ReUse of Stormwater, Produced Water and Municipal Effluent:

Case Studies

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Case Studies

#1 Stormwater Runoff for Irrigation (Calgary, AB)

#2 Treated Municipal Effluent for Hydraulic Fracturing (Rimbey AB)

#3 Flowback and Produced Water For Fracturing (Hudsons Hope BC)

#4 RO Reject for Brine Conditioning (Jansen SK)

#1 Urban Stormwater for Irrigation

- *The challenge: A golf course can consume between 500 to 1,000 m^3/day. Climate change likely to imposed watering restrictions during dry cycles and cause damage*
- *Solution: utilize stormwater runoff for irrigation*
- *Problem: Salt-laden runoff during storage period can exceed TDS > 6,000 mg/L and SAR 16.5 (Alberta Agriculture recommends <700 mg/L and <SAR < 9)*
- *High salinity water also stratifies in storage*
- *Fish Creek LTRN averages 109 mg/L chlorides with maximum of 690 during winter (CCME criteria 120 mg/L chronic, 640 mg/L acute)*
- *Spruce tree mortality is very high after decades of saline irrigation*

Growth Rings Steadily Getting Thinner

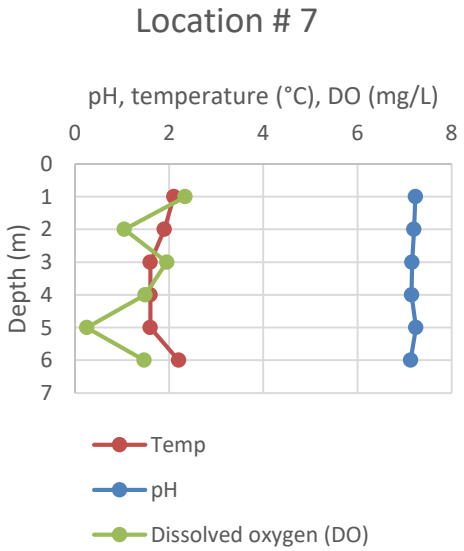
Calgary Snow and Ice Control

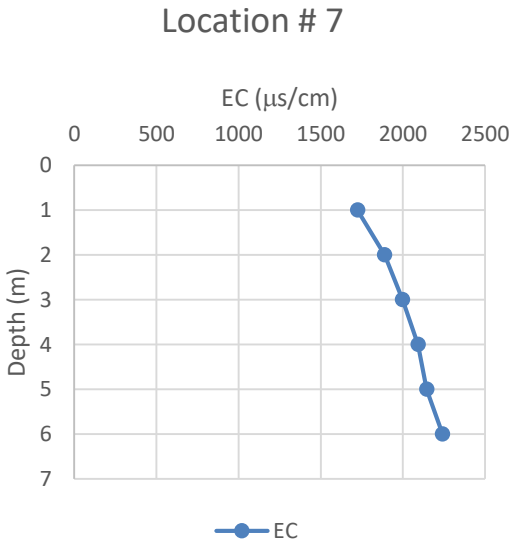
- *Pickled Gravel: 6 mm aggregate chips with 2% NaCl (granular road salt)*
- *Granular Road Salt: NaCl*
- *Calcium Chloride: used more recently for anti-icing*
- *Salt Brine: black ice locations*
- *Beet Brine: sugar beet 35% with sodium chloride brine 65%*
- *Salinity plummets during spring freshet but baseload concentrations are still high*

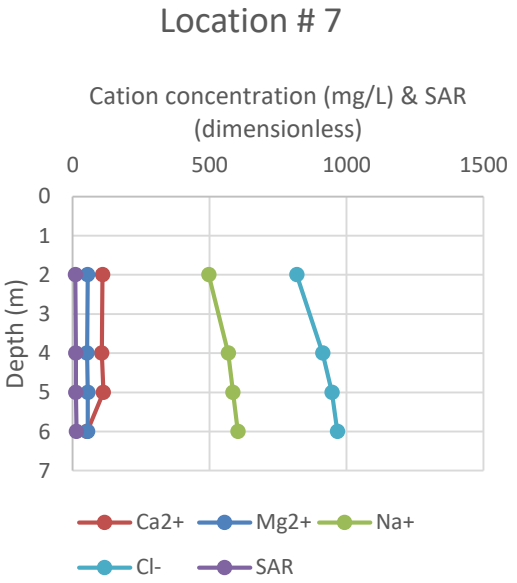
2019 Research Study with Uof C

- *Samples at inflow and salinity profiles within storage pond*
- *Examine stratification and seasonal variability*
- *Develop correlation between conductivity and TDS for real-time management tool*

