THE Water Research FOUNDATION®

Congressional Briefing

Environmental Surveillance of the Genetic Footprint of COVID-19 in Sewersheds

Thursday, May 21 | 2:00 PM EDT

THE Water Research FOUNDATION

Welcome!

Peter Grevatt, PhD, CEO

The Water Research Foundation

Agenda

- Introduction
  - Peter Grevatt, PhD, CEO, The Water Research Foundation
- Case Examples
  - Dan Gerrity, PhD, Southern Nevada Water Authority
  - Jim Pletl, PhD, Hampton Roads Sanitation District
  - Ken Williamson, PhD, Clean Water Services
- Q/A
  - Peter Grevatt, PhD, CEO, The Water Research Foundation

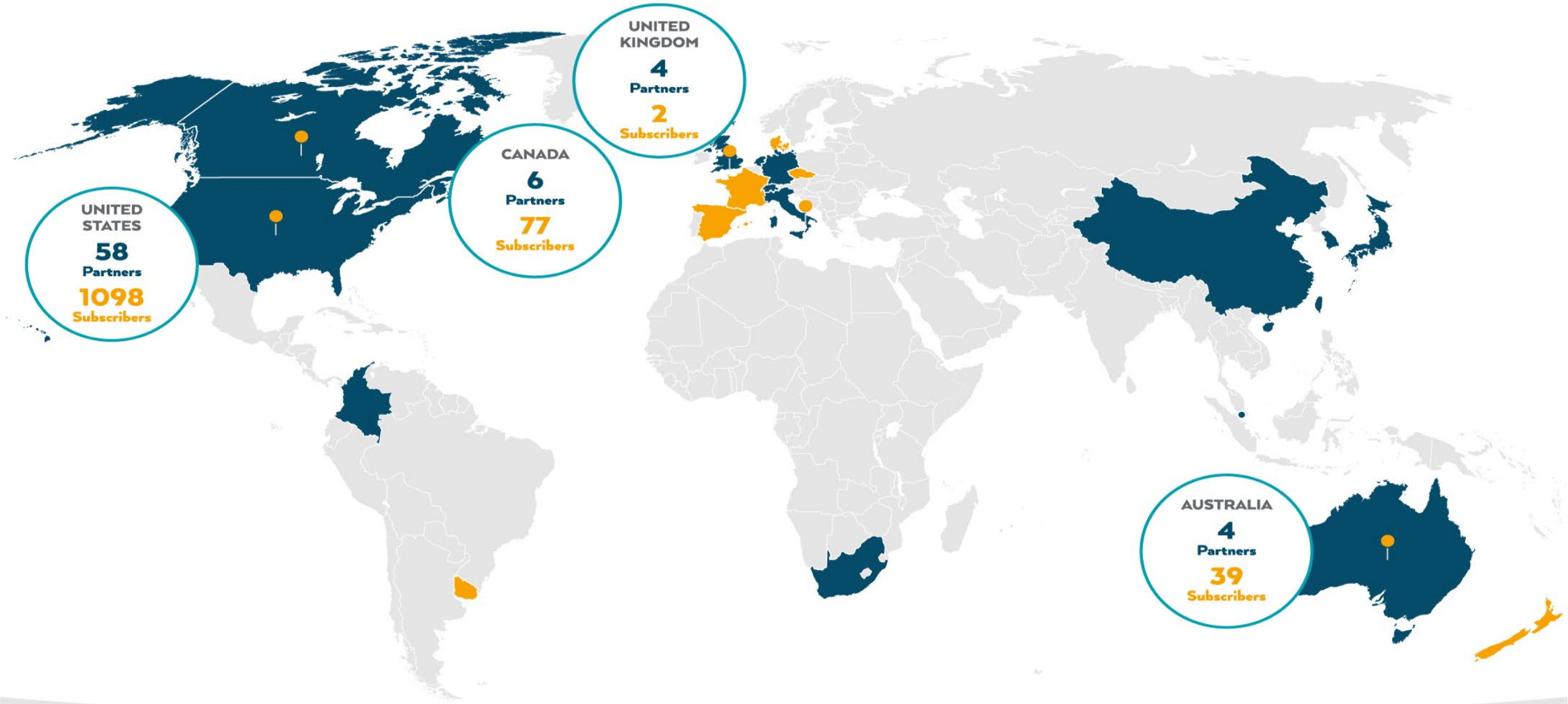
ABOUT

MISSION

Advancing the science of water to improve the quality of life.

VISION

To create the definitive research organization to advance the science of all things water to better meet the evolving needs of subscribers and the water sector.



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International Water Research Summit
Environmental Surveillance of COVID-19 Indicators in Sewersheds
April 27-30, 2020

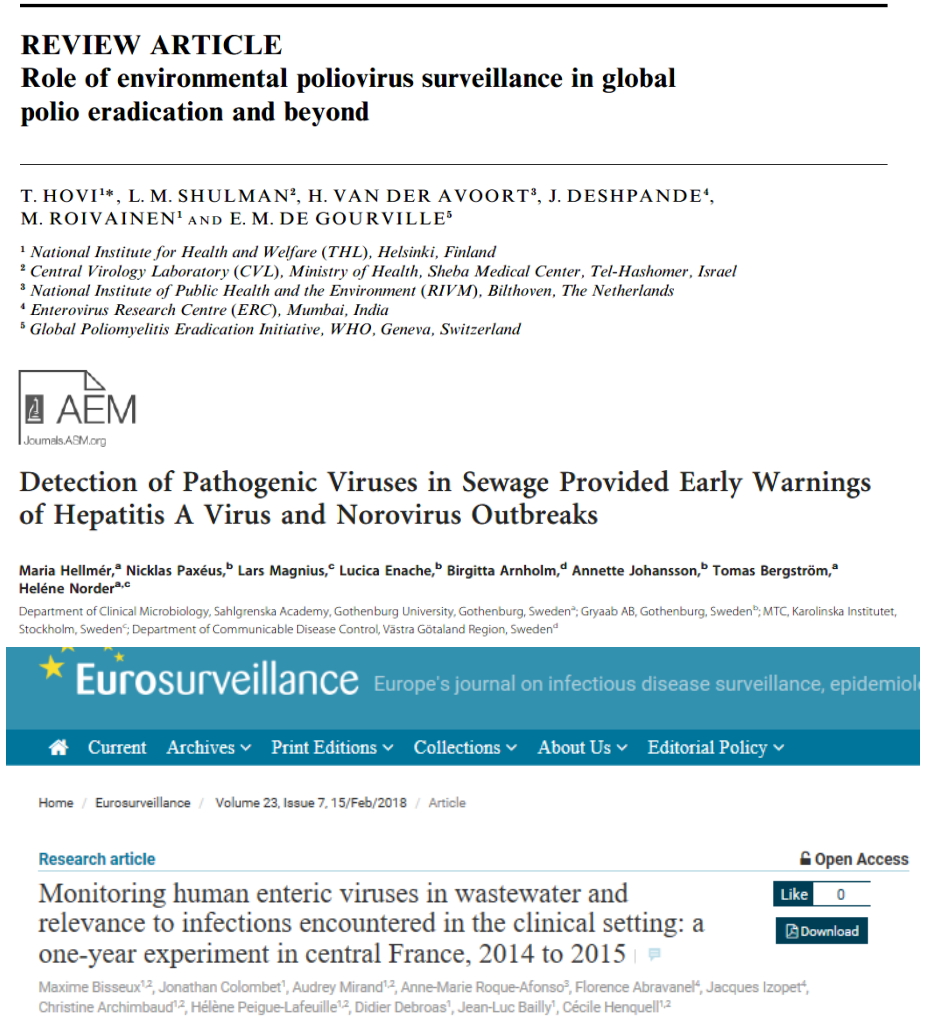
Use Cases of Sewershed Surveillance for Other Viruses

