BEATY WATER RESEARCH CENTRE

Annual Report 2020-2021

Queen's University, Kingston, Ontario, Canada

BWRC

Queen's UNIVERSITY

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DIRECTOR'S MESSAGE

Pascale Champagne, Director, 2017 - Sept. 2020:

It has been a pleasure to be the inaugural director for the Beaty Water Research Centre. Over the last three years, the Centre's team launched its first graduate diploma program in Water & Human Health, increased the number of research faculty actively engaged within the Centre, trained over 100 Highly Qualified Professionals (HQPs), launched the Canadian Algae Research Technology Network, and most recently it is my pleasure to announce the launch of the Contaminants of Emerging Concern – Research Excellence Network. This new network will house researchers affiliated with the Centre who are actively engaged in research related to emerging contaminants in the built and natural environment that pose great environmental and human health risk. The Network will be launched in September 2021, and I will take on the role of Scientific Director for the initiative. The Network already has several research activities funded through provincial and national initiaves. Stay tuned for announcements of these initiatives this summer.

Pascale Champagne, Ph.D., P.Eng., D.WRE, F.EWRI, F.ASCE, F.CAE
Director, Beaty Water Research Centre
Queen's University

INTERIM DIRECTOR'S MESSAGE

Kent Novakowski, Interim Director, Sept. 2020- Present:

The Beaty Water Research Centre has seen tremendous growth under the leadership of Dr. Champagne, and I would like to thank her for her vision and effort. As the interim director, I'm looking forward to working with the researchers who have been long-time members of the former Water Research Centre, as well as the new members who have joined over recent years.

As the Interim Director, my focus will be to ensure continued success of the Centre's research activities, assist in the search for a new permanent Director for the Centre, and provide my support and guidance for transitioning the Educational Diploma Programs to an academic home where they can thrive.

I look forward to working with our researchers and graduate students over the next year and seeing the initiatives undertaken by Dr. Champagne begin to take root.

Kent Novakowski, Ph.D., LEL, PGeo, FCSCE, FEIC
Associate Vice-Principal (Research), Interim Director, Beaty Water Research Centre
Queen's University

VISION

The BWRC aims to be a world-class entity for collaborative research and education in the multifaceted realm of water-related issues for the Queen's University and Royal Military College of Canada (RMC) communities.

MISSION

BWRC will develop and support opportunities in research, education, collaborations and international partnerships related to water. We are committed to fostering an environment that encourages collaborative research, excellence in teaching and the development of unique multidisciplinary approaches.

VALUES

Collaboration

Through national and international collaboration with experts and communities, BWRC strives to build partnerships that advance our mandate.

Interdisciplinary

Our membership includes complementary disciplines from engineering, natural, health and social sciences, law and policy studies, to achieve advancements.

Discover

We contribute to debate, development and dissemination of knowledge and innovations in research and education.

Innovation

We develop technology that enhances human and ecosystem health and supports the delivery of education and outreach.

Excellence

We demonstrate excellence through the delivery of programs and contributions to knowledge recognized globally.

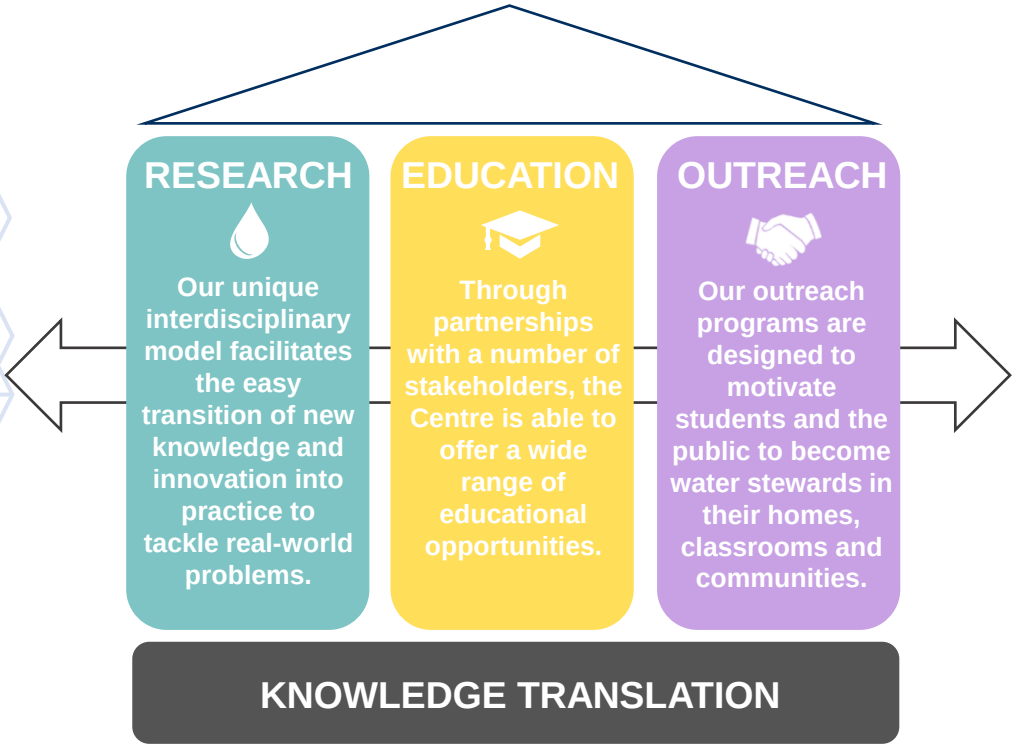
Respect (EDI)

We recruit researchers and HQP from equity seeking groups and empower them to participate by offering training and support.

OVERVIEW

The Beaty Water Research Centre (BWRC) is an interdisciplinary research and education Centre at Queen's University. We welcome collaborations with researchers, educators, policy makers, industry and communities on activities related to water access, resources, quality and use. Our research faculty are leaders in engineering, chemistry, biology, geology, geography and planning, health, computing and data analytics, business, law and policy.

As part of the Centre's Education and Outreach mandate, BWRC develops strong partnerships with academic departments, industry, school boards, public health units and local water conservation authorities. Through these partnerships, we offer educational opportunities and internships across various disciplines for students, the public and professionals. In fall 2019, the BWRC launched the first of a number of accredited online diploma programs. Courses offered through the BWRC bridge the gap between disciplines, theory and real-world applications for all students, providing graduates with a competitive edge in their chosen field.



OUTCOMES

EDUCATION	**Interdisciplinary** Graduate Diploma Programs offer courses that span multiple disciplines, providing students an advantage in today's workforce.	**Synergy & Collaboration** Cross disciplinary collaborations in the delivery of programs providing learning opportunities that allow broad application of knowledge.	**Networking Opportunities** Our programs allow students to network with a wide variety of stakeholders, providing them with a kick start to their career.	**Skill Building & Future Workforce** Our programs help students build practical and professional skills to prepare them to become capable STEM employees.	**KNOWLEDGE TRANSLATION** We train our students to effectively translate knowledge from research findings to a broad audience.
RESEARCH	**Enhanced Water Quality & Access** Interdisciplinary collaborations leading to the development of methods and innovation that improve water access and quality.	**Innovation in Water Treatment Systems** New technologies developed leading to improved water treatment systems and biosustainability.	**Sustainable Infra-structure Implemented** Natural and built infrastructure improvements implemented in response to climate change.	**Influence Environmental Policy & Law** Policies and innovations developed and implemented to improve water governance, use, resources and quality.	Through interdisciplinary collaborations, research knowledge is easily translated into action through implementation of innovation and policy development.
OUTREACH	**Inform & Empower** Informing and empowering the community leading to changing behavior related to water quality and sustainability.	**Engagement for Collaborative Change** Informing and educating motivating students and the public to become water stewards in their homes, classrooms and communities.	**Align Activities with Knowledge Gaps** Stakeholder consultations leading to alignment of activities with knowledge gaps.	**Change Implemented** Implement knowledge and innovation by working with conservation authorities, industry, health units and municipal, provincial and federal government.	Our outreach events improve the flow of communication between researches, professionals, policy makers and the public to influence and implement change.

