An Examination of Drinking Water in Two Indigenous Communities in Canada

by

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ABSTRACT

For decades, many Indigenous communities across Canada have dealt with poor levels of water security and associated drinking water problems both within the home and while on the land, hunting, fishing and participating in cultural events. Yet, despite this, little academic research has been conducted on this subject. Most of the studies examined the contaminants involved and the causes of contamination, or infrastructure issues related to drinking water. While these are very important considerations, they fail to address the larger scope of the problem such as the political environment, the social position, and the reduced capacity of Indigenous communities and how these have created conditions in many communities similar to those seen in developing nations around the world. In total, 99 semi-structured interviews were conducted over a two year period in two Indigenous communities (Dene Tha' First Nations & K'atl'odeeche First Nations) to better understand the variables that underlie participants' water consumption patterns and what factors influence their choices. The data was analyzed to further develop the existing research that has examined variables that influence Indigenous water consumption patterns. Overall, the results indicate that both communities consume far more bottled water than the Canadian average and support previous research findings for many of the variables that influence people's consumption behaviours. In particular, the Dene Tha' respondents indicated much higher levels of concern over their drinking water which corresponded to increased levels of perceived risk and bottled water consumption. Additionally, the research findings provided a basis to develop the concept of Indigenous water security and the various components involved. This will allow Indigenous communities to better understand and address levels of water security and the problems that many associate with drinking water in their communities across Canada.

PREFACE

This thesis was developed for the fulfilment of the requirements for a Master of Science degree in Community Risk and Resilience at the University of Alberta. The aim of the research is to collect, synthesize and document the existing local and traditional knowledge about water security and problems that many Indigenous communities in Canada face with their drinking water. This research was conducted as part of the Tracking Change Project in the Department of Resource Economics and Environmental Sociology at the University of Alberta. The aim of the Tracking Change Project is to track ecological change across the Mackenzie, Mekong and Amazon River Basins. This current research examines how some of these changes have impacted Indigenous communities in their drinking water and levels of water security. This thesis is an original work by Neal Spicer. Initially, the ethics approval was under the project name, "Tracking Change in the Mackenzie River Basin," study ID Pro00065907, which was granted on June 22, 2016. Subsequently, a separate ethics application was approved by the University of Alberta Research Ethics Board, project name, "Understanding Changes in Freshwater Ecosystems and Drinking Water in Northern Canada," Study ID Pro00064419, granted on November 24, 2016. The ethics approval for the work conducted in the Northwest Territories came from the Aurora Research Institute, License No. 16045 that was issued on February 9, 2017 under the project name, "Understanding Changes in Freshwater Ecosystems and Drinking Water in Northern Canada."

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ABBREVIATIONS

DTFN……Dene Tha' First Nations

KFN……..K'atl'odeeche First Nation

CRA……..Community Research Assistant

TT…….Traditional Territory

TK…….Traditional Knowledge

CBPR……Community-Based Participatory Research

DWA…….Drinking Water Advisory

SDWFNA……..Safe Drinking Water for First Nations Act

INAC…….Indigenous and Northern Affairs Canada

NWT……..Northwest Territories Government

YTG……Yukon Territorial Government

CHAPTER 1
INTRODUCTION

1.1 Introduction

Tensions surrounding drinking water are increasing, both on a global and local scale, as various stakeholders, both large and small, compete for a finite and essential natural resource that is increasingly under siege by natural causes (such as flooding and storms) and manmade causes (such as pollution, climate change, and a myriad of other activities). Canada has extensive water sources across the country, yet many Indigenous communities lack clean sources of drinking water (Dupont et al., 2014; Galway, 2016; Walters et al., 2012; Martin et al., 2007; Baird et al., 2015; and Morrison et al., 2015). Despite being only roughly five percent of the population, Indigenous communities receive approximately 20 percent of the issued water advisories in Canada (Castleden and Skinner, 2014).

Various theories explain this inequity in drinking water access and quality. Some of these theories are technical; lack of adequate training and services to ensure quality of drinking water has been highlighted by numerous studies (Daley et al., 2015; Galway, 2016; Walters et al., 2012; Martin et al., 2007; Morrison et al., 2015; and Neegan Burnside Ltd., 2011). Other theories examine deeper questions about colonial histories and institutions that have limited Indigenous community access to lands and resources and that have created dependencies on drinking water infrastructure that are poorly maintained by provincial, territorial and federal governments (Baird et al., 2015; Boyd, 2011; Brown et al., 2016; Mascarenhas, 2007; and LaBoucane-Benson et al., 2012).

Addressing this problem requires consideration of the complex ways in which Indigenous communities understand and experience drinking water challenges in their communities and regions. A growing number of studies have explored how perceptions and choices for drinking water vary by cultural group. Among the insights from these studies is that Indigenous communities are uniquely vulnerable to the impacts of poor drinking water due to their socio-economic disadvantage (i.e., low incomes), close cultural and spiritual connection to the land and the fact that many are remote from services and alternative drinking water options (Ekos

Research Associates, 2011; LaBoucane-Benson et al., 2012; Dupont et al., 2010; and Martin et al., 2007).

Critical consideration of the institutions and systems of governance is also needed in addressing the problem. Water management in Canada involves balancing the interests of all impacted parties – individuals, communities, agriculture, industry, hydroelectricity, and the natural ecosystem – that utilize and consume the water within a hydrological basin. The interests of Indigenous communities are often overlooked or undermined by these competing interests as well as by government (Fawcet, 2015; Gajadhar, 2013; Hanrahan, 2017; Mascaenhas, 2007; and Laidlaw et al., 2010). For example, lands granted for Indigenous reserves often lacked high quality natural water sources and were located in areas prone to flooding. Other policies such as residential schooling for Indigenous communities have decreased human and social capacities of many communities. It has been shown that a clear and definitive relationship exists between power dynamics and poverty, factors seen in many Indigenous communities across Canada, and that these factors can directly impact and influence levels of water security (WWC, 2000; Bakker & Morinville, 2013). This reduced social, political strength, and human capacity of Indigenous communities that often have no control over the resources within their area, combined with inadequate locations allotted for Indigenous communities and the lack of finances often greatly reduces the communities' ability to address water security issues (White et al., 2012).

Some of this vulnerability is compounded by the relationship of Indigenous communities to the federal government. Through Treaties (e.g., Treaty 8), the federal government has a fiduciary obligation to ensure safe drinking water for their communities as part of the requirement of providing basic needs for Indigenous people (Walters et al., 2012). However, the terms of the treaties and associated federal obligations are poorly understood and addressed in many regions (Laidlaw et al., 2010). The rules and regulations governing source water protection and municipal drinking water management vary significantly across the country.

While some critics argue that the Canadian government is investing to address the problems of water insecurity for Indigenous communities, other scholars suggest the opposite. One scholar suggests that the federal government of Canada has historically blocked domestic

and international efforts to acknowledge an individual's right to water (Collins, 2010). For example, Canada was one of 42 countries that abstained from voting in the 2010 United Nations resolution that declared water as a human right (Boyd, 2010). This lack of acknowledgement of this basic human right contradicts the Canadian Charter of Rights and Freedoms and the Canadian Constitution; as an essential service that is crucial to life, health and human dignity, safe drinking water is a constitutionally protected right under section 36 of the Constitution Act, 1982 and sections 7 and 15 of the Charter (Boyd, 2011).

The situation, however, is complex. A growing number of variables are impacting natural sources of water in Canada including over-usage, pollution from industry, weather pattern changes, and the reduction and destruction of wetlands which are integral in sustaining hydrological systems (Matsui, 2012). In particular, the Arctic region and the water resources located in it are being heavily impacted by climate changes such as permafrost melting and drops in levels of natural sources of water (White et al., 2007; and Martin et al., 2007).

While it is important to acknowledge the overall depletion and stresses on natural source water across Canada, this does not adequately explain or excuse the lack of access to clean drinking water that is a common problem in many Indigenous communities across the country. It is true that levels of water security can often be lower in remote rural communities than in large urban areas due to the geography and limited infrastructure; however, Indigenous communities in Canada have the overall worst levels of water security (Hanrahan, 2017). In fact, the majority of Indigenous communities in Canada experience problems with their potable water similar to those seen in many developing nations around the world (Neegan Burnside Ltd., 2011).

Over the last 20 years, consumption of bottled water has been on the rise across the world and researchers are trying to gain a better understanding of this phenomenon (Doria, 2006; Dupont et al., 2010; Doria, 2010). A cross-country survey showed that 22 percent of the respondents in Canada prefer bottled water as their main source of drinking water (Dupont et al., 2010). However, bottled water consumption is much higher on Indigenous reserves than in the general public (Neegan Burnside Ltd., 2011). Although many factors are involved in people's consumption habits of water, the higher rate of problems associated with drinking water in

Indigenous communities is assumed to be associated with higher rates of bottled water consumption (Walters et al., 2012).

Within this context, relatively little community-based research has explored individual perceptions of drinking water quality as well as the implications for drinking water choices within Indigenous communities in Canada. While quantitative research on bottled water consumption patterns has been done in some regions, the unique social, cultural, political and ecological dimensions of the problem within specific Indigenous communities has been of limited consideration in these studies.

1.2 Objectives

Guided by the literature on risk perception and theories on drinking water consumption patterns, this thesis has three interrelated objectives:

Objective 1 Explore how risk perception and other social-economic variables influence individual drinking water consumption patterns (including water from the land and water from home).

Objective 2 Explore how political jurisdiction and associated infrastructure and regulations influence individual drinking water consumption patterns by comparing results from Dene Tha' First Nation in Alberta and K'atl'odeeche First Nation in the Northwest Territories.

Objective 3 Develop a better understanding of the components involved in Indigenous water security, for both natural sources of water and household water, and how they are related and impact Indigenous communities.

1.3 Literature Review

1.3.1 Indigenous Community Drinking Water Overview

Problems with drinking water within Indigenous communities have existed for decades (Neegan Burnside ltd., 2011). Although the federal government has acknowledged and attempted to mitigate these issues surrounding drinking water for Indigenous communities, an examination of DWAs shows that, from 2004 to 2013, the number of issued advisories increased over the

period for First Nation communities within parts of Canada (Galway, 2016). As of November 30, 2017, 41 active short term DWAs (temporary water issue) and 95 active long term DWAs were in place (for more than one year) in Indigenous communities across Canada (Health Canada Website).

A national assessment of the 807 water systems that service Indigenous communities across Canada showed that 314 (39%) were categorized as high overall risk, 278 (34%) were categorized as medium overall risk, and 215 (27%) were categorized as low overall risk. Almost half (150) of the 314 high risk systems, which service 16 percent of the overall on-reserve population in Canada, were categorized as such because of excessive amounts of bacteria found in the water delivery system (Neegan Burnside Ltd., 2011). When comparing indigenous and non-indigenous communities and the corresponding levels of quality of water, although some non-indigenous communities were ranked as high-risk in some categories, all were overall ranked low risk (Walters et al., 2012).

Previous research (Galway, 2016) examined water advisories in First Nations communities in Ontario. The findings show there were 402 water advisories in these communities from 2004 and 2013 that averaged 294 days and totaled 118,307 days under advisory. The research showed an increase over this time period in the number of water advisories, with 2013 having the highest number of advisories. The three biggest reasons given for the DWAs was equipment malfunction, inadequate disinfection residuals, and turbidity. Over the decade examined, 70 percent of the First Nations communities received at least one water advisory. Across the 402 advisories, 47 percent occurred when inadequate training was provided for the equipment operator (Health Canada Website).

Despite the water security crisis in many Indigenous communities, it has received limited public attention. An examination of the two national newspapers (*Globe and Mail* and *National Post*) shows that, from 2000 to 2015, only 131 stories examined or discussed water problems associated with Indigenous communities. Yet, the same two newspapers published 652 articles that examined or discussed the Walkerton water crisis (a small town in Ontario where water borne diseases killed 7 people and 2300 became ill) within a two-year period after the crisis

started (Lam et al., 2017). This would appear to indicate, that despite the prevalence of water security issues for Indigenous communities across Canada for decades, newspaper coverage is biased. Significantly more coverage occurred in a situation where non-Indigenous communities were impacted. Despite consistent ongoing problems for many Indigenous communities across Canada, the only time there is an increase in news coverage is when there is an outbreak of significance. This lack of examination allows the issue of Indigenous community water security to be often swept to the side in the wake of other leading news stories.

The frequency of the examination of Indigenous drinking water problems in academic literature is just as sparse. Only 16 peer-reviewed articles from 2000-2015 examined drinking water and health in Indigenous communities in Canada (Bradford et al., 2016). In those articles, the most common problem found was contamination by microbial pathogens; however, poor health outcomes due to poor water quality, infections and pollutants in the water were also discussed and examined within the various articles. The most cited causes of water associated problems for Indigenous communities included human error, lack of funding, lack of awareness of cultural practices, weather, lack of clear and proper governance procedures, lack of properly functioning water distribution systems, and a lack of source water protection (Bradford et al., 2016). This lack of examination, both by the news media and academics, appears to indicate a relationship between the marginalization of Indigenous people in Canada and the resulting lack of societal concern over their problems.

Chronic water problems appear to have impacted the perception of drinking water for many Indigenous people. When examining remote communities, both Indigenous and non-indigenous, it becomes clear that the perceived quality of water by members of Indigenous communities is much lower than for members of non-Indigenous communities (White, Murphy, and Spence, 2012). Due to the existence of long-term drinking water issues within many Indigenous communities, the idea of water security for many members is non-existent. This often creates a sense of complacency and acceptance of not being able to drink the tap water and just becomes the normal way of life for many communities (Patrick, 2011). Research shows that nationally only three in ten Indigenous residents feel that their tap water supply is very safe. In

the same survey, four in ten Indigenous people think their tap water as somewhat safe and less than half rated the quality of water as good (Ekos Research Associates, 2011).

Not only does habitual poor water security impact perception of risk for individuals, it also has resulted in very direct, significant, health problems in some communities. Research that examined water security in Inuit communities indicated that water issues can cause mental stress, increased rates of infections and various health concerns such as increased rates of diabetes (Sarkar, Hanrahan, and Hudson, 2015). The participating community had inconsistent sources of safe water sources and members often had to rely on sources of untreated naturally sourced water. This practice often resulted in water borne diseases and severely decreased water consumption patterns which lead to health threatening practices such as reusing water for various activities such as washing and an increased intake of sugary drinks (Sarkar, Hanrahan and Hudson, 2015; and Martin et al., 2007).

1.3.2 Canadian Government's Responsibilities for Indigenous Drinking Water

Although the government has not formally recognized the right to water for Canadians, there have been numerous acknowledgements by the government of the problems associated with the drinking water in many Indigenous communities. In response to the drinking water situation, the Safe Drinking Water for First Nations Act (SDWFNA) was created in 2013. In the preface of this act, the government of Canada acknowledges the importance of Indigenous communities having access to safe drinking water and states that the Canadian Government and the Minister of Indian Affairs and Northern Development (INAC, now Indigenous Services Canada) is committed to working with Indigenous communities to improving the health and safety of their residents. In 2017, INAC, in its commitment to Indigenous residents accessing safe, clean and reliable drinking water, engaged in discussions with various First Nations to understand their points of view on the SDWFNA and to discuss ways forward to safe drinking water and wastewater treatment within their communities (INAC, 2017). This collaboration will allow for a more effective legislation and solutions that are likely to address the unique situation found in many Indigenous communities.

The federal government states two key responsibilities regarding creating and ensuring access to safe drinking water for Indigenous communities – funding and policy making. Federal funding for Indigenous communities' drinking water is designed to cover 100 percent of the construction, major repairs and other capital costs and 80 percent of the operating costs of drinking water systems. The remaining 20 percent of operating costs is typically the responsibility of the community, but in certain circumstances can also be covered by the federal government (McCullough and Farahbakhskl, 2012). On 23 January 2018, the Minister of Indigenous Services announced the federal government's commitment to the removal of all long-term water advisories on reserves by March 2021. In its commitment to address water security issues for Indigenous communities, the federal government is building close to another 250 additional drinking water systems by utilizing part of the $1.8 billion pledged for water and wastewater infrastructures on reserves in the 2016 budget (Indigenous Services Canada, 2018). However, while this is a very important step in addressing the drinking water problems, the problem is much bigger than infrastructure.

As part of the federal government's role, Health Canada partners with Indigenous communities across Canada (except those in BC and above the 60th Parallel) and supports the monitoring of all drinking water systems and advises them on any issues that are related to drinking water safety (Health Canada website). According to Health Canada, when a potential concern arises through testing results or other means, the chief and council are required to issue a DWA and take the necessary steps to address the problem based on the recommendations from the Environmental Health officer (employed by Health Canada or the First Nation community). North of the 60th parallel, the various governing bodies work in conjunction with Indigenous and Northern Affairs to maintain the stewardship of water and natural resources. The Northwest Territories government (NWT) and the Yukon Territorial Government (YTG) have developed policies and regulations that incorporate various stakeholder concerns towards providing security for water within the home and natural sources utilizing concepts that will promote sustainable usage of water. However, Nunavut lacks the personnel, regulations, policies and government departments to properly ensure natural source water security and provide any consistent territory wide method of governance (Medeiros et al., 2017).

1.3.3 Drinking Water Regulation

Theoretically, Canada has proper and sufficient legislation to ensure water security for all communities in the country. However, the problem is the degree of implementation and accountability for anyone that fails to properly follow or enforce the various regulations. This is especially true for many Indigenous communities, where there is often a disconnect between the actual conditions of water security within Indigenous communities and the various government offices involved in the process (Hanrahan, 2017).

In Canada, drinking water standards and practices are regulated by provincial and territorial governments that utilize guidelines provided by the federal government as a basis for their legislation. However, the regulation and maintenance of drinking water and wastewater in Indigenous communities south of the 60th parallel are federal government responsibilities (Boyd, 2011; Minister of Justice, 2013). Various government agencies including Indigenous and Northern Affairs Canada (INAC), Health Canada, Environment Canada and local indigenous governing bodies are responsible for different aspects for drinking water within Indigenous communities in Canada (Walters et al., 2012). However, this multiplicity of players allows gaps in some areas and overlap in others and further complicates the situation in some communities due to uncertainty about areas of responsibility. Additionally, numerous problems are associated with the current policies for First Nations communities, including substandard, inadequate, non-existent and antiquated water delivery systems, insufficient training for operators and monitoring of adherence to standards, inconsistent testing, regulatory gaps, and insufficient funding (Morales, 2006).

1.3.4 Drinking Water in Indigenous Communities

An important component of Indigenous drinking water is distribution methods within the communities. According to a survey that examined the water and wastewater systems of 571 out of 587 (97%) of First Nation communities within Canada, 72 percent of homes have pressurized pipe delivery, 13.5 percent of homes have cisterns and truck delivery, 13 percent of the homes have individual wells and 1.5 percent have no services. However, the distribution of water delivery systems varies greatly across Canada with the Atlantic, Quebec and British Columbia having more than 94 percent pipe service and Alberta (38%) and Yukon (31%) region having the

lowest. The hauling of water and cistern holding tanks is more common in the prairies (Alberta 31%, Manitoba 31%, and Saskatchewan 21%) and Yukon (51%). In Ontario, only 10% of communities use this method and it is not used in the Atlantic Region, Quebec and British Columbia (Neegan Burnside Ltd., 2011). The impacts of distribution are further developed and discussed in Chapters two and three and how it can influence water consumption patterns and water security levels.

1.3.5 Drinking Water Consumption Variables

A growing literature examines drinking water consumption and what factors influence an individual's choices and how they perceive their water sources. However, even though a high percentage of Indigenous water supplies across the country have been noted to be high risk, very limited research has explored the implications of such a problem on water consumption preferences. Past research that examined drinking water choices has presented numerous variables that, although they vary in their impact and consistency, appear to have relationships to drinking water choices and consumption patterns (Doria, 2006; Dupont et al., 2010; Doria, 2010). Due to the extensive problems associated with the drinking water in many indigenous communities across the country, it is assumed that risk perception of the community members will influence their consumption patterns, both within the home and while on the land. Risk perception can play a crucial component in an individual's decisions and the resulting actions.

Multiple variables can potentially impact people's perceived level of risk for drinking water including include demographics, level of perceived control over the situation, level of trust in institutions, familiarity of the environment, and information that is derived from external sources (Doria, 2010). This thesis examines multiple variables, most of which are further developed and examined in Chapter Three, that have been shown to impact levels of risk perception including health concerns over water sources, water advisories, and level of available information, organoleptics (physical characteristics of the water) and socio-demographics.

Numerous studies indicate a strong relationship between health concerns over the available sources and the impact these have on risk perception and consumption patterns for individuals (Doria, 2006; Dupont et al., 2010; Dupont et al., 2014; McSpirt et al., 2011; and Ekos Research Associates, 2011). It has been shown that small communities that suffer from chronic,

long-term problems with their delivery system have higher levels of perceived risk than communities where no persistent problems existed (Anadu and Harding, 2000). Although the same research showed that communities that suffered from water delivery system problems due to natural disasters had lowered levels of perceived risk, these communities still had elevated levels of bottled water consumption similar to high risk water systems than communities that had experienced no problems in the past (Anadu and Harding, 2000). The existence of water advisories, either current or previously issued, has also been shown to impact levels of risk perception and the resulting consumption of various water sources (Mcleod et al., 2014; Castleden et al., 2015; Ekos Research Associates 2011; Anadu et al., 2000; and Spence et al., 2012). The level of available information has also been shown to be linked with risk perception and the resulting water consumption of individuals (Contu et al., 2004; and Ekos Research Associates, 2011). Due to the high number of long-term DWAs and an overall lack of information concerning water issues for many Indigenous communities, it is presumed and supported by this research that this results in altered consumption patterns.