Poliovirus

- absence of virus circulation in (unvaccinated) population
- early warning outbreaks

Adenovirus, norovirus, rotavirus, parechovirus, enterovirus, astroviruses, hepatitis A and E viruses

- early warning outbreaks
- virus circulation in population
- virus genotypes circulating in population



REVIEW ARTICLE
Role of environmental poliovirus surveillance in global polio eradication and beyond

T. HOVI[1]*, L. M. SHULMAN[2], H. VAN DER AVOORT[3], J. DESHPANDE[4], M. ROIVAINEN[1] AND E. M. DE GOURVILLE[5]

[1] *National Institute for Health and Welfare (THL), Helsinki, Finland*
[2] *Central Virology Laboratory (CVL), Ministry of Health, Sheba Medical Center, Tel-Hashomer, Israel*
[3] *National Institute of Public Health and the Environment (RIVM), Bilthoven, The Netherlands*
[4] *Enterovirus Research Centre (ERC), Mumbai, India*
[5] *Global Poliomyelitis Eradication Initiative, WHO, Geneva, Switzerland*

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Detection of Pathogenic Viruses in Sewage Provided Early Warnings of Hepatitis A Virus and Norovirus Outbreaks

Maria Hellmér,[a] Nicklas Paxéus,[b] Lars Magnius,[c] Lucica Enache,[b] Birgitta Arnholm,[d] Annette Johansson,[b] Tomas Bergström,[a] Heléne Norder[a,c]

Department of Clinical Microbiology, Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden[a]; Gryaab AB, Gothenburg, Sweden[b]; MTC, Karolinska Institutet, Stockholm, Sweden[c]; Department of Communicable Disease Control, Västra Götaland Region, Sweden[d]

Eurosurveillance Europe's journal on infectious disease surveillance, epidemiol

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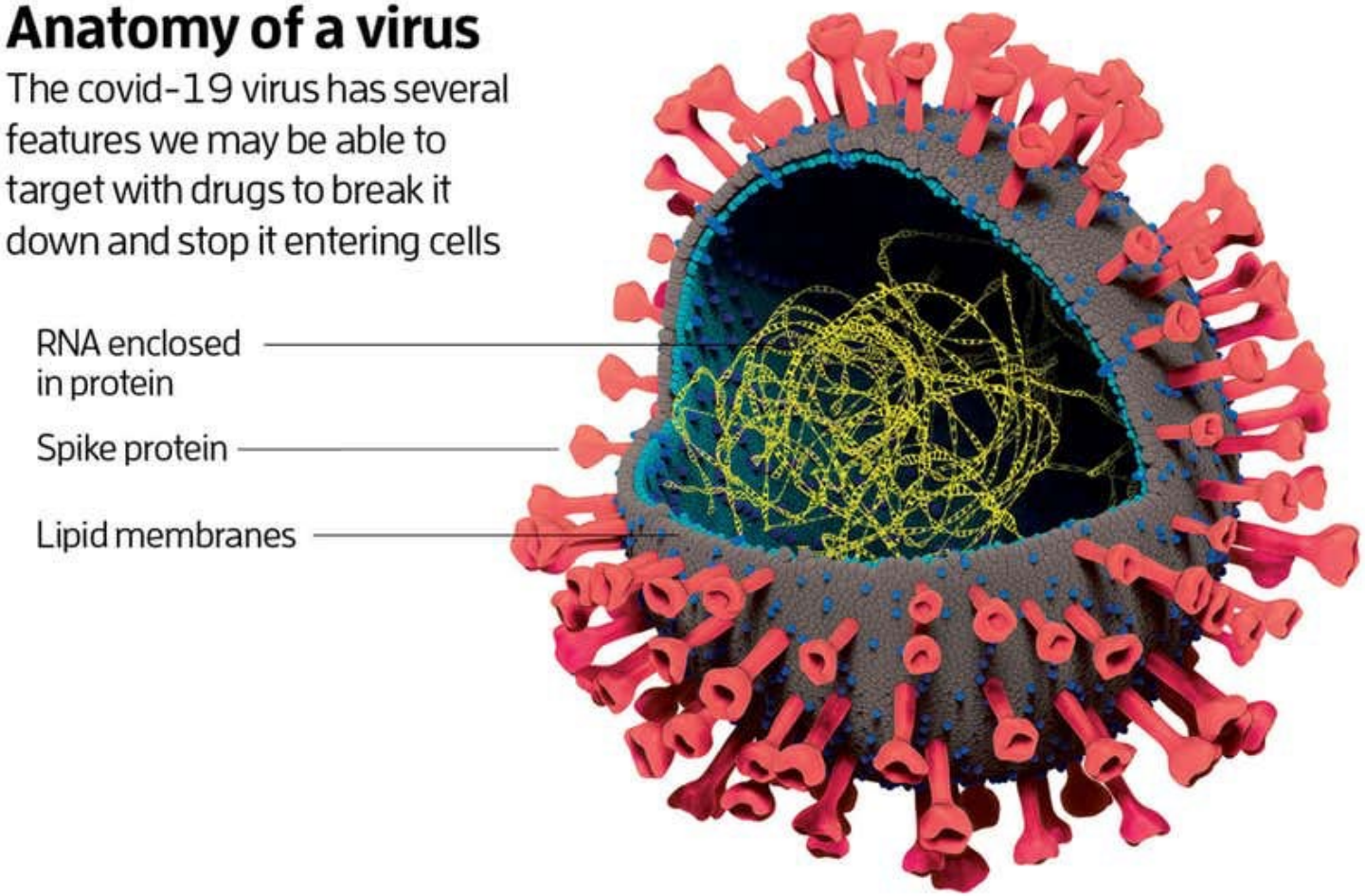
Research article — Open Access

Monitoring human enteric viruses in wastewater and relevance to infections encountered in the clinical setting: a one-year experiment in central France, 2014 to 2015

Like 0 Download

Maxime Bisseux[1,2], Jonathan Colombet[1], Audrey Mirand[1,2], Anne-Marie Roque-Afonso[3], Florence Abravanel[4], Jacques Izopet[4], Christine Archimbaud[1,2], Hélène Peigue-Lafeuille[1,2], Didier Debroas[1], Jean-Luc Bailly[1], Cécile Henquell[1,2]

