BRBC Science Forum
Wednesday, May 01, 2019
Ross Glen Hall, Mount Royal University

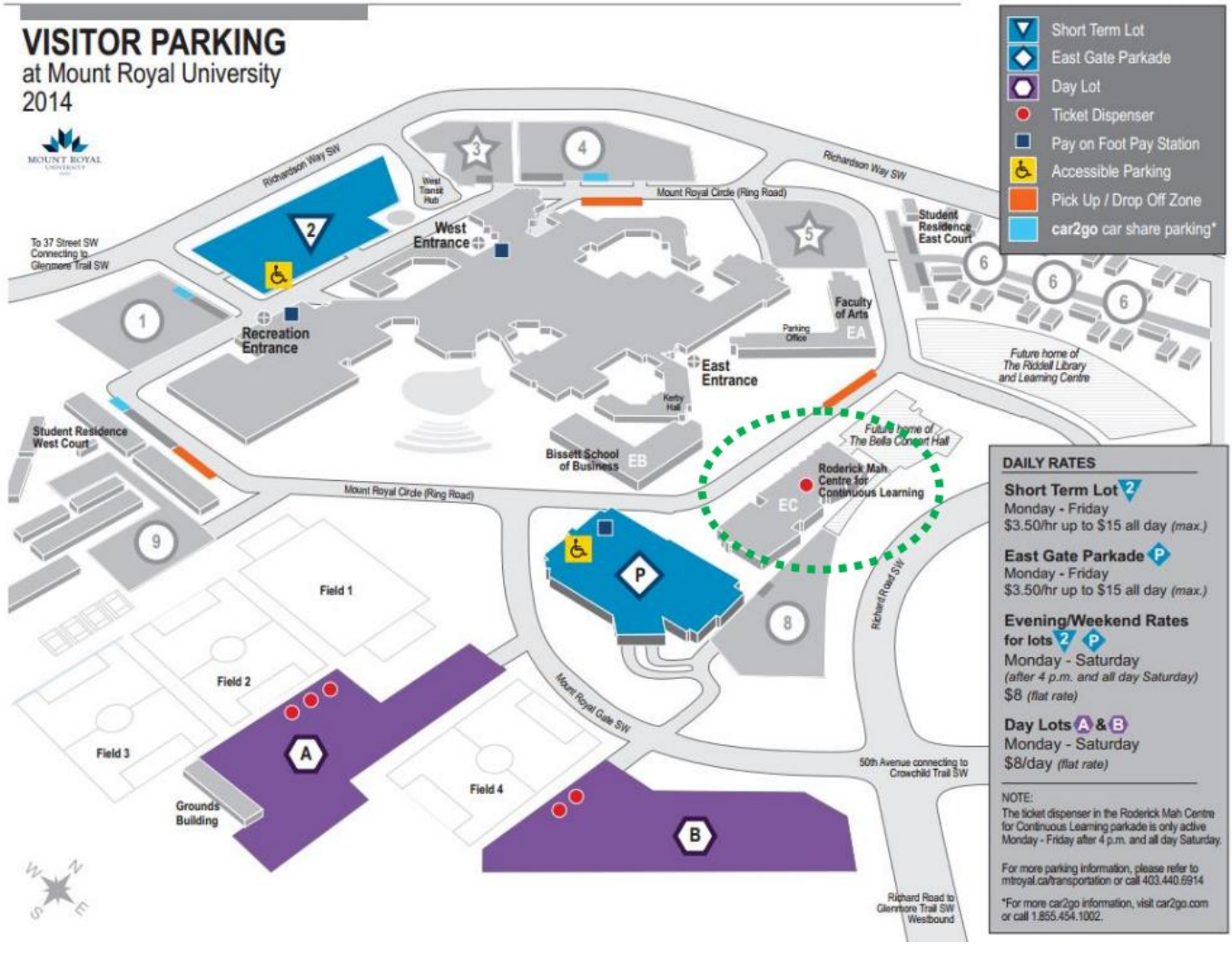
Forum Agenda

08:30 am – 09:00 am	**REGISTRATION**
09:00 am – 09:10 am	Welcoming remarks – *Mike Nemeth, Chair of BRBC Youth & Young Professionals Committee*
SPECIAL SESSION: Groundwater *(Chair: TBA)*	
09:10 am – 10:30 am	**Groundwater Keynote** – *Cathy Ryan, University of Calgary*
10:30 am – 10:50 am	**MORNING BREAK / POSTER SESSION**
10:50 am – 11:10 am	Groundwater is the river: groundwater contributions to the Elbow – *Éowyn Campbell, University of Calgary*
11:10 am – 11:30 am	Hydrogeologic controls on groundwater discharge to fall and winter streamflow in the Canadian Rocky Mountains – *Laura Beamish, University of Calgary*
11:30 am – 11:50 am	Effect of groundwater and soil parameters variabilities on streamflow prediction: a case study of the Upper Elbow River watershed – *Philip Mutulu, AquaClim Enviro Solutions*
11:50 pm – 01:00 pm	**LUNCH / NETWORKING**
Session 2: State of the Watershed *(Chair: TBA)*	
01:00 pm – 01:20 pm	Proof of the permanent existence and year to year flow of Confederation Creek – *Daryl Wylie, Friend of Confederation Creek*
01:20 pm – 01:40 pm	Nutrient distribution between different compartments of a wastewater-treatment effluent impacted river before and after a major flood event – *Nadine Taube, University of Calgary*
01:40 pm – 02:00 pm	A fish tale gone sideways, whirling disease in Banff National Park – *Colby Whelan, University of Calgary*
02:00 pm – 02:20 pm	**AFTERNOON BREAK / POSTER SESSION**
Session 3: Innovative Methods for Assessment and Management *(Chair: TBA)*	
02:20 pm – 02:40 pm	Nitrate concentrations and isotope compositions in Pine Creek wastewater effluents and ACWA streams – *Bentley Blondal, University of Calgary*
02:40 pm – 03:00 pm	Water quantity and quality performance monitoring at Okotoks Bioretention Research Site – *Anton Skorobogatov, University of Calgary*
03:00 pm – 03:20 pm	Evaluating effluent treatment and disposal for the town of Okotoks sewage treatment plant using the Banner At-Grade Lateral System – *Angus Chu, University of Calgary*
