BRBC Science Forum
Wednesday, May 03, 2017
SAIT, Macdonald Hall

Forum Agenda

08:30 am – 09:00 am	**REGISTRATION**
09:00 am – 09:10 am	Welcoming Remarks – *François Bouchart, BRBC Science Committee*
Session 1: State of the Watershed *(Chair: TBA)*	
09:10 am – 10:10 am	Global Water Futures – *John Pomeroy, University of Saskatchewan*
10:10 am – 10:30 am	Morphology of the Bow River through Calgary – *Wes Dick, Klohn Crippen Berger*
10:30 am – 10:50 am	Determining the source, pathways, and storage of Elbow River streamflow – *Éowyn Campbell, University of Calgary*
10:50 am – 11:00 am	**MORNING BREAK**
11:00 am – 11:20 am	Water quality response to hydrological and meteorological conditions in the Bow River – *Sajjad Rostami, University of Calgary*
11:20 am – 11:40 am	Riparian conditions in the headwaters of the Bow and Oldman – *Michael Wagner, Alberta Agriculture and Forestry*
11:40 am - 12:00 pm	Proactive water communication by oil and gas operators in the Lochend area – *Brent Bowerman, Baseline Water*
12:00 pm – 01:00 pm	**LUNCH**
Session 2: Threats to Human Health and Aquatic Ecosystems *(Chair: TBA)*	
01:00 pm – 01:20 pm	Environmental impact of road salts on surface water quality in Alberta – *Qianru Situ, University of Calgary*
01:20 pm – 01:40 pm	Empirical relationships between blue-green algal growth, sulfate and molybdenum in shallow prairie lakes – *Susan Anderson, University of Calgary*
01:40 pm – 02:00 pm	Water quality advisories on the Elbow River – *Eric Camm, City of Calgary*
Session 3: Connecting Science to Action *(Chair: TBA)*	
02:00 pm – 02:20 pm	A pre-screening tool to assess maximum groundwater level rise during flood events – *Don Haley, Golder Associates*
02:20 pm – 02:40 pm	The effect of wastewater phosphorus, nitrogen and salt removal on Frank Lake – *Dongnan Zhu, University of Calgary*
02:40 pm – 2:50 pm	**AFTERNOON BREAK**
Session 4: Innovative Methods of Aquatic Assessment *(Chair: TBA)*	
02:50 pm – 03:10 pm	Bow River Water Quality Model upgrade – *Lei Chen, City of Calgary*
03:10 pm – 03:30 pm	Nutrient leaching in early stage of green roof: Impact on stormwater quality – *Musa Akther, University of Calgary*
03:30 pm – 03:50 pm	Using paleolimnological techniques to a) evaluate the impacts of flooding and watershed disturbance and b) set realistic targets for phosphorus management in four canal lakes – *Francine Forrest, LimnoLogic Solutions Ltd.*
03:50 pm – 04:00 pm	Closing Remarks – *François Bouchart, BRBC Science Committee*

BRBC Science Forum
Wednesday, May 03, 2017
SAIT, Macdonald Hall

Presentation Abstracts

Session 1: State of the Watershed

09:10 am – 10:10 am

Global Water Futures

John Pomeroy, University of Saskatchewan

"Global Water Futures: Solutions to Water Threats in an Era of Global Change" is a University of Saskatchewan-led research program that is funded in part by a $77.8-million grant from the Canada first Excellence Research Fund. The aim is to transform the way communities, governments and industries in Canada and other cold regions of the world prepare for and manage these increasing water-related threats.

10:10 am – 10:30 am

Morphology of the Bow River through Calgary

Wes Dick, Klohn Crippen Berger

An overview of the geological formation of the river valleys through Calgary and its upper catchment will be discussed, followed by discussion of the general processes associated with constrained gravel bed rivers. Details as to how the rivers have changed in the last 100+ years will be provided and then followed by how we see the rivers continuing to change in the next 100+ years, and what we as stewards need to do to mitigate the impacts from these changes. Lastly, a brief overview of the morphological risk assessment that was performed will be provided.

