NL Decision Matrix for Potable Water Treatment & Service Delivery Options

Water Resources Management Division – Drinking Water Quality Improvement Initiative

Introduction

- In 2024, CBCL was engaged to review the existing framework for potable water delivery in the province by public entities, and develop a framework for determining what level of service delivery could be applied within a given community
  - Summarizing the state of public drinking in the province (populations, water quality, etc.)
  - Focus on small systems (<500 people)
  - Review available water treatment technologies
  - Comparing NL to other jurisdictions
  - Develop a “Decision Matrix” - a guidance tool for public drinking water supplies evaluating their own options for service delivery

NL Public Water System Population Overview

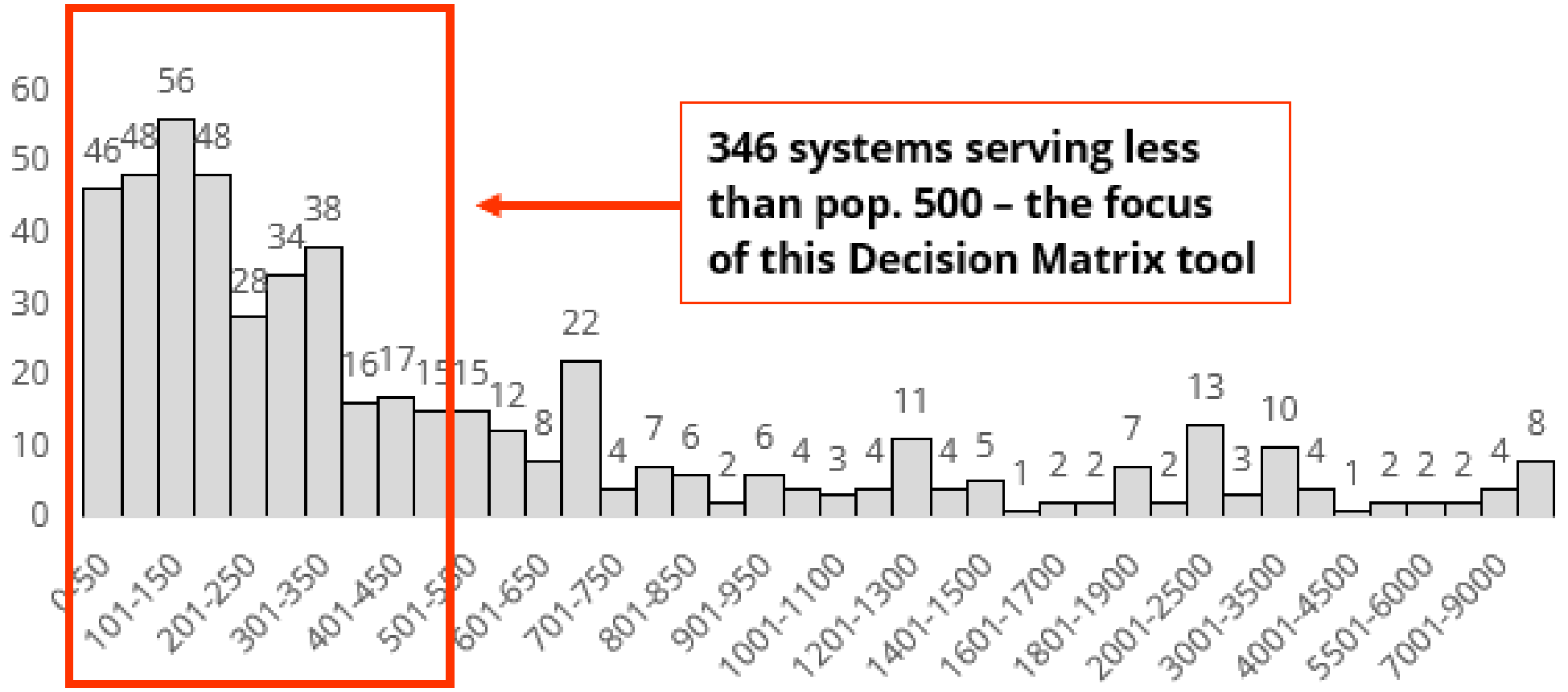


Figure 1-2: Number of drinking water systems by size of population served

NL Drinking Water Quality Overview

Public Drinking Water

85% of Population
443,311

Ground Water 7% Population 35,465		
Metals	0.7%	P. 3,545
Organics	0.1%	P. 425
Meets GCDWQ	6.2%	P. 31,492