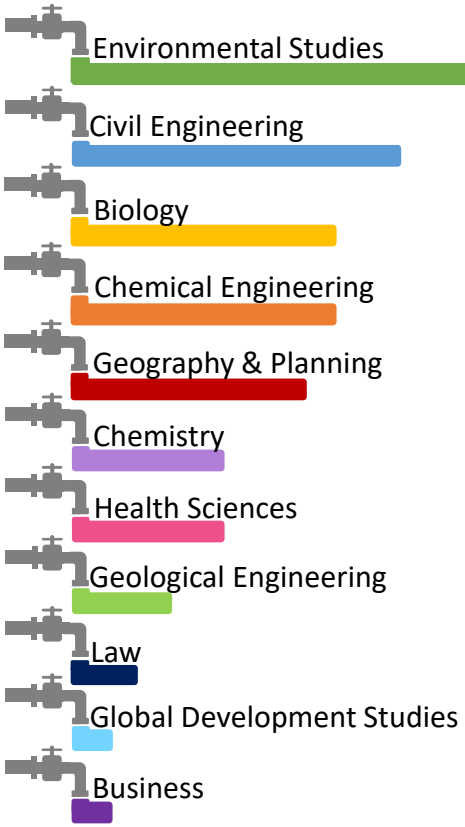
FACILITIES

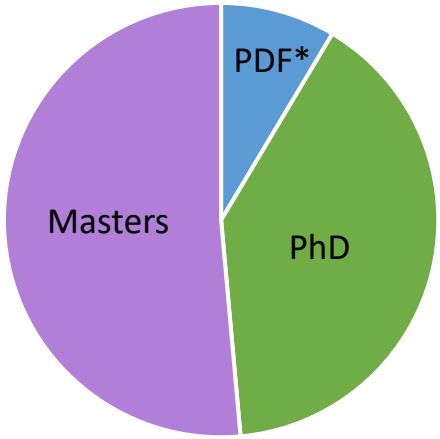
The Centre is located in a new state-of-the-art facility in Mitchell Hall at Queen's University in Kingston, Ontario. The Centre also has a strategic network of affiliated field and large-scale facilities that include:

- Queen's Coastal Engineering Lab
- Queen's Biological Station
- Kennedy Field Station
- Tay River Groundwater Network
- Loyalist Township Constructed Wetland
- Cape Bounty Arctic Watershed Observatory (CBAWO)

YEAR BY NUMBERS

88 Publications
61 Research Projects
5 Virtual Lectures/Seminars
1 Virtual Conference





*Postdoctoral Fellows

3 Faculties

1) Faculty of Applied Science and Engineering
2) Faculty of Arts and Science
3) Faculty of Health Sciences

11 Disciplines

66 Faculty

94 Students

RESEARCH HIGHLIGHTS

This year, we expanded collaborations with faculty from various disciplines at Queen's, the Royal Military College of Canada and external academic institutions at national and international levels. Our research links to industry and non-profit organizations including conservation authorities, school boards and public health units. This year's highlights include:

Stephen Brown and Sarah Jane Payne received over $500,000 from Ministry of the Environment, Conservation and Parks (MECP) to participate in a province wide Wastewater Surveillance Initiative (WSI) to detect SARS-CoV-2 in wastewater.

Sarah Jane Payne and Yves Filion established the Queen's Drinking Water Quality Group and partnered with the City of Calgary for a successful NSERC Alliance Grant ($450,000) that will investigate and characterize water quality degradation risks in Canadian water distribution systems.

Pascale Champagne received a Mitacs Accelerate ($180,000), in partnership with the Myera Group, that will investigate Agri-food processing opportunities for Indigenous farmers: optimization of fish waste fertilizer sourced from local integrated multi-trophic aquaculture (IMTA) operations.

NSERC CREATE Leaders in Water and Watershed Sustainability program (QU - $1.65 million), is currently supporting 20 HQP.

Co-applicants of the NSERC CREATE training program in Persistent, Emerging and Oil Pollution in Cold Marine Environments ($1.65 million - QU $81,000).

Several BWRC affiliated faculty received funding from the Queen's University Wicked Ideas Opportunity including: Pascale Champagne, Laurence Yang, Philip Jessop, Graeme Howe, Diane Orihel and Cathleen Crudden.

The Beaty Water Research Centre was a Finalist for the Canadian Museum of Nature, Nature Inspiration Award (Not-for-profit, Large Category).

Hosted LEADERS Virtual Symposium with the NSERC CREATE training program in Persistent, Emerging and Oil Pollution in Cold Marine Environments (PEOPLE Network).

Attendance of >125 Faculty, Staff and HQP's for across Canada for two days of keynote lectures, adjudicated student presentations and roundtable discussions on "hot button topics".

$$$

Projects associated with the Centre generated approximately **$20 million** in research revenue.

Faculty affiliated with the Centre led **61 research projects** that aligned with activities addressing the mandate of the Centre.

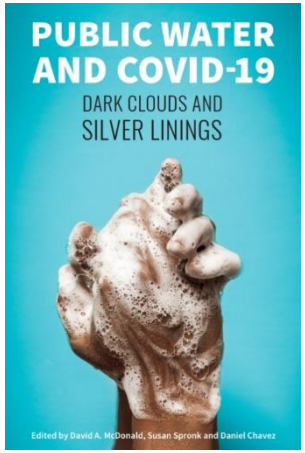
Centre affiliated research generated approximately **88-peer review publications**.

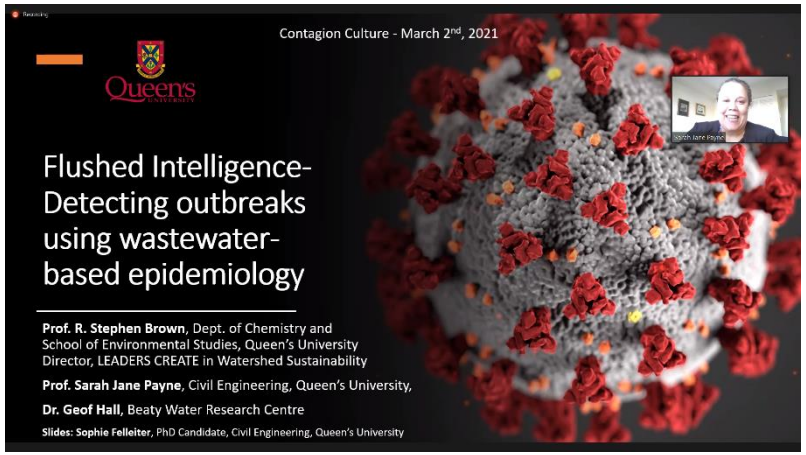
COVID-19

In response to the COVID-19 pandemic, the Centre made it a priority for staff, faculty and students to follow the advice of the Public Health Agency of Canada, and has continued its research, education and outreach initiatives with limited access to our laboratory and administrative spaces. This has reduced the numbers of graduate students recruited during the pandemic and therefore, the number of HQP's supported. Publications have seen only a slight decrease.

Although our activities were curtailed, BWRC has taken the lead in supporting provincial and national surveillance programs of research to track and predict COVID-19 outbreaks through wastewater-based epidemiology. We have done this by forming a collaboration with Queen's, KFL&A Public Health, Utilities Kingston and other municipal agencies, and have initiated the development of methods to detect the virus in wastewater samples. The Centre has also supported local health laboratories by providing them with the use of essential analytical laboratory supplies and equipment. Additionally, several of our affiliated faculty have been successful in obtaining funding for COVID-19 related research, have published related findings and have provided real-time knowledge mobilization through seminars to wider audiences.

David McDonald recently presented in the Contagion Culture series for his book: "Public Water and COVID-19: Dark Clouds and Silver Linings."





Stephen Brown, Sarah Jane Payne and Geof Hall recently presented in the Contagion Culture series on the wastewater-based epidemiology for COVID-19

COVID-19

Title	Program	Investigators	Departments	Funding
The Wastewater Surveillance Initiative for SARS-CoV-2 at Queen's University	Ministry of the Environment, Conservation and Parks	Stephen Brown, Sarah Jane Payne	Chemistry, Environmental Studies, Civil Engineering	$586,356
SARS-CoV-2 transmission and immunity on the Queen's University campus - Canada's COVID-19 Immunity Task Force	Government of Canada	Anne Ellis, Stephen Vanner, Prameet Sheth	Medicine, Biomedical and Molecular Sciences	$223,161
Developing Multiplexed COVID-19 Diagnostic Methods for Medical Surveillance	NSERC Alliance COVID-19	Zhe She, Prameet Sheth, Richard Oleschuk	Chemistry, Biomedical and Molecular Sciences	$50,000
The application of metabolomics to enhance detection of COVID-19 & predict disease severity: A proof-of-principle study	Southeastern Ontario Medical Organization	Prameet Sheth, Stephen Vanner	Biomedical and Molecular Sciences $	$30,000
Coronavirus infection of the ocular mucosa to model infection and systemic immunity	Southeastern Ontario Medical Organization	Martin Petkovich, Drs. Rullo and tenHove	Biomedical and Molecular Sciences, Ophthalmology	N/A
Developing, validating, and implementing a portable diagnostic prototype (COVID-19 Scanner) for rapid, point-of-care detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from nasopharyngeal swabs	Queen's COVID-19 Rapid Response	Aristides Docoslis	Chemical Engineering	N/A
Creating an integrated policy response to facilitate Canadian recovery from COVID-19	Queen's COVID-19 Rapid Response	Warren Mabee	Policy Studies	N/A

NATURE INSPIRATION AWARD

In September 2020, the Beaty Water Research Centre was recognized as a Finalist for the 2020 Nature Inspiration Awards in the Not-for-profit (Large) Category. The Nature Inspiration Awards recognize individuals and organizations whose specific projects encourage Canadians to take an interest in natural history, create links with nature and contribute to its preservation.

