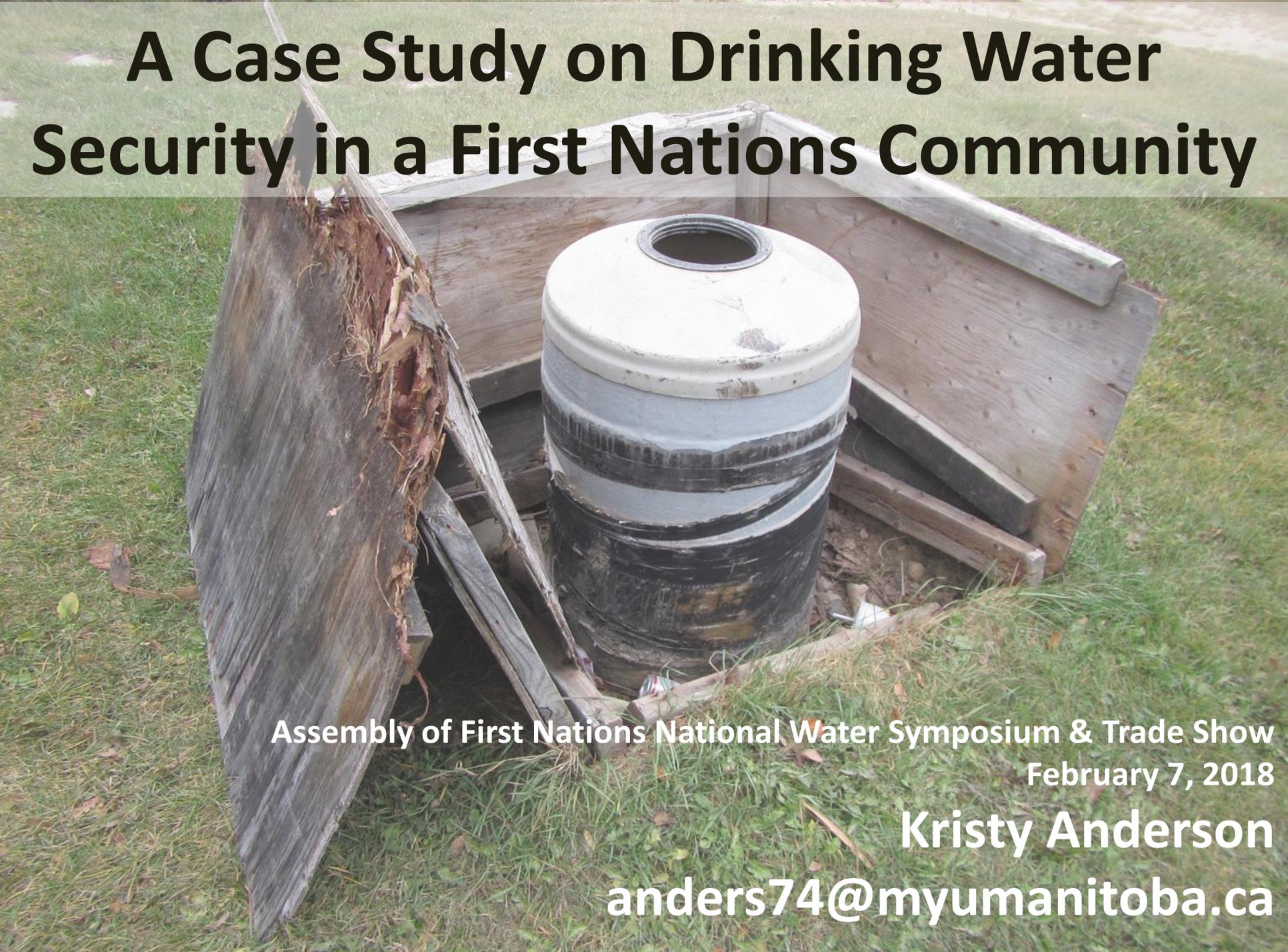


A Case Study on Drinking Water Security in a First Nations Community



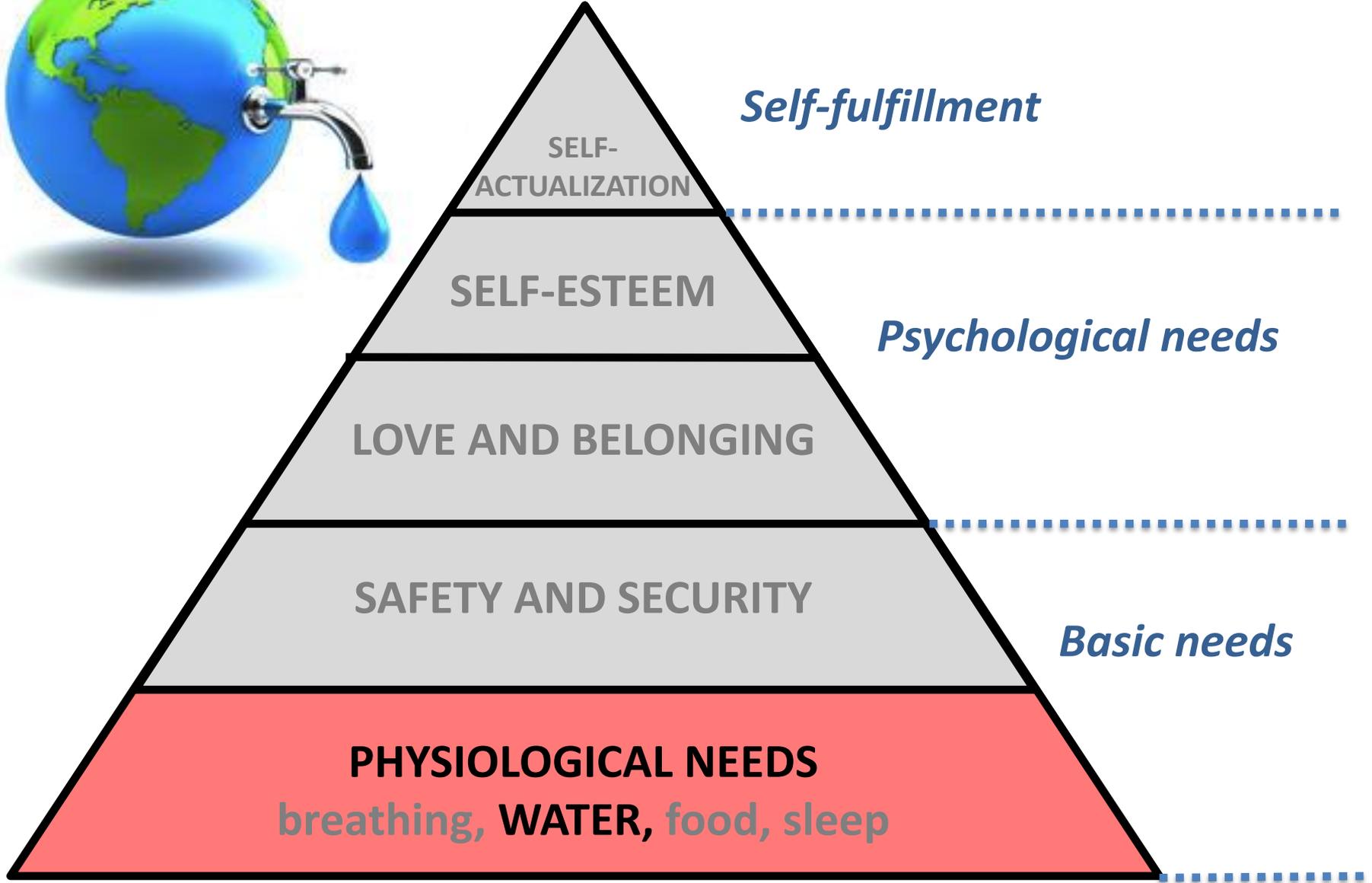
Assembly of First Nations National Water Symposium & Trade Show
February 7, 2018

