Bow River Water Quality Modeling using EFDC+

Lei Chen, Ph.D, P.Eng

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Canadian Water and Wastewater Association

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The City of Calgary
MATRIX SOLUTIONS INC.
DSI LLC

Outline of presentation

1) Why water quality modeling?
2) History of water quality modeling
3) The Environmental Fluid Dynamics Code (EFDC) vs. EFDC+
4) Calibrated Bow River Water Quality Model using EFDC+

Why water quality modeling?

Regulatory requirement

The City of Calgary (The City) operates its wastewater and stormwater management systems under the Environmental Protection and Enhancement Act (EPEA) Approval #17531-02-00 administered by Alberta Environment and Protected Areas (EPA) for the “construction, operation and reclamation of a wastewater system for the City of Calgary”. The Approval outlines the water quality parameters that require management to protect Bow River aquatic habitat.

The Approval is renewed every ten years, and an updated Total Loading Management Plan (TLMP) is required every five years.

Understand your system

Planning tool

History of water quality modeling

Late 1970s to mid-1980s:

U.S. EPA, Center for Water Quality Modeling (CWQM), Athens, GA

- Hydrologic simulation program – Fortran (HSPF)
- Water Quality Analysis Simulation Program (WASP)
- QUAL2E
- Exposure analysis modeling system (EXAMS)

U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS

- CE-QUAL-W2

1990s:

- The Environmental Fluid Dynamics Code (EFDC)

History of water quality modeling - EFDC

"EFDC was originally developed at the Virginia Institute of Marine Science (VIMS) and School of Marine Science of The College of William and Mary, by Dr. John M. Hamrick.

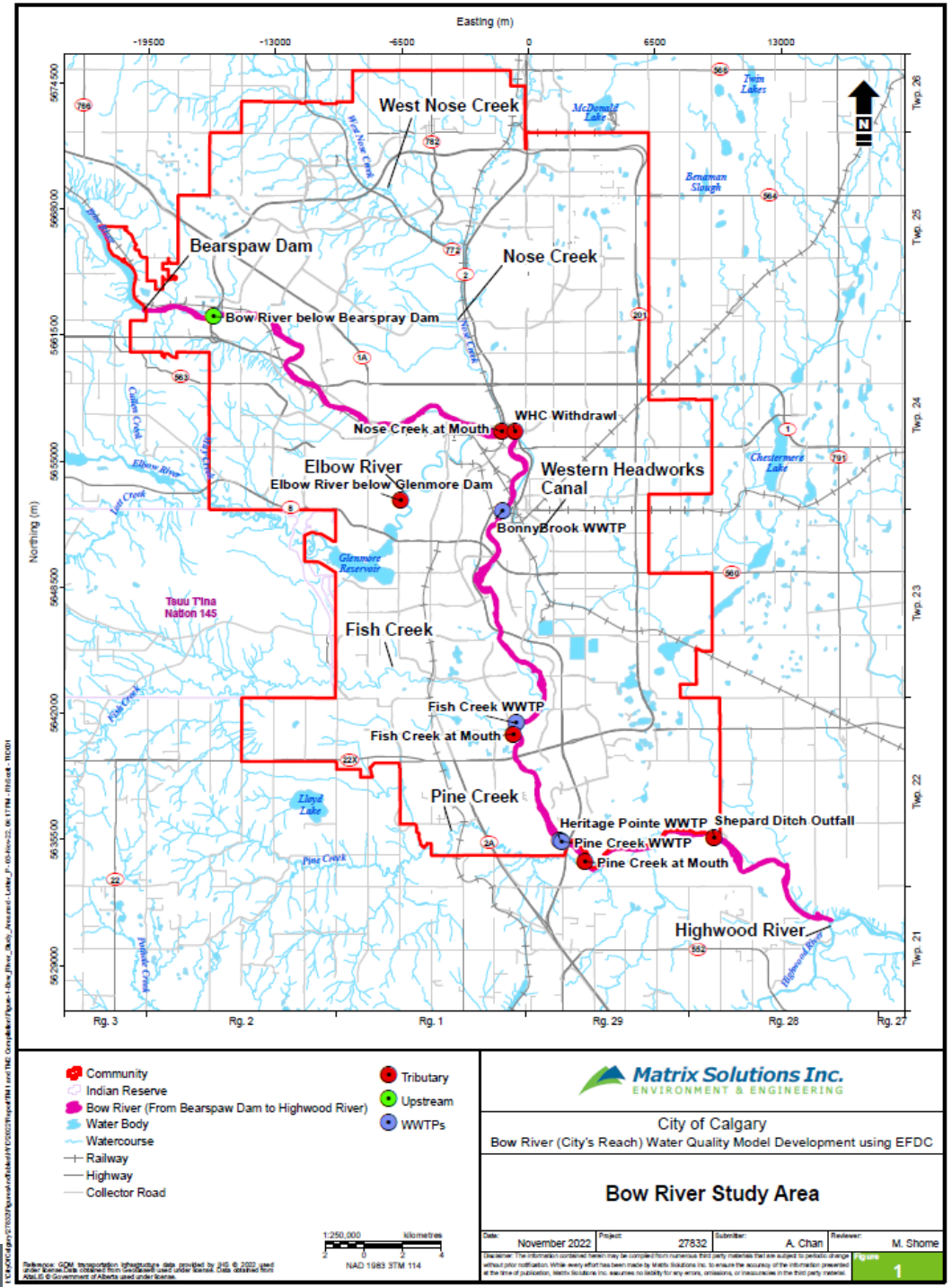
Tetra Tech, Inc. became the first commercial user of EFDC in the early 1990's and upon Dr. Hamrick's joining Tetra Tech in 1996, the primary location for the continued development of EFDC."

quoted from USEPA website

History of water quality modeling - EFDC

USEPA released version 1.01 of EFDC in September 2007.

DSI LLC. (Edmonds, USA) added more modules to the model, created user friendly interface for model input file preparation and model results post process, named EFDC+


Easting (m)
Northing (m)
West Nose Creek
Bearspaw Dam
Nose Creek
Bow River below Bearspray Dam
WHC Withdrawl
Nose Creek at Mouth
Elbow River
Elbow River below Glenmore Dam
Western Headworks Canal
BonnyBrook WWTP
Tsuu T'ina Nation 145
Fish Creek
Fish Creek WWTP
Fish Creek at Mouth
Pine Creek
Heritage Pointe WWTP
Shepard Ditch Outfall
Pine Creek WWTP
Pine Creek at Mouth
Highwood River
Twin Lakes
McDonald Lake
Benaman Slough
Chestermere Lake
Glenmore Reservoir
Lloyd Lake
Community
Indian Reserve
Bow River (From Bearspaw Dam to Highwood River)
Water Body
Watercourse
Railway
Highway
Collector Road
Tributary
Upstream
WWTPs
NAD 1983 STM 114
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING
City of Calgary
Bow River (City's Reach) Water Quality Model Development using EFDC
Bow River Study Area
November 2022
27832
A. Chan
M. Shome
1


Bow River WQ Model
2007-01-01 00:00
Model Grid
945.604
1082.493
Bottom Elevation (m)

Compare WASP and EFDC+ models

	WASP	EFDC+
Number of cells	176	5725
Avg. DX (m) (along the river)	1000~5000	100
Avg. DY (m) (across the river	16~100	16
Model run time for 8 years simulation	A few minutes	5 days
Bathymetry for calibration	Pre 2013 flood	Post 2013 flood
Hydrodynamics	1-D HEC-RAS	2-D
Ice formation and melt	Externally provided	Simulated using ice module

1. **Model Domain Outline:** The domain GIS coverage was provided by The City. Additionally, the background coverages of Google Maps, topographic maps are also freely available to identify the project location). BRWQM+ focuses on The City's reach below the Bearspaw Dam and immediately upstream of the Highwood River confluence. This section of river is about 70 km long and has an average bank full width of 90 m.
2. **Bathymetry:** Bathymetry is one of the most important inputs for an EFDC+ model. Two bathymetry data sources for the Bow River are available.
3. **Tributary Locations:** Location of tributaries discharging into the Bow River.
4. **WWTP Locations**: Location of WWTP discharging into the Bow River.
5. **Water Quality Sampling Locations:** Locations where grab samples were collected to analyze the water quality, and the locations where sonde data were collected.
6. **Meteorological Stations:** Location of stations where meteorological data were collected (Figure 6).
7. **Hydrometric Monitoring Station Locations:**