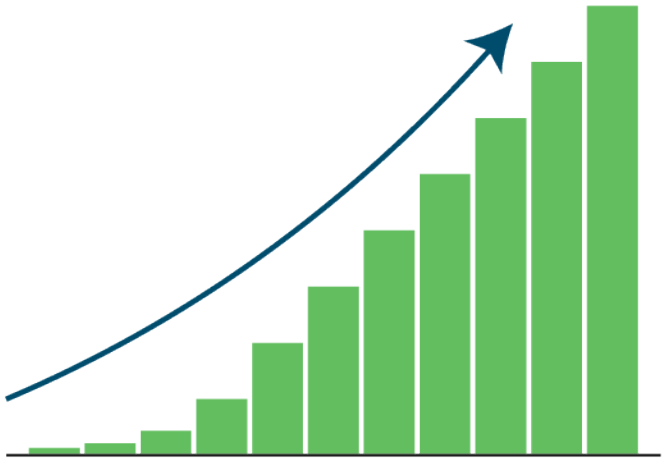
Example of Genes, RNA, and Remnants of Inactive Virus



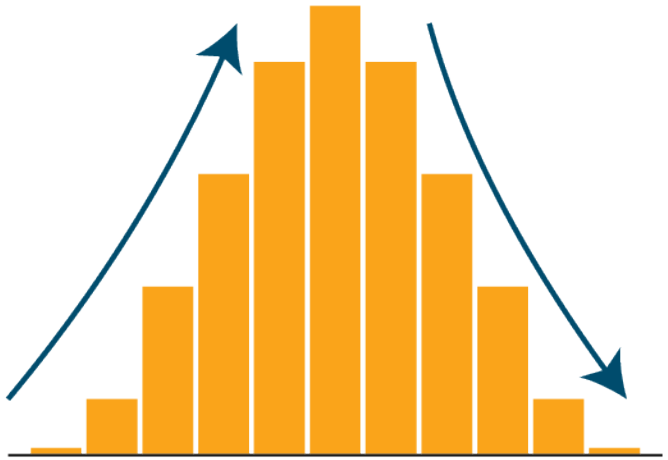
Source: Tim Vernon/Science Photo Library

Use Cases

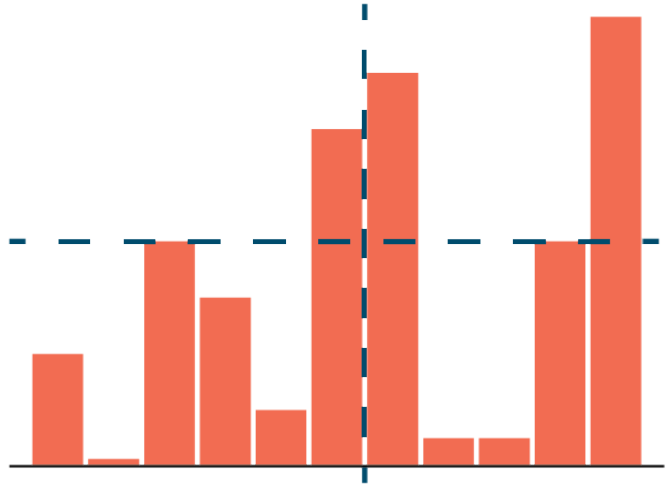
Trend Occurrence



Changes in Trends



Community Prevalence



What Can You Use Sewershed Surveillance Data For?

General Use Cases	Can Inform
Assess Level of Community Infection	Tracking disease prevalence in the community. Identification of "hot spots" and areas that are not impacted by the virus
Trends/Changes in Infection	Early detection of disease. Tracking the impact of medical and social interventions
Risk Assessment	Risk to utility workers and those exposed to raw sewage
Viral Evolution	Source tracking of the virus

Understanding the Potential of Sewershed Surveillance

- Sewershed surveillance can complement clinical data for community assessments or decision making
- Provides a leading indicator of community infection
- This work is rapidly developing, and has the potential to inform our understanding in the context of this pandemic

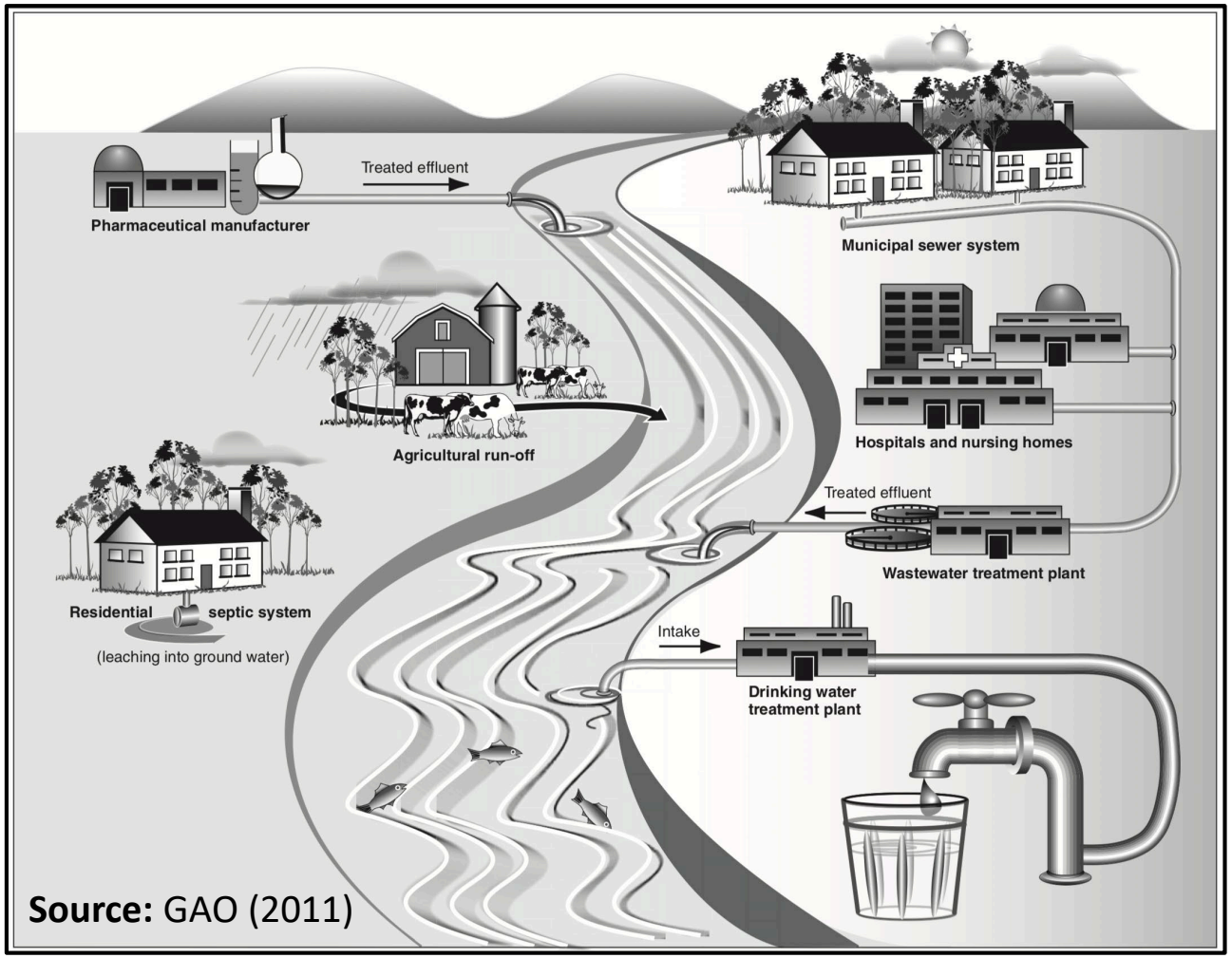
THE Water Research FOUNDATION

Daniel Gerrity, PhD

Principal Research Scientist, Water Quality R&D
Southern Nevada Water Authority (SNWA)
Associate Professor, Civil & Environmental Engineering
University of Nevada Las Vegas (UNLV)