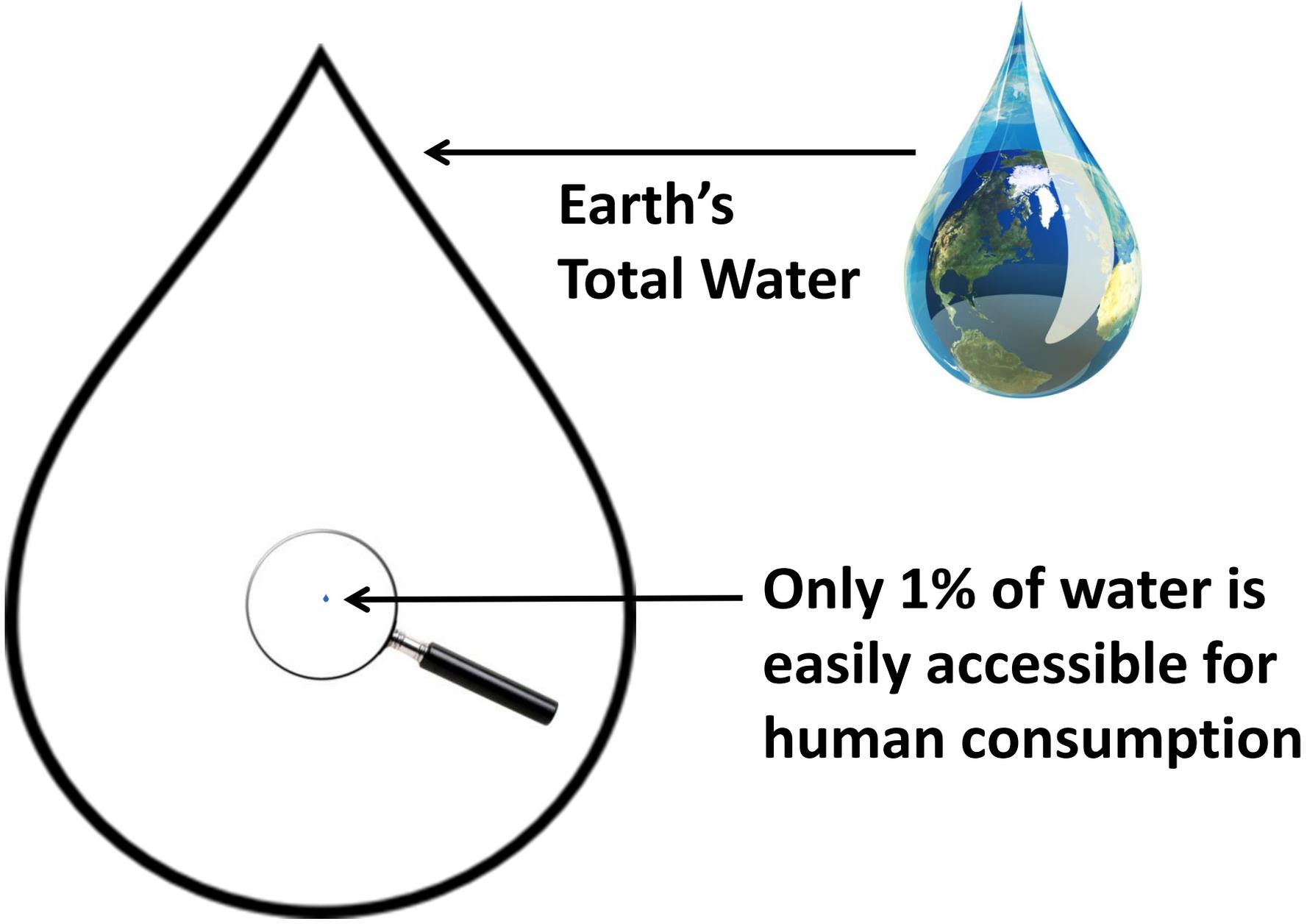
Kristy Anderson

anders74@myumanitoba.ca

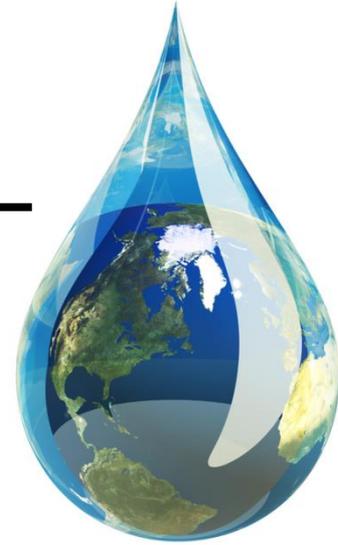


Maslow's (1943) Hierarchy of Needs

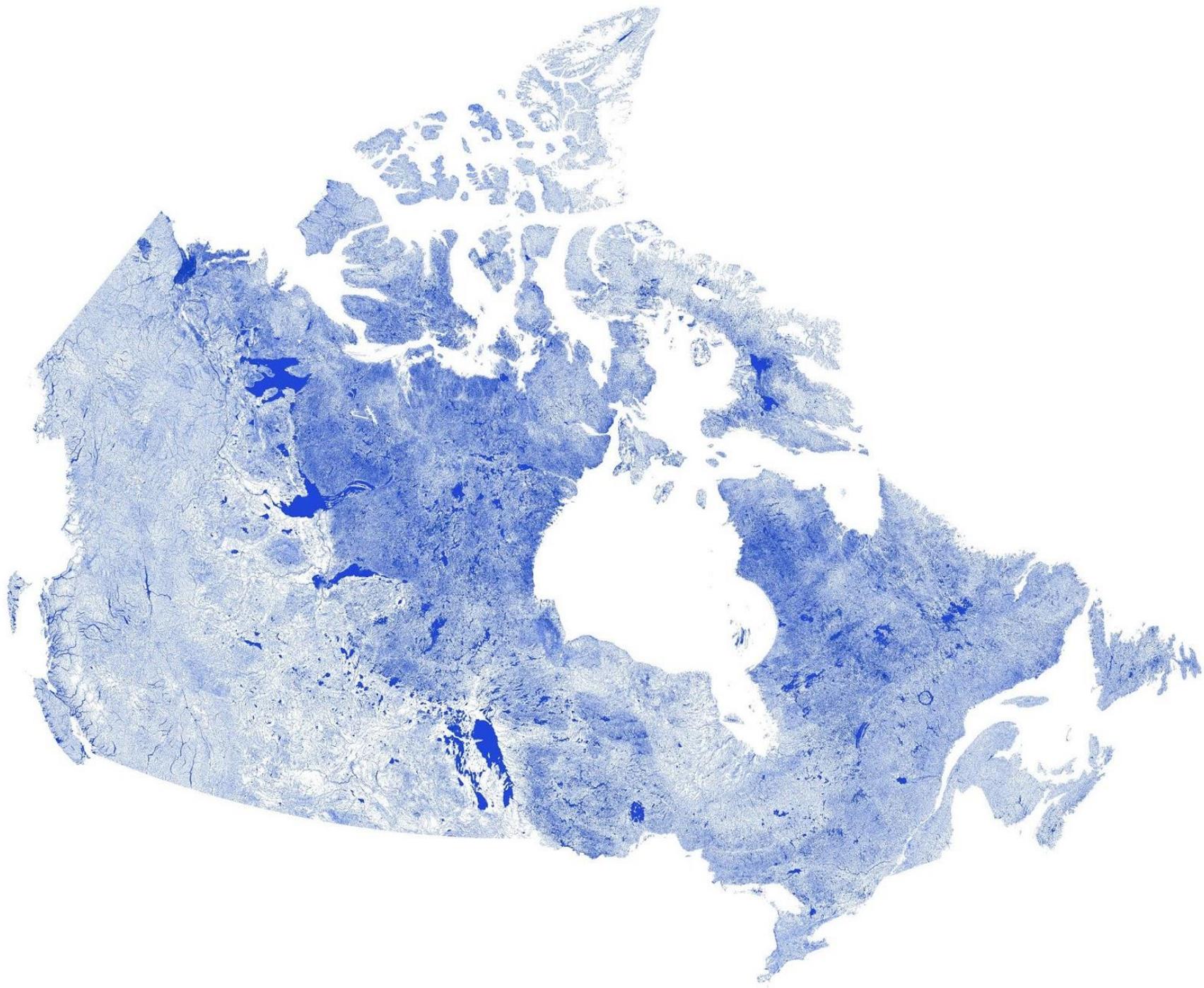


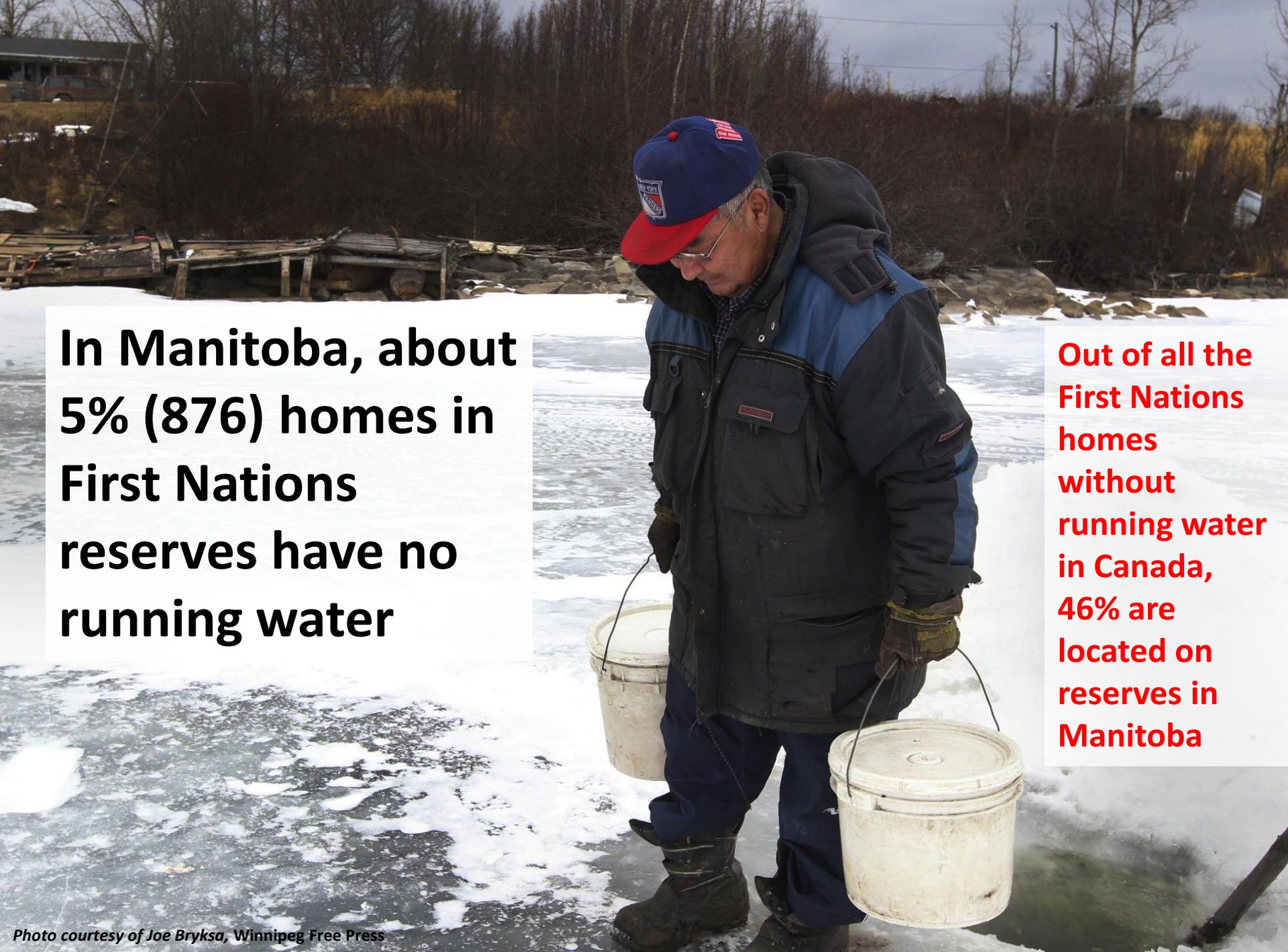


**Earth's
Total Water**



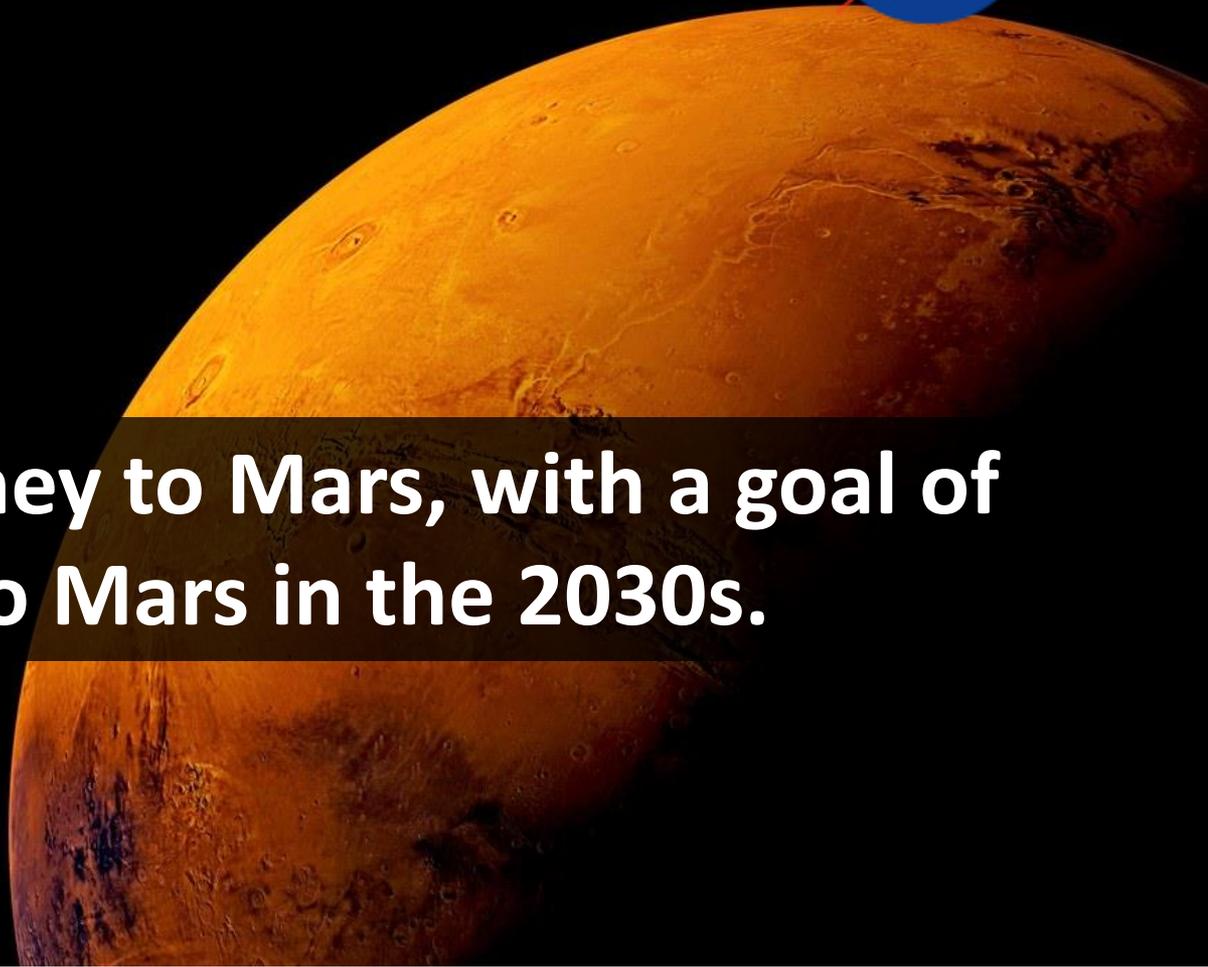
**Only 1% of water is
easily accessible for
human consumption**



A man wearing a blue and red baseball cap, a dark blue and black winter jacket, and dark pants is walking on a snowy and icy ground. He is carrying two large, light-colored plastic buckets, one in each hand. In the background, there are bare trees, a wooden structure, and a house on a hill under a cloudy sky.