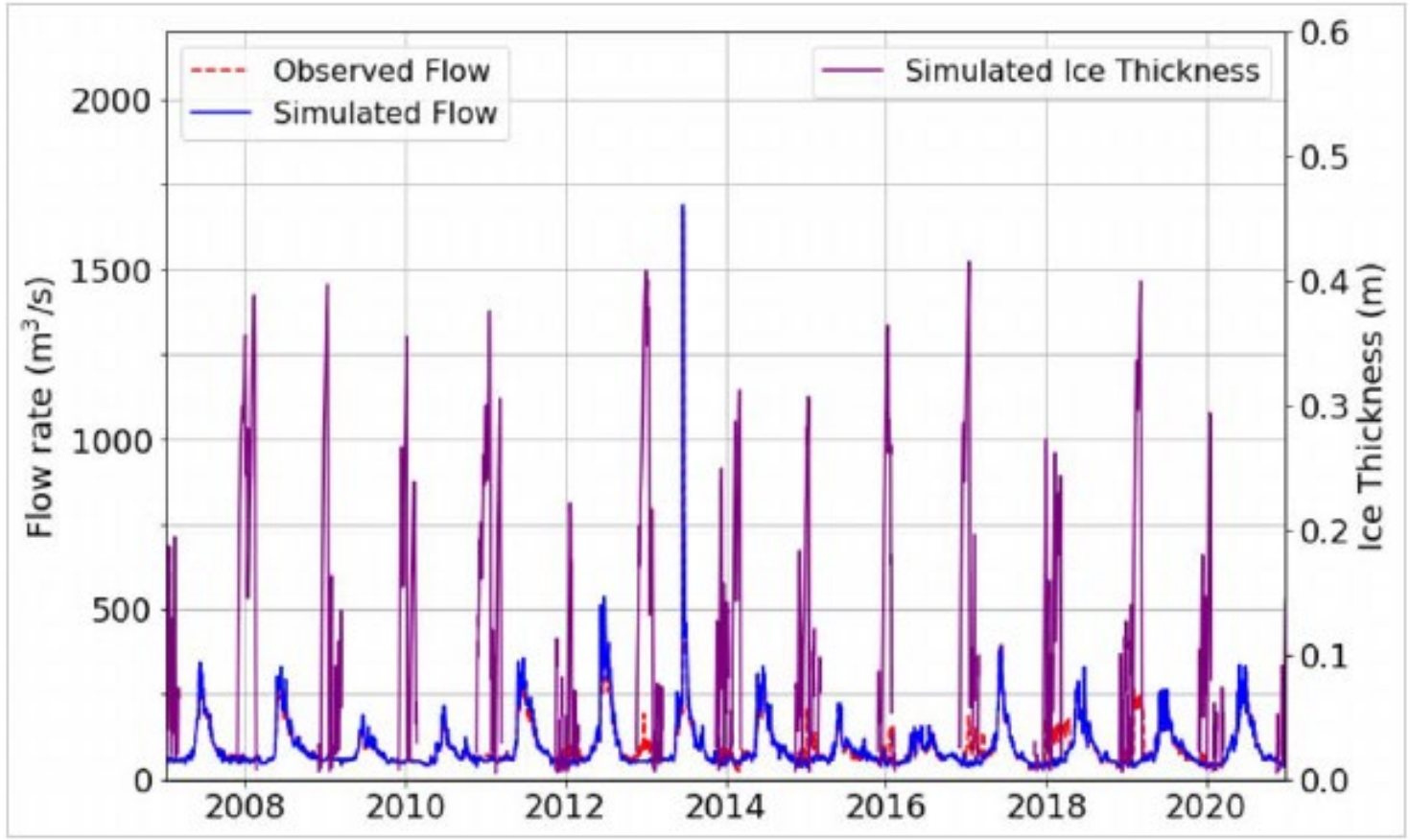
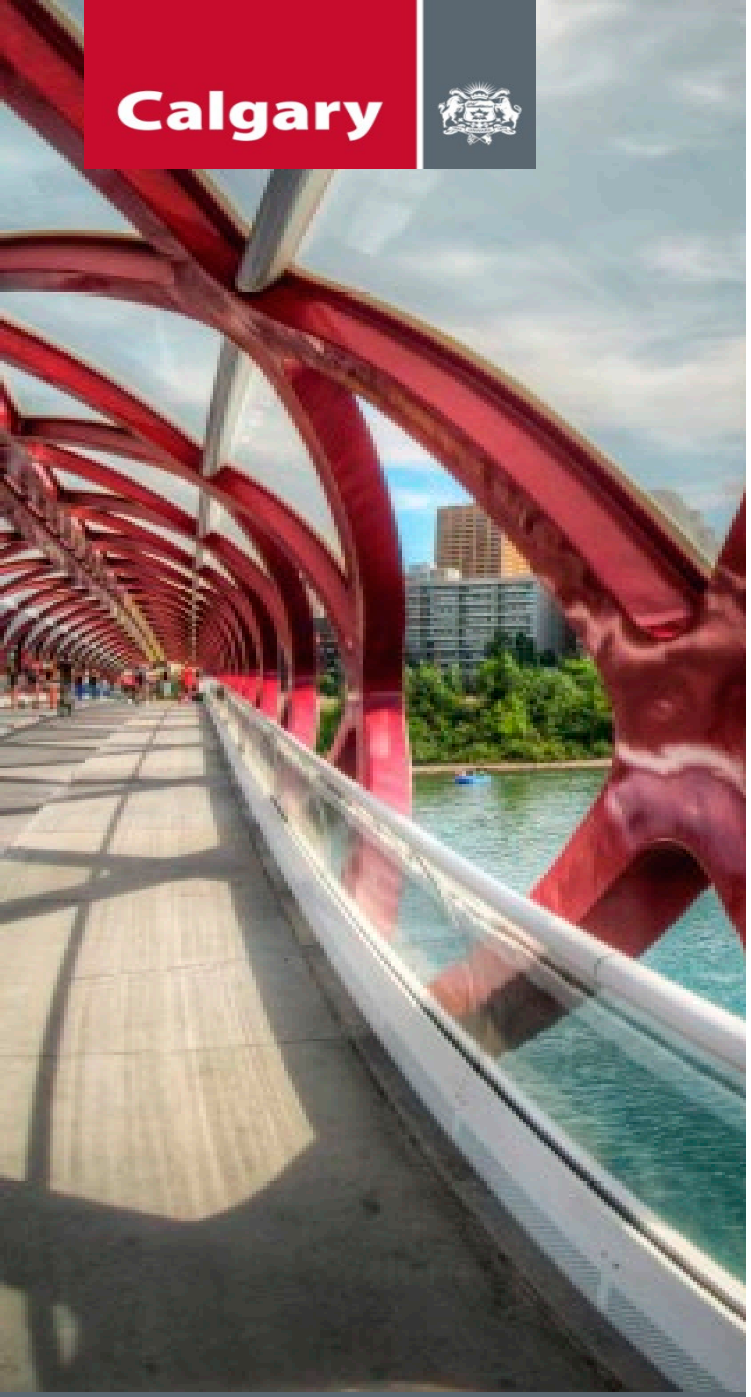
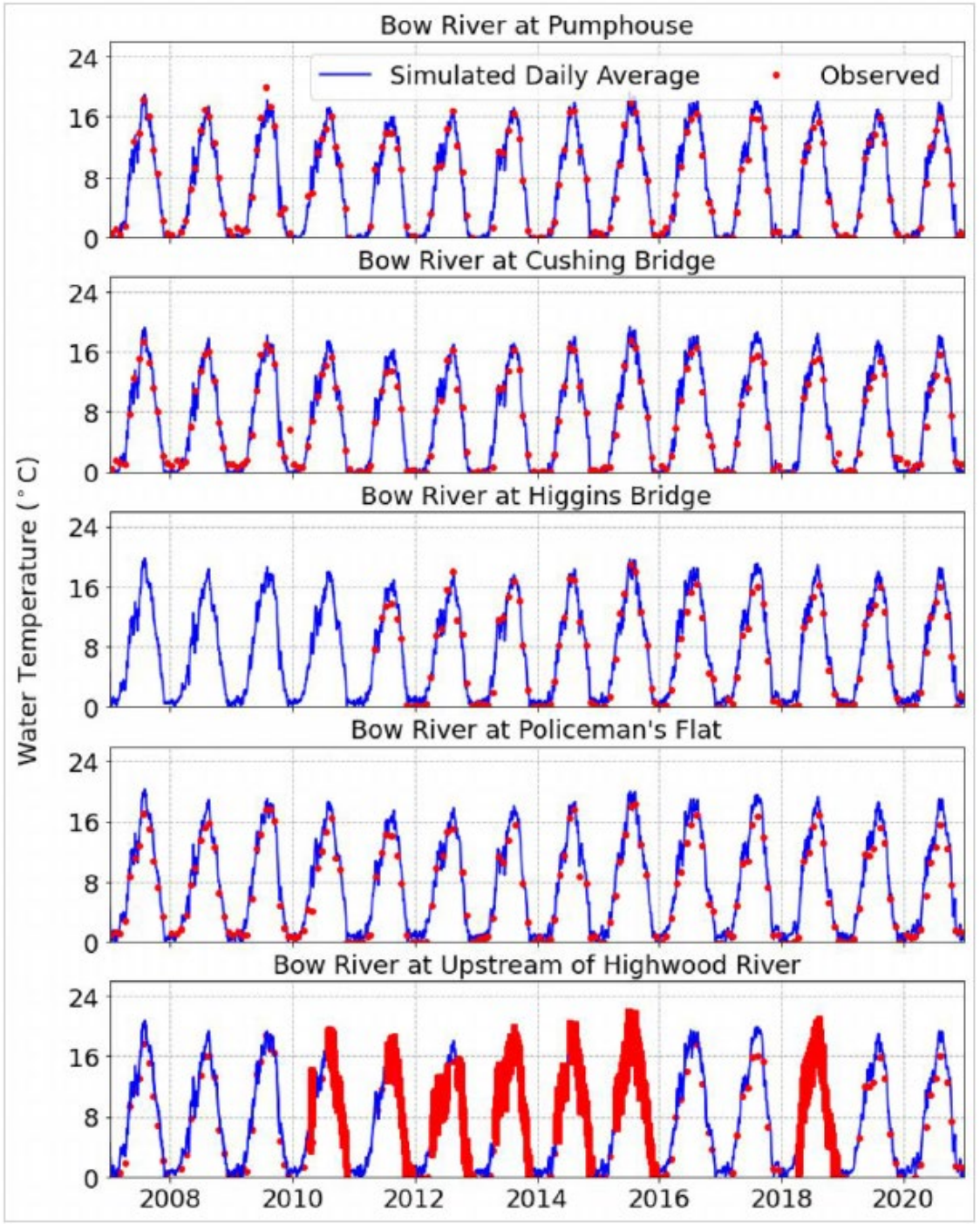
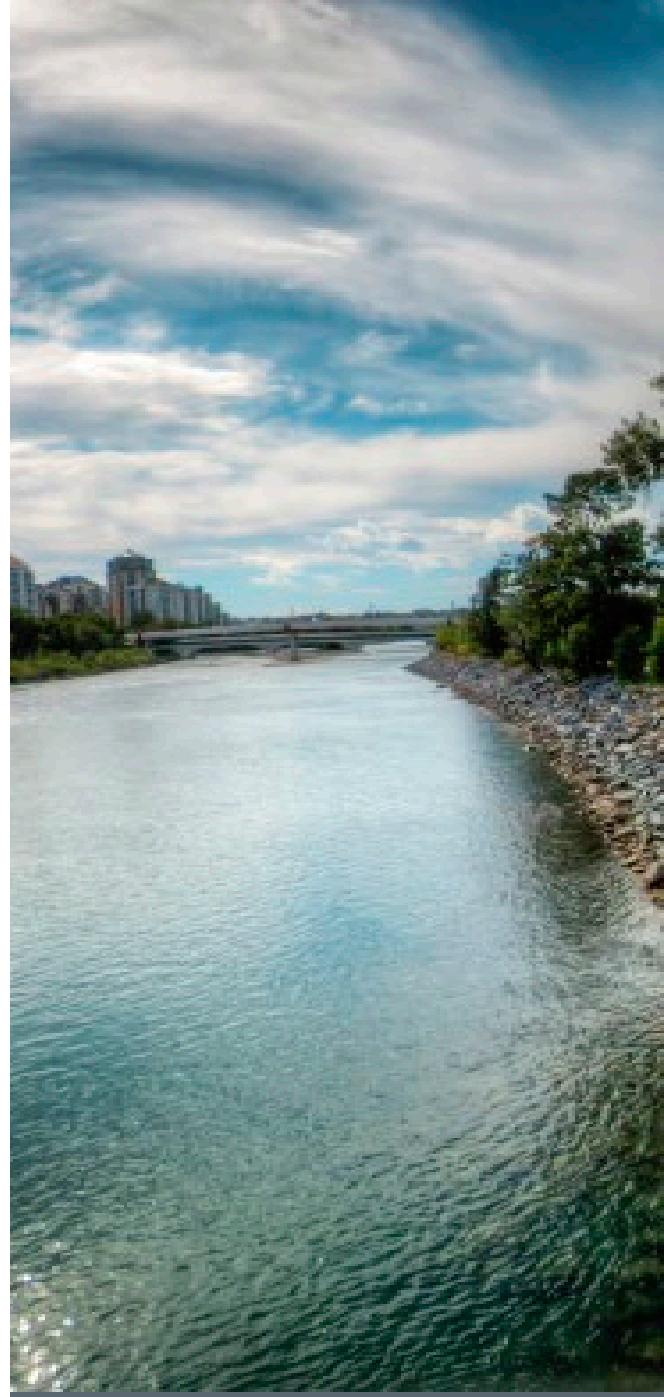
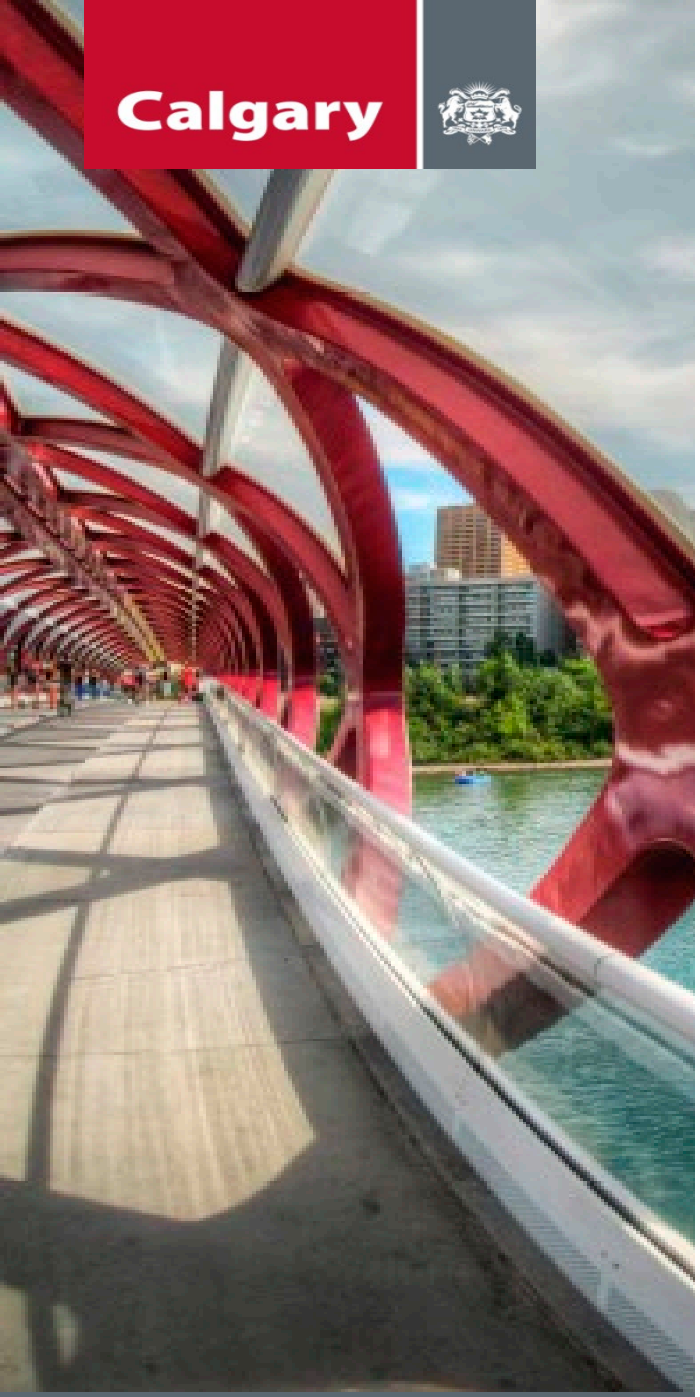