10:30 am – 10:50 am

Determining the source, pathways, and storage of Elbow River streamflow

Éowyn Campbell, University of Calgary
[Student Presenter]

We investigate the possible storage and flow pathways of water entering the Elbow River in Alberta, Canada, using hydrological, geochemical, isotopic, and geophysical methods. Glaciers are thought of as the source of eastern-slopes rivers, but climatic change has significantly diminished the Rae glacier (traditionally described as the source of the Elbow) without reducing streamflows. Worldwide, mountain streams have less than 5% “young” (<2.3 months) water (Jasechko et al. 2015). Both of these points indicate that there must be significant detention or storage of precipitation inputs in headwater catchments before that water reaches the open stream. River-connected alluvial aquifer sediments, glacial valley sediments, and deep fracture systems are some possible storage components. Data collection is ongoing, but preliminary results from our first field season show that the chemistry of samples from Elbow Falls (where all waters from the headwater catchment are integrated) is heavily

influenced by that of groundwater from the river-connected alluvial aquifer. We also see changes in the slope of the water table surface that indicate seasonal changes in source influence. Delineating the sources, storage processes, and dynamics of groundwater/stream water interactions in the Elbow river system is important to resource use and water security, and also helps answer the intriguing fundamental scientific question of why high-gradient mountain streams contain mostly “old” water.

11:00 am – 11:20 am

Water quality response to hydrological and meteorological conditions in the Bow River

Sajjad Rostami, University of Calgary
[Student Presenter]

Anthropogenic activities and natural factors such as hydrological and meteorological conditions are the key elements affecting riverine water quality. A large number of studies have examined the impact of various anthropogenic activities on water quality aiming to identify efficient measures to mitigate the degradation of surface water quality. However, the natural components, which in general are out of control of human, could also largely affect the variation of water quality. Therefore, the investigation of the impact of natural conditions on the variation of water quality would aid in formulating and implementing more effective water quality management strategies.

In this presentation, the dependency of ten selected water quality parameters on hydrological and meteorological variables including flow rate, air temperature, humidity and precipitation were investigated for the Bow River using data collected from 1988 to 2014. The spatial and temporal variations of these water quality parameters were also studied. The results demonstrated different behaviour of water quality parameters under different flow regimes. According to the response of these water quality parameters to flow, it appears that they could be categorized into four groups. Water quality constituents in a same group might have same contribution sources and are primarily govern by similar physical processes. In addition, among various water quality parameters investigated, the concentrations of dissolved oxygen, total nitrogen, sulphate and chloride and water temperature appear to be more prone to change with meteorological conditions, as they are more correlated with meteorological variables than other water quality parameters.

11:20 am – 11:40 am

Riparian conditions in the headwaters of the Bow and Oldman

Michael Wagner, Alberta Agriculture and Forestry

The value of riparian areas cannot be underestimated – riparian areas mitigate floods and droughts through dissipation of flows, retention of water and contributions to increased groundwater recharge. Field based

assessment of riparian areas can be applied to quantify their current state, identify potential problems and to provide guidance on management actions (Tripp et al., 2009). Assessment of riparian areas can identify candidate stream reaches or watersheds for restoration where the riparian area may not be providing the full range of ecosystem services including, but not limited to, those related to flood and drought resiliency.

Under funding from the Watershed Resiliency and Restoration Program (WRRP) riparian condition assessments, using British Columbia's Forest and Range Evaluation Program (FREP), were completed in the summers of 2015 and 2016 for 252 streams distributed across forested lands of the Bow and Oldman watersheds. Objectives were to 1) test the BC method for use in Alberta, 2) collect data on riparian condition in the Bow and Oldman headwaters, 3) identify factors contributing to riparian decline and 4) identify areas for rehabilitation. Preliminary results from 252 randomly selected and spatially distributed sites show condition scores of properly functioning (33%), functioning at risk (23%), functioning at high risk (21%) and non-properly functioning (23%) riparian areas. Sites with poor condition scores had characteristics associated with a lack of in-stream moss and wood, disturbed stream banks and excess sediment. These characteristics were most often associated with the 2013 flood but also a result of impacts from livestock (grazing and trampling).