Previously conducted research indicates that the physical characteristics of water can influence people's perception of level of risk and in result in altered consumption habits (Doria, 2010; Doria, 2006; Mcleod et al., 2014). In a Canada wide survey, seven out of ten respondents indicated that organoleptics was their biggest reason for drinking bottled water (Doria, 2006). Additionally, various socio-demographics have been shown to have relationships to how people perceive the risk of their drinking water sources and how it impacts their choice of what to drink. Gender (Sajjadi et al., 2016; Anadu and Harding 2000; Dupont et al., 2010; Spence et al., 2012; and Dupont et al., 2014), age (Dupont et al., 2010; Spence et al., 2012; and Sajjadi et al., 2016), education level (Dupont et al., 2010; Sajjadi et al., 2016; and Spence et al., 2012), income (Dupont et al.,2010; McSpirit et al.,2011; and Spence and Walters 2012) are all examined in much greater detail within Chapter Three.

One variable not examined in Chapter Three but one that plays an important part in consumption habits is the water delivery practices within the communities. In one study, the highest percentage of bottle water usage as the primary source of drinking water was in individuals who had their water delivered via water truck, while individuals on municipal water

supplies had the lowest bottle water consumption (Mcleod et al.,2014). In cross-Canada research conducted on behalf of Health Canada, it was found that community households that had water directly piped to their homes were the most satisfied with the quality of their tap water. On the opposite side of trust, individuals who were on wells (44 percent) and on cisterns (25 percent) often thought the water quality was bad (Ekos Research Associates, 2011). This current research supports these findings in that delivery practices seem to be related to the consumption patterns of many interviewed households.

1.3.6 Water Security Overview

A large component of this research and its findings are the impacts and implications of water security, both of household and natural water sources, on Indigenous communities. Water security is a term utilized to encompass a fairly large collection of challenges to water sources seen around the world such as the inadequate protection and supply of viable water sources against unsustainable usage, natural hazards, various impacts of human society, and the discriminatory and unequal distribution of water to all interested parties (Wheater and Gober, 2013). The use of the term water security within academic literature has grown extensively over the last 30 years and is being used by a variety of disciplines including water resources, environmental resources, geography, social sciences, agriculture and many more. However, this can be problematic as the term water security now encompasses many factors making it difficult to define the term in a universally accepted manner. Additionally, the methods by which water security is studied or examined are just as widespread and potentially conflicting depending on discipline(Cook and Bakker, 2012).

Although there are varied definitions of water security and what aspects are incorporated into the term, some common threads can be drawn from current literature. First, an essential part is the degree of access to safe drinkable water that allows the basic human and domestic needs to be meet; secondly, there is an acknowledgement of the requirement of water for production means including food, agriculture and industry; third, the sustainable use of water that incorporates the protection and conservation of the environment; and the aspect of natural disasters and how they impact water security of communities (Lautze and Manthrithilake, 2012; Cook and Bakker, 2012). Household water security can be quantified by three components that

include: water affect in the form of various subjective, cultural and emotional experiences and how they associated with water, water quality acceptability in the form of water organoleptics in the various biophysical aspects of water in taste, biochemistry, smell, colour, etc.; and level of access to water for consumption in the form of cost, reliability supply and physical access (Jepson, 2014).

Regardless of how water security is defined, and which discipline it is examined under, water security and everything it encompasses is one of the most important challenges faced by governments, the scientific community, and many individuals around the planet (Gain, Giupponi, and Wada, 2016). Due to the immensity and scope of the problems associated with water security, it is increasingly being recognized by governments and NGOS around the planet as a matter of significant concern due the critical importance it plays not only for humans but for the planet and all life that resides on it (Wheater & Gober, 2013). The poor water security levels for many Indigenous communities in Canada parallel the problems seen in many developing nations around the world.

According to the World Water Council (WWC, 2000), the seven main challenges to achieve a high level of water security include: meeting basic needs by ensuring access to adequate and safe water and sanitation sources; securing the food supply by ensuring adequate and equitable water allocation for food production; protecting ecosystems by utilizing sustainable water resources management practices; sharing water resources between the various users of a water source in a peaceful and meaningful manner; managing risks of water-related hazards such as flooding and pollution; valuing water as its actual multi-faceted value and ensuring water services pricing accurately represents the costs of provisions; and governing water wisely in a way that incorporates the points of view and interests of all impacted shareholders.

In a socio-hydrological context, natural water security consists of three components that include environmental change, population growth and economic development and governance. With climate change impacting water ecosystems around the world, environmental changes are becoming a very important factor in water security. In most cases, struggling hydrological systems are further being impacted by increasing population and economic development.

Governance plays a crucial part in the management of the hydrological system and it is often a very complicated process as most river systems travel through various borders. This means that, as often seen within Canada, management often needs to be done on an interprovincial, inter-territorial and potentially international level (Gober and Wheater, 2014). This complicates the process significantly and can negatively impact the level of the security of natural water sources, especially for many Indigenous communities.

1.3.7 Water Security Canada

One of the problems pertaining to water security in Canada is the lack of formal laws; instead, water is regulated by policies, guidelines and funding agreements (Baid et al., 2015). Along with the problems associated with the multi-jurisdictional overlap in the case of Indigenous communities and the lack of nationwide regulations, other reasons why natural source water security in Canada is in peril include: the lack of strict environmental control and regulations over industries and the resulting impacts on the environment; the high costs of pollution reduction practices and the required machinery/equipment; conflicts in balancing the needs and practices of the various stakeholders that are in the area or on the same hydrological system; and finally, the lack of control and participation of Indigenous people in the regulation of natural resources extraction practices that are impacting not only their traditional lands but also their way of life (Matsui, 2012). This lack of collaboration and formal laws has helped to create the problem of drinking water security for many Indigenous communities in Canada.

In the Arctic region, water security faces many threats in the forms of quality and quantity of water. The terrain often makes finding safe subsurface groundwater costly due to the difficulties of drilling below the permafrost; therefore, surface water, in the forms of lakes and streams, is often used for drinking water (Martin et al., 2007; Instanes et al., 2015). However, due to the impacts of climate change, the Arctic is experiencing drastic changes in the amount of available viable surface water sources due to weather pattern changes and overall levels of water. These impacts are dramatically challenging the various communities' ability to continue to supply clean water. Beyond climate change, other variables such as abandoned industrial sites, increasing numbers of resource extraction projects, population growth and growing pollution from the south are all impacting water security levels for Indigenous groups within the Arctic

region in Canada (Martin et al., 2007; Bates et al., 2008; Medeiros et al., 2017; White et al., 2007; Instanes et al., 2015). Overall, despite Canada's expansive water sources, water security levels for many parts of the country are being threatened by several factors.

1.3.8 Water Security for Rural and Remote Communities

It is important to understand that, although there are special circumstances for Indigenous communities such as the complexities of the many players involved, problems associated with small water delivery systems (less than 5000 people) are often seen in rural and remote locations (both Indigenous and non-Indigenous) across Canada. Small rural or remote communities often face a multitude of issues such as older or inadequate treatment facilities, improper personnel training and inadequate funding and capacity (Galway, 2016; Medeiros et al., 2017; Dickson, Schuster-Wallace and Newton, 2016). These problems are often complicated by the local geography.

In research published in 2014, Jepson examines low-income peri-urban and rural communities that are situated along the US-Mexico border. These communities are like indigenous communities in Canada in that, despite being part of a wealthy, fairly water secure nation, they are often separated from the economic, legal and institutional benefits of their host country and have decentralized water governance. These conditions combined with a lack of existing infrastructure, high costs involved of water supply and the low socio-economic status of many community member has led to wide variance in levels of water security from water secure (10 percent), marginally water secure (35 percent), water insecure (31 percent) and highly water insecure (24 percent) for households in these communities.

For rural and remote communities, the concept of water security should incorporate a number of variables that include: the level of consistently available viable natural water resources to the community and how the quality is impacted by a variety of factors such as pollution and turbidity; the intertwined relationship between the natural environment and water sources and how the environment is being impacted by human development; the water delivery system where the water and wastewater is collected, distributed, and managed and how it is impacted by the system capacity and personnel training; the levels of human and resource

capacity and capital available to and within the community to maintain and upgrade the delivery system; the degree of accessibility to water users within the communities to sufficient levels of clean drinking water; and the levels of health and well-being of community members in relationship to behaviour and knowledge in relationship to health and water (Dickson et al., 2016).

Due to the extreme conditions of the Arctic region, the typical water treatment and delivery systems seen throughout the rest of the continent are not typically feasible and are prone to malfunction. Therefore, the utilization of cistern tanks, one for drinking water, one for wastewater, is common within the region, with service trucks removing waste and delivering water as required (Daley et al., 2015). While, in theory, this system should be able to maintain an acceptable level of water security, it is often plagued with problems. Weather, training of personnel, adequate machinery, mechanical breakdown and more can all be factors in levels of water security in these northern, mostly indigenous, remote communities. Often, water is drawn from local natural water sources, chlorinated and distributed throughout the community (Daley et al., 2015). As the impacts of increased levels of resource extraction and climate change lower levels of natural source water security, this will result in a decrease in household water security as well.

1.3.9 Water Security for Indigenous Communities in Canada

The complexities (social, geographic, and economic) seen in Indigenous communities further complicate the issue of water security levels, especially when you consider water within the home and natural sources of it. To fully develop the concept of water security for Indigenous communities, it should be examined from a multitude of disciplinary approaches. Some of the approaches towards water security in various disciplines that may be appropriate for Indigenous communities include engineering (protection against water related hazards such as droughts and floods, security of the required supply), environmental science (quantity and quality of available water), hydrology (security of the hydrological system), public health (health and well-being of individuals, supply and security of safe water and water delivery system), law (legal requirements), policy (federal, provincial, First Nations government, Health Canada), and water resources (scarcity and supply security).

Despite billions of dollars of investment, the situation of water security for many Indigenous communities across the country remains a huge concern. Part of the reason for this is that many of the government regulations, policies, and programs are based on a top-down approach. This often excludes Indigenous community members' voices and concerns, their culture, and specific social, geographic and economic needs (Black and McBean, 2017). For comprehensive governance that can ensure a higher degree of natural water security for Indigenous communities, they must be involved throughout the process and acknowledged as crucial stakeholders. Adaptive co-management practices that utilize active participation of the community and their traditional knowledge should be implemented into the process, so their unique circumstances and perspectives are included (Matsui, 2012; and Plummer and Hashimoto, 2011).

Concerns from Indigenous communities over drinking water conditions have been examined by the federal government to help learn how to address them. During focus groups conducted by INAC in northern Indigenous communities in Canada, several issues were brought forward that included the lack of participation or involvement of Indigenous individuals in the decision process for infrastructure construction in their communities. Some mentioned a disconnect between community leaders and community members, which is founded in a lack of communication in some situations and or a low level of faith that community members have in their leadership in other communities. Concerns also exist over the level of awareness of the potential problems with the communities' water supply, especially those that impact their lands. Additionally, some individuals are concerned about the quality of work done on the water delivery system in the communities and feel that it is below par which will result in water security issues (White et al., 2012). To properly address the concerns that many Indigenous communities have over their water security, these issues will need to be examined and dealt with by the federal government.

1.3.10 Water Security Assessment Overview

The assessment of water security is fully examined within Chapter Four; however, the concept and aspects that are not covered in that chapter due to publication limitations are

introduced here to fully develop the concept. Although the concept of water security has grown in prevalence within academic literature over the last three decades, very little research or academic examination has been conducted to quantify the concept into a measurable fashion (Lautze and Manthrithilake, 2012; and Animesh et al., 2016). The fact that water security, as a concept, is still being developed and utilized by a wide variety of disciplines and often applied to a broad set of circumstances, makes operationalizing or quantifying the term very difficult (Cook and Bakker, 2012).

Currently, the assessment tool most used for assessing water security on a territorial basis is the Water Poverty Index. This index was designed as a comprehensive policy tool, that examines both social and physical sciences, to help decision makers to identify the physical, economic and social drivers that link poverty and water together (Jepson, 2014; and Sullivan, 2002). The creator of the index states that there is a clear relationship seen around the world between poverty and the impacts it has on water security (Sullivan, 2002). In the case of Indigenous communities within Canada, many of which are at socio-economic levels seen in poverty-stricken nations, these links would play a crucial role in the water security levels for these communities.

In order to address the lack of quantification of the term water security, while acknowledging its limitations as a tool, Lautze and Manthrithilake (2012) created a framework that was designed to create a country level water security indicator index. Incorporating the common threads found in water security literature, the index was based on five components that included: the level of water security of the natural environment; the degree of fulfillment of basic agricultural production requirements; the degree of water security achievement for basic human needs, the level of risk management completed to help water security; and the degree of independence the country has from outside water sources. There was a score of one to five based on the country's assessed levels for each of the five categories and the five subcategory scores were added together to give the country's water security index with a best possible score of 25 out of 25 for the most water secure nations.

Another index was published in 2016 by Animesh, Giupponi, and Wada, designed to address the lack of a global representation of water security, using methods that incorporated numerous criteria instead of previously utilized indexes that have examined aspects of water security such as the Water-Poverty Index (Sullivan, 2002) and the Water-Vulnerability Index (Hamouda, Nour El-Din, and Moursy, 2009). However, none of these current indexes fully examine the complexities of Indigenous water security. This research will start to address these gaps on a theoretical level and help provide a practical, albeit rudimentary, tool that Indigenous communities can utilize to score their levels of water security so that deficiencies can be addressed.

1.3.11 Risk Perception Overview

Chapter Three examines risk perception and how it affects individual consumption patterns in individuals in regard to drinking water preferences. Although the concept of risk perception is fully developed in that chapter, there are some larger theories such as environmental risk perception and cultural differences in risk perception that should be further developed beyond the scope presented in Chapter Three to fully present the overarching concepts this thesis is developed on. The perception of risk is a very complex, multi-dimensional process that is influenced by a multitude of cultural, political, and social processes (Bickerstaff, 2003).

Definition and Constructs of Risk

There is some variance in the definitions; however, risk it can been defined as "…the probability of an adverse future event multiplied by its magnitude" (Adams, 1995, p. 69). Risk is often based on the probability of a negative event happening (Brun, 1994). The research on risk is often divided between objective/statistical risk and subjective/perceived risk perspectives (Bickerstaff, 2003). Objective risk is based on phenomena and their causes in the natural world that can present harmful effects. Subjective risk is based on an interpretation of a phenomenon and may not necessarily be based on facts or scientific assessments (Boholm, 2003). Risk can be subjective in that beliefs, thoughts and societal constructs can help define what risk means to an individual (Sjöberg, 1979). The concerns for risk are based on the probability and the consequences of the occurrence of an event (Adams, 1995). The perception of risk can vary greatly and is often different than the level of objective risk associated with the situation

(Boholm, 1996). The "objective" risk of a situation is the degree of risk that is independent or outside of the individual's fears and knowledge about the source of the risk. (Ulleberg & Rundmo, 1996). In most situations, the level of perceived risk can reflect real risk, especially when risks are well-known (Sjöberg, 1995). This would be very true in the case of Indigenous drinking water and the very real and persistent problems associated with it.

Environmental Risk Perception

Studies have examined how concerns over environmental problems are related to levels of risk perception of people who are affected by the issues. Not surprisingly, this research has shown that in areas plagued with consistent environmental concerns, there is an increase in perceived risk associated with that problem. In a study that examined air pollution in China, relationships between the levels of air pollution and the related perception of risk were shown regarding impacts on the respondents' health. In areas that experienced higher levels of air pollution, perceived risk to people's health in relation to air pollutants was higher (Pu et al., 2018). In the Big Sandy Coal Mine region of West Virginia decades of coal mining have impacted the area with numerous environmental issues such as contamination of ground water and air pollution. These increased levels of environmental risks have been shown to be related to increased level of perceived environmental risk to the people that reside in the area (McSpirit and Reid, 2011). In many Indigenous communities in Canada, extensive environmental risks are often associated with their sources of drinking water; therefore, it is assumed that members who live in these communities should have heightened levels of risk in regard to their drinking water. However, since perception of risk is a subjective process, other factors, such as culture and lived experiences, can affect the level of concern.

Socio-Cultural Perspectives on Risk Perception

In research that examined perceptions of risk in eating traditional foods for northern Indigenous communities, it was shown that cultural practices and Traditional Knowledge affected levels of perceived risk and the resulting behaviours around it (Friendship et al., 2012). Like natural sources of water, traditional foods play an essential part in many northern Indigenous communities and many of the sources are increasingly becoming more contaminated with pollution and resource extraction in the area. Despite this increase in danger, many

community members continue to eat the contaminated traditional food sources. It was shown that the determination of safety was based on a complex individual evaluation process that involved personal value systems and levels of traditional knowledge about historically safe sources of foods (Friendship et al., 2012). This practice of self-evaluation is like what was seen during the interview process regarding drinking natural sources of water and the practices around it while on the land.

Overall, cultural research appears to indicate that the strong historical cultural practices in Indigenous communities while participating in hunting and traditional activities on the land may lower levels of perceived risk regarding drinking sources of natural water. This could help explain why many interviewed community members failed to indicate concern over the quality of their water sources in their community and why many members still drink potentially unsafe sources of water. Often, historical usage and necessity were mentioned as a reason for drinking local water sources.

1.4 Setting and Background

This thesis and its findings are based on research conducted in two northern Canadian Indigenous communities that are approximately 300 kms apart. The two communities involved are the Dene Tha' First Nations (DTFN) and the K'atl'odeeche First Nations (KFN). The DTFN consists of the three communities of Chateh, Meander River, and Bushe River (near High Level, Alberta) located in north central Alberta. The KFN has one community on the southern shore of the Great Slave Lake in the Northwest Territories that is located next to the community of Hay River. Both communities (DTFN and KFN) are Dene people which have strong spiritual connections, both to the land and to their culture. Both communities have been impacted by social injustices by the Canadian government such as residential schools and the destruction and reduction of their traditional lands. Although many historical and cultural ties connect these two First Nation communities together, many differences between them accentuate the problems associated with drinking water in both communities.

Figure 1.1 – Location of Participating Communities

(map from Google Maps)

1.4.1 History of the Participating Communities

History of the DTFN

Although the DTFN signed Treaty 8 in 1900, they did not receive their territorial reserve land until 1946 (Horvath & Dickerson, 2002). The predominant languages spoken are Athapaskan Dene and English. Historically, the Dene Tha' lived a mainly nomadic lifestyle, moving as necessary to follow and harvest various food sources. In the 1950's, missionaries encouraged families to settle in permanent settlements when a residential school was built in Assumption or what is now called Chateh (Horvath & Dickerson, 2002). As of 2018, approximately 1800 people live in roughly 350 dwellings spread across the three communities. The DTFN community governance consists of an elected chief and an eight-member council. Over 450 students from Kindergarten to Grade 12 are administered by the various schools situated in the three communities. Several administrative buildings and businesses service the communit'ies' various needs. (ttp://denetha.ca/about-us/).

The DTFN has various water delivery infrastructures throughout the three communities. Chateh has a modern water treatment plant in the community that effectively treats and provides

household water to the community members. Homes close to the plant are serviced by underground supply lines for their household water. However, households further away from the plant receive their household water using water trucks and underground concrete water cisterns. The current treatment plant in Meander River is old and, beyond adding and monitoring chlorine, does not treat or filter the water it supplies to the community. However, a new facility is being built with an intended completion date of 2019. The water in Meander River is very hard and fluctuates between safe and unsafe parameters for human consumption. A water softening plant on location was built a few years ago by the federal government; however, according to the plant operators, it has never been used because of the lack of a sufficient water supply to flush the system so the water softener plant cannot properly function. The households in Meander River are supplied through a pressurized water supply line or by water delivery trucks and cisterns. The households in Bushe River are supplied by water trucks and cisterns providing water that is purchased from the city of High Level from its municipal water treatment plant.

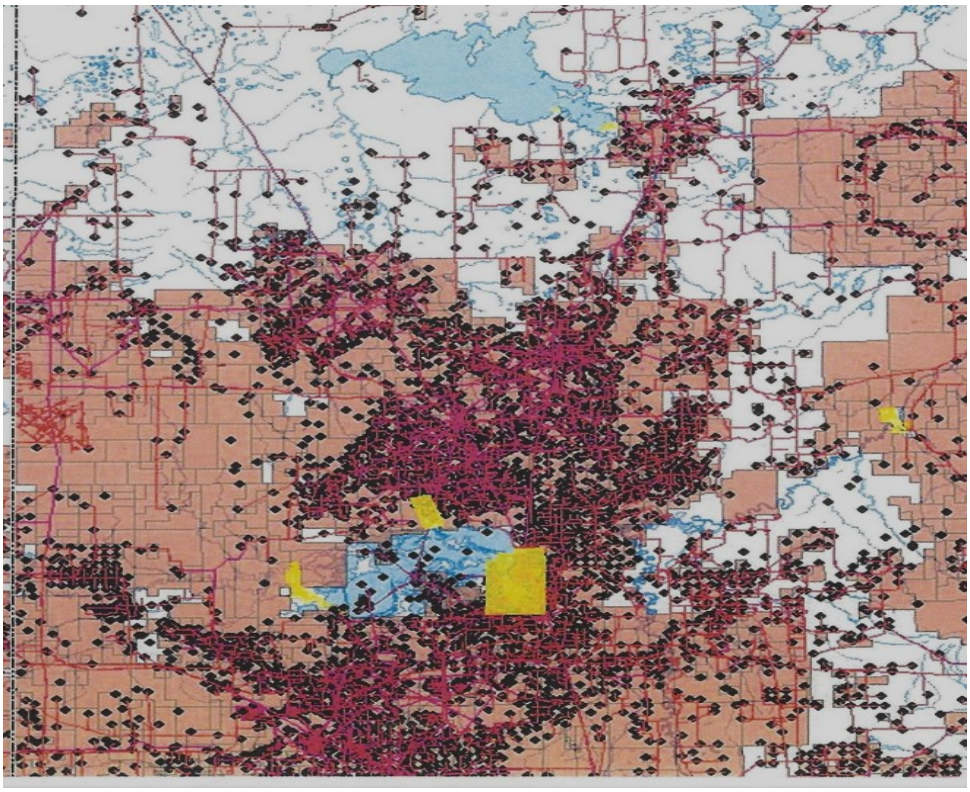
According to the research and interviews conducted, numerous problems are associated with the water delivery process in the DTFN communities. In the DTFN, the homes and their maintenance are the responsibility of the community. Unfortunately, a lack of funding makes testing and maintaining the water delivery system at acceptable levels a difficult and often impossible task. This leads to irregular testing and cleaning of individual water cisterns, something which is the source of many problems and about which many community members express concerns. Frequent flooding in the community of Chateh where many of the households are located on a floodplain causes problems. This means that some water cisterns are flooded regularly by floodwater and the pollutants that may come with it. In addition, natural sources of water are also impacted and contaminated during flooding events. At the time of the interviewing process in 2016, several homes were having their cisterns cleaned because of flooding that occurred two months previously. This habitual flooding in this community exacerbates the problems for drinking water for households and heightens concerns over drinking water security for the community overall.

