking at a fraction of the problem. As decentralized systems are not considered within the Federal program (Canada, 2021). Recognizing this fact, the *nîpiy* committee has led by example by implementing the first project in Alberta, in partnership with ISC, to begin addressing rural DWA's.

Through this Section the causes specific to rural Drinking Water Advisories in Samson Cree Nation will be discussed, and the research will present and evaluate the process by which the *nîpiy* committee has taken to address these challenges. Community impact and feedback will be included to provide a holistic understanding to the Nation for use in future endeavors.

## 5.1 Evaluating Community-led Processes

A community-led approach can provide better opportunities to identify a problem and lead to more successful execution in terms of community outcomes (Hanrahan et al., 2015; von der Porten & de Loe, 2013). When we consider this within Indigenous communities, community-led processes may provide Nations with an opportunity to further self-determination and self-governance. The term Indigenous self-determination refers to "the aspects of governance related to Indigenous autonomy, sovereignty and/or assertions of Indigenous nationhood in the context of (de)colonization" (von der Porten & de Loë, 2013). In the context of water, this means Indigenous people would have the right to freely pursue issues of economic, social or cultural concerns. As Having the community-led approach gives Nations the power to take back control of water issues occurring on reserve and bring to the table solutions that match their perspective, rather than the westernized narrative (Arsenault et al., 2018).

The westernized approach is a term that refers to the approach to water governance that has been adopted in many Western countries, including Canada. This approach typically involves the use of technical and scientific methods to manage and regulate water resources, with a focus on optimizing the use of these resources for human purposes such as agriculture, industry, and domestic consumption (Bradford et al., 2017). The westernized approach is habitually operationalized, hierarchical and context-independent, often ignoring social and normative beliefs (Bradford et al., 2017). The mixture of westernized engineering with Indigenous knowledge can provide the middle ground and shift the context in which we

address water challenges, an inherently transboundary resource. However, when incorporating Indigenous knowledge, we must be careful to not fall prey to simply identifying Indigenous people as key stakeholders. Indigenous people must be given a spot of equal power to comment on water related issues and be engaged in the decision-making process (Black & McBean, 2017a). An analysis of the challenges and opportunities during engagement identified "capacity, inadequate resources and, overall, a lack of respect or formal recognition of Indigenous rights" as main roadblocks to meaningful participation of Indigenous peoples (Black & McBean, 2017a).

Within Samson Cree Nation, a community-led approach allowed *nîpiy* to focus on Indigenous-led solutions that incorporate westernized engineering approaches, rather than a vice-versa approach. This alternative approach was incredibly important in a project that impacts a majority of the community on a personal level. Whether this be as a resident user, operational staff or leadership. General feedback from key team members gathered during interviews and group sessions identified many benefits to this process, including:

- Capacity building within Nation staff (i.e. staff gained experience in project delivery and technical knowledge on rural water and wastewater servicing)
- Greater awareness among residents of water servicing and management within the Nation (i.e. sharing operation and maintenance manuals made specifically to Nation residents)
- Better articulation of water concerns across the Nation (i.e. sharing findings of this project to the broader community)
- Trust building between the Nation, residents and federal agencies (i.e. transparency with residents and federal funders regarding the *nîpiy* committees' vision for the Nation)

Group feedback is further illustrated in Figure 10 and Figure 11 in Section 5.4.

The *'Priority DWA Project'*, while the first of its kind to address rural DWA's in Alberta, is a decade in the making if we consider the relationship and network building undertaken by the Nation to get to this point. As the Nation broadens its understanding to long-term solutions, the work completed through this project will inform future projects. A major concern in the outcome of the *'Priority DWA Project'* was the short-term vision to DWA's in the Nation, in reference to how rural systems are serviced and whether replacement is the best option. But when dealing with critical conditions where families and children are getting sick and having to move out of homes due to water condition, the Nation is still having to act reactively to these challenges. As summarized by a resident:

> "*It's making a dent in moving us in the direction of solving some of the long-standing water issues that many of our nation members have been dealing with, but we have to approach it with a little bit of patience. However, it's like I said, going back to the fire analogy, because people's clothes are on fire they're wanting that immediate fix now and I get the frustration, I can totally understand it and respect and appreciate it, but we have to find ways to communicate that there's no quick perfect fix out there."*
>
> - Samson Cree Nation Member

The community-led approach in Samson Cree Nation has shown the positive response from community that occurs and collaboration opportunities available when everyone at the table is on the same page. *nîpiy* provides the opportunity to sit and listen to a number of conversations where everyone is contributing with their unique perspective and experience. If we could see that on a larger scale and encourage meaningful collaboration, the opportunities are endless.

Though many participants considered the *'Priority DWA Project'* an overall success, there are a number of items that should be re-evaluated in the future. This includes:

- Communication: how the project team communicates with:
    - Nation departments impacted by the project (e.g. Housing, Public Works, Water/Wastewater); and,
    - Residents (those effected by the project AND those in similar conditions);
- Education: how to develop education and awareness programs or sessions to communicate water challenges back to community; and,
- Review: after each project, objectives and priorities should be revised to ensure they continue to meet the needs of the community and reflect lessons learned from previous projects

Overall, the community-led approach has given Samson Cree Nation the freedom and control to articulate the unique issues the Nation faces. The next step to the problem is bringing these learnings to federal tables where everyone can listen and collaborate to enact policy and regulation change in order to achieve sustainable long-term solutions.

## 5.2 Impact of Infrastructure on Drinking Water Advisories in Samson Cree Nation

The Nation has over 780 rural homes, each with individual wells and septic systems. It is challenging to centrally manage all this water and sewer infrastructure to ensure safe, reliable drinking water is available to all Nation members. The impact of this challenge is reflected in the number of DWA's across the

Nation due to condition, types of servicing and challenges with ecological conditions, as will be discussed below.

### 5.2.1 Condition

In Canada, the condition (e.g. age, quality of infrastructure) of rural water infrastructure can have a significant impact on the safety and quality of drinking water. Poorly maintained or outdated water infrastructure can lead to contamination of drinking water, which can result in the issuance of drinking water advisories by health authorities (Finn, 2010; Levangie, 2009; Mccullough & Farahbakhsh, 2012; Thompson et al., 2017). This problem extends beyond existing conditions and starts at inadequate design and construction (Swain et al., 2006).

The correlation between condition of infrastructure and DWA's, particularly BWA's, can clearly be seen in Samson Cree Nation. The majority of the 30 individual groundwater well and wastewater systems assessed appeared to be installed in the 1970-1980's, as suggested by the desktop evaluation. Most groundwater wells and septic systems typically reach the end of their useful life in 20-35 years depending on maintenance activities (Kala Geosciences Ltd., 2020). Looking at data collected during onsite visual inspections, 27% of well systems and 70% of septic systems were in poor to critical condition (shown in Section 4.3.2 and 4.4.2, respectively). The only services that were in good condition were either a new well or a proper septic system installed by the resident independently. Through the *'Priority DWA Project'*, 32 new wells were installed, 28 of which were under a BWA. Following construction, 27 of the 28 wells were removed off BWA (Urban Systems Ltd., 2022). The age of infrastructure is directly impacting to the number of BWA's within Samson Cree Nation.

In many cases, the age of plumbing systems in the homes contributed to poor water quality test results after new wells and pressure tanks were connected. For example, a home that remained on BWA through the *'Priority DWA Project'* suffered from internal home plumbing issues. This was verified by negative bacteriological samples taken directly from the well, when the faucet test results indicated the presence of total coliforms (Urban Systems Ltd., 2022). Additional flushing and chlorination were required for 10 homes before samples came back with no coliforms at the tap. Shock chlorination is also not a perfect solution. The chlorine only kills bacteria that it has been in contact with for sufficient time and if wells are not regularly cleaned, shock chlorination may be insufficient for the growth of bacteria because available free chlorine is consumed by the overabundance of bacteria and/or organics (Environmental Public Health & Alberta Health Services, 2021). Some studies have also shown that shock chlorination can also bring trace metals from the aquifer into solution and may form disinfection byproducts (DBP) through reactions with organics present in the water (Walker & Newman, 2011). The CDC reports that chronic exposure to

DBP's (e.g. trihalomethanes and haloacetic acids) may increase the risk of cancer, liver damage and decrease activity in the nervous system (CDC, 2022).

Considering the data obtained from the Nation and the onsite visual condition assessment, Table 25 below compares the average length of time homes have been under a DWA and the condition of the well based on the onsite visual inspection. This was done by comparing the start day of the BWA as reported by MHS with the onsite visual inspection ratings, as shown in Table 23.

Table 25: Comparison between Visual Condition Rating for Well and Average Length of Time Under BWA

| Water Well Visual Condition Rating | Average Length of Time Under BWA |
|---|---|
| 1 – Critical | 8.5 Years |
| 2 – Poor | 2.5 Years |
| 3 – Fair | 7 Years |
| 4 – Good | 3 Years |

We can see that generally, as the well condition decreases the length of time spent under DWA increases. Though the poor condition wells appear to be an outlier to this theory. This suggests that other effects are impacting the length of time homes spend under DWA.

To address condition concerns, Samson Cree Nation would need to replace rural water systems that have exceeded useful life. This has significant financial implications. As of 2022, construction of a new domestic water well with steel casing, screen, pump, controls, pressure tank and plumbing in the Nation typically costs between $25-32k depending on the depth of the aquifer in different areas of the Nation (Urban Systems Ltd., 2022). If we extrapolate this to the rest of Samson Cree Nation (94% needing replacement as they exceed expected life) the cost would be roughly $21 Million. This puts the Nation in a critical position when funding is unconfirmed, and systems get closer to failure every day. The crises of rural water systems are not unique to Samson Cree Nation either and national attention is needed to bring change to the growing issue in Canada.

### 5.2.2 Wastewater Servicing

When considering rural DWA's, a major implication is the septic system. Septic waste can contribute to diseases like typhoid, gastrointestinal illness, hepatitis A and cholera as a result of bacteria, viruses, and protozoa from the wastewater (Bio-Sol, 2022). In areas with inadequate septic management, septic effluent can easily travel overland. This is a risk not only to individual wells, but downstream rivers and ecosystems.

Within Samson Cree Nation, this has been a long-standing challenge. In 2010, Neegan Burnside identified the absence of a well-funded system for well decommissioning as a major risk due to surface contamination from improper septic systems (shoot-outs) (Canada, 2010). The abandoned wells act as an opening for bacteria and animals to potentially contaminate the aquifer as they are improperly sealed and can provide an opening to polluted surface waters. Comparing the onsite septic inspection results in Section 4.2.2 with the known BWA's, 70% of homes inspected had poor to critical septic condition that pose a major risk of contaminating the well head. Especially since 70% of septic systems had an above ground shoot-out and 93% of wells had crack casing or improperly sealed lids.

When we consider that 85% of homes have effluent discharge closer than allowable standards (shown in Section 4.4.2), this provides opportunity for the septic waste to seep into the cracked well casing. Having failing septic systems is directly impacting water quality in the Nation and in order to address drinking water advisories long-term the Nation must consider rural septic systems. One home inspected had septic waste pooling directly around the well head. Another five wells had historical presence of E.coli (per Table 23). The septic system may also be impacting source water due to disease-causing pathogens, nitrates and phosphorus pollution (US EPA, 2017).

