Canadian COVID-19 Wastewater Coalition

Webinar series – Tuesday, December 1, 2020

WBE in Canada: Use cases, challenges and next steps

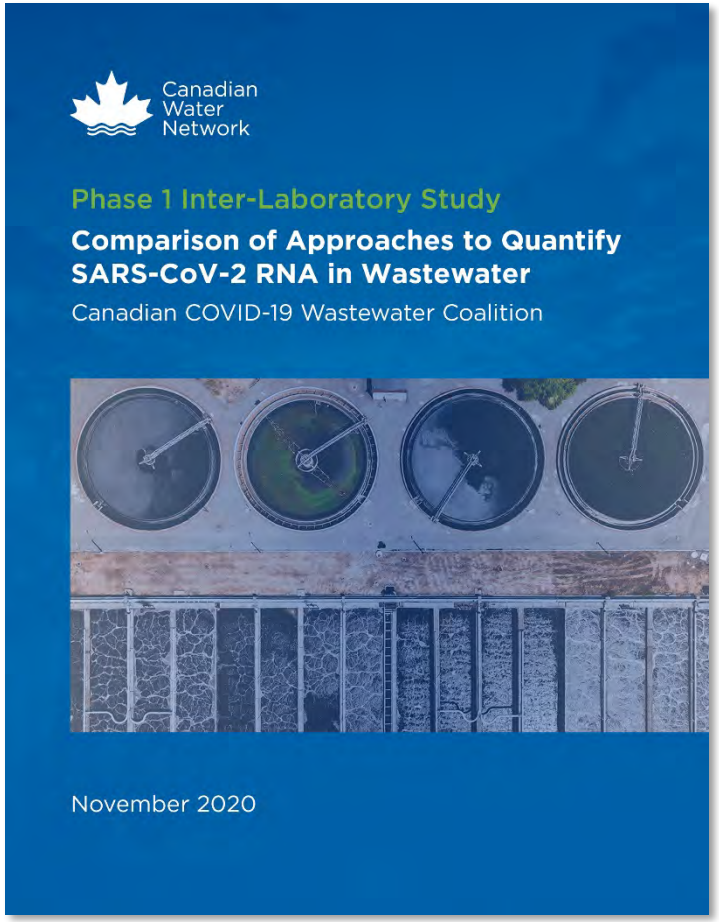
2:00 p.m. to 3:30 p.m. EST

CWN Webinars

Connecting water professionals to decision-ready knowledge

Canadian Water Network

Available at: cwn-rce.ca/covid-19-wastewater-coalition



Who should read the report?

- ✓ Public health leaders seeking to understand the potential (and limitations) of wastewater surveillance
- ✓ Decision makers considering the feasibility of wastewater surveillance programs
- ✓ Laboratories in the process of developing or adapting SARS-CoV-2 RT-qPCR methods to various wastewater matrices

How can SARS-CoV-2 sewage surveillance best support public health decisions?

- Reflecting asymptomatic and pre-symptomatic in addition to symptomatic individuals?
- Providing an efficient pooled sample?
- Tracking community trends?
- Potential to detect low levels of infection from communities or facilities (sentinel)?
- Potential to better understand spread within a community (support epidemiology)?

Canadian Water Network

Wastewater-based epidemiology in Canada
Use cases, challenges and next steps

Capabilities: Wastewater-based epidemiology

- SARS CoV-2 is shed in faeces — likely whether a person is asymptomatic, symptomatic, infectious or recovering.
- Genetic signals (RNA fragments) of SARS-CoV-2 **CAN** be detected in municipal wastewater.
- There are some indications that SARS-CoV-2 can be detected in community wastewater before clinical cases are reported.
- High hopes for wastewater monitoring to provide an early warning, **BUT**….
- High hopes for wastewater monitoring to inform public health decision-making, **BUT**….
- Potential for using sampling in sewer networks to inform public health decision-making, **BUT**….

Capabilities: Sample processing and analysis

- RT-qPCR can detect SARS CoV-2 in wastewater, but additional processing vs. clinical samples is necessary
- Inhibition of PCR amplification is a problem that is sample matrix-specific and is a pervasive challenge
- Determining recovery of *in-situ* SARS-CoV-2 is challenged by limitations of spiking and choice of spiked standard
- Calibration for the number of gene copies as a function of PCR Ct depends on the choice of agent used for calibration
- Likely to find greater sensitivity possible with an analytical focus on solids

Interpretation of WBE monitoring data

- Measured SARS-CoV-2 signals in municipal wastewater will vary over time, but: How much variation is caused by methods?
- Some compensation for variability in SARS-CoV-2 signals can be provided by correcting for flow, particularly as affected by precipitation / storm flow contribution.
- Further compensation for variability in SARS-CoV-2 signals can be provided by normalizing using indicators of fecal content like the Pepper Mottled Virus (PMMoV) or CrAssphage.
- Smoothing of data by using running averages is helpful for retrospective data presentation, but what choice is best?
- Best case indicator / comparator (e.g. number of cases, per capita cases, % positivity, other?) is not clear on first principles.

Webinar speaker

Robert Delatolla

Associate Professor

Civil Engineering

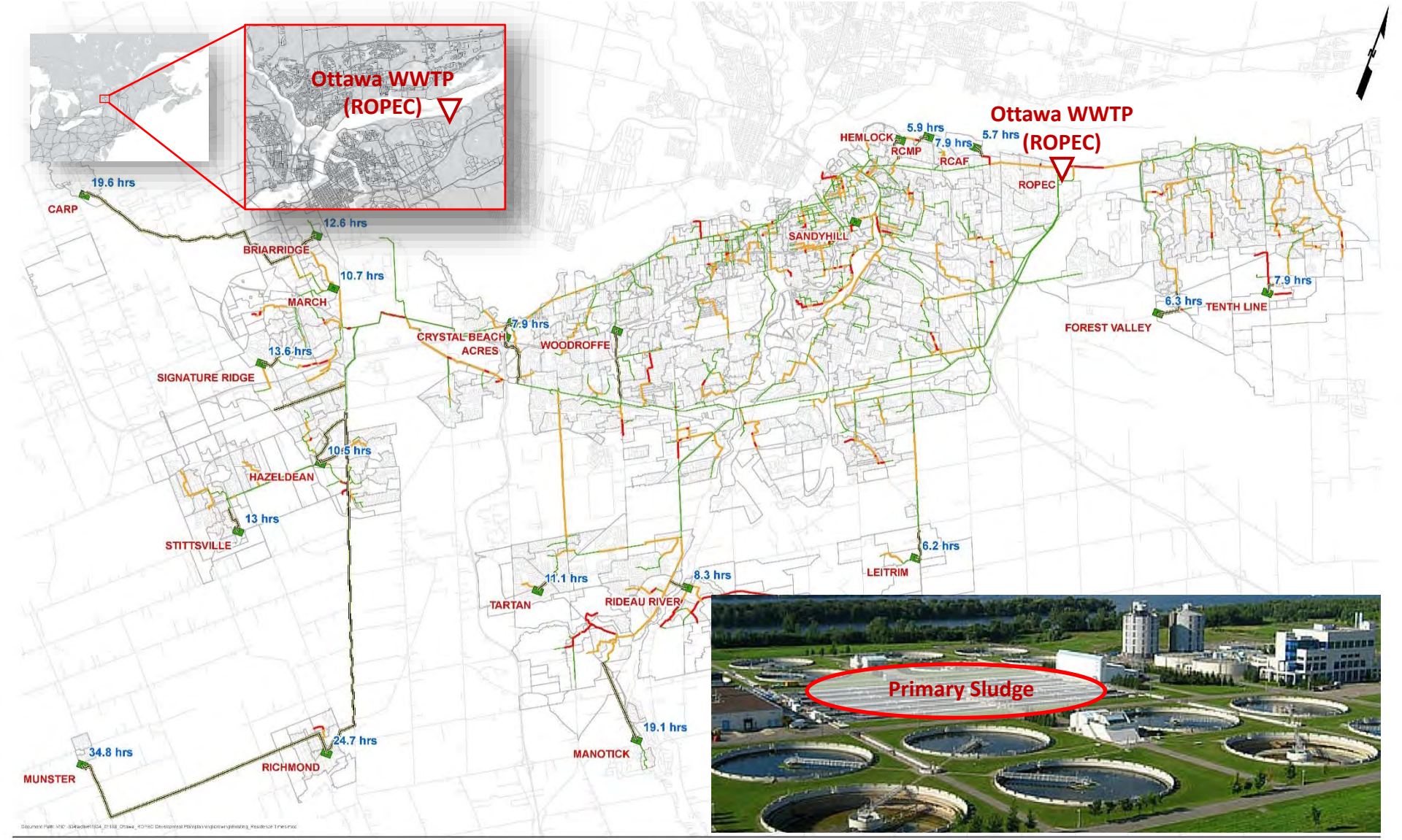
University of Ottawa

WASTEWATER SURVEILLANCE OF COVID-19 IN OTTAWA

Robert Delatolla, PhD, PEng
Alex MacKenzie, Patrick D'Aoust, Elisabeth Mercier and Tyson Graber
University of Ottawa & CHEO-RI

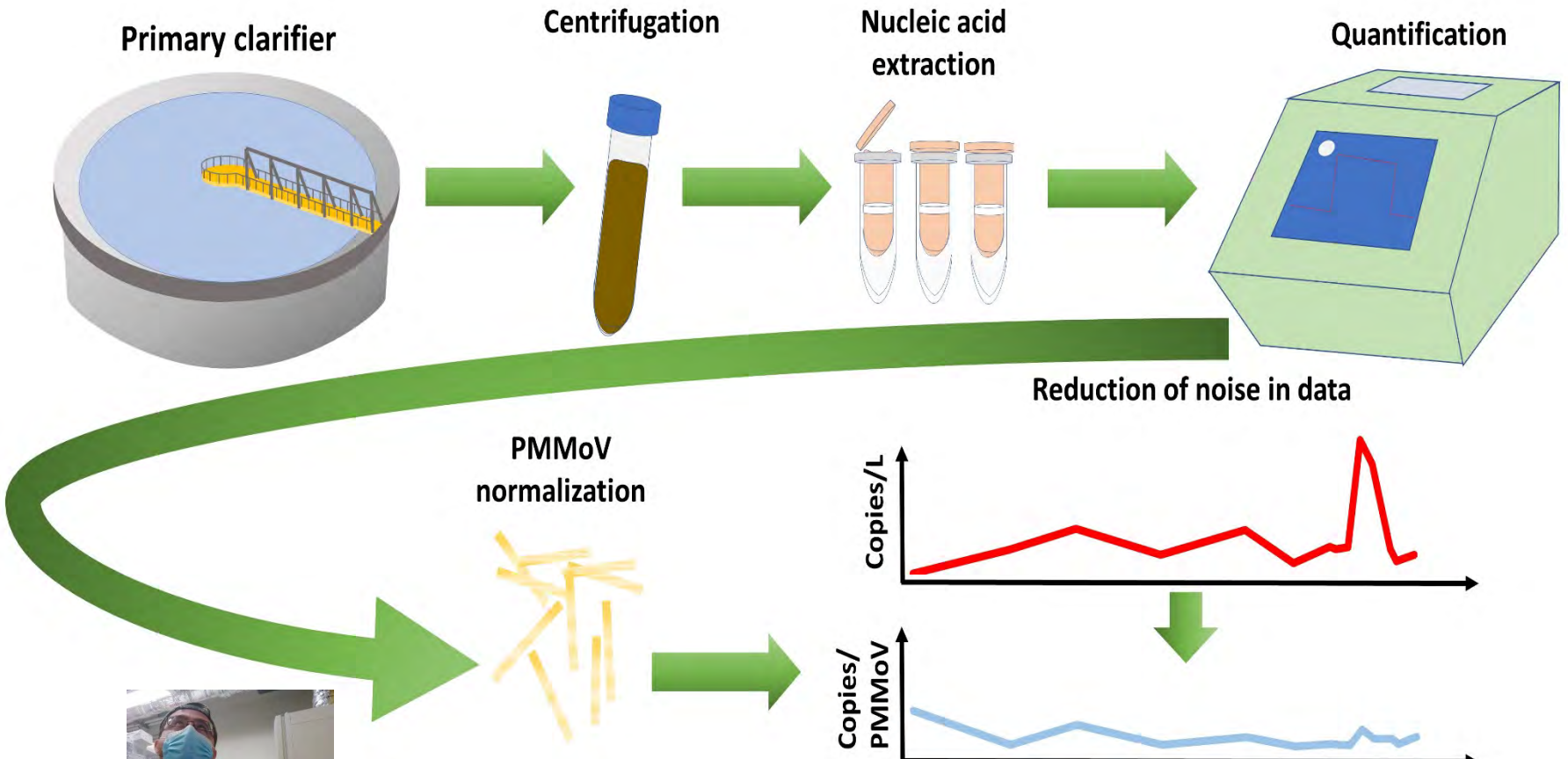
Research collaborators in this work:
Mark Servos, Nivetha Srikanthan, University of Waterloo
Doug Manual, Warsame Yusuf, Ottawa Hospital
James Brooks, Mike Mulvey, Chand Mangat, PHAC

OTTAWA WASTEWATER INFRASTRUCTURE



SAMPLE COLLECTION & PROCESSING

(Hill, Zamyadi, Deere Vanrolleghem, Crosbie, 2020)