03:20 pm – 03:40 pm	An integrated approach to fisheries restoration of a regulated creek in Banff National Park – *Helen Dickinson, Parks Canada*
03:40 pm – 03:50 pm	Closing remarks – *Mike Nemeth, Chair of BRBC Youth & Young Professionals Committee*

BRBC Science Forum
Wednesday, May 01, 2019
Ross Glen Hall, Mount Royal University

Venue

The 2019 BRBC Science Forum is held at Mount Royal University. Room EC1050 is in the Ross Glen Hall, which is located on the main level of the Roderick Mah Centre for Continuous Learning on the east side of the MRU main campus. Please look for signs directing you to the appropriate room. See the below map for the Roderick Mah Centre circled in green, and for campus visitor parking options (larger PDF of map available at http://mtroyal.ca/cs/groups/public/documents/pdf/visitorparkingmap2014mar.pdf.pdf).



BRBC Science Forum
Wednesday, May 01, 2019
Ross Glen Hall, Mount Royal University

Abstracts: Oral

Presenter names are in bold.

SPECIAL SESSION: Groundwater

GROUNDWATER KEYNOTE

Cathy Ryan

Department of Geoscience, University of Calgary

Groundwater is the river: groundwater contributions to the Elbow

Éowyn Campbell and Cathy Ryan

Department of Geoscience, University of Calgary

Almost every drop of the Elbow River is groundwater, and each drop has a story to tell. Here we present our findings from three years of research in the Elbow River watershed. Using the chemistry of the water, we show that virtually all of the rain and snow that fall in the watershed do not run directly into the river. Rather, they are mixed and stored in the sandstones and shales of the front ranges and foothills, the majestic limestone cliffs of the headwaters, and even the soils and gravels of the river valleys before becoming the waters of the Elbow River. How do we know where the water has been and how long it has stayed? We illustrate how the composition of the water in the Elbow River changes through the days, the seasons, and the years, and what these changes tell us about when flooding will occur, when to prepare for drought, and how the changing climate will change the river itself.

