# *Stormwater Reuse*

***October 7, 2020***
***ESAA***

***Bill Berzins***

# *Safety Moment*

- *Beware of “caution fatigue”*
- *Be compassionate with family, friends, co-workers and others: stress levels are extremely high due to concerns about health, economy and closed-in spaces*

# *Stormwater*

*"Stormwater is runoff from rainstorms, hailstorms or melting snow that is shed from urban and rural landscapes. Stormwater picks up pollutants, including trash and suspended and/or dissolved solids that impact the quality of downstream water bodies."*

*Calgary Metropolitan Region Board, 2019*

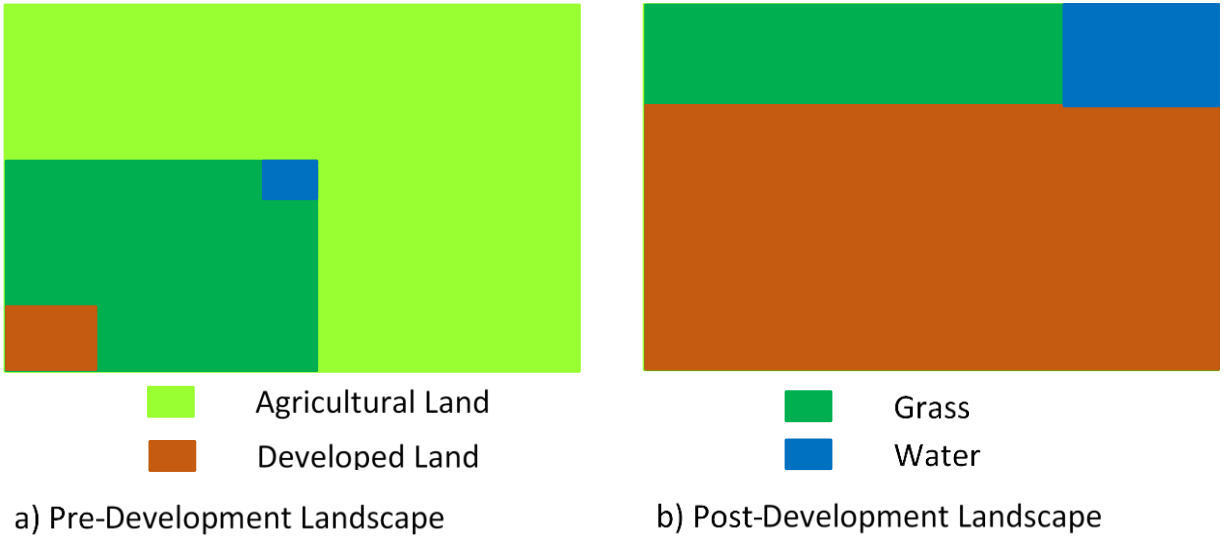
# *Governing Laws and Issues*

- *Provincial regulations govern quantity and quality of runoff*
- *Municipalities implement bylaws that control engineered structures and operational controls*
- *Issues within many prairie watersheds:*
  - *source water quality concerns related to upstream land uses*
  - *relatively flat landscape that increases susceptibility to overland flooding during extreme events*
  - *limited availability to receiving waters*
  - *air quality concerns (including H2S odours) associated with organic matter in ponds that sit idle under ice for extended period*
  - *co-mingling of hail and snow that often affect the sizing and performance of storage and control structures*

# *How is Stormwater Regulated in Alberta*

- *Water Act Regulation 119/1993 Wastewater and Storm Drainage Regulation (consolidated up to AR170/2012) establishes regulatory requirements*
- *AR119/1993 references Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (Part 5 March 2013 – 70 pages)*
- *AEP refers practitioners to Stormwater Management Guidelines for the Province of Alberta (1999 – 196 pages)*
- *Discharge to a waterway or wetland requires an EPEA approval which meets Environmental Quality Guidelines for Alberta Surface Waters (2018) to protect aquatic life, agricultural and recreational users*
- *Code of Practice can apply to an adequate outfall if it doesn't measurably alter natural peak flow, change the location/direction of flow or cause an adverse effect on aquatic environment*
- *Licence under Water Act is required to collect and use storm water unless a Master Drainage Plan is in place*
- *Delta water calculation is used to determine what quantity is available for use on site without approval*
- *Many storm water systems rely on annual renewal of Temporary Diversion Licence (TDL)*