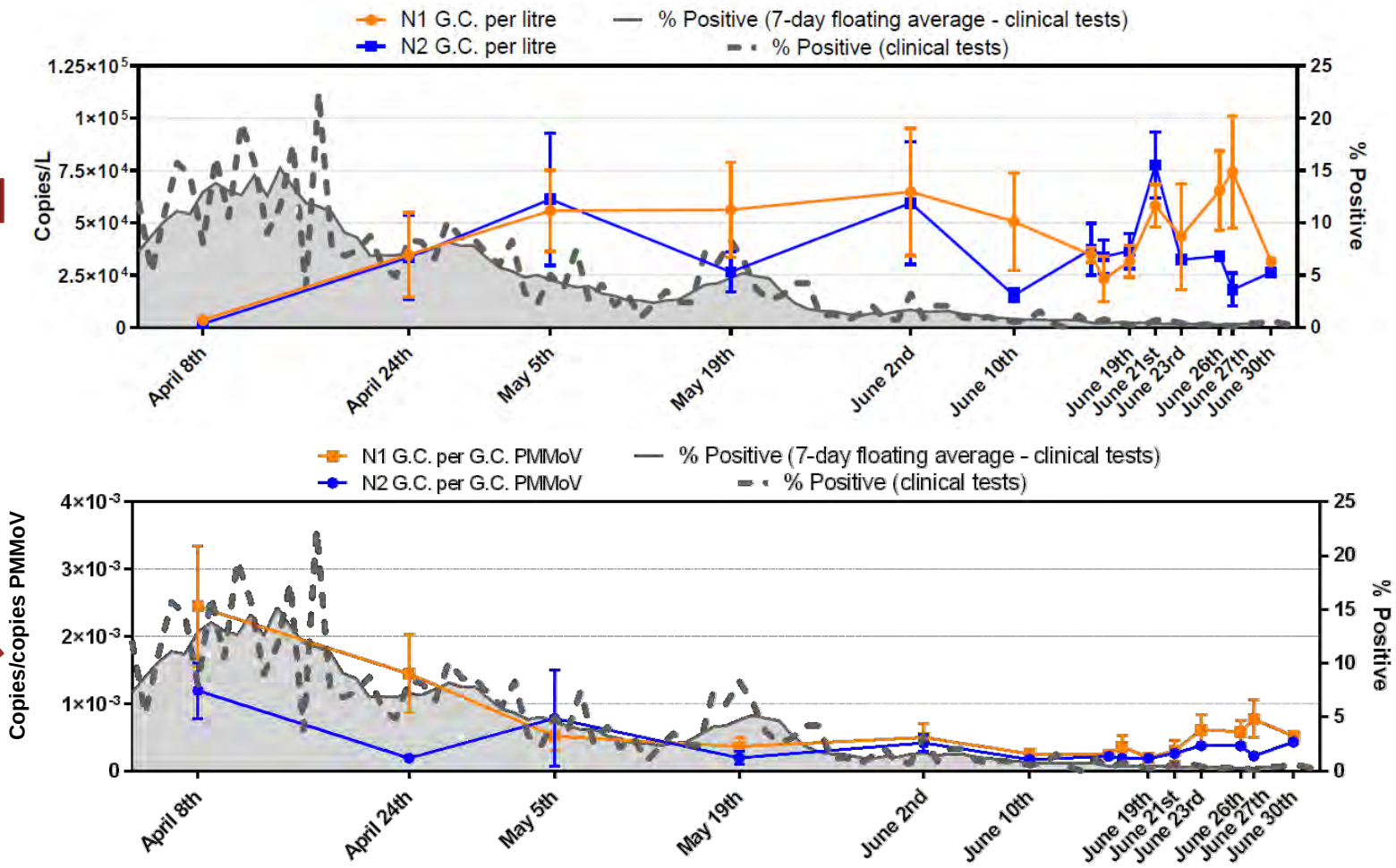


uOttawa

Canadian Water Network

CHEO RESEARCH INSTITUTE INSTITUT DE RECHERCHE

TRACKING THE DECREASE IN PREVALENCE (April to June)



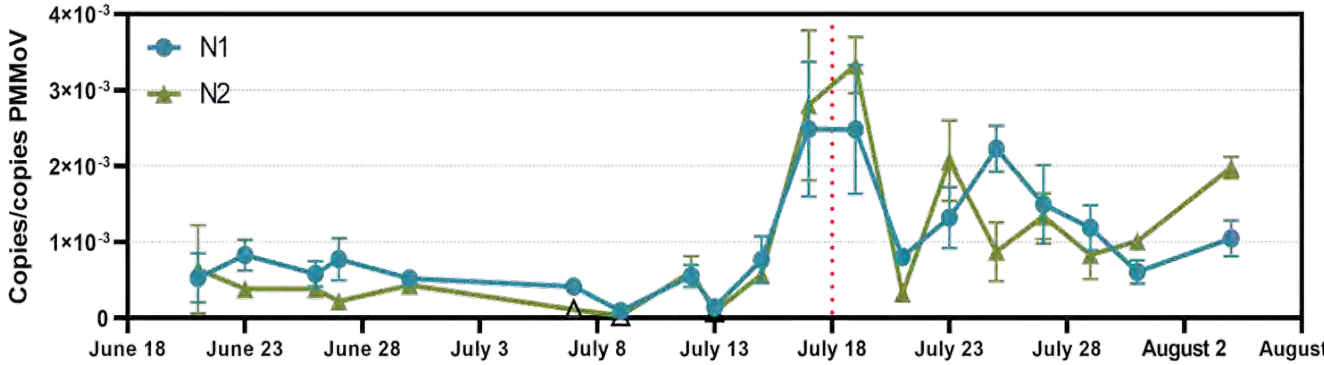
uOttawa

Canadian Water Network

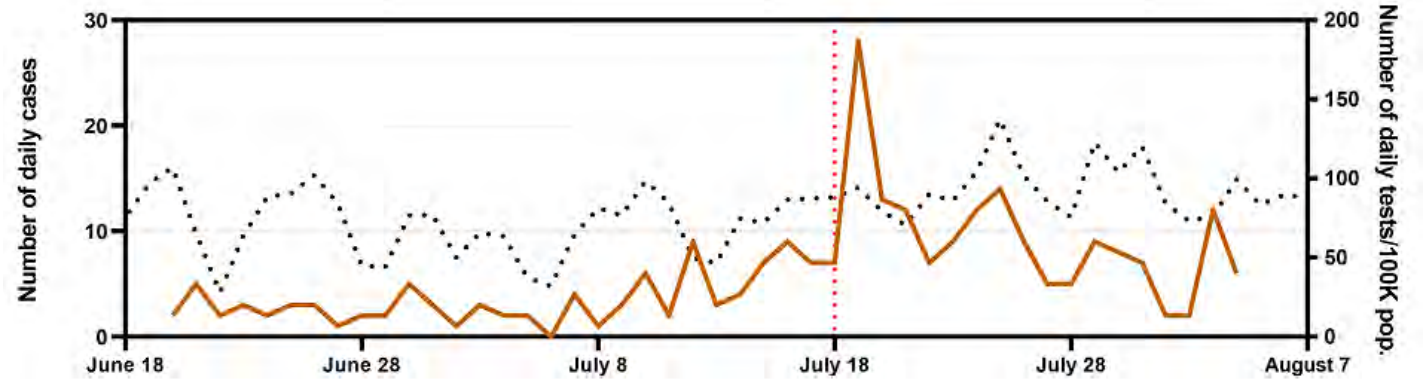
CHEO RESEARCH INSTITUTE INSTITUT DE RECHERCHE

EARLY DETECTION OF THE 2ND WAVE (June – August)

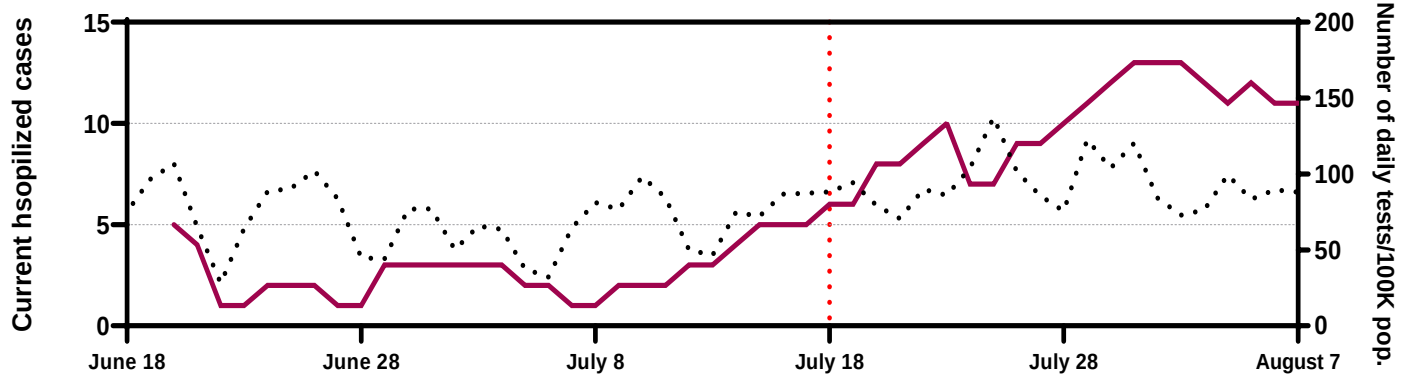
WW signal shows early detection



Detection 48 hours before increases in clinical cases



Detection 96+ hours before increases in hospitalizations



uOttawa

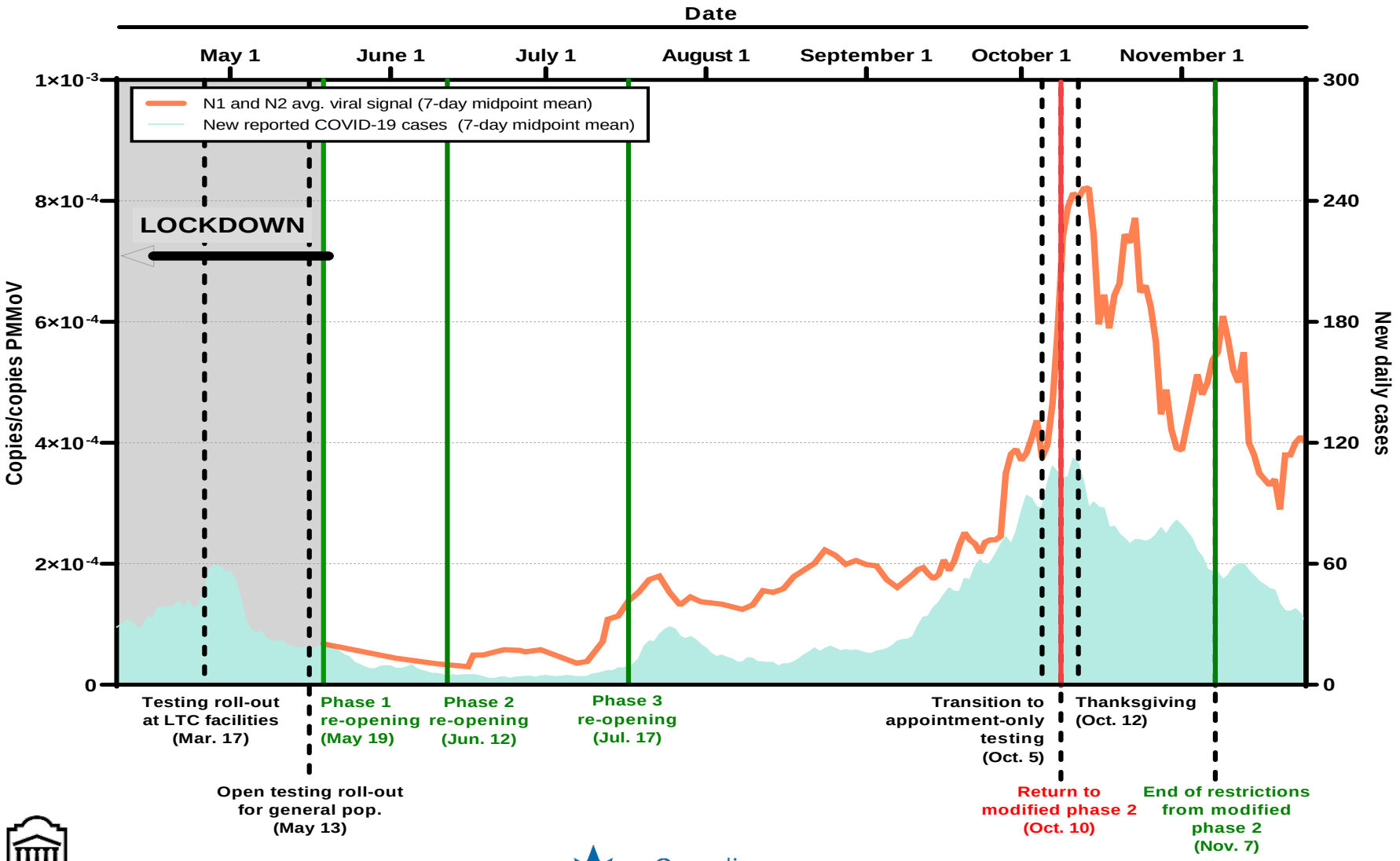
Canadian Water Network

CHEO RESEARCH INSTITUTE INSTITUT DE RECHERCHE

TRACKING THE 2ND WAVE (June – November)

https://613covid.ca/wastewater/

https://www.ottawapublichealth.ca/en/reports-research-and-statistics/Wastewater_COVID-19_Surveillance.aspx

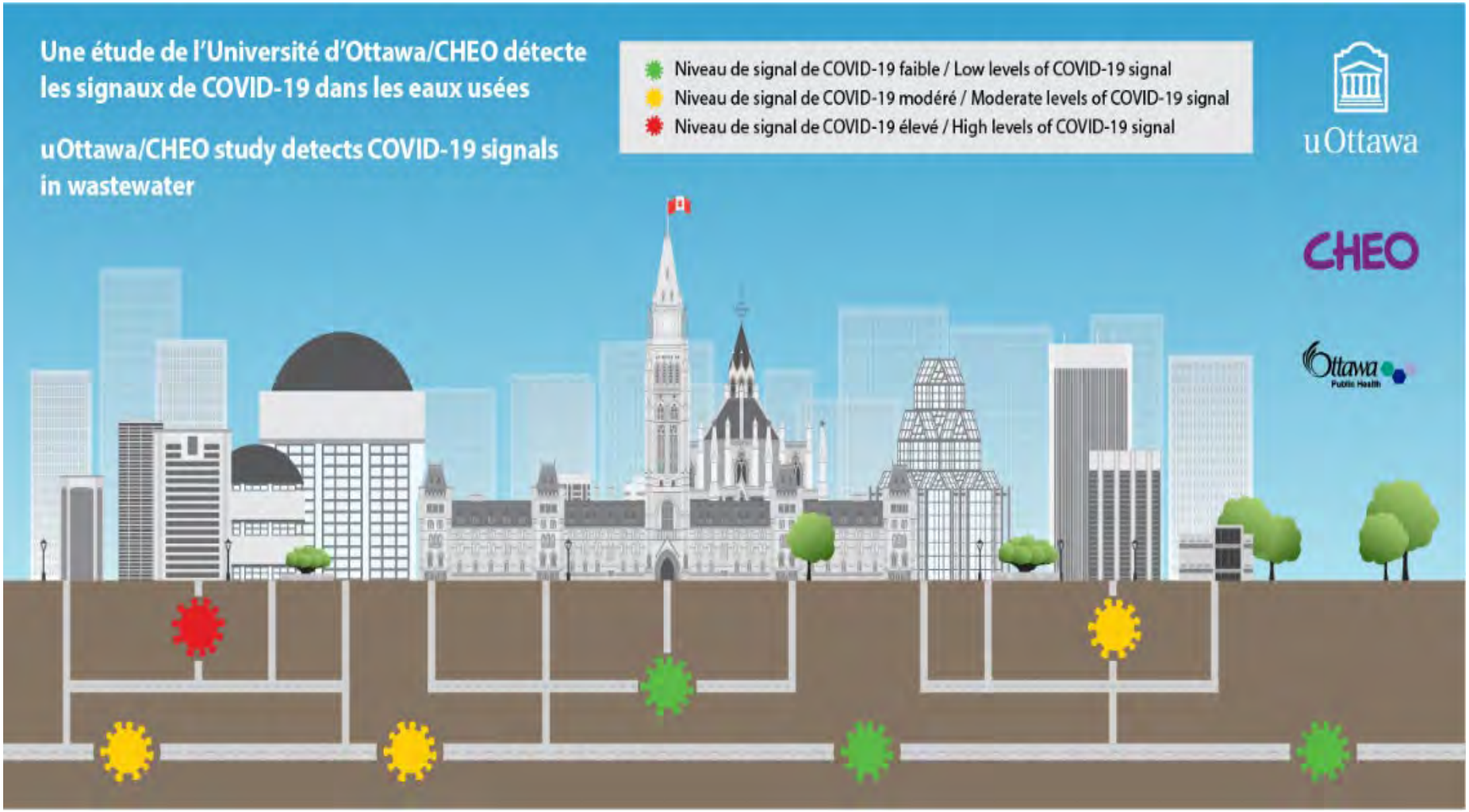


uOttawa

Canadian Water Network

CHEO RESEARCH INSTITUTE INSTITUT DE RECHERCHE

NEXT STEPS…KEY SITES IN OTTAWA AND ONTARIO



uOttawa

Canadian Water Network

CHEO RESEARCH INSTITUTE INSTITUT DE RECHERCHE

Webinar speaker

Mark Servos

Professor

Canada Research Chair in Water Quality Protection

University of Waterloo

Catching the Wave?