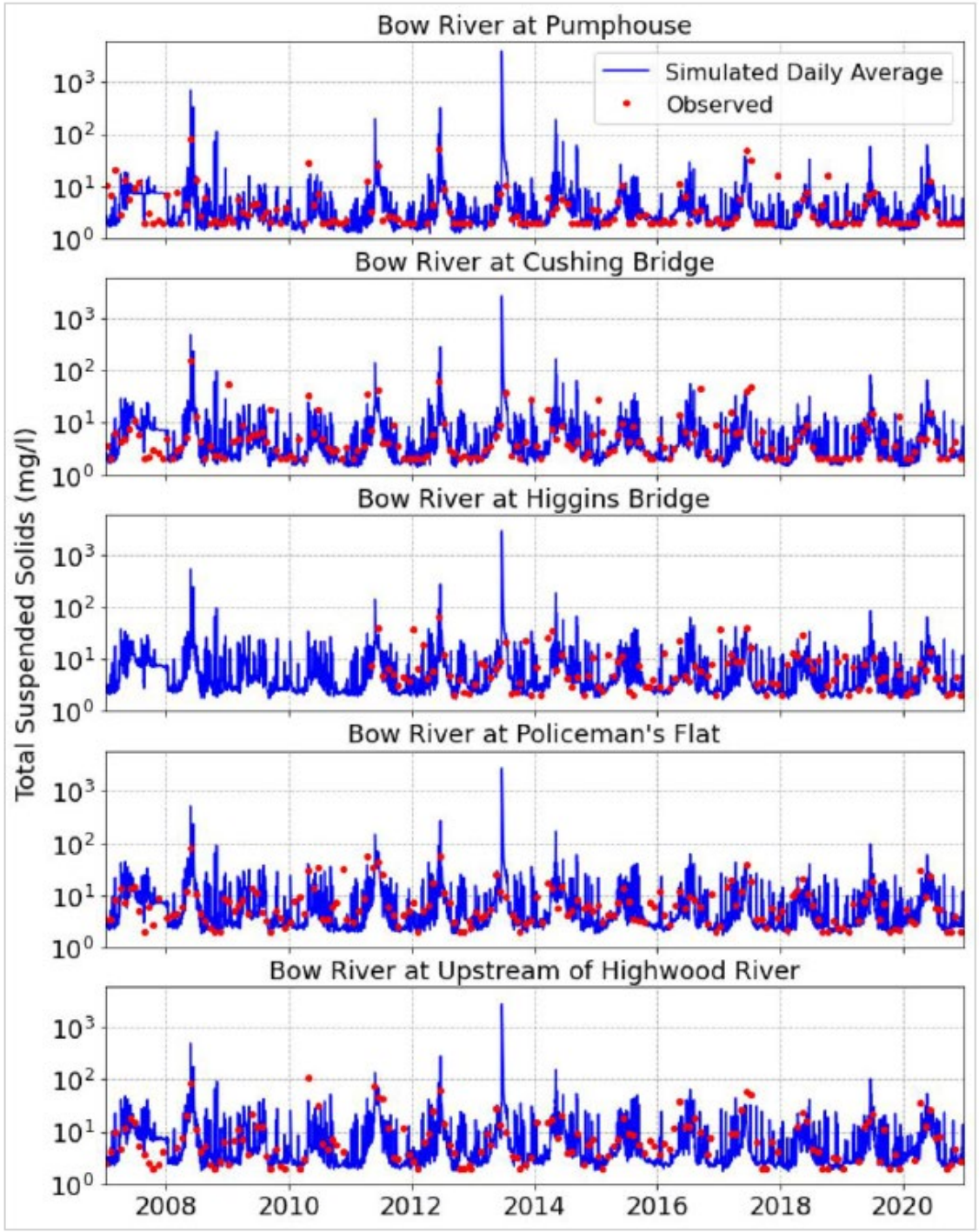
Figure 34 Observed and Simulated Daily Average Flow Rate and Simulated Daily Ice Thickness at the Bow River at Calgary