In Manitoba, about 5% (876) homes in First Nations reserves have no running water

Out of all the First Nations homes without running water in Canada, 46% are located on reserves in Manitoba

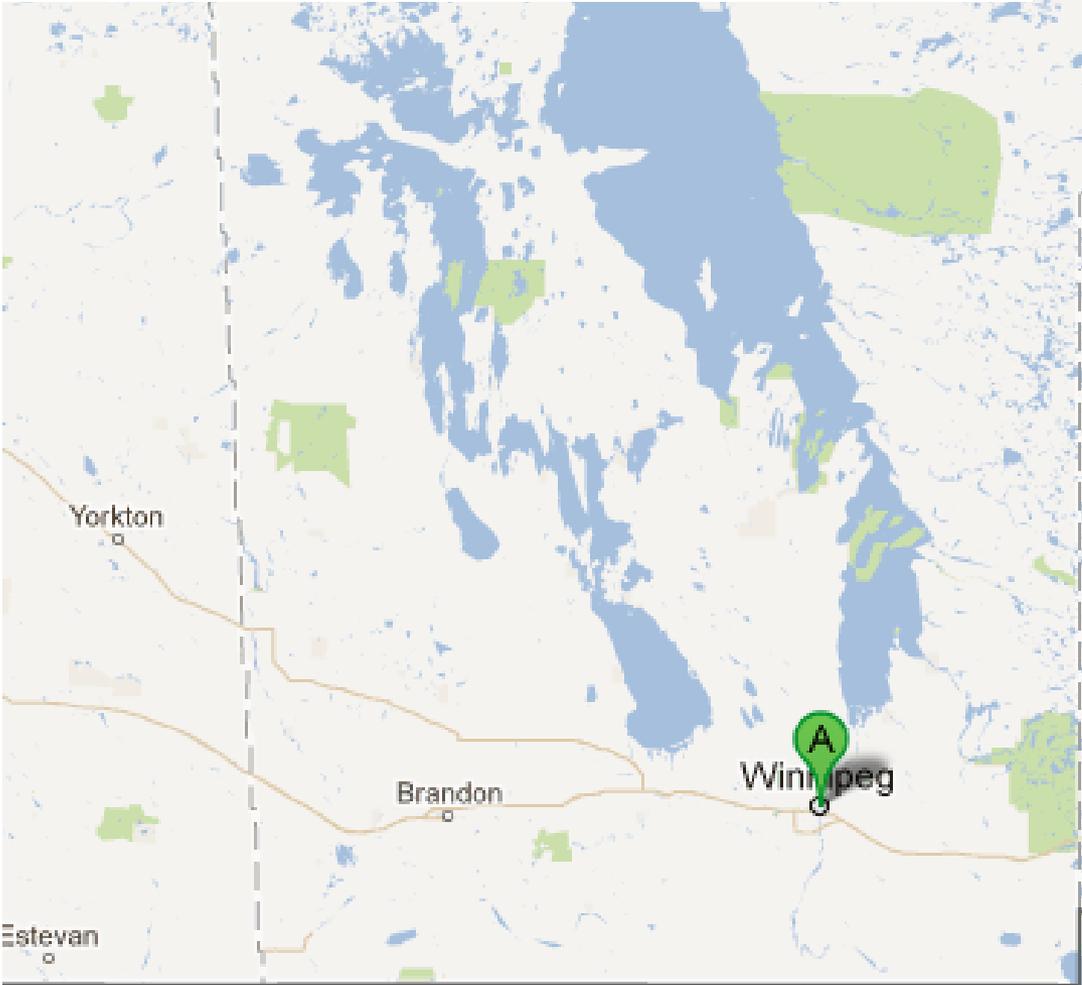
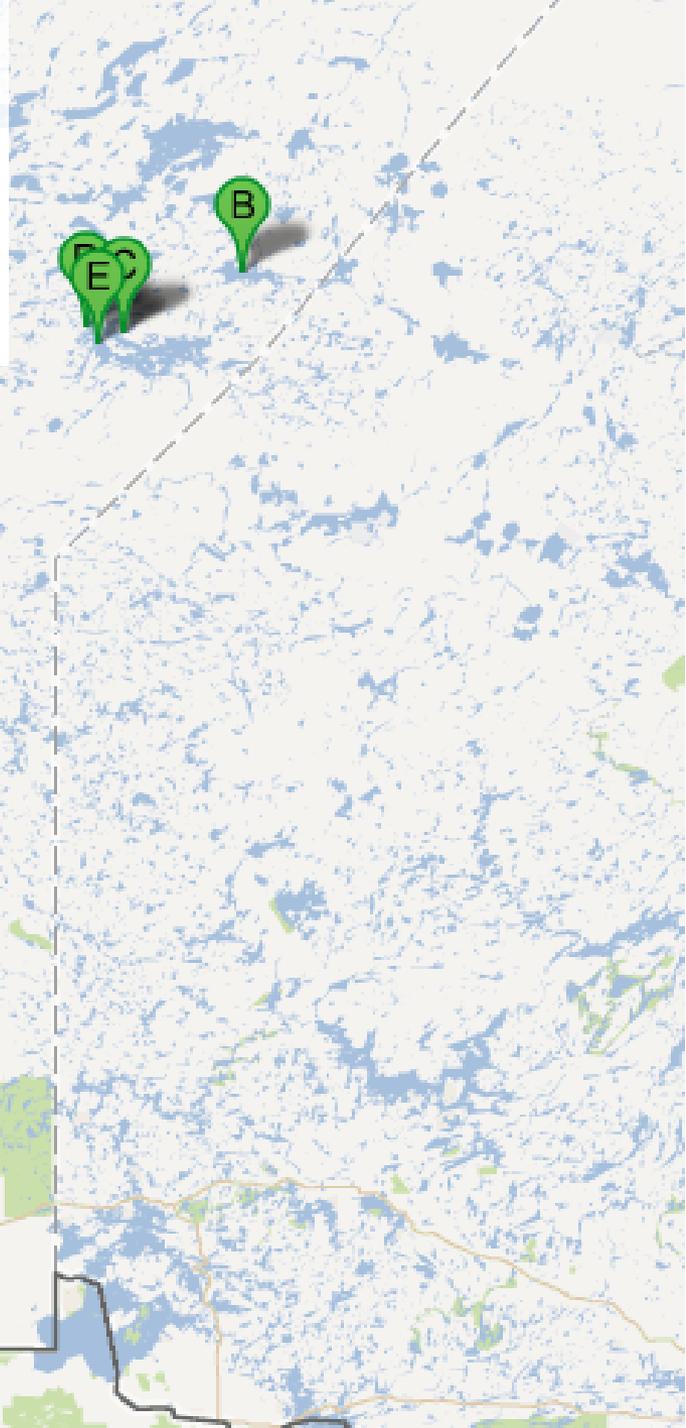


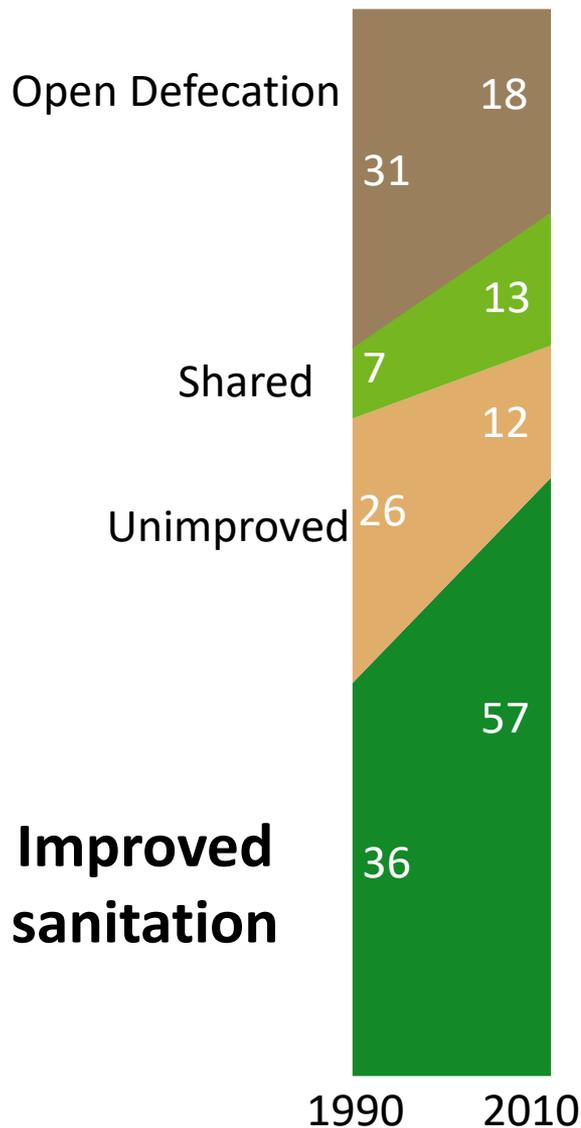
NASA is on a journey to Mars, with a goal of sending humans to Mars in the 2030s.