SARS-CoV-2 Detection in Wastewater

Prof. Mark R. Servos

Nivetha Srikanthan, Hadi Dhiyebi, Patrick Breadner, Sean McKay, Leslie Bragg,

Kirsten Nikel, Erika Burton, Meghan Fuzzen, Paul Craig, Wayne Parker

University of Waterloo

Many research collaborators including:

Robert Delatolla, Patrick M. D'Aoust, Élisabeth Mercier, University of Ottawa.

Municipal Partners:

Region of Peel working with you

York Region

Ontario

Canada Research Chairs
www.chairs-chaires.gc.ca

GWF

Canadian Water Network

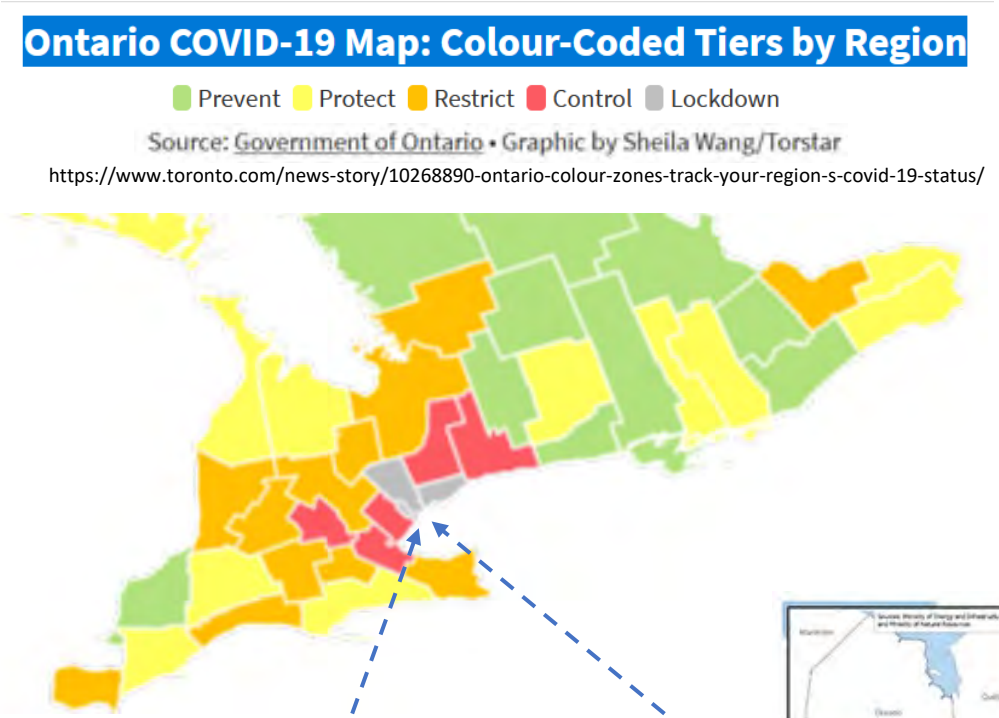
NSERC CRSNG

Environmental DNA
Global Water Futures

University of Saskatchewan

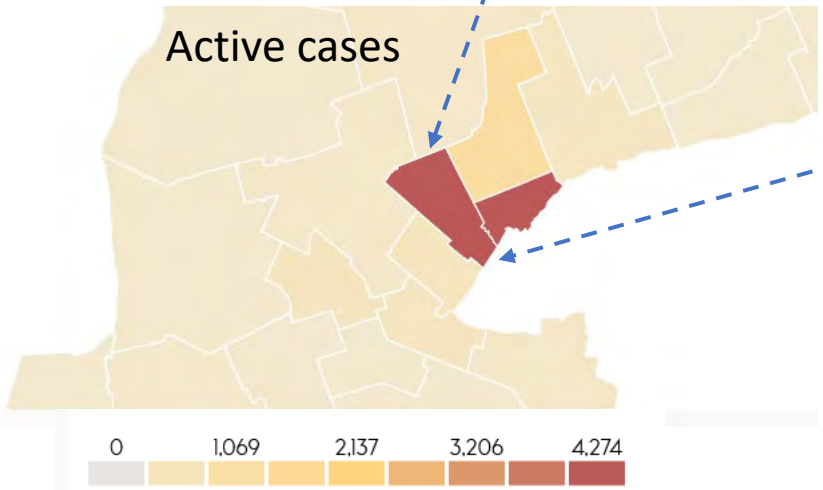
University of Waterloo

Canada Foundation for Innovation
Fondation canadienne pour l'innovation

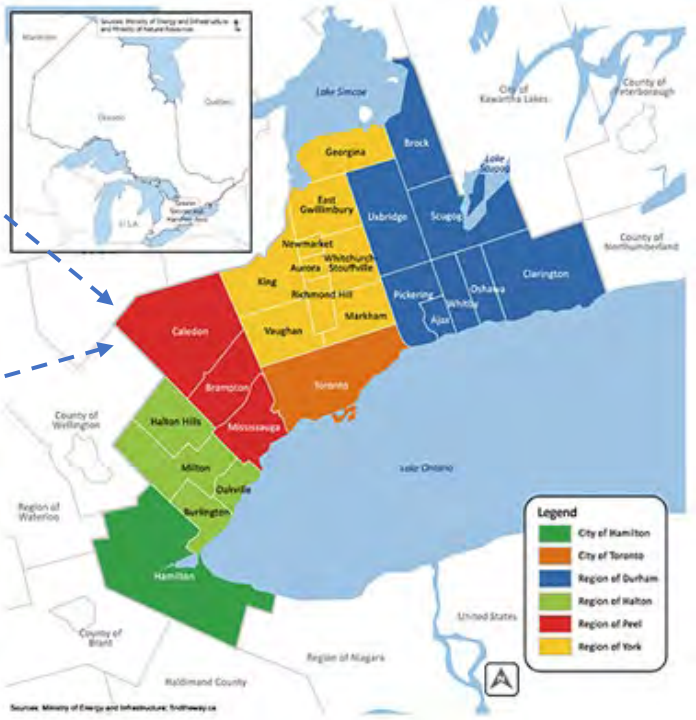


https://www.toronto.com/news-story/10268890-ontario-colour-zones-track-your-region-s-covid-19-status/

Peel Region
(Status: Lockdown)

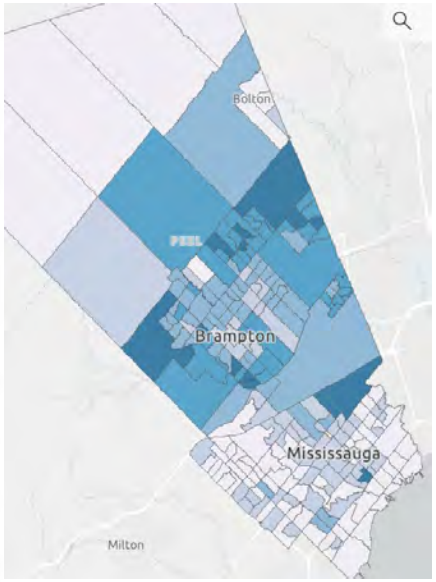


https://www.ctvnews.ca/health/coronavirus/provinces/ontario



Nov. 27, 2020

Region of Peel COVID-19: Currently in Grey (Lockdown)



Total Cases: Incidence Rate per 100,000 by Census Tract - 02/23 to 11/21

Total_Rate
- ≥ 3,676
- 2,443 to 3,675
- 1,523 to 2,442
- 915 to 1,522
- ≤ 914

25,166 total cases

Lockdown
Section 22
Additional Health Measures
Red Zone
Modified Stage 2
Testing Change
Stage 2
Stage 3

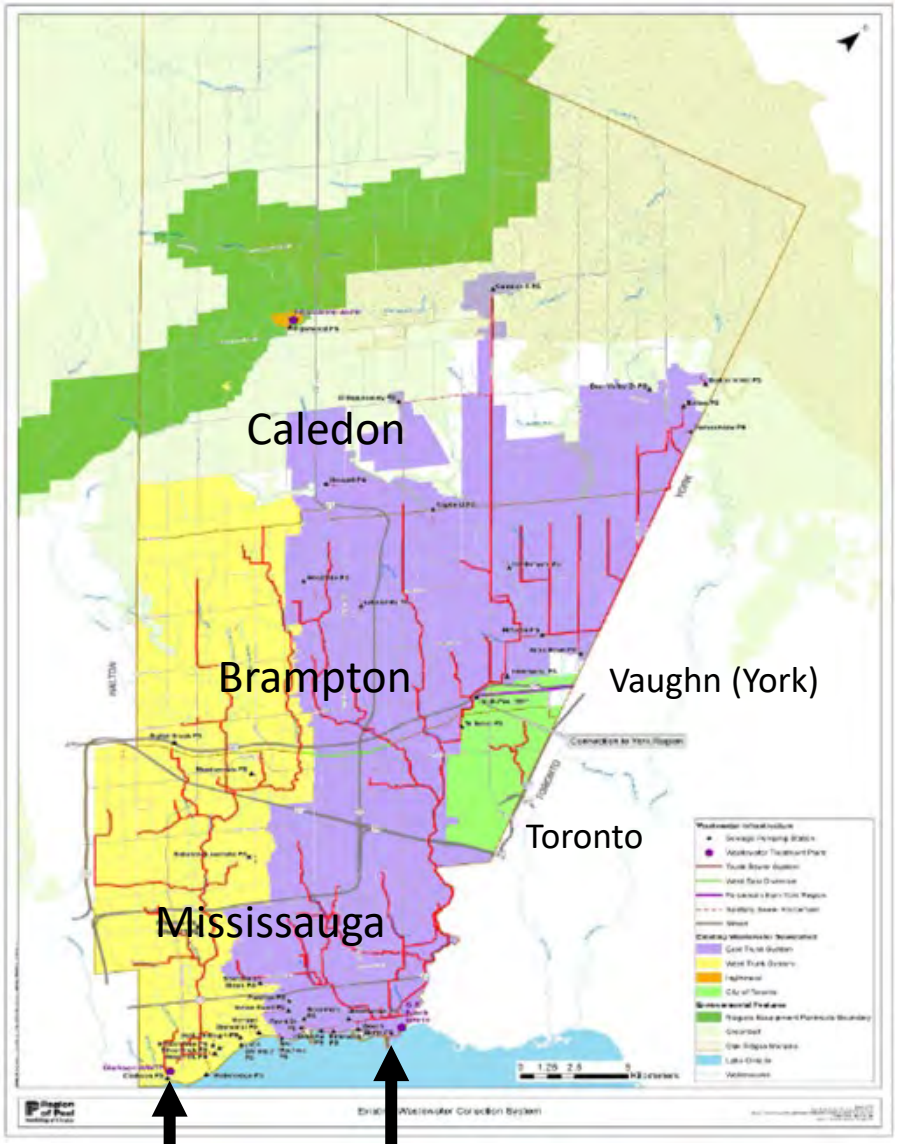
Cases Reported

600
500
400
300
200
100
0

31-Jan-20 05-Feb-20 10-Feb-20 15-Feb-20 20-Feb-20 25-Feb-20 01-Mar-20 06-Mar-20 11-Mar-20 16-Mar-20 21-Mar-20 26-Mar-20 31-Mar-20 05-Apr-20 10-Apr-20 15-Apr-20 20-Apr-20 25-Apr-20 30-Apr-20 05-May-20 10-May-20 15-May-20 20-May-20 25-May-20 30-May-20 04-Jun-20 09-Jun-20 14-Jun-20 19-Jun-20 24-Jun-20 29-Jun-20 04-Jul-20 09-Jul-20 14-Jul-20 19-Jul-20 24-Jul-20 29-Jul-20 03-Aug-20 08-Aug-20 13-Aug-20 18-Aug-20 23-Aug-20 28-Aug-20 02-Sep-20 07-Sep-20 12-Sep-20 17-Sep-20 22-Sep-20 27-Sep-20 02-Oct-20 07-Oct-20 12-Oct-20 17-Oct-20 22-Oct-20 27-Oct-20 01-Nov-20 06-Nov-20 11-Nov-20 16-Nov-20 21-Nov-20 26-Nov-20 01-Dec-20