Irrigation Source Stratification (SAR 8 to 11)

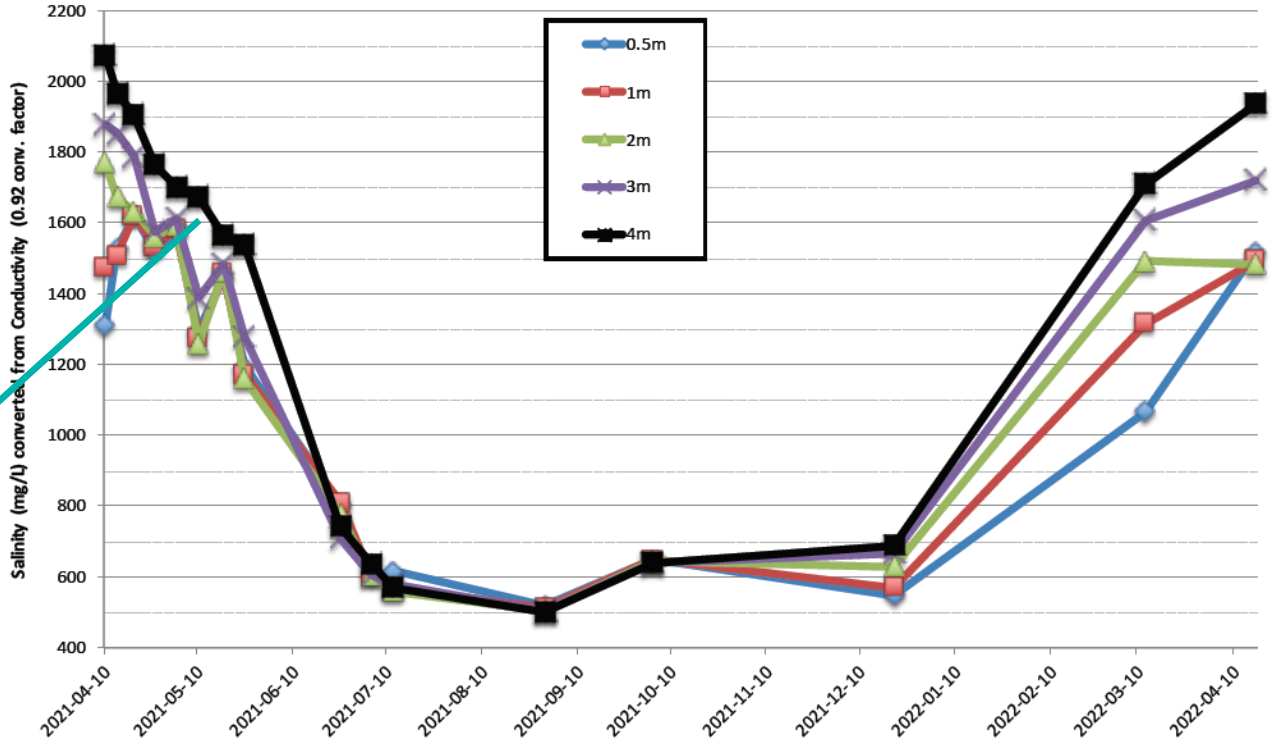




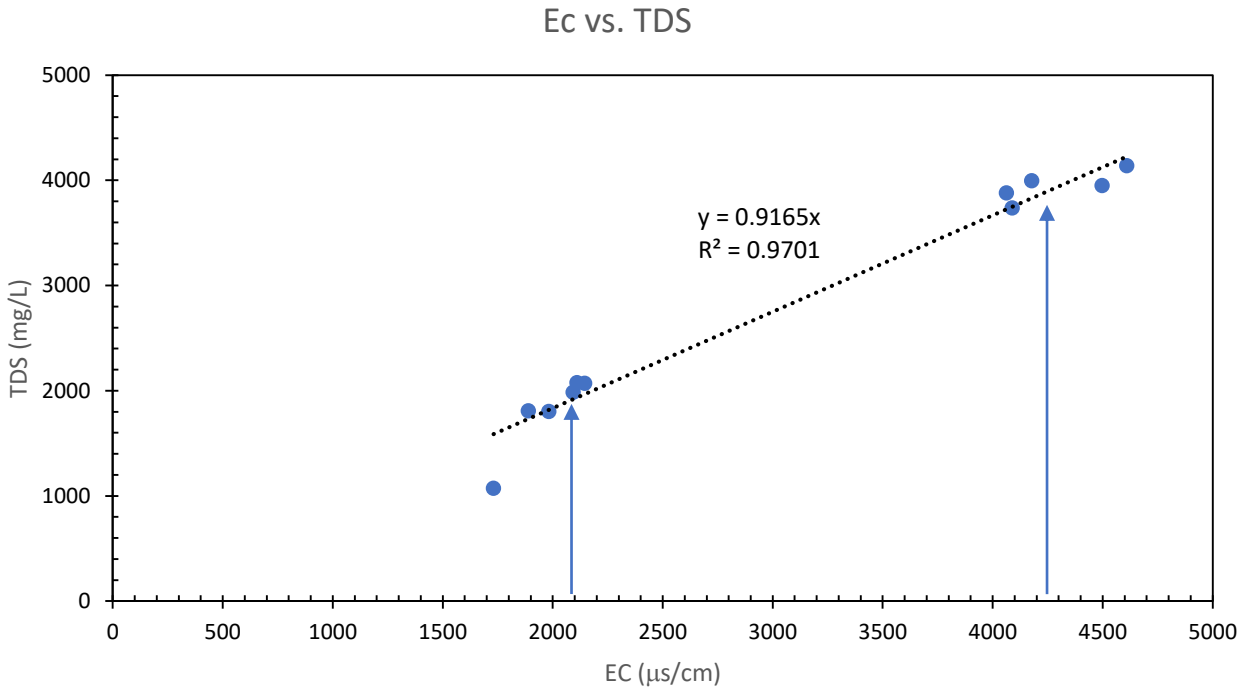


Salinity Stratification Throughout the Year: 48,000 m3 reservoir

Decanted 5,000 m3 from bottom of reservoir



Real-time Correlation Developed for On-Site Monitoring



Management Strategy

- *Year 1: Utilize real-time EC measurements to manage volume. Decant lower brine layer during spring freshet.*
- *Year 2: Blend with municipal water source to reduce levels.*