ISLAND LAKE REGION

Flights from **Red Sucker Lake (YRS)** to **Winnipeg (YWG)**

-  Non-stop flights: 1–2 per day, 1h 30m duration
- Airlines: **Perimeter Aviation**
- + [Schedule of non-stop flights](#)

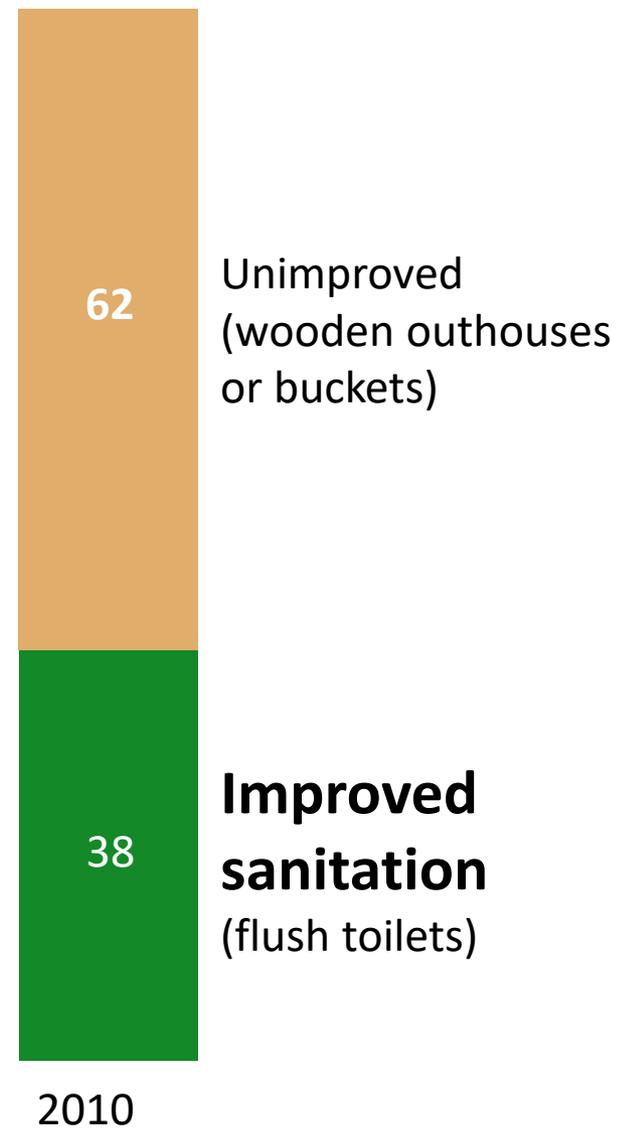




Developing countries

All numbers in bar graphs are % service

Left bar is reported by UNICEF/WHO (2012), right bar is based on data compiled by Island Lake Tribal Council for Aboriginal Affairs and Northern Development Canada.



Island Lake region of Manitoba



General Assembly

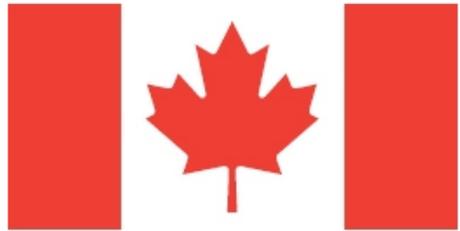
Distr.: General
2 October 2014

Original: English

Reaffirming that the human right to safe drinking water and sanitation entitles everyone, without discrimination, to have access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use and to have physical and affordable access to sanitation, in all spheres of life, that is safe, hygienic, secure, socially and culturally acceptable and that provides privacy and ensures dignity;



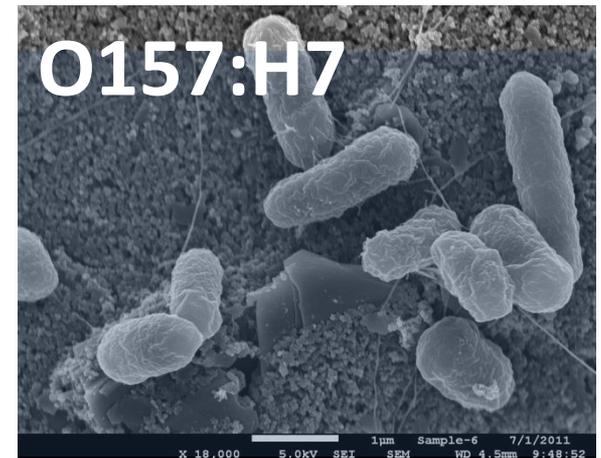
The Human Right to **Safe Drinking Water**



Health
Canada

*“To be safe for drinking, water must be **free of microbial pathogens** [while] **chemical contaminants must be kept at acceptable levels.**”*

*Species E. coli – many strains
Only some E. coli are pathogenic*





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MICROBIAL QUALITY GUIDELINES

E. Coli: 0 CFU/100 mL

- water leaving the treatment plant
- water in distribution and storage systems
- non-disinfected groundwater

CFU = colony-forming unit

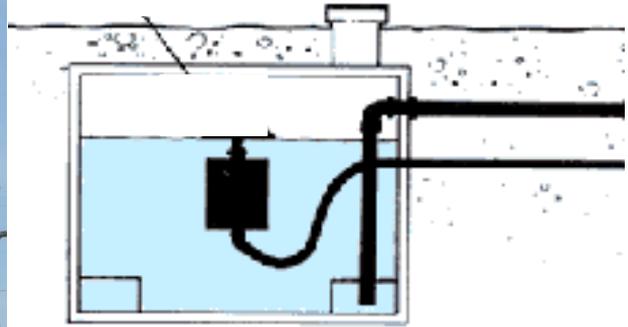


Free chlorine concentrations in most Canadian drinking water distribution systems range from 0.04 to 2.0 mg/L

**WATER
TREATMENT
PLANT**



WATER TRUCK

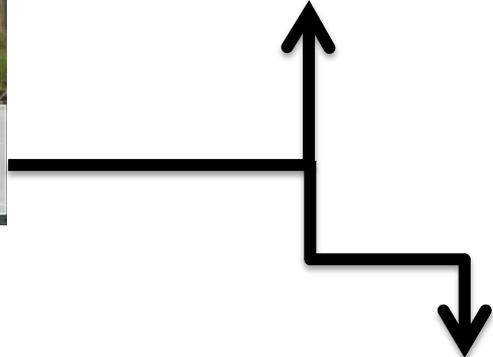


HOMES WITH CISTERNS

- **HOMES WITH PIPED WATER**
- **COMMUNITY STANDPIPE**



**HOMES WITHOUT
RUNNING WATER**



Examples of water distribution systems, First Nations reserves in Manitoba

(numbers refer to the number of homes)

	Community 1	Community 2	Community 3	Community 4
Piped water	151	170	0	60
Cisterns	69	34	6	151
Wells	0	0	90	0
No running water	300	0	1	0



PINE
CREEK



FIRST NATION

PINE CREEK FIRST NATION WATER TREATMENT PLANT

**Water Treatment Plant is providing clean
safe drinking water**

BE CAREFUL
KEEP THIS IN A CLEAN AND
DRY PLACE

CAUTION
BATTERY CHARGING
AREA
NO SMOKING

4/5

The free residual chlorine concentration in the water leaving the WTP was **1.6 mg/L**, within the range of free residual chlorine concentration (0.4 to 2.0 mg/L) typically observed for water treatment plants in Canada



When the clean water goes into the cisterns, the free chlorine is being readily depleted to low levels **0.04 mg/L**. Health Canada recommends, in general, a free chlorine residual of **0.2 mg/L** as a minimum level for the control of bacterial regrowth in the distribution system.