—Peel Cases by Report Date —Cases by Episode Date

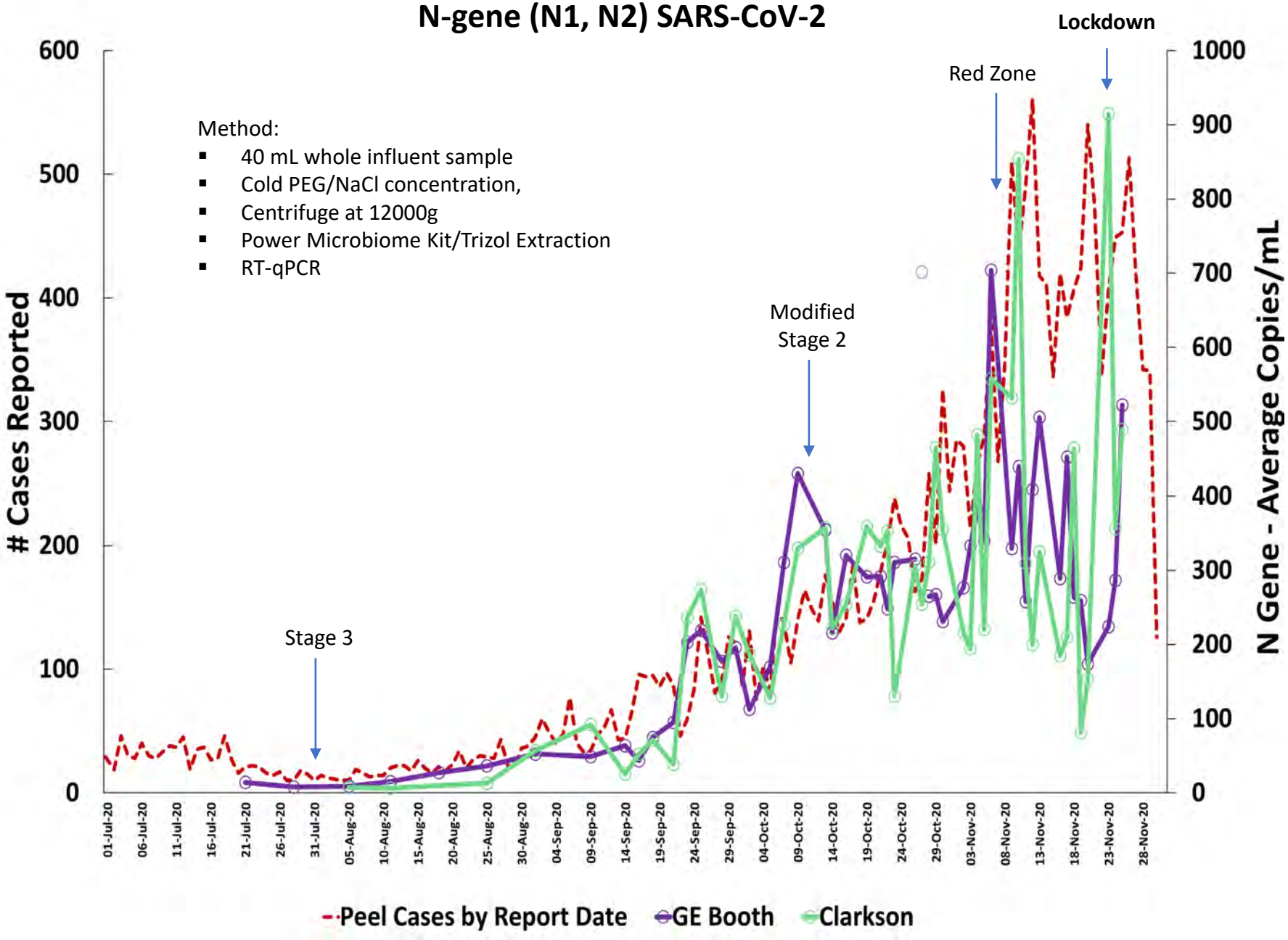
https://www.peelregion.ca/coronavirus/case-status/ Nov. 30, 2020



Clarkson WWTP
(228 million L/d)

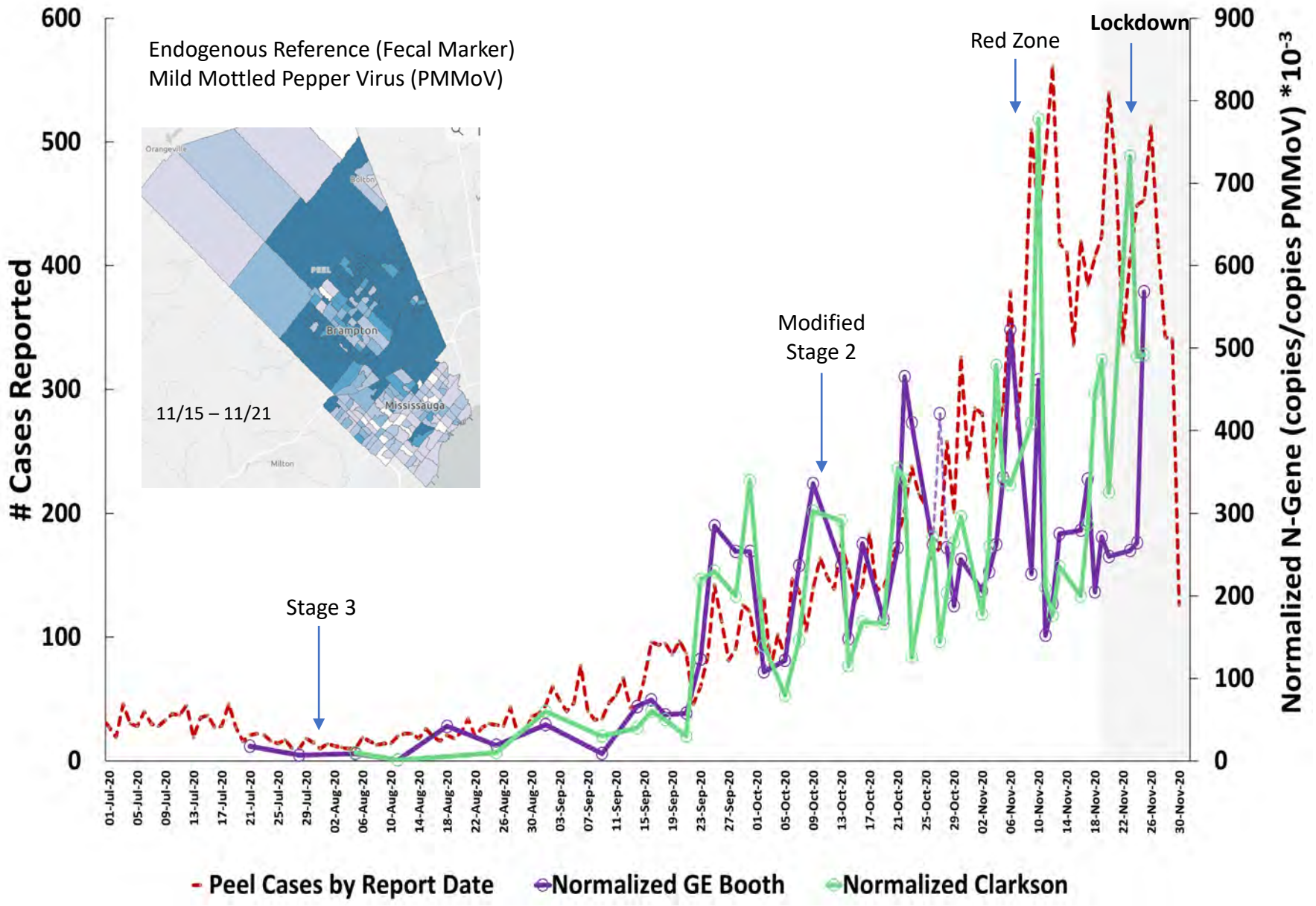
GE Booth WWTP
(469 million L/d)