# Delta Water Assessment Tool




a) Pre-Development Landscape

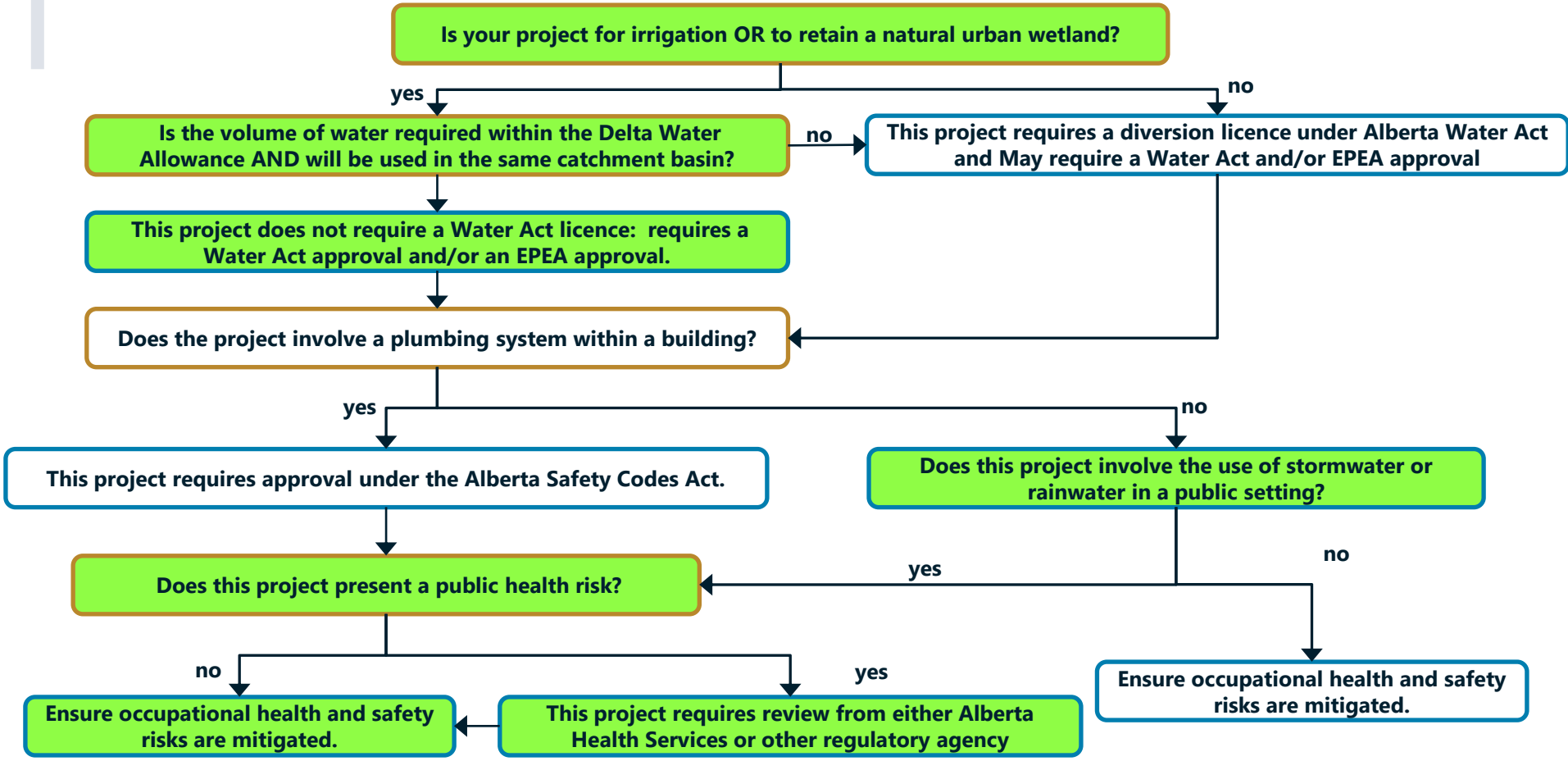
b) Post-Development Landscape

$$\Delta W = AW_{Post} - AW_{Pre}$$

*$\Delta W$=Delta Water, $AW_{Pre}$=Available Water in Pre-Development, $AW_{Post}$=Available Water in Post-Development*

Islam et al, 2019

# Approval Required to Irrigate Parks with Storm Water



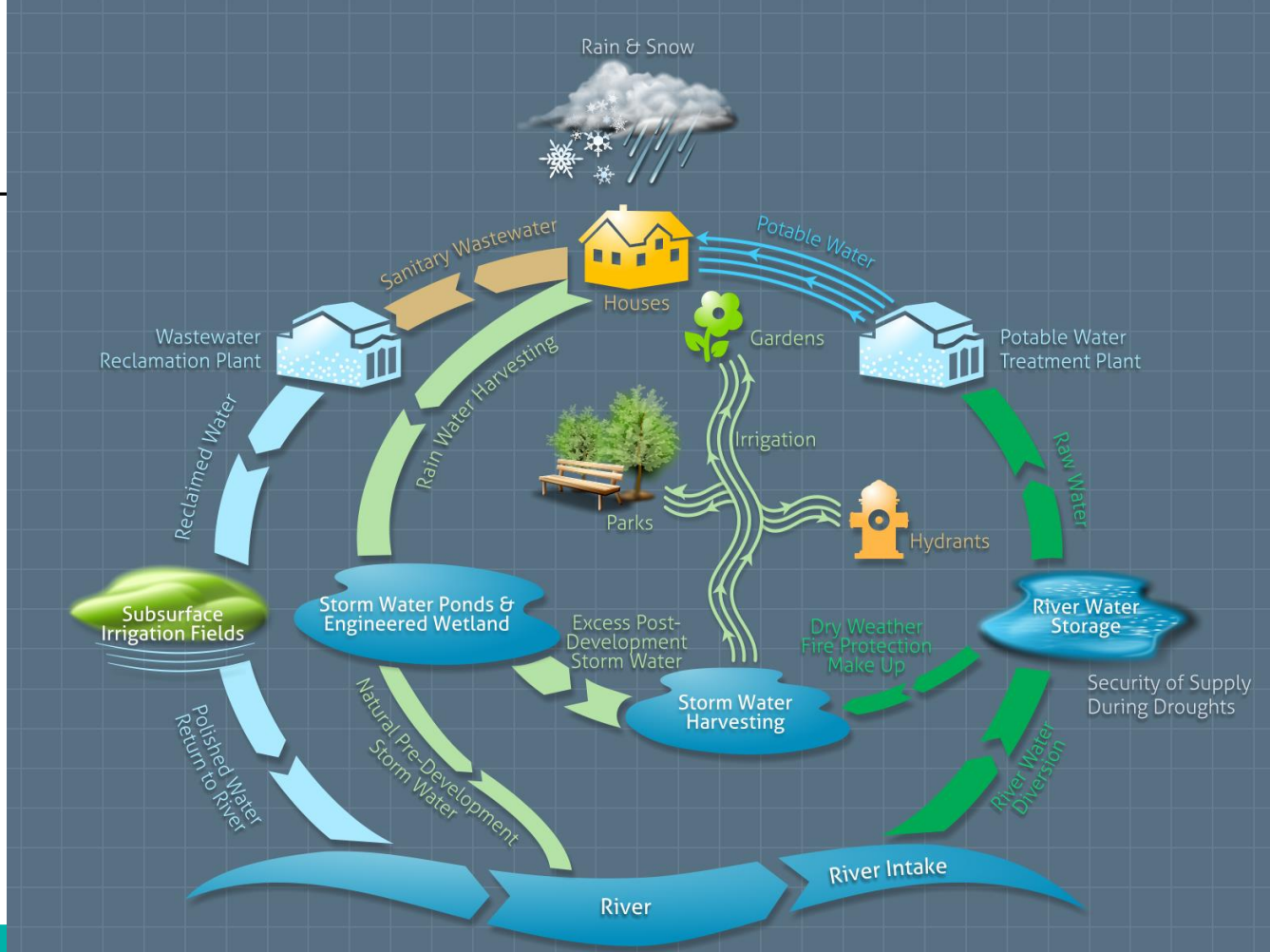
# *Worldwide Examples of Stormwater Reuse*