Hydrogeologic controls on groundwater discharge to fall and winter streamflow in the Canadian Rocky Mountains

Laura Beamish and Masaki Hayashi

Department of Geoscience, University of Calgary

Mountain headwaters, like those of the Bow River, supply essential water resources to downstream communities. Sustainable management of these resources requires an understanding of hydrologic processes in alpine watersheds. Fall and winter streamflows in the Canadian Rockies are largely sustained by groundwater, but mountain groundwater processes are poorly understood due to the scarcity of studies in these environments. This study investigated regional variability in mountain groundwater processes using two approaches: analysis of fall and winter recessions in 19 watersheds in the Rockies, including the Bow River; and hillslope modelling, to relate watershed-scale recession behavior to hillslope processes. In the first phase, most watersheds were observed to have a two-stage recession characterized by fast exponential decay followed by slower exponential decay.

Recession coefficients for both stages and the timing of the transitions between the segments were determined. Results showed slower recessions were associated with younger, more porous bedrock. Rainier, lower elevation watersheds transitioned to the slow recession phase later in the fall, suggesting that the timing of the transition is climatically controlled. Records from the Bow River at Banff showed that the transition point has been shifting to earlier in the fall, potentially due to climatic change. Hillslope modelling was in progress at the time of abstract submission and aims to determine if the two-stage recessions can be explained by layering or bedrock topography in hillslope aquifers. Results from this work indicate that both geology and climate control the groundwater processes that sustain fall and winter streamflows in mountain environments.

Effect of groundwater and soil parameters variabilities on streamflow prediction: a case study of the Upper Elbow River watershed

A. Ojekanmi[1], **Philip M. Mutulu[1]**, B. Faruk[2] and A. Srivastava[1]

[1]*AquaClim Enviro Solutions*
[2]*MR Engineering*

Uncertainties in the parameterization of surface and groundwater interaction can significantly affect streamflow prediction. Quantification of potential ranges in predicted flows due to these uncertainties are useful in water management and engineering design risk assessment projects. This study evaluates the effect of variabilities in groundwater and soil moisture parameters on predicted stream volume, flood peak magnitude and timing of the Upper Elbow River Watershed (UERW).

The study uses a continuous semi-distributed modelling approach based on the HEC-HMS and its Soil Moisture Accounting (SMA) module that treats water fluxes and storages based on a five-layer conceptual representation of the surface water-groundwater system. The main data required to drive the HEC-HMS models include precipitation, temperature, land cover/use, surficial geology and soil information.

The SMA parameters, such as canopy storage, surface storage, infiltration rate, percent impervious, soil percolation rate, soil storage, tension zone storage, have been derived from local data sources. The parameters which cannot be estimated with confidence from the available data including percolation rates, baseflow, are calibrated to obtain reasonable values.

For the UERW, the analysis shows significant spatial parameter variations and uncertainty. The impact of the variability within each sub-catchment is evaluated using a calibrated UERW model. This presentation summarises preliminary results of the sensitivity of streamflows at Bragg Creek gauging station as estimated with the input ranges of soil properties and groundwater parameters.

Session 2: State of the Watershed

Proof of the permanent existence and year to year flow of Confederation Creek

Daryl Wylie

Friends of Confederation Creek

The creek that flows in Confederation Park in north Calgary is the most prominent manifestation of the water in a 3400 hectare watershed that has most of its surface water buried in the municipal stormwater system. A development proposal at the lower elevation of the watershed, in the community of Highland Park planned to add 5 meters of fill to the valley bottom and 2100 condos. A mapping project was created to prove the existence of the water in all the historic tributary locations, recorded photographically and overlaid on several maps of different eras showing the city developing around and over the watershed. Base flow observations and measurements were taken over 2016 to 2018 as well. There were so many maps, air photos and pictures collected that it was decided to amalgamate the information into a Google Earth “My Places” project to promote understanding of how the watershed currently exists.

Nutrient distribution between different compartments of a wastewater-treatment effluent impacted river before and after a major flood event

Nadine Taube

University of Calgary

The relative masses of phosphorus (P) and nitrogen (N) stored in sediment, hyporheic zone, biomass, and water column of an oligotrophic river affected by wastewater treatment plant (WWTP) effluent were evaluated, along with the impacts of macrophyte growth and a major flood on sediment chemistry. Sediment stored 99% of total P and total N in a 25km long river reach. WWTPs locally increased P storage while N storage increased downstream of WWTPs for an extended spatial scale.