Looking at the implications to address these challenges, construction of a new 3-chamber septic tank sized to accommodate up to 8 residents, controls, a pump, alarm and 45m open discharge in the Nation typically costs between 22-27k (Urban Systems Ltd., 2022). Construction of septic fields or septic mounds would be more to account for the greater cost in material and labor for the lateral pipe system. If we use the average replacement cost to replace existing systems past useful life (86% per Section 4.2.2) in the Nation, the cost would be roughly $16 Million. Similar to the water servicing, this is simply unattainable for the Nation. It is unclear if replacement of the aging systems with the same type of infrastructure will benefit the community in the long-term, or if a more centralized servicing approach would make more sense. Consideration must be made to reduce the environmental impact, reduce risk of drinking water advisories due to septic contamination, increase reliability and improve levels of service. Without a holistic solution, conditions are likely to worsen on reserve and impact resident's physical, social and spiritual health.

### 5.2.3 Do Not Consume - Fluoride

Canada is one of two Organization for Economic Cooperation and Development (OECD) member states and the only G8 country that does not have legally enforceable drinking water quality standards at the national level (Bradford et al., 2017). With no national water policy, nor enforceable standards, and microbial testing being the only consistent testing standard across all jurisdictions, it is not surprising that other contaminates, such as fluoride, are largely unknown (Dunn et al., 2014). This passive approach to

drinking water regulation has adverse effects across Canada, particularly in Indigenous communities where Nations depend on Federal legislation.

Following the *'Priority DWA Project'* construction for the 34 homes, 19 homes remained on a Do Not Consume order due to fluoride levels exceeding the Maximum Allowable Concentration (MAC) under the Guidelines for Canadian Drinking Water Quality. This increased from the original 6 identified by MHS in September 2021. This means 55% of all homes from the *'Priority DWA Project'* are under a DNC. Based on the results from the comprehensive testing, it is likely that fluoride is naturally occurring in the aquifer. The results also indicate that the presence of fluoride is geographically diverse, as it is spread out across the Nation and not confined to a specific area. Given that many residents have never had comprehensive water testing completed, the homes may have been unknowingly dealing with high fluoride prior to replacement of their wells. If we extrapolate this to the remaining 750 homes in the Nation, that would mean up to 413 homes should be under a DNC. Though as of 2021, only 6 homes were under DNC, indicating a huge discrepancy between onsite conditions and monitoring. If we look back at data results from Neegan Burnside in 2010 (per Table 19), they indicated 54% of sampled homes had issues with Fluoride; applicable to a DNC order (G. of C. I. S. Canada, 2010). From this we infer that test results were not successfully shared from the 2010 report to the local health authority. Hence, the discrepancy between results.

According to Health Canada, the optimal level of fluoride in the water is 0.7 mg/l (H. Canada, 2015b). This amount takes into consideration the fluoride that people are getting from other sources like fluoridated toothpaste or mouth rinse. The MAC for Fluoride under the Guidelines for Canadian Drinking Water Quality is 1.5 mg/l (H. Canada, 2015b). Water quality samples taken after new wells were installed had fluoride concentrations ranging from <0.10 mg/l to 5.64 mg/l (CARO Laboratory Services, 2021).

Fluoride cannot be removed from the water without water treatment. Historically, water conditioning units installed in rural homes by the Nation have failed as there is no funding to complete the required maintenance. According to Nation operators. Water conditioning or treatment systems that are not adequately maintained can become a source of bacteriological contamination and negatively impact water quality (Daschner et al., 1996). Given the lack of capital and operation and maintenance funding available, the Nation was not able to install individual treatment units on any homes that were part of the *'Priority DWA Project'*.

When we consider the lack of trust residents have in water, the opinions appear to be founded. When 55% of residents receiving chemical water testing discover an issue with Fluoride, we must consider that until

we understand the extent of issues, we cannot convince others to trust the system. This is similar to what was reported by (Lucier et al., 2020), who observed that residents were often unaware of DWA's or unsure what they meant and noted that the knowledge gap could lead to risky behaviors. (Bermedo-Carrasco et al., 2018), recommended that programs were needed to increase community confidence in water in order to increase water consumption.

Until policy change occurs regarding operation and maintenance funding, DNCs in Samson Cree Nation will continue to persist. In the intern, educating residents on how to operate and maintain individual treatment units may allow the Nation to install systems with onus being on the resident. This was identified as a priority during the one-on-one interviews (per Section 4.1.1). These systems can be fairly straightforward. Reverse osmosis for example requires the filters to be replaced every 6-12 months (ESP Water Products, 2023). The filters are sold in packs that individuals can replace by switching out the old and running the water through. With some basic training, the systems are set up to be operated and maintained by the average person (ESP Water Products, 2023). However, this may still be unfeasible for residents who cannot afford filters and other maintenance items.

## 5.3 Impact of Water Management on Drinking Water Advisories in Samson Cree Nation

Indigenous peoples have been denied the right to safe and clean water for decades. Melanie Bateman suggests that DWA's persist because of 1) No long-term sustainable solutions; 2) Reactive maintenance; and 3) Inadequate support and capacity building for operators. Arguably, water management proves to be the biggest challenge Indigenous Communities face as changes are hard fought and slow won. Successful water management depends on the implementation of suitable governance structures that integrated Indigenous philosophies into financial resources, regulation and formalization (Alcantara et al., 2020). With no plan currently in place to resolve the funding gap nor considerations for policy and regulation modification for rural water and wastewater infrastructure, solutions become band-aid fixes that ultimately make the system worse long-term (Bateman, 2022). Using decolonizing research approaches for water governance to address current water issues we can begin moving forward together (Arsenault et al., 2018).

Samson Cree Nation recognizes this fact and their role in making meaningful change. The community-led approach has allowed Samson Cree Nation to explore the issue and take the first step towards open dialog with the Federal government. When discussing impacts regarding water management, respondents from the *nîpiy* committee were asked what they thought the biggest concerns surrounding water and wastewater servicing in the Nation was, as discussed in Section 4.1.1 and shown in Figure 10. Responses indicated:

- Lack of Communication – Both at the community level between leadership and members, as well as between departments (i.e. how CCP communicates with *nîpiy*)
- Need Engagement – At the community level for residents and how the Nation offers this engagement in a meaningful way. Need to look at how the Nation passes on learnings.
- Inspiring – Getting residents to care about their systems. Many residents feel uninterested or defeated given the poor conditions. To promote education, the Nation must encourage residents to want to learn and be involved in the solution.
- Education – People don't have the opportunity to learn about their systems which impact all three concerns above.
- Funding - Don't have adequate funding for maintaining the current system.

However, to address these challenges we must all sit at the same table with the same goal. This was expressed by a Nation member:

> "*if we can continue to do things shoulder to shoulder we're going to get a lot further and that's what keeps me motivated. It is daunting, it's frustrating, it's challenging, it's overwhelming, but knowing that you've got people who are willing to walk alongside you and it's not just for an ulterior motive, it's not exploitative, but that it's a genuine, hey we care about each other let's do this together*, *that's what motivates me."*
>
> - Samson Cree Nation Member

In the previous Section, it was articulated that poor infrastructure has perpetuated DWA's in Samson Cree Nation. In this Section, we will further explore how we get to critical condition as a result of inadequate water management. Specifically, the link between DWA's and O&M, Funding and Regulation.

### 5.3.1 Operation and Maintenance Limitations in Samson Cree Nation

Rural water and wastewater systems in Indigenous communities in Canada are typically owned and operated by the community itself, with support from various levels of government, as described in Section 1.2.2. Rural areas typically rely on individual well and septic systems as they are more suitable and cost effective over larger areas than communal systems (Levangie, 2009). However, in Indigenous communities where servicing for all homes on reserve is centrally managed this becomes an extensive scope of work to operate and maintain. Without sufficient resources, Nations are unable to purchase new assets, repair existing infrastructure, build capacity or hire necessary staff to maintain the water and wastewater system (Alcantara et al., 2020). A study completed by Mccullough & Farahbakhsh, indicated that sub-standard operation and maintenance practices are directly correlated to prolonged exposure to

BWA's in Indigenous communities. Given O&M activities in Samson Cree Nation occur on an 'as-needed basis' (where issues are triaged based on level of importance), the systems have tended to degrade quickly, and operational concerns continue to rise. An operator from Samson Cree Nation indicated:

> *"We drill water wells for our homes but when it comes to boil water advisory, we don't have the funds and we don't have the staff to really look after it."*

And:

> *"The life expectancy of the way we used to install the sewer systems is anywhere from ten fifteen twenty years for sewer system and when that failed samson didn't have the money to fix the sewer system, so we just ended up temporarily putting it on the ground hoping that we'd get to it at a later date, but we never did."*
>
> - Samson Cree Nation Operator

Both of which account for the rising number of DWA's within the Nation. When operators live day-to-day with little to no financial or human capacity, they are forced to prioritize poor and critical conditions, leading to infrastructure O&M falling through the cracks. As was noted in Section 4.1.1. This has been similarly recorded in a study that noted lack of human and financial capacity as a factor constraining source water protection (R. J. Patrick, 2011).

The discrepancy across provinces and gaps in available data have made identifying solution strategies difficult (Thompson et al., 2017). Previous studies have indicated that operational changes in water service delivery can improve drinking water implementation and operation. Recommendations included 1) adopting quality assurance standards; 2) hiring back-up operators; and 3) availability of technical support (Mccullough & Farahbakhsh, 2012). Adapting this to a rural setting within Samson Cree Nation, having additional staff would alleviate capacity limitations. Furthermore, creating and implementing a Maintenance Management Plan, as specified by ISC, could provide the Nation with clear roles and responsibilities as they move towards proactive maintenance.

Hypothetically it sounds good, but in practice it becomes a challenge. Always leading us back to the question of how to accomplish this within resource-constrained environments. The need for broader funding policy change for rural system operation and maintenance continues to grow as the issues persist, as discussed in Section 4.5.2. O&M funding must be sufficient to provide adequate services to all Indigenous peoples with supplemental resources and training to grow operator capacity (Bateman, 2022). When we consider a community-led approach, how does Samson Cree Nation begin to make change

towards community autonomy, rather than relying on the Federal government in its efforts to achieve self-determination. Through this research, two potential solutions are proposed:

1) Educate residents on rural operation and maintenance

By educating residents, Samson Cree Nation can encourage members to assist in the day-to-day operation. As discussed in Table 18, this was a common observation among participants. Though centrally managed operations are still required for more technical items, many simple tasks could be handled by the resident and alleviate the strain on Public Works. A majority of residents that were spoken to through the group engagement session wanted to learn more about their system and had little to no knowledge on how it worked. By giving residents the tools, the Nation can improve infrastructure conditions while building capacity through the Nation.

2) Develop specific operation and maintenance procedure required to achieve adequate servicing

Similar to the success the Nation found in the community-led approach for addressing rural DWA's, the Nation could take the same approach for O&M. Having processes made by community, for community, can generate more holistic understandings that reflect the needs of the Nation. Though this would require investment on the Nations part to develop, having pre-meditated solutions would allow the Nation to join the conversation at a level playing field.