- *New York City worked with State regulators and Watershed Agricultural Society to implement Catskill farm program to implement pollution control on upstream farm lands*
- *Sydney Park (Australia) treats 860 million litres of stormwater to meet 10% of City's demands*
- *Orange County (California) uses treated wastewater for landscape irrigation, cooling and aquifer protection*
- *Singapore recycles treated sewage for industrial and drinking water uses during droughts*

# *CMR Initiatives*

- *Bearspaw Reservoir Trilateral Task force (Calgary, Rocky View, Transalta) launched in 2018*
- *Bow River Phosphorous Management Plan launched in 2011*
- *Cooperative Stormwater Management Initiative (WID, Rocky View, Chestermere, Wheatland, Strathmore, Calgary) launched in 2012*
- *Nose Creek Watershed Management Plan (Airdrie, Rocky View, Calgary, YYC, Crossfield) ongoing*
- *Elbow River Watershed Partnership*
- *WID receives stormwater but also supplies water to >400 farms and >12,000 people*

# *Stormwater Reuse Can Be Integrated Into Water Supply: Highway 8 Model*

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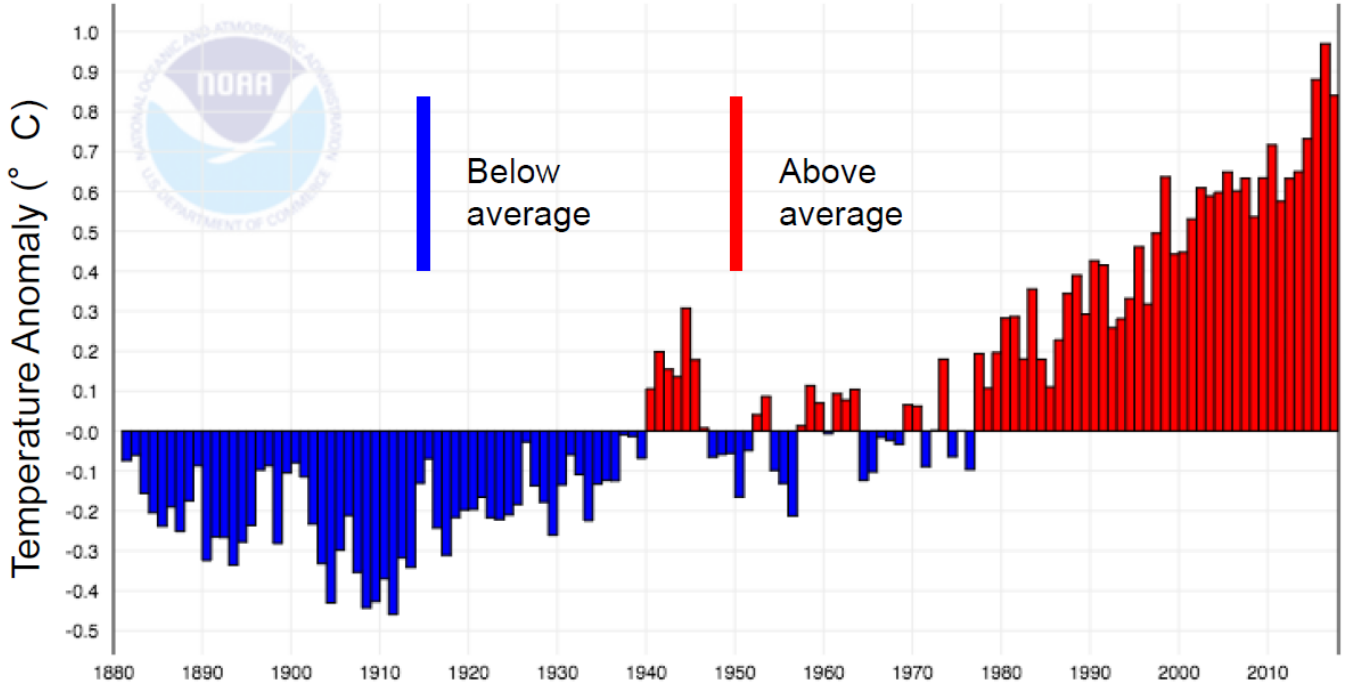
# *City of Calgary Stormwater Pond Dale Hodges Park*