SNWA Water Quality R&D – Mission

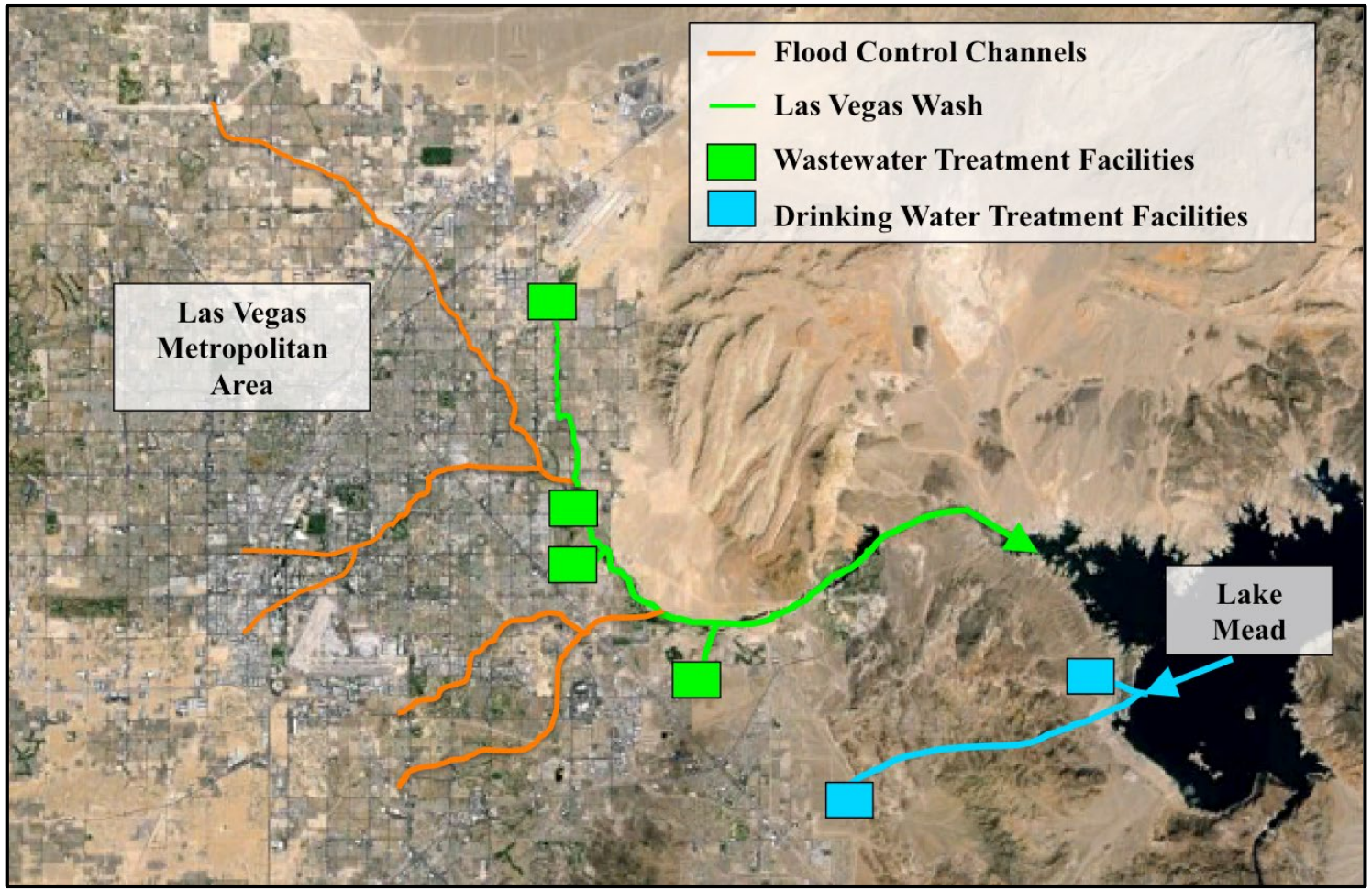
1. Research that is directly applicable to water quality and ensuring a reliable water supply in Southern Nevada
2. Research that is applicable to the broader water industry, often with funding from The Water Research Foundation, Bureau of Reclamation, National Science Foundation, and other agencies



Source: GAO (2011)

SNWA Water Quality R&D – Brief History

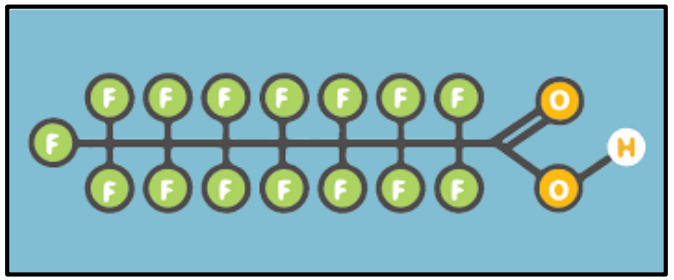
- **Return Flow Credits** = collaborative relationship between wastewater and drinking water agencies
- Approximately 20 years of research into contaminants of emerging concern (CECs)
- R&D expanded to include *microbial* CECs in late 2019



Contaminants of Emerging Concern (CECs)

Pharmaceuticals (2000s)

PFAS/PFOS/PFOA (2010s)



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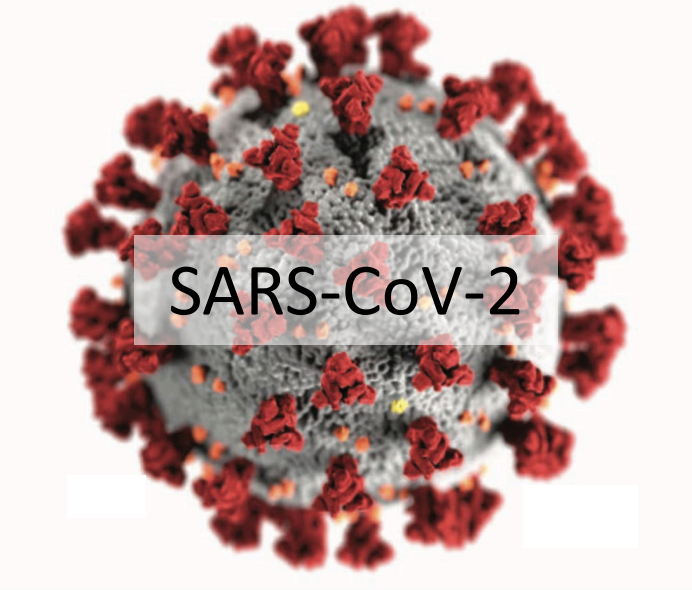
Emerging Challenges