Finalists receive national recognition through different media, including; press releases, advertisement in The Globe and Mail and The Walrus, social media exposure, brochures and the Nature Inspiration Awards website.

We were honored to be recognized this year, particularly in the same category as the David Suzuki Foundation.

AWARDS

2021 Ontario Professional Engineers Engineering Medal for Research and Development: Michael Cunningham (Fig. 3)

2021 Thieme Chemistry Journals Award: Graeme Howe

2020 John Charles Polanyi Prize: Graeme Howe

2020 Nature Inspiration Awards Finalist (Not-for-profit Organization): BWRC Team

2020 Canada's Massey Medal: John Smol (Fig. 4)

2020 Queen's Prize for Excellence in Research: Michael Cunningham

Federation of Canadian Municipalities, 2020 Sustainable Community Award (Water): Loyalist Township (Fig. 1)

Fellow of the Canadian Academy of Engineering: Michael Cunningham

2020 Queen's Engineering Outstanding Thesis: Cole Van De Ven (former PhD student of Kevin Mumford's)

2020 Queen's Distinguished University Professors: John Smol

LEADERS & PEOPLE Virtual Symposium:
1st Eden Hataley (MES Candidate): *Assessing the sorption of the cyanotoxins microcystins to microplastics* (Fig. 2)
Runner up: Max Robinson (MASc Candidate): *Sediment Dynamics in a mixed primarily gravel cobble stream (The Salmon River, Ontario, Canada)*

Fig. 1

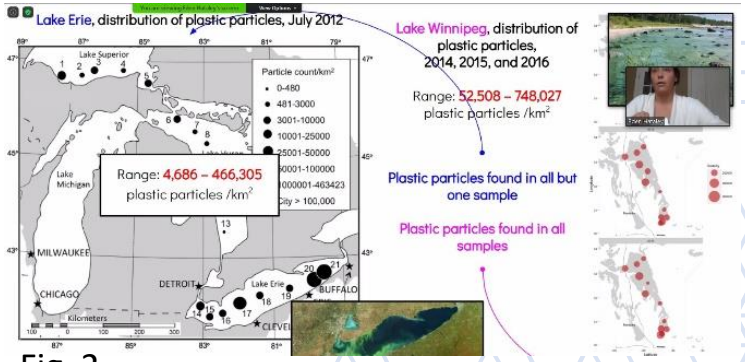


Fig. 2


Fig. 3


Fig. 4

LEADERS CREATE

The LEaders in wAter anD watERshed Sustainability (the LEADERS) program is lead by Dr. Stephen Brown, Associate Professor in the Department of Chemistry and School of Environmental Studies. The program is funded ($1.65M over six years) through the NSERC Collaborative Research and Training Experience (CREATE) and was launched in 2018.

This year we recruited an additional 6 HQPs through a competitive application process for a total of 21 graduate students and postdoctoral fellows from the Departments of Civil Engineering, Biology, Environmental Studies and Geography and Planning.

2020-2021 STUDENT PROJECTS

Student	Program	Supervisor(s)	Department	Project
Julianah Adediji	PhD	Neal Scott	Geography & Planning	Landscape control on soil organic matter quality in High Arctic
Zoe Armstrong	MSc	Brian Cumming	Biology	Ecological impacts of long-term mercury and heavy metal exposure in the Cornwall waterfront
David Blair	PhD	Pascale Champagne, Stephen Brown	Civil Engineering	"Real time“ detection and quantification of indicator organisms for source water protection
Jeffrey Cederwall	PhD	Diane Orihel	Biology	Understanding the ecological impacts of diluted bitumen in freshwater lakes and their watersheds
Francois Daudelin	MASc	Pascale Champagne, Warren Mabee	Civil Engineering	Transient heat flux models for uncertainty based waste stabilization pond design
Anbareen Farooq	PhD	Kela Weber	Chemistry and Chemical Engineering - RMC	The fate and effect of silver nanomaterials on subsurface wetland mesocosms

2020-2021 STUDENT PROJECTS

Student	Program	Supervisor(s)	Department	Project
Matthew Fyfe	MASc	Pascale Champagne	Civil Engineering	Microalgae to treat wastewater and emerging contaminants
Stephanie Graves	PDF	Diane Orihel	Biology	Testing the use of novel stable isotope tools to manage nutrient inputs
Lauren Halliwell	MASc	Pascale Champagne	Civil Engineering	Modelling wastewater stabilization ponds in the face of climate change
Eden Hataley	MES	Diane Orihel, Xavier Ortiz Almirall	Environmental Studies	Can microplastics act as a medium to concentrate waterborne microcystins?
Madeleine Kelly	MES	Anna Majury, Stephen Brown, Paul Hynds	Environmental Studies	Investigation of the levels of antimicrobial resistance in private well water derived *E. coli* in southeastern Ontario
Sarah Lavallee	PhD	Anna Majury, Stephen Brown, Paul Hynds	Environmental Studies	Exploring the knowledge, attitudes and practices of current well water stewardship in rural Ontario communities: Implications for drinking water vulnerability and public health risks
Tessa Latchmore	PhD	Anna Majury, Stephen Brown, Paul Hynds	Environmental Studies	Development of a QMRA for private well users in Ontario
Katherine Moir	PhD	Brian Cumming	Biology	Cumulative impacts on algal assemblages in Lake St. Francis: The importance of multiple stressors
David Patch	PhD	Kela Weber	Chemistry and Chemical Engineering - RMC	Release of silver nanoparticles from commercial products into the water cycle

2020-2021 STUDENT PROJECTS

Student	Program	Supervisor(s)	Department	Project
Max Robinson	MASc	Ana da Silva, Geof Hall	Civil Engineering	Sediment dynamics and growth/decay of biofilms in a mixed primarily gravel-cobble stream
Ioan Petculescu	MES	Anna Majury, Stephen Brown, Paul Hynds	Environmental Studies	Assessing the relationship of Total Coliform to *E. coli* in the context of drivers of microbial contamination of drinking water wells in Ontario
Matthew Senyshen	MSc	Dongmei Chen	Geography and Planning	Land use and climate change impacts on water temperature in the St. Lawrence River Watershed
Paisley Thomson	PhD	Valérie Langlois	Water Sciences - INRS	The effects of chronic exposure to agricultural retention pond water in amphibians
Baris Uzel	MSc	Neal Scott	Geography & Planning	The effect of winter warming on nitrogen transformation rates in High Arctic soils

Participating Institutions

Queen's University

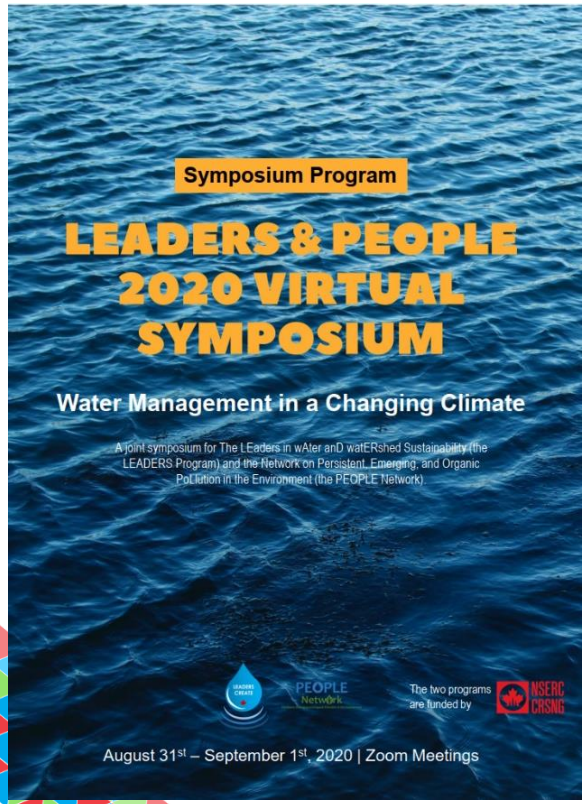
Ryerson University

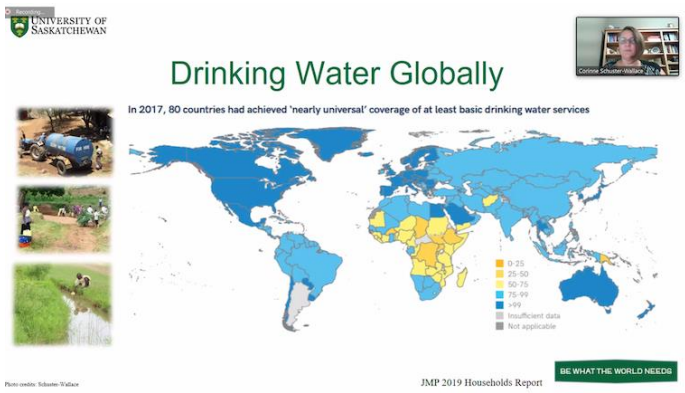
INRS Institut national de la recherche scientifique