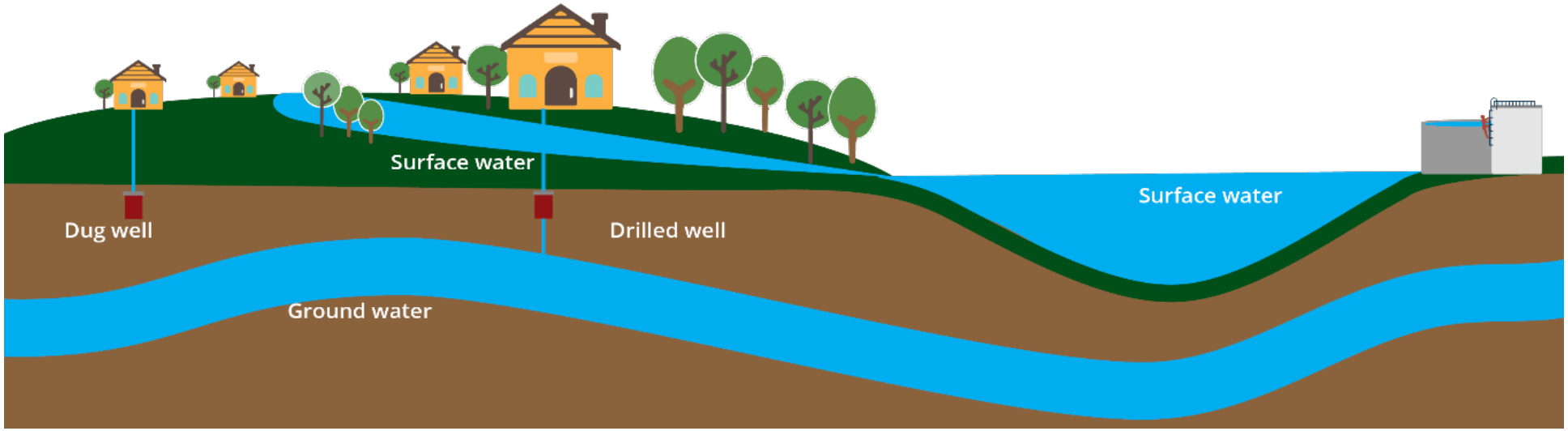
Surface Water 78% Population 407,846		
Metals	11%	P. 57,098
Organics	25.6%	P. 134,589
Meets GCDWQ	41.4%	P. 216,158

Private Drinking Water

15% of Population
78,231

Dug Well 7.5% Population 39,116		
Potential for Bacteria, Metals and Organics	7.5%	P. 39,116

Drilled Well 7.5% Population 39,115		
Metals	3.75%	P. 19,558
Meets GCDWQ	3.75%	P. 19,558



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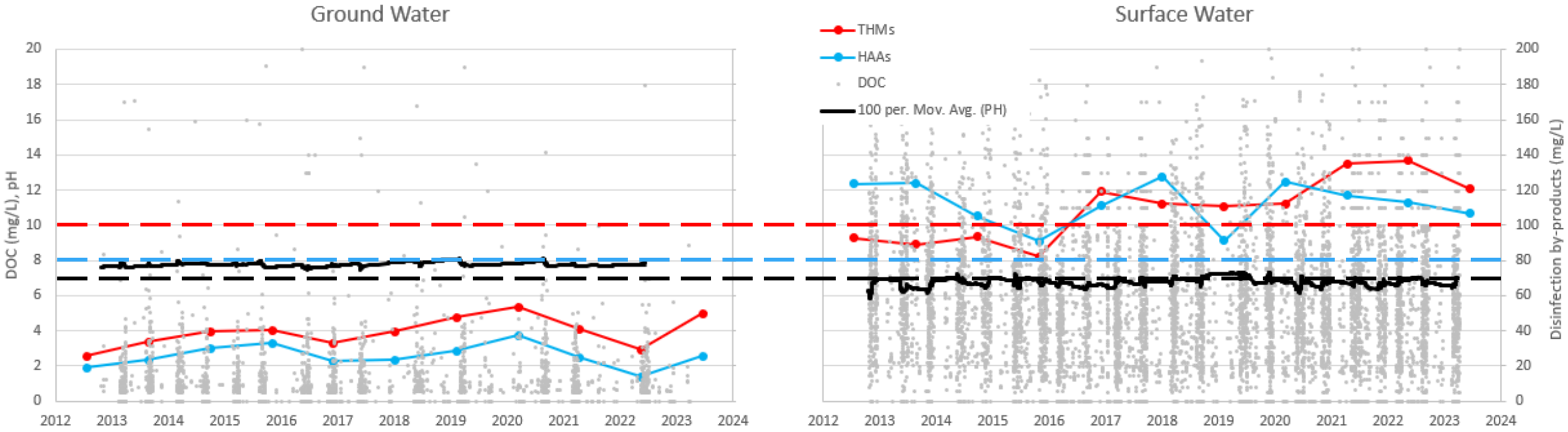
Most Common WQ Issue: DOC and DBPs in Public (Surface) Water Supplies