Starting in the 1960’s, various extractive industries including forestry and oil/gas industries moved into north central. These developments led to the traditional territory of the

DTFN becoming heavily accessed and affected by these industries. Although the extensive repercussions from these industries are still being felt today, the DTFN received very little compensation for this exploitation and destruction of their lands. This means that although Alberta has experienced substantial economic growth and large increases in the standard of living for most Albertans, the living conditions in these communities were, and continue to be, far below provincial standards (Horvath & Dickerson, 2002). In addition to the lack of economic reimbursement, the various extractive industries have had large environmental impacts due to low environmental regulations. This created substantial impacts on the ability of the DTFN members to hunt and fish to support and feed their families. This further compounded the social problems in the communities and directly affected their ability to participate in traditional activities. Still today, despite lower levels of extraction, the impacts are being felt by the communities today with community members being forced to go further and for longer times to hunt for food sources due to the destruction of habitat.

While touring the area, the extensive contamination in the area from the extractive industries is clear. Through the interview process, extensive concerns over the pollution and contamination of natural sourced water within the DTFN area were expressed.

Figure 1.2 – Map of Oil Wells in the DTFN Traditional Territory



(Map provided by DTFN Health Director. Each Black dot represents oil well within the area surrounding the community)

History of the KFN

The KFN was a signatory to the historical Treaty 8 in 1899 and is one of two reserves located in the NWT. The KFN received its reserve land in 1974 (approximately 52 square miles). The KFN has a band membership of approximately 600 individuals with 327 living on the reserve in 2016 in approximately 80 households (http://www. Katlodeeche.com; https://www.statsnwt.ca/ community-data/Profile -PDF/Hay%20River%20Reserve.pdf). The community governance consists of a chief and six councilors who are elected by the community membership every three years. A school, a community owned store (Ehdah Cho) and a variety of administrative and support offices service the needs of the community (www.Katlodeeche.com). In 2015, the community completed the construction of a Wilderness Lodge on Sandy Creek which was built with the intention of attracting tourists, providing a gathering place for the community members and hosting conferences.

The KFN has no community-based water treatment plant. The source water, drawn from Great Slave Lake, is treated by the municipal water treatment plant in Hay River and piped over to the KFN community. The water is then delivered via a water truck to the various households located throughout the reserve. The water cisterns, due to the extreme environmental conditions of the north, are mostly situated within the home, or in some cases under the home.

During the interview and research process, numerous concerns and problems associated with drinking water in households were brought forward. Some respondents mentioned a concern about the tap water due to spring breakup and the resulting annual DWA issued to the community. Some members mentioned concerns over the frequency of water cistern testing and cleaning in the households. In the KFN, the homes are owned by the individuals and the maintenance of the water cisterns is the responsibility of the household. However, the testing (done by request) is a community health representative responsibility.

Historically, minimal resource extraction has taken place within the KFN traditional territory; however, global warming and technological advancements have made the exploration and exploitation of resources more commonplace within the area. Growing concerns are being expressed by KFN community members about the potential impacts of various sources of pollution. Many respondents mentioned the pollution that was coming downstream from Alberta, especially in the Hay River. Other sources of pollution that were mentioned were the Giant Mine in Yellowknife, N.W.T. (an old abandoned gold mine responsible for extensive arsenic contamination in the area) and Pine Point (an old abandoned iron ore mine within an hour of the KFN).

1.5 Overview of the Thesis

This thesis consists of five chapters and follows the format of a paper-based thesis. Chapter one presents an introduction to the overall project, the thesis, the objectives, the significance of the study, and a literature review of the overarching theories involved. Chapter two presents the methodology used for this project including data collection, the interview structure, the scope of the research, the collaborative partners involved and the limitations of the research. Chapter three

presents the examination of drinking water consumption patterns of the two participating communities to better understand how various factors influence people's consumption choices both within the home and while on the land. Chapter four examines water security levels, both household and natural sources, for Indigenous communities in Canada. It outlines the various components of the problem both on a social and structural level. It presents an assessment tool that is designed to allow communities and the federal government to identify and assess the various components of water security. The last chapter provides an overview of the subject matter, recommendations, further research and possible policy implications that arise from this research.

CHAPTER 2
METHODOLOGY

2.1 Methodological Approach

This research was developed and conducted to better understand the complex subject of Indigenous drinking water in Canada. Guided by previously conducted research on water security, drinking water consumption variables and environmental risk perception, this thesis provides an in-depth examination of drinking water patterns in two Indigenous communities in northern Alberta and the Northwest Territories, Canada.

A collaboration with K'atl'odeechee First Nation and Dene Tha' First Nation was developed to address local questions of the leadership about drinking water insecurity. Both communities were contacted at the start of the process and were consulted to see if the subject matter was an appropriate and current concern within their community. The community contacts for the research and the research assistants were asked for input on suggested questions and confirmation of the finalized questions that would be used in the interview process. The interviews were conducted in a wide variety of environments that provided the most convenient setting for the participants and put them most at ease in the process.

Case study Approach

A case study was considered to be the approach that was best suited to address the various research questions upon which this thesis is based. The case study method is defined by Yin (1984) as "…an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (p. 23). A case study provides a systematic approach to examine an event or a group of related events to explain and describe the topic of interest (Bromley, 1990). Case studies allow complex phenomena to be examined in great detail without the need for extensive data collection (Rowley, 2002; Yin, 1984; Harrison, 2017; & Rowley, 2002). Given limited time and money available to conduct research, I focused on two communities (2 separate case-studies) which allowed for detailed results that are specific to those communities while allowing for some comparison between them. These communities were

chosen because of their similar cultures, their willingness to participate, their locations and their desire to address the problem of drinking water.

Community-Based Participatory Research

This research was conducted using the Community-based Participatory Research (CBPR) methodology as it has long been recognized as an important process that allows addressing inequities in knowledge and power within many societies (Stanton, 2014; Castleden et al., 2012; & Ball et al., 2008). Its history is well developed in Canada with increasing recognition that equitable research engagement with Indigenous communities is a key step towards decolonization and reconciliation (McGregor, 2010). According to Castleden et al.,(2012), CBPR is "…a process by which decision-making power and ownership is shared between the researcher and the community involved; bi-directional research capacity and co-learning are promoted; and new knowledge is co-created and disseminated in a manner that is mutually beneficial" (p.162).

The use of CBPR allows for the communities to help direct the research throughout the process and incorporates Indigenous ways of knowing. It also acknowledges that there are different ways of learning and different types of knowledge. Traditional Knowledge (TK), under CBPR, is given equal weight with the more traditional forms of scientific knowledge (Fletcher, 2003). The use of CBPR has grown in response to the growing political autonomy of Indigenous groups in Canada as it acknowledges their right to self-governance and authority over what happens in their communities (Castellano, 1993). This method is crucial in conducting meaningful research that truly incorporates the local TK and the perspective of the participating communities on the subject being examined which produces a much more beneficial outcome that properly addresses the topic (Stanton, 2014; & Ball et al., 2008).

This research exhibits the three characteristics of CBPR as outlined by Stanton (2014). First, it was formed and carried out with the active collaboration of the participating communities throughout the process. Second, the project was democratically directed throughout with goals that suited both the participating communities and the researcher. Third, this research

will lay a foundation that could help direct improvement and awareness in a very important subject that is crucial to many Indigenous communities across Canada.

Conducting CBPR within the context of the case-study approach provided an in-depth analysis of the two participating communities while following the practices outlined in the CBPR literature. This research was carried out in two Indigenous communities (the DTFN and KFN) that, despite sharing a similar Dene heritage and being only a three-hour drive apart, have different perspectives and problems associated with their drinking water. Conducting case study research allows the unique perspective of the communities to be presented from a variety of participants that have varied backgrounds and this presents a better, more developed picture of the problems being examined. Having two communities that are situated close together and have similar cultural backgrounds allows for the same topic to be discussed and examined while highlighting the differences and similarities regarding drinking water.

Examining two communities that were both collaboratively involved throughout the entire process allows a better understanding of the different variables involved and how they influence the different aspects of drinking water within these communities. In addition, the communities were located in different jurisdictions, Alberta and the North West Territories. This allowed for the development of a better understanding on how different regulations and governance can play a significant role in the quality of drinking water available to these communities. For this research, approximately 10 days were spent in each community while conducting the interviews. While this allowed for a fair number of interviews to be conducted, the development of relationships between the researcher and the community members was limited.

2.2 Scoping

Review of Secondary Data

Prior to and after conducting the research, literature reviews were performed in relation to each of the objectives of this thesis. The intention of the initial literature review was to have a better understanding of the previously conducted research for this subject matter. Unfortunately, research that has examined the specific topics of water security, water consumption patterns, and

drinking water problems from the perspective of Indigenous communities is very limited; therefore, the literature review had to include a much broader scope, where water security, consumption patterns and water problems were examined from a multitude of perspectives, lenses and disciplines. This expansive literature steered this research in the direction of a focus on Indigenous communities. From this literature review and in consultation with Dr. Brenda Parlee, Kevin Ahkimnachie (originally from the DTFN) from the office of Treaty 8, and representatives from the KFN, the interview questions were compiled to help further develop this subject matter.

2.3 Interview Approach

Ethics Requirements

This research was conducted in accordance with procedures as outlined in the University of Alberta Ethics requirements. The ethics approval for the University of Alberta was issued under "Tracking Change in the Mackenzie River Basin," study ID Pro00065907 (see appendix G) and "Understanding Changes in Freshwater Ecosystems and Drinking Water in Northern Canada," Study ID Pro00064419 (see appendix H) The ethics approval for the work conducted in the Northwest Territories came from the Aurora Research Institute, License No. 16045 (see appendix F) under the project name, "Understanding Changes in Freshwater Ecosystems and Drinking Water in Northern Canada."

After the initial introductions at the start of the interviews, a written copy of a plain language summary of the research (see appendix D) was given and explained to the potential participants. If needed, a translator was used to ensure that the individual fully understood what the research was about and why it was being done. The interviewees were informed that they would receive a $50.00 gift card for participating in the research. The consent form (see appendix E) was then given to the participant and each section was verbally explained while the researcher checked yes or no to the various categories of the form. The participants had the ability to decide if they could be identified in any publications that arose from this research and if they wanted their interview transcripts given back to the community after the research and writing of the thesis was complete. They also were asked if the conversation could be recorded. The participants were told that they were under no obligation to participate and that they could

withdraw at any point of the interview process. After going through the various aspects of the consent form, the interviewees were then asked to sign it. At this point the interview itself started and for those who consented, the interview was recorded via phone by the researcher.

Respondent Sampling

For the selection of possible participants, purposive sampling of the respondents was conducted. The community research assistants (CRA) played a crucial role in the selection of the respondents in that they had extensive knowledge of the communities and ’their members and selected people that fit within 3 categories that would give as wide a range of answers. These categories included elders (approximately 10 in total of both genders), reserve administrative people (approximately 10 in total that ranged in age and gender), and other community members (approximately 30 in total that ranged in age and gender). Both CRAs had previously supported research in their community and had a basic understanding of research methods. They were instructed to ensure as wide a variability in the respondents as possible to provide as much variance to the answers and perspectives presented as possible.

Interview Structure

The interviews were designed to collect specific information that had been ascertained through the literature review to be related to the subject matters this thesis examines. The two central questions of the interview guide were:

- Do you drink water from the land? If not, why?
- Do you drink water from the tap? If not, why?

The interviews were conducted in the environment that best suited the respondents. These locations included the respondent’’s home, the researcher’s vehicle, community buildings, and beside fire pits in the bush. The interviews ranged from 12 to 60 minutes in duration, depending on the respondent’s answers and desire to present their views on the drinking water situation in their community. The researcher, if allowed, recorded the conversation and wrote the answers to the questions as they were given throughout the interview process.

After the administrative aspects (explained previously in ethics requirements) were conducted, the interview started with questions to ascertain personal variables that included name, gender, age, employment, education level, fluency in English, and address (see Appendix A). Although initially in the DTFN, participants were asked their income level during the interview, it was decided that the information was too personal in nature. After the first few interviews, this question was excluded so not to create tension throughout the interview. Following the socio-demographic questions, a series of questions were asked to ascertain consumption patterns and perceptions of risk, both within the household and while on the land participating in traditional activities, to find out what sources of water the interviewees drank from and why (see Appendix A). Additionally, people were asked if they have expressed concerns over the drinking water within their community, to whom and whether they had been addressed. Finally, at the end of the interview, the respondents were given the opportunity to bring forward additional information they thought was pertinent to drinking water in their community. In the KFN, after the first few interviews, an additional set of questions was compiled and added to the interview (see Appendix B). Although the results from this last set of questions in the KFN are not presented in this thesis, the questions were designed to help the community develop a better understanding and address specific concerns from community members that were being consistently being brought up such as fees for water delivery and who should be responsible for the cleaning of the water cisterns. Throughout the entire interviewing process, no pressure was exerted for the participants to answer all questions.

Semi-structured Interviews

The use of semi-structured interviews was considered to be the most appropriate technique to use due to its flexibility in allowing members to answer as they saw fit, but under the desired direction of the researcher to ensure that the research questions were being answered. Using a list of the same questions for every interview ensured the continuity and consistency of answers that allowed for more thorough and comprehensive results and analysis.

Analysis of the results of Semi-structured Interviews

After the interviews were conducted, they were transcribed into an electronic format and Excel spreadsheets were created for both communities where the results were combined. This allowed for a better understanding of the results and allowed for the tabulation of the various answers. It also permitted easy analysis of the various results in a quantitative format. This quantitative data made comparison between the two communities and analysis of the results a much easier process. There was no need really to code the information as the answers were very specific in nature due to the structure of the interview questions.

Respondent Information

In August of 2016, 49 interviews were conducted in the three DTFN communities. In community of Bushe River, 14 out of 146 households (9.59 percent) were interviewed. In Chateh, 24 out of 280 households (8.57 percent) were interviewed. In Meander River, 11 out of 122 households (9.02 percent) were interviewed. In total, 27 females throughout the three communities that ranged from 20 to 84 years of age, with an average age of 56 years, were interviewed. Their education levels ranged from no formal education to a university degree with an overall education average of grade ten. There were 22 males interviewed throughout the three communities that ranged from 22 to 86 years of age, with an average age of just under 54 years. Their corresponding levels of education ranged from no formal education to some university education with an average of grade eight.

In April of 2017, a total of 50 interviews were conducted which involved 46 out of approximately 80 (57.50 percent) of the total households within the KFN. Another two individuals who lived within the adjacent town of Hay River, NWT but were KFN band members were also interviewed. In total, there were 32 females interviewed throughout the two communities that ranged from 21 to 83 years of age, with an average age of just over 51 years. The education levels for these respondents ranged from grade 3 to university degrees and an overall average of grade ten. In total, 18 males were interviewed ranging from 24 to 78 years of age with an average age of just under 50 years. Their education levels were from grade six to university degree with an overall average of grade ten.

Community Debriefing

After research was completed and the results compiled, the researcher went back to the participating communities and distributed the results via a newsletter, along with a copy of their interview transcripts to each of the participants. At both communities, a short public presentation was given at the communities' annual general meeting and the newsletters were available to anyone who was interested in the results. It is the intention of the researcher to go back to the communities and fully brief the chief and council about the research and what the results were. Once the work has been completed, the transcripts will be returned to the community, minus the ones where the interviewees did not want the community to receive their interview records.

2.5 Limitations

Some limitations of this project should be outlined. One of the first limitations to this data is the small sample size. Although the completion of 99 interviews is quite extensive for a master's thesis, it does not provide enough data to provide any true predictive ability for the research findings. Language was a limitation in the case of some interviews conducted in the DTFN as some Elders did not speak English; however, the use of Molly Chisaaky as an interpreter made the process a fairly easy one beyond a longer period for the completion of the interview. However, language could have created some unknown barriers that may have some impact on the results in that respondents may not have been able to fully understand what was being asked of them or the results were misinterpreted.

Another limitation was the amount of time spent in the communities. It is recommended for Indigenous, community-based research to spend extensive time in the communities to be able to develop a better understanding of the community and the subject matter being examined. However, because of constraints due to personal commitments in Edmonton, I was not able to spend a great deal of time in the communities. However, the use of CRAs, the use of the semi-structured interviews, and having spent time collaborating with the communities prior to the interview process allowed me to complete the necessary research in a timely manner.

The nature and structure of First Nation communities makes a truly random sampling a very difficult and unrealistic approach for the selection of participants. Some households in both

communities were not included due to concerns over potential personal safety of the researcher. Due to the non-random selection of respondents, there is no truly predictive ability of the results and the results could be potentially biased.

CHAPTER 3
DRINKING WATER CONSUMPTION PATTERNS: AN EXPLORATION OF RISK PERCEPTION AND GOVERNANCE IN TWO FIRST NATION COMMUNITIES

3.1 Introduction

The sustainability of drinking water is an important issue around the world. Many Indigenous communities in Canada struggle to have safe and acceptable sources of drinking water both in their homes and out on the land (Dupont et al., 2014; Galway 2016; Walters et al., 2012; Baird et al., 2015; Hrudey, 2011; Morrison et al., 2015). Indigenous communities from northern Canada historically have depended on clean sources of drinking water from the land (e.g., rivers, muskeg); however, the sustainability of these sources is increasingly tenuous due to the impacts of climate change, resource development and other human disturbances (Schindler, 2001; Martin et al., 2007; Schindler and Donahue, 2007; Mora-Rodríguez et al., 2014). Equally concerning is limited, poorly maintained or failing drinking water infrastructure (Ekos Research Associates, 2011). While efforts are being made to create and enforce consistent water quality guidelines across Canada, the standards in different federal, province and territorial jurisdictions remain varied (Bakker, 2007). In Canada, the communities who experience the poorest water quality conditions are frequently Indigenous. This research tries to better understand the implications of poor drinking water quality on the patterns of water consumption in the participating communities.

This research examines drinking water consumption patterns in two northern Canadian First Nation communities of Dene Tha' First Nation (DTFN) in Alberta and K'atl'odeeche First Nation (KFN) in the Northwest Territories. Working collaboratively with the First Nations leadership and their communities, data was collected from 99 individuals from 2017 to 2018 with the aim of addressing the following objectives.

1. Explore how risk perception and other social-economic variables influence individual drinking water consumption patterns (including water from the land and water from home).

2. Explore how political jurisdiction and associated infrastructure and regulations influence individual drinking water consumption patterns by comparing results from Dene Tha' First Nation in Alberta and K'atl'odeeche First Nation in the Northwest Territories.

3.2 Setting

Dene Tha' First Nation

The DTFN is a community of both Cree and Dene and Beaver speaking families. Approximately 1800 people (350 households) live in the three communities of Bushe River, Meander River and Chateh; however, there is also a population of Dene Tha' members who live outside of these communities as well. The total region of Dene Tha' territory is currently defined as 74,224 acres; however, their traditional hunting, trapping and fishing territories constitute a much larger area of present-day Alberta, Saskatchewan and the Northwest Territories. A variety of services are provided in these reserve communities, including municipal water services. The Dene Tha' was a signatory group to Treaty 8 in 1900 and they received their territorial lands in 1946. The Dene Tha' lived a mainly nomadic lifestyle until a residential school was built in Assumption in the 1950s, and the missionaries encouraged families to settle in permanent settlements (Horvath and Dickerson, 2002). Extensive oil and gas extraction and forestry (pulp and paper production) have created widespread environmental stresses on the DTFN territory (Vanderklippe, 2013; Wang et al.,1998; & McClure, 2013).

The DTFN has water treatment plants in two of its three communities (Meander River and Chateh) and buys water from the city of High Level to provide households in Bushe River. It delivers household water via water truck and water cisterns or pressurized supply lines. Numerous problems are associated with the water delivery process. Along with the lack of regular testing and cleaning of the cisterns, another major cause of contamination and increasing the number of water advisories is flooding. In Chateh, many community households lie within a floodplain, which means that their water cisterns are sometimes polluted by natural water and all the pollutants that may potentially come with it. In fact, at the time of interviewing in the community, homes were having their cisterns cleaned because of flooding that occurred in June, 2016. This clearly exacerbates the problems for drinking water. In these three communities, the administration is responsible for testing and cleaning household water supplies.

