



Water Treatment Facility Effectiveness in Newfoundland and Labrador

Drinking Water Safety Workshop, Gander

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Definitions

- Water Treatment Facility
 - A public drinking water system that has a drinking water treatment process other than chlorine disinfection.
 - Can include a single treatment process or multiple treatment processes that target specific water quality parameters.

- Water Treatment Plant
 - A water treatment facility that is designed to produce drinking water that meets all required drinking water standards and guidelines.

Treatment Processes Evaluated

OBJECTIVE: To determine the effectiveness of various types of water treatment facilities in the province

- Treatment processes evaluated:
 - Infiltration galleries
 - In-line filtration systems
 - Arsenic removal systems
 - Iron removal systems
 - Manganese removal systems
 - Lead removal systems
 - Strontium removal system

Study Approaches

■ Approach
No. 1

- “Pre/Post”

Tap water before
treatment
installed

Vs.

Tap water after
treatment
installed

■ Approach
No. 2

- “Raw/Treated”

All
Source
water

Vs.

Tap water after
treatment
installed

■ Approach
No. 3

- % Removal

Infiltration Gallery



Infiltration Gallery

- An intake structure in which the intake is buried or contained within a berm
- A perforated intake pipe is placed and permeable material is backfilled on top or around it creating a barrier to filter water before it reaches the intake pipe



Construction of Buried Infiltration Gallery



Finished Infiltration Gallery

Infiltration Gallery

- Newfoundland & Labrador currently has 24 infiltration galleries in operation
- Approximately half of which are of the buried type, located directly in the main source
- The majority of those introduced to specifically target turbidity are berm infiltration galleries
- Cost ranges from \$20,000 to \$130,000 depending on the size and type
- Average cost is approximately \$95,000

Infiltration Galleries in Newfoundland & Labrador

Community	Commissioned	Cost
Anchor Point	2007	-
Appleton	2000	115,000
Bird Cove	1996	-
Burlington	2012	74,700
Centreville- Wareham- Trinity	2003	50,000
Comfort Cove- Newstead	2004/2005	115,000
Cow Head	2006	-
Crow Head	2010	-
Flower's Cove	2000	-
Gander Bay South	2006	115,000
Harbour Breton	2007	-
Hare Bay	2007	115,000

Community	Commissioned	Cost
Loon Bay	2003	23,000
McIvers	2011	-
Millertown	2007	115,000
Morrisville	2005	-
New Perlican	1992	-
Norris Arm	2007	126,300
Northern Arm	1998	70,000
Phillips Head	2007	100,050
Robert's Arm	2012	115,000
Springdale	2007	895,625 (Also intake upgrade)
St. Paul's	2006	-
Twillingate	1998	-

Results - Infiltration Galleries

- Majority of tests indicated no significant difference in parameters considered:
 - pH
 - Colour
 - Turbidity
 - DOC
 - Iron
 - Manganese
 - THMs
 - Free chlorine residual
- The majority of the significant results can be attributed, in part, to some other factor
- The results show that when installed to specifically reduce turbidity, the reduction was achieved, however the results were rarely significant

Conclusion - Infiltration Galleries

- Marginally effective in specific cases for turbidity reduction
- Dependent upon:
 - Source
 - Design
- Other options may be more effective in dealing with certain issues (i.e. in-line filters)

Recommendations- Infiltration Galleries

- Establish criteria which must be met prior to the approval for construction of an infiltration gallery
 - i. intake pond is shallow
 - ii. intake is in an exposed pond prone to wave action
 - iii. turbidity is an issue
 - iv. icing of the intake is an issue

- ENVC should develop design guidelines for the construction of future infiltration galleries