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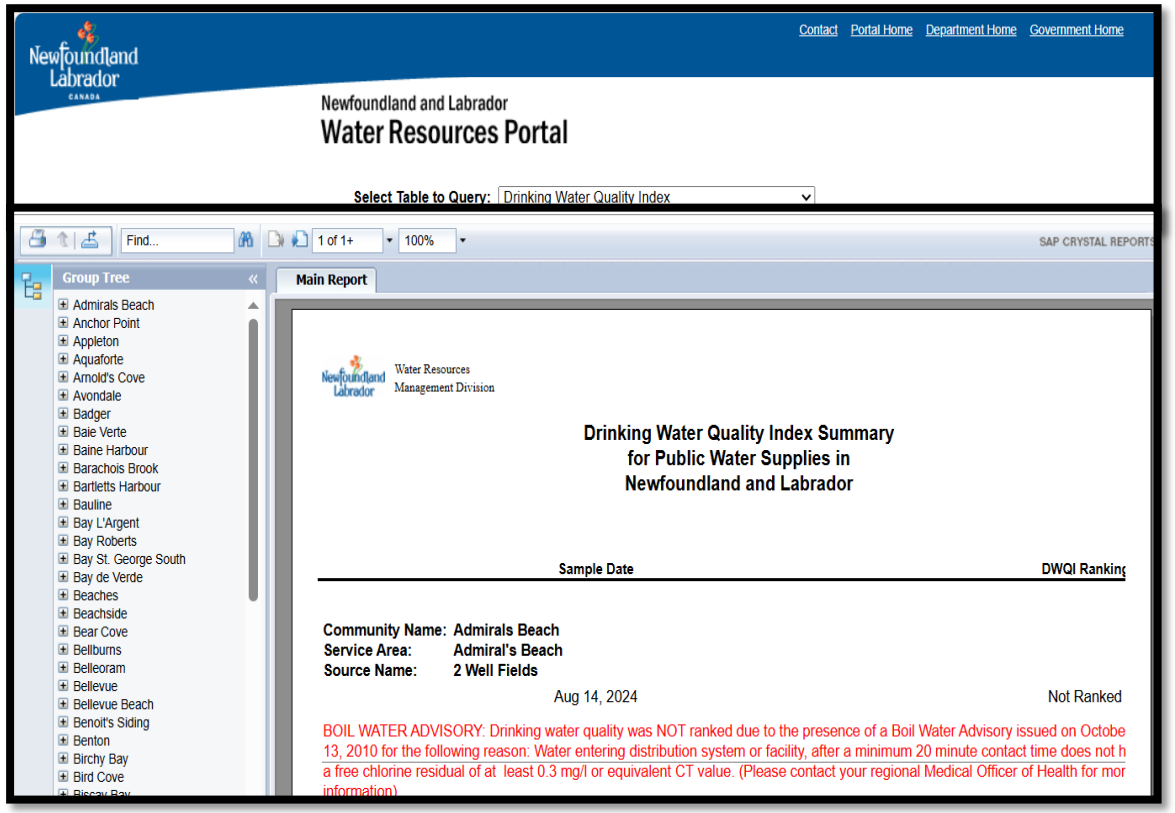
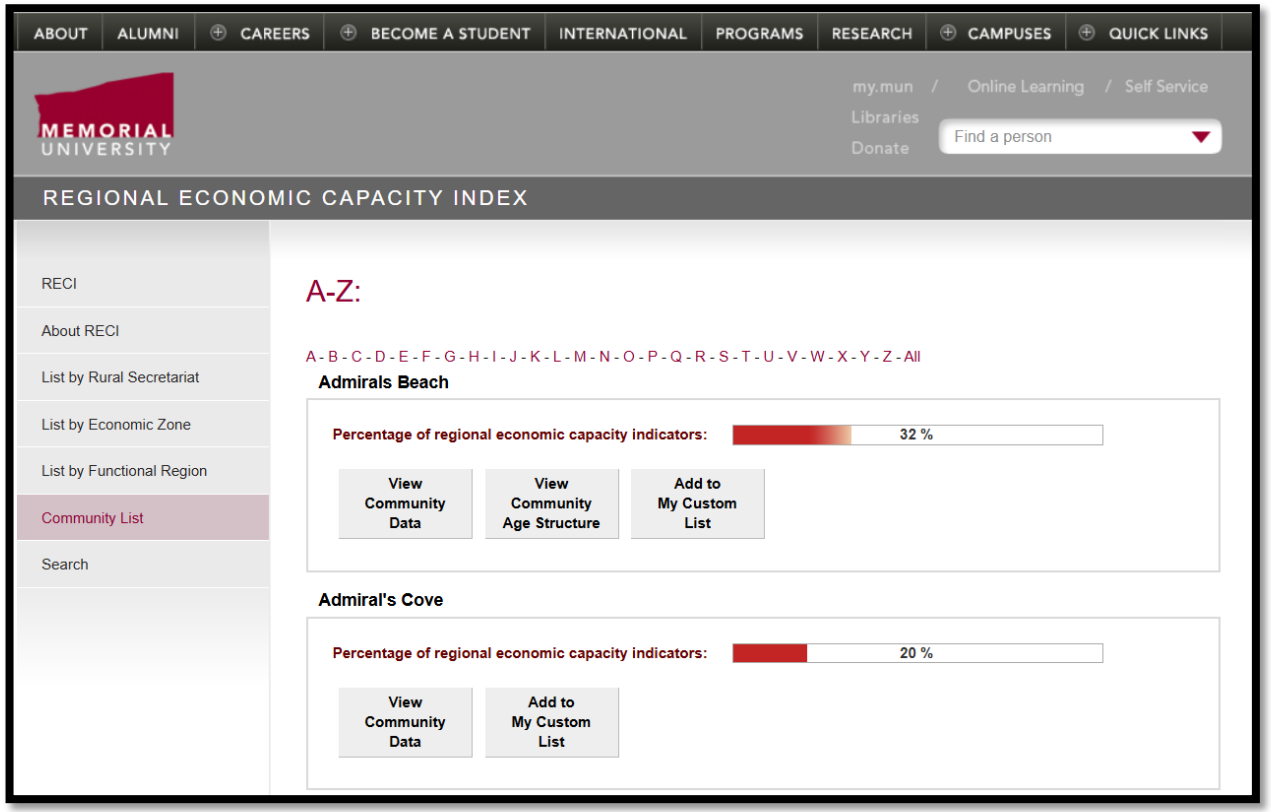
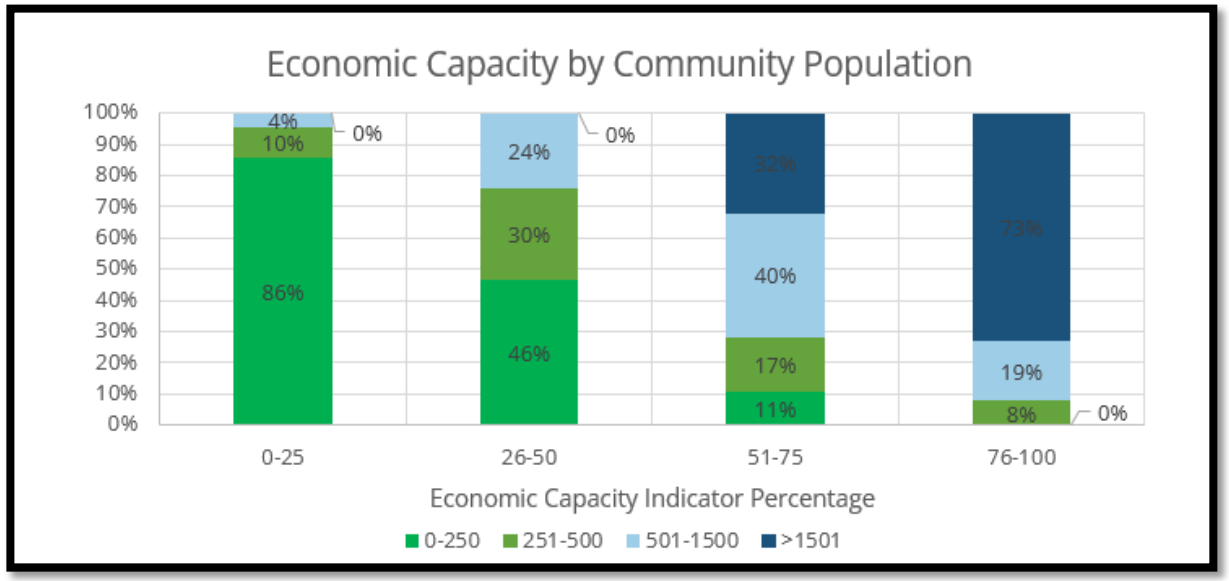
Water Quality as an Economic Problem