### 5.3.2 Comparing Regulation and the Impacts on Samson Cree Nation

Researchers have argued that the failure to provide safe drinking water is credited to inadequate financial resources, improper regulation standards, insufficient monitoring and control, lack of capacity and insufficient political will, all of which can be attributed to institutional and organizational issues (Bradford et al., 2017). These factors are often referred to by the general term "governance"—the laws, rules, regulations, policies, practices and institutions related to the use and management of water.

The Canadian constitutional framework is generally thought to be effective and well-designed in the overall Canadian context, but it creates challenges in coordinating water governance across different jurisdictions (Bradford et al., 2017). While Canada appears to comply with international water rights and has enacted domestic law to address the deficiencies of water provision in Indigenous communities, in actions government policy illustrates a gap that marginalizes the human right to water while masquerading as compliance (Schiff, 2016). Using a vague division of governing responsibilities between the Federal Government and Indigenous Nations, Canada may never fully adhere to the human right to water on reserves (Schiff, 2016). The variance in water governance often leads to fragmented decision-making around water management. When we consider the role of water management in Indigenous

communities, the responsibility is shared between Nations and the Federal Government. Under the Constitutional Act of 1897, the Federal government holds authority to make laws applying to "Indians and lands reserved for the Indians" as per Section 91(24) (Palmater, 2019). For Canada to then turn a blind eye to the living conditions on reserves shows willful ignorance. Palmater points out that the Federal Government cannot:

> *"Spend decades controlling First Nations and then claim the right to ignore some constitutional obligations because they cost too much. The Federal Government is legally responsible for infrastructure on-reserve, and its failure to uphold these legal obligations is a significant liability on its part — and a real health crisis for First Nations*" (Palmater, 2019).

When we consider how the management of Indigenous lands and resources have historically been restrictive and controlled by the Federal government, it begs the question; how can Canada ignore the very problem that many would argue they have caused?

In 2013, the Safe Drinking Water for First Nations Act was implemented to partner with First Nations communities to "develop enforceable federal regulations to ensure access to safe, clean and reliable drinking water; the effective treatment of wastewater; and the protection of sources of water on First Nation lands" (Assembly of First Nations, 2019). Many have voiced concerns around whether Nations will be funded to meet those demands, otherwise they face punitive action (Assembly of First Nations, 2019). While officials have indicated that implementation will be held off till Nations are "ready", what is the criteria for this as the funding gap continues to increase across the country. Furthermore, while the act promotes partnership the Federal government, authority over reserve jurisdiction is not conductive to true collaboration but rather a repeat of historic "consultation" that continues to fall short of adequate solutions.

With a complex federal structure between ISC, Health Canada and Environment Canada, and with federal agencies ill-equipped to provide appropriate physical, financial, technical, and organizational support necessary for the provision of safe drinking water, uncertainties, inconsistencies and failed systems are the norm for Indigenous communities (Bradford et al., 2017). The misalignment in governance, regulation and policy continues to create a grey zone of confusion. In Samson Cree Nation, various construction types and standards have been reportedly used over the years with little to no consistency in rural infrastructure, as reported by Nation staff. Not only that, but interview participants indicated that historically many contractors have taken advantage of the lack of quality inspection and control to install sub-par systems. Additionally, federally funded projects within the Nation must select the lowest bidder, this often leads to deficiencies and construction concerns in the Nation as they are forced to choose

inadequate contractors. This leads to more O&M requirements and earlier failure, all of which contributes to DWA's in the Nation. Leading back to higher costs put on the Nation to achieve standards the rest of Canada receives without question.

Within Indigenous communities there is little flexibility in infrastructure design, with the current system favoring existing models (Mirosa & Harris, 2012). This creates challenges as Nations begin to look at alternative solutions to the growing rural servicing issue. Many alternative systems such as low-pressure distribution lines or small-scale treatment systems have a higher upfront capital. Often eliminating the option in federally funded capital projects. Leaving the Nation to operate and maintain infrastructure based on priorities arising from Federal programs (Murphy et al., 2015). Not only does this impact the type of systems installed to begin with, the Federal government have historically ignored decentralized systems. As correlated in the lack of federal studies and academic articles available regarding the decentralized water and wastewater system. Leaving the Nation with one choice during construction with no support for the implications that arise from choosing individual wells and septic systems. We also cannot simply abandon rural systems as recommended by ISC, as this is a way of life for Indigenous people and the way they have lived long before we arrived (Boyd, 2011).

Given the enormity of scope within a decentralized system, it may be beneficial for the Nation to consider alternative service methods in rural areas that still respect the traditional way of living. Though not "ideal" within the current funding models, it may be easier to implement within existing regulation, rather than waiting on policy charges for O&M in rural water and wastewater servicing.

### 5.3.3 Evaluation of Funding Models and the Impacts on Samson Cree Nation

Funding is important for water and wastewater systems in Indigenous communities in Canada for a number of reasons. First and foremost, access to clean water and proper wastewater management is essential for the health and wellbeing of community members. Without adequate funding, these systems may not be able to operate properly, leading to potentially serious health consequences. Additionally, funding is necessary to ensure that these systems are able to be maintained and updated over time, as well as to expand them to meet the needs of growing communities. Without sufficient funding, Indigenous communities are unable to access the same level of water and wastewater services as non-Indigenous communities, creating inequities that disproportionately affect Indigenous people (R. J. Patrick, 2011). Funding discrepancies can be seen at all stages of infrastructure lifespan, as discussed below.

#### *5.3.3.1 Design and Construction*

Decentralized systems are more costly to install than the standard budgets provided by ISC for home servicing. For example, based on the 2021 On-Reserve Housing Immediate Needs Fund, Zone 1 First Nations are provided with $30,000/unit for new lot servicing (Urban Systems Ltd., 2022).

In general, these funding amounts are structured to support housing developments within a townsite where communities can pull services from central mains. In Samson Cree Nation, the average quotes to install individual water and sewer systems were $30k and $25k, respectively. Just these two services alone are almost double of the standard allocation for servicing a new home and this doesn't include site grading, natural gas, power or communications. Installation of a wastewater treatment system like a mound or septic field instead of an open discharge out would increase capital costs even further and be more expensive to maintain.

Limiting the Nation from conception increases the likelihood of poor-quality material, and inadequate construction. Thus, contributing to poor infrastructure and higher possibility of water quality concerns.

#### *5.3.3.2 Operation and Maintenance*

No annual funding is currently available from ISC for operation and maintenance of decentralized systems (Government of Canada; Indigenous Services, 2022). Even if we consider implementing user fees to offset the cost, as suggested by ISC, the potential revenue is limited by the local economy (Alcantara et al., 2020). With Indigenous people living on reserve over 3 times more likely to be unemployed than their non-Indigenous counterparts, the user fees are unlikely to be effective as many residents may not have the necessary income to pay a service (Alcantara et al., 2020; *Employment as a Social Determinant of First Nations, Inuit and Métis Health*, n.d.). As a result, Indigenous communities have no budget for capacity building or preventative maintenance on these systems. Due to lack of funding, the entire maintenance strategy for the Nation's housing stock is reactionary and triaged to address significant health and safety concerns first. This often means that nothing is done for the individual water and wastewater systems unless they fail. This was similarly communicated by Nation operators.

Not only does funding inadequacies create infrastructure deficiencies, but the exclusion of individual water and wastewater systems from funding models can result in high-risk Nations being passed over for upgrades in favor of centralized systems (Swain et al., 2006). The *Report of the Expert Panel on Safe Drinking Water for First Nations* indicate:

> "*With limited resources, the upgrading of a high-risk community plant elsewhere in the region might take precedence over building a plant that might lower the (largely undocumented) risks from individual systems; and neither band councils nor members themselves have the resources, in many cases, to ensure the adequacy of individual systems*."

Within Samson Cree Nation, it is clear that the funding currently provided is not adequate to support operation and maintenance in rural areas of the Nation. During interviews 100% of participants saw funding as a roadblock to future projects addressing DWA's in the Nation.

#### *5.3.3.3 The Funding Gap*

There are many areas where funding and capacity have limited the community and contributed to rural DWA's as a result. Though it must be noted that funding change will not address the problem alone. Many studies have commented on the significant dollar amounts contributed to Indigenous communities over the last decade, but pointed out how efforts have arguably fallen short of expectations across Canada (Hanrahan et al., 2015; Mirosa & Harris, 2012; T. 1991- Vogel, 2019). The Auditor General comments that "despite the hundreds of millions in federal funds invested, a significant proportion of drinking water systems in First Nations communities continue to deliver drinking water whose quality or safety is at risk" (Swain et al., 2006). As a result, there is a lack of confidence between Nations and the Federal government and many see not only money required to address the issues, but trust built between the community and the government (Lucier et al., 2020).To increase engagement, financial autonomy within management must be considered (Black & McBean, 2017a). To ensure access to clean drinking water for all Indigenous people living on reserve the current gaps in policy must be addressed in conjunction with funding models in consultation with Indigenous communities.

Addressing the gap must begin with acknowledging and understanding the gap. Minimal research has been completed on decentralized systems and other than the Federal reporting in 2011, little to no data is available when looking at systems across Canada. Including decentralized systems in the E-ACRS assessment or providing separate funding programs to verify and catalog each Nations unique system would provide Nations the knowledge to make decisions themselves. The Extended Asset Condition Reporting System Program (E-ACRS) provides inspections for all ISC funded infrastructure every three (3) years. This includes a review of general condition, O&M processes, deficiencies, estimated life remaining and estimated costs for major and minor components (G. of C. I. S. Canada, 2022). This first step is required before suitable long-term solutions can be found and must be made available to all Nations, not just those in a position to push forward without support.

Within the discussion with *nîpiy* members, it was agreed that the Nation is growing and with this Samson Cree Nation needs to look at new ways to supply services. The question became how does Samson Cree Nation move forward, especially in light of existing funding structures? As one of four Nations in Maskwacîs, they are a part of a major system and it was suggested that the Nation should also look outside their boundaries to work together and make decisions that benefit the community. Having a larger team with greater capacity can potentially increase the scope of achievable outcomes. As seen with MHS, the partnership and collaboration between Nations created a nation directed health institute that looks after the best interest of community members.

## 5.4 Evaluating Community Impact

The community impact of DWA's it arguably the most important piece when we consider the long-standing persistence. Water quality issues are not solely ecological issues from a First Nation's perspective (Baird et al., 2015). Long term DWA's can have a significant impact to an individual's financial, physical, psychological, social and spiritual health, as well as a significant time burden (Lucier et al., 2020). In some cases, the advisories may cause feelings of anxiety or stress, particularly if the individual is unsure of the quality of the water they are drinking. This can lead to a lack of trust in the safety of the water supply, which can affect an individual's social interactions and relationships (Lucier et al., 2020). Additionally, if the advisories are in place for an extended period of time, they can lead to a sense of isolation and a disruption in an individual's daily routine. Residents without running water or sufficient sanitary systems reported higher levels of depression and distress than those with adequate servicing (O'Gorman, 2021). When asked to think about what comes to mind when considering rural water and wastewater systems in Samson Cree Nation, the *nîpiy* committee responses surrounded three main themes (as shown in Figure 10 and Figure 11):

- Concerns - Ideas surrounding unsafe, unhealthy, uncertain – pertaining to unhappiness with the current structure.
- Cultural Connection - There was also discussion around what water means to individuals with water being a life-giving element that sustains and improves life – understanding the importance of water in Samson Cree Nation and the cultural connection that cannot be forgotten when looking through a technical lens.
- Right – The understanding that water is a basic human right and can be hard to live without

We can see the connection between these themes and the consequences of BWA's, as one resident in Samson Cree Nation reflected:

*"For a long time, I drank water in the city or away from my house. Away from Samson, because I got sick from beaver fever. And that was from drinking contaminated water. For a long time, I was afraid to drink any kind of water."*

- Samson Cree Nation Resident

Public perception regarding water in Samson Cree Nation is generally negative. The feeling comes from widespread distrust in the system and inaction due to inconsistencies. People in Samson Cree Nation have "gotten use to poor water quality" as one responded noted during the group engagement session. There is also the general feeling of the "Nation will take care of it." When we consider the number of residents unknowingly living with DNC orders, the beliefs appear to be partially founded. A greater understanding of the extend and severity of drinking water quality concerns within the Nation must be a top priority before the Nation can fully re-build confidence in residents. Having this information provides greater power to community to be informed and leadership when making decisions.