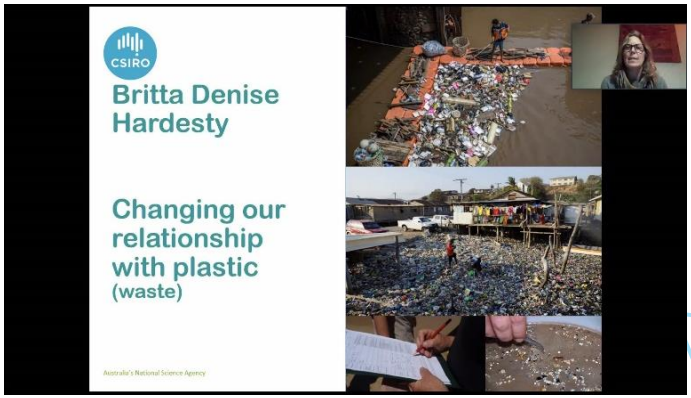
RMC CMR

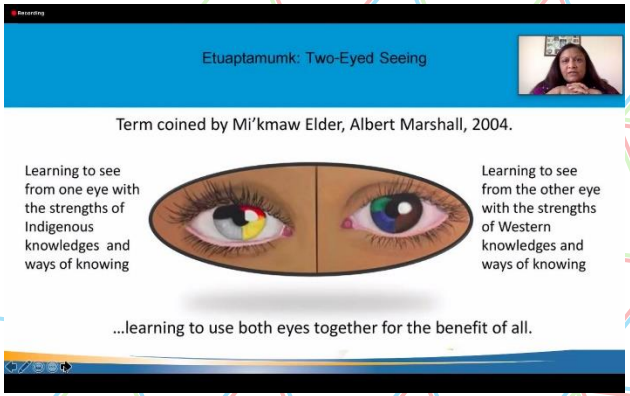
LEADERS CREATE VIRTUAL SYMPOSIUM

The LEADERS Program collaborated with the Network on Persistent, Emerging, and Organic PoLlution in the Environment (PEOPLE), an NSERC CREATE program led by Dr. Bing Chen at Memorial University, to host a Virtual Symposium, “Water Management in a Changing Climate.” The symposium examined issues arising from persistent, emerging and organic pollutants, that pose ecological and health risks due to their persistent, toxic, carcinogenic and/or bio-accumulative properties and associated long term ecological and health risks. The Symposium featured keynotes from Dr. Denise Hardesty and Dr. Corinne Schuster-Wallace, over 30 presentations from graduate students at participating institutions and round-table discussions on a range of topics including Indigenous engagement in research and training.









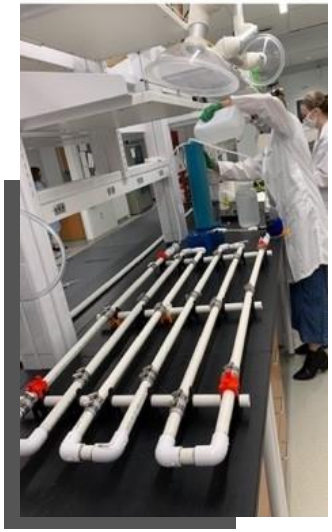
RESEARCH HIGHLIGHT – DRINKING WATER QUALITY GROUP

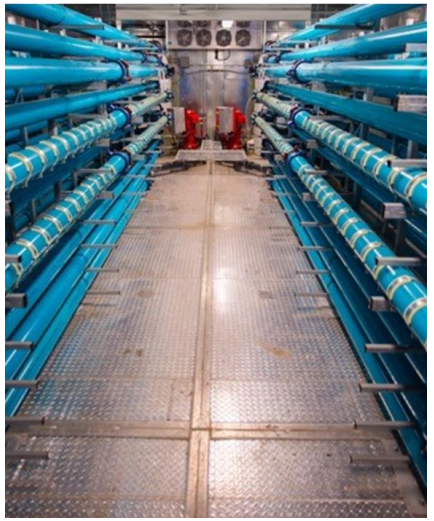
Drinking Water Quality Group
QUEEN'S UNIVERSITY

The Centre's portfolio focusing on contaminants of emerging concern will become a research excellence Network in 2021. As part of that portfolio, Drs. Filion and Payne have launched their Drinking Water Quality Group. This Group will focus on examining the factors and mechanisms that lead to poor water quality in drinking water systems and on developing innovative technologies and best practices to protect drinking water in Canadian systems. Research themes of this group will include:

- Metal accumulation and release in drinking water distribution systems
- Role of hydrodynamic forces and water quality in distribution systems in establishing biofilm properties (strength, microbial composition)
- Impact of antibiotics and metals in developing resistance in drinking water biofilms
- Effectiveness of disinfection technologies and operational best practices on controlling antibiotic resistance in drinking water systems
- Impact of water quality changes on downstream infrastructure
- Lead and copper corrosion control
- Accumulation and release mechanisms (microbiological, chemical, physical) for inorganic contaminants in premise plumbing

Leaders of the DWQG, Drs. Yves Filion and Sarah Jane Payne from Civil Engineering





Laboratory facilities in the BWRC (left) and Drinking Water Distribution Laboratory (right)

RESEARCH HIGHLIGHT – WICKED IDEAS

The Wicked Ideas Program at Queen's provides seed funding for interdisciplinary, high-risk, high-reward research that has the potential to make lasting and long-term positive change. As part of this initiative, the Centre's research faculty successfully received funding for the following two major research projects.

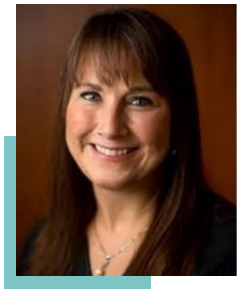
Reducing the Greenhouse Gas Burden of Livestock by Harnessing Carbon-Neutral Algae to Produce Milk - $75,000

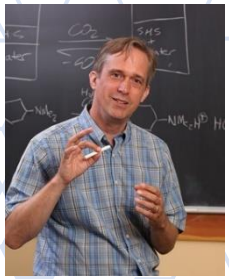
Principal Investigators: Pascale Champagne, Laurence Yang
Co-Applicants: Martin Petkovich, Graeme Howe, Cao Thang Dinh, George diCenzo, Philip Jessop

Solving the Water-Removal Bottleneck in Sustainable Chemistry- $75,000

Principal Investigators: Philip Jessop, Graeme Howe
Co-Applicants: Cao Thang Dinh, Warren Mabee

These two studies will provide innovative solutions to the reduction of greenhouse gases in the environment.





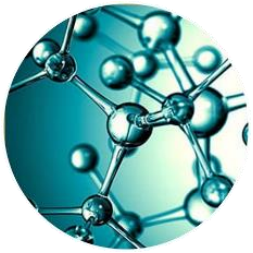
EDUCATION

The Water & Human Health diploma was launched last year. This program is designed to give recent graduates and professionals an enhanced understanding of the role that water plays in driving health outcomes and ultimately, the sustainability of populations and communities. In its first year, the program recruited two cohorts of students who will continue until completion. To support expansion of the education program, the Centre is in discussions related to transitioning this diploma program and other education and outreach programs into a new academic home. The transition of this program into an academic unit will provide the program with a framework for continued success.