N-gene (N1, N2) SARS-CoV-2



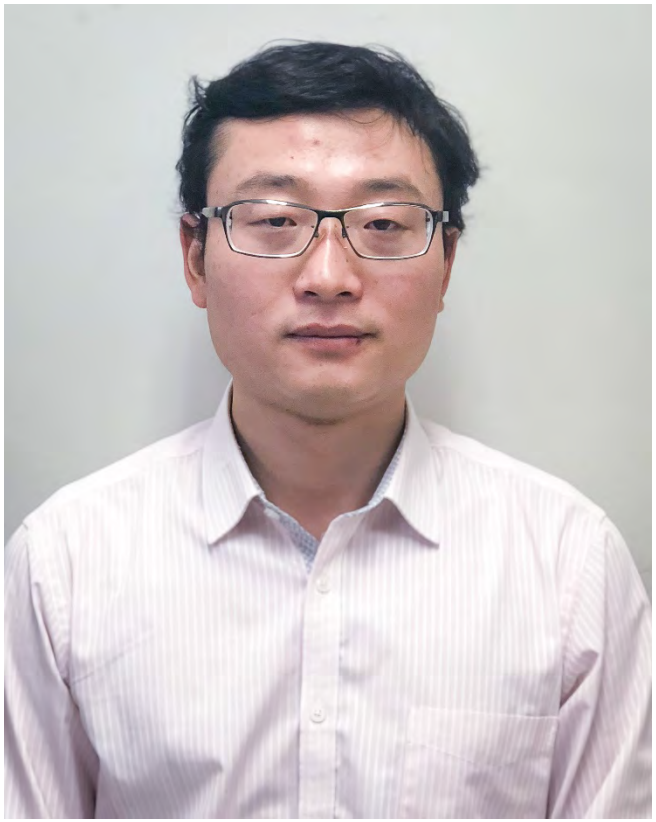
SARS-CoV-2 as of Nov. 25, 2020

PMMoV Normalized N-gene SARS-CoV-2



As of Nov. 25, 2020

Webinar speaker



Yuwei Xie

Postdoctoral Fellow

Toxicology Centre

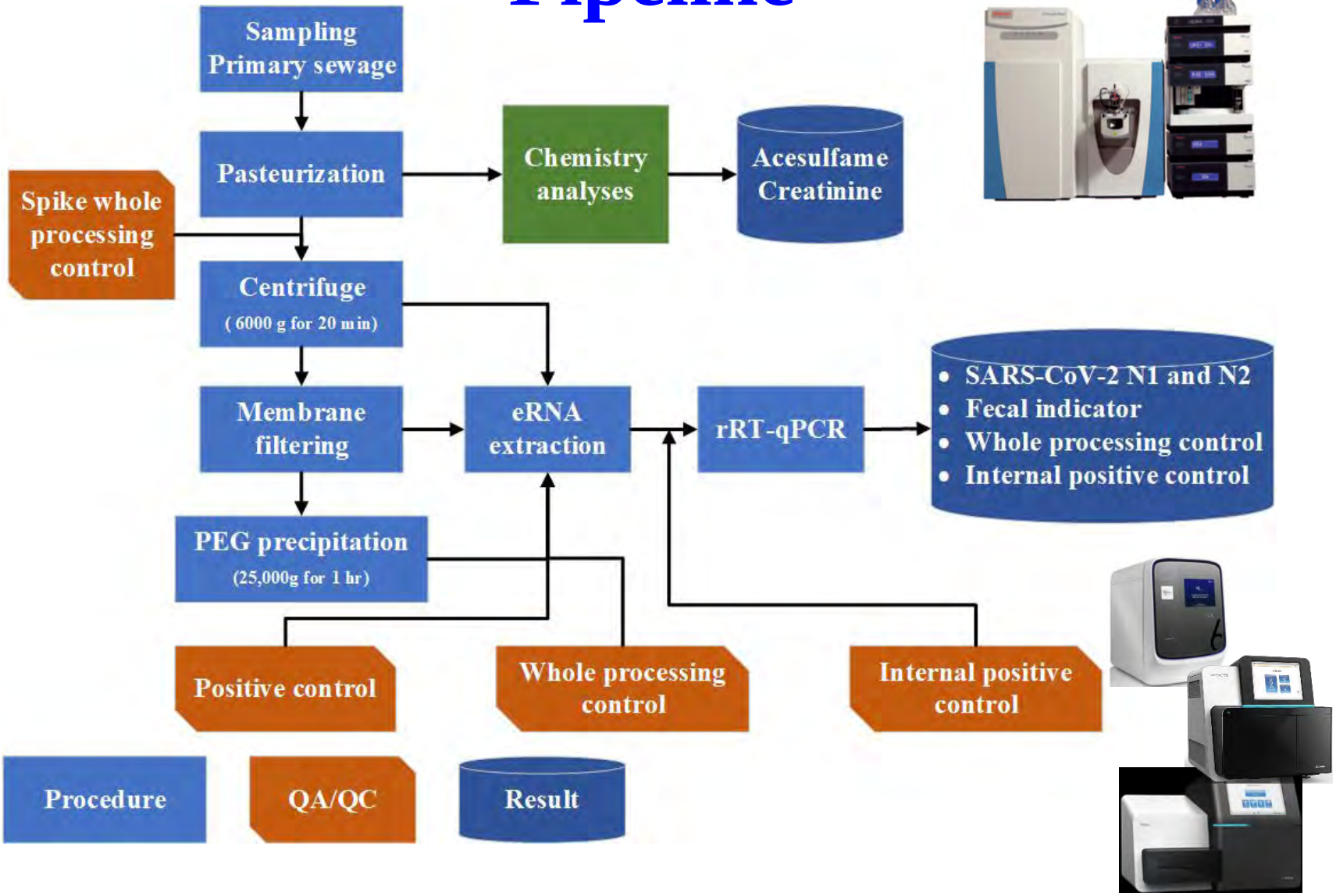
University of Saskatchewan

eRNA based wastewater surveillance of SARS-CoV-2 at Saskatoon

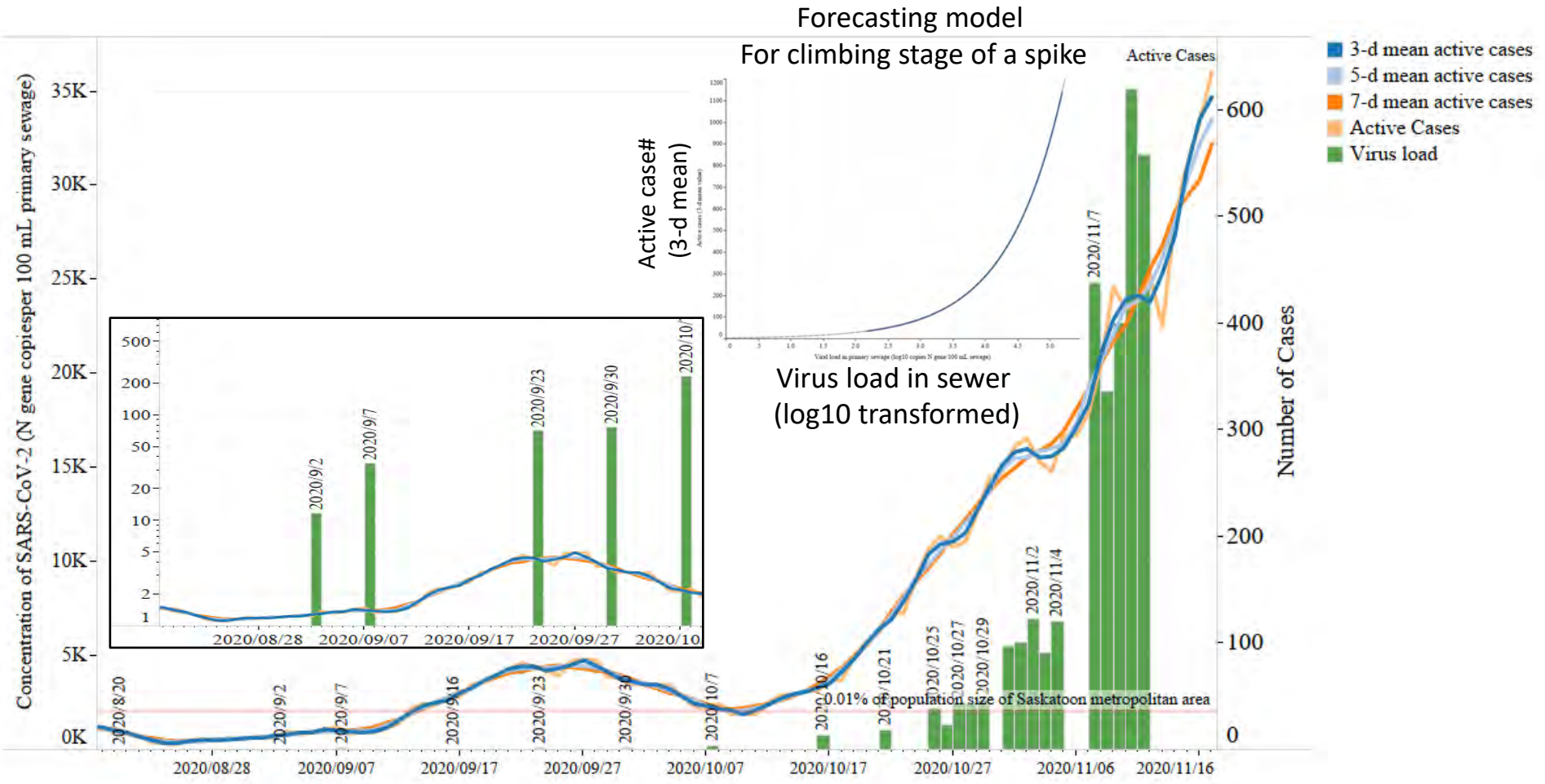
Yuwei Xie, Ph.D., yuwei.xie@usask.ca
John P. Giesy, Ph.D., FRSC, FSETAC, DSAHC, jgiesy@aol.com
Toxicology center, University of Saskatchewan

Nov. 17th 2020

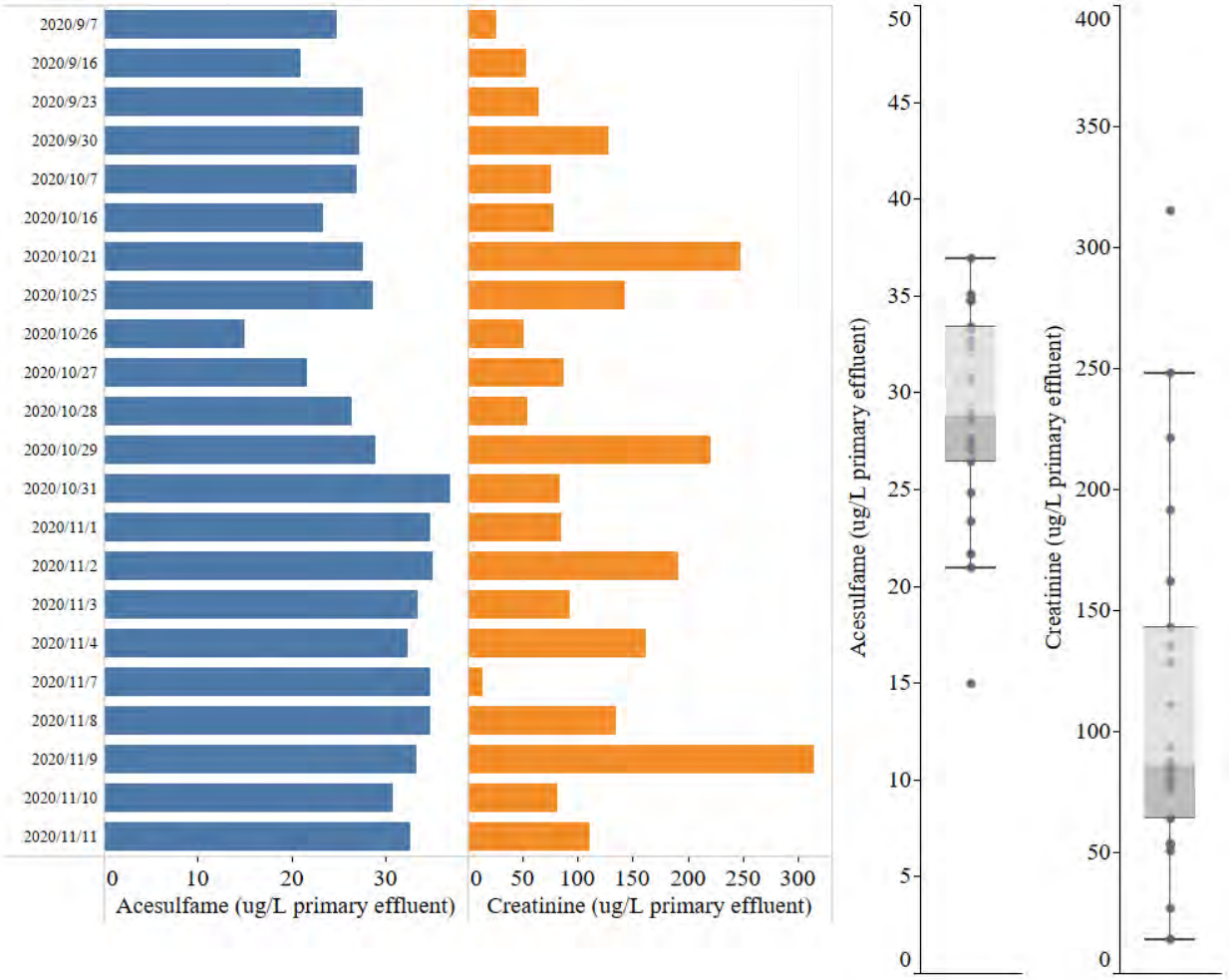
Pipeline


Sampling
Primary sewage
Pasteurization
Spike whole processing control
Chemistry analyses
Acesulfame
Creatinine
Centrifuge
(6000 g for 20 min)
Membrane filtering
eRNA extraction
rRT-qPCR
SARS-CoV-2 N1 and N2
Fecal indicator
Whole processing control
Internal positive control
PEG precipitation
(25,000g for 1 hr)
Positive control
Whole processing control
Internal positive control
Procedure
QA/QC
Result

eRNA-driven outbreak forecasting of active cases



Chemical biomarker for population normalizing



Conclusion

- eRNA based Wastewater-Based Epidemiology revealed the trend of outbreaking in a real-time manner
- Acesulfame is more stable than Creatinine in the primary sewage from Saskatoon WWTP, and can be used for population normalizing

Acknowledgments

GWF

Government of Saskatchewan

City of Saskatoon

Saskatchewan Health Authority

Webinar speaker

Robert (Mike) McKay

Executive Director

Great Lakes Institute for Environmental Research

University of Windsor

S.M.Research

A Tale of Two Cities: WBE applied to North America's largest cross-border conurbation

Canadian Water Network

@McKayGLIER

NSERC CRSNG

GLWA Great Lakes Water Authority

AMHERSTBURG

London CANADA

INNOVATION.CA
CANADA FOUNDATION FOR INNOVATION | FONDATION CANADIENNE POUR L'INNOVATION

GREAT LAKES CENTER FOR FRESH WATERS AND HUMAN HEALTH
AT BOWLING GREEN STATE UNIVERSITY
BGSU

Municipality of Leamington
live | play | work

Mitacs

GLIER
GREAT LAKES INSTITUTE FOR ENVIRONMENTAL RESEARCH
at the University of Windsor

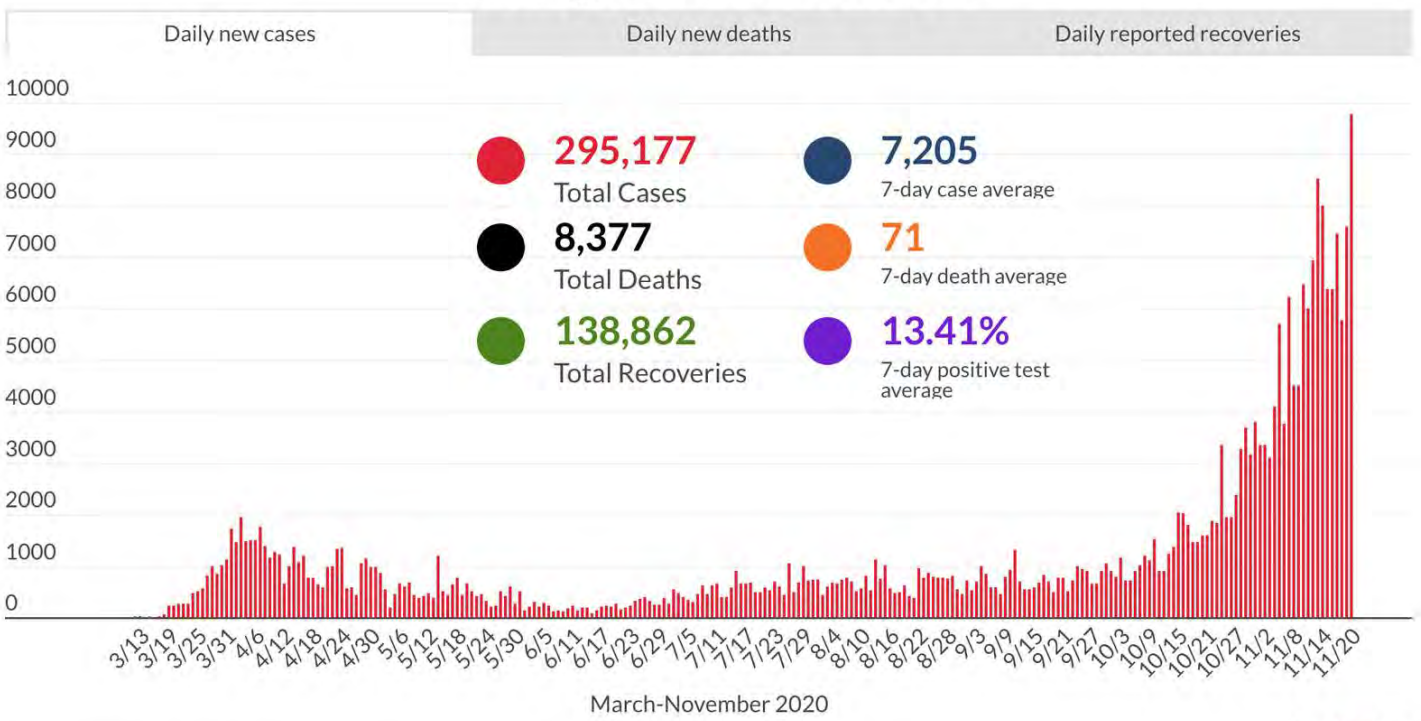
University of Windsor

uwindsor.ca/GLIER

EMERGENCY ALERTS

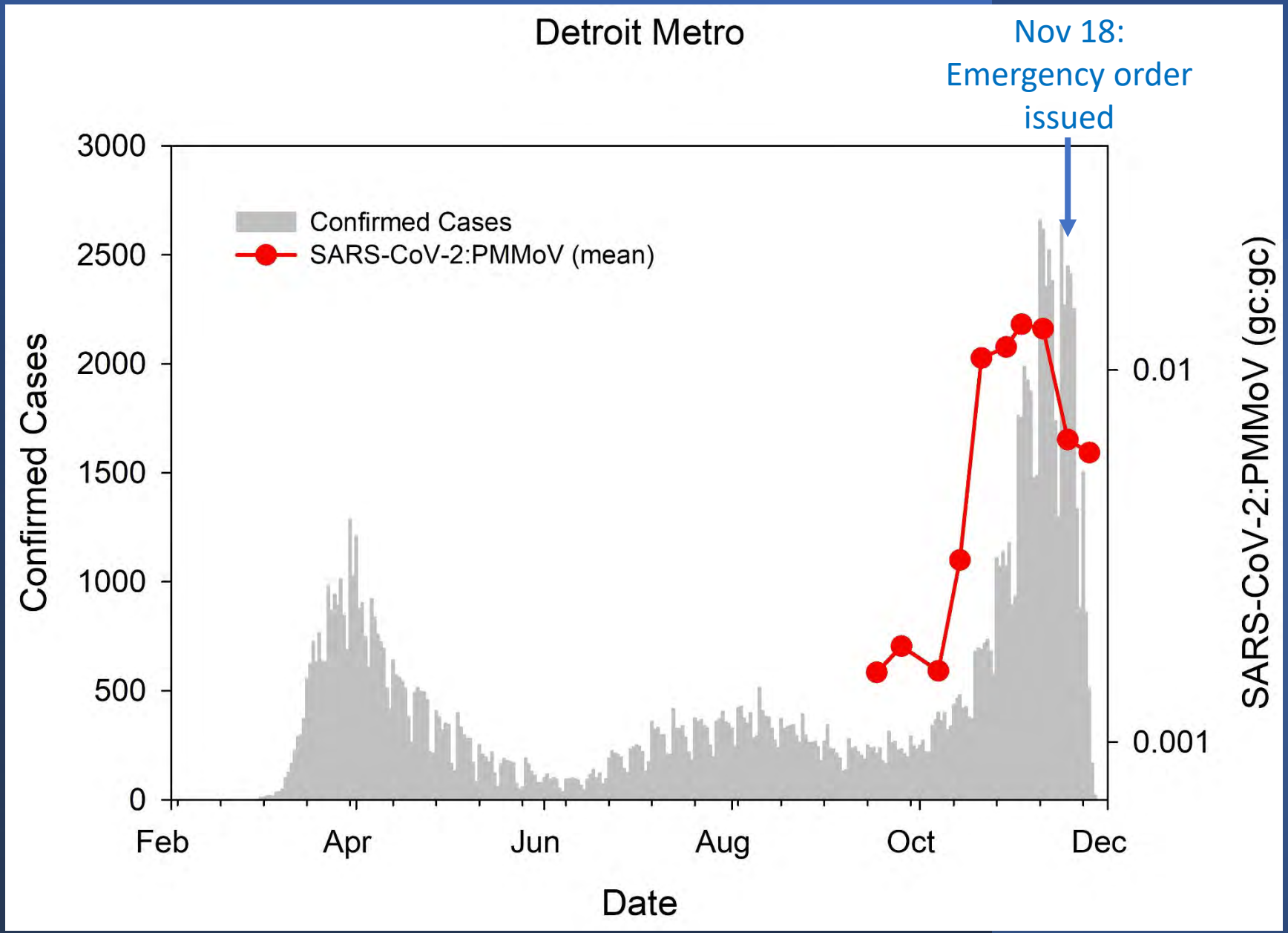
Public Safety Alert
MDHHS COVID-19 updated order requiring face masks and limiting gatherings to save lives starts today. New limits on indoor residential gatherings; bars and restaurants open for outdoor dining and carry-out only; colleges and high schools must end in-person classes. For more info, see www.michigan.gov/coronavirus