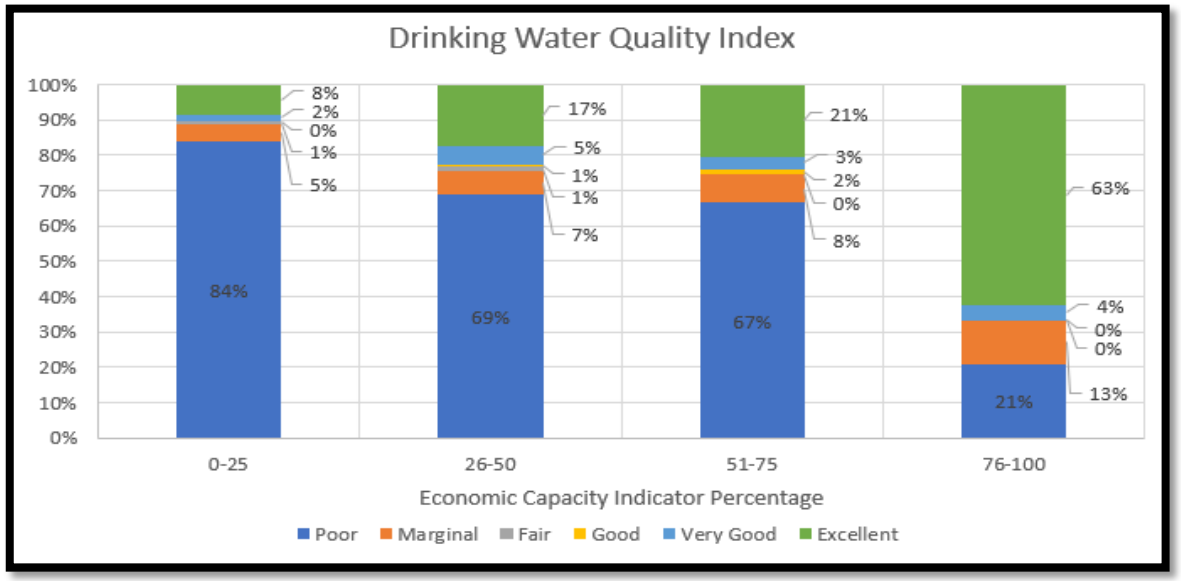
- Smaller communities often lack the economies of scale which allow larger communities to deliver higher levels of service – attempt to demonstrate empirically
- Database of water quality by community including "Drinking Water Quality Index" – developed by WRMD
- Database of economic capacity by community including "Percentage of Regional Economic Capacity Indicators" – developed by MUN research group