In-Line Filters

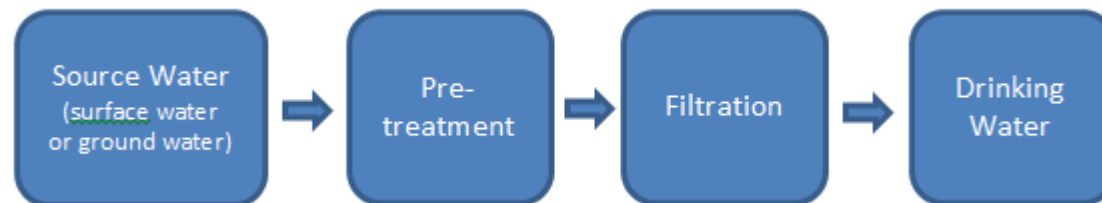


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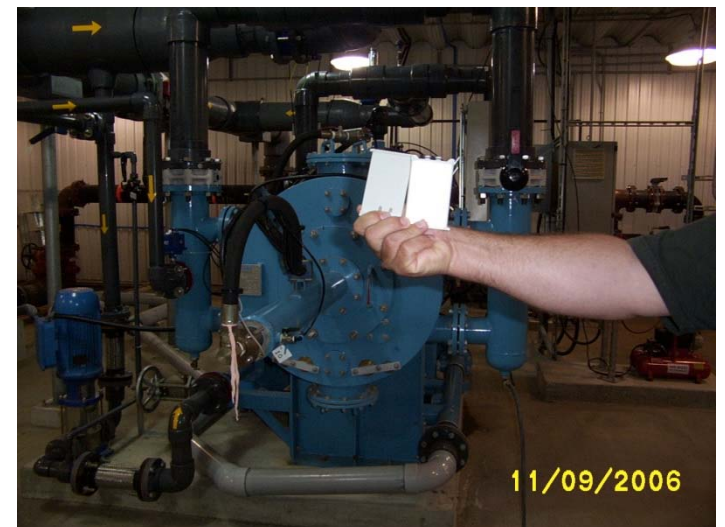
In-Line Filters

- Filtration is the process where water flows through a permeable media while solid particles are retained or adsorbed.
- The filter pore size represents the size of solid particles that can be removed by the filter.
- Newfoundland & Labrador currently has 34 in-line filters in operation
- 19 communities were involved in this study



Types of In-Line Filters

- Filter Types in NL
 - Media filter (Sand, anthracite & GAC)
 - Retaining and adsorbing
 - Mesh filter
 - Single-layer Retaining
 - Thread filter
 - Multi-layer Retaining



In-Line Filters in Newfoundland and Labrador

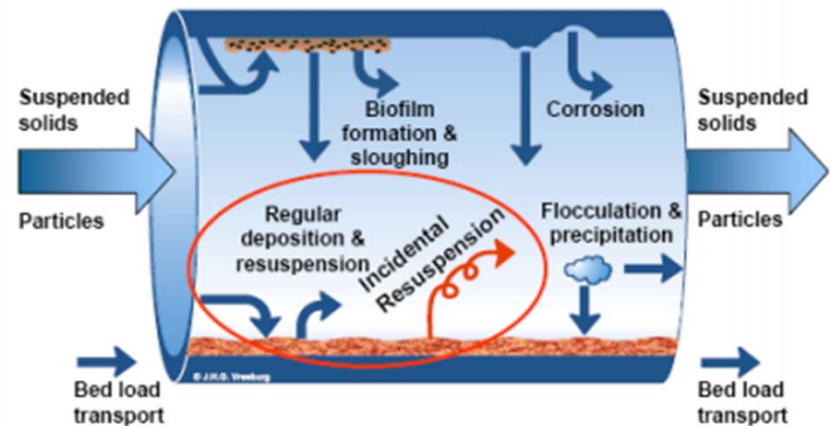
- Media Filter
 - Cottrell's Cove
 - Grand Bank
 - Hermitage
 - Isle aux Morts
 - Lewisporte
 - Milltown-Head of Bay
D'Espoir
 - Salvage
- Thread Filter
 - Deer Lake
 - Pasadena
- Mesh Filter
 - Burnt Island
 - Cape Freels North
 - Embree
 - Happy Adventure
 - Harbour Breton
 - Hare Bay
 - Mile's Cove
 - Rattling Brook
 - Seal Cove
 - Steady Brook

Results - In-Line Filters

Approach	Parameter	Increase	Decrease
“Pre/Post”	Colour	7	0
	Turbidity	3	0
	DOC	12	0
	Iron	1	2
	Manganese	0	9
	Total THMs	15	1
	Free Chlorine	11	2
“Raw/ Filtered”	Colour	1	18
	Turbidity	4	2
	DOC	10	0
	Iron	10	1
	Manganese	1	13