Michigan COVID-19 data

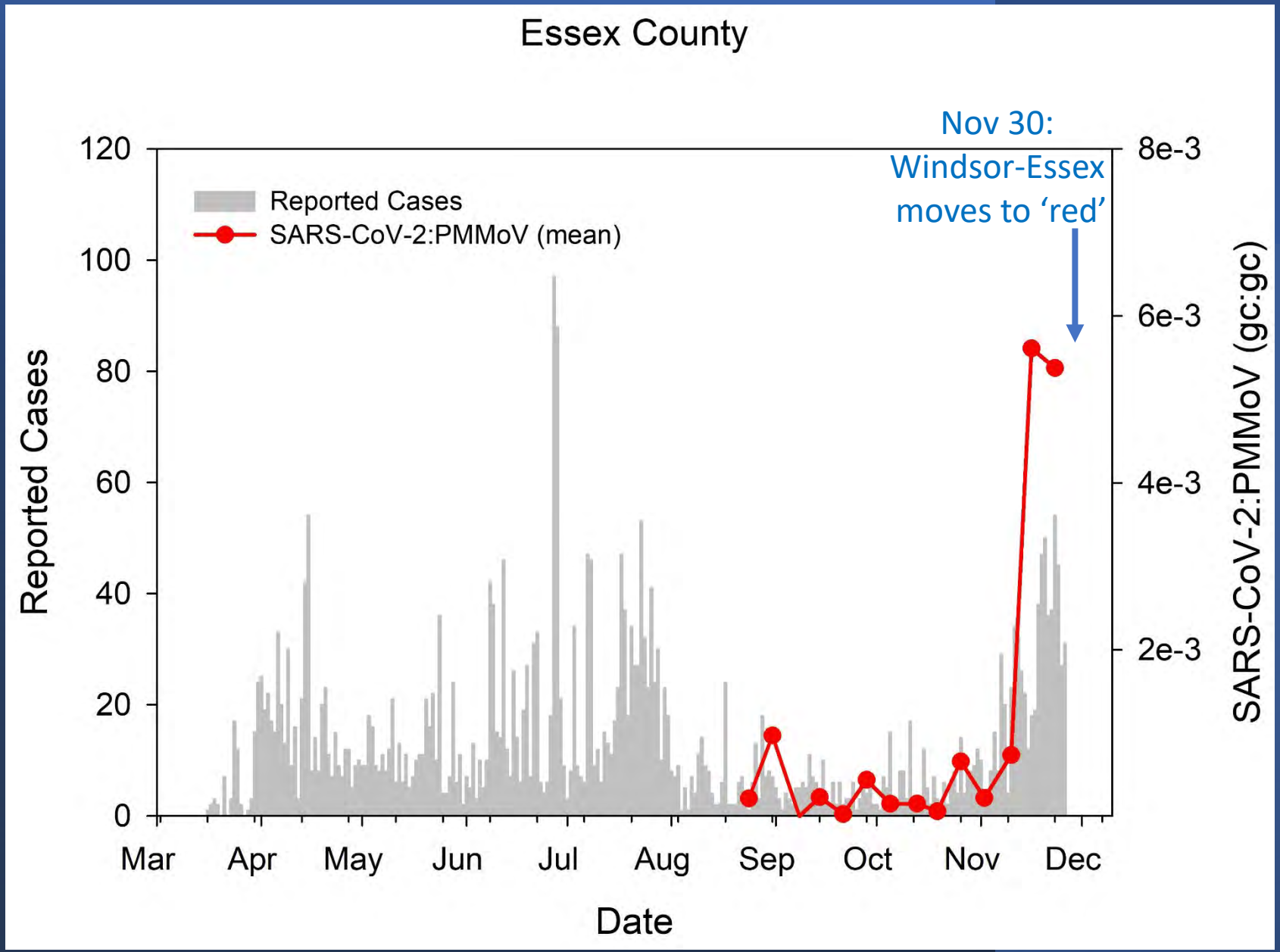


All data from MDHHS (Michigan Department of Health and Human Services)

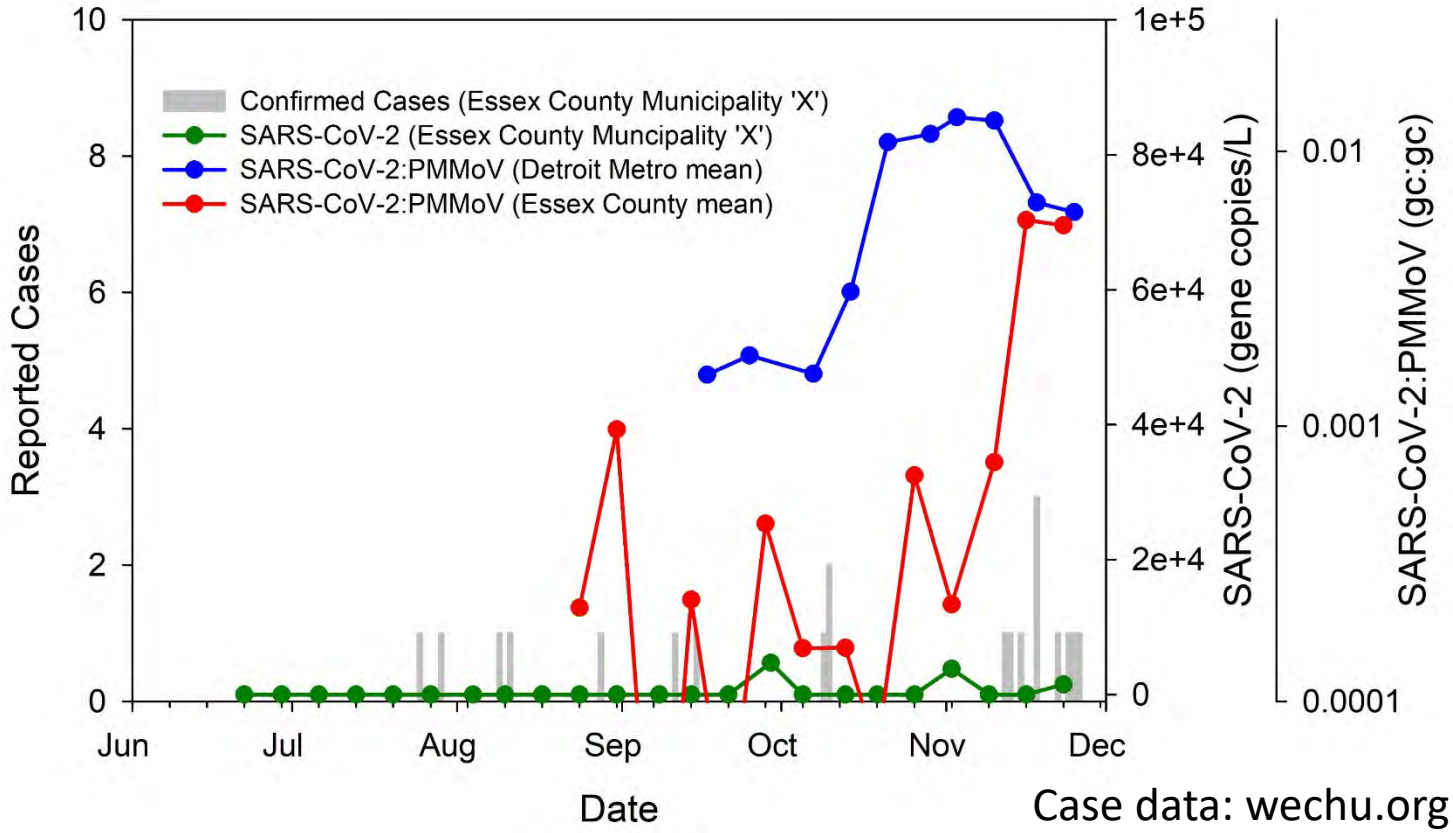
CLICK ON DETROIT



Case data: michigan.gov/coronavirus



Case data: publichealthontario.ca/



Yet municipalities of low incidence remain

Webinar speaker

Michael Parkins, MD

Associate Professor

Departments of Medicine and Microbiology, Immunology and Infectious Disease
University of Calgary

Clinic Director
Southern Alberta Adult Cystic Fibrosis Clinic,
University of Calgary Medical Clinics

Monitoring Hospital Wastewater for SARS-COV2 in Calgary

MD Parkins on behalf of a large team from the Faculties of Medicine, Science and Engineering

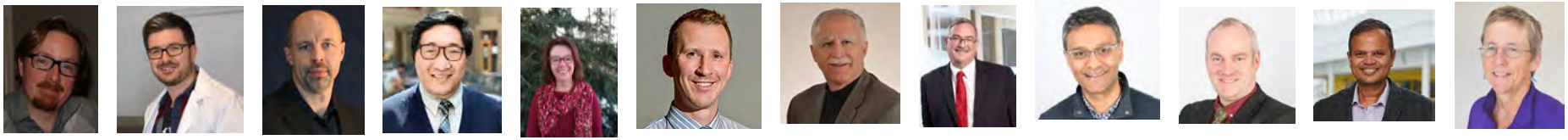
December 1, 2020

Disclosures

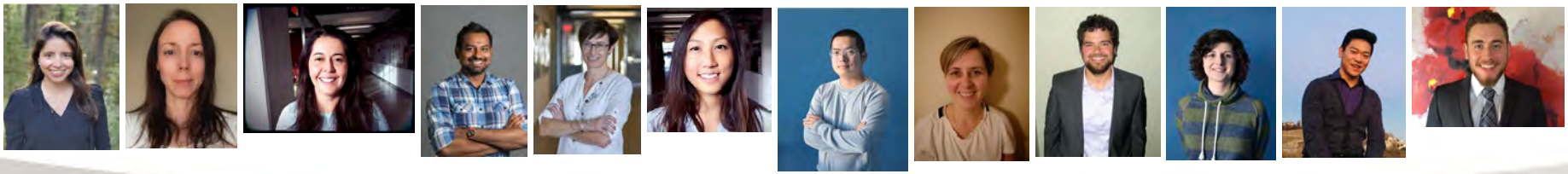
- None related to this talk

- Prior to June – I had no wastewater experience – nor ambition ….
  - What is being presented is on behalf of our entire team

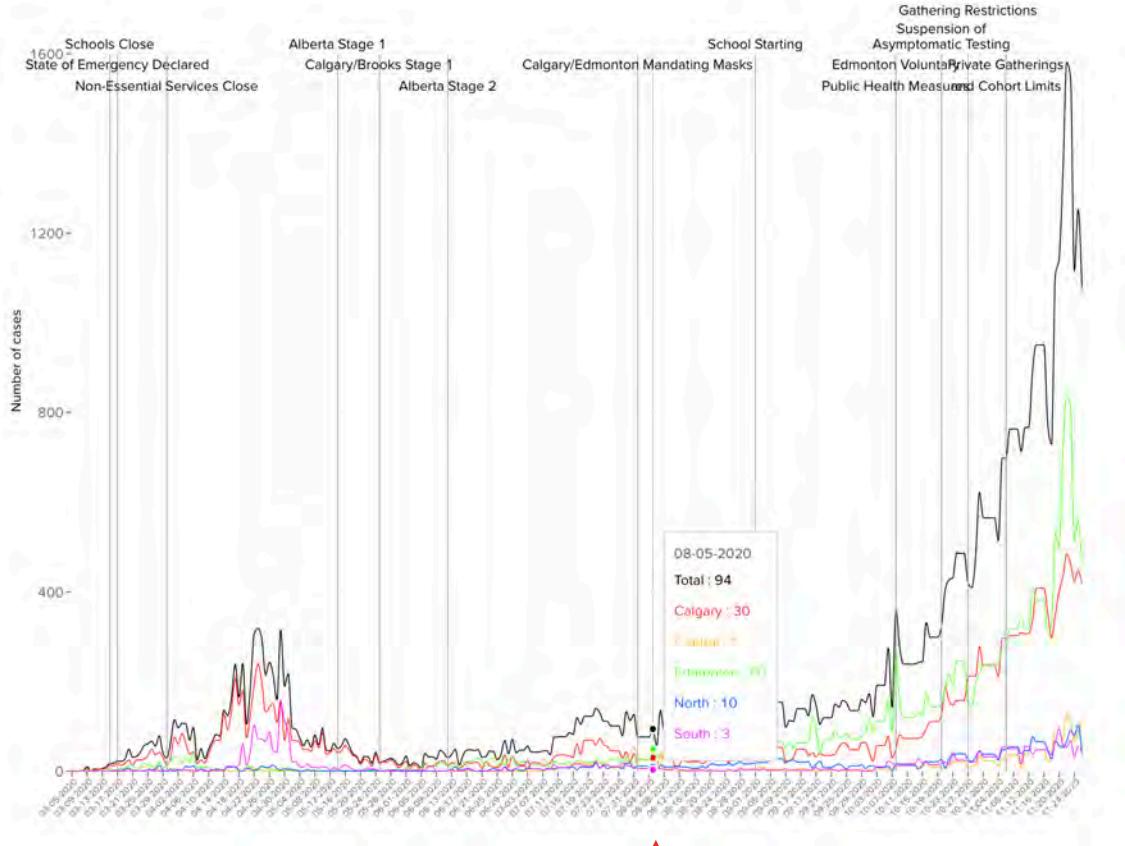
Investigative Team:



HQP:



Why monitor hospital wastewater?