Create **Uncertainty**

for the Water Industry

Contaminants of Emerging Concern (CECs)

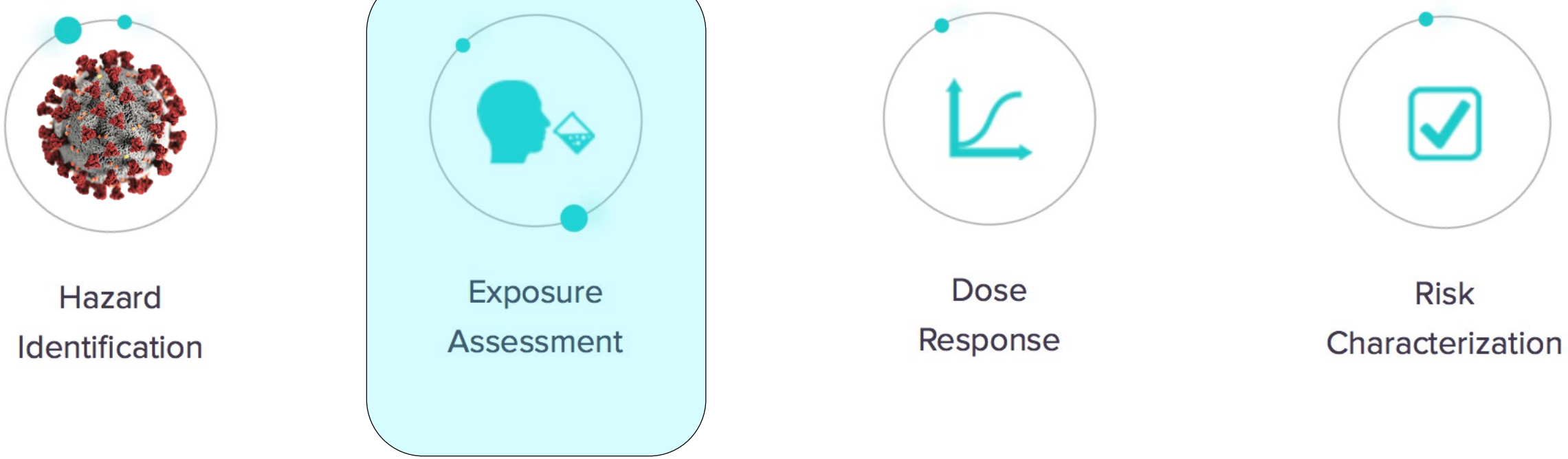


= Water Industry Can Reduce **Uncertainty** Through Research

- Knowledge from Research on Past Outbreaks (SARS, MERS, Ebola)
- Knowledge from Research on Current Outbreak (COVID-19)

Quantitative Microbial Risk Assessment (QMRA)

Do our existing water systems adequately protect public health against emerging pathogens today (SARS-CoV-2) and in the future?



Source: Center for Advancing Microbial Risk Assessment

Current Understanding of Drinking Water Risk

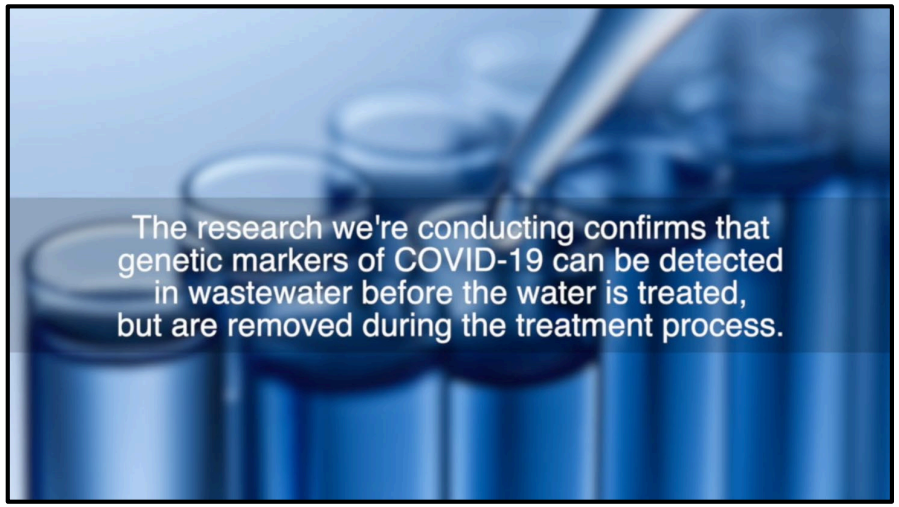
Do our existing water systems adequately protect public health against emerging pathogens today (SARS-CoV-2) and in the future?

Exposure Assessment

1. Expected concentrations of SARS-CoV-2 genetic material?
   - **Non-detect** in treated wastewater, source water, and drinking water
2. Expected concentrations of *infectious* SARS-CoV-2?
   - Appear to be **low (if any)** in feces and ultimately raw wastewater
3. Reductions during natural and engineered treatment?
   - Likely **highly susceptible to treatment** based on surrogates (literature)

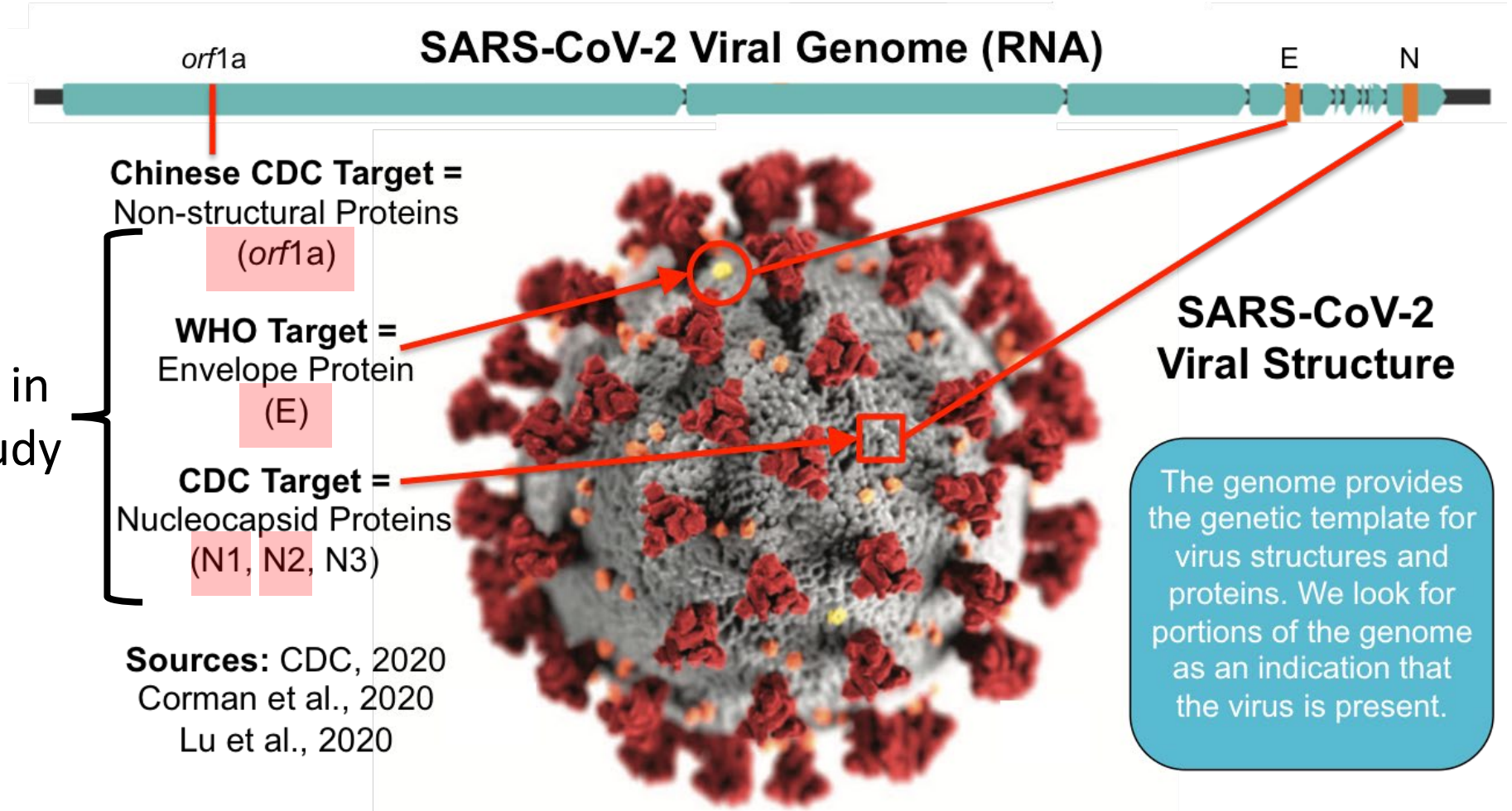
SNWA Response to COVID-19 and SARS-CoV-2