- *Year 3 (plan): Decant or divert of peak TDS flows during freshet*
- *Year 4 (plan): Nano-bubble pilot to reduce bioactivity and increase DO*

Lessons Learned

- *Stratification in stormwater ponds can be significant*
- *Elevated salts damage soil structure and increase mortality of spruce trees*
- *Observational approach needed for water management throughout growing season*

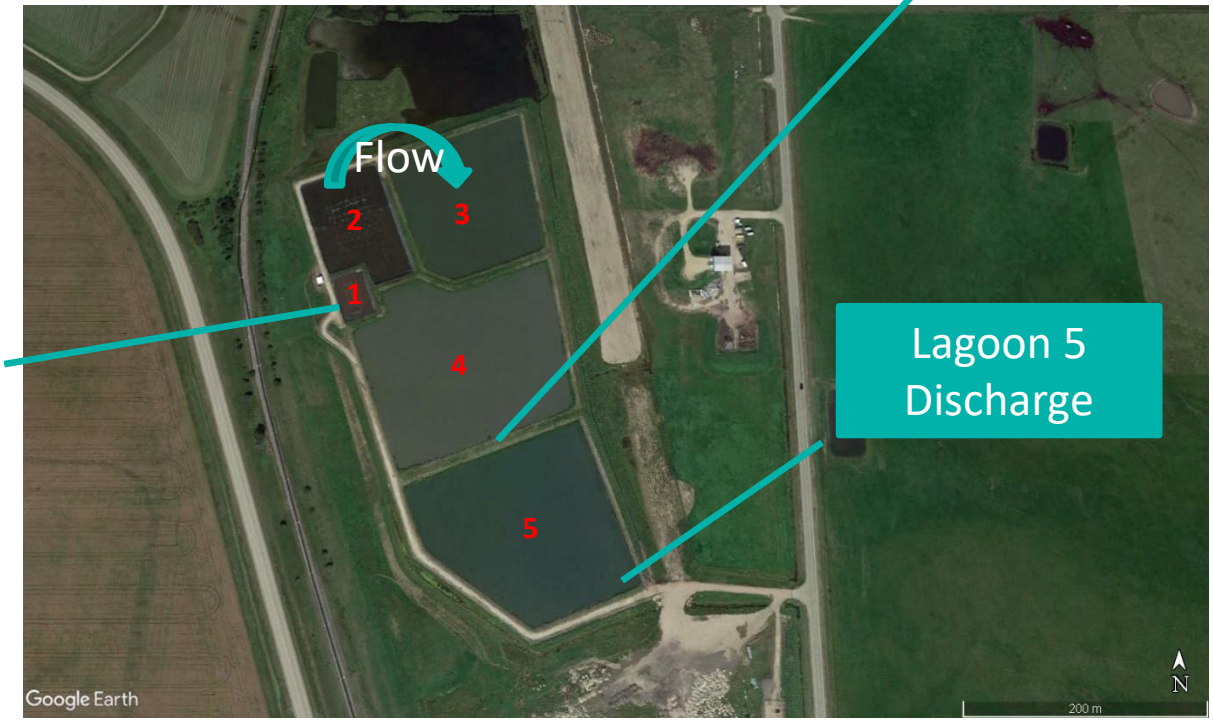
#2 Treated Municipal Effluent for Hydraulic Fracturing