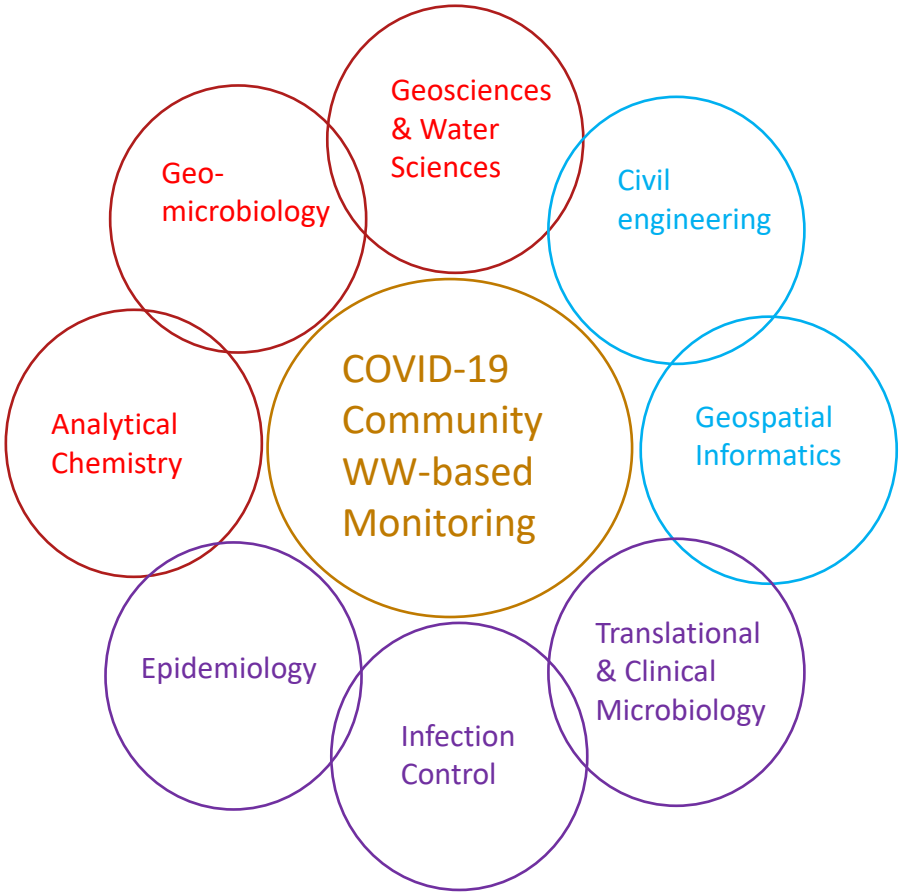
CSM COVID-19 Tracker

RATIONALE:

- Few community cases – when we started….
- Validation - Known Denominator
- Outbreak identification?
- Ease of access/Fixed nodes
- Leverage samples for other studies

Critical Partnerships

- Partnerships are critical for this project.
- Trans-disciplinary approach
  - ACWA
  - Alberta Health Services (AHS)
  - City of Calgary
  - UofC



General workflow

- SARS-CoV-2 wastewater-based epidemiology project:

01

Sample collection

Current location sites:

Hospital and wastewater treatment plants

02

Sample Clean up and concentration

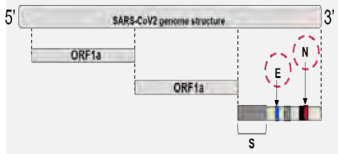
Methodology → Silica column done in ACWA.

40ml of ww samples are collected and spiked with a surrogate organism

03

Molecular analysis

RT-qPCR: Detection of viral RNA material, spike (BCoV) and normalization control from wastewater samples.

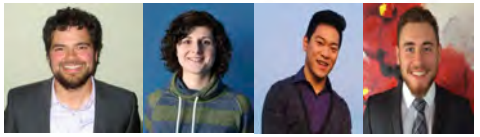


04

Data analysis

Sample Collection

UNIVERSITY OF CALGARY

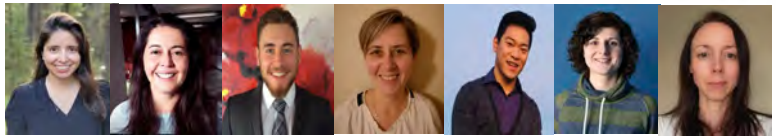


- 24-hour composite samplers
- Placed in or near sewer access ports

ONWARD Calgary

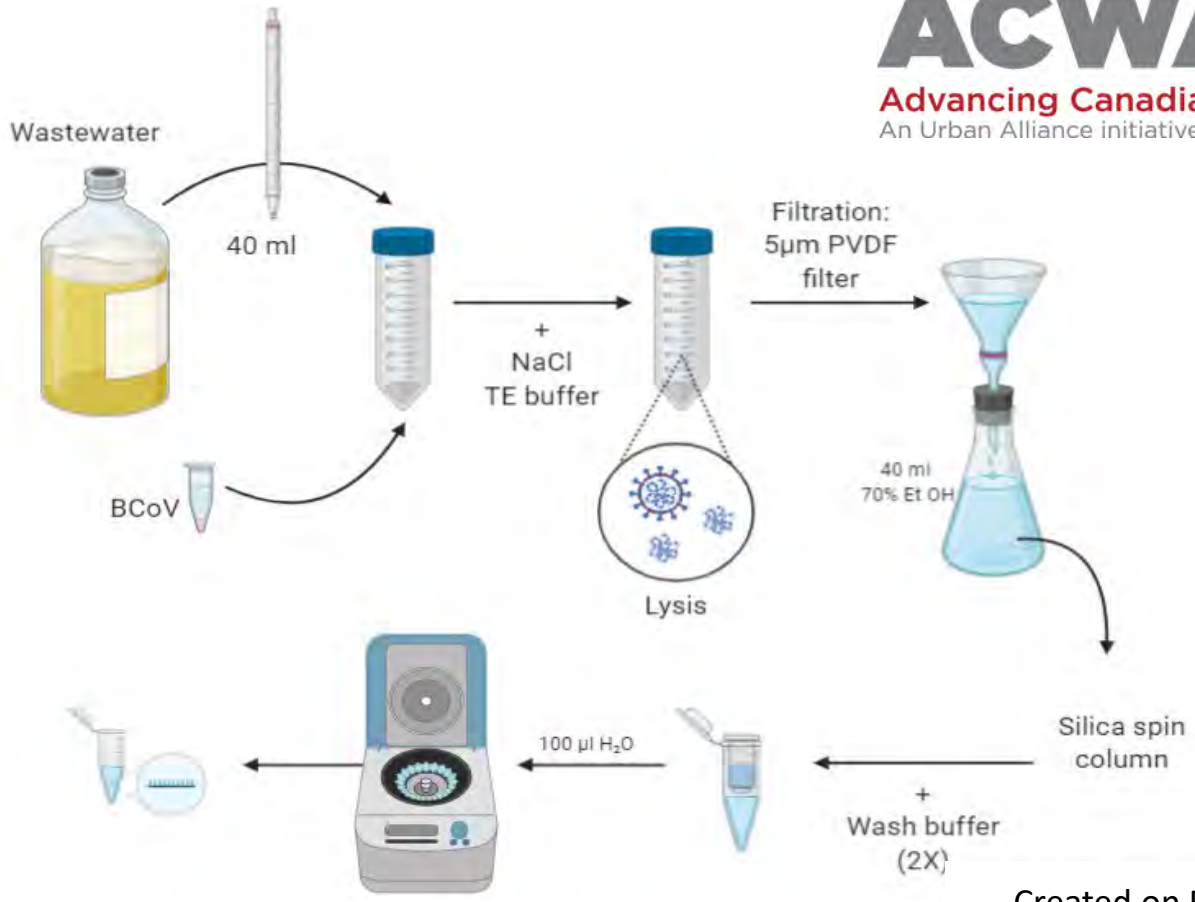
Sample Clean Up and Concentration

UNIVERSITY OF CALGARY



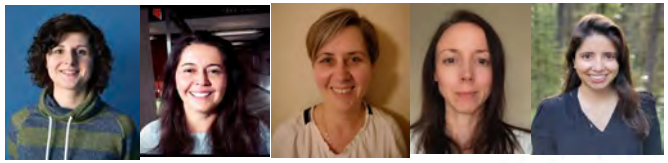
ACWA
Advancing Canadian Wastewater Assets
An Urban Alliance initiative

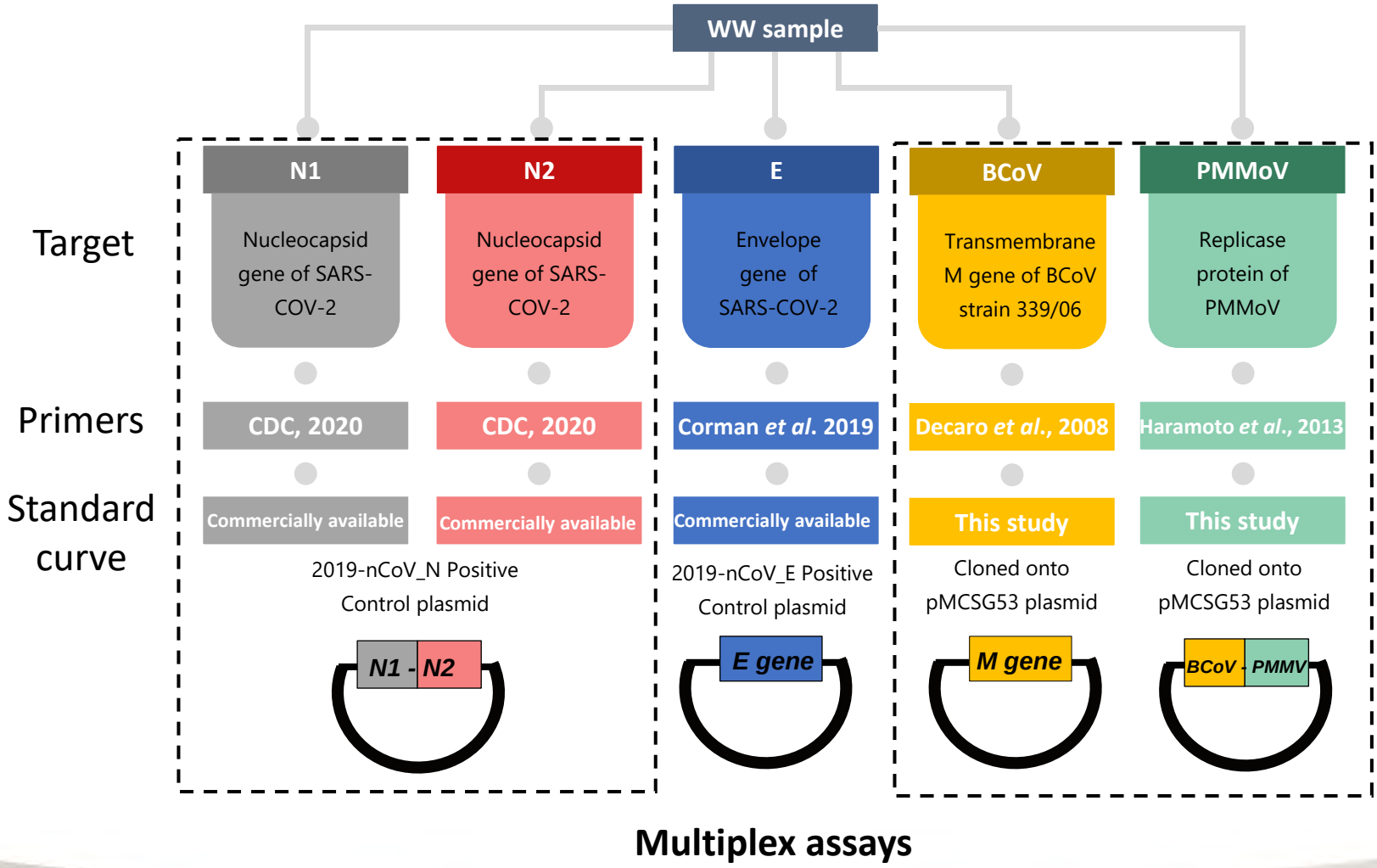
- Silica column



Created on Biorender.com

Molecular analysis –TARGET MONITORING





Hospital monitoring of SARS-COV-2 Activity

UNIVERSITY OF CALGARY

Aim:

- Pilot Project to assess for SARS-CoV-2 in WW from Calgary hospitals:
  - FMC: Foothills Medical Center ~1200 beds adult hospital NW
  - PLC: Peter Lougheed Center ~ 700 beds adult hospital NE
  - RGH: Rockyview General Hospital ~ 700 beds adult hospital SW
- Collection start date:
  - August 5th – one site at each facility
  - October 1st: expansion to two additional locations at FMC (i.e. B and C)
- Sampling time frame:
  - Twice per week (but scalable)