Looking at this from a Nation level, the *nîpiy* committee was asked how to rebuild confidence in the community regarding rural water and wastewater systems, *nîpiy* members suggested:

- Host more Community Engagement Sessions – present the direction the team is taking
- Share the Strategic Community Plan with the larger community so people understand the Nation's vision – highlighting that water was a part of the community desires section and that Nation staff listened and reflected these comments in the strategic plan
- Share *nîpiy* progress and purpose

To visually represent the community impact of DWA's the group engagement sessions were visually recorded. Figure 10 and Figure 11 below display the results from the group session with *nîpiy* committee members and Samson Cree Nation members, respectively. These figures highlight the perspective and understanding the research has aimed to portray.

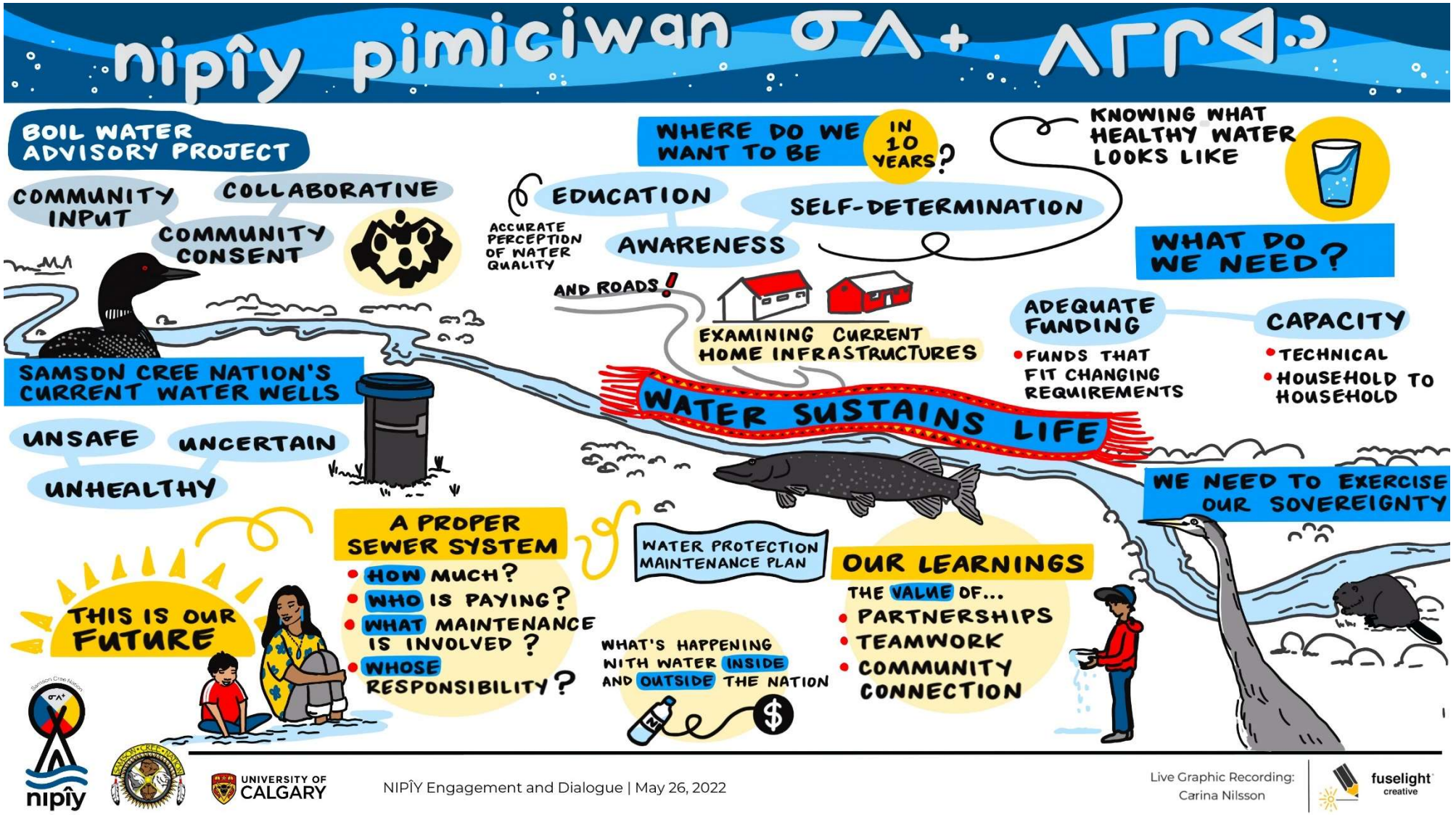


Figure 10: Visual Recordings from nîpiy Group Engagement Session

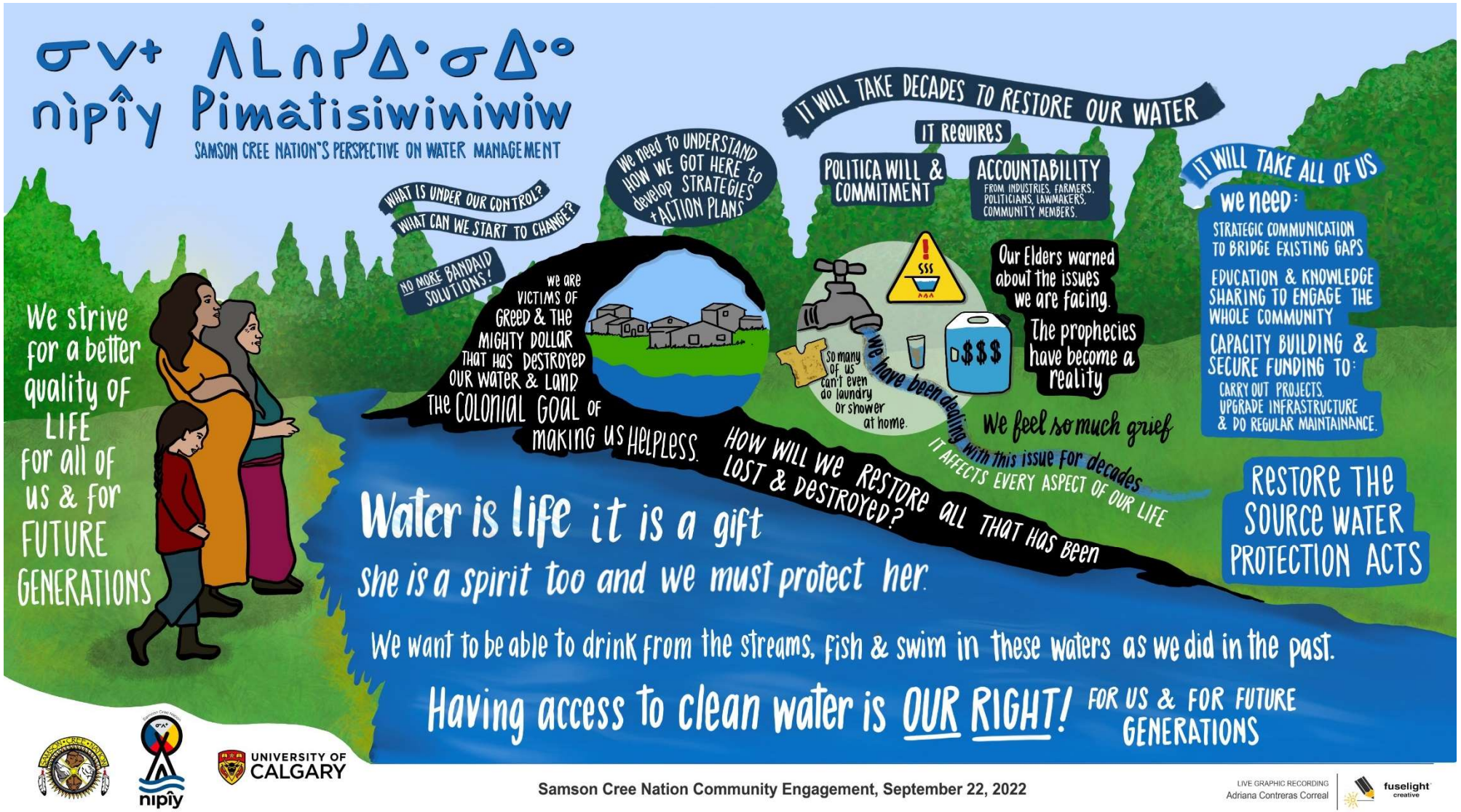


Figure 11: Visual Recordings from Resident Group Engagement Session

### 5.4.1 Water Education and Awareness

Education and awareness are a common theme when identifying next steps. The desire for education and awareness of water-related issues in Indigenous communities in Canada is driven by a number of factors. First, access to clean, safe water is essential for the health and wellbeing of individuals and communities. In many Indigenous communities in Canada, access to clean water has historically been limited, which has led to a range of health issues and challenges (Arsenault et al., 2018; Boyd, 2011). As a result, education and awareness about the importance of clean water, and how to protect and maintain it, is crucial for the health and wellbeing of these communities.

Additionally, water-related issues are often closely tied to broader issues of environmental justice and the rights of Indigenous communities (Ellis, 2005). Many Indigenous communities in Canada have a deep spiritual connection to the land and water, and protecting these natural resources is an important part of their culture and identity (Bradford et al., 2017). As a result, education and awareness about water-related issues can help to empower Indigenous communities to protect their natural resources and defend their rights. Recommendations from the interviews and group engagement sessions to improve and encourage education included:

1. Water Protection Maintenance Plan;
2. Education Programs in the schools to talk about what's happening with the water in the Nation;
3. Radio segments with Nation operators where residents can call in and ask questions; and
4. Videos for Self-Troubleshooting and Education.

Based on conversations with residents, it was clear that there was minimal knowledge on how to get their water tested, how to operate their water and wastewater systems and what to do if an issue arises. This lack of awareness regarding the status of their water leads to residents either using unhealthy water or assuming a BWA status, as is a common belief on reserve (Lucier et al., 2020). Relevant resources weren’t readily accessible to home occupants to learn about these systems. Looking at the water testing program run by MHS, findings indicated that residents were unaware of how often their well should be tested and that they had the option for chemical testing to understand water quality issues beyond bacteriological contamination.