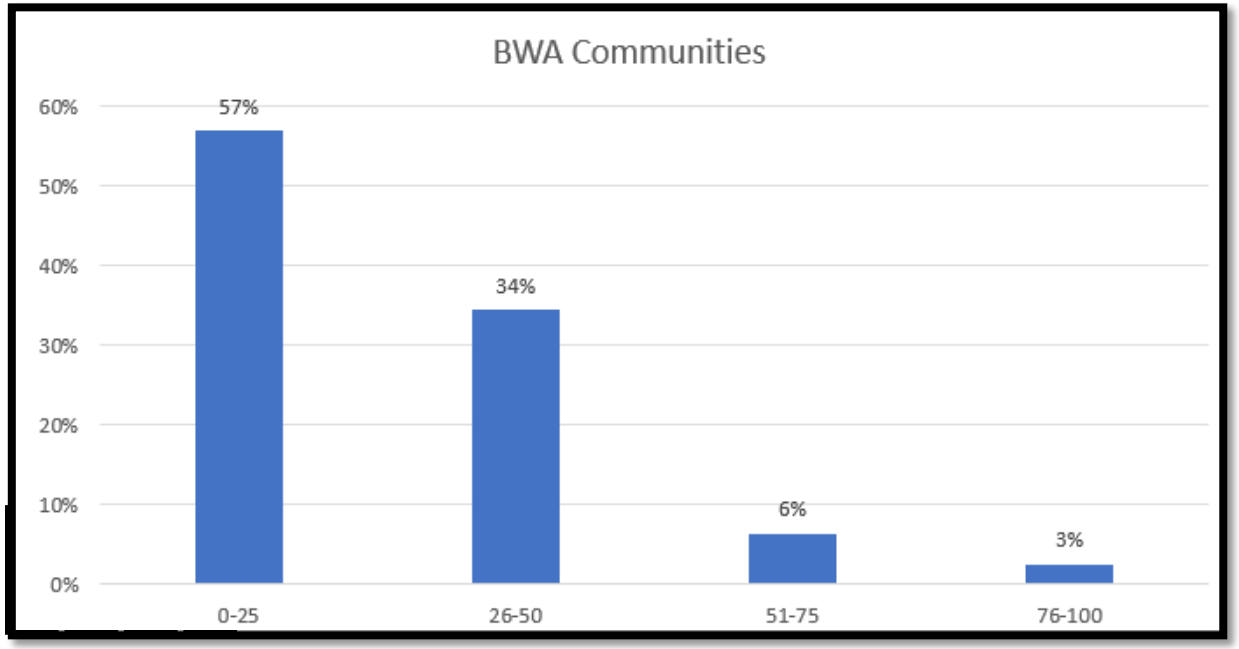


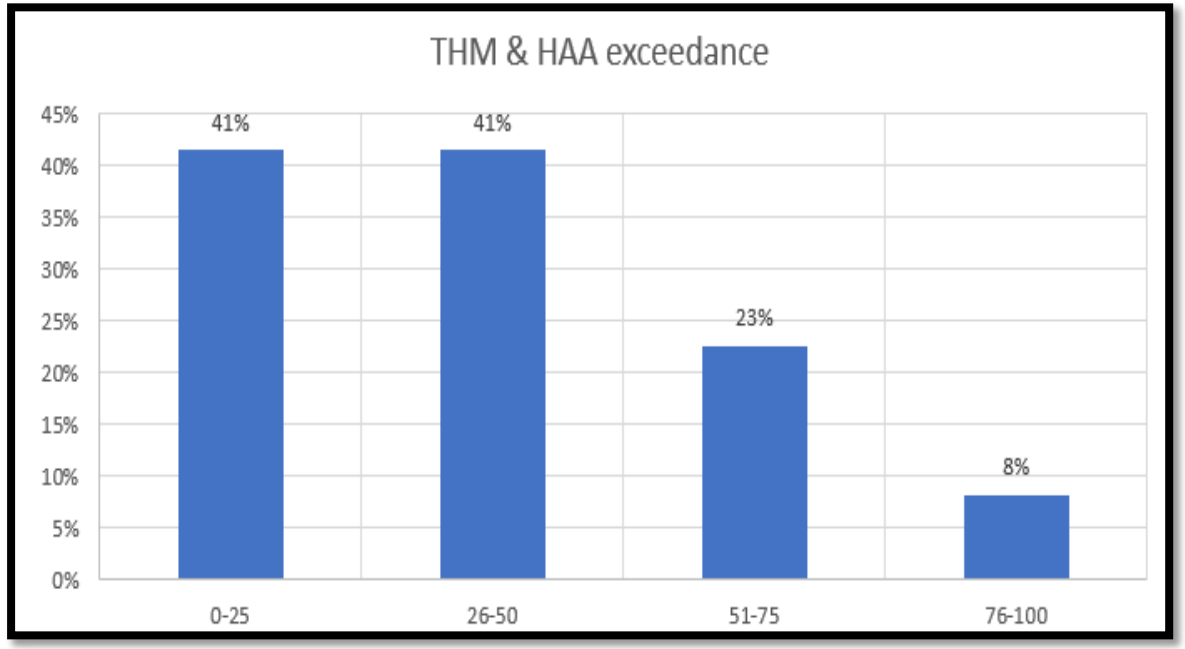


Water Quality as an Economic Problem

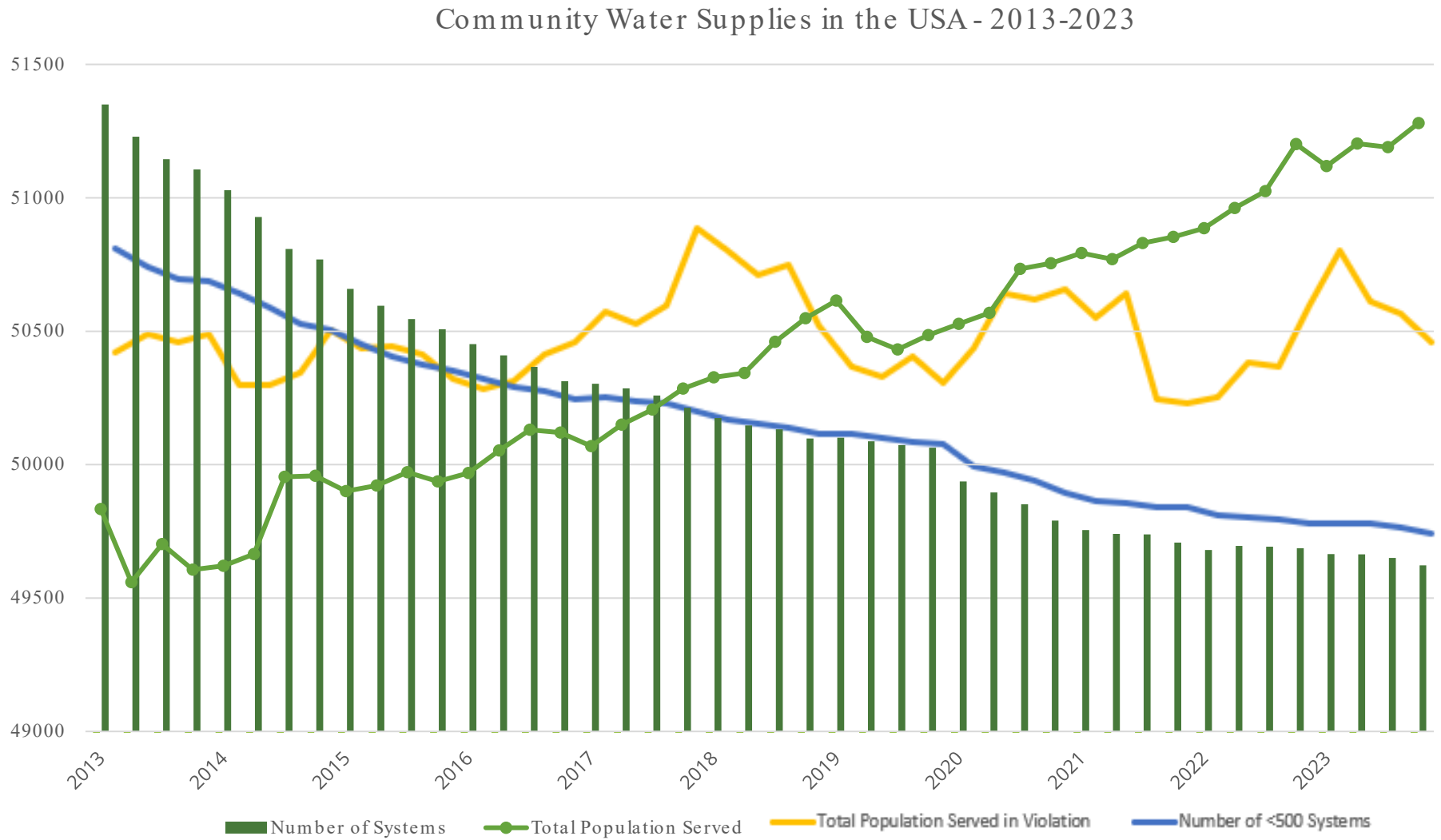








Effect of Economies of Scale: US Growth and Consolidation



Change in Total Population Served: +6.7%