To learn more about the Water & Human Health Diploma, which contains four unique courses, visit our website:

COURSES

Watershed Hydrology



Chemistry & Biology of Natural Waters

Water Policy & Governance

Water & Human Health

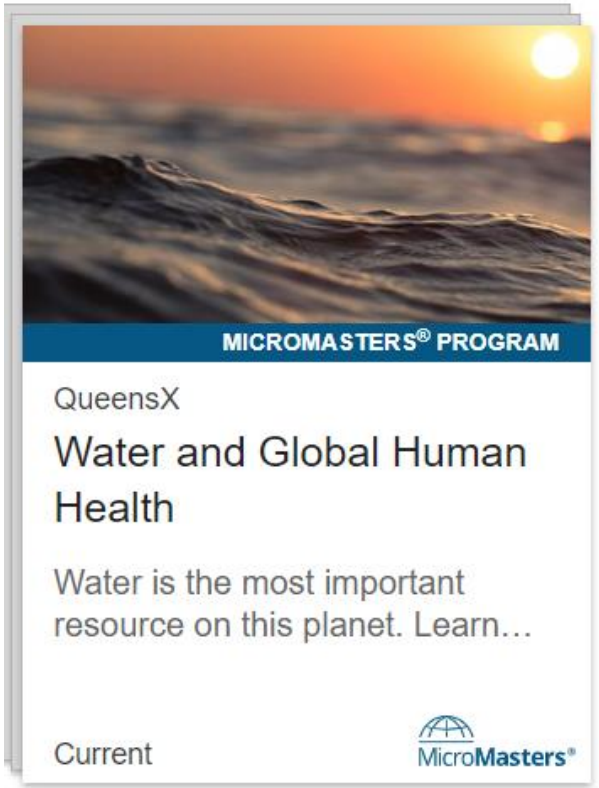
https://waterresearchcentre.ca/whh-about/

EDUCATION

To support universal access to education, we have created a subset of our diploma courses for free participation through the edX platform. edX is an online platform for education and learning founded by Harvard and MIT. It currently hosts over 20 million learners, many top-ranked universities worldwide and various industry-leading companies. edX removes many of the traditional barriers to education including cost, location and access.

The BWRC offers a MicroMasters® program through edX, “Water and Global Human Health,” which consists of 6 graduate level courses taken over approximately 6 months. These courses are also available as stand alone offerings:

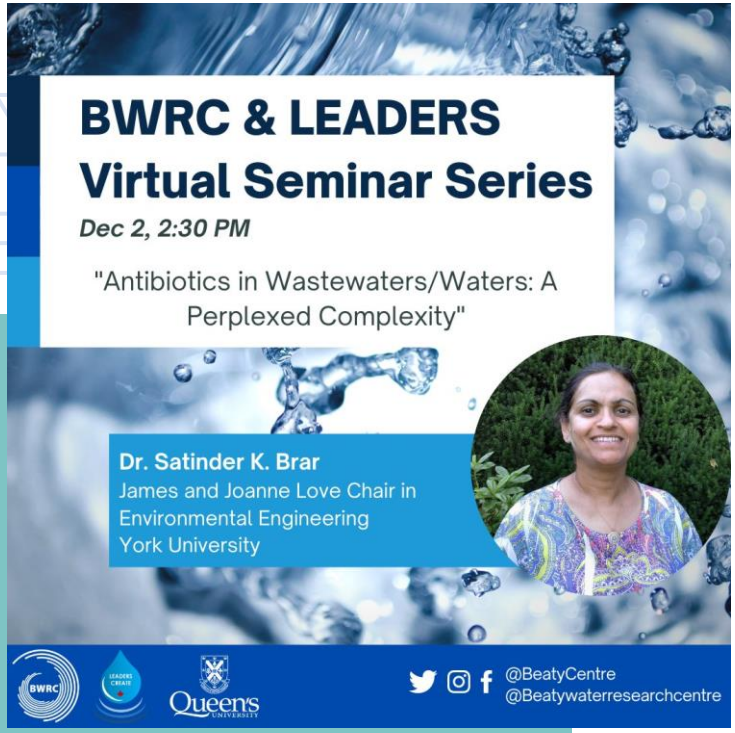
1. Water on Earth: An Introduction
2. Opportunities in Water and Health
3. Water Related Health
4. Global Water Use and Climate Change
5. Modelling Watershed Processes for Water Resource Management
6. Watershed Systems and Their Influence on Water Movement and Quality

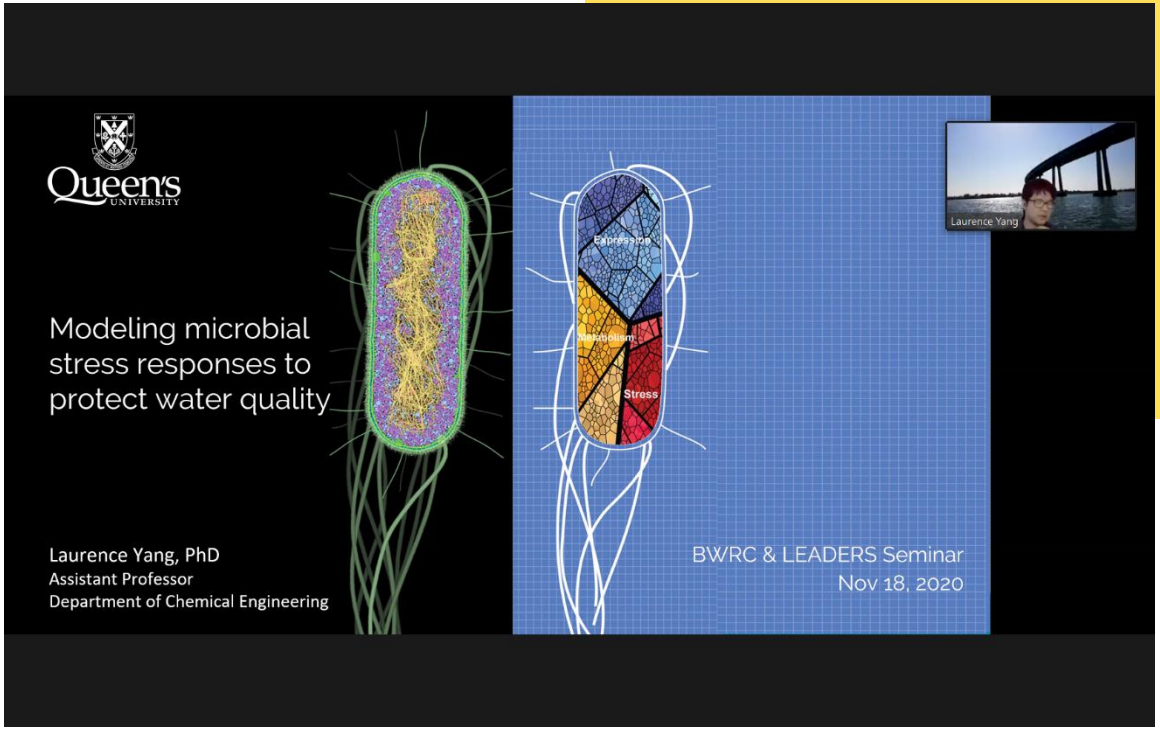


https://www.edx.org/school/queensx

VIRTUAL SEMINAR SERIES

In September, the BWRC and LEADERS program transitioned their monthly Seminar Series to a virtual format. This year, we focused on encouraging our new affiliated research faculty to present including; Drs. Sarah Jane Payne, Laurence Yang, Graeme Howe and Prameet Sheth. This is an excellent way for new faculty to introduce themselves and their research to students and other researchers within the Centre, to spark the beginnings of interdisciplinary collaboration.





Dr. Laurence Yang, a new faculty member with Queen's Department of Chemical Engineering. Dr. Yang joined the BWRC in winter 2020.

ADMINISTRATIVE STAFF

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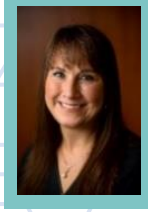
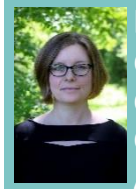
ADVISORY BOARD

The Centre is governed by an Advisory Board. This board was established in 2019 and its members provide representation from the Queen's Faculty of Engineering and Applied Science, Faculty of Arts and Science, Faculty of Health Sciences, industry and community organization members.

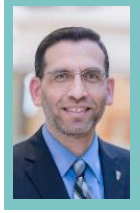
Chair
David Carnegie
Industry Partner, Malroz Engineering Inc.