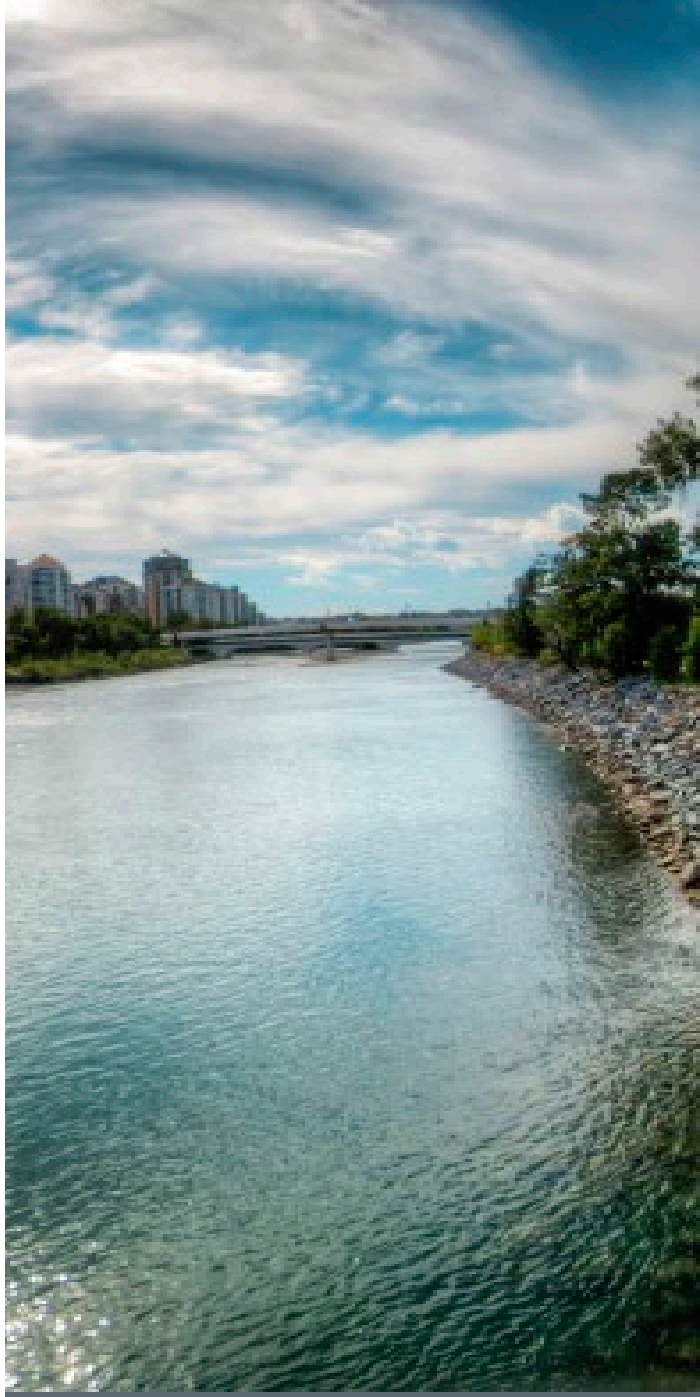


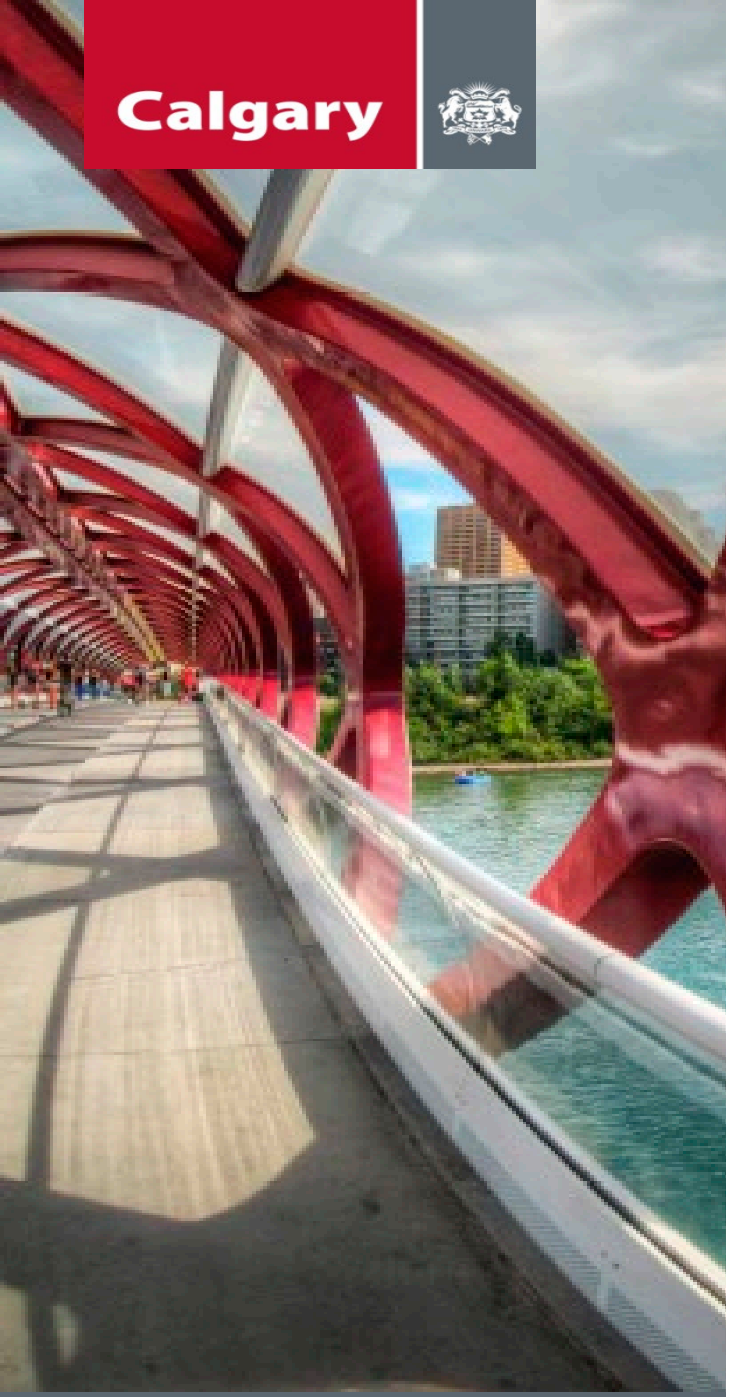

Bow River at Pumphouse
Simulated Daily Average
Observed
Bow River at Cushing Bridge
Bow River at Higgins Bridge
Bow River at Policeman's Flat
Bow River at Upstream of Highwood River
Water Temperature (°C)
0
8
16
24
2008
2010
2012
2014
2016
2018
2020