Change in Total # of Systems: -1,728

Change in Total # of VSS: -1626

Change in Total Population Served in Violation: -1.9%

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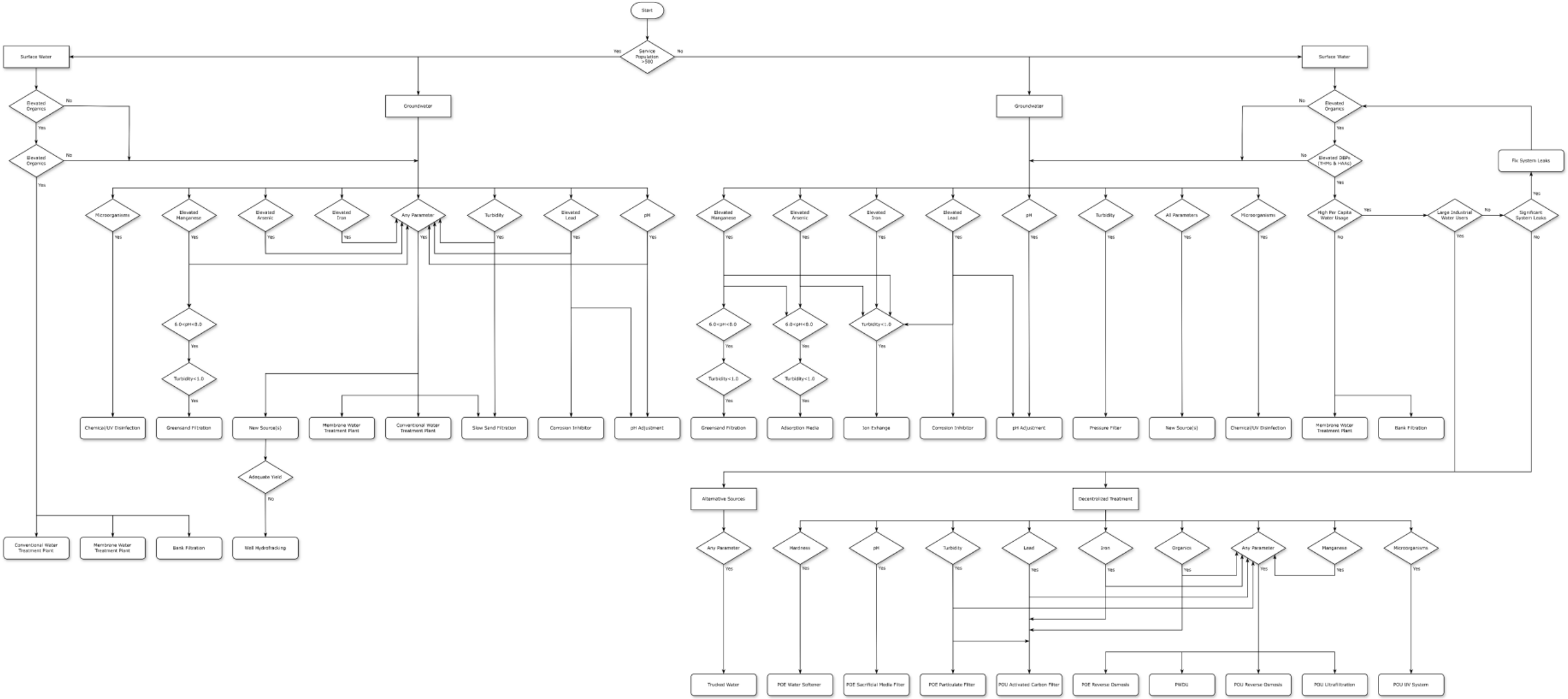
Options for Service Delivery – Centralized/Decentralized, POE/POU, Trucked