- Enacted elements of *Pandemic Readiness and Response Plan* on March 17 to ensure continued reliable water supply for Southern Nevada
- Quickly initiated monitoring of SARS-CoV-2 ‘fingerprint’ in wastewater, source water, and drinking water in early March
- Developed guidance documents and presentations leveraging past research findings and new monitoring data
- Communicated findings to the public through social media

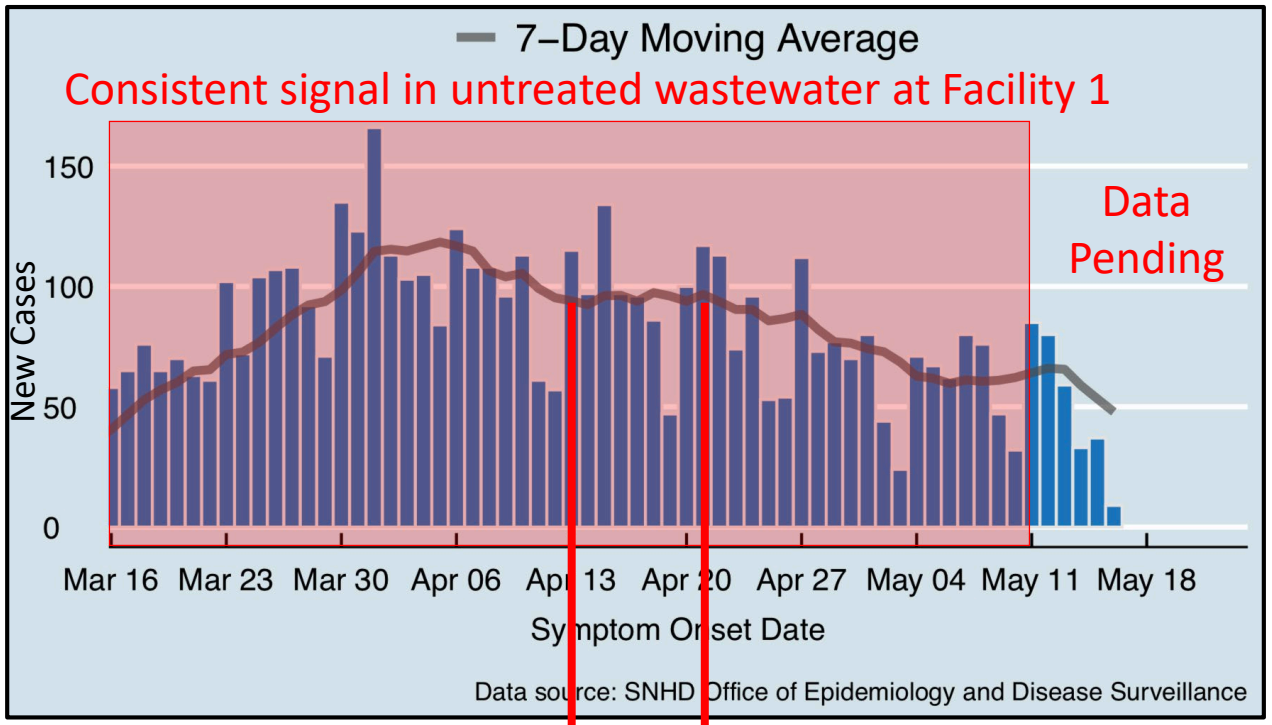


Molecular Targets for Environmental Surveillance

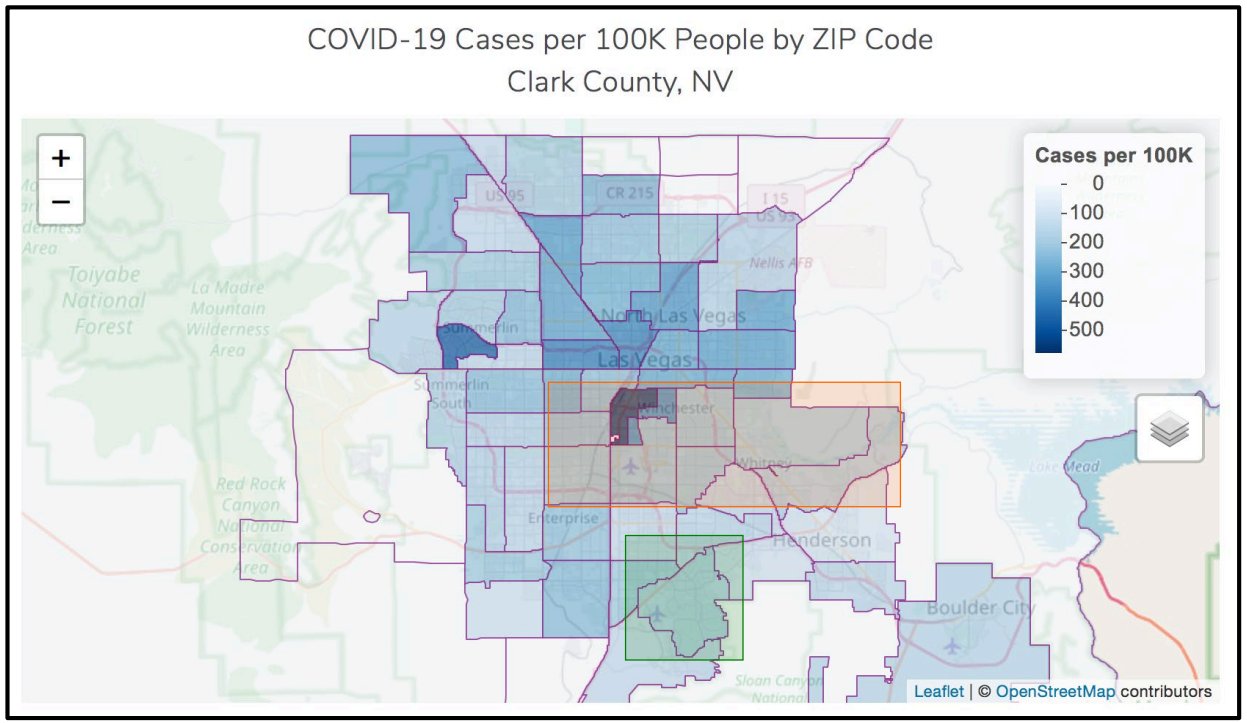
4 targets in SNWA study



SARS-CoV-2 Data for Southern Nevada



Multiple samples with 'hits' for all 4 molecular targets



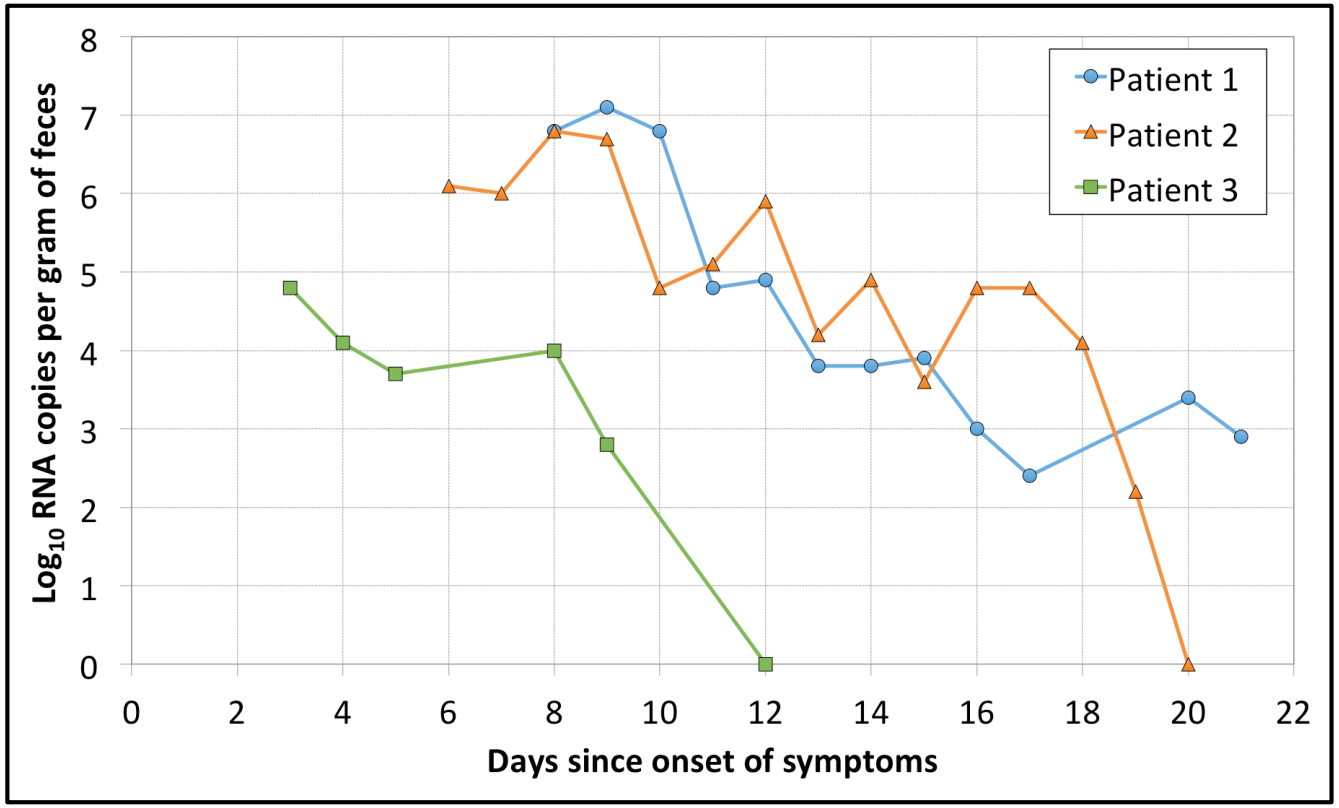
- Service Area 1: 200-600 cases per 100,000
  - Consistent 'hits' in untreated wastewater
- Service Area 2: <200 cases per 100,000
  - Fewer 'hits' in untreated wastewater

Source: Southern Nevada Health District

Potential for Prevalence Calculations

$$\text{Infections (persons)} = \frac{\text{Concentration (gene copies/L)} \times \text{Wastewater Flow Rate (L/day)}}{\text{Feces Production Rate (grams/person-day)} \times \text{Fecal Shedding Rate (gene copies/gram)}}$$

- Environmental surveillance has the potential to inform prevalence calculations
- This tool requires further refinement to reduce uncertainty and capture variability of key parameters
- Ratios of SARS-CoV-2 RNA to common wastewater constituents may be valuable

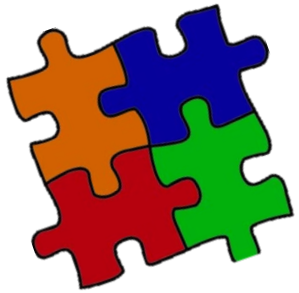


Source: Wolfel et al. (2020) Nature

Future Outcomes of Environmental Surveillance

- We have an **opportunity** and **responsibility** to leverage our resources to:
  - Learn from the current pandemic to establish best practices
  - Develop effective tools to better inform policymakers/stakeholders
  - Prepare for future challenges so that we can quickly respond
- **Environmental surveillance** is a critical 'piece of the puzzle' in understanding the link between water and public health