11:40 am - 12:00 pm

Proactive water communication by oil and gas operators in the Lochend area

Brent Bowerman, Baseline Water

A regional hydrogeological / hydrological study in the Lochend Industry Producers Group (LIPG) operating field area was conducted to provide a baseline of natural variations in groundwater chemistry. The area is located within the Municipal District of Rocky View and overlaps both the Red Deer River and Bow River sub-basins of the South Saskatchewan River Basin. Groundwater from the Paskapoo Formation is the primary water source for local landowners. The LIPG practices include offering landowners pre-drilling quality and quantity (yield) tests on water wells within 400 metres of oil and gas wells. Shallow groundwater in surficial and bedrock aquifers are characterized by Total Dissolved Solids (TDS) concentrations generally lower than 1,000 mg/L. Water types range from HCO_3^- with no dominant cation to Na-HCO_3 and Na-SO_4, and a predominant groundwater flow direction to the east. An average chloride concentration of 12.56 mg/L was observed in water samples collected in 2011 from 323 water wells and 29 springs with concentrations of < 0.10 mg/L to 269 mg/L. Groundwater from deeper aquifers is characterized by TDS and chloride concentrations greater than 4,000 mg/L and 1,860 mg/L, respectively. Indicators of potential impacts to groundwater from oil and gas activities include elevated chloride and TDS concentrations, and the presence of

hydrocarbons. Results of long-term groundwater quality monitoring between 2013 and 2016 at a local domestic water supply well indicated no adverse impacts from adjacent oil and gas operations. Findings of the surface and groundwater assessments were provided to landowners and published on the LIPG website.

Session 2: Threats to Human Health and Aquatic Ecosystems

01:00 pm – 01:20 pm

Environmental impact of road salts on surface water quality in Alberta

Qianru Situ, University of Calgary
[Student Presenter]

Chloride is a naturally occurring element and widely distributed in the environment. In pristine surface water, chloride concentration is typically below 10 mg/L. However, chloride level of surface water is also prone to the impact of various anthropogenic activities, for example, the use of road salts for winter road maintenance. The Code Practice for the Environmental Management of Road Salts has been implemented since 2004 to reduce the impact of road salts on chloride level. Besides, chloride level and its variations are also governed by various natural environmental factors (e.g., flow). The impact of both natural and anthropogenic factors on chloride level is expected to be regional and site-specific.

To understand the impact of road salts in Alberta's rivers including the Bow River, chloride, the use of road salts, and flow data were collected. Statistical analysis was conducted to assess the impacts of natural and anthropogenic factors on temporal and spatial variations of chloride in the rivers. In general, chloride concentration was elevated after 2004. The detected significant/or insignificant upward trends of chloride level at majority of stations suggests that chloride levels in surface waters continuously increases. The increase of chloride level is coincident with the increase of the use of road salts suggesting its negative impact on surface water quality. In addition, flow was shown to be another primary factor driven the seasonal variation of chloride concentrations.

01:20 pm – 01:40 pm

Empirical relationships between blue-green algal growth, sulfate and molybdenum in shallow prairie lakes

Susan Anderson, University of Calgary
[Student Presenter]

The frequency of blue-green algal blooms has been thought to be increasing over recent decades. Blue-green algae can produce toxins that can affect surface drinking water sources and limit recreational activities. Blue-green algal blooms can also lead to fish kills and alter aquatic food web structure, potentially altering energy cycling. Warming climate may

cause salinity increases in endorheic basins, which in Alberta will increase sulfate concentrations. However, sulfate has been shown to compete with molybdenum for uptake sites, potentially altering molybdenum availability, the most common enzyme co-factor for nitrogen fixation.