Decision Matrix – Flow Chart



Decision Matrix – Excel Tool Inputs

Service Delivery Assessment Tool

Community:	
Supply Name:	
Water Source:	
Population:	
Population (Override):	

Raw Water Quality:	Average	Maximum	Unit
Turbidity			NTU
Colour			TCU
Alkalinity			mg/L
pH			
Hardness			mg/L
Iron			mg/L
Manganese			mg/L
Copper			mg/L
Sulphate			mg/L
DOC			mg/L
TDS			mg/L

Treated Water Quality:	Average	Maximum	Unit
Turbidity			NTU
Colour			TCU
Alkalinity			mg/L
pH			
Hardness			mg/L
Iron			mg/L
Manganese			mg/L
Copper			mg/L
Lead			mg/L
Arsenic			mg/L
Sulphate			mg/L
DOC			mg/L
TDS			mg/L
Trihalomethanes (THM)			mg/L
Haloacetic Acid (HAA)			mg/L

Target Water Quality Parameters

Organics (NOM, DOC)	Target
Manganese	Target
Lead	Target
Arsenic	Target
Iron	Target
Hardness	Target
pH	Target
Turbidity	Target
DBPs (THM & HAA)	Target

Resources

- Health Canada Organic Matter (2020)
- GCDWQ Manganese (2019)
- GCDWQ Lead (2019)
- GCDWQ Arsenic (2006)
- GCDWQ Iron (2024)
- GCDWQ Hardness (1979)
- GCDWQ pH (2015)
- GCDWQ Turbidity (2012)
- GCDWQ THMs (2006)
- GCDWQ HAAs (2008)

Centralized Corrective Measures (CM)

New Source(s)	Valid CM
Conventional Treatment	Valid CM
Membrane Treatment	Valid CM
Slow Sand Filtration	Invalid CM
Ion Exchange	Invalid CM
Adsorption	Invalid CM
Chemical Disinfection	Valid CM
Oxidative Media	Invalid CM
Bank Filtration	Invalid CM
pH Adjustment	Valid CM
Corrosion Inhibitor	Valid CM

De-Centralized Corrective Measures (CM)

PWDU	Invalid CM
POE Water Softeners	Invalid CM
POE Particulate Filters	Invalid CM
POE Sacrificial Media Filter	Invalid CM
POE Reverse Osmosis	Invalid CM
POU Under Sink RO	Invalid CM
POU Activated Carbon Filters	Invalid CM
POU UV System	Invalid CM
POU Ultrafiltration	Invalid CM
Trucked Water	Invalid CM

Decision Matrix – Excel Tool Output (Centralized Options with Costs)

Valid CM?	Corrective Measure	Description	Estimated Capital Cost	Estimated Annual Operational Cost
Valid CM	Ion Exchange	Ion exchange is a treatment process in which undesirable ions, including manganese, arsenic, iron and lead, are removed. The ion exchange process occurs on an resin media, whereby the target ions replace the harmless ion on the media, releasing the harmless ion into the treated water. The anionic/cationic exchange (media dependent) occurs on a continuous basis until the media is exhausted. Once exhaustion is reached, the resin undergoes a recharge phase to remove the target ion from the media and replace it with more harmless ions. Various natural ions will compete with for adsorption on the resin, and as such, low turbidity and low DOC waters are desirable.	$998,000	$30,000
Invalid CM	Adsorption	In water treatment, adsorptive medias are applied for the removal of various contaminants of concern. In adsorption media systems, dissolved target ions adherence and become trapped on the filter media. A variety of different types of adsorptive medias exist and are typically designed to target certain water quality parameters of concern. Adsorptive media is commonly used in the treatment of arsenic and fluoride in municipal source waters. The medias in these systems slowly become exhausted and need to be replaced with new media. Another common adsorptive media is granular activated carbon (GAC), which is adsorptive for a wide range of water quality parameters.	$998,000	$30,000
Valid CM	Chemical Disinfection	Disinfection is the treatment process specifically designed for the reduction of harmful microorganisms. Disinfection is an essential aspect of the drinking water treatment process critical for protection against various waterborne pathogenic microorganisms (bacteria, viruses, protozoa). Harmful microorganisms are the most significant risk to public health from drinking water. The removal/inactivation of microbiological parameters is the highest priority for water treatment and is critical to providing safe drinking water. The most common type of disinfection is chemical disinfection, which is achieved through the addition of a variety of chemicals or physical agents. The most common disinfectant agent is chlorine, which is found in most water treatment plants throughout Canada. In the province of Newfoundland and Labrador, chemical disinfection is widely implemented in water treatment plants and water treatment facilities.	$90,000	$23,000
Valid CM	Oxidative Media	Oxidative greensand media filters are a traditional method used to remove dissolved manganese (Mn(II)). Greensand filters function on the principle of adsorbing dissolved Mn particles onto a manganese oxide (MnOx) coating on the media. As the media absorbs manganese over time, it eventually requires to be regenerated, which commonly achieved using chlorine. Direct greensand filtration is commonly used on groundwater sources with low turbidity. In water with elevated turbidity, a prefiltration unit is often used prior to an oxidative media filter.	$838,000	$30,000