Effectiveness on Turbidity

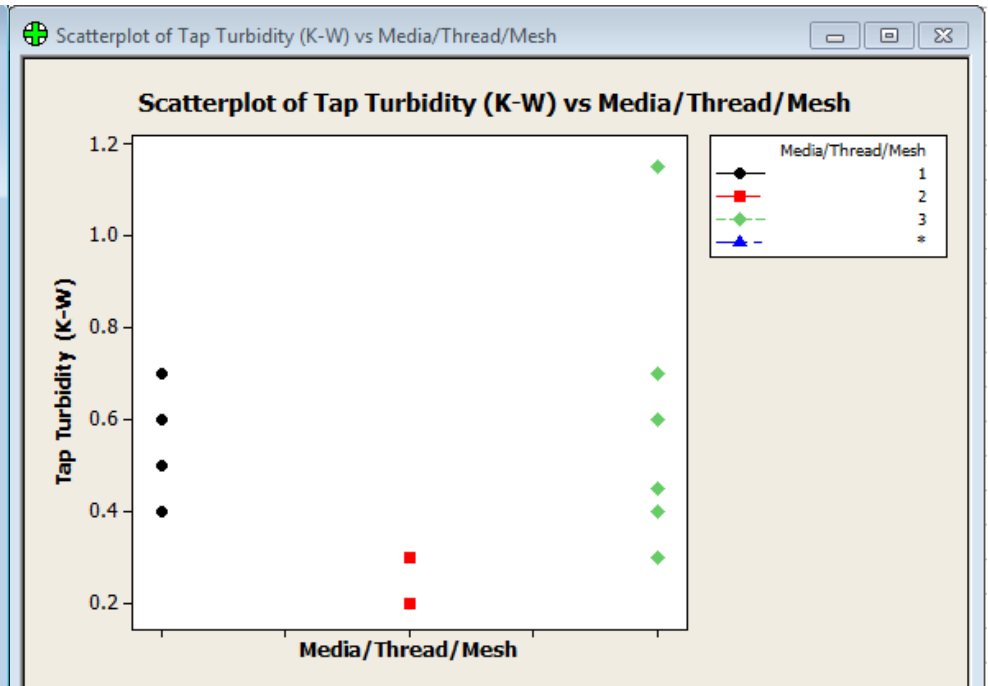
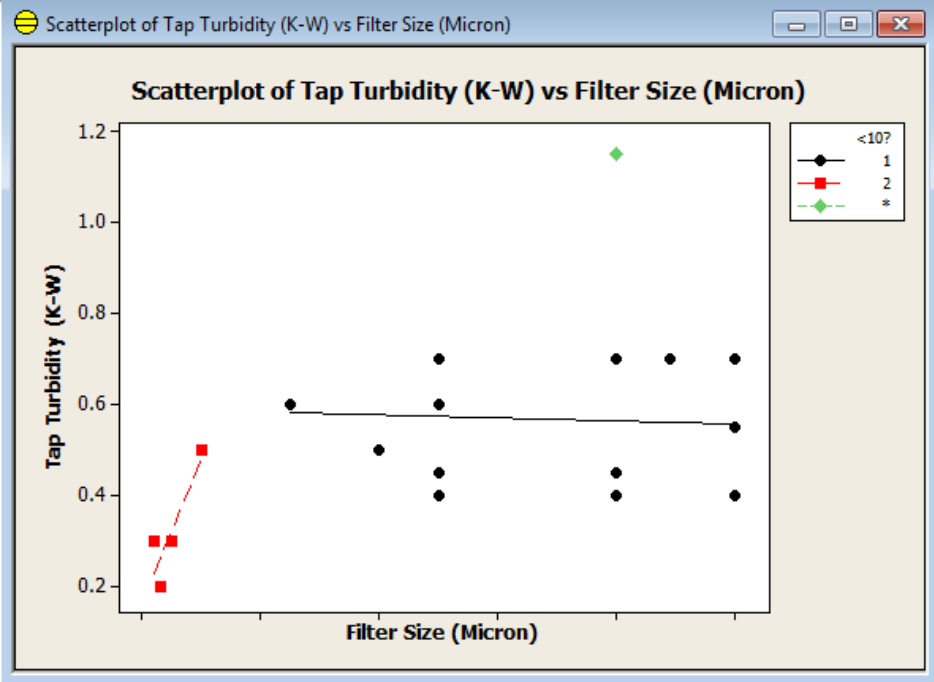
- Only 2 communities showed significant decreases
- About 11 communities showed increases from the pre-filter water to filtered water
- Why?
 - Corrosion of distribution system pipes over the years
 - Re-suspended sediments in pipes



“Mass Balance Model”, J.H.G. Vreeburg (2004)