We choose 25 shallow prairie lakes east of Calgary with a wide range in conductivity to sample four times throughout summer 2016 to determine if there were specific concentrations of nutrients that led to blue-green algal blooms, and whether there was suppression of blue-green algal growth at high sulfate concentrations. Our results show that many lakes had favourable conditions for blue-green algae growth. Chlorophyll concentrations ranging from 0 (below detectable limits) to 4725 µg/L suggest that the lakes we sampled may fall into distinct high and low chlorophyll categories. These results will be discussed relative to N:P and sulfate:molybdenum.

01:40 pm – 02:00 pm

Water quality advisories on the Elbow River

Eric Camm, City of Calgary

The Elbow River, its riparian area and numerous parks located between the Glenmore Dam and the Bow River confluence are popular sources of recreation for Calgarians. Changes to the river flow patterns as a result of the 2013 flood, has resulted in more points of direct access, which has led to more recreational users, and an increased concern for public health. While historical data indicates the *E. coli* levels in this region of the Elbow are sporadic within a year, but consistent across years, further monitoring was conducted by the City of Calgary and Alberta Health Services (AHS) in the interest of public health. As a result of the more extensive monitoring programs, AHS issued and extended a number of Water Quality Advisories for the lower portions of the Elbow River in both 2015 and 2016. Investigations by the City of Calgary indicated that there were no major infrastructure failures or point sources of contamination which could be identified as the source of *E. coli*. Water quality is historically known to be highly variable across this stretch of the river due to heavy rainfall, upstream sources such as agriculture, stormwater discharges, wildlife that live in the corridor, high river flows, recreation and other factors. While the health risks associated with wading or swimming in the river may be low, citizens should be aware of potential hazards. To alert the public of potential risks with recreational use of the river, educational signage was developed and posted along the river in 2016. The presentation will discuss the results from the sampling work with exploratory data analysis, outline how water quality advisories are issued, discuss the continued collaboration between the City and AHS and make recommendations for addressing public health risks to users of the river.

BRBC Science Forum
Wednesday, May 03, 2017
SAIT, Macdonald Hall

Session 3: Connecting Science to Action

02:00 pm – 02:20 pm

A pre-screening tool to assess maximum groundwater level rise during flood events

Don Haley, Golder Associates

The City of Calgary commissioned a Flood Mitigation Options Assessment study to assess different flood mitigation strategies along sections of the Bow and Elbow Rivers within the city for different flood return periods (20-, 100-, 500-year etc.). The objective of the study was to determine how potential flood damage estimates are predicted to decrease compared to the Base Case scenario of no additional flood protection measures being implemented. The project required the following analyses be completed for each return period:

1. Determine the extent of surface water inundation (i.e., areas impacted by surface flooding), with and without protective measures;
2. Given the extent of surface water inundation, determine the maximum groundwater level rise in areas past the edge of surface water inundation (i.e., potential areas impacted by groundwater flooding);
3. Use the results of Steps 1 and 2 above to estimate flood damage costs.

The presentation will discuss how a screening level groundwater modelling approach was developed to predict the maximum groundwater level rise over the course of a flood event (Step 2, above). The main tasks involved:

- Developing numerical (MODFLOW) cross-sections along the Bow (2) and Elbow (1) Rivers.
- Applying the river surface hydrographs as boundary conditions at the rivers.
- Using the numerical model results to develop empirical relationships that describe the difference between the peak river level and the peak groundwater level versus distance from the edge of inundation.
- Use geospatial modelling tools to determine the maximum groundwater level elevation over the alluvial aquifer.