Epilithic algae, macrophyte biomass, and porewater contributed a small amount (<2%) to the nutrient storage in the river. The water column in the river reach seems to be an important component for N (nitrate + ammonium) storage and export whereas P is stored to a higher degree in macrophyte biomass as well as sediment porewater. Export calculations led to the conclusion that little WWTP effluent stays in the reach and most is exported with the water column. The export of nutrients by senescing epilithic algae and macrophytes is negligible in comparison to water column transport.

The 2013 extreme flood event substituted relatively nutrient-rich sediment in the urban reach with nutrient-poor sediment from upstream. The 2013 post-flood sediment N concentrations were decreased proportionately more than sediment P compared to the subsequent year of monitoring. The lower sediment N:P ratios after the 2013 flood could also have contributed to slow macrophyte re-growth post-flood. However, seasonal differences in nutrient source evidently play a more substantial role in determining aquatic biomass nutrient content than extreme hydrological events. After low to moderate magnitude floods, macrophyte biomass recovers at a rate of on average

100 g dry weight per m^2 per year. Nutrient storage analysis showed that, even with this recovery rate, macrophyte biomass did not influence the nutrient budget on a reach scale but should instead be considered for localized dissolved oxygen conditions, and benthic nutrient processing.

A fish tale gone sideways, whirling disease in Banff National Park

Colby Whelan

Department of Biological Sciences, University of Calgary

Whirling disease was discovered in fish from Johnson Lake in Banff National Park in 2016. This was the first wild infection in Canada. The causative agent is the myxozoan parasite *Myxobolus cerebralis*. Infected fish experience a deterioration of cartilage surrounding the spinal column, this decreases swimming ability and leads to an increased chance of mortality. The parasite also requires the presence of an intermediate host to facilitate transmission between individual fish. The host is a small bottom dwelling oligochaete known as *Tubifex tubifex*. The objectives of the study were to determine the extent of *T. tubifex* in several waterbodies (Johnson Lake, the Cascade and lower Spray watersheds), and whether they have predictable habitat associations. Landscape wide surveys revealed that *T. tubifex* were present in low levels in both Johnson Lake and the lower Spray watershed, however no *T. tubifex* were located in the Cascade watershed. These are the first surveys of *T. tubifex* in western Canada, and they indicate that while *T. tubifex* are not present in large numbers, they are spread across a variety of habitat types in levels sufficient to sustain *M. cerebralis* transmission amongst fish populations.

Session 3: Innovative Methods for Assessment and Management

Nitrate concentrations and isotope compositions in Pine Creek wastewater effluents and ACWA streams

Bentley Blondal, Véronique Fau and Bernhard Mayer

Applied Geochemistry Group, Department of Geoscience, University of Calgary

Stable isotope techniques are an excellent tool to identify the sources and the fate of nutrients in watersheds, provided that the isotopic compositions of nutrient end-members are well characterized and isotopically distinct. The objective of this ongoing study is to characterize the temporal variability of the isotopic compositions of nitrate in waste water effluents and to assess how this isotopic composition changes along the experimental streams in the Advancing Canadian Wastewater Assets (ACWA) facility located at the Pine Creek wastewater treatment plant (WWTP) in Calgary (Alberta, Canada). Five samples were collected weekly along 3 different effluent streams at downstream distances of approximately every 20 meters. One stream contained Bow River water only, whereas the other two streams contained either post UV or ozonated effluent (3%) mixed with Bow River water. Samples were analyzed for chemical compositions and the isotopic composition of nitrate. Nitrate concentrations in the post UV effluent stream are ~1 mg L-1 higher than the nitrate concentrations in the stream with Bow River water over the same downstream distance. The average δ15NNO3 values in both effluent streams are approximately 9.0 ‰, whereas δ15NNO3 of Bow River water was +8.1 ‰, due to effluent from the Bonnybrook WWTP. There was little

change in the δ15N values of nitrate with downstream distance in any of three streams. These results suggest that effluents from Pine Creek and Bonnybrook WWTPs are difficult to distinguish based on their δ15NNO3 values, but both these effluents are isotopically distinct from riverine nitrate upstream of Calgary.