- *The challenge: to treat 10 m^3/minute of secondary municipal effluent down to 10 microns (µm) for hydraulic fracturing. Conventional bag filtration failed to produce 4 m^3/minute.*
- *The problem: algae and aquatic bugs immediately foul 10 µm filters*
- *Solution: design-build screening system*

  400 µm mesh screen → 130 µm AOS non-woven fabric → 10 µm bag filter
- *Reduced bag filter change frequency from <5 minutes to >45 minutes.*
- *Treated 40,000 m^3 in 7 days*

Rimbey Lagoon Overview

Screening Filtration System



Aerated Primary Lagoon #1

Lagoon 5 Discharge

Bag Filter Fouling: Algae and Protozoa

Rimbey Layout: Lagoon 5

6 m^3/minute

Custom Screening and Blending Unit

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Typical Layout

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400 µm
Screen Mesh

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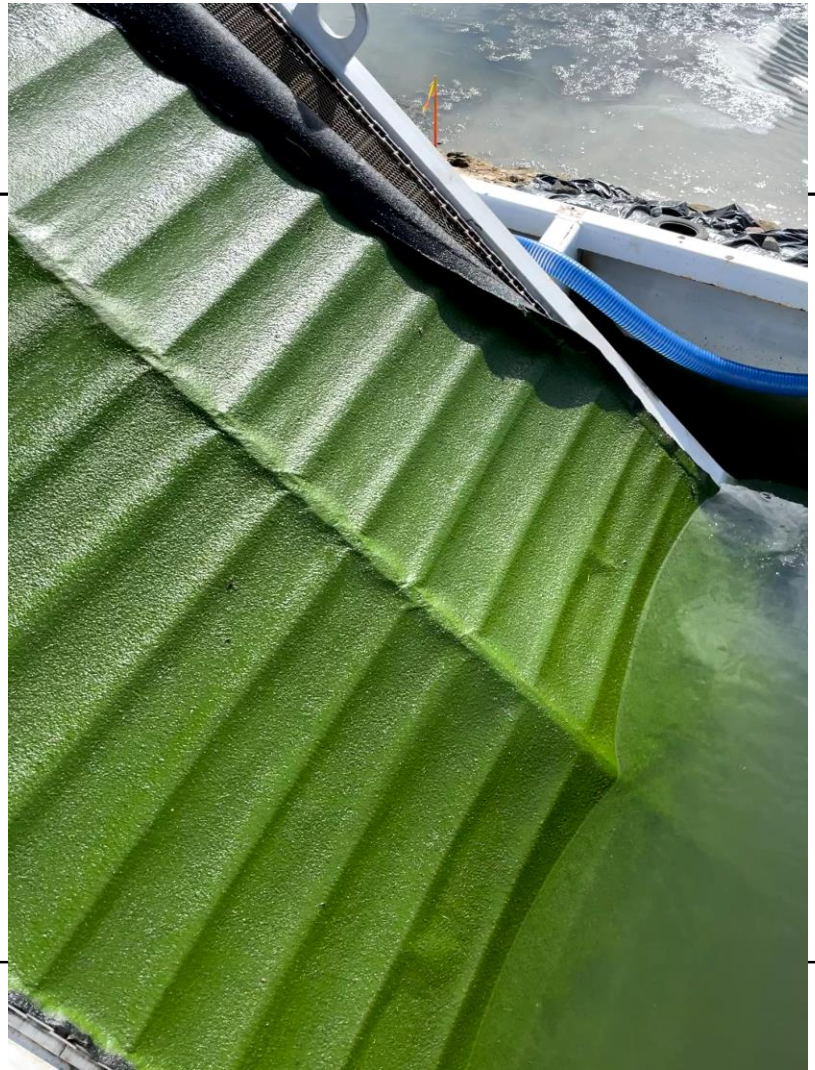
Algae and Protozoa on 130 micron non-woven fabric