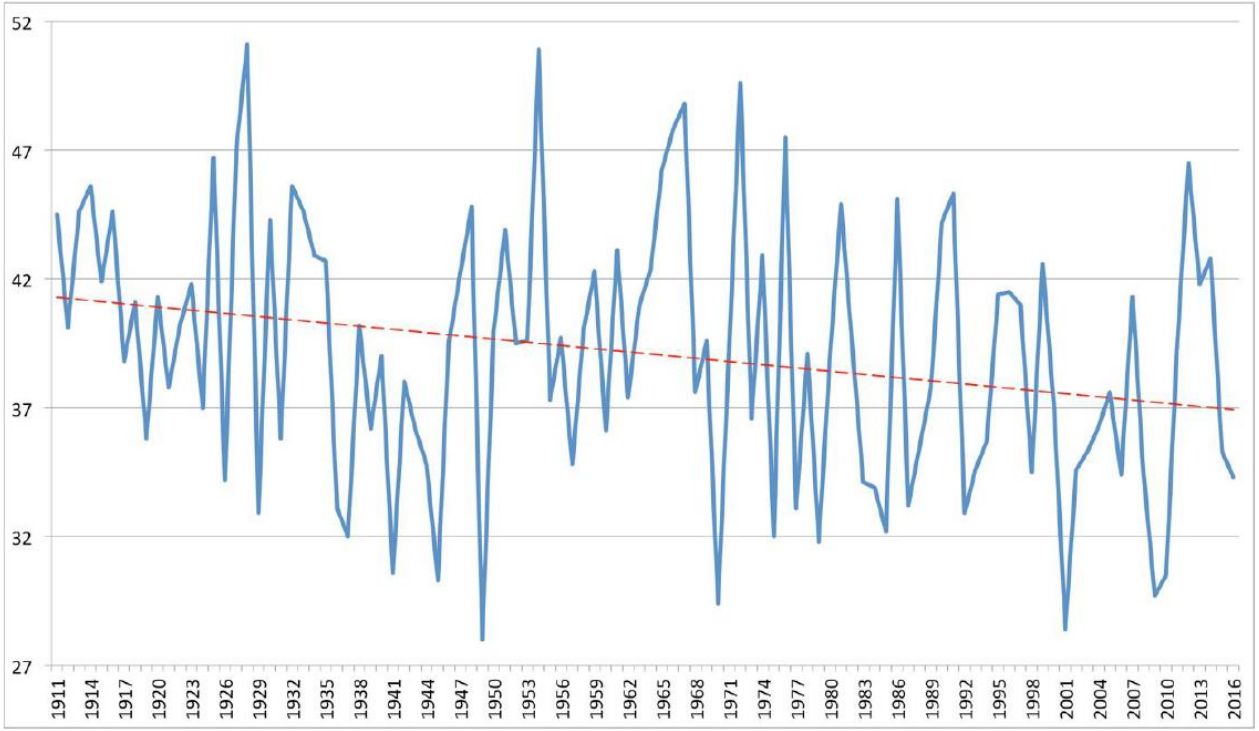
# *But Climate Change, Drought Cycles and Saline Runoff are Causing Problems*

- *Climate change means:*
  - *warmer-drier winters and cooler-wetter summers*
  - *more severe droughts with potential for multi-year droughts*
  - *Last 4 years have been drier than average*
- *Highly saline watering combine with less rainfall have contributed to spruce tree mortality in Calgary region*

# *April 2019 Was 412th Consecutive Month with Temperature Above 20th Century Average*



## *Less Water in the Bow River Headwaters: Average Annual Flow at Banff $m^3$/sec*

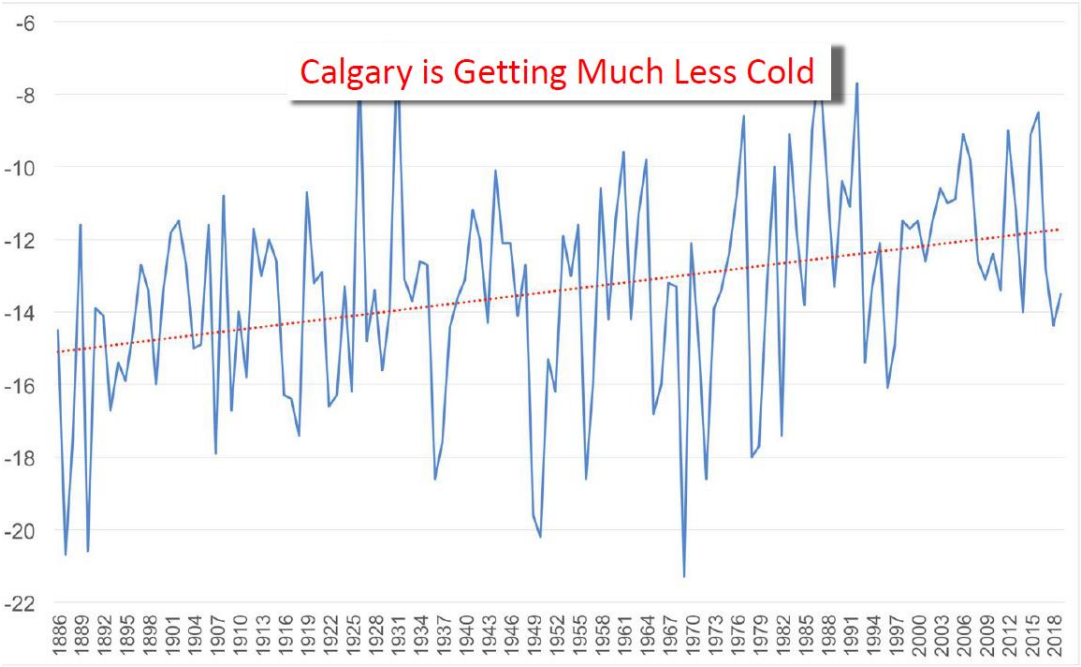





(Sauchyn, 2019)