Water quantity and quality performance monitoring at Okotoks Bioretention Research Site

Anton Skorobogatov[1], Dr. Jianxun (Jennifer) He[1], Dr. Angus Chu[1], Dr. Caterina Valeo[1], Bert van Duin[1,2], Bernie Amell[3] and Leta van Duin[4]

[1]*Department of Civil Engineering, University of Calgary*
[2]*Water Resources, City of Calgary*
[3]*Source2Source Inc.*
[4]*Alberta Low Impact Development Partnership (ALIDP)*

There is a growing interest in implementing Low Impact Development (LID) practices as part of urban stormwater management. However, the lack of context-specific performance data limits the practical application of these technologies. Bioretention is one of the most common LID practices which uses permeable soils and vegetation to reduce the runoff quantity and enhance the runoff quality through a combination of physical, chemical, and biological processes.

This presentation will focus on the performance data collected at the bioretention research facility in the Town of Okotoks during the growing season of 2018. The overarching objective of the research is to investigate the roles of bioretention media, vegetation, and their combination in the overall performance of bioretention systems. The facility consists of 24 testing beds and includes three types of bioretention media planted with three types of vegetation. A total of 25 runoff applications was simulated during the field season of 2018. Hydrologic and water quality parameters were recorded. Data showcasing seasonal and event-specific runoff volume retention, nutrient capture, and organics removal will be presented.

Evaluating effluent treatment and disposal for the town of Okotoks sewage treatment plant using the Banner At-Grade Lateral System

Angus Chu

University of Calgary

The University of Calgary, in collaboration with Banner Environmental Engineering Consultants Ltd. and the Town of Okotoks has developed a study to evaluate the application of the Banner At-Grade Effluent Dispersal System for enhancing the treatment and disposal of sewage effluent from the EPCOR-operated Okotoks wastewater treatment plant (WWTP). The pilot project will involve the use of a single perforated pressure-driven lateral to evenly distribute tertiary treated effluent from the WWTP, onto a forest located to the west of the WWTP. The main objectives of the study are to:

- Test the feasibility of using one continuous 610 m (2000 ft) Banner At-Grade distribution lateral.

- Determine evapotranspiration credits and maximum application rate for an at-grade effluent field, based on the existing configuration of the test site.
- Evaluate the effects of the Banner At-Grade technology on groundwater constituent fate and transport.

An integrated approach to fisheries restoration of a regulated creek in Banff National Park

Helen Dickinson

Parks Canada, Fisheries and Oceans Canada, TransAlta

The Minnewanka Dam in Banff National Park was constructed in 1941, forming the Lake Minnewanka reservoir and diverting the Cascade River to the TransAlta Cascade Hydro Power Plant. The dam reduced flows to 9 km of the Cascade River (now Cascade Creek) by more than 99%. Cascade Creek functions as the reservoirs' spillway for emergency flood situations and the small flow is provided by way of a riparian penstock (pipe) through the dam. The reduced flows in Cascade Creek have been insufficient to support a healthy aquatic ecosystem or maintain a wetted channel. The 2013 flood required an unprecedented emergency spillway release that further impacted channel morphology, expanding laterally into the old Cascade River substrate.

The project combines engineering and ecological sciences to design and build a downscaled habitat channel within the alignment of the former Cascade River. A 250 m long demonstration reach was completed in fall 2018 and physical works over another 5.5 km are scheduled for 2019. The channel is scaled to provide sustainable native fish habitat and downstream connectivity with the Bow River based on flows within the operating range of TransAlta's riparian penstock. The project's setting, within a flagship national park, demands an integrated approach that includes consideration of flood concerns, infrastructure capacity, recreational opportunities, public access, partner and stakeholder engagement, interpretive programming and building ecological restoration skills and capacity. I will present the project as a case study that demonstrates the need for and benefit of this multidisciplinary approach, highlighting both challenges and opportunities.

Abstracts: Poster

Application of a multi-tracer method to support the design and implementation of an adaptive monitoring program to evaluate impacts of municipal wastewater in Alberta rivers

Rajiv Neal Tanna, Michael Moncur, John Gibson

InnoTech Alberta

In order to maintain healthy aquatic ecosystems in Canada, an adaptive monitoring approach is proposed to assess effects induced by the release of municipal wastewater effluents (MWWE) into freshwater receiving environments. In order to quantify exposure in an effects-directed manner, a series of tracers were selected for characterizing exposure to MWWE in the receiving environment. Tracers included contaminants of emerging concern, metals and isotopes. Water samples were obtained across a 12km reach of the Bow River downstream of the Bonnybrook sewage treatment plant in Calgary over two sampling campaigns. Concentrations of the selected indicators was compared to other watersheds were similar tracers were quantified and assessed in the context of biological response. This analysis and cross-comparison is intended to support the establishment of limits of change in water quality which are protective of biological receptors, and inform potential future regulations and/or infrastructure upgrades within the province of Alberta.