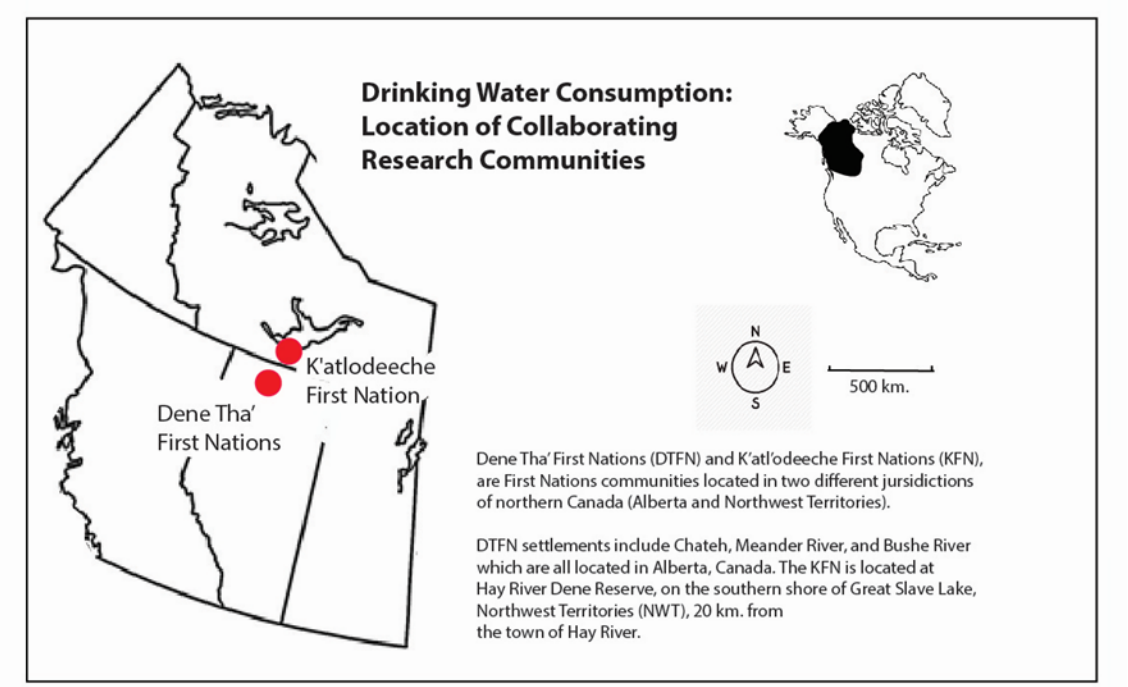


Figure 2.1 – Map of Locations of Collaborating Research Communities

K'atl'odeeche First Nation

The KFN, are also a Dene people who signed the Treaty 8 in 1899 and whose reserve lands were created in 1974. The reserve currently consists of roughly 600 individuals with approximately 300 living in about 80 households (http://www.katlodeeche.com). A school, a variety of businesses, and numerous administrative offices service the needs of the community. Historically, very little resource extraction took place within the KFN traditional territory; however, this is changing, and members are growing more concerned about the potential impacts of various resource extraction industries both within their area and in Alberta as the community is seeing the pollution coming downstream. There have been some problems and concerns associated with resource extraction in the area, including the Giant Mine in Yellowknife, N.W.T. (an abandoned gold mine that has poisoned the area with extensive arsenic contamination) and Pine Point (an abandoned Iron ore mine approximately 91 km from the KFN.

In the KFN, the water is supplied by the city of Hay River, delivered to community households via water truck, and stored in water cisterns either in or under the house. There is a yearly concern regarding the water at spring breakup and the resulting DWA that impacts the

community's' view on the quality and safety of the tap water. Some members expressed concerns over the consistency and frequency of water cistern testing and cleaning within the households. In this community, individual households are responsible for the cleaning of their own cisterns, and the community Health Representative is responsible for testing the water. The testing of household water is typically only done by request.

3.3 Literature Review

3.3.1 Context of Drinking Water Regulation

The regulation of drinking water in Indigenous communities is particularly complex and multi-layered, involving various government agencies that include Indigenous and Northern Affairs Canada, Health Canada, Environment Canada and local indigenous governments, with each department having their own area of responsibility (Walters et al., 2012). The situation is further exacerbated because guidelines and policies rather than formal laws and legislation govern drinking water, which results in confusion and lack of overall oversight and established regulatory practices. According to Morales (2006), numerous problems with the current policies for First Nations include regulatory gaps for drinking water on Indigenous reserve lands across Canada, substandard and inadequate water delivery infrastructure, inconsistent water testing, and insufficient community capacity due to improper training for operators, often insufficient funding, and poor monitoring of drinking water facilities to ensure adherence to policies and procedures.

Additionally, the effects of colonialism and numerous interrelated social factors, accentuated by exclusion from mainstream society perpetuate problems of access associated with drinking water in many First Nations communities (Hanrahan, 2017). The location of reserves is often problematic, as the land designated regularly lacks quality natural water sources (White et al., 2012). Furthermore, the historical treatment and policies of the Federal Government toward First Nations communities, such as residential schools and forced assimilation practices, have reduced the human and social capacities of Indigenous communities, exacerbating the problems associated with drinking water in many communities (Maxim and White, 2003). Resource extraction in Indigenous traditional territories can also have extensive effects on water security for the area. Among the issues in the Slave River region (where the DTFN and KFN are located)

are downstream (transboundary) contamination from Alberta oil sands activities, as well as the impacts of gold mining including arsenic contamination of surface and ground water near Yellowknife (Fawcett et al., 2015).

3.3.2 Drinking Water Patterns: The Trend toward Bottled Water Use

The consumption of bottled water has been increasing around the world (Doria, 2006; Dupont et al., 2010; Doria, 2010). In Canada, a cross-country survey conducted in 2004 showed that 38 percent of the respondents drink tap water, 40 percent filtered tap water, and 22 percent prefer bottled water as their main source of drinking water (Dupont et al., 2010). This emerging pattern of increased bottled water usage by individuals has been examined by academics extensively.

However, limited research on the motivations and patterns of the increased bottled water usage within Indigenous communities has been done. The increased levels of bottled water consumption seen within Indigenous communities could perhaps be explained by the fact that the risks are, on average, far greater than in non-Indigenous communities (Walters et al., 2012). Evidence of these increased risks is that, as of November 30, 2017, 95 long-term (in place for more than one year) Drinking Water Advisories (DWAs) and 41 short-term DWAs (temporary water issue) were active in various First Nations communities (not including BC or communities north of the 60th parallel) across Canada (Health Canada website).

In response to the increased use of bottled water there is growing research around the choices and perceptions of drinking water sources (Doria, 2006; Dupont et al., 2010; Doria, 2010; Neagan Burnside Ltd., 2011; Spence et al., 2012). The ways in which cultural beliefs, norms and knowledge influence water preferences is also a growing area of research (Larson et al., 2016; Sajadi et al., 2016; Skuras and Tyllianakis, 2018). Related areas of work focus on how previous water contamination events (e.g., illness and water advisories) influence perceptions of water safety (Cote et al., 2017). However, to date, relatively limited research has focused on the unique socio-economic conditions and risk perceptions of First Nations communities and how these influence drinking water consumption patterns; the majority has been macro in scale with limited attention to the distinct socio-economic, ecological and jurisdictional contexts of

individual communities (Brown et al., 2016). While some research has been done in Alaska, Nunavut and Labrador, no similar studies have been done with First Nations in Alberta and Northwest Territories (Eichelberger et al., 2017; Wright et al., 2018).

3.3.3 Risk Perception

Risk perception is the subjective judgement that individuals make about the characteristics and severity of a risk. While subjectivity is sometimes dismissed as of limited value in understanding water quality, an emerging number of academics recognize subjective assessment of risks as a valuable proxy indicator of environmental quality. Risk perception is also a common framework for understanding drinking water consumption patterns including bottled water use. Numerous variables can impact perceived risk including various demographics, level of perceived control, level of trust in institutions, familiarity of the environment, and information that is derived from external sources (Doria, 2010). Due to reported problems with drinking water in many Indigenous communities, it is hypothesized that risk perception would play a very important part in water consumption patterns.

The Role of Knowledge in Risk Perception

The knowledge and information that Indigenous communities use to evaluate the risks of drinking water from both the land and from the home comes from a variety of sources including water advisories, technical expertise as well as Traditional Knowledge.

It has long been assumed that a lack of information or formal education about the quality of water increased the perception of risk, resulted in an increased consumption of bottled water, and caused a lack of trust in the supplied tap water in some individuals (Contu et al., 2004). In research conducted in various First Nations communities, it was shown that an increase in the available information about testing practices and quality of tap water would make the respondents feel safer about the quality of tap water (Ekos Research Associates, 2011). This seems to indicate that if people were not aware or had low understanding of this information, there would be a tendency to have a decreased level of trust in the quality of their tap water.

An emerging body of work shows that other kinds of knowledge and expertise also influence the perception of water quality. Unlike other studies who approach communities through a deficit lens, this body of work assumes that local lived experience including experience on the land is a strength that outweighs more technical kinds of assessments. Moreover, such knowledge is more readily considered legitimate and meaningful in Indigenous communities. Traditional Knowledge of First Nations and other Indigenous communities has become the basis for the development of indicators for assessment and monitoring of water quality including the risks of drinking water (Galway, 2016; Fresque-Baxter, 2013; Furgal et al., 2010; Gajadhar, 2013).

Previous experiences of poor water quality including advisories on water quality have been shown to have long term implications on risk perception (Cote et al., 2017). Local advisories as well as significant water problems in one's own environment or community can create new or reinforce existing fears about drinking water quality. Water crises and related advisories can also impact many more communities and over a much larger time frame as a result of the amplifying effects of media reporting (e.g. newspapers). The Walkerton water crisis, for example, was shown to have impact across Canada (Cote et al., 2017). In communities experiencing frequent or chronic water advisories including Indigenous communities and those living in flood zones, etc., the situation can be more significant (Spence and Walters, 2012). These heightened perceptions of risk have been tied to increased bottled water consumption (Mcleod et al., 2014). Research in small rural coastal towns that had either experienced boil water advisories and/or water shortages shows that when under the boil water advisories, most people used bottled water as their main source of drinking water (Castleden et al., 2015).

Risk Perception – Worries about Health and Safety

While drinking water quality is frequently evaluated according to technical standards in Canada, subjective assessments of water quality including individual perceptions of whether the water is healthy or safe to drink are considered equally valuable. This includes subjective evaluation of both source water quality as well as human health implications of drinking poor water. Poor environmental quality has been strongly correlated with individual perceptions that drinking water is also of poor quality (Johnson, 2003). In a survey conducted in the United States

and Canada (including First Nations communities from southern Canada), concerns over the safety of the tap water were also strongly linked to bottled water consumption (Doria, 2006; Dupont et al., 2010; 2014; Ekos Research Associates, 2011). In some cases, the cause of increased health concern is tied to a particular event or site of perceived or reported water pollution. In research conducted in the Big Sandy Coal Mine region of West Virginia for example, it was shown that health concerns over tap water sources due to pollution from mining was associated with increased bottle water usage (McSpirit and Reid, 2011).

The Role of Taste and Smell in Risk Perception

Prior research and surveys indicate that the taste, colour, turbidity and odour of water play crucial roles in perceptions of drinking water and consequent choices about drinking bottled water (Doria, 2010). In particular, the taste of water can play a very important role in the decision to drink bottled water (Doria, 2006). In small rural towns in Saskatchewan, it was found that one or more aesthetic complaint about the tap water significantly correlated to an increased consumption of bottled water (Mcleod et al., 2014). In a cross-Canada survey of various First Nations communities, when examining why individuals thought the tap water was unsafe, various aspects including appearance (14 percent), taste (12 percent) and odour (10 percent) of the water played a major part in perception of risk, including whether the water is healthy or safe to drink (Ekos Research Associates, 2011).

Demographics and Socio-Economic Variations in Risk Perception

Various demographics have been previously shown to have weak but significant relationships to how people perceive the risk of their drinking water sources and how it impacts their choice of what to drink. Gender, age, education level, income and others are examined in this paper to see how they relate to people's choices and risk perception regarding drinking water.

Studies have shown that women are more likely to drink bottled water. In a survey that was conducted across Canada, it was shown that, despite regional differences, overall 59 percent of women respondents thought that bottled water is safer than tap water (Dupont et al., 2010). In Spence and Walter's (2012) examination of the APS results, it was shown that women were

statistically more likely than males to be more concerned about the safety of their tap water. In research conducted in First Nations communities, it was shown that women are more likely to have increased bottled water consumption and higher distrust of water sources in their communities (Dupont et al., 2014).

There are conflicting results when it comes to age and its impact on drinking water perceptions. In one study, some areas showing older people drinking more tap water than others, while in other areas, the opposite is true (Dupont et al., 2010). In the examination of the 2001 APS, it was found that age had no relationship to First Nations participants' response when it came to their perception of the degree of safety of their drinking water (Spence and Walters, 2012).

Surveys conducted across Canada indicate that less educated people are more likely to drink filtered water and it was hypothesized that this was because they are less able to assess the health risks of their drinking water; therefore, they were more likely to believe the claims of safety through home filtration units (Dupont et al., 2010). The same study indicated that individuals with higher education are less likely to drink bottled water as their primary source of water. The researchers felt this may indicate that educated people are more likely to be able to assess the available information and better understand the viability of the available drinking water sources (Dupont et al., 2010). The results of a 2001 APS show that higher education is related to greater concerns about the safety of the drinking water (Spence and Walter, 2012). In the case of many First Nations communities, it is hypothesized that individuals with higher levels of education are more likely to drink bottled water due to the high occurrence of problems with drinking water sources in the communities.

There are varying results in previous research on the impacts of income on bottled water consumption. Some research suggests that increased income or availability of money increases the likelihood of drinking bottled water as the primary source (Dupont et al., 2010). However, a study of the Appalachian Mountain region—an area with extensive coal mining—showed that where extreme potential health concerns associated with the mines existed, bottle water usage was high regardless of income (McSpirit and Reid, 2011). In a 2001 APS examination, it was

found that income had no effect on the perception of risk for drinking water (Spence and Walters, 2012).

3.4 Approach and Methods

The approach to data collection and analysis had several dimensions; data analysis followed a similar approach to Crampton and Ragura (2016). Interviews took place over several weeks with each First Nation. The Dene Tha' interviews were conducted in August 2016 and the Katlo'dechee interviews were conducted in April 2017. The Dene Tha' and Katlocechee samples are presented here as separate data sets with participants differentiated by membership to the First Nation. It is however, important to note that the data from Dene Tha' First Nations sample is presented as a single group, with participants not differentiated by their specific community of residence (Meander River, Bushe River and Chateh); all interviewees from Dene Tha' First Nation were, however, residents of one of these three community. All participants of Katlodechee First Nation were residents of the Hay River Reserve.

All analyses were conducted using the entire sample. Findings in the results section are presented as descriptive statistics to illustrate patterns in drinking water in the home and on the land. Additional results from simple bivariate analysis are offered to explain other patterns in the data. Quantitative data was analyzed using PSPP with Pearson's correlations; T-tests were also performed to test for significant relationships between various independent and dependent variables.

The non-normative distribution of results precluded regression analysis. The independent variables considered in the analysis were age (born before or after 1964), gender, employment status, and education (Tables 7, 8, 9). The main dependent variable considered was bottled water consumption (Table 1). Other dependent variables related to drinking water risk perception are presented in Tables 2, 4, 5, 6. These variables were developed based on responses to the questions: Do you drink water from the land? Why or Why not? as well as "Do you drink water from the home? Why or Why not?

It is important to note that data collection instrument included both qualitative (short answer) and survey style questions. While a more standardized and structured survey would have made data collection and analysis simpler, a more conservational approach to interviews was needed to ensure the comfort of interviewees. Due to that fact than answers to many questions were provided in the interviewee's "own words" (i.e., not standardized for all interviewees), qualitative thematic analysis had to be conducted to utilize the data in quantitative analysis. However, in many instances the responses were not lengthy enough to present as narrative. Responses were coded according to themes and then grouped according major themes (i.e., "the water is no good" and the "water is not healthy" were similarly grouped under the theme, "the water is not healthy").

3.4.1 Limitations

There are limitations or possible problems with using a bivariate analysis versus a multivariate analysis in that there could be external variables (and probably are) that are influencing the results of a simple bivariate analysis. However, this research is more about examining various variables and how, on the surface, they appear to be related to drinking water consumption patterns within Indigenous communities. This research was not intended to give definitive results on the relationships between variables and drinking consumption patterns but is more exploratory research to show possible variables that may influence people's drinking habits. Due to the extremely wide-ranging conditions for drinking waters for Indigenous communities, it is the opinion of this researcher that definitive relationships, even through a multivariate analysis, would be unlikely to truly be representative of all Indigenous communities.

3.5 Results

Data from 99 interviews about bottled water consumption are presented in this section in relation to the two main sets of questions asked during the interview process. The sources of water which are normally consumed by the respondents both within the home and from the land are presented in Table 3.1. In the DTFN, the vast majority of people drank bottled water both in the home and while on the land. In the KFN, although lower than the DTFN, roughly a third of the respondents drank bottled water while in the home. On the land, more similar results are seen

in relation to the DTFN when examining bottled water consumption in that the vast majority of respondents regularly drink bottled water.

Table 3.1 – Water Sources Normally Consumed

	Male		Female		
	# of respond.	%	# of respond.	%	T test
Normally Drinks at Home:					
Dene Tha' First Nations					
Bottled water	12	54.6	20	74.1	1.66*
Tap water	6	27.3	7	25.9	-0.27
Both Tap/Bottled water	3	13.6	0	0.0	-2.12*
Other	1	4.5	0	0.0	-1.16*
Total Respondents	22	100	27	100	
K'atl'odeeche First Nations					
Bottled water	7	38.9	10	31.3	-0.14
Tap water	6	33.3	17	53.1	0.68
Both Tap/Bottled water	4	22.2	5	15.6	-0.72
Total Respondents	18	100	32	100	
Normally Drinks on Land:					
Dene Tha' First Nations					
Bottled	18	81.8	22	81.5	0.10
Bottled/Natural Source Water	2	9.1	2	7.4	-0.30
Bring Tap Water	0	0.0	2	7.4	1.24*
Water from the Land	2	9.1	1	3.7	-0.86
Total respondents	22	100	27	100	
K'atl'odeeche First Nations					
Bottled	9	50.0	25	83.3	1.49*
Bottled/Natural Source Water	2	11.1	0	0.0	-0.69
Water from the Land	7	38.9	5	16.7	-2.09*
Total respondents	18	100	30	100	

significant at p < .05

3.5.1 Risk Perception

Worries about Health and Safety

When examining the reasoning behind individual preferences of water sources for consumption (see table 3.2), safety/health concerns were shown to play a crucial role in respondents' choices of drinking water, especially in the DTFN.

Table 3.2 – Reasons behind Choices to not Drink Water from the Home/Land

	Male # of respond.	Female # of respond.
Do you drink regularly bottled water at home? If yes, why?		
Dene Tha' First Nations		
Taste/Smell	9	9
Health / Safety	10	14
Ease/Access	1	2
Other	2	1
K'atl'odeeche First Nations		
Taste/Smell	10	14
Health / Safety	5	8
Ease/Access	3	5
Other	1	1
Do you drink regularly bottled water from the land? If yes, why?		
Dene Tha' First Nations		
Taste/Smell	0	2
Health / Safety	8	11
Ease/Access	11	15
Other	0	0
K'atl'odeeche First Nations		
Taste/Smell	0	1
Health / Safety	4	13
Ease/Access	7	12
Other	0	0

*respondents could give multiple reasons for consumption.

It became apparent early in the interview process that some sources were considered by many respondents to be important natural water supplies. To analyze the degree of importance of the sources to the two communities, after the first few interviews, more questions were added about the perceived degree of safety regarding five natural water sources: Muskeg filtered water, spring water, rainwater, snow water, and ice water (see table 3.3). In the DTFN, all of the five sources were considered safe and important sources of water by a majority of the respondents. In particular, water filtered by muskeg was a particularly important and safe source of water for the male respondents. In the KFN, muskeg water is much less significant as a source of drinking water and the corresponding levels of trust were lower as well. Sources of spring water are not readily available in the immediate area and the related perceived levels of safety were also lower than average. The majority of water consumed on the land came from the Great Slave Lake in either liquid or frozen form.

Table 3.3 Safe Community Natural Sources of Water

	Male	%	Female	%	T-test
DTFN					
Muskeg Water	18	90.0	13	48.2	-3.12*
Spring Water	16	84.2	19	70.4	-0.98*
Rainwater	10	58.8	11	47.8	-1.02
Snow Water	16	80.0	15	55.6	-0.91
Ice Water	14	82.4	13	56.5	-1.70*
KFN					
Muskeg Water	6	33.3	12	37.5	0.69
Spring Water	6	33.3	3	9.4	-1.03*
Rainwater	11	61.1	19	59.4	-0.08
Snow Water	16	88.9	23	71.9	-0.81
Ice Water	18	100	27	84.4	-1.71*

*significant at $p < .05$

In the DTFN, additional natural water sources beyond the five already mentioned that were considered good or safe were running water sources (20 people), standing water sources (7 people) and specific water sources (7 people). In the KFN, the Great Slave Lake (48 people), most natural sources (15 people), running water sources (4 people) and specific water sources (3 people) were mentioned as good or safe additional water sources.

One of the interview questions was why certain natural water sources were considered safe (see table 3.4). In the DTFN, the top three answers given were muskeg water was naturally filtered, the grotto spring was holy and built by Reverend Merriman, and moving water is better. In the KFN, the three top reasons given why specific natural water sources were good were that it was clean, the taste, and it was easy to access.

Table 3.4 Why Natural Sources of Water are Good?

	DTFN	*KFN*
Muskeg Naturally Filtered	9	2
Grotto is holy and/or built by Priest	8	1
Moving water is better	5	0
Clean	5	25
Others drink it	4	0
Taste	4	7
Free	1	0
Spiritual Connection to Muskeg	1	0
Easy	0	2
Haven't heard anything bad about it	0	1
Rain is from Heaven	0	1

During the interview, the participants were asked what natural sources of water are not considered safe to drink (see table 3.5). In the DTFN, the top three answers for poor natural water sources were everywhere, lakes in general, and specifically Zama Lake. In the KFN, the majority mentioned the Hay River, which travels north up through the DTFN territory into the KFN territory. The two other top answers for poor natural water sources were most natural sources and ponds.