## 5.5 Engineering Significance

Within the engineering community, we hold in esteem the representation of accurate and thoughtful scientific data. Mistrust between Indigenous communities and researchers has long existed due to misuse of data, research completed without informed and prior consent, and disregard for cultural resources (Kovach, 2021). We as researcher are not immune to or removed from the need for reconciliation (Wong

et al., 2020). As supported within the United Nation Declaration for the Rights of Indigenous Peoples (UNDRIP), we must ensure continuous efforts are made to work towards reconciliation and uphold the human rights of Indigenous peoples (United Nations, 2007). Wong et al, identify 10 calls to action to natural scientists working in Canada to recognize and respect their responsibility towards reconciliation.

### 5.5.1 Calls to Action

Within this research, 7 calls to action were relevant and influenced the approach and submission of the findings herein. Each call will be defined and explained below (Wong et al., 2020).

#### *5.5.1.1 Call 1: Understand the socio-political landscape around the research sites*

Understanding was given within Samson Cree Nation to acknowledge jurisdiction over the research and following ethical guidelines as defined by the Nation. Collaboration with *nîpiy* allowed the research to genuinely engage with the Nation and meet the priorities of the community.

#### *5.5.1.2 Call 2: Recognize that generating knowledge about the land is a goal shared with Indigenous peoples and to seek meaningful relationships and possible collaboration for better outcomes for all involved*

Ensuring a mutually beneficial relationship helped to ensure honest and meaningful research. As indicated by Wong et al. “professional credentials are often not valued as much as humility, honesty, and a willingness to listen, adapt, and respond”. This research had to acknowledge that as researchers we do not have the experience nor perspective of community. Being out in the Nation for events, talking with residents and joining the *nîpiy* committee was important to gain perception. Which can be used to refine research questions, methods, outcomes, and deliverables such that the community is better served and respected (Wong et al., 2020).

#### *5.5.1.3 Call 3: Enable knowledge sharing and knowledge co-production*

As a collaborative project, learnings from the community-led approach were adapted into the research and supported through the Two-Eyed seeing methodology. This included creating time and space to listen to community and make participation accessible. All information and data obtained was shared back with the *nîpiy* committee in accordance with OCAP. Opportunities for educational sessions regarding the research and the perspective of DWA’s in the Nation is being explored to continue building capacity within the Nation beyond this project. Time must be given for community to review and understand the research for appropriate knowledge sharing.

#### *5.5.1.4 Call 5: Provide meaningful opportunities for Indigenous community members, particularly youth, to experience and participate in science*

Though youth was not specifically involved through this process, work with the *nîpiy* committee is ongoing to bring back research findings and education to youth within the community. As researchers it is our responsibility to respect the calls to action and re-evaluate future processes to bring more engagement opportunities to youth.

#### *5.5.1.5 Call 7: Natural scientists and their students to take a course on Indigenous history and rights*

Prior to the formal start of this research, I took a class in the ethics of Indigenous research offered at the University of Calgary to build understanding and awareness to Indigenous knowledge and methodology.

#### *5.5.1.6 Call 8: Funding bodies to change approaches to funding*

Though not specifically impacted by the research, this project provided testimony to the issues faced by Samson Cree Nation as a result of DWA's. The Nation can use this when advocating for change within funding and policy. The current Federal landscape is resistant to change and has been criticized for not listening to Indigenous people without "proof". The oral histories and accounts of long-standing issues are unfortunately ignored in current practice and while this begs to questions Canada's willful ignorance of Indigenous issues, the project can help Samson Cree Nation articulate the problem in our current political landscape.

#### *5.5.1.7 Call 10: All natural scientists and postsecondary research institutions to develop a new vision for conducting natural science: fundamentally mainstreaming reconciliation in all aspects of the scientific endeavor, from formulation to completion*

Influence from liliology and the Two-Eyed seeing methodology contributed to bringing this research away from traditional colonialized research approaches. In conjunction with the community-led approach, this project aimed to respect various ideologies to find long-term solutions to water concerns across Canada. I acknowledge my role within reconciliation and hope to continue advocating for change in the context of research and engineering.

# 6.0 Summary and Conclusions

Findings of this thesis are discussed in the section herein. A summary of next steps to improve the community-led approach and further address DWA's in Samson Cree Nation are suggested.

## 6.1 Community-led Approach

The community lead approach to address rural DWA's in Samson Cree Nation was initiated and implemented by the *nîpiy* committee. The process included defining key objections, prioritization review and engagement with multiple departments, and executing the project by prioritizing capacity building within existing Nation staff. Collaboration between Nation staff, MHS, Urban Systems ltd. and the University of Calgary allowed the Nation to articulate and explore the issue while taking the lead through planning and execution. Overall, the process worked well for Samson Cree Nation, but other Nations need to understand the long-term implementation and capacity building required within the Nation and with Federal agencies to get to a point of execution. A major success within the *'Priority DWA Project'* was the collaboration and trust built between multiple platforms that created a respectful space to share ideas where everyone is working towards the same goal. A major part of this was having a Nation champion who can lead and advocate for the project at the community level.

Looking at how this can be recreated by SCN in the future and by other Nations looking to address community concerns, some lessons learned from the process include:

- Further education and awareness activities need to be built in to educate the community about drinking water concerns, operation and maintenance practices and types of servicing
- Additional communication with residents/ community members before and after project construction to minimize risk for miscommunication
- Share the community plan and vision with members to allow feedback – specifically the goals for the *nîpiy* committee to build capacity from the ground up

## 6.2 Water and Wastewater Servicing Infrastructure

Issues with rural water and wastewater infrastructure has increased over the last few decades in Samson Cree Nation. As a result, the Nation is seeing an increase in reactive maintenance, degrading water quality and higher risk to human health. The most significant factors found to influence the concern to drinking water quality on the Nation are:

- Aging Infrastructure – 91% of wells systems and a majority of septic systems are beyond expected life increasing the likelihood for failure and surface contamination. 27% of well systems and 70% of septic systems were in poor to critical condition.

- Inadequate wastewater servicing – The conversion of failed septic systems to shoot-outs creates a major risk to public health and the surrounding environment due to the presence of septic waste close to the home and/or well head. 70% of inspected homes had a shoot-out and 85% of homes have effluent discharge closer than allowable standards
- Unknown Water Quality Concerns – Comprehensive water quality analysis is not completed routinely within the Nation. With Fluoride being a risk to upwards of 50% of homes on the Nation a significant risk arises in regards to water quality.

To improve water and wastewater infrastructure, I would recommend:

1. Completing comprehensive water quality testing across the Nation – This would provide the Nation a better understanding around the extent of fluoride and the level of effort required to manage water quality concerns.
2. Complete a rural servicing feasibility study – This would allow the Nation to identify viable solutions to water and wastewater management at the community level.
3. Create a replacement forecast plan – Identify and evaluate the cost required to replace aging infrastructure while keeping in mind the long-term servicing strategy. This would allow the Nation to identify capital requirements for funding and build capacity within the Nation for future infrastructure management.

A key factor is that the technical issues must be considered with water governance management to create long-term solutions rather than band aid fixes.

## 6.3 Water Management

Water management within the Nation falls under the jurisdiction of Housing and Public Works, with the *nîpiy* committee providing support for capital projects and education. A prevalent roadblock to creating long-term solutions for water and wastewater servicing in Samson Cree Nation is the limitations of operation and maintenance. 100% of interviewed participants commented on the lack of O&M. With no formal allocations, the process is reactive and triaged based on first come first serve. To reduce the gap, the Nation can begin with Nation-led solutions. This includes:

1. Educate residents on rural operation and maintenance
2. Develop specific operation and maintenance procedure at the Nation level

However, adjustments must be made to funding policies at the Federal level to ensure safe and reliable servicing to all Canadians. The existing framework is rigid and limiting to Nations, specifically those that have minimal economic activity, low capacity and are located in remote areas. The funding gap exists

from planning and design through to operation and maintenance. In Samson Cree Nation, this gap has perpetuated the issue of poor-quality systems with frequent failures. To begin addressing these issues, we would need to consider:

- Defining the existing gap – This includes understanding quantity, condition, operation and maintenance at a provincial or federal level
- Creating collaboration opportunities between the Federal government and Indigenous leadership to modify policy that reflects the unique needs and challenges of Indigenous communities. This must include discussions around:
    a. Capital Funding
    b. Operation and Maintenance Funding
    c. Water and Wastewater Regulation (construction and O&M)
- Incorporating communities into implementation

Advocating for policy change and sharing Samson Cree Nation's experience is beneficial to highlight the gaps and further the ongoing conversation. For successful water governance, it is essential to have sufficient financial resources, clear regulations for delivery and management of water and wastewater servicing, and formalized structures for processes and decision-making related to community assets. The *'Priority DWA Project'* has demonstrated the success of Nation involvement and how advocacy at the community level is vital to finding meaningful solutions.

## 6.4 Community Impact

Throughout this research it was evident that the community has suffered as a result of inadequate water and wastewater servicing. Impacts included physical, mental, financial, and spiritual wellbeing. Not only do members have to worry about everyday activities such as cooking or bathing, but a long-standing mistrust has divided individuals from their cultural routes. Addressing these concerns is a long-term process that begins with addressing the infrastructure issues and then rebuilding confidence.

To increase awareness and re-build trust within the community, I recommend holding education sessions for community that focus on:

1. What is a DWA – Topics should include:
    - Types of DWA's
    - What different DWA's mean
    - Water usage while on DWA, such as:
        - Hygiene (brushing teeth, bathing, laundry)
        - Food preparation (cooking, washing)
        - Usage of bottle filters
2. Water Quality Testing Procedure and Results –Topics should include:
    - Types of testing available
    - Meaning of test results
    - Frequency of testing
    - How to request testing in the future
3. Rural Water and Wastewater Servicing O&M – Topics should include:
    - Types of rural servicing
    - How each system works
    - How to operate each system
    - Basic maintenance and troubleshooting residents can perform
    - How to handle arising issues
4. The *nîpiy* Committee's Approach to Water – Topics should include:
    - What is the *nîpiy* committee?
    - What does the *nîpiy* committee do?
    - What is the vision for water in the Nation
    - How can individuals get involved with water management?

By bringing awareness to water related issues and management within the Nation, Samson Cree Nation can begin to re-evaluate the relationship the community has with water.

## 6.5 Future Work

To expand upon the findings herein, future research opportunities could include:

- Continuing onsite inspection of rural servicing in Samson Cree Nation. The expanded data collection would allow the Nation to further articulate water and wastewater servicing concerns and potentially identify other environmental concerns that pose a risk to the water quality.
- Continue comprehensive water quality testing to identify other contaminants that pose a risk to the water quality. This could include the incidence of disinfection byproducts due to shock chlorination or the extent of fluoride, in addition to other contaminants of concern. A community-based approach could be used, where community can voice concerns and develop a community-led identification of water contaminants of concern.
- Define specific costs for current and desired operation and maintenance activities within Samson Cree Nation and compare them to ISC's funding formulas to further define the funding gap. This could lead to innovative research in community-relevant costing for water and wastewater servicing.
- Review design, construction, operation and maintenance activities at the Nation level to identify how to move towards pro-active maintenance. In collaboration with Nation operators and staff, the research could look to support a community-led approach by defining gaps and opportunities within the Nations organizational structure and processes.
- Work with the *nîpiy* committee to develop and create innovative education tools and programs that reflect the Nations vision for water in an accessible format. This could include engagement and educational sessions to connect all levels of community.
- Develop a framework for, and complete a rural servicing feasibility study that looks at existing and future servicing options within the Nation. Uniquely, this could include looking at the technical, financial and social implications of servicing types as Samson Cree Nation looks towards long-term, sustainable solutions.