Filtered Tap Turbidity vs. Filter Size & Type

- 1 – 10 microns group
 - Red dots
 - Lower turbidity
 - Follow a linear trend
 - More effective
- 11 – 100 microns group
 - Black dots
 - Higher turbidity
 - Mesh filters showed the highest turbidity



Most Effective Filters in NL

- The lowest two turbidity results
 - Pasadena (Decreased 38% from source to filtered tap)
 - Deer Lake (Decreased 31% from source to filtered tap)

Community	Filter Size (Micron)	Filter Types	Pre-filtration (Micron)	Filtered Tap Turbidity Mean	Filtered Tap Turbidity Median
Pasadena	2	Thread	80	0.2650	0.30
Deer Lake	3	Thread	50	0.2875	0.20

Recommendations- In-Line Filters

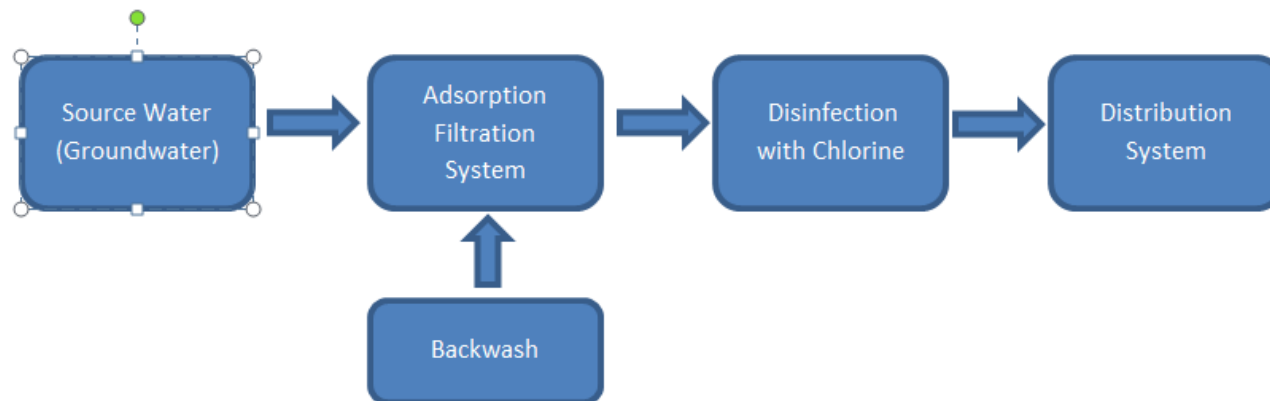
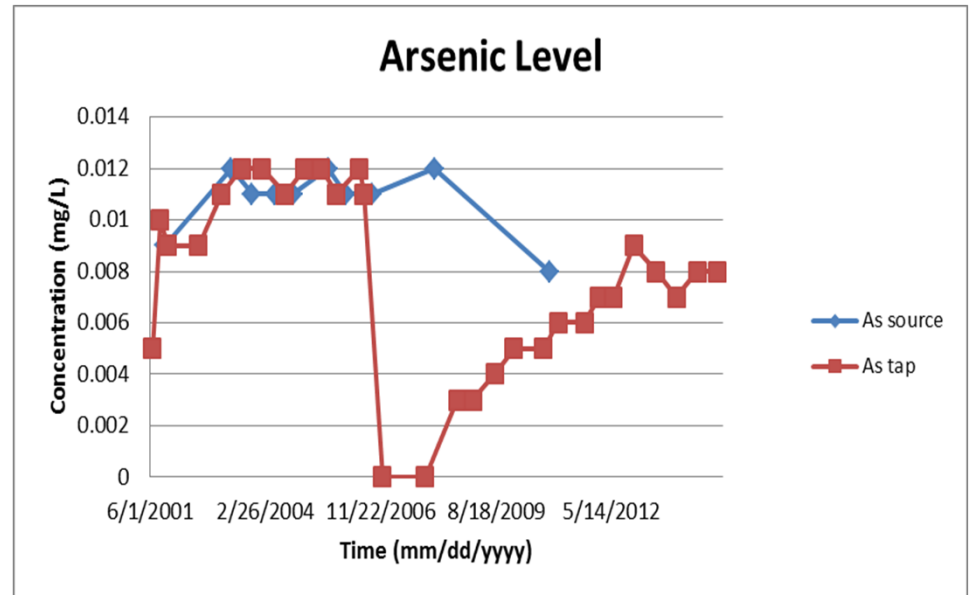
- For the filters size of 11 – 100 microns
 - Add a filter of 1 – 10 microns
 - Keep the current filter as pre-filtration
- For media filters
 - Proper maintenance required
 - Replacing the media material
- For mesh filters
 - Consider switching to thread filters
- For the increased turbidity from Pre-filter to Post-filter tap water
 - Investigate condition of the distribution pipes
 - Check for water main breaks or rupture in the distribution system
 - Flush to remove sediments from the pipes