Pascale Champagne
Director BWRC



Holly Evans
Community Partner, Cataraqui Region Conservation Authorities



Amir Fam
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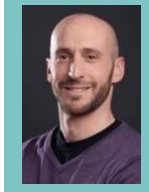
Geof Hall
Associate Director BWRC, Education and Outreach

Jyoti Kotecha
Associate Director BWRC, Research and Business Development

Anastasia Lintner
Community Partner, Lintner Law

Nicholas Mosey
Associate Dean (Research), Faculty of Arts and Science

Kent Novakowski
Associate Vice Principal (Research), Office of Vice-Principal (Research)



Steven Smith
Director of Research, Faculty of Health Sciences

Bruce Anderson
Professor Emeritus,
Civil Engineering

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Professor, Biology

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Associate Professor,
Civil Engineering

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Professor, Civil
Engineering

Stephen Brown
Associate Professor,
Chemistry

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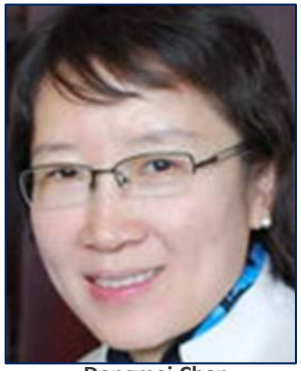
Adjunct Professor,
Biology

Pascale Champagne
Professor, Civil
Engineering



Dongmei Chen
Professor, Geography
& Planning

Brian Cumming
Professor, Biology

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& Molecular Sciences

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Environmental Studies

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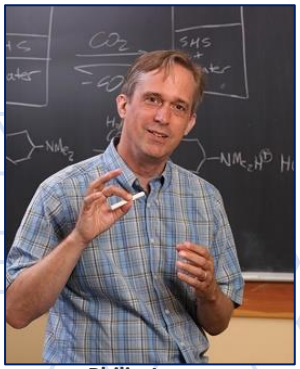
Engineering



Philip Jessop
Professor, Chemistry

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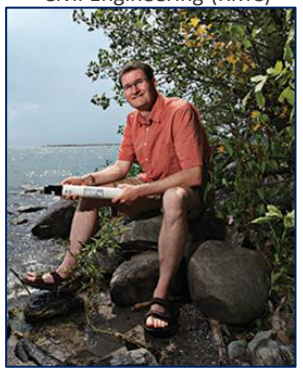
Bernard Kueper
Professor, Civil
Engineering

Melissa Lafrenière
Associate Professor,
Geography & Planning



Scott Lamoureux
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Professor, Biology

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Steven Liss
Professor,
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Steve Lougheed
Professor, Biology

Kristin Lowitt
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Warren Mabee
Professor, Geography
& Planning

Anna Majury Assistant
Professor, Biomedical &
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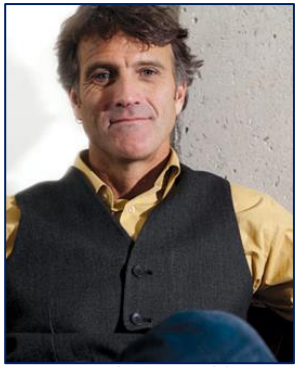
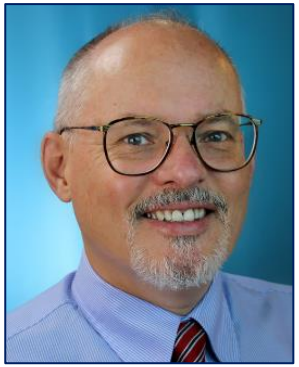


David McDonald
Professor, Global Development Studies

James McLellan
Professor, Chemical Engineering

Louise Meunier
Assistant Professor, Chemical Engineering

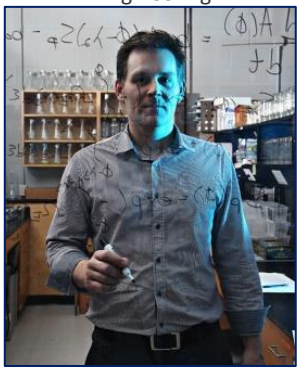


Kieran Moore
Professor, School of Medicine

Steven Moore
Adjunct Professor, School of Business

Ryan Mulligan
Associate Professor, Civil Engineering

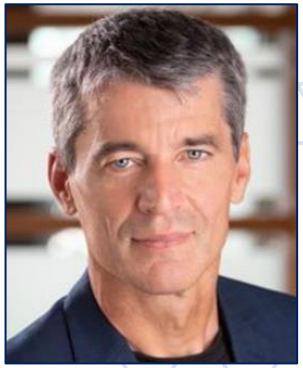
Kevin Mumford
Associate Professor, Civil Engineering



Bill Nelson
Associate Professor, Biology

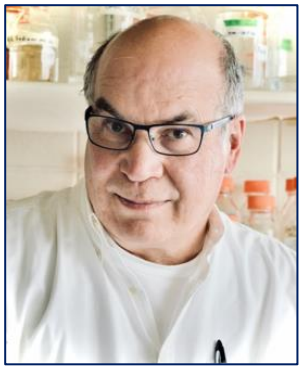
Kent Novakowski
Professor, Civil Engineering

Diane Orihel
Assistant Professor, Biology



Bruce Pardy
Professor, Law

Sarah Jane Payne
Assistant Professor, Civil Engineering



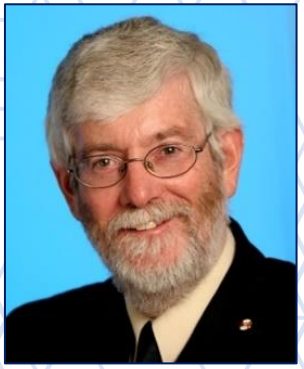
Martin Petkovich
Professor, Biomedical & Molecular Sciences

Ugo Piomelli
Professor, Mechanical & Materials Engineering

Juliana Ramsay
Professor, Chemical Engineering

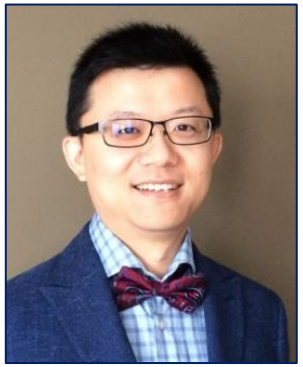
Victoria Remenda
Associate Professor, Geological Engineering

Mark Rosenberg
Professor, Geography & Planning



Kerry Rowe
Professor, Civil Engineering

Neal Scott
Associate Professor,
Geography & Planning



Zhe She
Assistant Professor,
Chemistry

Prameet Sheth
Assistant Professor,
Pathology

John Smol
Professor, Biology

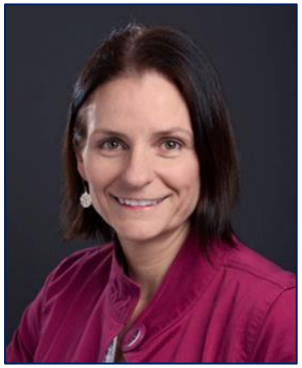
Bruce Tufts
Professor, Biology

Bas Vriens
Assistant Professor,
Geological Engineering

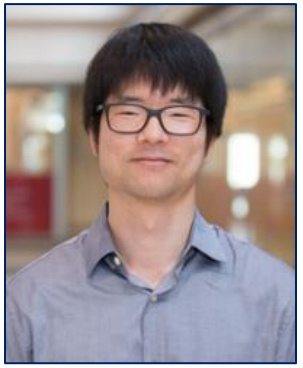
Yuxiang Wang
Associate Professor,
Biology

Kela Weber
Associate Professor,
Chemical Engineering (RMC)

Graham Whitelaw
Associate Professor,
Environmental Studies



Louise Winn
Professor, Biomedical
and Molecular Sciences



Laurence Yang
Assistant Professor,
Chemical Engineering

Barb Zeeb
Professor, Chemical
Engineering (RMC)

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Leaders in wAter anD watershed Sustainability (The LEADERS Project)	Stephen Brown	$1.65 million over 6 years	NSERC CREATE
Methods for Automated Detection of Bacteria in Drinking Water	Stephen Brown	$200,000	TECTA-PDS
The Wastewater Surveillance Initiative for SARS-CoV-2 at Queen's University	Stephen Brown, Sarah Jane Payne	$586,356	Ministry of the Environment, Conservation and Parks
Wholly Green: Sustainability Through a Systems Approach	Pascale Champagne Michael Cunningham Philip Jessop Warren Mabee	$250,000	NSERC Brockhouse Prize
Persistent, Emerging, and Oil PoLlution in cold marine Environments (PEOPLE CREATE Training Program)	Bing Chen Pascale Champagne - Queen's lead	$1.65 million over 6 years	NSERC CREATE
Wastewater Treatment Systems under Changing Climate	Pascale Champagne	$43,490	NRC New Beginnings
Wastewater Treatment with Native Microalgal-Bacterial Consortia from the Ecuadorian Amazon, Andean Region and Galapagos Islands	Pascale Champagne	$15,000	Universidad San Francisco de Quito (USFQ) Collaboration Grants

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Biogeocementation of a Coal Mine Tailings Pond	Pascale Champagne	$20,000	Mitacs Accelerate BGC Inc.
Photosynthetically-Enhanced Eco-Engineered Treatment Systems	Pascale Champagne	$594,000	NSERC Discovery
Intersectorial Centre for Endocrine Disruptor Analysis	Valerie Langlois, Pascale Champagne	$300,000	Institut National de la Recherche Scientifique (INRS) Regroupements de Recherche Émergente
Reducing the GHG Burden of Livestock by Harnessing Carbon-Neutral Algae to Produce Milk	Pascale Champagne, Laurence Yang	$150,000	Queen's University Wicked Ideas Funding Program
Agri-food processing opportunities for Indigenous farmers -Optimization of fish waste fertilizer sourced from local integrated multi-trophic aquaculture (IMTA) operations	Pascale Champagne	$180,000	Mitacs Accelerate Myera Group
Paleolimnology and Environmental Change	Brian Cumming	$240,000	NSERC Discovery
Role of Climate Change and Fire on the Landscape of Cape Breton Highlands National Park	Brian Cumming	$112,000	Collaborative Research Agreement