It is important that research continues to involve residents through interviews, education sessions or outreach programs and both quantitative and qualitative research methods. All potential projects must prioritize building capacity and awareness throughout the community to ensure everyone is working towards the same objectives.

Looking ahead, I hope to continue my own contribution to *nîpiy* and Samson Cree Nation. Whether as a researcher or supporter, there are many opportunities for future collaboration. Key areas include: 1) advocating for policy and regulation change regarding water and wastewater management in Indigenous

communities; 2) creating documents to communicate my research and findings within Samson Cree Nation in order to increase awareness and education; and 3) highlighting Samson Cree Nation's role as a single piece to a much larger issue facing Indigenous Communities across the country. The residents and staff of Samson Cree Nation have gotten the ball rolling on a long-standing issue. By bringing the conversation forward and finding opportunities to empower other communities, they have initiated dialog with relevant experience. Ultimately, I hope this research and my future work can help, even minutely, bring about change to ensure that everyone has access to safe and reliable water and wastewater servicing.

# 7.0 References

*About Us | Maskwacis Health*. (n.d.). Retrieved December 3, 2022, from https://www.mymhs.ca/about-us/

AFN, A. O. F. N. E. S. U. (2005). *OVERVIEW OF ENVIRONMENTAL ISSUES FACING FIRST NATIONS: CONTEXT FOR PARTICIPATION IN NUCLEAR FUEL WASTE MANAGEMENT ISSUES*. https://www.nwmo.ca/en/~/media/Site/Files/PDFs/2015/11/04/17/30/406_11-AFN-10.ashx

Agrawal, A. (1995). Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change*, *26*(3), 413–439. https://doi.org/10.1111/j.1467-7660.1995.tb00560.x

*Alberta Private Sewage Systems Standard of Practice*. (2021). Safety Codes Council. https://ebs.safetycodes.ab.ca/documents/webdocs/PI/PSS_SOP_2021-web6.pdf

Alcantara, C., Longboat, S., & Vanhooren, S. (2020). Improving First Nations water security through governance. *Canadian Public Administration*, *63*(2), 155–176. https://doi.org/10.1111/capa.12363

Anderson, K., Clow, B., & Haworth-Brockman, M. (2013). Carriers of water: Aboriginal women's experiences, relationships, and reflections. *Journal of Cleaner Production*, *60*, 11–17. https://doi.org/10.1016/j.jclepro.2011.10.023

Andorra, Angola, Barbuda, A. and, Armenia, Bahamas, Bhutan, Herzegovina, B. and, Bulgaria, Faso, B., Verde, C., Chile, Colombia, Congo, Rica, C., Croatia, Cyprus, Czechia, Djibouti, Republic, D., … Vanuatu. (2022). *The human right to a clean, healthy and sustainable environment: Draft resolution /: Andorra, Angola, Antigua and Barbuda, Armenia, Bahamas, Bhutan, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Cabo Verde, Chile, Colombia, Congo, Costa Rica, Croatia, Cyprus, Czechia, Djibouti, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Finland, France, Georgia, Germany, Greece, Guatemala, Honduras, Jordan, Kenya, Latvia, Lebanon, Luxembourg, Maldives, Mali, Malta, Marshall Islands, Micronesia (Federated States*

*of), Monaco, Montenegro, Morocco, Netherlands, Nigeria, North Macedonia, Palau, Panama, Peru, Portugal, Qatar, Republic of Korea, Romania, Samoa, Senegal, Slovakia, Slovenia, Spain, Switzerland, Togo, Ukraine, Uruguay and Vanuatu*. https://digitallibrary.un.org/record/3982508

Archibald, J.-A. (2008). *Indigenous Storywork: Educating the Heart, Mind, Body, and Spirit*. UBC Press.

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Arsenault, R., Diver, S., McGregor, D., Witham, A., & Bourassa, C. (2018). Shifting the Framework of Canadian Water Governance through Indigenous Research Methods: Acknowledging the Past with an Eye on the Future. *Water*, *10*(1), 1. https://doi.org/10.3390/w10010049

Assembly of First Nations. (2019). Water. *Assembly of First Nations*. https://www.afn.ca/policy-sectors/housing-infrastructure-water-emergency-services/water/

Baijius, W., & Patrick, R. J. (2019). "We Don't Drink the Water Here": The Reproduction of Undrinkable Water for First Nations in Canada. *Water*, *11*(5), 5. https://doi.org/10.3390/w11051079

Baird, J., Plummer, R., Dupont, D., & Carter, B. (2015). Perceptions of Water Quality in First Nations Communities: Exploring the Role of Context. *Nature and Culture*, *10*(2), 225–249. https://doi.org/10.3167/nc.2015.100205

Barnes, G. B. (2021a). *Data Analysis*.

Barnes, G. B. (2021b). *Method of Data Collection*.

Barry. (n.d.). *First Nations Drinking Water Class Action*. First Nations Drinking Water. Retrieved December 5, 2022, from https://firstnationsdrinkingwater.ca/

Baskin, C. (2005). STORYTELLING CIRCLES: Reflections of Aboriginal Protocols in Research. *Canadian Social Work Review / Revue Canadienne de Service Social*, *22*(2), 171–187.

Bateman, M. (2022). *EMPTY COMMITMENTS? THE INDIGENOUS WATER CRISIS IN CANADA AND THE COMMITMENT TO ENDING ALL DRINKING WATER ADVISORIES ON FIRST NATION RESERVES* [Master of International Development]. Dalhousie University.

Bermedo-Carrasco, S., Bharadwaj, L., & Waldner, C. L. (2018). Factors associated with drinking and being satisfied with tap water in Indigenous communities in Saskatchewan, Canada. *International Journal of Circumpolar Health*, *77*(1), 1466605. https://doi.org/10.1080/22423982.2018.1466605

Bio-Sol. (2022). *The impact of septic system pollution on water*. https://www.bio-sol.ca/blog/en/the-impact-of-septic-system-pollution-on-water/

Black, K., & McBean, E. (2017a). *Analysis of challenges and opportunities to meaningful Indigenous engagement in sustainable water and wastewater management | Water Policy | IWA Publishing*. https://iwaponline.com/wp/article-abstract/19/4/709/20584/Analysis-of-challenges-and-opportunities-to

Black, K., & McBean, E. (2017b). Indigenous water, Indigenous voice – a national water strategy for Canada's Indigenous communities. *Canadian Water Resources Journal / Revue Canadienne Des Ressources Hydriques*, *42*(3), 248–257. https://doi.org/10.1080/07011784.2017.1333044

Boyd, D. R. (2011). No Taps, No Toilets: First Nations and the Constitutional Right to Water in Canada. *McGill Law Journal*, *57:1*. https://lawjournal.mcgill.ca/article/no-taps-no-toilets-first-nations-and-the-constitutional-right-to-water-in-canada/

Bradford, L. E. A., Ovsenek, N., & Bharadwaj, L. A. (2017). Indigenizing Water Governance in Canada. In S. Renzetti & D. P. Dupont (Eds.), *Water Policy and Governance in Canada* (pp. 269–298). Springer International Publishing. https://doi.org/10.1007/978-3-319-42806-2_15

Cameron, P., Cameron, G., Cameron, A., Fuller, A., Bremner-Williamson, E., Anderson, R., Conway, S., & Tremblay, S. (2009). *A Homeowner's Guide to Septic Systems*. Waste Water Nova Scotia Society & Nova Scotia Environment. https://novascotia.ca/nse/wastewater/docs/Homeowners.Guide.to.Septic.Systems.pdf

Canada, G. of C. (2022). *Indigenous peoples and communities*. https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303

Canada, G. of C. I. S. (2002). *Assessment Study of Water and Wastwater Systems and Associated Water Management Practices—Samson Cree Nation*. Neegan Burnside.

Canada, G. of C. I. S. (2010). *National Assessment of First Nations Water and Wastewater Systems-Samson Cree Nation*. Department of Indian Affairs and Northern Development.

Canada;, G. of C. I. S. (2010, September 9). *Protocol for Decentralised Water and Wastewater Systems in First Nations Communities* [Standard]. https://www.sac-isc.gc.ca/eng/1100100034991/1533666283450

Canada, G. of C. I. S. (2011a, August 1). *Water and Wastewater Policy and Level of Services Standards (Corporate Manual System)* [Policy]. https://www.isc-sac.gc.ca/eng/1312228309105/1533729544122

Canada, G. of C. I. S. (2011b, August 15). *National Assessment of First Nations Water and Wastewater Systems – 2009-2011* [Fact sheet]. https://www.sac-isc.gc.ca/eng/1313426883501/1533821951118

Canada, G. of C. I. S. (2011c, September 8). *National Assessment of First Nations Water and Wastewater Systems—Alberta Regional Roll-Up Report* [Assessment]. https://www.sac-isc.gc.ca/eng/1315502688073/1533826927190

Canada, G. of C. I. S. (2018a). *Investing in Indigenous community infrastructure* [Administrative page; resource list]. https://www.sac-isc.gc.ca/eng/1526995988708/1526996020578#water

Canada, G. of C. I. S. (2018b, September 28). *About drinking water advisories* [Notice]. https://www.sac-isc.gc.ca/eng/1538160229321/1538160276874

Canada, G. of C. I. S. (2020a, March 10). *Wastewater in First Nations communities* [Organizational description]. https://www.sac-isc.gc.ca/eng/1583865272500/1583865325391

Canada, G. of C. I. S. (2020b, March 17). *Septic tank and leaching bed safety* [Resource list]. https://www.sac-isc.gc.ca/eng/1584477135878/1584477188866

Canada, G. of C. I. S. (2021, February 26). *Achieving clean drinking water in First Nations communities* [Administrative page; home page; interactive resource; resource list]. https://www.sac-isc.gc.ca/eng/1614385724108/1614385746844

Canada, G. of C. I. S. (2022, May 16). *Extended Asset Condition Reporting System program* [Guide]. https://www.sac-isc.gc.ca/eng/1652711786079/1652711831265

Canada, H. (2015a, June 5). *Guidance for Issuing and Rescinding Boil Water Advisories in Canadian Drinking Water Supplies* [Guidance]. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-issuing-rescinding-boil-water-advisories-canadian-drinking-water-supplies.html

Canada, H. (2015b, June 5). *Page 2: Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Fluoride* [Research;guidance]. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-fluoride/page-2-guidelines-canadian-drinking-water-quality-guideline-technical-document-fluoride.html

Canada, H. (2019, April 1). *Be Well Aware: Test your well water* [Education and awareness]. https://www.canada.ca/en/health-canada/services/publications/healthy-living/water-talk-test-well.html

CARO Laboratory Services. (2021). *Samson Cree Nation—Chemical Water Testing Results*.

