Drinking Water Quality as Affected by Water Treatment, Distribution, and Source Water Quality

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Introduction

Raw water → Coagulation & Flocculation → Sedimentation → Filtration

Disinfection

Chlorine, Chloramines, Chlorine dioxide, Ozone, UV light

Finished water
• Cl decays in water distribution
  ▫ Volatilization
  ▫ Bulk decay – by reacting with organic/inorganic compounds in water
  ▫ Wall decay – by reacting with pipes & tank walls
• Chlorine decay –

  ▪ Decreases disinfection efficiency
  
  Can result microbial re-growth
**Chlorine decay –**

- Produces disinfection by-products (DBPs)

\[
\text{DBPs} = \text{Chlorine} + \text{organic matter}
\]

*e.g., Trihalomethanes (THMs)*

![Chemical structures of THMs](image)
Factors affecting on bulk chlorine decay

- Type & dose of chlorine
- Chemistry of water – composition, pH
- Natural & anthropogenic organic matter content
- Temperature
- Contact time - storage
- Sediment properties of water source
- Algal growth in source water – amount & species
Water Distribution Methods

Raw water → Coagulation & Flocculation → Sedimentation → Filtration → Disinfection → Finished water → Pipes → House holds

Cisterns → House holds
Water Systems in First Nation’s communities

<table>
<thead>
<tr>
<th></th>
<th>Manitoba (%)</th>
<th>Canada (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped</td>
<td>51</td>
<td>72</td>
</tr>
<tr>
<td>Truck delivery - Cisterns</td>
<td>31</td>
<td>13.5</td>
</tr>
<tr>
<td>Individual Wells</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>No Water Service</td>
<td>5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Concerns about Cisterns

• Cl may react with compounds in the water & tank walls
• Cl decay may reduce the residual chlorine concentration in the cisterns
• These reactions may reduce the disinfection efficiency
• Risks in transportation of water

Baird et al., 2013 & Personal communications
Objectives

- To compare the water quality of direct pipe water & the cisterns in the communities
- To study seasonal variation of water quality (chlorine decay and DBP formation) in the cisterns
- To identify the factors (treatment/source water quality) affecting on water quality issues
Experimental Approach - Field

1. **On-site study** – Water samples from direct piped water & cisterns will be collected four times a year during spring, summer, fall, and winter to study bacterial re-growth & DBP formation.
2. **Laboratory study I** – Source water samples from the source water will be incubated under a range of chlorine concentrations & temperatures to study the chlorine decay kinetics & DBP formation.

3. **Laboratory study II** – Source water will be incubated under different light conditions to study the growth of algae in source water on DBP formation

4. **Laboratory study III** – Sediments from the source water will be incubated to study the DBP formation potential
Significance of the Research

• Research will evaluate effects of using cisterns as a drinking water storage and distribution method in First Nation’s communities

• Results will identify the potential sources of DBP precursors in drinking water

• Results can be used to develop effective and novel techniques to remove those precursors during the water treatment process.
Thank you