# *Milder Winters Affect Soil Moisture*

**Average Minimum Winter Temperature (°C) at Calgary, 1886 to 2019**

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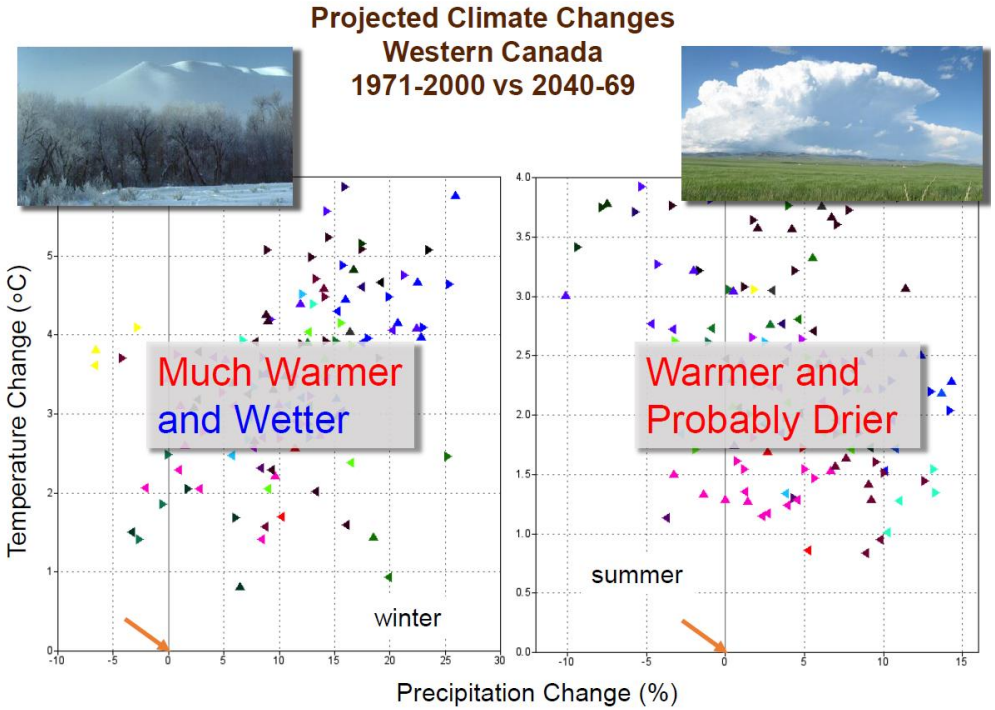
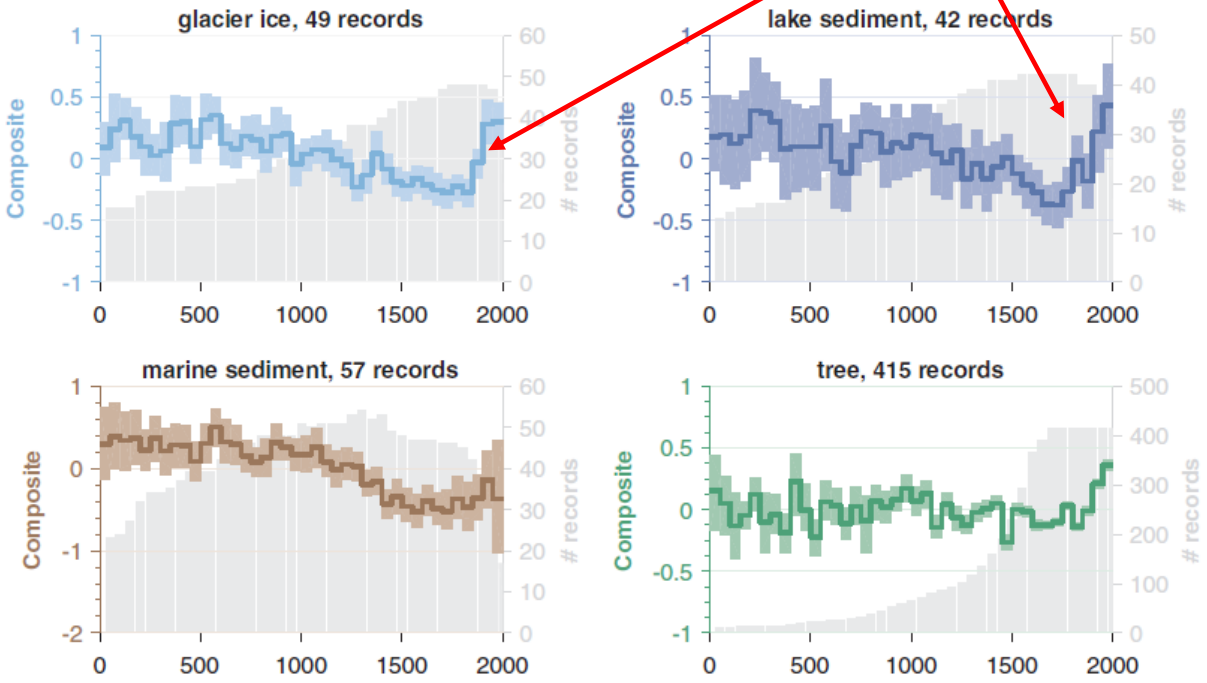
Sauchyn, 2019

# *We likely won't get the precipitation when we need it*




Sauchyn, 2019

# *Global Warming Over Past 2000 years: Sharp Increase Last Century*



## *Typical Stormwater Quality in December in Calgary*

- *pH = 7.49*
- *Hardness = 466.78*
- *EC 2.52 mmhos/cm*
- *Soluble salts = 1609.6 ppm*
- *Chloride = 521 ppm*
- *SAR = 16.52 (Alberta Agriculture recommends 4 to 9 as limits for crops)*

# *UofC Research Study*

1. *Determine suitability of stormwater quality produced through snowmelt and rainfall events for irrigation from February through April 2020.*
2. *Tested at variety of locations: stormwater inflow, forebay pond and storage pond.*
3. *Develop a real-time method for in-situ analysis of stormwater qualityn an ongoing basis*
4. *In-situ analysis using probe YSI ProComm II for electrical conductivity (EC), pH, temperature and dissolved oxygen (DO)*
5. *Laboratory measurements of TDS, total suspended solids and orthophosphate ($PO_4^{3-}$)*
6. *Researcher = Satyam Arya (Chemical Engineering Student UofC. Advisor = Dr. Roya Pishgar, Postdoctoral Research Student University of Calgary. Supervisor = Dr. Angus Chu, Professor Civil Engineering*