CDC. (2022, July 18). *Disinfection By-products (DBPs) Factsheet | National Biomonitoring Program | CDC*. https://www.cdc.gov/biomonitoring/THM-DBP_FactSheet.html

Daley, K., Castleden, H., Jamieson, R., Furgal, C., & Ell, L. (2015). Water systems, sanitation, and public health risks in remote communities: Inuit resident perspectives from the Canadian Arctic. *Social Science & Medicine*, *135*, 124–132. https://doi.org/10.1016/j.socscimed.2015.04.017

Daschner, F. D., Rüden, H., Simon, R., & Clotten, J. (1996). Microbiological contamination of drinking water in a commercial household water filter system. *European Journal of Clinical Microbiology & Infectious Diseases: Official Publication of the European Society of Clinical Microbiology*, *15*(3), 233–237. https://doi.org/10.1007/BF01591360

Dunn, G., Bakker, K., & Harris, L. (2014). Drinking Water Quality Guidelines across Canadian provinces and territories: Jurisdictional variation in the context of decentralized water governance.

*International Journal of Environmental Research and Public Health*, *11*(5), 4634–4651. https://doi.org/10.3390/ijerph110504634

Dziegielewski, B., & Bik, T. (2004). Technical Assistance Needs and Research Priorities for Small Community Water Systems. *Journal of Contemporary Water Research & Education*, *128*(1), 13–20. https://doi.org/10.1111/j.1936-704X.2004.mp128001003.x

Eggertson, L. (2006). Safe drinking water standards for First Nations communities. *CMAJ*, *174*(9), 1248–1248. https://doi.org/10.1503/cmaj.060399

Ellis, S. C. (2005). Meaningful Consideration? A Review of Traditional Knowledge in Environmental Decision Making. *Arctic*, *58*(1), 66–77.

*Employment as a social determinant of First Nations, Inuit and Métis health*. (n.d.).

Environmental Public Health, & Alberta Health Services. (2021). *Flooded Private Water Supply: Shock chlorinating private wells*. https://myhealth.alberta.ca/Alberta/Pages/shock-chlorination-private-water-wells.aspx

ESP Water Products. (2023). *How to Maintain a Reverse Osmosis System*. https://ca-espwaterproducts.glopalstore.com/reverse-osmosis-maintenance/?utm_campaign=oth_r&utm_source=https://www.espwaterproducts.com&utm_medium=wi_proxy&utm_content=en_US&utm_term=c

Finn, S. (2010). *The Multiple Barrier Approach to Safe Drinking Water for First Nations Communities: A Case Study* [Master of Environmental Studies in Environment and Resource Studies]. University of Waterloo.

*First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge*. (n.d.). Retrieved December 3, 2022, from https://www.afn.ca/uploads/files/fn_ethics_guide_on_research_and_atk.pdf

Government of Alberta. (2019). *Shock Chlorinating Your Well*. Government of Alberta.

Government of Canada; Indigenous Services. (2022). *Operation and Maintenance – ISC Level of Service Standard, Corporate Manual System*. Indigenous Services Canada.

Government of Canada, O. of the A. G. of C. (2021, February 25). *Report 3—Access to Safe Drinking Water in First Nations Communities—Indigenous Services Canada*. https://www.oag-bvg.gc.ca/internet/English/parl_oag_202102_03_e_43749.html

Government of Canada, P. S. and P. C. (2011, January). *Alberta regional roll-up report - final / Neegan Burnside Ltd. ; Department of Indian and Northern Affairs Canada.: R6-1/2-2011E-PDF - Government of Canada Publications - Canada.ca*. https://publications.gc.ca/site/eng/9.812604/publication.html

Government of Canada, P. S. and P. C. (2014). *Canada's groundwater resources / compiled and edited by Alfonso Rivera.: M184-8/2014E-PDF - Government of Canada Publications - Canada.ca*. https://publications.gc.ca/site/eng/9.854795/publication.html

Government of Manitoba. (2003). *Onsite Wastewater Management Systems Regulation*.

Government of Manitoba. (2014). *Water Storage Tanks (Cisterns)*. Manitoba Conservation and Water Stewardship. https://www.gov.mb.ca/sd/pubs/water/drinking_water/water_factsheet_cisterns.pdf

Government of Saskatchewan. (2011). *Private Sewage Works Regulations*.

Grenier, L., & Centre (Canada), I. D. R. (1998). *Working with Indigenous Knowledge: A Guide for Researchers*. IDRC.

*Habitat for Humanity Canada | Clean drinking water in Pikangikum*. (n.d.). Habitat for Humanity Canada. Retrieved October 27, 2022, from https://habitat.ca/en/stories/clean-drinking-water-in-pikangikum

Hanrahan, M., Sarkar, A., & Hudson, A. (2015). Water insecurity in Indigenous Canada: A community-based inter-disciplinary approach. *Water Quality Research Journal*, *51*(3), 270–281. https://doi.org/10.2166/wqrjc.2015.010

Hnidan, T. (2014). *Domestic Water Use in Samson Cree Nation*. University of Alberta.

*How much should I budget for home maintenance costs?* (n.d.). Retrieved February 1, 2023, from https://www.scotiabank.com:443/content/scotiabank/ca/en/personal/advice-plus/features/posts.how-much-should-i-budget-for-home-maintenance-costs.html

Irvine, A., Schuster-Wallace, C., Dickson-Anderson, S., & Bharadwaj, L. (2020). Transferrable Principles to Revolutionize Drinking Water Governance in First Nation Communities in Canada. *Water*, *12*(11), 11. https://doi.org/10.3390/w12113091

Islam, M., & Yuan, Q. (2018). First Nations wastewater treatment systems in Canada: Challenges and opportunities. *Cogent Environmental Science*, *4*(1), 1458526-. https://doi.org/10.1080/23311843.2018.1458526

Jewelland, E., & Mosby, I. (2021). *Calls to Action Accountability: A 2021 Status Update on Reconciliation*. Yellowhead Institute.

Kala Geosciences Ltd. (2020). *Samson Cree Nation Domestic Water Well Evaluation—DRAFT*.

Kala Geosciences Ltd. (2021). *Water Well & Onsite Wastewater Disposal System Evaluations—DRAFT*.

Kala Geosciences Ltd. (2022). *Onsite Wastewater Treatment and Disposal Considerations—DRAFT*.

Kovach, M. (2021). *Indigenous methodologies: Characteristics, conversations and contexts* (2nd ed.). University of Toronto Press.

Levangie, J. (2009). *A BOTTOM UP APPROACH TO EVALUATE RISK ASSESSMENT TOOLS FOR DRINKING WATER SAFETY IN FIRST NATIONS COMMUNITIES* [Master of Science]. The University of Guelph.

Lindbo, D., Godfrey, J., & Rashash, D. (2014). *Why Do Septic Systems Fail? | NC State Extension Publications*. https://content.ces.ncsu.edu/why-do-septic-systems-fail

Lipetzky, S. (n.d.). *Wastewater Lagoon Sludge Disposal The Ins and Outs | Great West Engineering*. Retrieved December 11, 2022, from https://www.greatwesteng.com/wastewater-lagoon-sludge-disposal-the-ins-and-outs/

*Lubicon Lake Band v. Canada, Communication No. 167/1984 (26 March 1990), U.N. Doc. Supp. No. 40 (A/45/40) at 1 (1990).* (n.d.). Retrieved October 27, 2022, from http://hrlibrary.umn.edu/undocs/session45/167-1984.htm

Lucier, K. J., Schuster-Wallace, C. J., Skead, D., Skead, K., & Dickson-Anderson, S. E. (2020). “Is there anything good about a water advisory?”: An exploration of the consequences of drinking water

advisories in an indigenous community. *BMC Public Health*, *20*(1), 1704. https://doi.org/10.1186/s12889-020-09825-9

Lui, E. (2011, June 13). Auditor General Report reveals little progress with First Nations drinking water. *The Council of Canadians*. https://canadians.org/analysis/auditor-general-report-reveals-little-progress-first-nations-drinking-water/

Mah, F. J. (2014, Fall). *We Used to Drink Our Water: Understanding the causes and consequences of boil water advisories in rural drinking water wells*. ERA. https://doi.org/10.7939/R3SN01C4T

Maskwacîs Health Services. (2021). *2021 Drinking Water Advisoires Data In Samson Cree Nation*.

Mccullough, J., & Farahbakhsh, K. (2012). Square Peg, Round Hole: First Nations Drinking Water Infrastructure and Federal Policies, Programs, and Processes Square Peg, Round Hole: First Nations Drinking Water Infrastructure and Federal Policies, Programs, and Processes. *The International Indigenous Policy Journal*, *3*. https://doi.org/10.18584/iipj.2012.3.1.3

McFarlane, K., & Harris, L. M. (2018). Small systems, big challenges: Review of small drinking water system governance. *Environmental Reviews*, *26*(4), 378–395. https://doi.org/10.1139/er-2018-0033

Ministry of Health. (2014). *Sewerage System Standard Practice Manual—Province of British Columbia*. Province of British Columbia. https://www2.gov.bc.ca/gov/content/environment/waste-management/sewage/onsite-sewage-systems/sewerage-system-standard-practice-manual

Mirosa, O., & Harris, L. M. (2012). Human Right to Water: Contemporary Challenges and Contours of a Global Debate. *Antipode*, *44*(3), 932–949. https://doi.org/10.1111/j.1467-8330.2011.00929.x

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*, b2535. https://doi.org/10.1136/bmj.b2535

Morrison, A., Bradford, L., & Bharadwaj, L. (2015). Quantifiable progress of the First Nations Water Management Strategy, 2001–2013: Ready for regulation? *Canadian Water Resources Journal /*

*Revue Canadienne Des Ressources Hydriques*, *40*(4), 352–372. https://doi.org/10.1080/07011784.2015.1080124

Murphy, H., Corston-Pine, E., Post, Y., & McBean, E. (2015). Insights and Opportunities: Challenges of Canadian First Nations Drinking Water Operators. *International Indigenous Policy Journal*, *6*. https://doi.org/10.18584/iipj.2015.6.3.7

nipiy. (2020). *Water Road Map*.

O'Gorman, M. (2021). Mental and physical health impacts of water/sanitation infrastructure in First Nations communities in Canada: An analysis of the Regional Health Survey. *World Development*, *145*, 105517. https://doi.org/10.1016/j.worlddev.2021.105517

OHRC. (2007). *Submission to the 70th Session of the UN Committee on the Elimination of Racial Discrimination with Regard to Lack of Canadian Compliance with UN Human Rights Decisions and General Recommendation No. 23 of the Committee on the Elimination of Racial Discrimination*. Lubicon Lake Indian Nation.