02:20 pm – 02:40 pm

The effect of wastewater phosphorus, nitrogen and salt removal on Frank Lake

Dongnan Zhu, University of Calgary
[Student Presenter]

Wastewater effluent treatment is a challenge, particularly for small communities and rural industries that lack significant wastewater treatment

facilities. Frank Lake (FL) is a wetland (Alberta) complex that has received increasingly strong municipal and slaughterhouse wastewater since 1989. This study combined hydrologic and water quality data collected between 2012 and 2015 with historic data to estimate average annual water, salt, and nutrient mass balances, and evaluate downstream impacts.

The lake received roughly equivalent volumes of annual inflow from three sources: spring melt (via ephemeral creeks), precipitation, and wastewater. About two-thirds of outflow was via evaporation, and one-third via discharge into the receiving watershed. An estimated one-fourth of the annual 845 ± 18 tons/yr of chloride that enter FL was stored in the lake sediment and shoreline soils, while the remaining three-fourths were discharged into the Little Bow River (LBR). An estimated 60% of the annual phosphorus, and 5% of the nitrogen mass flux was discharged to the LBR system. The remaining phosphorous mass was stored in the lake sediment and shoreline soils.

Increasing salt and nutrient accumulation in sediment and shoreline soils are a long-term concern at FL. An estimated 6,000 tons of chloride stored in the lake, with electrical conductivity and chloride guidelines exceeded in some lake water samples. The salt, and an estimated 275 tons of sediment phosphorus could be released into the receiving water body during an extreme weather event.

Water quality impacts on the LBR watershed were significant. Frank Lake discharge to the LBR caused estimated increases in dissolved mass fluxes of 80 times for chloride, 20 times for nitrogen, and 235 times for chloride. Downstream surface water quality standards were routinely exceeded for electrical conductivity and phosphorus.

Session 4: Innovative Methods of Aquatic Assessment

02:50 pm – 03:10 pm

Bow River Water Quality Model upgrade

Lei Chen, City of Calgary

In 2004, the City developed a Bow River Water Quality Model (BRWQM) to simulate the water quality constitutes in the Bow River from the Bearspaw Dam to the Highwood River confluence.

The previous BRWQM included three model components: a stormwater model, the Quality Hydrologic Model (QHM); a hydraulic model, Hydraulic Engineering Centers River Analysis System (HEC-RAS), and a water quality model, an enhanced version of United States Environmental Protection Agency's (USEPA) Water Quality Analysis Simulation Program (WASP-MG). The QHM model provides stormwater runoff to the HEC-RAS model and stormwater loading information to the WASP-MG model; the HEC-RAS model simulates flow through the Bow River; the WASP-MG simulates the material transport and kinetics of chemical and biological

processes, especially the growth of periphyton and macrophytes.

The BRWQM has gone through several updates by the City of Calgary and Alberta Environment and Parks (AEP) ever since the first version. The updates included the extension of simulation period and simulation spatial domain expansion from Bow River headwater to Bassano Dam.

Aquatic environment has been changed since previous version of BRWQM was developed. For example, the river morphology has been changed due to flooding in 2005 and 2013. Effluents from two wastewater treatment plants (WWTPs), Bonnybrook and Fish Creek WWTPs were considered in previous version, while the Pine Creek WWTP, which started operation in 2008, was not in previous model. The footprint of the city has also increased from 722 km2 to 836 km2. In addition to these, a better stormwater model was required to better understand non-point source pollutant contribution from stormwater system.

The upgraded BRWQM model includes a Stormwater Management Model (SWMM) for the entire City of Calgary. The SWMM model simulates the city-wide stormwater runoff from 2007 to 2014 using the most recently available land use data which were created in 2007, and 2010 impervious cover. The spatial resolution in the SWMM is much finer than the QHM model with more than 300 stormwater sub-catchments covering the entire city. The SWMM model also directly simulates performance of stormwater ponds. The results of the SWMM model serve as inputs to the HEC-RAS and WASP-MG models to simulate the flow and water quality in the Bow River. The SWMM model is under calibration at this time.