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Decision Matrix – Excel Tool Output (Decentralized Options with Costs)

Valid CM?	Corrective Measure	Description	Unit Cost	Unit Annual Operational Cost	Total Capital Cost	Total Annual Operational Cost
Valid CM	Potable Water Dispensing Unit (PWDU)	Potable water dispensing units, abbreviated as PWDU's, are decentralized drinking water treatment systems that are designed to treat the consumptive fraction of a community's water demand. PWDU are intended to provide high quality drinking water that is only used for consumptive uses (drinking, cooking, baby formula, etc.). As such, water for nonconsumptive uses (showering, toilet, laundry) needs to be supplied from a different drinking water system (centralized distribution or private supply). The treated water from a PWDU is not connected to a centralized distribution system. PWDU's are typically constructed in a standalone building that contains the treatment system and an on site storage tank. The high-quality drinking water produced by a PWDU requires manual collection or a bottle delivery service for consumers to obtain the water. A PWDU can make advanced treatment technologies used in full scale water treatment plants, available to small communities with reduced financial capacity and technical expertise.	$4,255	$183	$651,000	$28,000
Invalid CM	POE Water Softeners	Particulate filters are a POE treatment system that consist of a sand media in an automatic backwashing media tank. The sand media in the particulate filters is designed to trap particulate matter and reduce the turbidity of the source water. Particulate filters are typically run in tandem with other treatment alternatives (oxidative media filters, ion exchange, etc.) when there is elevated turbidity and elevated concentrations of other problematic water quality parameters. The benefit of particulate filters in the configuration will reduce turbidity from a source water, which will generally help to improve the performance/efficiency of the subsequent treatment alternative.	$1,750	$125	$122,000	$8,600
Valid CM	POE Particulate Filters	Particulate filters are a POE treatment system that consist of a sand media in an automatic backwashing media tank. The sand media in the particulate filters is designed to trap particulate matter and reduce the turbidity of the source water. Particulate filters are typically run in tandem with other treatment alternatives (oxidative media filters, ion exchange, etc.) when there is elevated turbidity and elevated concentrations of other problematic water quality parameters. The benefit of particulate filters in the configuration will reduce turbidity from a source water, which will generally help to improve the performance/efficiency of the subsequent treatment alternative.	$2,000	$200	$140,000	$14,000
Valid CM	POE Sacrificial Media Filter	Sacrificial Media Filters are POE treatment systems that are designed to treat water with low pH. Low pH or corrosive (acidic) water degrade metal piping over time, leading to weakened metal and eventually developing pinhole leaks or breaks. The corrosion of metal pipe will also release metal ions into the water which can have negative health and aesthetic effects. When treating for low pH water, a slow dissolving sacrificial media system can be added, increasing the pH by neutralizing acidity. Sacrificial media filter systems are low complexity treatment systems that do not require regular maintenance. As the sacrificial media is slowly dissolving, annual maintenance will be required to refill the media tank with fresh media.	$1,750	$300	$122,000	$20,900

Full Cost Accounting Assessment Tool

- Still a "screening tool" level of cost estimate generation, but more comprehensive than the Decision Matrix Tool

- Currently integrating both tools together to provide guidance on potential upgrades, along with capital and operating costs and financing projections

Title Page

Newfoundland Labrador

Province of Newfoundland & Labrador

Full Cost Accounting Assessment Tool

To Achieve Complete Cost Recovery of Drinking Water Supply System Operation & Maintenance, Capital Upgrade Projects and Infrastructure Replacement

Cost Curve Predictions

Predicted Capital Costs for Upgrades

Enter the number of customers on the water supply system: 80

Enter the Current Annual Water Tax: $500

Has a cost estimate for the proposed upgrades been developed through an engineering study?

- ○ Yes, the estimate is:
- ◉ No, have the tool calculate an approximate value based on historical data.

Note: Estimates obtained through an engineering study are considered to be more reliable than the values generated by this program, which are based on cost data from previous projects in the Province.

Enter the fraction of the capital cost will be covered by government funding: 90%

Note: Project funding is reduced by the amout of GST rebate due to the community if the full project project costs are expended. The community is responsible for applying for the appropriate rebates and interim financing of the rebates

Upgrade Component	*Capital Cost*	*Government Contributions*	Balance Covered by Community
Water Treatment Facility	*$1,742,000*	*$1,567,800*	*$174,200*
Pumping Systems			
Distribution			
Storage			
Range of Probable Cost			
-30%	*$1,219,400*	*$1,097,460*	*$121,940*
Median	*$1,742,000*	*$1,567,800*	*$174,200*
+30%	*$2,264,600*	*$2,038,140*	*$226,460*