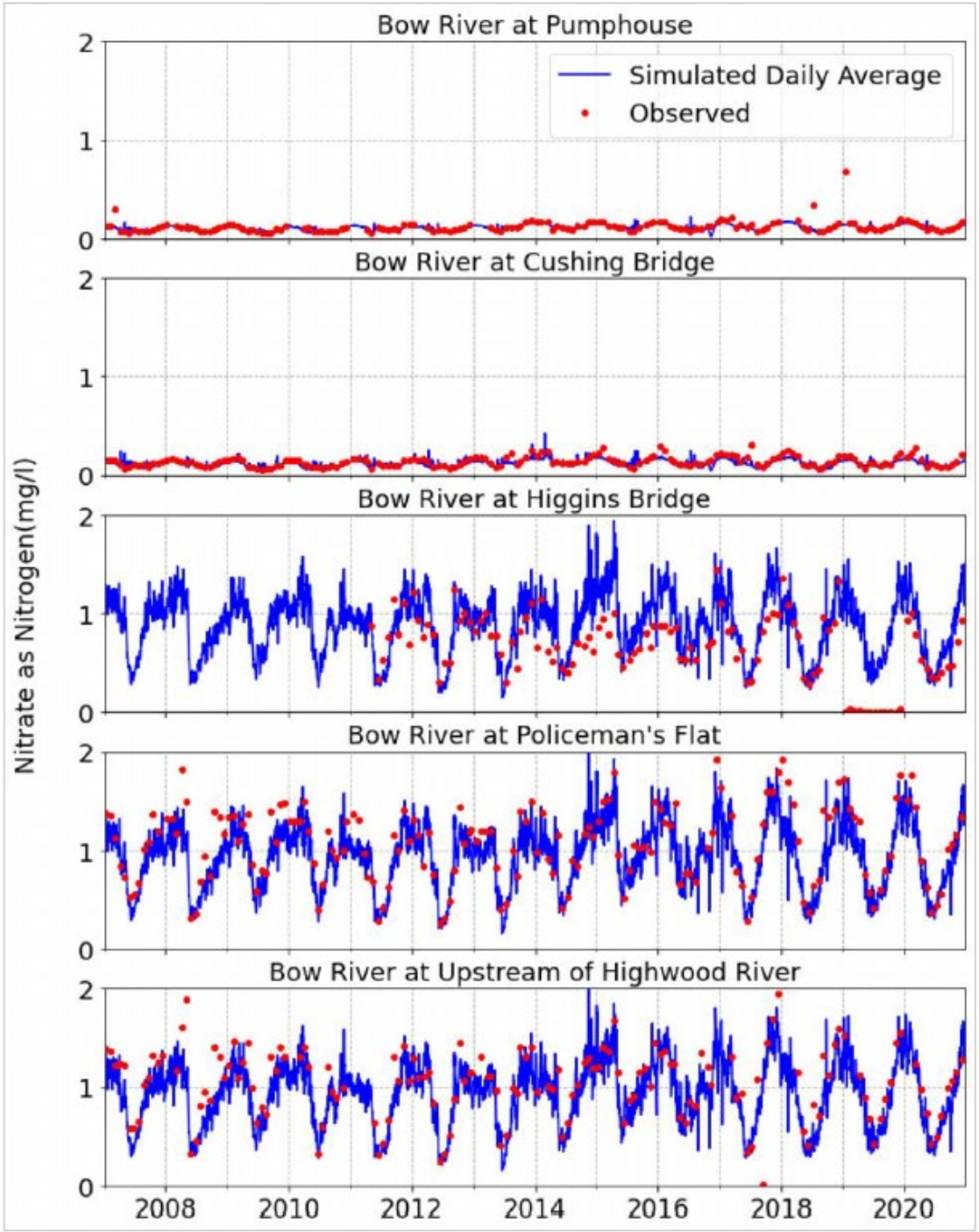


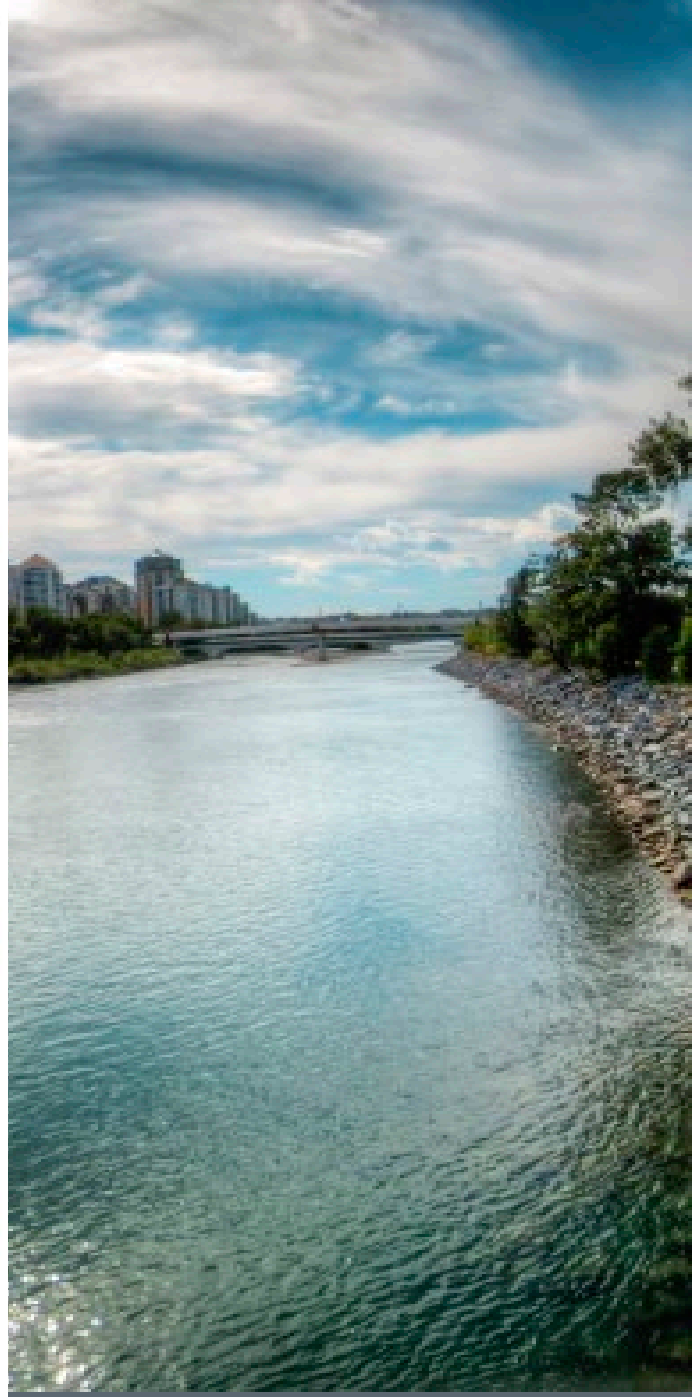


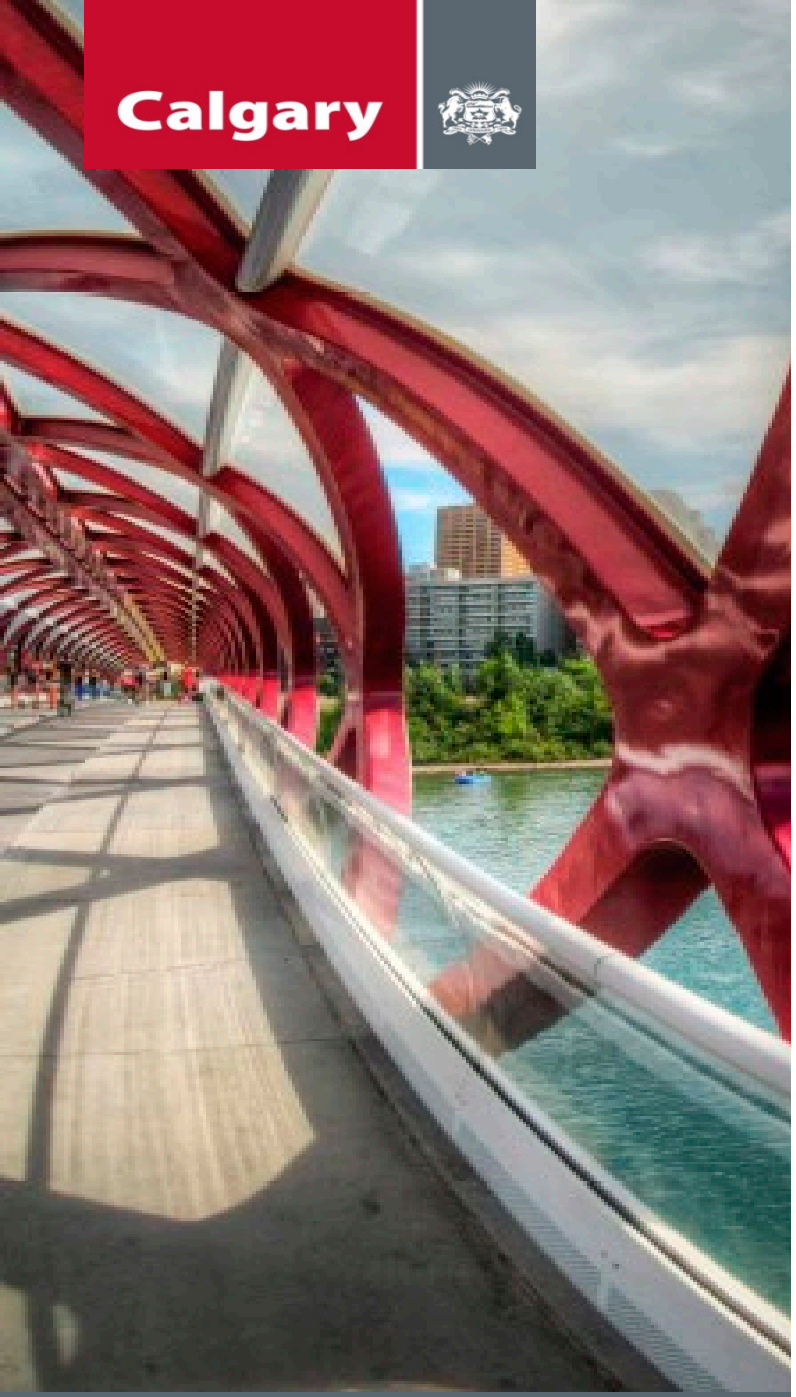

Bow River at Pumphouse
Simulated Daily Average
Observed
Bow River at Cushing Bridge
Bow River at Higgins Bridge
Bow River at Policeman's Flat
Bow River at Upstream of Highwood River
Total Suspended Solids (mg/l)
10^3
10^2
10^1
10^0
2008
2010
2012
2014
2016
2018
2020