Table 3.5 Where are Natural Sources are Poor?

	DTFN	*KFN*
Everywhere	16	0
Lakes	9	0
Most Natural Sources	0	4
Zama Lake	8	0
Standing water	5	2
Rivers	5	2
Creeks	0	2
Anywhere near Oil and Gas	4	0
Ponds	0	3
Hay River	3	30
Rainbow Lake	2	0
Sousa Creek	2	0
Chateh	2	0
Anywhere near towns	2	0
Habay	1	0
Natural Precipitation	1	0
Bushe River	1	0
Sandy Creek	2	3
Down South	0	1
Great Slave Lakes around edges	0	1
Polar Lake	0	1

When asked why the natural water sources were considered unsafe (see table 3.6), the health concerns related to resource extraction in both areas were expressed as major points of concerns for natural sources of water. In the DTFN, oil and gas extraction activity were the biggest reason as to why people considered the natural water sources to be unsafe. Additionally, pollution, the dirtiness of the water, and the local sawmill were the most commonly given answers. In the KFN, the biggest concern over natural sources of water was pollution with additional concerns over the dirtiness of the water and oil and gas.

Table 3.6 Why are Natural Sources Bad?

	DTFN	KFN
Oil and gas	29	7
Pollution	10	23
Dirty	5	16
Sawmill	5	0
Fish factors	3	0
Taste	3	1
Told not safe	3	0
Garbage	2	4
Low water level	1	0
Smells bad	1	1
Stale	1	0
Murky	0	5
Beaver fever	0	4
Dump in Hay River	0	4
Arsenic in Yellowknife	0	3
Sewage	0	2
Pig farm on Hay River	0	1
Smell	0	1
Bugs	0	1
Algae	0	1
Pine Point mine	0	1

Water Advisories

In the DTFN, 15 of the 49 households interviewed (30.6 percent) recalled having previously received boil water advisories for their tap water. In the KFN, only 2 of the 46 households interviewed remembered receiving individual water advisories; however, every year during spring break-up, the entire community is placed on a boil water advisory due to concerns about contamination of the tap water. In all cases of individual water advisories in both communities, only one household stated that they received a follow-up notice that their water was safe to drink.

Level of available information

Many of the interviewees in both communities did not know when their cisterns were last cleaned or tested. In the DTFN, 12 of 37 interviewees who had cisterns did not know when their

cistern was last cleaned, and 16 of 37 interviewees did not know when their cistern was last tested. Nine of the 12 people who did not know when their cisterns were last cleaned regularly drank bottled water. Twelve of the 16 interviewees who did not know when their cistern was last tested drank only bottled water. In the KFN, 11 of 49 interviewees did not know when their cistern was last cleaned, and 10 of 49 interviewees did not know when it was last tested. For those who did not know when the cistern was last cleaned, 3 of 11 regularly drank bottled water. Of those who did not know when their cistern was last tested, 4 of 10 regularly drank bottled water.

3.5.2 Organoleptics

As shown in table 3.2, taste played a significant role in people's consumption patterns in the home in both communities. However, taste plays a much less significant role in water consumption patterns while on the land.

3.5.3 Demographics and Socio-Economic Variables

For the purpose of this research, various socio-demographics were analyzed (see tables 3.1, 3.2, 3.3, 3.7, 3.8, and 3.9) that were previously studied by other academics to see if this study confirmed or contradicted those research findings.

Gender

Gender is presented in various tables to better understand the relationship between gender and consumption patterns (see tables 3.1, 3.2. and 3.3). In the DTFN, it was shown that there are statistically significant relationships between gender and consumption patterns in three of the four categories examined. Overall, female respondents (74.1 percent) were much more likely to regularly consume bottled water at home than the male respondents (54.6 percent). While on the land, the statistical difference was minimized as both a very large percentage of both men (81.8 percent) and women (81.5 percent) drink bottled water regularly. In the KFN, no significant relationships were indicated in the results for consumption patterns in the home. Overall, in the home fewer women (31.3 percent) drink bottled water than men (38.9 percent). While on the land, two statistically significant relationships are shown between gender and consumption

choices. On the land, more women (83.3 percent) regularly drink bottled water than men (50.0 percent) and men are more statistically likely to consume natural sources of water.

In table 3.3, the various types of natural sources of water commonly used for drinking are examined. In the DTFN, in three (muskeg, spring water and ice water) of the five sources a significant relationship exists between gender and what sources are considered safe. In the DTFN, 90 percent of males considered muskeg water safe, versus 48.2 percent of females. Spring water was considered safe by 84.2 percent of males and 70.4 percent of female respondents. When considering ice water, 82.4 percent of males considered it safe, while only 56.5 percent of females thought it was safe. However, in all cases, female respondents were more likely to consider the natural sources of water unsafe to drink in comparison to male respondents. In the KFN, ice water (100% male and 84.4 % females) and spring water (33.3 % male and 9.4 % female) indicated significant relationships between gender and consumption choices. Muskeg was the only natural water source considered safer by more females (37.5 percent) versus males (33.3 percent). The other two sources indicated similar relationships between male and female respondents in consumption patterns in relation to natural sources of water.

Age

For ease of analysis in the age category, the data was broken down into 2 groups—members who were born after and including 1965, and members who were born before 1965. This date was chosen because it split the number of respondents roughly in half and was approximately the average age of the respondents. The results in regard to age versus consumption patterns are presented in table 3.7. In the DTFN, 70 percent of those respondents who were born prior to 1965 primarily drank bottled water within the home versus 60 percent of those respondents who were born in 1965 or later. The only significant relationship indicated in this category of home water sources was in the KFN where 54.2 percent of respondents born prior to 1965 primarily drank bottled water versus 15.4 percent of those who were born in 1965 or later.

The opposite effect is noted when examining the natural water source consumption habits. In the DTFN, almost 4 out of 5 people (79.3 percent) who were born before 1965 drank

bottled water while on the land, compared to 85 percent of people who were born after and including 1965. In the KFN, this same drinking pattern was also shown in that 69.6 percent of people born before 1965 drank bottled water on the land while 72 percent of people born after and including 1965 drank bottled water.

Table 3.7 - Bottled Water Consumption vs Age

	Born 1964 or prior		Born 1965 or after		
	#	%	#	%	T-test
Dene Tha' First Nations					
In home	20/29	70.0	12/20	60.0	-0.64
While on the Land	23/29	79.3	17/20	85.0	0.50
K'atl'odeeche First Nations					
In home	13/24	54.2	4/26	15.4	-3.11*
While on the Land	17/23	73.9	18/25	72.0	-0.45

*significant at $p < .05$

Education

The relationship between education levels and consumption patterns is presented in Table 3.8. In the DTFN, education levels appeared to have a significant relationship with consumption patterns while on the land. However, education levels did not appear to be related to consumption choices while in the home. In the KFN, the opposite significant relationship between education and consumption choices while on the land is indicated in that higher educated people drink less bottled water. However, education levels do not appear to have a significant impact on consumption choices while in the home.

Table: 3.8 Bottled Water Consumption vs Education Levels

	Grade 9 or Less		Grade 10 or more		
	#	%	#	%	T-test
Dene Tha' First Nations					
In home	15/23	65.22	17/26	65.38	0.01
While on the Land	16/23	69.57	24/26	92.31	2.10*
K'atl'odeeche First Nations					
In home	5/13	58.3	12/37	31.6	-0.39
While on the Land	11/13	84.6	27/37	79.4	-1.17*

*significant at $p < .05$

Income

Table 3.9 presents the analysis of the relationship between employment status and consumption patterns. In the DTFN, a significant relationship was shown between employment status and drinking bottled water. Interestingly, a higher percentage of people with no or limited income indicated a higher rate of bottled water consumption. However, the results indicate that employed people are more likely to drink bottled water than people with limited income while on the land. In the KFN, a significant positive relationship was indicated between employed people and drinking bottled water where people with higher levels of income were more likely to drink bottled water in the home. While on the land, opposite results were shown in the relationship between non-employed respondents and their corresponding consumption patterns in that they were more likely to drink bottled water than employed people.

Table 3.9 Bottled Water Consumption vs Employment Status

	Employed		Not Emp./retired		
	#	%	#	%	T-test
Dene Tha' First Nations					
In home	14/26	53.85	18/23	78.26	1.82*
While on the Land	22/26	84.61	18/23	78.26	-0.56
K'atl'odeeche First Nations					
In home	12/29	42.86	5/21	22.7	-1.93*
While on the Land	17/29	65.38	17/21	77.3	1.19*

*significant at $p < .05$

3.6 Discussion

The Role of Knowledge in Risk Perception

These findings support previous research that show increased levels of safety concerns over water sources results in an increase of bottled water consumption (Johnson, 2003; McSpirit et al., 2011; Ekos Research Associates, 2011; Dupont et al., 2014; Dupont et al., 2010; and Doria, 2006). A significant number of interviewed community members in the DTFN regularly consume bottled water due to concerns over the safety of household and natural source water sources. The lower levels of safety concerns over water in the KFN are related to a lower level of consumption of bottled water than the DTFN; however, bottled water consumption within the KFN community is still higher than the national average. The use of spring water, rainwater,

snow water, ice water and muskeg water as viable sources in the DTFN shows the importance of natural sources of water while on the land hunting and fishing. It can be difficult for community members to bring drinking water with them while on the land, so they must use water sources available to them in the area. This does not necessarily mean that these natural sources of water are safe but they are thought to be the safest options available in the area. For members of the KFN, the Great Slave Lake was the largest source of natural water, with almost all interviewee considering it a safe source of drinking water.

In the DTFN, safety concerns were expressed over the water cisterns including the frequency of cleaning and testing and but also what had been found in the cisterns. The cisterns in the DTFN are located outside and consist of concrete pieces that may have originally fit well together, but decades of ground upheaval have caused many of them to no longer maintain structural integrity, which allows dirt and other items to get into the tanks. Many people complained about hearing of, or having found, rodents and insects and garbage in water cisterns. There have also been reports of diapers and garbage being found in the cisterns. Having contaminated water cisterns would mostly likely increase the levels of safety concerns over the water that is contained in them.

Some interesting parts of the interviews were the interaction between personal beliefs and the perceived level of safety people had. Some interviewees mentioned that they felt muskeg water was safer and an important source of water because traditional medicine came from it. Some people mentioned that the spring grotto in Meander River was safe because it was built by a man of the church and the water was holy.

The high level of concerns over the safety of natural sources of water in the DTFN is directly related to worries over contamination and pollution by natural resource extraction activities in the area. Oil and Gas development, past and present, is extensive throughout the traditional DTFN territory and is very problematic for the quality of natural water sources due to contamination. These safety concerns result in the consumption of bottled water when it was feasible while on the land. If taking bottled water out on the land was not possible, drinking

water from the previously mentioned sources is the common practice to help minimize the problem.

In the KFN traditional territory, resource extraction activities have been limited, which has resulted in fewer safety concerns over natural sources of water and a corresponding lower consumption of bottled water while on the land. There were still concerns over pollution, especially from what was coming downstream from Alberta and resource extraction activities that are on the increase in the area. Therefore, it is hypothesized that, in the future, higher levels of pollutants and impacts from increased resource extraction activities in the KFN territory will result in higher consumption of bottled water by community members.

Water Advisories

Both the KFN and the DTFN have had various drinking water advisories issued over the last few years. A few people in the DTFN mentioned that even though they may not have received a water advisory, they knew family members or friends that have received them. It is hypothesized that despite their own households not being affected, knowing other people had received DWAs may lead to higher levels of risk perception over health concerns over the water sources. In the KFN, very few households mentioned receiving individual DWAs; however, the community itself is placed on an annual DWA during the spring break-up of the Hay River and the Great Slave Lake. The high number of DWAs in the DTFN and the annual DWA in the KFN help to explain the heightened levels of risk perception in the communities and the resulting increased bottled water consumption. These results are like the results from previous research that showed a relationship between bottled water consumption and the existence of advisories (Mcleod et al., 2014; Spence et al., 2012; and Castleden et al., 2015).

Level of available information

The results in this category appear to be somewhat conflicting. The results from the DTFN appear to support previous research that claims a lack of knowledge about water quality results in an increase in the consumption of bottled water (Contu et al., 2004). In the DTFN, 75 percent of people who did not know when their cisterns were last cleaned or tested regularly drank bottled water. This is higher than the overall average of 65 percent of respondents who

drank bottled in the community. However, in the KFN, 27 percent of those who did not know when their cistern was last cleaned regularly drank bottled water versus the 34 percent overall. For those individuals in the KFN who did not know when their cistern was last tested, 40 percent regularly drank bottled water versus the 34 percent overall of all respondents. Perhaps the smaller number of interviewees who did not know when their cisterns were cleaned last can explain the inconsistency with the other results. In any case, most of the results appear to support previous research that a lack of knowledge about the quality of water will typically result in a higher rate of consumption of bottled water.

The Role of Taste and Smell in Risk Perception

This research appears to confirm prior research that the physical qualities of the water play a crucial part in decisions regarding water consumption practices (Doria, 2006; 2010; Mcleod et al., 2014; and Ekos Research Associates, 2011). As shown, taste played a very important role in an individual's consumption of bottled water at home, both in the DTFN and the KFN. While on the land, where safety and convenience were a bigger reason for bottled water consumption, taste played a significantly lesser role in decisions about drinking water.

Socio-demographics

There does appear to be some consistency in this research with the findings of previous research when examining the various socio-demographics.

Gender

The examination of gender shows that the results found in this research are mostly consistent with earlier findings in that there appears to be a relationship between gender and consumption habits of individuals in these two communities. The results from the DTFN appear to confirm previous results, while the KFN results somewhat contradict previous results when examining this variable (Dupont et al., 2010; Spence and Walters, 2012; Dupont et al., 2014). In the DTFN, more women regularly drink bottled water at home than men. While on the land, the gender gap is eliminated, with many of both genders regularly drinking bottled water, perhaps because of the severity of the situation for natural source water within the area. In the KFN, the relationship of gender and bottled water consumption is inconsistent with other findings in that

within the home, fewer women drink bottled water than men. This could perhaps be explained by the low number of participants who stated they drank bottled water in the home. However, while on the land, far more women stated they regularly drank bottled water than men. This would suggest that women perceive bottled water as safer than natural water sources while on the land.

An examination of what specific natural sources of water are considered safe further details gender differences and indicates that women are much less likely to think that natural sources of water are safe for consumption. For the specific natural sources of water including muskeg water, snow water, ice water, rainwater, and spring water, only muskeg water was considered safer by women (37.5 percent) in the KFN than men (33.3 percent). In all other circumstances, men were typically much more confident in the safety of these natural sources than women. These results support previous research that shows that women have much lower confidence in natural sources of water than men.

Age

Age does not appear to have a fully consistent relationship with consumption habits with the people interviewed, which may help to explain the conflicting results with previous studies (Dupont et al., 2010; and Spence et al., 2012). Splitting the interviewees into two groups (those born before and those born after 1965) shows that in the two communities, there appears to be consistency in the results when examining specific types of drinking water. Both communities show that younger people are less likely to drink bottled water while in the home, while older people are less likely to drink bottled water while on the land.

Additional research could help further develop this variable as, on the surface, the results appear to be contradictory. Why are the same individuals changing their consumption patterns depending on where they are? Perhaps familiarity or repetition of habits would help explain. If young people have grown up with access to running tap water and are accustomed to the taste of chlorine (which is a complaint of some respondents), they may be more likely to drink tap water. Older people on reserves often did not have access to running water in their homes when growing up and were more accustomed to using alternate sources of drinking water and not often exposed to the taste of chlorine. While on the land, older people grew up drinking local water

sources while younger people have not, due to the increased concerns over pollution or degradation of natural water sources.

Education

The results from this research, although contradictory in some ways to previous surveys that indicate that more educated people are less likely to drink bottled water, makes sense when you look at the conditions that exist within the communities, especially within the DTFN. Research in the past showed that less educated individuals are more likely to drink bottled water (Dupont et al., 2010). However, the drinking water situation in many Indigenous communities, especially within the DTFN, is so problematic that those with a higher education are more likely to drink bottled water than less educated people because of very legitimate concerns over the safety of the water sources. These results support previous research that shows that individuals with a higher level of education are more concerned about the drinking water in First Nations communities where conditions for water quality are low (Spence and Walter, 2012). These results also support our hypothesis that individuals with higher levels of education are more likely to drink bottled water due high occurrence of problems with drinking water sources in the communities. It should be stated that less educated individuals may still (and probably do) fully understand the concerns about water sources and the results show that they are still far more likely to drink bottled water than residents of non-First Nations communities.

In the KFN, although more people drink bottled water in the household than the national average, the results are more typical of those seen in non-Indigenous communities. Supplied water in the homes in the KFN, although some problems do exist, is generally considered by most participants (86 percent) to be safe, which explains the lower consumption of bottled water overall and lower bottled water consumption by more educated people. As these results indicate, people with more education are less likely to drink bottled water in the home and this supports the findings of Dupont et al. (2010). Similar results are shown for on-the-land water consumption habits. Although bottled consumption while on the land is very high for both categories, it appears that more highly educated people are still less likely to consume bottled water while on the land.

Income

The relationship between income and water consumption patterns seems to be in contradiction between communities and when compared to findings from other research. These results may indicate how high the level of perceived problems is with drinking water both in the home and while on the land, especially within the DTFN. Although level of income was not asked (stopped after the first few interviews) due to the sensitive nature and respondent reaction to the question, employment status was examined. If people indicated employment, it was assumed that they had income of some form. It appears that regardless of employment status, the extreme conditions associated with the DTFN household water meant that bottled water consumption was very high, which supports the findings of McSpirit and Reid (2011) that examined concerns about pollution in the Appalachian Mountains and the resulting impacts on water consumption habits. In fact, of the individuals interviewed in the DTFN, those who were unemployed were more likely to consume bottled water in the home than those who were employed. This appears to contradict the expected outcome in that people with lower levels of income would normally spend less money on bottled water. It could be that more interviewed employed people were on pressurized delivery lines versus cisterns, which may have lowered the concerns over the tap water and resulted in lower rates of bottled water consumption; however, further research would be needed to clarify why this trend occurs in the DTFN. The opposite consumption patterns occur in the KFN, where household water conditions are better. These results support the findings of Dupont et al. (2010) that show that availability of money is related to a higher rate of bottled water consumption. However, while on the land, the opposite relationship is indicated. To better understand this unexpected outcome, further research will be needed. Overall, in both communities, the vast majority of people regularly drank bottled water while on the land, regardless of income levels, which would be reflective of concerns over safety as observed by McSpirit and Reid (2011).

3.7 Conclusion

This research appears to confirm and sometimes contradict previous research that has examined this subject matter. It indicates that numerous variables can potentially impact people's consumption patterns for drinking water. Although taste does play an important part, heightened risk perception levels in these communities are shown to be directly related to an increase of

bottled water consumption in that many respondents feel that bottled water is a safer source of drinking water. As discussed in the previous section, it seems that some relationships exist between various demographics such as age, education and income and bottled water consumption.

These results conclusively show that the poor conditions of many water sources in the DTFN communities require many members to drink bottled water instead of the provided water sources. In the KFN, although the drinking water conditions are generally better, community members still drink far more bottled water than the national average. Unfortunately, this is the case in most Indigenous communities across Canada and many Indigenous households are spending large sums of money on bottled drinking water. This is a direct result of the federal government failing to properly address the massive problems associated with drinking water in most Indigenous communities across Canada.

Moving forward, it appears that the federal government has acknowledged the urgency and importance of safe drinking water sources. INAC has recently claimed that "all Canadians should have access to safe, clean, and reliable drinking water (INAC website, May 29, 2017). The same news release stated that it will work with First Nations communities to address concerns over the *Safe Drinking Water for First Nations Act* and come up with an agreed upon course of action to overcome the problems (INAC website, May 29, 2017). To help correct the course of history, the federal government pledged on January 23, 2018 to eliminate all long-term drinking water advisories by March 2021 (retrieved from www.canada.ca on January 25, 2018). It is to be hoped that the federal government will follow through on these promises; however, its track record to date has been poor.

CHAPTER 4
DEVELOPING A BETTER UNDERSTANDING OF INDIGENOUS WATER SECURITY AND THE VARIABLES THAT IMPACT IT

4.1 Introduction

In 2000, the Ministerial Declaration of The Hague on Water Security in the 21st Century stated, "water is vital for the life and health of people and ecosystems and a basic requirement for the development of countries, but around the world women, men and children lack access to adequate and safe water to meet their most basic needs (WWC, 2000)." Water security can be defined as "the sustainable use and protection of water resources that integrates acceptable levels of water risk to ecosystems and humans, while providing access to water of proper quantity and quality that can support livelihoods, economic development, human and ecosystem health, national security and protection against water-related hazards" (Wheater and Gober, 2013; Bakker and Morinville, 2013). Water security is increasingly being recognized by governments and non-governmental organizations (NGOS) around the globe as a matter of significant concern. In Canada, access to safe drinking water is not equally shared. Indigenous communities in many parts of the country including northern Alberta face disadvantages in the availability of and access to clean drinking water in their communities and on the land. Most of the research on this problem has attributed the problem to infrastructure and technical issues of water treatment and delivery in communities. "Attempts to "fix" water quality problems using technology alone have produced only limited success" (Patrick, 2011, p. 386).

Although Canada is rich in freshwater resources relative to many other countries, there are a growing number of stresses on sources of drinking water (source water), including contamination/pollution from industry, urbanization and the destruction/reduction of wetlands, which are crucial aspects of biodiversity and sustaining hydrological systems (Matsui, 2012). Climate change is also impacting water security, especially in the Arctic region where permafrost is melting and natural sources of water are changing (White et al., 2007).