After the SWMM model development, the HEC-RAS model was updated. The HEC-RAS model uses bathymetry representative of the period after the 2005 flood. The HEC-RAS model reads in all the flow information and simulates the flow through the City and then provides flow field to the WASP-MG model. Along with the update of the HEC-RAS model, the WASP-MG model was updated using the flow and loading results from SWMM, HEC-RAS, as well as water quality monitoring data at the tributaries and from WWTPs from 2007 to 2014. Fine tuning of the model coefficients from the previous models was conducted to improve the model results.

03:10 pm – 03:30 pm

Nutrient leaching in early stage of green roof: Impact on stormwater quality

Musa Akther, University of Calgary
[Student Presenter]

Green roof has been demonstrated to be effective to manage urban stormwater runoff in many regions across the world. The wide recognition and appreciation of green roof promotes its acceptance in the City of Calgary. It is very common practice to apply soil media containing high level of nutrients to ensure plant establishment at the initial stage. As a

result, green roof might initially behave as a source rather than a sink of pollution, which poses negative impact on stormwater quality if it is implemented in a large scale. Therefore, the objective of this research is to examine green roof's behavior and its potential linkage with design variables including soil media and depth and hydrologic conditions (soil moisture) at its initial stage.

In this presentation, the preliminary results from a laboratory experimental study is given. The laboratory cells were constructed using three types of soil media, which are commercially used in the City, at three depths (100, 150, and 200 mm). Simulated storms were applied on the cells under different soil moisture conditions (dry, normal, and wet) to monitor runoff quantity and quality (including PO43-, TP, NO3--N, NH4+-N, TN, etc.). The results confirmed that in early stage green roof acts as a source of pollution. The dependence of nutrient concentrations on these design and hydrologic variables was observed. Furthermore, nutrient concentrations of effluent generally tend to decrease with the increase of total rainfall amount applied. These results suggest that attention should be paid to reduce nutrient leaching for green roof construction.

03:30 pm – 03:50 pm

Using paleolimnological techniques to a) evaluate the impacts of flooding and watershed disturbance and b) set realistic targets for phosphorus management in four canal lakes

Francine Forrest, LimnoLogic Solutions Ltd.

Phosphorus has been identified as a parameter of concern in the Bow River and a Phosphorus Management Plan has been developed. Paleolimnological techniques may be useful to help set phosphorus targets and optimize management of certain reservoirs in the Bow River. A case study will demonstrate the use of the paleolimnological techniques used to set realistic targets and assess the impacts of water level changes and watershed disturbances on several lakes within the Rideau Canal System, Ontario. Limnology features of the Glenmore Reservoir will be included for general context and help evaluate the potential for paleolimnoligical methods in this and other Bow River reservoirs.

In Ontario, paleolimnological techniques and the Lake Shore Capacity Model have been used to set phosphorus targets and make informed decisions on watershed development for over 20 years. Stratigraphical analysis of diatom microfossils and physical sediment characteristics in 210Pb and Ambrosia dated sediment cores, along with a diatom-based water quality model, were used to reconstruct their trophic histories (ca 200 years). Limnological responses of four canal lakes to canal construction and watershed disturbance varied in magnitude and differences were attributed to a number of variables, including surface-area: watershed ratio, depth and watershed activity. These results and future loading scenarios were used by resource managers to make informed shoreline development decisions.

BRBC Science Forum
Wednesday, May 03, 2017
SAIT, Macdonald Hall

Venue

The 2017 BRBC Science Forum is held at **Southern Alberta Institute of Technology (SAIT)** (1301 16 Ave NW, Calgary, AB, T2M 0L4)**. Macdonald Hall** is located in the **Heritage Hall Building** in the centre of the SAIT main campus, close to the C-Train line and SAIT parking garage (see star on below map). Please look for signs directing you to the appropriate room.

SAIT is accessible by the **SAIT/ACAD/Jubilee LRT Station**. Parking is also available at various visitor parking lots as indicated on the map. Please refer to http://www.sait.ca/about-sait/campus/transit-and-parking/parking for parking rates.