**Treated water is free
of total coliforms
and *E.coli***

**Water in water trucks is
free of total coliforms
and *E.coli***

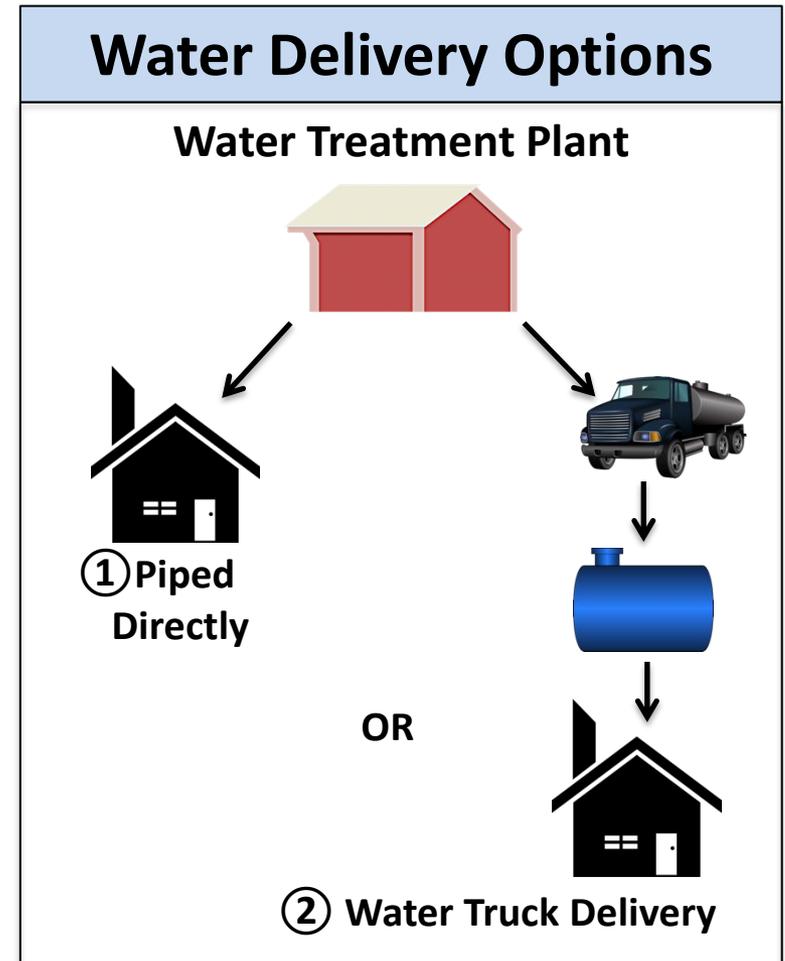


Water Delivery in the Community

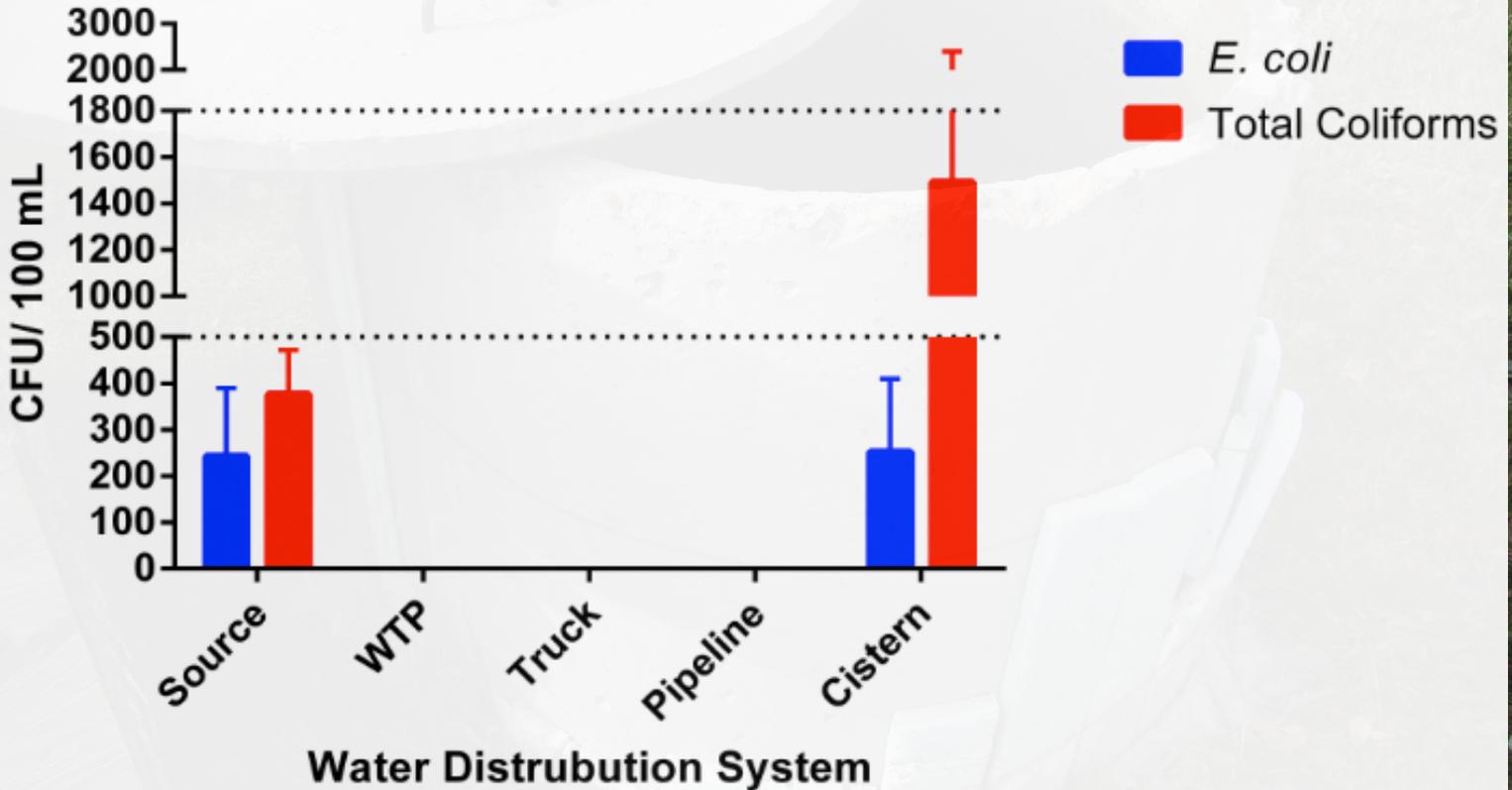
- ① Homes with **piped water** (60 homes): no total coliforms or *E. coli*

BUT

- ② Homes with **cisterns** (150 homes): unacceptable levels of total coliforms and *E. coli*