In addition to the stresses on source water, lack of access to clean source water is a common problem among many Indigenous communities. Research shows that although the

levels of water security can often be lower in remote rural communities than in large urban areas, Indigenous communities in Canada have the worst levels of water security in the country (Hanrahan, 2017). Indigenous communities experience problems of lack of potable water similar to those seen in low-income developing nations where limited infrastructure and non-standardized regulations are the norm (Neegan Burnside Ltd., 2011). Key problems are poor infrastructure, a lack of human resources, capacity and resources to treat and supply water in homes, with the possibility of numerous problems in the process (Daley et al., 2015).

But the issue is not just technical. Poor water security in Indigenous communities is rooted in histories of colonialism that have led to the marginalization of people from their lands and resources and from mainstream society (Hanrahan, 2017). For example, at the signing of Treaty 8 and in other treaty areas, the location of reserves was the decision of the Crown and the land chosen was often non-productive land that lacked high quality natural water sources (White et al., 2012). Other kinds of policies such as the creation of residential schools have arguably decreased human and social capacities of many Indigenous communities and exacerbated water insecurity through a decrease in the communities' ability to address this and other kinds of social problems (Maxim and White, 2003; White et al., 2012).

The poor condition of on-reserve infrastructure including safe drinking source water has been a focus of significant federal attention and investment (Indigenous Services Canada, 2018). However, solutions to what has been described as a water quality crisis have been limited. It has also been suggested that the top-down approach (as opposed to a bottom-up approach) is also part of the problem; community members' voices and concerns, their cultures and specific social, geographic and economic needs are often not incorporated into the proposed solutions (Black and McBean, 2017).

It is in this context that this paper examines the range of capacities that contribute to water insecurity for Indigenous communities in Canada. Inspired by the capabilities or community capitals framework, we use the idea of capitals (natural, human, social/cultural and financial) to help us think about the factors that influence the availability and access to safe drinking water as well as local perceptions of water quality. This conceptual framework builds

on early work by Flora and Flora (2004), Emery et al. (2007) and others who defined community capitals as those natural, social, cultural, financial, built and human capital or assets that work together that provide people with the means to achieve their goals or improve conditions in their own lives. These assets can be quantified but they are also intertwined with local livelihoods and identities. In other words, "people's assets are not merely *means* through which they make a living: they also give *meaning* to the person's world" (Bebbington, 1999, p.2022). However, assets are not entirely positive but are defined and measurable within a spectrum. In the same way that we might ask how can the assets of a community contribute to improved food security, we might ask the question, how does the absence of assets contribute to water insecurity?

This paper offers a framework for understanding some of the complex socio-economic, cultural and ecological factors that affect water security. Drawing on outcomes of research in an Indigenous community in northern Alberta and an extensive literature review, the paper offers some criteria for assessing water security that go beyond the technical and challenge us to think about the various kinds of capacities (and capitals) that constrain or shape water security futures for Indigenous communities in Canada.

4.1 Setting

The research that contributed to this paper was developed with the Dene Tha' First Nations (DTFN) in northern Alberta. The DTFN comprises three communities in northern Alberta (Chateh, Meander River, and Bushe River near High Level). Community members have strong spiritual connections both to the land and their culture and are striving to make their communities better for future generations, and to heal the wounds of past injustices. In 1899, the DTFN was part of the signatory group to Treaty 8 but did not receive their territorial lands until 1946. Prior to the construction of a residential school in Assumption in the 1950s and the church's encouragement to settle, the DTFN lived a mainly nomadic lifestyle. Today, more than 1800 members live in the three communities. A school and a variety of administrative buildings and businesses service the community's various needs (http://denetha.ca/ about-us/).

During the 1960s, in response to the discovery of oil reserves and extensive forest coverage, various oil and gas and forestry industries moved into the area. Very quickly, the

traditional territory of the DTFN became one of the most accessed and developed areas by these industries in Alberta. Despite the vast amount of wealth generated for industry from the extracted resources, the DTFN received very little compensation for the exploitation and destruction of their lands. Sadly, living conditions in these communities are still far below provincial standards (Horvath & Dickerson, 2002). The development of various extractive industries substantially impacted the ability of DTFN members to hunt and fish to support their families, which compounded the social problems within the communities (Horvath & Dickerson, 2002). These impacts are still being felt today. Members are often forced to travel longer distances and for longer periods of times to find the necessary natural food sources such as moose, fish and fowl due to the interruption and destruction of wildlife habitats. There is also extensive contamination of the ecosystem in the area from the oil and gas industry and this has impacted the security of both natural and household sources of water. During the interview process in 2016, many community members mentioned concerns over the oil and gas contamination in the area. Respondent 39 mentioned that there were no longer fish in the area because of the pollution, which made them very concerned over the quality of the water as well beyond not being able to feed their families.

4.2 Methods

For this chapter, the data gathered through the interview process is used to illustrate the concepts presented in the two assessment frameworks that are presented. Due to the fact that these concepts of assessing levels of water security were developed after the gathering of data, not all aspects presented were actually examined through the interview process and so not all categories in these frameworks can be illustrated by the data. These concepts presented are admittedly very rudimentary and designed to help roughly outline the components presented. Further research will be required to further define and refine the concepts into a more workable framework that could more accurately ascertain levels of water security.

4.3 Overview of the Framework for Natural Source Water Security

This section examines and explains the natural source water security assessment tool. In the natural source water security table (see table 4.1), there are two main components: capacities and natural environment. In the capacities section, there are three individual categories (level of

awareness of potential problems, knowledge of natural sources of water, and frequency of drinking from natural sources) and one community category (level of degree that community is involved and has control over resource extraction in their traditional territory). In the natural environment section, three categories (environmental disturbance, impacts of environmental disasters, and impacts of environmental changes) are examined. The basis for these components came from an extensive literature review of water security and through discussion and collaboration with my supervisor, Dr. Brenda Parlee, and the participating community. This allowed us to develop a concept that attempts to fully encompass the multiple dimensions (social, cultural and physical perspectives) of natural water security for Indigenous communities in a meaningful and useful way.

Capacities of Individuals in Natural Water Source Security

The capacities of individuals are important components of water security, as the level of knowledge of potential problems associated with natural water sources can play a crucial role in natural source water security (Dickson et al., 2016). In most traditional territories (TT) belonging to Indigenous communities in Canada, numerous potential issues such as pollution and contamination can directly impact the quality of water and the levels of water security. This assumes that there are problems associated with some natural water sources and that they should not be consumed. This component will be based on the number of concerns voiced during the interviews about natural water sources, ranging from no concern or awareness of problems, low levels of concern or awareness of problems, moderate levels of concern or awareness of problems, and high levels of concern or awareness of problems. If individuals lack awareness and/or concern over potential problems, this might indicate low levels of water security in that they may be drinking unsafe natural source water.

The second component of individual capacity is traditional knowledge (TK). TK of the land plays a key role in water security in that community members who have awareness of historically safe local natural water sources will be less likely to drink unsafe natural water sources; thus TK is often an indication of the levels of natural source water security (Dickson et al., 2016). This component will be based on the amount of time spent on the land hunting and fishing—from individuals who never go on the land (holds no TK about natural source water),

individuals who rarely go on the land (holds little TK about natural source water), individuals who regularly go on the land (holds some TK about natural source water), and those who frequently go on the land (holds significant TK about natural source water). More time on the land would typically mean greater TK of safe natural water sources, which should result in higher natural water security levels. Conversely, those that do not have TK of the land will be less aware of safe natural water sources and more likely to drink from unsafe water sources, which could result in lower levels of natural source water security for that individual. However, it does need to be stated that regardless of levels of TK, individuals could still be drinking unsafe sources of water due to unknown contaminants.

The last individual capacity component is the frequency of drinking from safe sources of natural water by individuals while on the land. The availability of safe natural sources of water is a major component of natural water security (Dickson et al., 2016). The ability to drink from safe natural sources regularly is directly linked to the level of natural source water security for indigenous groups and is a crucial part of their participation in traditional activities. Members of indigenous communities often go out on the land, hunting and fishing, for weeks at a time and having available safe natural sources of water rather than having to transport bottled water plays a large factor in overall natural source water security levels. This component will be assessed as follows: does not drink natural source water sources due to lack of safe sources of water, sometimes has safe natural source water to drink, frequently has safe natural water source water to drink, and always has safe natural water sources to drink. A lack of safe natural sources of water will result in lower natural water security and individuals will either have to bring bottled water with them or drink from questionably safe or unsafe water sources, which could result in health complications. Indigenous communities that have greater numbers of safe natural water sources will typically have higher levels of natural source water security. This category assumes that the individuals have knowledge of what natural sources of water are safe to drink.

Community Capacities for Natural Water Source Security

Source protection and shared governance over water bodies by all shareholders plays a crucial role in natural water source security (CCME, 2004; WWC, 2000; Cook and Bakker, 2012; Bakker and Morinville, 2013; Black and McBean, 2017; Lautze and Manthrithilake,

2012). Two factors potentially impact the community capacities category of Indigenous natural water source security: the degree of consultation over the natural resources within the traditional territory and the degree of control over the extraction of those resources. These two variables play important roles in natural source water security as they allow the communities to potentially minimize the impacts of resource extraction and protect natural water sources (Dickson et al., 2016). Ascertaining the levels of natural water security within this component will be examined using the following variables: no control over the resources and the extraction process within their TT (no effective consultation and no ownership of natural resources); has little control over resources and the extraction process (some effective consultation and no ownership over resources within their TT); has some control over resources and extraction process (effective consultation and some ownership of resources within their TT); and, complete control over resources and extraction process (full control over the natural resources within their TT). Indigenous communities that have full control over the natural resources within their territory and that can minimize the impacts of extraction through a fully effective consultation process should have resulting higher levels of water security, as this control should help minimize the impacts on natural water sources. Those communities that have little or no control of their natural resources and/or do not minimize the impacts of the extraction will typically have lower levels of natural water security due to contamination associated with poor management and regulation.

Natural Environment Factors in Natural Water Source Security

Within the natural environment component of Indigenous natural water security three factors are important: environmental disturbance, environmental disaster and environmental impacts (Lautze and Manthrithilake, 2012; Dickson et al., 2016). A crucial part of natural source water security is the amount of land disturbance, both in the immediate area and within the entire water basin. Resource extraction can result in large impacts on levels of natural source water security (Bates et al., 2008; Medeiros et al., 2017; Cook and Bakker, 2012). This is especially true when a lack of regulations or unsustainable practices impact the natural water supply (WWC, 2000). This component will be assessed as follows: high level of disturbance both within the TT and the overall water basin; high disturbance within TT and medium level of disturbance within the overall water basin; medium disturbance within the TT and within the overall water

basin; low disturbance both within the TT and within the overall water basin. The level of disturbance is a rough guideline and the projects should be assessed on an individual basis. Some will be far more destructive than others. One large project, such as the Great Mine in Yellowknife and the resulting arsenic contamination, could be enough to be rated overall as a high level of disturbance for the TT and overall water basin. Indigenous communities that have low levels of land disturbance, both within their own TT and also within the overall water basin, will typically be associated with higher levels of natural source water security. Conversely, areas with high levels of land disturbance will normally be associated with lower levels of natural source water security.

Another important part of natural water security within the natural environment component is the impact of environmental disasters (WWC, 2000; Cook and Bakker, 2012; Mascarenhas, 2007). Natural disasters can be directly related to the levels of natural source water security within many Indigenous communities as they are situated in flood-prone areas due to the historical treaty process. Indigenous communities that are located in a floodplain and plagued constantly with flooding events will often have lower levels of natural source water security, as the water sources will have higher levels of disturbance and contamination. Therefore, this component will be evaluated on the following: high impact of natural disasters; medium impact of natural disasters; low impact of natural disasters; minimal impact of natural disasters. Indigenous communities that are less prone to natural disasters due to their locations and TT will typically have higher levels of natural source water security.

A last aspect of the environmental component of natural source water security is environmental impacts such as climate change. Increasingly, environmental changes are challenging communities and their natural sources of water (Bates et al., 2008; Medeiros et al., 2017; Instanes et al., 2016). Due to the impact of climate change, many Indigenous communities are reporting lower water levels, less snow and rainfall which is further affecting the quality of natural source water as the water is warmer, more turbid and has higher levels of contaminants. Assessment of this component will be as follows: high impact from environmental changes; medium impact from environmental changes; low impact from environmental changes; and minimal impact from environmental change. Many Indigenous communities, especially those in

the far north, have experienced higher impacts of environmental changes which often results in lower levels of natural source water security. Those Indigenous communities that are less impacted by environmental changes and the resulting problems are often associated with higher levels of natural source water security. One thing that needs to mentioned is that while interviewing community members, it is important to realize that they may not attribute changes such as lower water levels to climate change, and it is at the discretion of the data compiler what category the remarks should fall under.

Table 4.1 Indigenous Water Security Assessment Tool – Natural Source Water Security

Capacities				**Natural Environment**		
Individual/Household			**Community**	**Environmental Disturbance**	**Environmental Disasters**	**Environmental Impacts**
High level of concern and or awareness of potential problems	Holds significant knowledge about natural water Sources	Drinks a lot of water from safe natural sources	Complete control over resources and their extraction within TT	Low overall levels of land disturbance within TT and water basin	Minimum impacts of natural disasters such as flooding	Minimum impact from environmental changes
Moderate level of concern and or awareness of potential problems	Holds some knowledge about natural source water	Frequently drinks water from safe natural sources	Some control over resources and their extraction within TT	Medium overall levels of land disturbance within TT and water basin	Low impacts of natural disasters such as flooding	Low impacts from environmental changes
Low level of concern and or awareness of potential problems	Holds little knowledge about natural source water	Sometimes drinks water from safe natural sources	Little control over resources and their extraction within TT	High overall levels of land disturbance within TT and water basin	Medium impacts of natural disasters such as flooding	Medium impacts from environmental changes
No concern and or awareness of potential problems	Holds no knowledge about natural source water	Drinks no water from safe natural sources	No control over resources and their extraction within TT	Very high overall levels of land disturbance within TT and water basin	High impacts of natural disasters such as flooding	High impacts from environmental changes

4.4 Overview of the framework for Household Water Security

Household water security has two components: household capacities and infrastructure (see table 4.2). In the capacities component, there are four individual/household categories and two community level categories. The individual/household capacities examined for household water security for Indigenous communities include socioeconomic factors, the level of affect associated with tap water, the level of quality of tap water, and frequencies of cleaning and testing. The community capacities examined are the level of training and competence of community health representatives responsible for water testing and employees responsible for the treatment and delivery of household water. The infrastructure component includes two categories: household infrastructure and delivery infrastructure. Similarly, as seen within natural source water security levels, it is important to note that some of these factors are based on the perception of water security factors by the individuals, which may or may not be related to the actual levels of water security.

Capacities of Individuals/households and Communities

The individual capacities within individual/household component consists of four categories. The first is the socioeconomic status of individuals. Past research indicates that poverty is often directly linked to low levels of water security (Jepson, 2014; Sullivan, 2002; Bakker and Morinville, 2013; WWC, 2000). For the purposes of this category, the socioeconomic status is calculated by the employment status and education level and both are given equal value to ascertain levels of household water security. Education levels will be: no education; grades one to nine; high school; and post-secondary. Employment status will be: not-employed, pension or part time work, or full-time work. Higher levels will be related to the probability of higher levels of household water security. The variables for this category are: very low levels of socioeconomic status; low levels of socioeconomic status; medium levels of socioeconomic status; and high levels of economic status. This category is particularly important in communities that have poor quality household tap water. Individuals and households with lower socioeconomic status have less ability to purchase bottled water, which may result in higher levels of consumption of unsuitable tap water and lower levels of individual/household water security.

The next category is the level of emotional connection that people have to their household water and how it is related to the perceived level of individual/household water security. Previous research has shown that cultural, subjective and various emotional attachments to water can play an important part of household water security (Jepson, 2014; Cook and Bakker, 2012). This category with be assessed through the number of negative comments (examples such as worried about water or water made a friend or family member sick) or positive comments (not worried about water) made about household water during the interview process. The levels will be assessed from: very negative emotional connection to household water; negative emotional connection to household water; neutral emotional connection to household water; and positive emotional connection to household water. Higher levels should equate to a greater potential for higher levels of household water security. However, this category is often affected by the perceived water security and is not necessarily based on the actual levels of household water security.

Another important category for individual/household water security is the level of water quality acceptability (Jepson, 2014). This category is assessed through the responses from interviewees about the perceived quality and the organoleptics (physical components such as taste, smell, and appearance) of their household water sources. Levels are ascertained as: very negative perceptions of quality of water; negative perception of quality of water; positive perception of quality of water; and very positive perceptions of quality of water. Higher scores should be related to higher levels of household water security, based on both perceived and actual physical characteristics of water.

Another category examined within the capacities section is the frequency of cleaning and testing of the water cisterns. Proper and regular cleaning and testing of cisterns can be directly related to household water security (Daley et al., 2015). Please note that this variable cannot be used for households attached to pressurized supply lines and which do not have holding tank cisterns; however, the majority of Indigenous communities use cisterns (either in ground or in the home) to provide water to their residents. The responsibility for cleaning cisterns falls either on a household or a community, depending on the Indigenous community in question. The levels are: three or more years since last test of water; tested one to three years ago; and tested within

the last year. The cleaning scores will be based on more than three years since last cleaning; one to three years since the last cleaning; and cleaned within the last year. These categories will then be combined to give a ranking of very irregular or no cleaning and testing; infrequent cleaning and testing; somewhat regular cleaning and or testing; and regular testing and cleaning. Within this category, households that regularly clean and test their cisterns should have higher levels of household water security than homes that do not clean and/or test their cisterns regularly.

The last capacity examined is the level of training for community workers who are responsible for testing the community's household water and the workers who are responsible for treating the water. Proper training of the various persons responsible for water treatment, testing, and delivery is a crucial part of household water security (Cook and Bakker, 2012; Dickson et al., 2016; Daley et al., 2015). The levels will be rated on two categories: testers who do not have the appropriate and required training, and those who have the required training and are capable of testing household water as per their training. The same basis will be used for the water treatment plant workers who do not have the required levels of training, and those who do have the proper training. For the purposes of overall assessment, the levels are: inadequate training for both testers and treatment workers; proper training for either the tester or the treatment worker; and proper training levels for both testers and treatment workers. For communities with multiple individuals who are responsible for the testing or treatment of the community household water supplies, the assessment would be the compiled average of these individuals rounded up or down according to the closest rating. The range would go from the probability of very poor household water security, where the testers and treatment plant workers do not have the proper and required levels of training; to the probability of high levels of household water security, where everyone has the required and appropriate training.

Infrastructure of Household and Communities

The water distribution system for communities plays a very important part in household water security (CCME, 2004; Dickson et al., 2016; Jepson, 2014; Daley et al., 2015). The lack of infrastructure and outdated and/or damaged equipment can lead to low levels of household water security (Jepson, 2014; Cook and Bakker, 2012). For Indigenous communities in Canada, this is particularly true because there is a wide variance in the components of the delivery system that

can have major impacts on the levels of household water security. For proper water quality and high levels of household water security, all components of the water treatment and delivery system must properly function and be well regulated. Regardless of access to a water treatment plant, if the water truck or cisterns are dirty, contaminated or not properly maintained, the household security level will still be low. There are two categories within this component of household water delivery system, and the level of government support for water system services. Within the household delivery system category are four variables: no services; older concrete in-ground holding tank or non-accessible for cleaning holding tank; accessible plastic indoor or outdoor holding tank; and pressurized water delivery system. Within this category, household water security would have the probability of being the highest in homes that have pressurized supply lines from a treatment plant, while households with no services would typically have the lowest level of household water security.

The last category within this component is the community water delivery infrastructure which can play a crucial role in household water security (Jepson, 2014; Cook and Bakker, 2012). This component is an important part of household water security because it examines the physical infrastructure the community uses to deliver household water. There are four components: no treatment plant with water delivery truck; treatment plant, but no well-regulated water truck; treatment water plant with properly regulated water truck; and, treatment plant and pressurized water delivery system. For this category, communities that have no access to a water treatment plant will often have lower levels of household water security. Conversely, those communities with a pressurized water delivery and treatment plant would normally have higher levels of household water security. One thing to note: some communities may have a treatment plant, but it may not be functioning properly. In this case, it would be up to the researcher to place the community into the appropriate level.

Table 4.2 Indigenous Water Security Assessment Tool: Household Water Security Table

Capacities					Infrastructure	
Socio economic	**Level of affect**	**Quality of water**	**Frequency of cleaning and testing**	**Government Official Training**	**Household**	**Local Government**
High levels of socioeconomic resources	Positive emotional connection to household water	Very positive perceptions of quality of water	Regular cleaning and testing	Proper levels of training for both testers and treatment workers	Pressurized water delivery system	Treatment plant with pressurized water delivery system
Medium levels of socioeconomic resources	Neutral emotional connection to household water	Positive perceptions of quality of water	Somewhat regular cleaning and /or testing	Proper levels of training for either the testers or treatment workers	Outside or inside accessible plastic holding tank	Treatment plant with well-regulated water truck
Low levels of socioeconomic resources	Negative emotional connection to household water	Negative perceptions of quality of water	Infrequent cleaning and / or testing		Older in-ground concrete or non-accessible water tank.	Treatment plant with poorly regulated water truck
Very low levels of socioeconomic resources	Very negative emotional connection to household water	Very negative perceptions of quality of water	Very Irregular or no cleaning and testing	Improper training for both testers and treatment workers	No services	No treatment plant either on or off site

4.5 Results

In this section, the concept of measuring levels of water security will be illustrated or further developed through the use of the results of the interviews conducted in the DTFN. In addition, the current role the community plays in the area in resource development and how the communities are impacted by various environmental components, although not part of the actual interviews, was ascertained through a literature review and discussion with members and the administration of the community. Because this concept of assessing water security levels for Indigenous communities was developed after the research was conducted, not all aspects were covered in the interview process. Therefore, it is not possible to use interviews as a way to fully illustrate the concept as there are gaps in the results. Instead, responses from individuals were picked to help illustrate how this assessment tool was used. To fully develop the tool and make a claim for its effectiveness, additional, more developed questionnaires based on the concepts presented here would have to be administered so that these specific questions were answered by every respondent. Although not part of the interview questionnaires, some participants gave answers as part of the discussion during the interview process that could be used to illustrate the idea. An example would be the amount of time that people spend on the land. This was not asked as part of questions that were asked in the DTFN; however, it was mentioned by a couple of individuals that they never went on the land, so that data was used to help illustrate that category in the results.