Arsenic Removal Systems



Arsenic Removal Systems

- 10 systems in NL
- GCDWQ for arsenic is 0.01 mg/L
- AdEdge Ad-33 Adsorption System



Arsenic Removal Summary

Town	Percent Removal
Chance Cove (Angus Brace Well)	71.35%
Conception Harbor (Healey's Pond Road Well)	50.23%
Conception Harbor (Upper Bacon Cove)	100%
Grates Cove (#1C Well)	54.72%
Harbour Grace (#2 Thicket New Well)	98.29%
Harbour Grace (Southside Wellfield)	100%
Small Point-Adam's Cove-Blackhead-Broad Cove (#6 Well- Herb Trickett Well)	88.79%
Small Point-Adam's Cove-Blackhead-Broad Cove (#9- Walter Reynolds Well)	100%
Small Point-Adam's Cove-Blackhead-Broad Cove (#1- Reg Burse Well)	100%
Small Point-Adam's Cove-Blackhead-Broad Cove (#8- Effie Flight Well)	43.13%

- Significant decrease in Arsenic observed
- Arsenic levels tend to increase over time as media is spent
 - ~3 years

Iron and Manganese Removal Systems

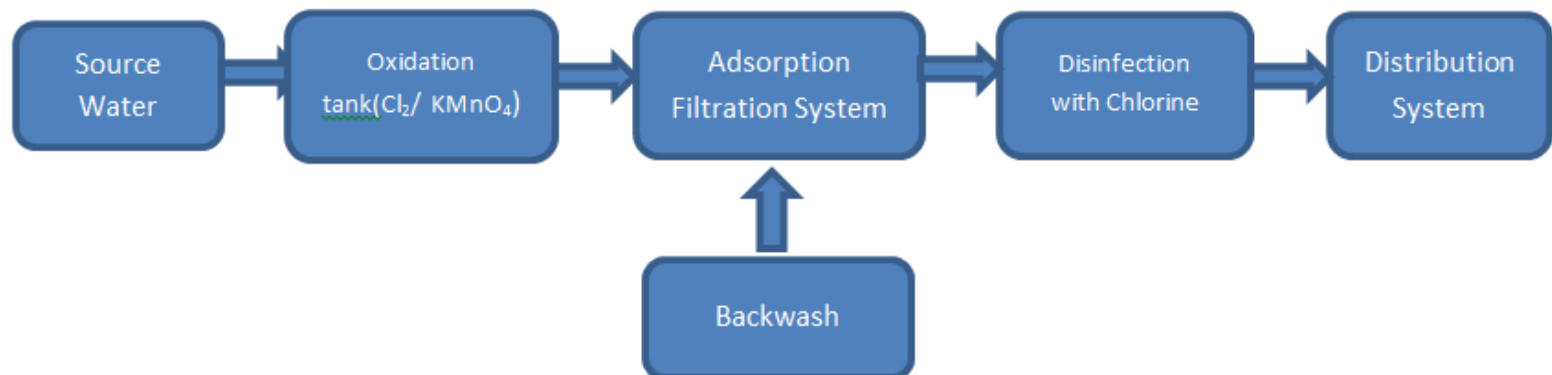


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Iron and Manganese Removal Systems

- GCDWQ
 - Iron- 0.3 mg/L
 - Manganese- 0.05 mg/L
- Health Canada looking at revising Mn guideline:
 - proposed MAC of 0.1 mg/L
 - Affects 76 public drinking water systems
 - Proposed AO of 0.02 mg/L
 - Affects 232 public drinking water systems
- Greensand adsorption removal system