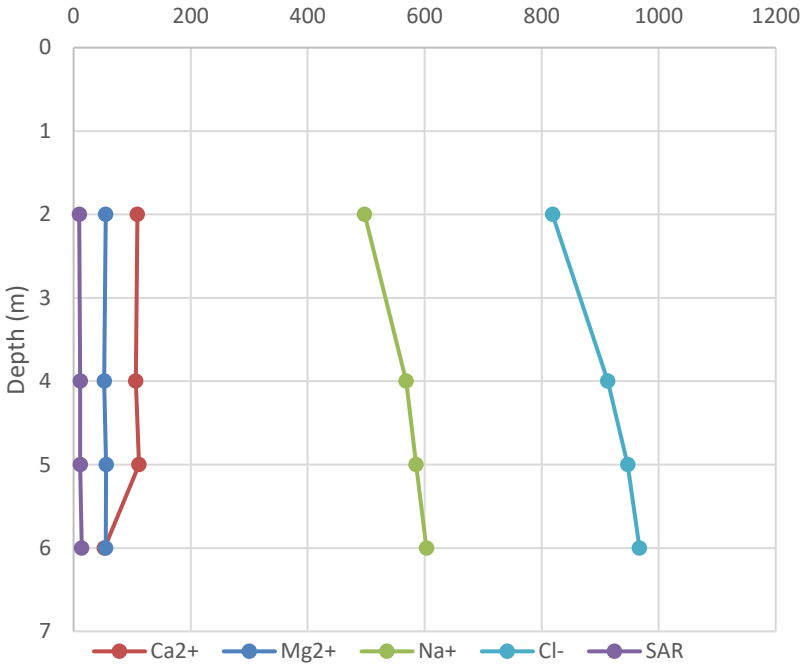
# *Typical Water Quality – January 2020*

- *Dissolved Oxygen = 6.6 mg/l ( a level of below 5.0 can stress fish whereas a level below 1-2 mg/l can kill fish)*
- *pH = 8.2 (normal pH for irrigation water is between 6.5 and 8.4)*
- *Electrical Conductivity = 1652 micro-siemens per cm (1.65 mhos/cm = 1060 mg/l TDS)*

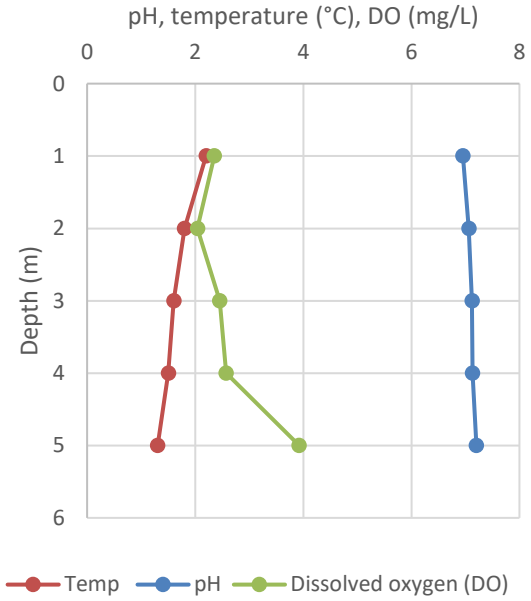
# *Highlights of February 2020 Sampling*

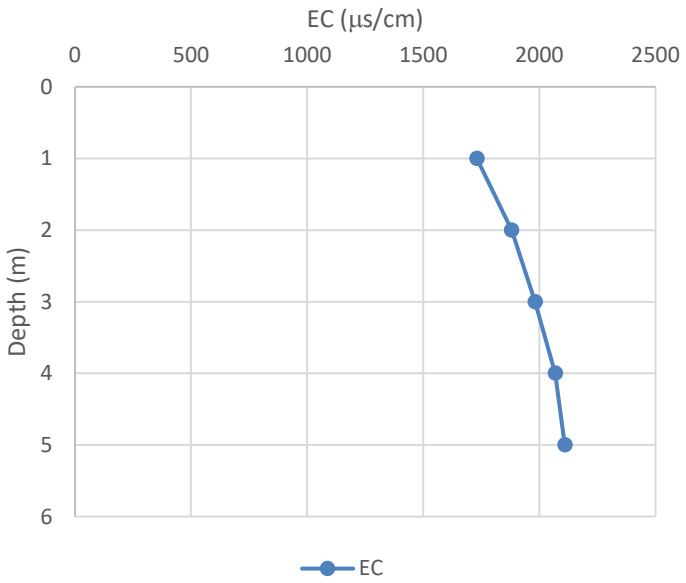
- *Incoming EC = 3100 µs/cm vs 4400 µs/cm @ forebay pond and 2100 µs/cm @ storage pond*
- *SAR is measure of Sodium relative to Calcium and Magnesium: high Sodium disperses clay while Calcium and Magnesium promote flocculation*
- *SAR @ in forebay pond = 8.2 to 16.2*
- *SAR @ storage pond = 8 to 11*
- *Alberta Agriculture recommends SAR between 4 – 9*
- *Salt concentration higher in forebay pond: warmer with more evaporation losses and precipitation of salts?*

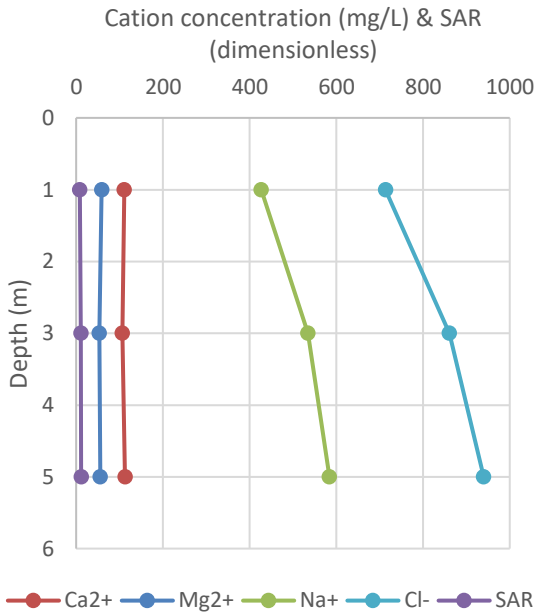
# *Chloride Levels: Forebay Pond Elevated With Depth*