4.5.1 Natural Source Water Security Assessment Tool

Capacities of Individuals in Natural Water Source Security

The first component of individual capacity is related to the level of concern and or awareness of potential problems with natural water sources. In the interviews, respondent 8 gave three specific concerns about the water from natural sources (low water levels, mercury levels in fish, and pollution from oil and gas) and stated that, beyond Bistcho Lake, no natural source water was safe to drink. In this case, the respondent clearly has high levels of concerns and awareness of potential problems.

The second component of individual capacity is the level of TK and is calculated from the amount of time spent on the land. Respondent 26 spent zero time on the land which results in very little TK regarding safe natural water sources.

The last component of individual capacity relates to the frequency of drinking water from natural sources while on the land. Respondent 41 sometimes drinks bottled water on the land because of the convenience of not having to find safe natural source water. However, the respondent believes that muskeg, ice, snow, and certain rivers and creeks are safe sources of water from which to drink. Respondent 9 drinks bottled water on the land because it is safe. This respondent believes that most natural sources of water are not safe, and the only safe sources were rainwater after a couple of days and spring water from the grotto in Meandering River.

Community Capacities for Natural Water Source Security

Ascertaining the community capacity for natural source water security is undertaken by examining the level of control over resources and the extraction process within their TT. In the case of the DTFN, the community is being consulted about resource extraction that occurs within their area. However, in the past when the majority of the resource extraction occurred, little or no consultation took place. Nor does the community own the resources that are being extracted within their TT. Therefore, for this component, the DTFN have had a little control or consultation over the resources and/or extraction process and do not have ownership of the resources within their TT.

Environmental Factors in Natural Source Water Security

The first consideration of the natural environment is the extent of land disturbance from resource extraction, which plays an essential role in natural source water security both in the immediate area and in the entire water basin. Extensive resource extraction has taken place both within the DTFN TT and the overall basin. Hundreds of oil wells spanning more than a 50-year period have had extensive impacts on the area and there is widespread contamination of many natural sources of water.

The second consideration is environmental disasters. Natural source water security in indigenous communities is often impacted by natural disasters as many are in flood prone areas. The DTFN consists of three communities. The community of Chateh is situated on a flood plain and feels the effectsof flooding events every few years. Therefore, Chateh would have tend to have a low level of natural water security in this environmental factor. Meandering River and Bushe River are on higher ground and rarely have flooding.

The last category related to impacts from such environmental factors as climate change. Since the DTFN is south of the Arctic region, the impacts of climate change are not as dramatic or potentially noticeable as they are north of the 60th parallel. However, the interviews revealed that there were concerns and complaints (low water levels, less snow) that can be attributed to the impact of climate change.

4.5.2 Household Water Source Security Assessment Tool

Capacities of Individuals/Households and Communities

The capacities of individual/households consist of four categories. The first is the socioeconomic status of individuals. For this category, the socioeconomic status is calculated using employment status and education level. For scoring, both are given equal value to determine levels of household water security. For example, respondent 20 has a fulltime job and a college education. Respondent 29 was retired and had no formal education.

The second category is the level of emotional connection that people have to their household water and how it is related to the perceived level of household water security. Respondent 16 (on cistern) stated that they do not use the tap water for drinking, washing or cooking because they get sores when they have showers. In this case, this respondent would have a negative emotional connection to household water. Respondent 33 believes the tap water is safe and the household uses it for drinking, washing and cooking.

The third category is the level of water quality acceptability which is assessed through the perceived quality and organoleptics of the household water sources. Respondent 14 (on mainline) drinks the tap water and gave no comments about the quality of tap water. In this case,

the respondent has a positive perceived quality of water. Respondent 28 (on cistern) drinks bottled water at home stating that the tap water is not safe. However, tap water is used for cooking and cleaning. In this case, the respondent has a negative perception of the quality of water.

The fourth category in the capacities section is the frequency of cleaning and testing of the water cisterns. Note that this variable cannot be applied to households using pressurized supply lines (they do not have a holding tank or cistern). In the case of DTFN, the cleaning and testing of the cisterns are a community responsibility. Respondent 21 (Bushe River) stated that the cistern was cleaned in 2016, and before that in 2012. The cistern was tested in 2014, but the respondent was not aware of when it was tested prior to that. Respondent 32 (Meandering River) had the cistern cleaned in 2012 and believes it was tested in 2014.

The last factor examined is the level of training of community workers (who test the household water) and the water treatment plant workers. The workers at the Chateh and Meandering River treatment plants have the proper required training as established by the government. The water at Bushe River is actually drawn from the treatment plant of the adjacent city of High Level and the training levels of the workers are unknown, but it is assumed they meet provincial guidelines. At the time of the interviews, two qualified community health representatives were responsible for testing various water sources for the DTFN.

Infrastructure of Household and Communities

For the category of household water delivery system, services within the DTFN range from no services, to cisterns or holding tanks, to pressurized water delivery. The level of household security is often directly related to the type of service to the household. Respondent 2, who lives in Chateh, is on the pressurized waterline which should result in a higher level of household water security. Respondent 40, who lives in Bushe River, has an older in-ground concrete cistern for the household water which would typically mean lower levels of household water security for this individual and their home.

The last category is the delivery infrastructure in the community. The three communities in the DTFN use a variety of delivery methods. In Chateh, a fairly new water treatment plant services some homes in the community around the treatment plant with a pressurized water line. The other homes are serviced by a water delivery truck. Bushe River receives its water from the municipal treatment plant in High Level. All homes in Bushe River have cisterns that are serviced by water truck. Meandering River has an improperly functioning and outdated water treatment plant that only adds and monitors chlorine levels but does not have a filtration system. It also provides pressurized water delivery to some homes while other homes are serviced with cisterns and water delivery trucks. It should be noted that according to the water truck drivers and the community health representatives, the water trucks are cleaned and tested regularly to help minimize potential problems.

4.6 Discussion

Natural Source Water Security

Capacities of Individuals for Natural Water Source Security

Individual knowledge can be essential to natural source water security (Dickson et al. 2016). Given what we know about environments around many Indigenous communities and their traditional lands within Canada, this factor assumes that issues like pollution and contamination are directly related to levels of water security and water quality. In the area surrounding the DTFN, there are extensive sources of contamination and pollution that individuals should be aware of and take into consideration when drinking water from natural sources. In the interviews, respondent 8 spoke of contamination of the water (mercury in fish), lower levels of water (resulting in more turbidity), and pollution from oil and gas. Respondent 39 was aware of the problems associated with oil and gas and bacteria. Both took what they felt were appropriate steps to minimize the impacts of those problems that included not drinking from most natural sources (respondent 8) and not drinking from known contaminated areas (such as Zama Lake), or drinking from commonly used sources such as rain, ice, water and muskeg filtered water (respondent 39). These practices would typically increase their levels of individual natural source water security for this category.

Since the second factor—TK of the land—plays a very important part of natural water security in that community, members who have awareness of historically safe local natural water sources will be less likely to drink water from unsafe sources (Dickson et al., 2016). This factor was difficult to assess properly using the data collected during the interviews with the DTFN, as the amount time spent on the land hunting and fishing was not a question that was asked explicitly. However, Respondent 26 claimed to never go out on the land hunting or fishing and has zero TK regarding water. It would be logical that this lack of knowledge would result in a low level of natural water security for this category for this individual given that the respondent admitted to not knowing what water sources were safe and would not drink naturally sourced water if they ever decided to go on the land. On the opposite end of the spectrum, an individual who spent extensive time on the land hunting and fishing should have a much higher level of TK of the historically and currently safe natural sources of water from which they could drink. This should mean that these individuals would have higher levels of natural water security for this category.

The last individual capacity factor is the frequency of drinking from available safe sources of natural water, a major component of natural water security (Dickson et al., 2016). Many traditional activities require community members to spend time on the land hunting and fishing and being able to drink from safe natural sources regularly is a direct reflection of the level of natural source water security. Respondent 41 drinks bottled water for the sake of convenience while on the land, but also drinks regularly from a variety of safe natural sources, which should indicate a fairly high level of natural source water security for this category. Respondent 9 restricted natural source water consumption to rainwater a few days after it was collected and drank bottled water the majority of the time. This should mean that that this individual would have a lower level of natural water security for this category.

Community Capacities for Natural Water Source Security

A crucial factor in natural water source security is source protection and shared governance by all shareholders (CCME, 2004; WWC, 2000; Cook and Bakker, 2012; Bakker and Morinville, 2013; Black and McBean, 2017; Lautze and Manthrithilake, 2012). For the purposes of this category, the level of consultation and control of resources within their TT by

Indigenous communities is examined. As discussed in the previous section, there has been extensive resource extraction within the DTFN territory (more than 50 years) with very little ownership of the resources or consultation in the process in the past. This means little was done to minimize the impacts on the DTFN and the community is still suffering the consequences. Only recently has the community been involved in the process and been able to try to minimize and control the impacts of natural resource extraction in their region. This should mean that the DTFN would have an overall low level of natural water security for this category.

Natural Environmental Factors in Natural Water Source Security

Land disturbance in an area can play an essential role in natural water source security as resource extraction can have large and lasting impacts on levels of natural source water security (Bates et al., 2008; Medeiros et al., 2017; Cook and Bakker, 2012). In the immediate area and the overall water basin of the DTFN, there are hundreds if not thousands (actual number not on record) of oil well heads, both in operation and capped off. The majority are more than 30 to 40 years old and are more likely to be problematic due to potential breakdown and because they use older, less environmentally friendly technology. Therefore, this would result in a very low level of natural source water security for this category for the DTFN.

Environmental disasters can cause major problems to impacted areas and can play a very important role in natural water security within the natural environment component (WWC, 2000; Cook and Bakker, 2012; Mascarenhas, 2007). The DTFN can very effectively illustrate how varying levels of natural disasters can impact affected communities. Chateh, because of its location, is prone to fairly regular flooding. During flooding events, not only are natural sources impacted, but in-ground cisterns are often filled and contaminated with the flood waters, which greatly impacts security of both natural and household water sources. This would result in lower levels of natural water security for this community in this category. The communities of Meandering River and Bushe River should have higher levels of natural water source water security in this category because they have a much lower risk of flooding events.

Impacts from environmental change are increasingly challenging communities and their natural water sources (Bates et al., 2008; Medeiros et al., 2017; Instanes et al., 2016). Lower

water levels, less snow and less rainfall are frequently reported by many Indigenous communities, especially those in the Arctic region, which is suffering the impacts of climate change more dramatically than other regions. Although the DTFN is not in the Arctic and the exact impacts of climate change are hard to pinpoint, the mention of lower water levels and less snow could be related to this category. However, the lower water levels could also be attributed to other causes such as the use of water in the oil and gas industry for such practices as fracking. However, the DTFN probably has medium levels of natural water security for this category. Again, it is important to realize that observations articulated by the respondents in the interviews may not be directly attributable to climate change, and the researcher needs to assess the overall situation and how the respondent's answers can be interpreted.

Household Water Security

Capacities of Individuals/households and Communities

The socioeconomic status of individuals is often directly linked to the levels of water security (Jepson, 2014; Sullivan, 2002; Bakker and Morinville, 2013; WWC, 2000). Employment status and education level have been used by other researchers to indicate levels of socioeconomic status and are considered valid assessment factors (Cirono et al.,2002). For respondent 20, who has a full-time job and a post-secondary education, this would mean that if there were problems associated with the household water, this respondent would be able to drink bottled water. This would result in a higher level of household water security for this category. For respondent 29, being retired and having no formal education would typically result in a lower level of socioeconomic status and this person would be less likely to be able to afford bottled water if the household water was not safe to drink; therefore, for this category, this individual would probably have lower levels of household water security.

Subjective, cultural and emotional connections that people have with their household water can play an important part in perceived levels of household water security (Jepson, 2014; Cook and Bakker, 2012). In the case of respondent 18, their negative experience of their children getting sores when bathing in the water logically equates to a lower level of household water security. Respondent 33's negative experience with the tap water and a lack of utilization of it should indicate a lower level of household water security for this category. It needs to be

understood that this factor is often based on a perception of water quality and may and may not equate to the actual quality of water in the household.

Although subjective in response, the perceived quality and organoleptics of household water can play a very important part in household water security (Jepson, 2014). Respondent 14, who is on the main pressurized line, drinks the tap water and did not express any concerns. This positive perception of the water quality and no visible contaminants in the water would typically correspond with a higher level of household water security for this category. Respondent 28, who is on a cistern, despite a negative perception of the tap water, drinks the tap water; however, this perceived lower quality of water could be related to a lower level of household water security for this category.

The frequency of cleaning and testing water cisterns can be directly related to levels of household water security (Daley et al., 2015). In the DTFN, the cleaning of cisterns is a responsibility of the community Operations and Management department and testing is the responsibility of the community health representatives. Respondent 21, who lives in Bushe River, with a recent cleaning in 2016 and test in 2014 would probably have a medium level of household water security levels for this category. Respondent 31, who lives in Meandering River, had the cistern cleaned and tested in 2014, and would also likely have a medium level of household water security.

Proper training for workers associated with water delivery and treatment within communities plays a crucial part of water security levels for the household (Cook and Bakker, 2012; Dickson et al., 2016; Daley et al., 2015). In the DTFN, the three communities have various people responsible for the different components of the household water treatment and delivery system. All people interviewed that were involved in water treatment or testing stated they had the required levels of training as set out by the provincial government. This should result in higher levels for this category of household water security for these communities.

Infrastructure of Household and Communities

An essential part of household water security is the water distribution system for communities in that outdated, missing or damaged infrastructure can have direct impacts on the quality of water supplied (CCME, 2004; Dickson et al., 2016; Jepson, 2014; Cook and Bakker, 2012; and Daley et al., 2015). In the three communities that comprise the DTFN, the variance in water treatment and delivery systems for households is well illustrated, as some households are without services, some have cisterns, and some are on pressurized water lines. Respondent 2 who has a pressurized line for delivery would typically have higher levels of household water security in this category in that pressurized lines typically allow for the least possible contamination. Respondent 40, who has an in-ground concrete cistern, would most likely have a lower level of household water security in this category as these holding tanks are prone to leakage and there is often contamination of the water.

The final and crucial infrastructure component of household water security is the community water delivery infrastructure (Jepson, 2014; Cook and Bakker, 2012). The DTFN once again illustrates this component very well because of the variety of water delivery systems in the three communities. For Bushe River, receiving water from a municipal water treatment plant in High Level from a water delivery truck that is well maintained, cleaned and tested should result in a medium level of household water security for this category. Although not as secure as a pressurized system, if the water treatment plant and the water truck are properly maintained, the possibility of contamination is fairly low. For Meandering River, the treatment plant is non-functioning. Beyond adding chlorine and testing for hardness levels, the water is not filtered which means that despite having homes on a pressurized system, the chance of having problems with the water is higher. Therefore, this community would probably have a lower level of household water security for this category. In Chateh, a properly functioning water treatment plant in the community means that the water quality prior to delivery should be high. For households that are on the pressurized system, there should be low levels of contamination in the process of delivery from plant to tap; therefore, these homes probably have high levels of household water security for this category. For homes that have the water delivered via truck, although the trucks are well maintained, cleaned and tested, there is a higher chance of contamination, which may lead to lower levels of household water security for this category.

4.7 Conclusion

This research examines water security in many contexts but focuses on Indigenous water security within Canada and the problems associated with it in many communities across the country. Although small rural communities face problems in water security in general within Canada, Indigenous communities fare the worst by a significant factor (Hanrahan, 2017). The federal government has acknowledged these problems on numerous occasions and has spent billions of dollars over the last two decades, yet the drinking water conditions seen within many Indigenous communities are similar to what is seen in poorer, developing nations (Neegan Burnside Ltd., 2011).

Despite Canada's vast amount of fresh water, many challenges threaten the security of natural source water that include industrial pollution, urbanization, destruction/reduction of wetlands, and the impact of climate change (Matsui, 2012; White et al., 2007). This destruction of water resources combined with the impacts of colonialism, poor placement of communities, and diminished capacities of Indigenous groups has exacerbated and compounded the issues of poor drinking water for many communities (Hanrahan, 2017; White et al., 2012; Maxim and White, 2003). Another problem is that often Indigenous communities are not heard nor are their desires implemented in the top-down government regulations, policies, and programs (Black and McBean, 2017).

Despite the increase in the literature on water security over the last three decades, very little has been done to quantify the concept in a measurable fashion (Lautze and Manthrithilake, 2012; Animesh at al., 2016). Currently this work is the only known comprehensive assessment of water security for Indigenous communities. Although other community specific components may impact the level of water security within many communities, the categories examined under this framework should address most, if not all, of the major components of it within most Indigenous communities.

Socioeconomic factors, individual emotional connection to water, and the perception of the quality of the tap water can all play important roles in people's decisions and perceptions in regard to water consumption and preferences and perceived and actual levels of household

security. The lack of economic ability to buy bottled water when necessary can directly impact levels of water security in that individuals may be required to drink poor quality tap water. Having a positive emotional connection or view of the quality of water should normally be related to higher levels of water security. However, it could also mean that due to these positive connections to the tap water, individuals may be drinking water that is not actually safe to drink.

A very important component of household water security that can be directly related to the water quality is the frequency of testing and cleaning of water holding tanks. Households with water tanks that are cleaned and tested regularly typically have far fewer problems with the tap water than households with infrequent testing and cleaning. The capacities and training of individuals responsible for the testing and treatment of drinking water within a community should also be related to the level of water quality and the resulting levels of water security. If the personnel within the community lack the proper training, there is a much higher probability of problems associated with the water provided.

As indicated in this paper, the water delivery infrastructure is a crucial part of household water security. Indigenous communities across the country use a wide variety of delivery and treatment options. Those communities with up-to-date and properly running treatment plants with pressurized delivery lines to homes will typically be able to provide the best quality of water and result in the highest levels of water security. However, the majority of Indigenous communities utilize water trucks and cisterns, and many do not have any treatment plant, never mind a properly functioning one. These communities typically have a much higher potential for problems associated with the drinking water and lower overall levels of water security for that community.

Individual capacities, in the form of knowledge of potential problems, the level of TK and frequency of drinking from safe natural sources of water, can play important roles in levels of natural water security. Individuals who have awareness of potential problems and spent a lot of time on the land are typically going to have to have higher levels of natural source water security in that they will typically not be drinking from unsafe sources of natural sources while on the land. Conversely, individuals who do not have awareness of problems or do not have

knowledge of what sources are safe to drink from are much more likely to drink unsafe water and have lower levels of water security in this component.

As previously discussed, the ability to control resources and be part of the resource extraction process can be a very crucial component of natural water security for Indigenous communities. Community consultation is now a requirement for any project that can potentially impact the way of life of Indigenous people within their traditional territory. However, often the process is merely a 'check the box' procedure and true consultation is not actually conducted. Many communities do not own the resources within their territory and so have very little true control over them. It is assumed that communities will typically have the community's future in mind when agreeing to the development of extraction within their area and would attempt to minimize the impacts on the environment. This means communities who are fully involved in the consultation and extraction process should typically have higher levels of natural water security.

The last category of the natural environment and its three components of environmental disturbance, environmental disasters and environmental impacts, can all impact levels of natural water security in many ways. Resource extraction within a water basin can have massive impacts on natural sources of water and is directly linked to levels of water security for that area. The higher the impacts, the lower the resulting levels of security. Communities that regularly experience flooding events or the results of climate change will typically have lower levels of water security as the natural sources within the area will be constantly be impacted by these events.

It needs to be acknowledged that this framework is a guideline and is not a firm or guaranteed equation of Indigenous water security. Although the components within these frameworks should be applicable to most situations and most communities, each Indigenous community will potentially have individual concerns or problems that will require further examination.

Chapter 5
CONCLUSION

5.1 Summary of Thesis

Although safe sources of drinking water are becoming an issue for countries around the world, Canada should be more suited to deal with the problem due to our expansive sources of water. However, resource development, climate change, changing weather patterns, and population growth is reducing levels of water security for many communities in Canada (Dupont et al., 2014; Galway, 2016; Walters et al., 2012; Baird et al., 2015; and Morrison et al., 2015). While it is true that there are growing problems for clean viable sources of drinking water across Canada, Indigenous communities continue to suffer the worst overall drinking water conditions, often similar to those seen in many developing nations (Hanrahan, 2017; Neegan Burnside Ltd., 2011). Even when compared to other rural and remote communities in Canada, problems associated with drinking water are far more prevalent in Indigenous communities. This thesis has tried to better understand and develop why that is and the underlying factors that are involved in this very complex situation.

In addition to historical shortfalls of adequate infrastructure and funding, the problems with drinking water security for Indigenous communities are further exacerbated by the social problems that exist, including reduced community capacity caused by the legacy of residential schooling, colonization, and marginalization from mainstream society and more (Daley et al., 2015; Hanrahan, 2017;White et al., 2012). The problem is often compounded by the location of the reserves and the effects of climate change that are dramatically changing the northern landscape (White et al., 2007).

The findings of this thesis support previous research that indicates a definitive relationship between poverty and power dynamics and how these can impact Indigenous drinking water and community water security levels (WWC, 2000; Bakker and Morinville, 2013). Looking at the situation in Canada and the results of this current and previous research, social marginalization and reduced capacity appear to directly result in lower levels of water security and an increase in problems associated with drinking water for many Indigenous communities. The components introduced in Chapter four show how various social and

economic variables related to drinking water security are directly linked to the current position of many Indigenous communities.