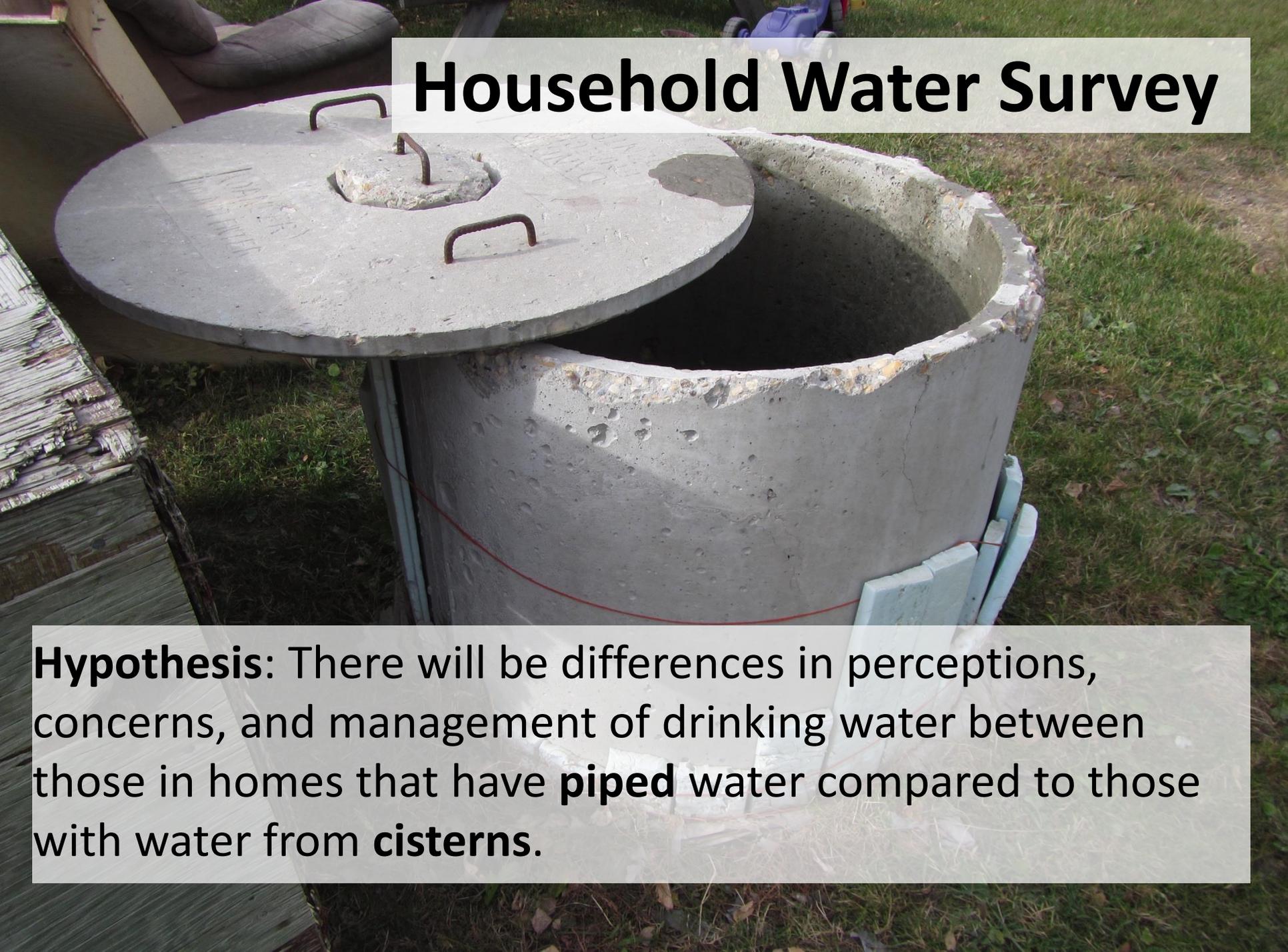


Presence of *E.coli* and Total Coliforms





Household Water Survey

A large, cylindrical concrete cistern is the central focus of the image. It has a circular concrete lid with three metal handles. The cistern is situated outdoors on a grassy area. To the left, there is a wooden structure, possibly a fence or a shed. In the background, there are some outdoor chairs and a blue object, possibly a cooler or a bag. The overall scene suggests a rural or semi-rural setting where such water storage is common.

Hypothesis: There will be differences in perceptions, concerns, and management of drinking water between those in homes that have **pip**ed water compared to those with water from **cisterns**.

Methods

- Hired a community researcher
- Adapted an existing survey that was developed and used in partnership between First Nations communities and the University of Saskatchewan



Methods

- Received approval from Chief & Council as well as from the University of Manitoba Ethics Board
- Summer 2017 completed 121 surveys (58% of the community)
- Regular meetings with Chief & Council



Is it safe?

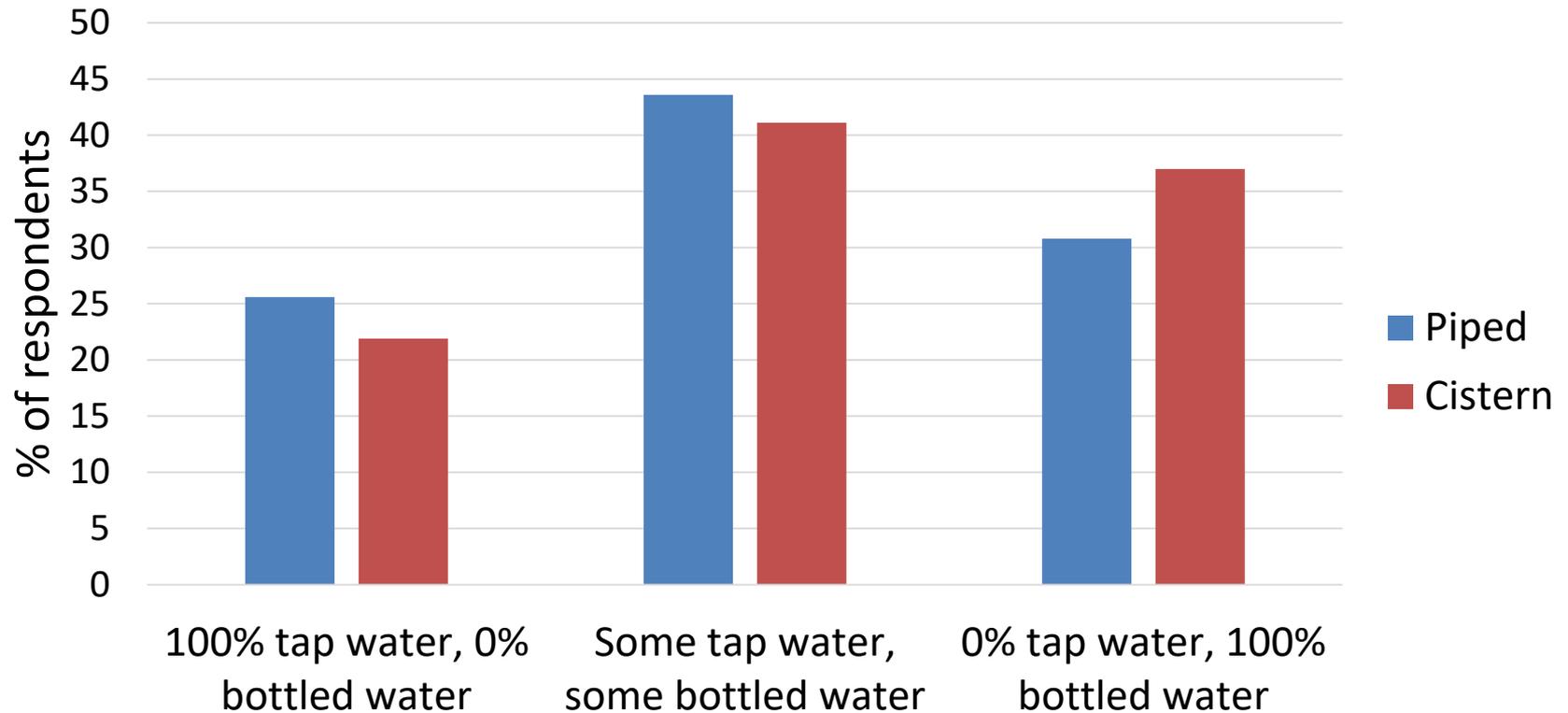
“...I’d rather drink ditch water”

40% of respondents believe their tap water to be safe

88% of non-First Nations people in small communities believe their tap water to be safe (EKOS, 2009)



Tap water and bottled water consumption preferences



35% of respondents report drinking 100% bottled water

8% of Non-First Nations people report drinking 100% bottled water

(Dupont et. al, 2014)



3 out of 4 people regularly buy bottled water

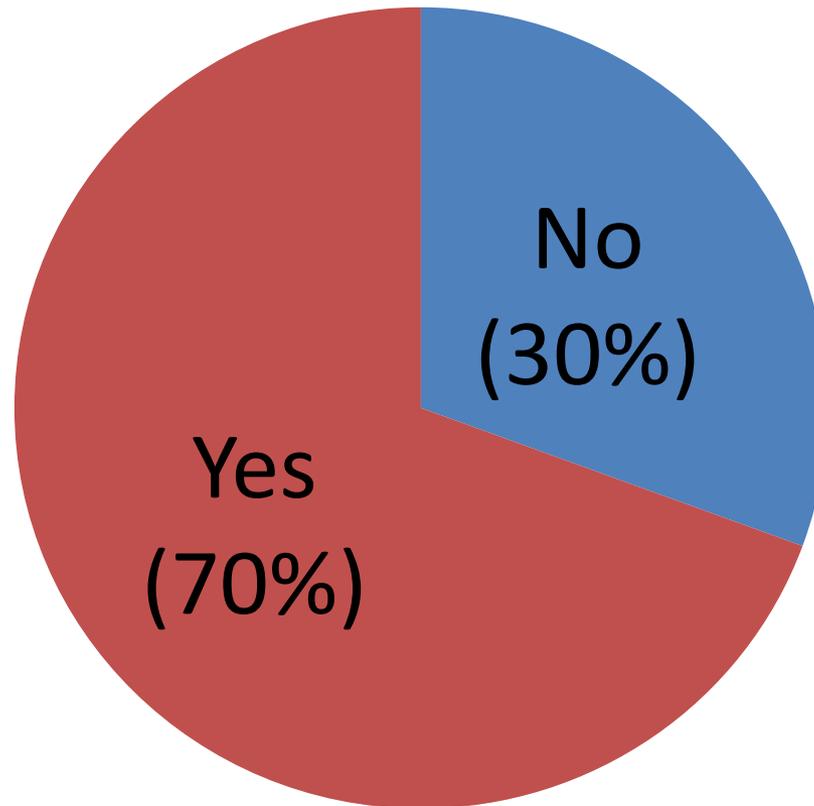
62% spend less
than \$50/month

38% spend over
\$50/month

Running out of water

- Only people with cisterns experienced this
- Many people have experienced running out of water, and now try to avoid this by rationing their water.

Do you ever run out of water?



“...the water in my home does affect me socially. I can't even have visitors because of the water in my home”

“Bullied from dirty clothes”

“I am a grandmother, aunty. I have children in my home. When there is no water, I cannot give them a bath!”