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Developing new, real-time, community-based environmental DNA protocols for assessing freshwater ecosystem health	Brian Cumming, Dongmei Chen, Stephen Lougheed, Shelley Arnott	$249,614	New Frontiers in Research Fund – Exploration
Meandering Morphodynamics and Related Fluvial Processes	Ana Maria da Silva	$215,000	NSERC Discovery
Electro-bio hybrid system for sustainable fuel and chemical production	George Colin diCenzo	$63,000	Queen's FEAS, Dean's Research Fund
Electrode engineering for carbon dioxide electroreduction to fuels and chemicals	Cao Thang Dinh	$165,000	NSERC Discovery Grant
Electrochemical CO2 conversion to fuels and chemicals	Cao Thang Dinh	$125,000	CFI-JELF
Electrochemical production of ethylene from CO2	Cao Thang Dinh	$25,000	Imperial Oil University Award
Hybrid Graphene-Metallic Optofluidic Nanostructures for the Point-of-Care Detection of Illicit Drugs and Biological Agents	Carlos Escobedo	$140,000	NSERC
Microtechnology-based models of human organs and bacteria-based bio-robots for treating gynecologic cancer and infertility after cancer survival	Carlos Escobedo	$150,000	Government of Ontario

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Investigating and Characterizing Water Quality Degradation Risks in Canadian Water Distribution Systems	Yves Filion, Sarah Jane Payne	$450,000	NSERC Alliance City of Calgary
Using Real-time, Continuous, and High-Frequency Water Quality Data to Develop Early Warning Systems for Water Security in the Great Lakes	Yves Filion	$1 million	NSERC Alliance
Energy Cost Savings in Canadian Water Distribution Systems Through Data Analytics	Yves Filion	$258,000	NSERC Discovery
Examining the Mechanisms for Antibiotic Resistance Development in Drinking Water Systems	Yves Filion	$20,000	Way Memorial Trust Award
Tracing enzyme mechanisms across evolution to elucidate the origins of enzymatic catalysis	Graeme Howe	$157,500	NSERC Discovery and Discovery Launch Supplement
Solving the water-removal bottleneck in sustainable chemistry	Philip Jessop, Graeme Howe	$150,000	Wicked Ideas/ Queen's University
The Development of CO2-Switchable Polymers as Draw Solutes for Forward Osmosis	Philip Jessop	$60,000	Mitacs Accelerate Forward Water Technologies
CO2-Triggered Draw Agents for Forward Osmosis	Philip Jessop	$552,740	NSERC

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
The WELLness Project	Anna Majury	$25,000	Canadian Foundation of Infectious Diseases
UnWELL: Assessing the Presence of, and Implications for, Antimicrobial Resistant Organisms in Private Drinking Groundwater Wells in Ontario	Anna Majury	$25,000	N/A
Remuncipalization: The Future of Water Services?	David McDonald	$180,000	SSHRC
Bioaccessibility of inorganic contaminants from water and soil	Louise Meunier	$142,500	NSERC Discovery
Detection of hexavalent chromium from drinking water and mine leachate	Louise Meunier	$35,000	NRCan
The Canadian Lyme Disease Research Network	Kieran Moore	$4 million	CIHR
Remediation Education Network	Brent Sleep – Program Lead Kevin Mumford and Kent Novakowski – Queen's Leads	$1.65 million over 6 years	NSERC CREATE
Remediation of Soil and Groundwater Impacted by Per- and Polyfluoroalkyl Substances	Bernard Kueper	$229,000	NSERC CRD

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
The Role of Gases in Groundwater Contamination and Remediation	Kevin Mumford	$135,000	NSERC Discovery
Impacts of Stray Gas Migration on Shallow Groundwater: Insights from Laboratory Experiments and Numerical Modelling	Kevin Mumford	$537,475	NSERC SPG
Enhanced in situ thermal treatment of soil and groundwater: high temperature treatment and combined remedies	Kevin Mumford	$320,000	NSERC Alliance
Protecting Canada's Coasts from Extreme Waves and Water Levels	Ryan Mulligan	$180,000	NSERC Discovery
Nature-Based Infrastructure for Coastal Resilience and Risk Reduction	Ryan Mulligan	$105,500	Defence Research and Development Canada (DRDC), Canadian Safety and Security Program
Understanding of Hydrodynamics and Sediment Dynamics Along Coral Reef-Lined Coasts	Ryan Mulligan	$45,000 USD	US Geological Survey
Modelling Waves, Storm Surge, and Tides in the Gulf of Maine and Bay of Fundy	Ryan Mulligan	$36,000	Fisheries and Oceans Canada
High resolution nearshore wave and current modelling to investigate nonlinear wave effects on velocity profiles and sediment transport	Ryan Mulligan	$94,180 USD	US Office of Naval Research (ONR-Global)

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Transitioning from hindcasting to forecasting: Advancing computational models to enable real-time simulations for public safety and resource management	Ryan Mulligan, Leon Boegman	$100,000	Deans Research Fund, Queen's FEAS
A Hybrid Mesocosm-ecosystem Facility for Aquatic Ecotoxicology	Diane Orihel	$167,602 $167,602 $163,000	John R. Evans Leaders Fund, Canadian Foundation for Innovation, Ontario Research Fund for Small Infrastructure, Queen's University
Integrated aquatic animal responses to petroleum products in the environment for freshwater aquatic risk assessment	Diane Orihel	$120,000	Grants and Contributions Program, Environment and Climate Change Canada
Advanced Multiplex Technology for Pathogen Detection and Recognition	Zhe She	$144,090	National Defense (Canada), (IDEaS)
A 10,000-ton Algal Liver: Genetic Engineering for Improved Wastewater Treatment	Bas Vriens	$250,000	NFRF Exploration
The environmental footprints of human trace metal use: from sources to sinks	Bas Vriens	$294,699	Queen's University RIG and Infrastructure Grants
Fate and Effects of Metallic Nanoparticles in Wetland Systems	Kela Weber	$215,000	NSERC Discovery

RESEARCH PROJECTS

Project	BWRC Faculty Lead	Funding	Organization
Field Testing of Novel Technologies for Restoring Challenging Contaminated Sites	Kela Weber	$99,000	NSERC CRD
Development and Validation of Analytical Methods for Comprehensive Profiling of Perfluoroalkyl and Polyfluoroalkyl Substances in Firefighting Foam Impacted Environmental Matrices	Kela Weber	$187,698	SERDP
Demonstration of Smoldering Combustion Treatment of PFAS-impacted Investigation-Derived Waste	Kela Weber	$75,000	SERDP
Remediation of Soil and Groundwater Impacted by Per- and Polyfluoroalkyl Substances	Kela Weber	$70,000	NSERC CRD
Learning models of metabolism and gene expression from biological big data	Laurence Yang	$162,500	NSERC Discovery
Systems biology for health enabled by high-performance computing.	Laurence Yang	$18,228 (in-kind)	Compute Canada

FACULTY PUBLICATIONS 2020-21

1. Adams JE, Brown RS, Hodson PV. (2020) The bioavailability of oil droplets trapped in river gravel by hyporheic flows. *Environ. Pollut,* 269: 116110.

2. Adams JE, Madison BN, Charbonneau K, Sereneo M, Baillon L, Langlois VS, Brown RS, Hodson PV. (2020) Effects on trout alevins of chronic exposures to chemically-dispersed Access Western Blend and Cold Lake Blend dilbits. *Environ. Toxicol. Chem,* 39:1620-1633.

3. Amadu AA, Qiu S, Ge S, Addico G , Ameka G, Ziwei Y, Xia W, Abbew AW, Shao D, Champagne P, Wang S. (2021) A review of biopolymer (Poly-β-hydroxybutyrate) synthesis in microbes cultivated on wastewater. *Sci. Total Environ*, 756: 143729.

4. Arredondo J, Woodcock N, Garcia-Valdez O, Jessop P, Champagne P, Cunningham M. (2020) Surface Modification of Cellulose Nanocrystals via RAFT Polymerization of CO2-Responsive Monomers – Tuning Hydrophobicity. *Langmuir,* 36(46): 13989-13997.

5. Bdour Y, Gomez-Cruz J, Escobedo C. (2020) Structural stability of optofluidic nanostructures in flow-through operation. *Micromachines*, 11(4): 373.

6. Beel C, Heslop JK, Orwin JF, Pope MA, Schevers AJ, Hung JKY, Lafreniere MJ, Lamoureux SF. (2021) Emerging dominance of summer rainfall driving High Arctic terrestrial-aquatic connectivity. *Nat. Commun*, 12(1): 1448.