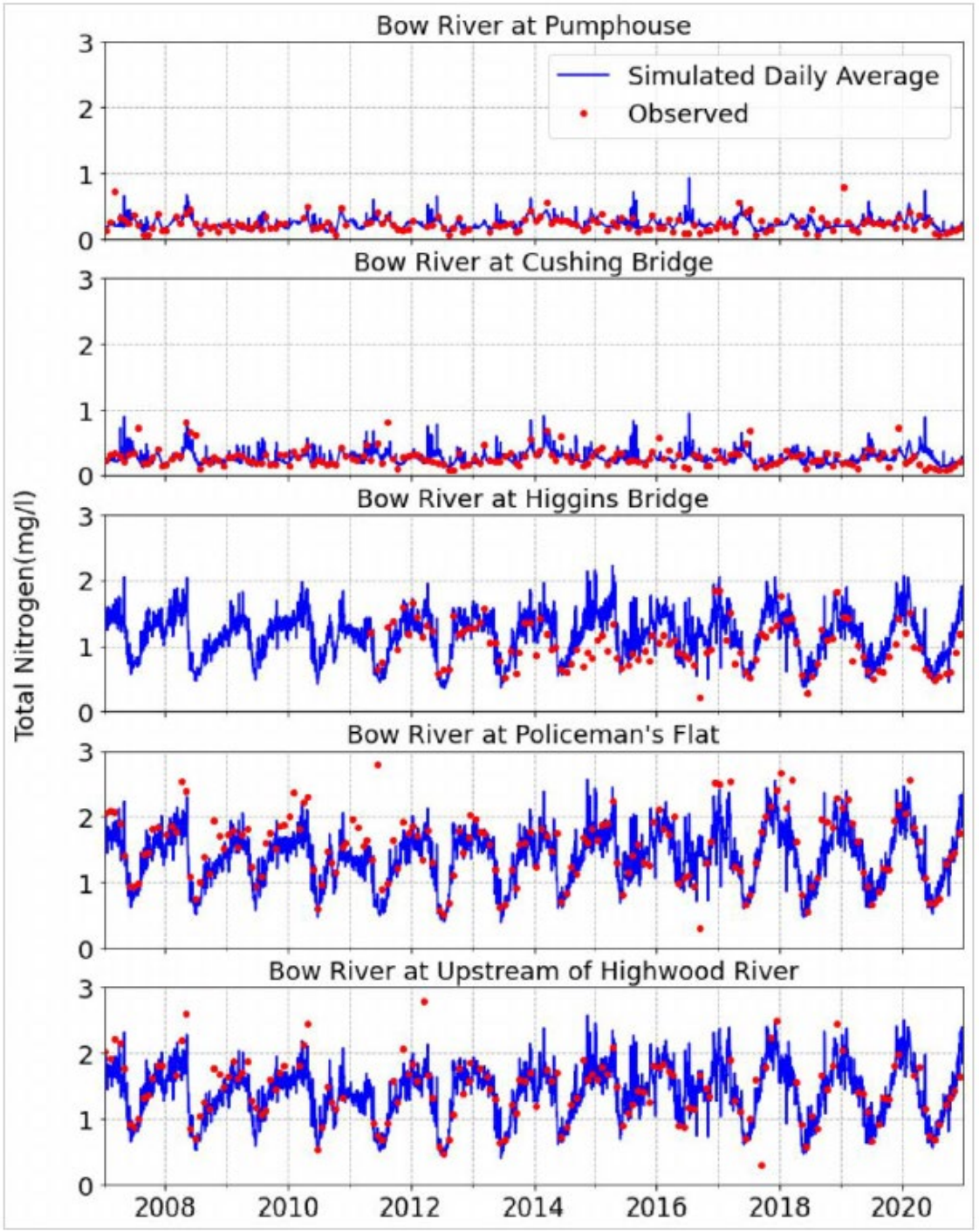


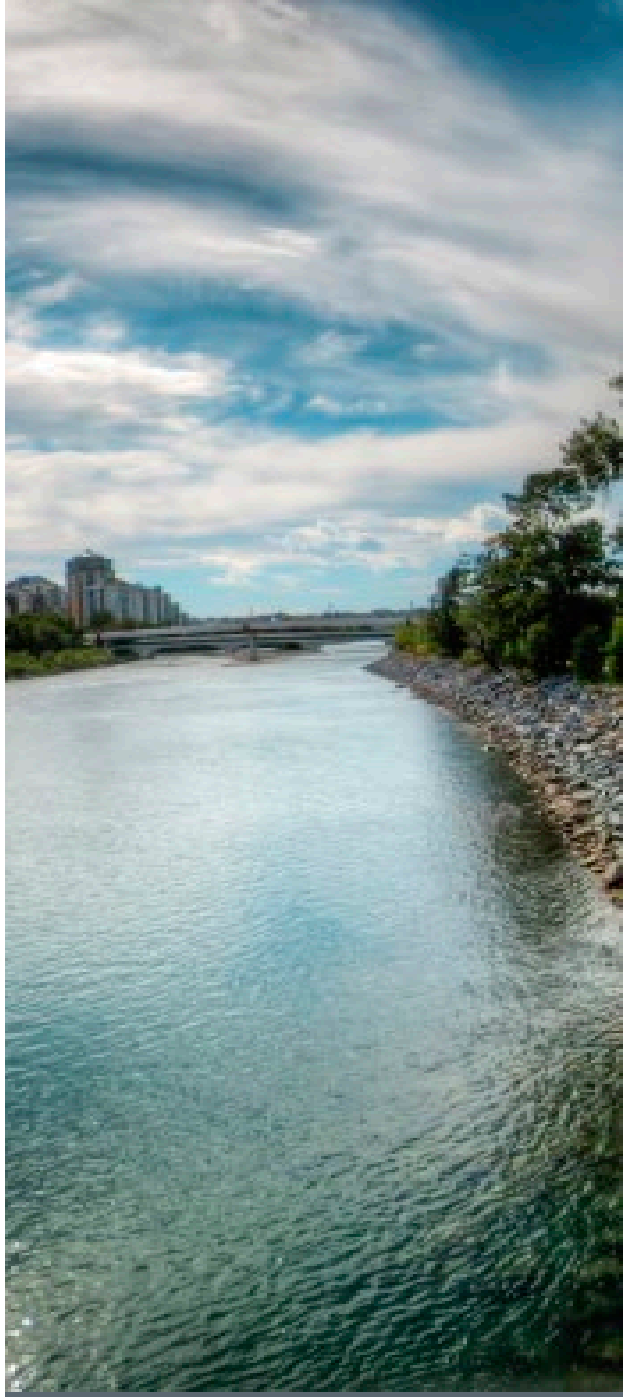


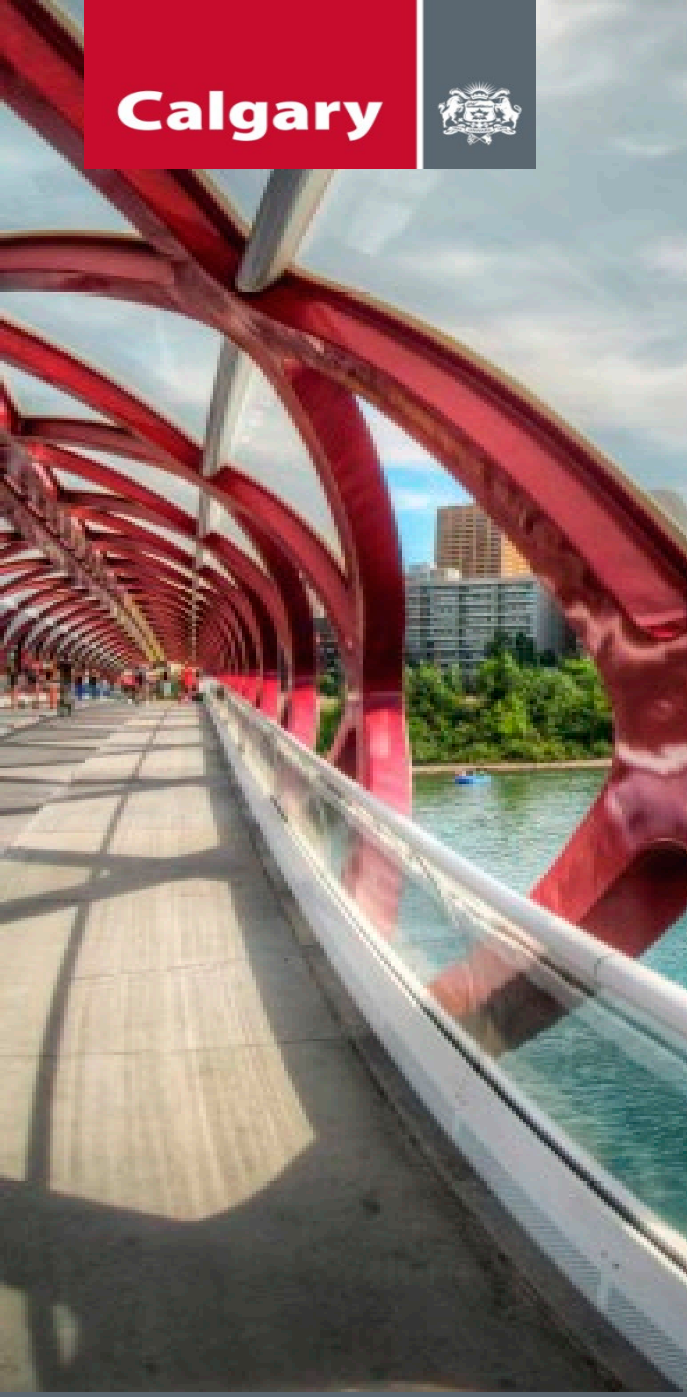

Bow River at Pumphouse
Simulated Daily Average
Observed
Bow River at Cushing Bridge
Bow River at Higgins Bridge
Bow River at Policeman's Flat
Bow River at Upstream of Highwood River
Nitrate as Nitrogen(mg/l)
0
1
2
2008
2010
2012
2014
2016
2018
2020