Cisterns CAN be a good option

- Some communities we work with use above ground cisterns (in heated sheds) and do not have water quality problems
- Provides jobs



Solutions

- **New Cisterns or hook up homes with pipes**
- **Decommission broken septic fields**
- **Resources for more frequent cleaning of cisterns**
- **Resources for more frequent testing of water**



Detection of Antibiotic Resistance Genes in Source and Drinking Water Samples from a First Nations Community in Canada

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ABSTRACT

Access to safe drinking water is now recognized as a human right by the United Nations. In developed countries like Canada, access to clean water is generally not a matter of concern. However, one in every five First Nations reserves is under a drinking water advisory, often due to unacceptable microbiological quality. In this study, we analyzed source and potable water from a First Nations community for the presence of coliform bacteria as well as various antibiotic resistance genes. Samples, including those from drinking water sources, were found to be positive for various antibiotic resistance genes, namely, *ampC*, *tet(A)*, *mecA*, β -lactamase genes (SHV-type, TEM-type, CTX-M-type, OXA-1, and CMY-2-type), and carbapenemase genes (KPC, IMP, VIM, NDM, GES, and OXA-48 genes). Not surprisingly, substantial numbers of total coliforms, including *Escherichia coli*, were recovered from these samples, and this result was also confirmed using Illumina sequencing of the 16S rRNA gene. These findings deserve further attention, as the presence of coliforms and antibiotic resistance genes potentially puts the health of the community members at risk.

IMPORTANCE

In this study, we highlight the poor microbiological quality of drinking water in a First Nations community in Canada. We examined the coliform load as well as the presence of antibiotic resistance genes in these samples. This study examined the presence of antibiotic-resistant genes in drinking water samples from a First Nations Community in Canada. We believe that our findings are of considerable significance, since the issue of poor water quality in First Nations communities in Canada is often ignored, and our findings will help shed some light on this important issue.

Antibiotic resistance in bacteria has been recognized as one of the greatest threats to human health by the World Health Organization (1). Overuse and misuse of antibiotics contribute to the buildup of selective pressure aiding the proliferation of antibiotic-resistant bacteria (2, 3). While hospital environments are notorious for selecting for antibiotic-resistant bacteria, it is now becoming increasingly evident that overuse and misuse of antibiotics are also creating a selective pressure outside hospital settings. Studies over the last few years have shown the presence of antibiotics and of antibiotic-resistant bacteria in the broader environment, including water supplies and soil samples (4). This is indeed alarming as the high number of antibiotic-resistant bacteria in communities makes the treatment of community-acquired infections increasingly challenging (5, 6).

Not surprisingly, water samples from communities that lack access to clean water contain high numbers of bacteria (7–9). While a high bacterial count in the water supply itself poses an increased health risk (10), the presence of antibiotic-resistant bacteria makes this risk even more serious. Lack of access to clean and safe water is a problem that is generally associated with developing countries; however, this is a reality as well for many First Nations communities in Canada. For example, it has been reported that between December 2015 and February 2016, there were 157 drinking water advisories in effect in 110 First Nations communities in Canada (11), which amounts to about 20% of all First Nations reserves in Canada. A national analysis has cited “unacceptable microbiological quality” as the reason in 43% of these advisories (12).

In this study, we examined the bacterial load and diversity as

well as the presence of various antibiotic resistance genes in water samples from a northern Manitoba First Nations community. Our work shows high prevalences of *Escherichia coli* and coliform bacteria and also of antibiotic resistance genes in these water samples. This study reports the presence of antibiotic resistance genes in drinking water in a First Nations community in Canada.

MATERIALS AND METHODS

Community profile. Water samples were collected from a First Nations community in the Island Lake Region of Manitoba, which is located about 500 km from Winnipeg, Manitoba, Canada. The community has an on-reserve population of approximately 4,000 and a total registered population of about 4,500, with a median age of ~20 years. This is a fly-in community, which is accessible from Winnipeg by two flights per day during summer (with no road access during summer) and by ice road during winter. The community has a water treatment plant, and just over 300 homes in the community are served by piped tap water. The majority of the houses that do not have piped tap water from the water treatment

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Bacteria in drinking water sources of a First Nation reserve in Canada

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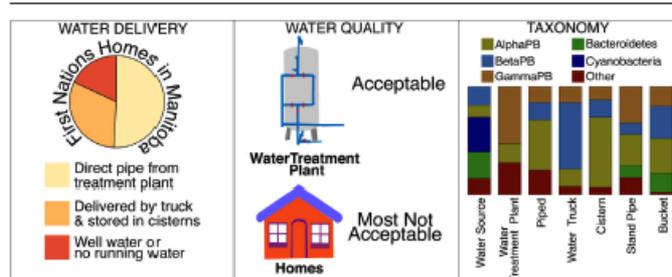
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HIGHLIGHTS

- *Escherichia coli* at levels up to 62,000 CFU/100 mL detected in drinking water sources
- Homes with cisterns or no running water always showed unacceptable *E. coli* levels.
- Abundance of Alphaproteobacteria in piped and cistern water suggests biofilm formation.
- Betaproteobacteria in water truck and buckets suggests contamination by dust (soil).
- First Nations on reserves may be at higher risk of contracting water-borne illnesses.

GRAPHICAL ABSTRACT



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Homes without running water

ABSTRACT

Approximately 20% of the 600 First Nations reserves across Canada are under a drinking water advisory, often due to unacceptable levels of bacteria. In this study, we detected fecal bacteria at an alarmingly high frequency in drinking water sources in a fly-in First Nations community, most notably in buckets/drums of homes without running water where *Escherichia coli* levels ranged from 20 to 62,000 CFU/100 mL. The water leaving the water treatment plant was free of *E. coli* and its free residual chlorine concentration (0.67 mg/L) was within the range typically observed for treated water in Canada. Water samples from taps in homes served by cisterns, and those sampled from the water truck and community standpipe, always showed unacceptable levels of *E. coli* (1 to 2100 CFU/100 mL) and free residual chlorine concentrations below the 0.2 mg/L required to prevent bacterial regrowth. Samples from taps in homes served by piped water had lower levels of *E. coli* (0 to 2 CFU/100 mL). DNA- and RNA-based 16S rRNA Illumina sequencing demonstrated that piped and cisterns water distribution systems showed an abundance of viable cells of Alphaproteobacteria indicative of biofilm formation in pipes and cisterns. The alpha diversity, based on observed OTUs and three other indices, was lowest in water truck samples that supplied water to the cistern and the low free residual chlorine concentration (0.07 mg/L) and predominance of Betaproteobacteria (63% of viable cells) that were immediately detected after the truck had filled up at

Cisterns in Manitoba First Nations communities contain E. coli

Professor says getting rid of underground cement cisterns which crack is a short term fix
By Christopher Read, CBC News Posted: Nov 20, 2015 7:25 PM CT | Last Updated: Nov 20, 2015 7:44 PM CT



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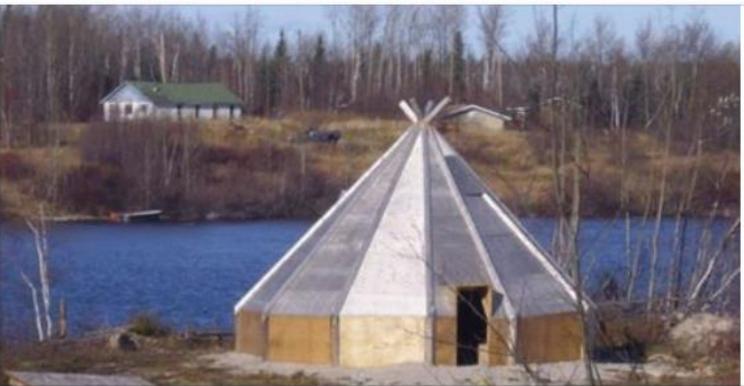
Water 'alarmingly' tainted even on reserves with good treatment plants, study suggests

TOM BLACKWELL | October 16, 2016 | Last Updated: Oct 17 10:14 AM ET
More from Tom Blackwell | @tomblackwellNP

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The Huffington Post Canada
October 29 at 3:00pm

"Some countries want to put people on Mars... if we think that's possible, why is it not possible to provide people in Canada with clean drinking water?"



First Nation Has A Treatment Plant But Water Is Still Tainted: Study

The water is "far below" the standard for a developed country.
HUFFINGTONPOST.CA

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Next Steps

- Continue monitoring water quality
- Antibiotic Resistance Genes
- Bacteria Composition Analysis in order to see if sewage tanks are a source of bacteria in the cisterns
- Work with other communities that are interested in doing a household water survey



CREATE 20



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