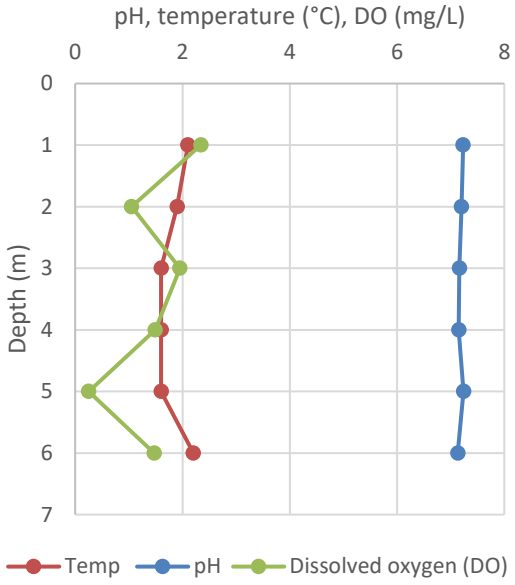
# Storage Pond Water Quality

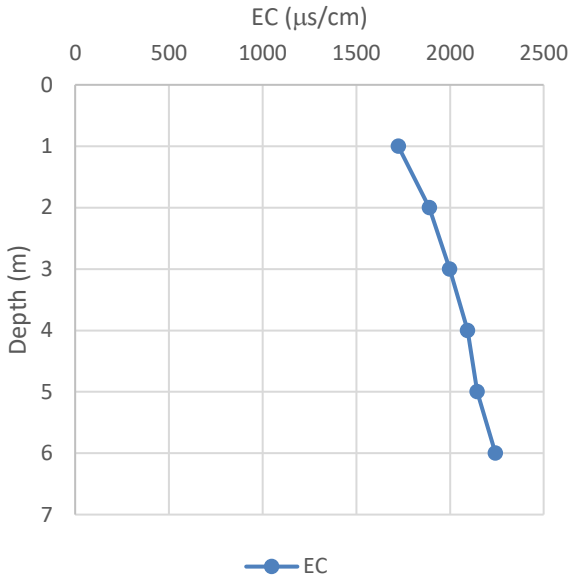


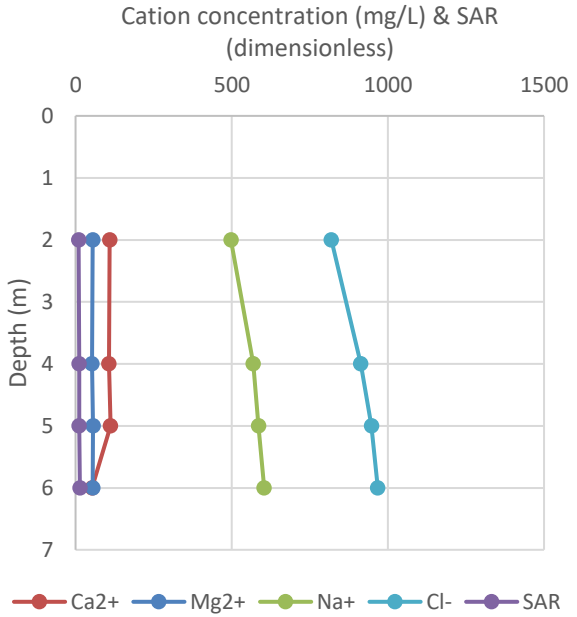



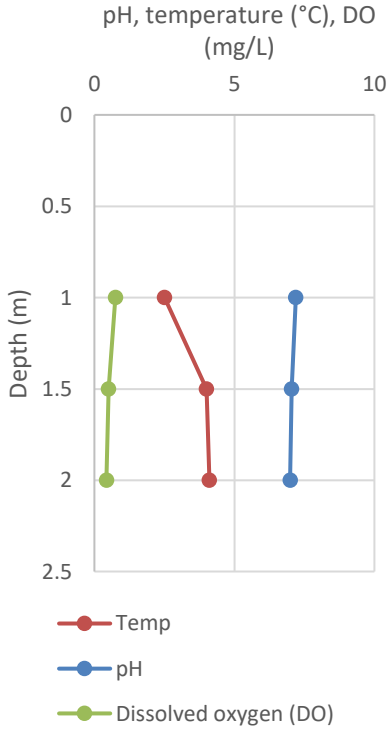
# Storage Pond: SAR 8 to 11

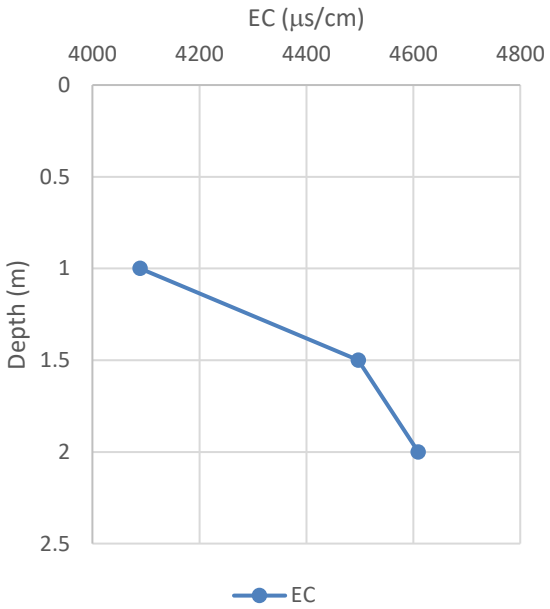


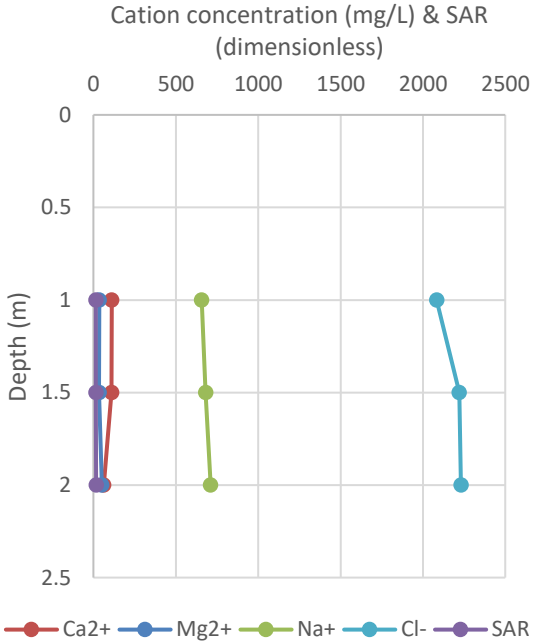



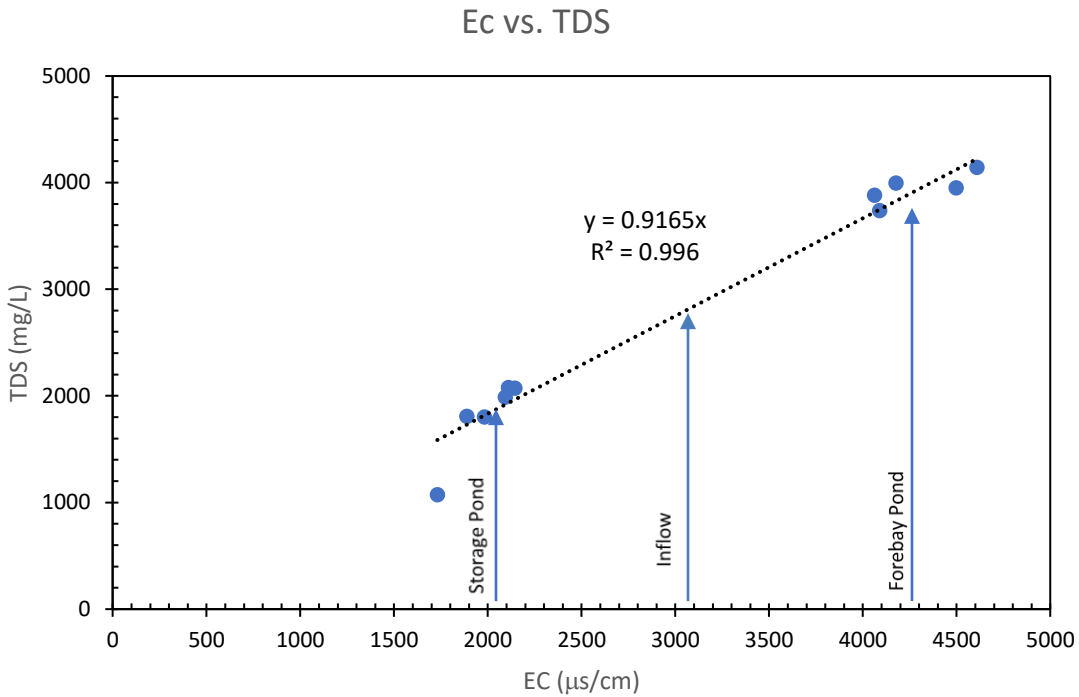
# Storage Pond: SAR 8.2 to 16.2



# Correlation Between Conductivity and TDS = 0.9165



# *Stormwater Water Quality During Precipitation Events*

| Date | 24-hour precipitation (mm) | TDS (mg/L) |
|---|---|---|
| May 4 | 10.6 | 741 |
| 8 | 1.6 | 391 |
| 21 | 33.3 | 160 |
| 31 @ 08:57 hrs | 41 | 500 |
| 31 @ 19:11 hrs | | 228 |
| June 7 12:00 hrs | 10 | 220 |

# *May 2020 Water Quality Profiles in Storage Pond*

| Location | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 m | 514 | 511 | 521 | 468 | 474 | 472 | 490 | 487 | 488 | 511 |
| 1 m | 509 | 513 | 514 | 472 | 533 | 487 | 550 | 550 | 505 | 512 |
| 2 m | 529 | 519 | 517 | 503 | 639 | | | 538 | 530 | 527 |
| 3 m | 1,596 | 1,426 | 1,457 | 1,422 | 1556 | | | | 1,435 | 1,585 |
| 4 m | 1,601 | 1,433 | 1,461 | 1,431 | | | | | | |
| 5 m | 1,332 | | 1,444 | | | | | | | |

# 2020 Forebay Water Laboratory Sample Results

| Parameter | Alberta Irrigation Water Quality Target | March 6 | April 20 |
|---|---|---|---|
| Hardness | | 406 | 217 |
| **Total Soluble Salts ppm** | **TDS 500 to 3,500 mg/L** | **3,727** | **1,455** |
| Sodium ppm | | 1,054 | 358 |
| **Chloride ppm** | **100 to 700 mg/L** | **1,060** | **550** |
| **SAR** | **5** | **50.38** | **19.95** |

# *Water Quality Summary*

- *TDS > 7,000 mg/L during mid-winter melt*
- *>20 mm rain events flush forebay and storage ponds with lower TDS water*
- *Pond salt levels are stratified: fresh water decants into outfall leaving high salt level behind*
- *Spring freshets “float” over denser saline water rather than mix*

# *Implications for Design*

- *Traditional design of stormwater storage focuses on suspended solids*
- *Dissolved solids, especially from road salt runoff must factor into design*
- *Design solutions:*
  - *Aggressive management of mid-winter runoff*
  - *Configure ponds to minimize high-salinity volume and capture more freshet*
  - *Design of decant systems to retain freshet and shed high-salinity water from stratified ponds*
  - *Integration with naturalized landscapes*

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