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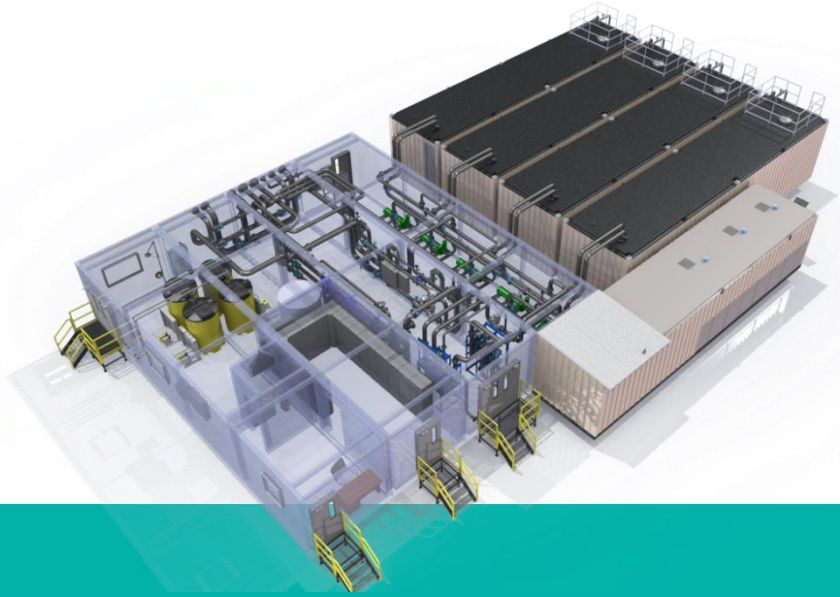
130 µm Washing System

Lessons-Learned

- *Pumping systems macerate algae mats*
- *Aquatic bugs foul filters more aggressively than algae*
- *Multi-stage screening and filtration very effective in reuse application*

#3 Reuse Flowback for Hydraulic Fracturing

- *Challenge: flowback chemistry includes residual chemicals and elevated iron, algae, paraffin wax, hydrocarbons. Iron often 100 mg/L vs target of 5 mg/L*
- *Schedule: 9-months from concept-to-commissioning*
- *Solution: parallel-track design-build*
- *Initial treatment using settling, aeration, clarification and backwashable screen*



Lessons-Learned

- *Conventional aeration not aggressive enough for iron removal*
- *Oxidation options: ozone, H_2O_2, NaOCl, "bleach"*
- *Hydrogen peroxide and sodium hypochlorite more commonly applied along with nano/micro-bubble vs sparging*

#4 RO Reject for Brine Conditioning

- *Challenge: cleanup 60,000 m^3 of stormwater and process wastewater for surface discharge plus dispose of 17,000 m^3 of brine from shaft excavation.*
- *Also: Souris Formation water incompatible with host Deadwood formation water*
- *Solution for stormwater:*
  - *media filter → bag filter → reverse osmosis*
- *Solution for Souris brine*
  - *Brine tank → blend with RO reject → PD pump down formation*

Lessons Learned

- *Expect elevated TSS from both windblown debris, pond bank stability and elevated algae production*
- *Reject cycling can be effective up to 8,000 mg/L inlet TDS*

Conclusions for Water ReUse Strategy

- *Define physical and chemical characteristics of inflow including upset conditions*
- *Select front-end screening and physical separation to reduce load in downstream biological and chemical processes*
- *Select a robust design with broad performance range*
- *Utilize modular systems for plug-and-play adaptability*
- *Startup and commissioning with highly-experienced team to trouble-shoot and optimize*

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