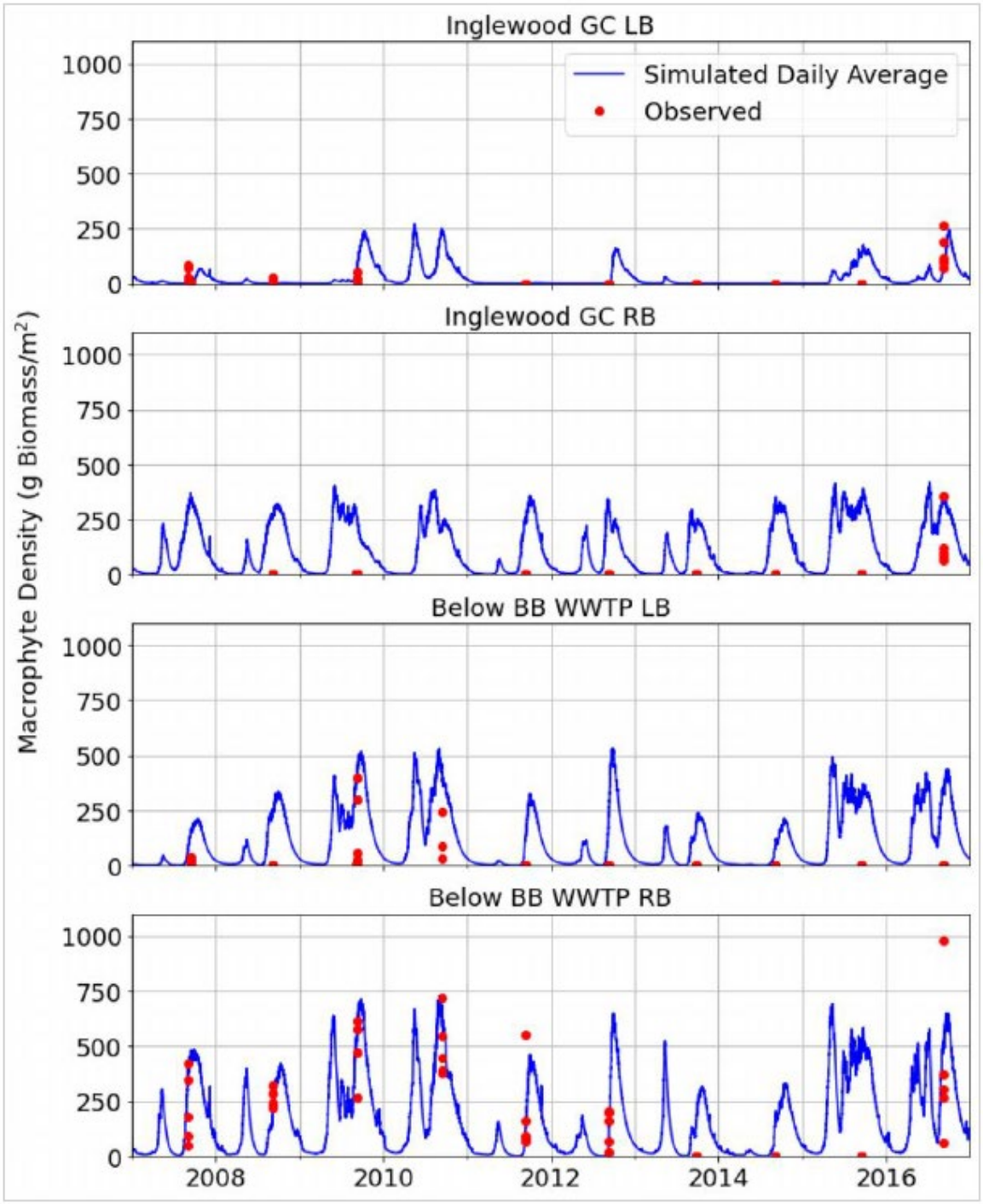


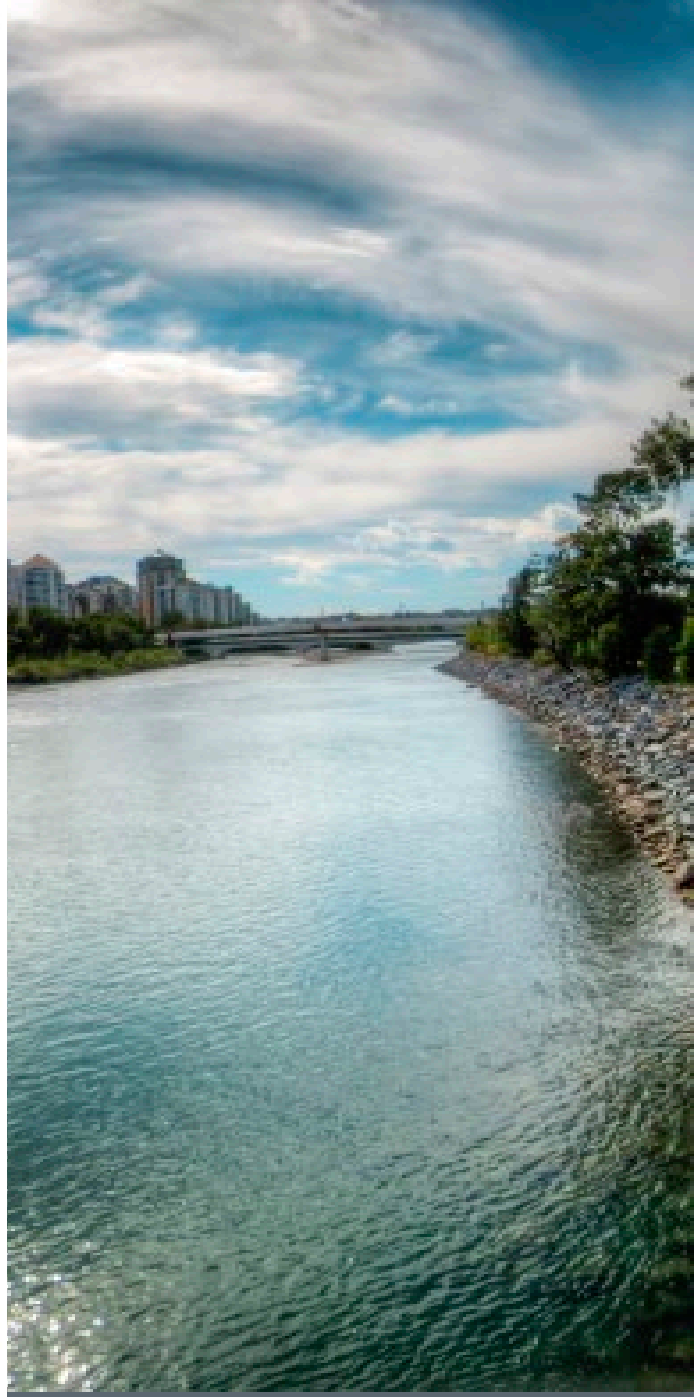


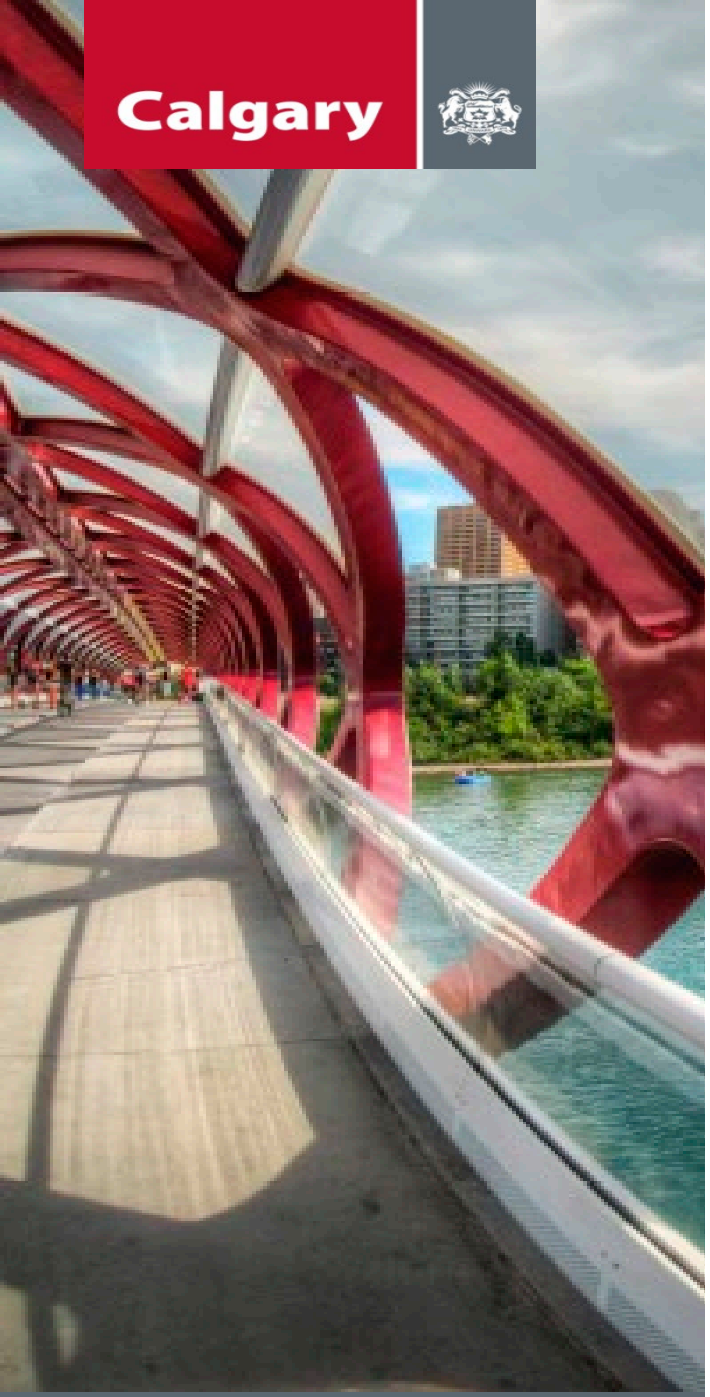

Bow River at Pumphouse
Simulated Daily Average
Observed
Bow River at Cushing Bridge
Bow River at Higgins Bridge
Bow River at Policeman's Flat
Bow River at Upstream of Highwood River
Total Nitrogen(mg/l)
0
1
2
3
2008
2010
2012
2014
2016
2018
2020

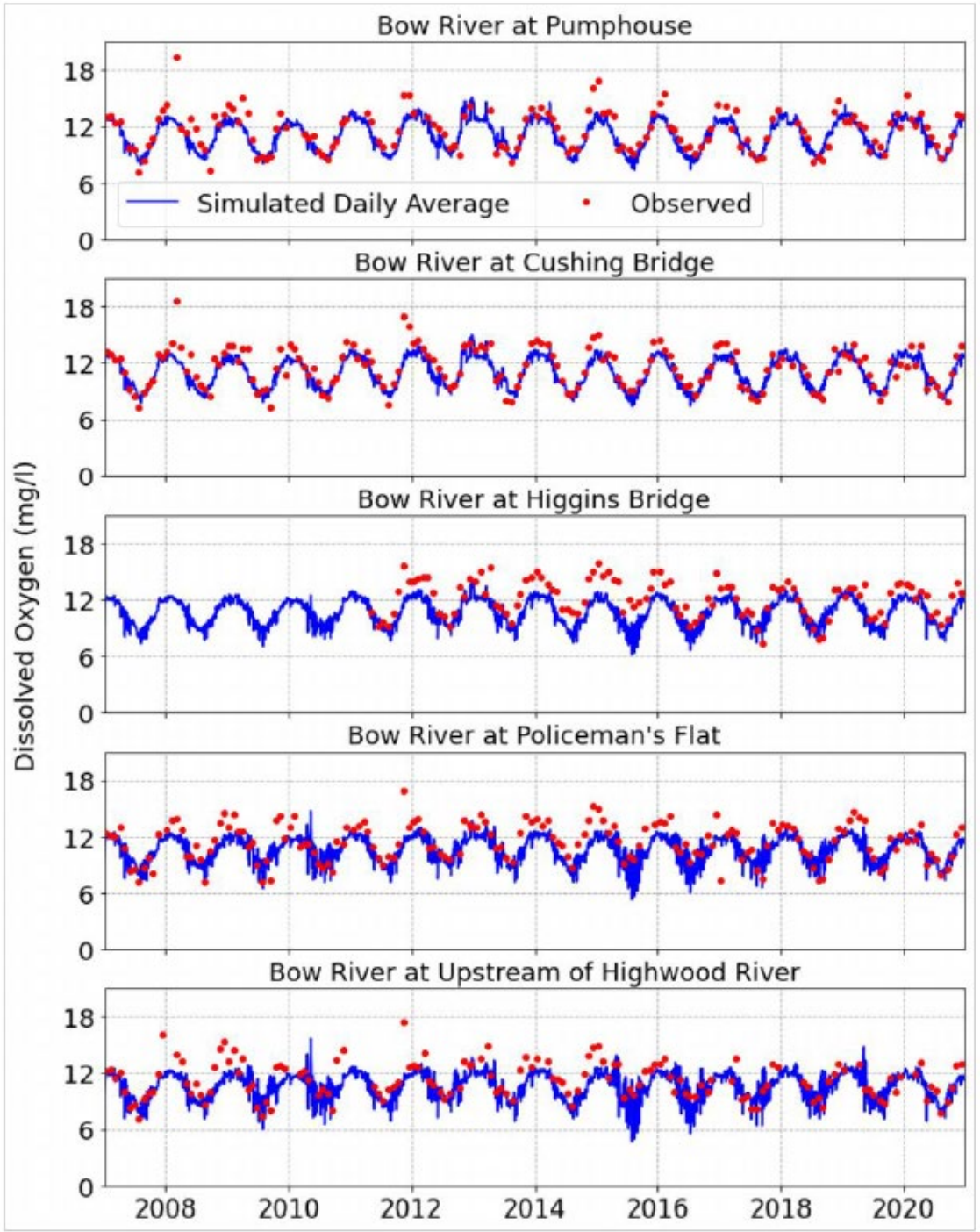


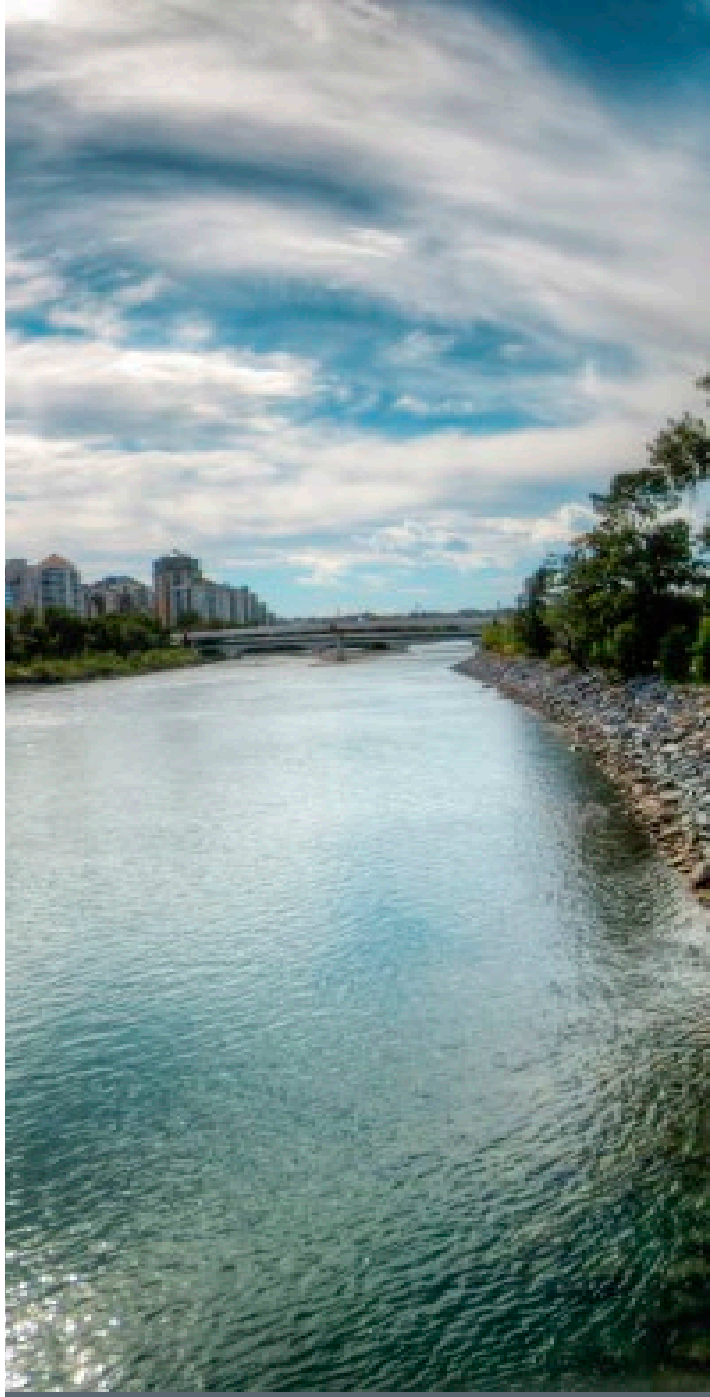



Inglewood GC LB
Simulated Daily Average
Observed
Inglewood GC RB
Below BB WWTP LB
Below BB WWTP RB
Macrophyte Density (g Biomass/m²)
0
250
500
750
1000
2008
2010
2012
2014
2016






Bow River at Pumphouse
Bow River at Cushing Bridge
Bow River at Higgins Bridge
Bow River at Policeman's Flat
Bow River at Upstream of Highwood River
Simulated Daily Average
Observed
Dissolved Oxygen (mg/l)
0
6
12
18
2008
2010
2012
2014
2016
2018
2020




Calgary
Discussion /
Questions ?