FOOTHILLS MEDICAL CENTRE

UNIVERSITY OF CALGARY

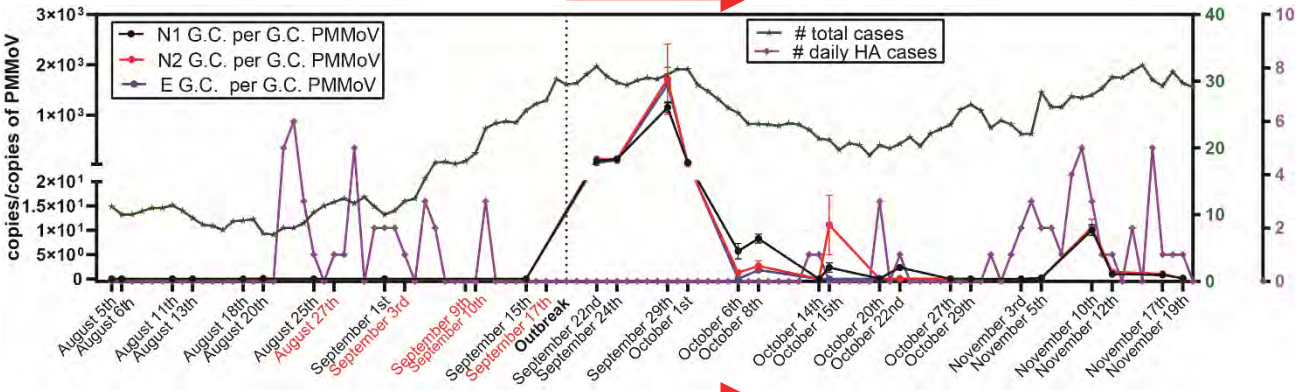
FOOTHILLS MEDICAL CENTRE

- August 5th to Nov 19th

FMC A

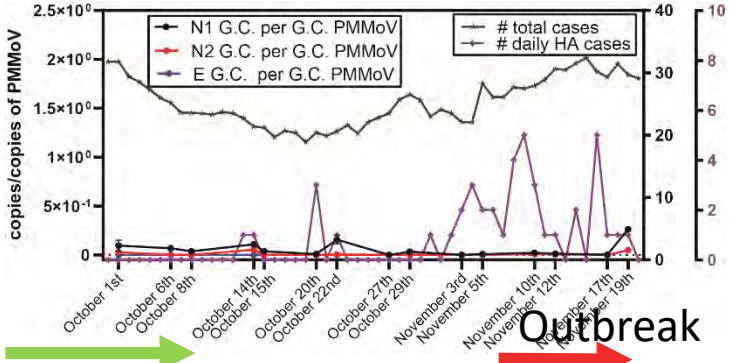
43.8%

Outbreak

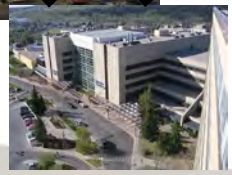


FMC B

93.3%

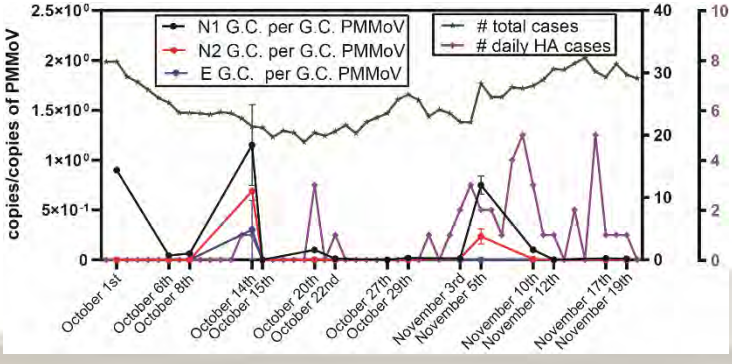


Outbreak



FMC C

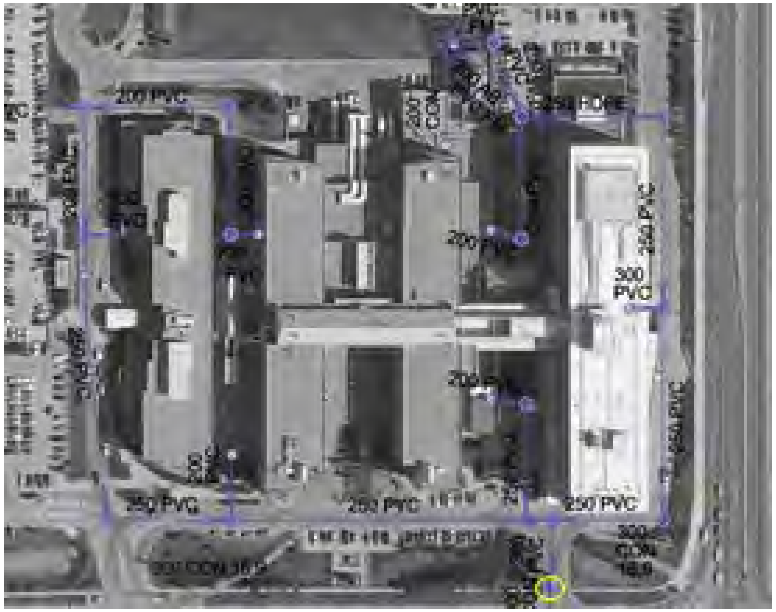
86.7%

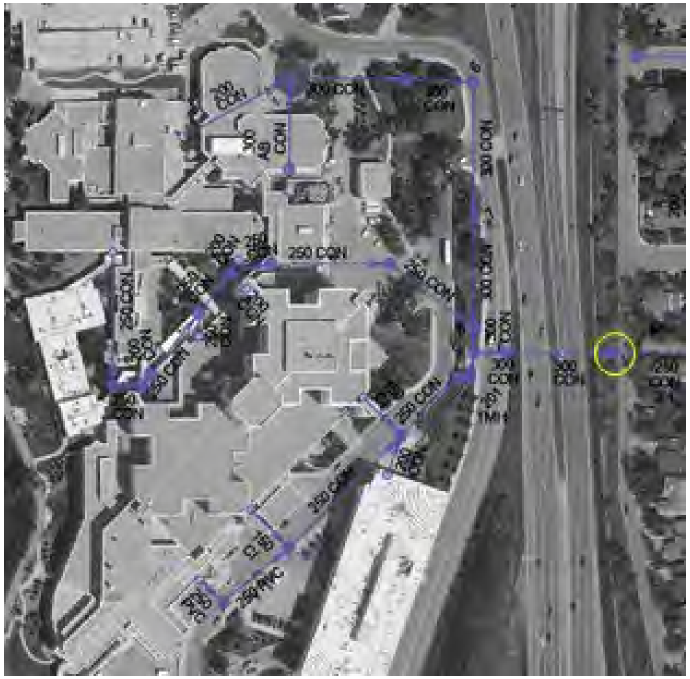


UNIVERSITY OF CALGARY

PETER LOUGHEED CENTRE

ROCKYVIEW GENERAL HOSPITAL





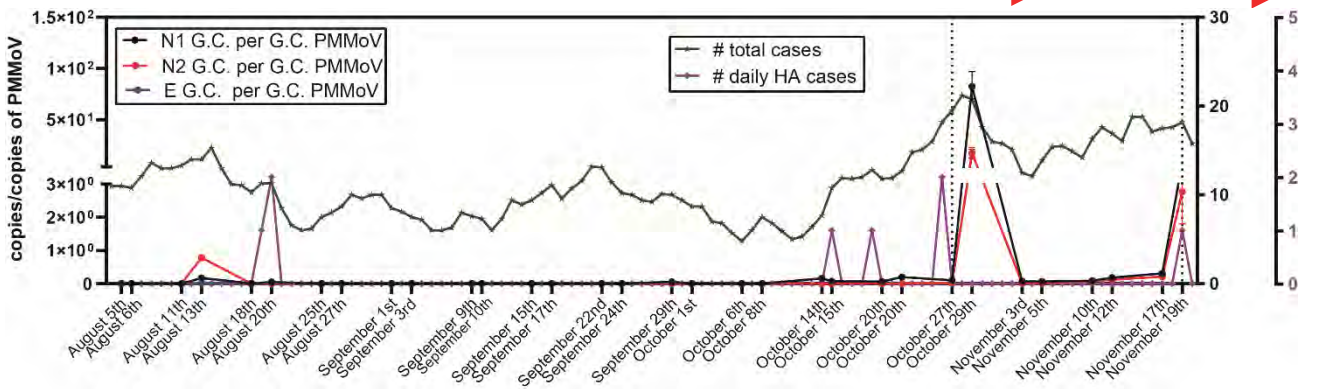
Hospital Based WW SARS-COV2 Monitoring

UNIVERSITY OF CALGARY

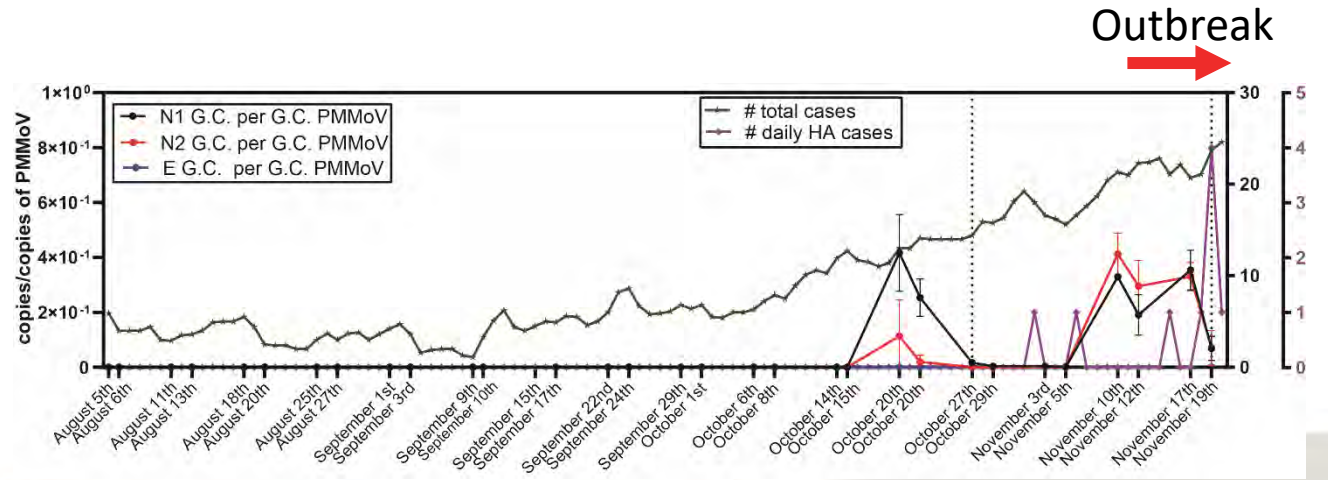
SARS-Cov2 signal

- August 5th to Nov 19th

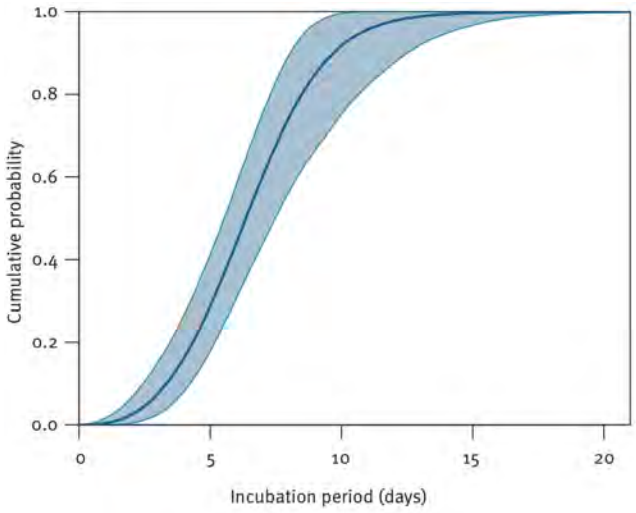
PLC
53.1%



RGH
31.3%

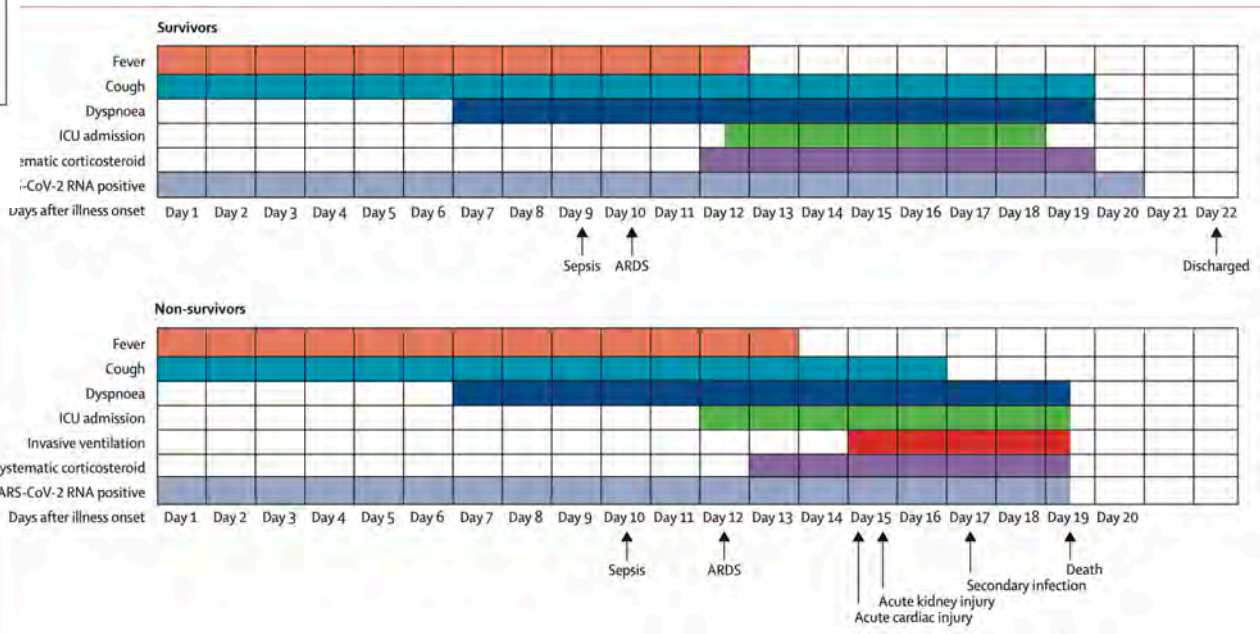


Why aren't we detecting significant community acquired cases in hospital?



Backer Euro Surv 2020

Natural History of COVID-19



Zhou Lancet 2020;395:1054

Early Lessons Learned in Hospital

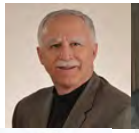
- SARS-COV2 virus can be found in hospital – both % of samples and abundance increasing over time
- Complete capture of hospital system is required
- Monitoring is only effective for hospital "poopers"
  - Hospitalized COVID-19 patients often too sick to self-toilet


  - HCW habits?
- WW SARS-COV2 signal correlates with incident cases of COVID-19 and not prevalent cases
- WW SARS-COV2 signal in hospitals correlates with outbreaks affecting patients and staff (?) – not community acquired cases
- Some hospital samples may not be evaluable …. Why remains to be determined

Acknowledgements







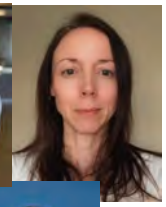




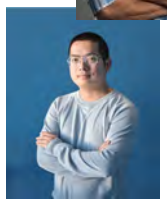


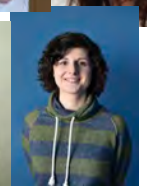












UNIVERSITY OF CALGARY

ONWARD Calgary

Alberta Health Services
Infection Prevention & Control

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Parkins Hubert Conly Achari Ruecker Meddings Pillai Naugler Ryan Hu Cabaj Frankowski

UNIVERSITY OF CALGARY

Parkins
Hubert

INNOVATION.CA
CANADA FOUNDATION FOR INNOVATION | FONDATION CANADIENNE POUR L'INNOVATION

Hubert Parkins Ryan Conly Achari

COVID-19 Wastewater Coalition
WBE in Canada: Use cases, challenges & next steps

Thank you, webinar speakers!

- Steve Hrudey, COVID-19 Wastewater Coalition
- Robert Delatolla, University of Ottawa
- Mark Servos, University of Waterloo
- Yuwei Xie, University of Saskatchewan
- Mike McKay, Great Lakes Institute for Environmental Research, University of Windsor
- Mike Parkins, University of Calgary

Thank you for attending today's webinar series.

Slides and recordings will be available next week at:
cwn-rce.ca/events/webinars/cwn-webinars

COVID-19 Wastewater Coalition
Phase 2 Inter-Laboratory Study
Estimated start date: February 2021

Canadian Water Network

Canadian Water Network

Insights for the water sector

helping decision-makers move forward

Canadian Water Network frames what is known and unknown in a way that usefully informs the choices being made.

cwn-rce.ca