7. Braga A, Cushing A, Saulnier R, Filion Y. (2020) Accumulation of discoloured material in a full- scale drinking water distribution system. World Environmental and Water Resources Congress 2020, Las Vegas, Nevada, May 17-21, 2020.

8. Braga AS, Filion Y. (2021) A New Imaging Technique to Characterize Iron Oxide Deposits on Pipe Wall Coupon Samples. World Environmental and Water Resources Congress 2021, Milwaukee, Wisconsin, May 24-27, 2021.

9. Braga AS, Filion Y. (2021) Direct Observations of Fine Iron Oxide Particle Deposits on Pipe Wall Coupons in a Full-Scale Drinking Water System Laboratory. World Environmental and Water Resources Congress 2021, Milwaukee, Wisconsin, May 24-27, 2021.

10. Braga A, Saulnier R, Cushing A, Filion Y. (2020) Dynamics of material detachment from drinking water pipes under flushing conditions in a full scale drinking water laboratory system. *Urban Water J*, 17(8).

11. Cabrera MA, Pinzon G, Take WA, Mulligan RP. (2020) Wave Generation Across a Continuum of Landslide Conditions From the Collapse of Partially Submerged to Fully Submerged Granular Columns. *JGR Oceans,* 125(12).

12. Cushing A, Rilstone V, Vignale L, Braga A, Champagne P, Filion Y (2020) Developing an experimental pipe rig to grow multi-species biofilms to examine antimicrobial resistance (AMR) in municipal drinking water distribution systems. World Environmental and Water Resources Congress 2020, Las Vegas, Nevada, May 17-21, 2020.

13. Dahal S, Yurkovich JT, Xu H, Palsson BO, Yang L. (2020) Synthesizing Systems Biology Knowledge from Omics Using Genome-Scale Models. *Proteomics,* 20(17-18):1900282.

14. Dahal S, Zhao J, Yang L. (2021) Genome-scale Modeling of Metabolism and Macromolecular Expression and Their Applications. *Biotechnol. Bioprocess. Eng,* 25:931-943.

15. Di Battista V, Rowe RK, Patch D, Weber KP. (2020) PFOA and PFOS diffusion through LLDPE and LLDPE coextruded with EVOH at 22 °C, 35 °C, and 50 °C. *Waste Manage*, 117(4):93-103.

FACULTY PUBLICATIONS 2020-21

16. Dies H, Bottomley A, Nicholls L, Stamplecoskie K, Escobedo C, Docoslis A. (2020) Electrokinetically-driven assembly of gold colloids into nanostructures for surface-enhanced Raman scattering. *Nanomaterials,* 10(4): 661.

17. Dinh CT. (2020) Boosting chemical and fuel production. *Nat. Catal,* 3: 474-475.

18. Duchesne AL, Brown J, Patch DJ, Major D, Weber KP, Gerhard JI. (2020) Remediation of PFAS-Contaminated Soil and Granular Activated Carbon by Smoldering Combustion. *Environ. Sci. Technol*, 54(19): 12631 – 40.

19. Fagorzi C, Bacci G, Huang R, Cangioli L, Checcucci A, Fini M, Perrin E, Natali C, diCenzo GC, Mengoni A. (2021) Nonadditive transcriptomic signatures of genotype-by-genotype interactions during the initiation of plant-rhizobium symbiosis. *mSystems*, 6(1): e00974-20.

20. Fan L, Wang J, Liu X, Luo H, Zhang K, Fu X, Li M, Li X, Jiang B, Chen J, Fu S, Mo Y, Li L, Chen W, Cheng L, Chen F, Ji L, Ma D, Zhang X, Anderson BC. (2020). Whether the carbon emission from green roofs can be effectively mitigated by recycling waste building material as green roof substrate during five-year operation? *Environ. Sci. Pollut. R*, 27: 40893–40906.

21. Gao Y, Champagne P, Blair D, He O, Song T. (2020) Activated Persulfate by Iron-Based Materials Used for Emerging Contaminants Degradation: A Review. *Water Sci. Technol*, 81(5): 853-875.

22. Garcia-Valdez O, Champagne P, Cunningham M. (2021) Perspective on the Controlled Polymer-Modification of Chitosan and Cellulose Nanocrystals: Towards the Design of Functional Materials. *Can. J Chem. Eng,* in press.

23. Geddes BA, Kearsley JVS, Huang J, Zamani M, Muhammed Z, Sather L, Panchal AK, diCenzo GC, Finan TM. (2021) Minimal gene set from Sinorhizobium (Ensifer) meliloti pSymA required for efficient symbiosis with Medicago. *PNAS USA,* 188(2): e2018015118.

24. Grenade NL, Howe GW, Ross AC. (2020) The Convergence of Bacterial Natural Products From Evolutionarily Distinct Pathways. *Curr. Opin. Biotechnol,* 69: 17.

25. Gushulak CAC, Cumming BF. (2020) Diatom assemblages are controlled by light attenuation in oligotrophic and mesotrophic lakes in northern Ontario (Canada). *J. Paleolimnology*, 64(4): 419-433.

26. Haseeb S, Vanderveen J, Elamaldeniya D, Harris J, Boniface K, Lee R, Champagne P, Jessop P. (2021) Conversion of Lignin Pyrolysis Oil to Cyclohexyl Methyl Ethers for Use as Biomass-Derived Solvents. Green Chem, Preprint.

27. Hashemi S, Filion Y, Speight V, Long A. (2020) Effect of Pipe Size and Location on Water-Main Head Loss in Water Distribution Systems. *ASCE J. of Water Resources Planning & Management,* 146(6): 06020006.

28. Heslop JK, Hung JKY, Tong H, Simpson MJ, Chapman F, Lafreniere MJ, Lamoureux SF. (2021) Diverging pond dissolved organic matter characteristics yield similar CO2 flux potentials in a disturbed High Arctic landscape. *Environ. Res. Lett,* 16(4).

29. He O, Zhang Y, Wang P, Liu L, Wan Q, Yang N, Li W, Champagne P, Yu H. (2020) Experimental and Kinetic Study on the Coproduction of Furfural and 5-Hydroxymethylfurfural from Glucose. *Catalysts,* 11(1): 11.

30. Hodson PV, Wallace SJ, de Solla SR, Head JA, Hepditch SLJ, Parrott JL, Thomas PJ, Berthiaume A, Langlois VS. (2020) Polycyclic aromatic compounds (PACs) in the Canadian environment: The challenges of ecological risk assessments. *Environ. Pollut*, 266: 115165.

FACULTY PUBLICATIONS 2020-21

31. Jabbari A, Ackerman JD, Boegman L, Zhao Y. (2021) Increases in Great Lake winds and extreme events facilitate interbasin coupling and reduce water quality in Lake Erie. *Sci. Rep*, 11(1): 5733.

32. Jabbari A, Boegman L. (2021) Parameterization of oscillating boundary layers in lakes and coastal oceans. *Ocean Model,* 160(4): 101780.

33. Julseth M, Ramsawak N, Payne SJ, Filion Y, Ruecker N (2021). Use of Principle Component Analysis to Identify Probable Causes of Manganese and Arsenic Occurrence in the Distribution System. World Environmental and Water Resources Congress 2021, Milwaukee, Wisconsin, May 24-27, 2021.

34. Laird KR, Mushet GR, Flower RJ, Wolfe AP, Cumming BF. (2020) Heterogeneous response of diatom assemblages since c. 1945 in lakes from boreal regions of northern Alberta and Saskatchewan. *J. Paleolimnology*, 64(2): 137-153.

35. Lavallee S, Latchmore T, Hunds PD, Brown RS, Schuster-Wallace C, Dickson-Anderson S, Majury A. (2021) Drinking Water Consumption Patterns among Private Well Users in Ontario: Implications for Exposure Assessment of Waterborne Infection. *Risk Anal*, preprint.

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FINANCIAL STATEMENT
April 1, 2020 – March 31, 2021

	Item	Actual
Revenue		
	Carry Forward	$136,005
	*†Research Projects COVID 19 Sewage Surveillance	$586,356
	Other Revenue	
	FEAS Centre funding	$36,000
	FEAS Associate Director R& D	$75,000
	Conference Sponsorship (WatIF & Annual)	$15,052
	VPR-Director Stipend	$8,000
	Total Revenue	**$ 856,413**
Expenses		
	Salaries and Benefits	$131,289
	Non-salary Expenses (specify)	$143,034
	Total Expenses	**$323,820**
Surplus (deficit)	The surplus is related to research funding which is committed.	$532,611

***This only captures research funding held within the Centre**
† The total funding brought in through faculty membership is $20 million

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