Iron and Manganese Removal Systems

Town	Year	Percent Iron Removal	Percent Manganese Removal
Bunyan's Cove (#1 Wellfield)	2004	60.50%	66.20%
Holyrood (Main Line)	2013	100.00%	100.00%
Long Harbour- Mount Arlington Heights (Shingle Pond and/ or Trout Pond)	1997	0.62%	47%
Marysvale	1994/2003	78.30%	12.90%
Port Hope Simpson (Arnold's Brook and Pond)	2003	-18.20%	49.40%
West St. Modeste	2013	58.20%	73.50%
Chance Cove (Albert Rowe Well)	2015	100%	78.7.%
Grates Cove (Lower Cove East)	2014	-0.53	-0.18

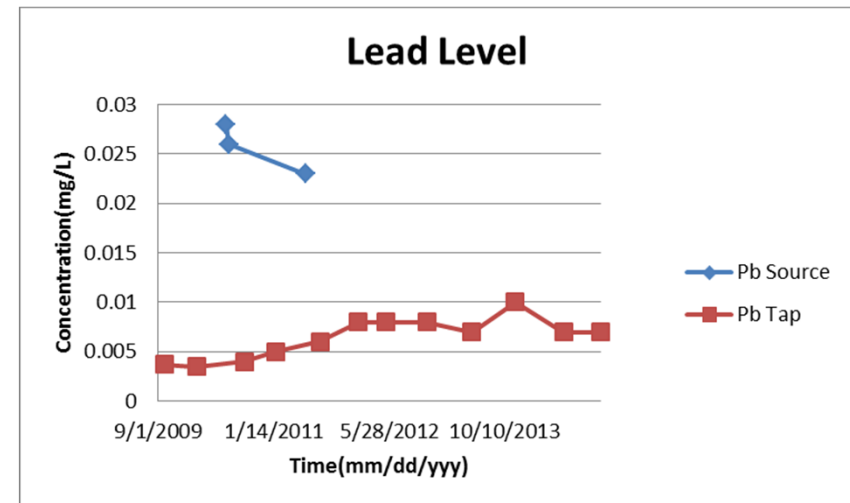
- Most results were not significant
- Iron removal more effective than Manganese removal

Lead Removal Systems



Lead Removal System

- One system in NL
- GCDWQ is 0.01mg/L
- Significant decrease in Lead observed
- 1 micron cartridge filter replacement time varies but usually it is done every 6-8 weeks



Town	Percent Removal
Port au Port West	74.93%

Strontium Removal Systems

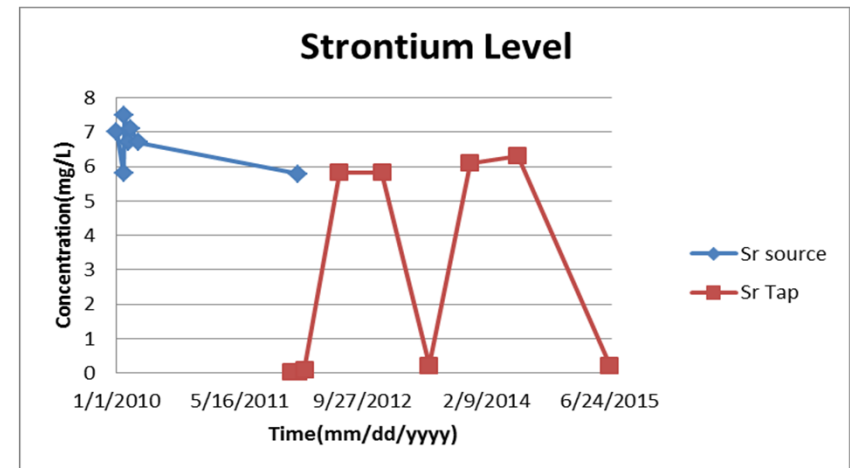


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Strontium Removal System

- One system in NL
- HC drinking water guidance value of 4.4mg/L
- Ion exchange using a sodium resin
- Significant decrease in Strontium observed
- Values above 4.4 mg/L observed
 - Sodium resin needs to be regenerated regularly



Town	Percent Removal
Bay St. George South	58.82%

Conclusions

- Communities should determine if the anticipated improvement in water quality is worth the capital and O&M costs for the treatment system
- Infiltration galleries do not significantly improve drinking water quality
- Smaller filters (<5 microns) are more effective at removing turbidity
- The condition of the distribution system has a major impact on tap water quality
- Treatment systems need to be operated and maintained effectively in order to work properly
- Need to continuously monitor water quality to make sure treatment systems are working
- Iron and manganese removal systems may need to be decoupled with a focus on manganese removal systems

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Thank You

Questions?