Evaluating the impacts of episodic acidification from urban vehicle on the surface waters of Calgary, AB

Yusra Warsi and Brian Gaas

Department of Environmental Science, University of Calgary

Surface water chemistry can be affected by the deposition of metals, ions, and acids. In cold climates, such as Calgary, AB, deposited acids can accumulate in the snow pack, and be released into aquatic receptors in a relatively large pulse when the snow melts during “Chinooks”. In Calgary, the aquatic receptors that receive this snow melts are the Bow and Elbow Rivers, where a combination of snow melt diluting natural alkalinity and the additional load of acids can result in a short-term decrease in pH (episodic acidification) that is potentially harmful to aquatic organisms. In this work, the potential of acid loading from vehicle emissions from Calgary’s highways to induce episodic acidification was examined, in order to determine the plausible impacts of this phenomenon on Calgary’s surface waters. Major ion concentrations were measured in fresh snow deposited in the catchment area of a storm water pond adjacent to a busy road in Calgary. The distribution of sodium and chloride indicated a road salt source at the sampling locations whilst the nitrogen species distribution suggested that (I) urban vehicle emissions can contribute to the acid load; and (II) acid deposition can occur up to 100 m away from the source. Snow chemistry was also measured in recently deposited snow along four major roadways in Calgary. Estimated and observed nitrogen species deposition rates were consistent with reported values from vehicle emissions. However, the estimated pH of the snowmelt of 5.2 was much lower than the observed average value of 7.2, indicating the presence of acid neutralizing compounds in the snow pack. Although the acids emitted by vehicles have the potential to affect surface water quality during snowmelt, the effect on the Bow and Elbow Rivers is likely to be negligible due to the co-deposition of acid neutralizing compounds.

BRBC Science Forum
Wednesday, May 01, 2019
Ross Glen Hall, Mount Royal University

Decadal trends in flow, precipitation and snowpack loss in an unregulated eastern slope river

Yixuan Zhou[1], Cathryn Ryan[1], Jianxun (Jennifer) He[2]

[1]*Department of Geoscience, University of Calgary*
[2]*Department of Civil Engineering, University of Calgary*

Mountain regions are important water resources, supplying more than one-sixth of world's population with freshwater. The eastern slope rivers of the Rocky Mountains are particularly significant since the decreasing flows will exacerbate water supply issues, and recent urban development combined with increasing high peak flow and extreme hydrologic events may result in flooding. The Elbow River, which is located in the eastern slopes, supplies drinking water to about 50% the population of Calgary, or about 17% of the population of Alberta. Hence, Mann-Kendall's trend analyses of available meteorological and hydrometric data of was performed to detect historical trends and in the unregulated Elbow River watershed upstream from Calgary watershed. The Spearman's rho correlations were calculated between various meteorological conditions and the flow discharge of the Elbow River. Multiple linear regression analysis was conducted to investigate the relationship between peak flow, cumulative snowpack loss and precipitation in the Elbow River watershed. Most of the flow in the Elbow River that reaches Calgary, which has an average flow rate during the open water season (March to October; 1967-1995) of 7.2 m^3/s was generated in the Front Ranges and Foothills. The increased total flow volume in the upper and middle watersheds was attributed to increased total precipitation in these two subwatersheds, while increased peak flow at all three gauging stations was attributed to increased maximum 48-hour cumulative precipitation observed in all three subwatersheds. Although total snowpack loss affected peak flow to some degree, the maximum 48-hour cumulative precipitation and cumulative precipitation had the most important influence on peak flow. High peak flows (> 90^{th} percentile of all peak flows) at all three gauging stations occurred within 3 days after the maximum 48-hour cumulative precipitation. Increased overwinter baseflow was observed at the middle station, where the longest data record was available. The increased overwinter baseflow could be a response to a significant rise in both the annual precipitation and amount of snowpack available for spring melt. While increased baseflow and open water season flows bodes well for water supply at least in the near future, the increased maximum 48-hour cumulative precipitation is consistent with the observation of increasing frequency and magnitude of extreme hydrologic events.