Oxford Languages. (n.d.). *define holistic—Google Search*. Retrieved February 16, 2023, from https://www.google.com/search?q=define+holistic+&rlz=1C1GCEU_enCA903CA903&sxsrf=AJOqlzUDxMoZ9xixIu50WVt87lp3zjGe3g%3A1676598502656&ei=5tzuY-SSJ-jTkPIPyYOTuAo&ved=0ahUKEwjknbmRuJv9AhXoKUQIHcnBBKcQ4dUDCA8&uact=5&oq=define+holistic+&gs_lcp=Cgxnd3Mtd2l6LXNlcnAQAzIECCMQJzIECCMQJzIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyCAgAEIAEEIsDOgoIABBHENYEELADSgQIQRgAUKsDWKsDYKkFaAFwAHgAgAGFAYgBhQGSAQMwLjGYAQCgAQHIAQK4AQHAAQE&sclient=gws-wiz-serp

Palmater, P. (2019). *First Nations water problems a crisis of Canada's own making*. Policy Options. https://policyoptions.irpp.org/magazines/february-2019/first-nations-water-problems-crisis-canadas-making/

Patrick, R. (2018). Adapting to Climate Change Through Source Water Protection: Case Studies from Alberta and Saskatchewan, Canada. *International Indigenous Policy Journal*, *9*. https://doi.org/10.18584/iipj.2018.9.3.1

Patrick, R. J. (2011). Uneven access to safe drinking water for First Nations in Canada: Connecting health and place through source water protection. *Health & Place*, *17*(1), 386–389. https://doi.org/10.1016/j.healthplace.2010.10.005

Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: Advancing the approach and enhancing the consistency. *Research Synthesis Methods*, *5*(4), 371–385. https://doi.org/10.1002/jrsm.1123

*Pikangikum First Nations*. (n.d.). The Primate's World Relief and Development Fund. Retrieved October 27, 2022, from https://pwrdf.org/pikangikum-first-nations/

Ramlogan, V. V. (2019). *The media portrayal of First Nations drinking water advisories under the modern Trudeau era*. https://tspace.library.utoronto.ca/handle/1807/102477

Renzetti, S., & Dupont, D. P. (2016). *Water Policy and Governance in Canada*. Springer International Publishing AG. http://ebookcentral.proquest.com/lib/ucalgary-ebooks/detail.action?docID=4731235

Rompré, A., Servais, P., Baudart, J., de-Roubin, M. R., & Laurent, P. (2002). Detection and enumeration of coliforms in drinking water: Current methods and emerging approaches. *Journal of Microbiological Methods*, *49*(1), 31–54. https://doi.org/10.1016/s0167-7012(01)00351-7

Safe Water for First Nations. (2019, November 13). *The Council of Canadians*. https://canadians.org/fn-water/

Samson Cree Nation. (2022, October 5). *Samson Cree Nation—Priority Rural Drinking Water Advisories Project Overview*. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/5898a48b672a41bb91b4ced07ad88576

Schiff, J. S. (2016). Masquerading as Compliance: Tracing Canada's Policy Implementation of the Human Right to Water. *Journal of Human Rights Practice*, *8*(2), 264–283. https://doi.org/10.1093/jhuman/huw006

*Sewerage System Standard Practice Manual Version 3—Volume 2*. (n.d.). Retrieved August 8, 2022, from https://www2.gov.bc.ca/assets/gov/environment/waste-management/sewage/spmv3-24september2014.pdf

Smith, J. A. (2015). *Qualitative Psychology: A Practical Guide to Research Methods*. SAGE.

Stewart, B. (2014, September 12). *Lubicon chief collected $1.5M, while community had no running water: Audit | CBC News*. CBC. https://www.cbc.ca/news/indigenous/lubicon-chief-collected-1-5m-while-community-had-no-running-water-audit-1.2763972

Swain, H., Louttit, S., & Hurdey, S. (2006). *Report of the expert panel on safe drinking water for First Nations*. Minister of Indian Affairs and Northern Development.

*The Cost of Maintaining a Home*. (n.d.). Retrieved February 1, 2023, from https://canadalend.com/blog/cost-maintaining-home

Thompson, E. E., Post, Y. L., & McBean, E. A. (2017). A decade of drinking water advisories: Historical evidence of frequency, duration and causes. *Canadian Water Resources Journal*, *42*(4), 378–390.

United Nations. (2007). *United Nations Declaration on the Rights of Indigenous Peoples | United Nations For Indigenous Peoples*. https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html

Urban Systems Ltd. (2022). *Samson Cree Nation – Priority Drinking Water Advisories (Decentralized Water System) – Household Groundwater Well Improvements – Project Summary Report*.

US EPA, O. (2017, November 2). *Septic System Impacts on Water Sources* [Overviews and Factsheets]. https://www.epa.gov/septic/septic-system-impacts-water-sources

US EPA, O. (2018, November 15). *Types of Septic Systems* [Overviews and Factsheets]. https://www.epa.gov/septic/types-septic-systems

Vogel, T. 1991-. (2019). *Assessing Design and Funding Methods of Water Infrastructure for Saskatchewan First Nations* [Thesis, University of Saskatchewan]. https://harvest.usask.ca/handle/10388/11772

Vogel, T. M., Zagozewski, R., Fonstad, T. A., & McPhedran, K. N. (2018). ASSESSMENT OF COSTS OF CENTRALIZED AND DECENTRALIZED WATER SYSTEMS ON FIRST NATION COMMUNITIES. *Canadian Society for Civil Engineering*.

von der Porten, S., & de Loe, R. (2013). Water governance and Indigenous governance: Towards a synthesis. *Indigenous Policy Journal*, *XXIII*(4).

von der Porten, S., & de Loë, R. C. (2013). Collaborative approaches to governance for water and Indigenous peoples: A case study from British Columbia, Canada. *Geoforum*, *50*, 149–160. https://doi.org/10.1016/j.geoforum.2013.09.001

Walker, M., & Newman, J. (2011). Metals releases and disinfection byproduct formation in domestic wells following shock chlorination. *Drinking Water Engineering and Science*, *4*(1), 1–8. https://doi.org/10.5194/dwes-4-1-2011

Walters, D., Spence, N., Kuikman, K., & Singh, B. (2012). Multi-Barrier Protection of Drinking Water Systems in Ontario: A Comparison of First Nation and Non-First Nation Communities. *The International Indigenous Policy Journal*, *3*(3), 3. https://doi.org/10.18584/iipj.2012.3.3.8

*Water Act—Open Government*. (n.d.). Retrieved December 6, 2022, from https://open.alberta.ca/publications/w03

*Water (Ministerial) Regulation—Open Government*. (n.d.). Retrieved December 6, 2022, from https://open.alberta.ca/publications/1998_205

*Water wells and ground source heat exchange systems directive—Open Government*. (n.d.). Retrieved December 6, 2022, from https://open.alberta.ca/publications/9781460141588

White, J., Maxim, P., & Beavon, D. (2003). *Aboriginal Conditions*. UBC Press.

White, J., Murphy, L., & Spence, N. (2012). Water and Indigenous Peoples: Canada's Paradox | The International Indigenous Policy Journal. *The International Indigenous Policy Journal*, *3*(3), 25. https://doi.org/10.18584/iipj.2012.3.3.3

White, J. P., Maxim, P. S., & Whitehead, P. C. (2000). Social Capital, Social Cohesion and Population Outcomes in Canada's First Nations Communities. *PSC Discussion Papers Series*, *14*(7).

Wilson, N. J., Mutter, E., Inkster, J., & Satterfield, T. (2018). Community-Based Monitoring as the practice of Indigenous governance: A case study of Indigenous-led water quality monitoring in the Yukon River Basin. *Journal of Environmental Management*, *210*, 290–298. https://doi.org/10.1016/j.jenvman.2018.01.020

Wong, C., Ballegooyen, K., Ignace, L., Johnson, M. J. (Gùdia), & Swanson, H. (2020). Towards reconciliation: 10 Calls to Action to natural scientists working in Canada. *FACETS*, *5*(1), 769–783. https://doi.org/10.1139/facets-2020-0005

World Health Organization. (2013). *Progress on sanitation and drinking-water—2013 update*.

Wright, A. L., Gabel, C., Wahoush, O., Ballantyne, M., & Jack, S. M. (2019). *Using Two-Eyed Seeing in Research With Indigenous People: An Integrative Review*. https://doi.org/10.1177/1609406919869695

Xiiem, J. A. Q. Q., Lee-Morgan, J. B. J., & Santolo, J. D. (2019). *Decolonizing Research: Indigenous Storywork as Methodology*. Bloomsbury Publishing.

# 8.0 Appendix A – Question Templates

**Question Template for One-on-one Interviews**

| |
|---|
| 1. From your understanding, what was the intent of the project? |
| 2. Do you think the team achieved this? |
| 3. If you could describe the process in a few sentences, what would be the main components to complete the project? |
| 4. In your opinion, what worked well in regard to the process? |
| 5. If the project were to go forward again, how should the process be adjusted? I.e., What were some of the lessons learned? |
| 6. How did this project better achieve its objectives as a community-led project, rather than a typical westernized top-down approach? |
| 7. How do you think this project benefited the community? |
| 8. Do you think there's anything preventing a project like this kind of going forward again? |
| 9. How should Samson managed water and wastewater infrastructure in the future? |

**Question Template for *nîpiy* Group Engagement Session**

| |
|---|
| 1. When thinking about the rural water and wastewater systems in Samson Cree Nation what is one word that comes to mind when you think about them? |
| 2. Imagine in 10 years every problem regarding the rural water and wastewater system in Samson Cree Nation has been addressed, what is one word that comes to mind if that were the case? If you feel comfortable, please expand on your word. |
| 3. What do you think is the biggest concern surrounding the rural water and wastewater system is in Samson Cree Nation? |
| 4. How does public perception influence the concerns around capacity, adequate fundings or knowledge? What do you think is the public perception of individuals in Samson Cree Nation regarding the Water and Wastewater System? |
| 5. How do you think Samon can rebuild the confidence in the community regarding the rural water and wastewater systems? |
| 6. What is one thing you have learned, whether it be through your involvement with *nîpiy*, this project or even just this session, that you think would be important for the community of Samson Cree Nation to know in regarding to rural water and wastewater in the Nation? |

**Question Template for Resident Group Engagement Session**

| |
|---|
| 1. When thinking about water what is one word that comes to mind? |

# 9.0 Appendix B – Onsite Visual Condition Rating Criteria

**Well Rating Criteria**

| Condition Ranking | Classification | Description |
|---|---|---|
| 1 | Critical | • No water service to the home |
| 2 | Poor | • Presence of animals or other contaminates in the well.<br>• Well has no cap.<br>• Well shaft is dented and/or bent. |
| 3 | Fair | • Well is not sealed properly.<br>• Electrical connection is not sealed properly.<br>• Showing corrosion.<br>• Near the end of service life. |
| 4 | Good | • Well is adequate and functioning. |

**Septic Rating Criteria**

| Condition Ranking | Classification | Description |
|---|---|---|
| 1 | Critical | • Shoot-out <10m from home.<br>• Septic pools close to the home.<br>• Septic tank has collapsed inward or is otherwise unserviceable.<br>• Power is damaged/inoperable. |
| 2 | Poor | • Shoot-out 10-15m from home, if above ground, septic improperly drains and may have evidence of minor pooling and if underground, septic shows signs of leakage or seepage.<br>• Septic lid has cracking or obvious weathering. |
| 3 | Fair | • Shoot-out 15-20m from home, if above ground it drains away from home and if underground it is in an adequate location.<br>• Infrastructure is aging but in relatively fair condition. |
| 4 | Good | • Septic filed adequate distance from the home and drains away.<br>• Septic is functioning properly. |

# 10.0 Appendix C – Raw Data

The raw data herein is the property of Samson Cree Nation and is to be accessed and utilized at the discretion of the appropriate personnel at Samson Cree Nation. If you wish to access the raw data which formed the basis of this thesis, please contact Ayla Lauret at ayla.lauret@ucalgary.ca.