Research on this subject matter is advancing; however, there has been relatively little community-based research with Indigenous peoples that explores how risk perception affects drinking water consumption patterns (from both the municipal and land-based sources). Furthermore, few studies have investigated how these patterns may be influenced by the systems of government in place in different jurisdictions.

To this end, the objectives of this thesis were to:

Objective 1 Explore how risk perception and other social-economic variables influence individual drinking water consumption patterns (including water from the land and water from home).

Objective 2 Explore how political jurisdiction and associated infrastructure and regulations influence individual drinking water consumption patterns by comparing results from Dene Tha' First Nation in Alberta and K'atl'odeeche First Nation in the Northwest Territories.

Objective 3 Develop a better understanding of the components involved in Indigenous water security, for both natural sources of water and household water, and how they are related and impact Indigenous communities.

5.2 Summary of Conclusions

This thesis includes two manuscripts that address the three stated objectives. In Chapter three, the research examines how risk perception and other variables, including socioeconomics, demographics and jurisdictional differences can influence water consumption patterns in the two participating communities. The main conclusion of this chapter was that numerous variables impact people's consumption patterns for drinking water. The results appear to indicate that heightened risk perception levels in these communities are related to an increase in o bottled water consumption. It also indicates that various relationships exist between demographics such as age, education and income and bottled water consumption. This research shows that the poor

condition of many water sources requires a large percentage of community members to drink and use bottled water instead of the provided water sources, especially in the DTFN where they suffer from very low levels of water security, both in the home and natural sources of water. In the KFN, although the drinking water conditions are generally better, community members still drink far more bottled water than the national average.

In Chapter four, the concept of Indigenous water security was developed, for both natural sources of water and household water, and various components that contribute to drinking water quality for Indigenous communities were identified. The main conclusions from this research and analysis was that numerous variables affest the levels of water security for Indigenous communities and these variables are interrelated. Natural sources of water in Canada are constantly under attack by urbanization, pollution, climate change and a multitude of variables; however, Indigenous communities often face the most extreme conditions because of their locations, reduced community and individual capacities, lack of participation and consultation within the process of addressing the problems, and other reasons. Many interrelated variables affect people's decisions to drink tap water and the level of water security for households. The water delivery system used, the frequency of testing and cleaning of water tanks, and personnel training all play crucial roles in the resulting levels of household water security. The main benefit of this research is the identification of variables to consider in any assessment of the water security of Indigenous individuals, households and communities. Water security is, of course, affected by the interrelation of these variables but it is useful to identify and assess them separately in order to address the problems in water security in Indigenous communities.

5.3 Further Research

The work presented in Chapter four for assessing water security levels should be further researched and developed. Once refined, the assessment tool could be utilized by Indigenous communities and the federal government to help identify the various components of water security for both household and natural water sources. This will allow them to properly address the appropriate underlying component(s) of water security that are causing the problems for the community.

5.4 Practical and Policy Implications

Another reason for poor water security for many Indigenous communities is that many communities are downstream of major contributors of pollution, such as agriculture, mining, and oil and gas industry. This often results in lower levels of natural water security and overall poor health conditions of community members (Mascarenhas, 2007). Although any resource extraction activities that impact Indigenous traditional territories are required to involve the communities in the process to ensure minimal impacts, this is often done ineffectively. The federal government and the corporations must do more than a check in the box investigation as history has shown that this process is extremely ineffective in bringing the true community voice and concerns to the table. Furthermore, it is the opinion of this researcher that any development within a hydrological system should involve all stakeholders in the process including and especially Indigenous communities. Often communities are affected by activities that are outside their traditional territories by the pollution/contamination as it comes downstream into their area. A prime example of this is the KFN. Even though there is little historical resource development within the KFN's traditional territory, the community is being affected by the pollution from resource development in northern Alberta and Saskatchewan. To reduce the impacts on natural sources of water, all communities within the water basin should have a voice in what development occurs and how.

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Appendix A
Interview Questions

Personal Information Sheet:

Date of Interview:

Lives in:

Gender-

1. Full Name:

2. Year of Birth:

3. Employment:

4. Income:

5. Education Level:

6. Fluent in English? Yes or No

7. Mailing Address:

1. Where do you normally get your drinking water from?

2. Do you drink bottled water?
   Why? (convenience, taste, etc.)

3. Do you drink bottled water when you are out on the land?
   Why? (convenience, taste, etc.)

4. Other than bottled water, where are the best places for drinking water supplies?
Drinks Muskeg?
Spring water?
Snow water?
Ice water?
Rainwater?

a. Why?

b. Has it always been the same or has it changed in the last decade?

c. What are some of the factors that affect water quality in that place?

d. What is the security of that source water in the future?

5. Where are the areas where water (for drinking) is poor?

a. Why do you think they are poor?

b. Are these areas places where people did get water from in the past, but now don't? If so why?

6. If you have concerns over drinking water sources, have you brought those concerns forward? To who?

7. Have those concerns been addressed / acknowledged? By whom?

8. anything else that needs to be brought forward.

Appendix B
Additional Interview Questions for Hay River Interviews

Fees for water are fair?
Should the community have the holding tanks cleaned?
If yes, how often should tanks be cleaned by community?
How often should cisterns be tested?
How often should the water truck be cleaned/sanitized?
How often should the water truck be tested?
Should anywhere else be tested? If so where? And how often?
Should these places be cleaned? If so, how often?
Should the water pumping station be tested? How often?
Should the pumping station be cleaned? If yes, how often?
Should there be water monitoring of GSL? Of Hay River?
Of anywhere else? If yes – why?
Is equipment supplied by the community to clean the holding tanks a good idea?
Is a How-to manual clean the holding tanks a good idea?

Appendix C
Confidentiality Agreement

Understanding Changes in the Freshwater Ecosystems and Drinking Water in Northern Canada

Research Lead / Organization

Neal Spicer
University of Alberta
Department of Resource Economics
and Environmental Sociology
507 General Services
Edmonton, AB. Canada T6G 2H1
Cell (780) 951-2271
Email:nspicer@ualberta.ca

Principal Investigator

Dr. Brenda Parlee, Canada Research Chair
University of Alberta
Department of Resource Economics
and Environmental Sociology
507 General Services
Edmonton, AB Canada T6G 2H1
Office (780) 492-6825
email: brenda.parlee@ualberta.ca

I, _____, am involved in this project as a

_____ (i.e., translator, interviewer).

I agree to:

1. keep all the research information shared with me confidential by not discussing or sharing the research information in any form or format (e.g., disks, tapes, transcripts) with anyone other than the *Researcher(s)*; and
2. keep all research information in any form or format (e.g., disks, tapes, transcripts) secure while it is in my possession; and
3. return all research information in any form or format (e.g., disks, tapes, transcripts) to the *Researcher(s)* when I have completed the research tasks; and
4. after consulting with the *Researcher(s),* erase or destroy all research information in any form or format regarding this research project that is not returnable to the *Researcher(s)* (e.g., information stored on computer hard drive); and
5. _____

Signed: _____ Printed Name: _____

Witness: _____ Date: _____

The plan for this study has been reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at 780.492.2615.

Appendix D

RESEARCH INFORMATION SHEET

Drinking Water - An examination of a Crucial First Nation's Resource.

Research Coordinator:

Neal Spicer
University of Alberta
Department of Resource Economics and Environmental Sociology
Edmonton, AB
Canada T6G 2H8
Cell: (780) 951 2271
email: nspicer@ualberta.ca

Principal Investigator:

Dr. Brenda Parlee, Canada Research Chair
University of Alberta
Department of Resource Economics and Environmental Sociology
507 General Services
Edmonton, AB
Canada T6G 2H1
Office (780) 492-6825
email: brenda.parlee@ualberta.ca

What is the Research project about and how can I help?

This research focuses on determining the degree of environmental degradation from resource extraction and how it is impacting your community, the environment, and your drinking water supplies. It also strives to better understand the connection that community members have to the physical environment and its relationship to how you view drinking water and its sources.

Specifically the objectives include:

1) determine where the participating communities obtain their drinking water from and why; and determine the areas of each region that are considered valuable and important areas of water quality;

2) Determine what the concerns are concerning the sources of water both currently and in the future.

Why is this research being done?

The research is being carried out under the guidance of your community government offices to better understand how and where community members are obtaining their drinking water from

and why. I am a graduate student at the University of Alberta. I am interested in exploring the relationship between that connection that you have to the physical environment and your community and how concerned you are over possible ramifications of resource extraction on your drinking water supply.

The Interview Process:

I will provide you with a list of questions. Together we will sit and have a conversation (narrative interview) about the questions I have given you. You are also encouraged to share any stories that come to mind when thinking about these questions. I will be taking notes and, if you agree, I will be digitally recording the conversation to be able to refer back to our conversation if clarification or confirmation of details is required. Because your knowledge is valuable and I am grateful for the time we will have shared I will be providing you with a $50.00 cash honorarium to say thank you.

What are the risks and discomforts?

There are no risks or discomforts that may result from the study.

What will you need to do?

You will sit with an interviewer (Neal Spicer) and you are free to tell him anything about your life that you think is relevant to the study.

What are the benefits to me?

You will receive a $50 honorarium (gift card) to compensate you for your time.

Do I have to take part in the study?

You do not have to participate in the study, and you can stop the interview anytime.

Will my information be kept private?

In addition to your story, we would like to record your first name and last initials, your phone number, and email address in order for us to send you a transcript of your interview. We would also like to use your name in public documents. You can choose not to have your name included and so your information will remain anonymous.

Your name and address will not be shared with any other person or organization. All of your information will be kept private and secure in an office at the University of Alberta. You will have 30 days (following the interview) to contact us about any changes you might want to make to your interview data including withdrawal of the transcript. We would also like to have the information you provide stored with your community government office so that it can contribute to knowledge in the community.

If you are NOT interested in participating please notify me immediately.
If you have any questions regarding this research project you may contact me at:

Neal Spicer
University of Alberta
Department of Resource Economics and Environmental Sociology
GSB building
Edmonton, AB
Canada T6G 2H8

Cell: (780) 951 2271

OR

Dr. Brenda Parlee
507 GSB
Department of Resource Economics and Environmental Sociology
Faculty of Agricultural Life and Environmental Sciences
University of Alberta
Tel: (780) 492-6825
Fax: (780) 492-0268

If you have any questions or concerns regarding your rights
as a participant, or how this study is being conducted, you may contact the
University of Alberta's Research Ethics Office at 780-492-2615.
This office has no affiliation with the study investigators.

Appendix E

Consent Form

Understanding Changes in the Freshwater Ecosystems and Drinking Water in Northern Canada

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	Yes	No
Do you understand that you have been asked to be in a research study?	☐	☐
Have you read and received a copy of the attached Information Sheet?	☐	☐
Do you understand the benefits and risks involved in taking part in this research study?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Do you understand that you are free to leave the study at any time, without having to give a reason?	☐	☐
Has the issue of confidentiality been explained to you?	☐	☐
Do you wish to be identified by name in any public documents that might results from this research project?	☐	☐
Do you wish to have information that may be used to identify you removed from any records that may become public?	☐	☐
Is it okay that the interview is audio recorded?	☐	☐
Do you wish the results of this interview to be stored with your community government?	☐	☐
Do you agree that the information from your interview can be stored at the University of Alberta for the purposes of the study defined in the Information Sheet?	☐	☐

I agree to take part in this study:
Signature of Research Participant

_____

(Printed Name) _____ Date: _____

Signature of Witness _____

Only required if you anticipate that your participants will be unable to read the consent for themselves. If so, an impartial witness (i.e. not associated with the study team) must be present during the entire informed consent discussion and is witnessing that the participant understood what was discussed.

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator or Designee _____ Date _____

Study Coordinator: Neal Spicer Phone Number(s): 780-951-2271
Principal Investigator(s): Dr. Brenda Parlee Phone Number(s): 780-492-6825

The plan for this study has been reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at 7

Appendix F

NWT Research License

Licence No. 16045
File No. 12 410 1081
February 09, 2017

2017
Northwest Territories Scientific Research Licence

Issued by:	**Aurora Research Institute – Aurora College** Inuvik, Northwest Territories
Issued to:	Mr. Neal Spicer University of Alberta 8305 117 Ave NW Edmonton, AB T5B 0N5 Canada Phone: (780) 951-2271 Fax: (780) 951-2271 Email: nspicer@ualberta.ca
Affiliation:	University of Alberta
Funding:	Social Science and Humanities Research Council of Canada-Tracking Change Project Northern Scientific Training Program-University of Alberta Northern Awards
Team Members:	Brenda Parlee; Wiktor Adamowicz
Title:	**Understanding Changes in the Freshwater Ecosystems and Drinking Water in Northern Canada**
Objectives:	To determine where participating communities obtain their drinking water from, both within their home and while on the land, and why.
Dates of data collection:	February 9, 2017 December 31, 2017
Location:	Hay River and Lutselk'e

Licence No.16045 expires on December 31, 2017
Issued in the Town of Inuvik on February 09, 2017

*** original signed ***

Jolie Gareis
Vice President, Research
Aurora Research Institute

Appendix G

University of Alberta Research License #1

Notification of Approval

Date:	June 22, 2016
Study ID:	Pro00065907
Principal Investigator:	Brenda Parlee
Study Title:	Tracking Change in the Mackenzie River Basin
Approval Expiry Date:	Wednesday, June 21, 2017

Approved Consent Form:	Approval Date	Approved Document
	6/22/2016	Information Sheet
	6/22/2016	Consent Form

Sponsor/Funding Agency: SSHRC - Social Sciences and Humanities Research Council SSHRC

RSO-Managed Funding:	Project ID	Project Title	Speed Code	Other Information
	RES0016416	SSHRC Resources and Sustainable Development in the Arctic	40942	

Thank you for submitting the above study to the Research Ethics Board 1. Your application has been reviewed and approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Anne Malena, PhD
Chair, Research Ethics Board 1

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix H

University of Alberta Research License #2

Notification of Approval

Date:	November 24, 2016
Study ID:	Pro00064419
Principal Investigator:	Brenda Parlee
Study Title:	Understanding Changes in the Freshwater Ecosystems and Drinking Water in Northern Canada
Approval Expiry Date:	Thursday, November 23, 2017

Approved Consent Form:

Approval Date	Approved Document
11/24/2016	Confidentiality agreement.docx
11/24/2016	REvised Consent form Aug29rev (1).docx
11/24/2016	Information sheet revised Aug29rev2 (1).docx

Sponsor/Funding Agency: Northern Scientific Training Program NSTP

Sponsor/Funding Agency: Tracking Change SSHRC Partnership Grant

RSO-Managed Funding:

Project ID	Project Title	Speed Code	Other Information
RES00280289	University of Alberta Faculty Support to Parlee (SSHRC PG)	ZE235	
RES0027633	WEPGN	ZF181	

Thank you for submitting the above study to the Research Ethics Board 1. Your application has been reviewed and approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Anne Malena, PhD
Chair, Research Ethics Board 1

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix I

Researcher Recommendations

Despite the fact that the federal government of Canada has failed to properly rectify the problems associated with drinking water for many Indigenous communities, it should be acknowledged that it has and currently still is making strides towards addressing the problems. The Minister of Indigenous Services' announcement of the elimination of all long term DWA by 2021 and the approval of almost two billion dollars in infrastructure spending in 2016 shows that the extent of the commitment. However, it will not be an easy process and many components must be addressed to properly "fix" the problem of drinking water security in Indigenous communities in Canada. Based on the research conducted, both this current and previous studies, there are numerous recommendations that could help address the problems that the majority of Indigenous communities have with their drinking water.

Community involvement

Community involvement is a crucial component in addressing the problems that Indigenous communities regularly face with their drinking water. Part of the reason for the failure of the federal government in dealing with this problem is that many of the government regulations, policies, and programs are based on a top-down approach that fails to address the specific and unique problems that exist in many communities. As indicated by previously conducted focus groups and research, the voices of Indigenous communities are frequently left out of the conversation when it comes to drinking water concerns. This is extremely ineffective as this excludes the most important factor – the community perspective. As indicated by Black and Mcbean (2017), this exclusion means that community members' voices and concerns, their culture, and specific social, geographic and economic needs are not properly addressed which greatly reduces the effectiveness of any attempted solution to the problem.

Previous research (Matsui, 2012; Plummer & Hashimoto, 2011) indicates that community involvement and the resulting co-management practices leads to more effective policies and procedures. The resulting recommendations, based on adaptive co-management practices with the Indigenous communities playing an active role in the process, allow for the unique circumstances and context of the communities to be identified. This will allow the government to

correctly identify and address the underlying problems and causes of poor water security and the resulting drinking water problems. Therefore, for a comprehensive solution that can ensure a high degree of water security for Indigenous communities, they must be involved throughout the process and acknowledged as crucial stakeholders.

Communication/presentation of the problems

Despite the widespread problem, there has been minimal investigation, by either academics and media outlets, and this lack of interest has allowed Indigenous drinking water problems to grow, not diminish. Examination and illumination of the situation could help by highlighting the problems and this could help develop support from non-Indigenous communities to address the problems that exist. Although it is only a small component in the overall problem, it is the opinion of this researcher that Indigenous Services Canada should attempt to educate (through various media outlets) the general public of the problems that exist so that support would grow for rectifying the problems for the majority of Indigenous communities in Canada.

Regulations

As indicated in the previous chapters, one of the problems surrounding water security in Canada is the lack of formal laws; instead, drinking water is regulated by policies, guidelines and funding agreements (Baid et al., 2015). To address this problem, the federal government should introduce enforceable federal legislation that clearly indicates what standards need to be met and by whom to help reduce the jurisdictional overlap and confusion. There should be increased consequences for individuals/communities/corporations who fail to adhere to these new rules to ensure that the potential for problems is minimized. Furthermore, in order to protect natural sources of water, the federal government needs to increase environmental regulations and monitoring overall and implement large financial and possible legal ramifications for those corporations and individuals who fail to adhere to them. The government could also encourage green technology that helps to reduce the environmental impacts on our struggling water ecosystems in the form of tax breaks to corporations and communities.

Training

This current research and previous research (Morales, 2006, Neegan Burnside Ltd., 2011) indicates that there are often problems with proper levels of training for the various individuals involved throughout the drinking water process in many Indigenous communities (Chapter 3 examines this as part of the overall levels of drinking water security). This is clearly problematic if the people who are fulfilling various roles are not qualified to do so. This can lead to mistakes, which can result in deaths or illnesses, or at the very least people are drinking water that may not be safe. Indigenous communities and Health Canada must ensure that the people who are involved in the various aspects are not only properly trained, but also feel competent to fulfill their roles and responsibilities accordingly. An additional component of training is the role that chief and councils fill in their responsibilities of issuing DWAs. In the two participating communities, it was indicated that issuance of DWAs was problematic at times and the procedures for the issuance and removal were not always followed. This can lead to problems and, at the very least as shown in Chapter two, can result in a diminished level of trust that community members have in their drinking water and result in an increase in the consumption of bottled water.

Testing and Cleaning of Cisterns

An important part of household water security levels and safe sources of drinking water is the regular cleaning and testing of the water cisterns that homes utilize to store their household water. As presented in Chapter two and three, there are differences as to who is responsible for cleaning and testing water cisterns depending on the community. The DTFN community is responsible for cleaning and testing the cisterns, while in the KFN, the household is responsible for the cleaning while the community tests at the request of the homeowner. In both cases, there was often irregular cleaning and testing. In the DTFN, there was a lack of community money to clean cisterns regularly. An immediate solution to this problem would be additional funding by the federal government that is designated for cistern cleaning. In the KFN, there was a lack of ability (by mobility restricted individuals), equipment and knowledge by some households to appropriately clean the cisterns. This could be remedied by having training sessions or, at the very least, information pamphlets outlining the proper way to clean the cisterns. One of the additional questions asked in the KFN during the interview process was whether or not the community should provide the equipment necessary to properly clean out the cisterns. Although

there was some concern about the equipment being returned or damaged, the majority of people thought that community owned equipment that could be loaned out to members to clean their cisterns was a good idea. So, having people who were aware of the proper way of cleaning cisterns and who had access to the proper equipment would have a significant impact potentially on the level of water security and could help households have clean, drinkable tap-water.

Water delivery systems

This research indicates that the water distribution system on reserves plays a very important part of water security. Many Canadian reserves (especially those in the prairie region) do not have a fully developed water delivery system and that is problematic for household water security. To further reduce the problems associated with delivery, the federal government and Indigenous communities should consider installing pressurized delivery lines where practicable as the chance for contamination would be greatly reduced. However, the costs would be often prohibitive due to the often scattered placement of homes throughout the reserves and in the far north. If water delivery trucks are utilized, the potential problems with drinking water contamination are dramatically higher. To help overcome the problems often associated with water trucks, communities and/or the companies that deliver the water must ensure that they are cleaned and tested regularly, and that the drivers use proper techniques while filling cisterns to ensure the fewest problems. Where water cisterns are utilized, it must be ensured that they are in good shape and integrally sound. In the DTFN, many cisterns were no longer 100 percent intact, which meant dirt, insects and rodents were able to get inside and contaminate the cistern.

Appendix J

Holding Tanks verse Mainline: In High Level, a significant variable whether or not people drink bottled water within their home is whether or not they are on a cistern holding tank for their water.

	#'s	%
Normally Drinks Tap Water:		
On Cistern	8/34	23.5
On main Line	5/13	38.5
Normally Drinks Bottled Water:		
On Cistern	25/34	73.5
On Main Line	5/13	38.5
On Inside Cistern	1/1	100
No Services	1/1	100
Normally Drinks Both Tap and Bottled Water:		
On Cistern	1/34	2.0
On Main Line	2/13	15.4
Normally Drinks Meander River Grotto		
On Main Line	1/13	7.7