Water ⟷ Public Health



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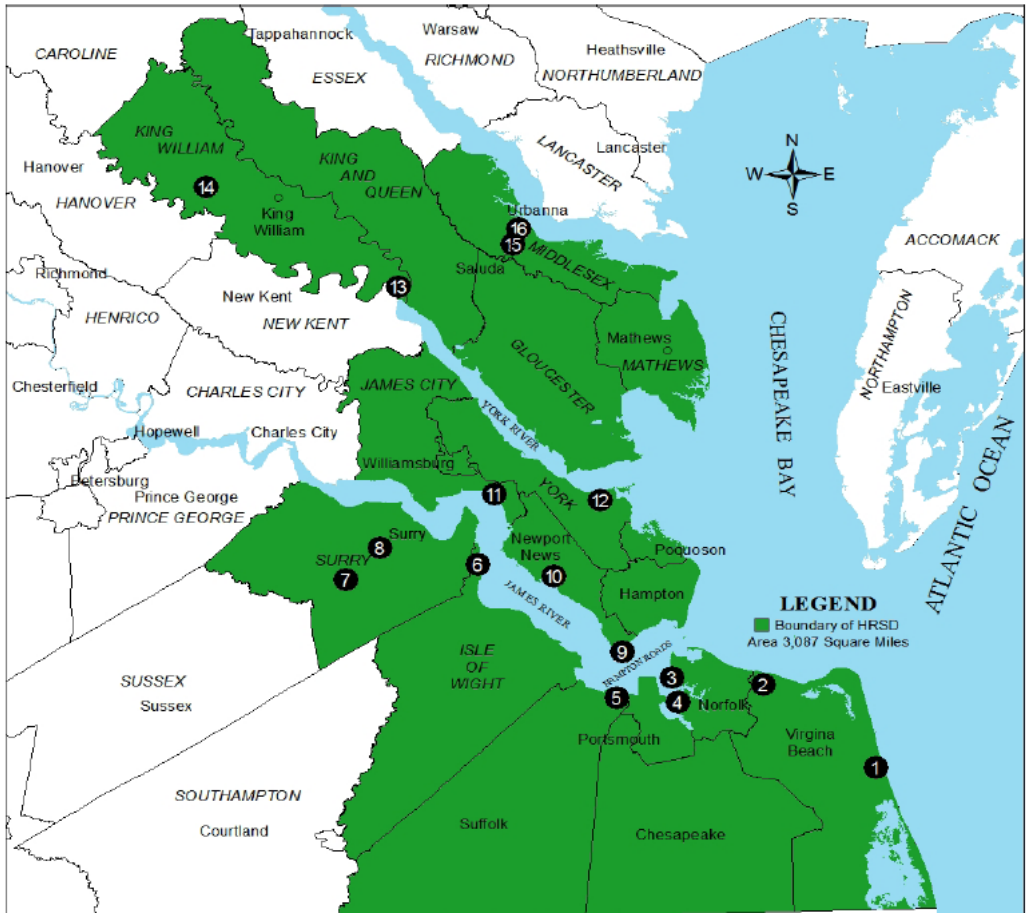
Jim Pletl, PhD

Director of Water Quality

Hampton Roads Sanitation District

Hampton Roads Sanitation District (HRSD)



- Independent political subdivision
- 18 cities and counties
- 1.8 million residents served
- 17 facilities total, 9 majors
- 3100 square mile service area
- >500 miles of pipe
- >100 pump stations
- 150 mgd avg daily flow treated

HRSD Wastewater Surveillance

- Began qPCR and microbial source tracking 5 years ago
- Successful in identifying failed infrastructure causing violations of water quality standards in local surface waters
- Use biomarkers unique to human wastewater to trace sources
- Dedicating 1-2 managers and 3-4 field sampling/laboratory staff at any point in time
- Staff have also been involved in other PCR-viral projects:
  - national inter-laboratory studies of viral analytical methods
  - wastewater load and treatment studies of viruses
  - viral investigations relative to potable uses of highly treated wastewater

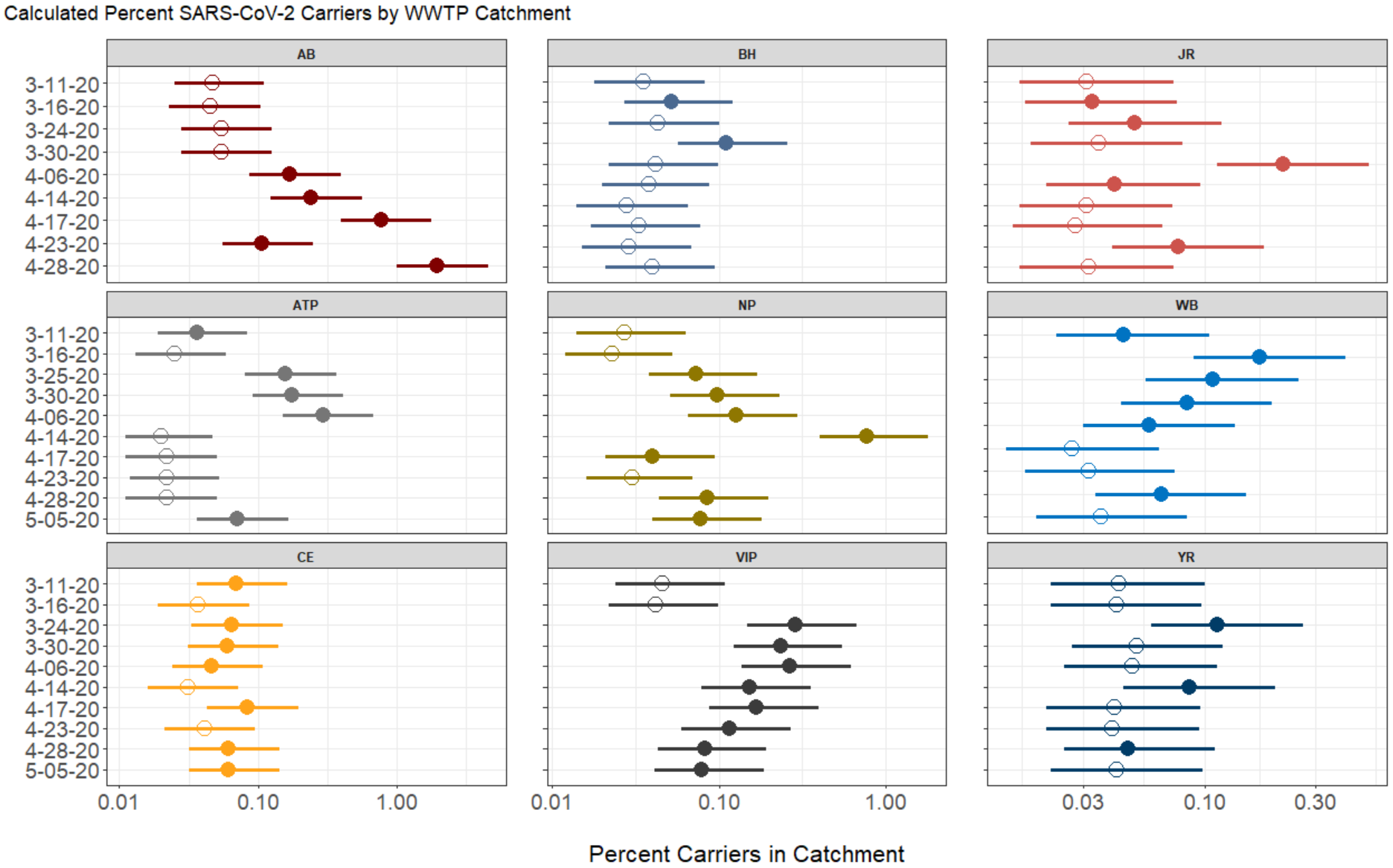
Why Pursue a COVID-19 WS Study?

- …basic tools and knowledge in place
- …desire to support local health officials
- …genetic primers available for qPCR
- …understood the value based on previous WS studies investigating community stress relative to opioids
- …test to see how long it takes for our staff to come up to speed given a new target

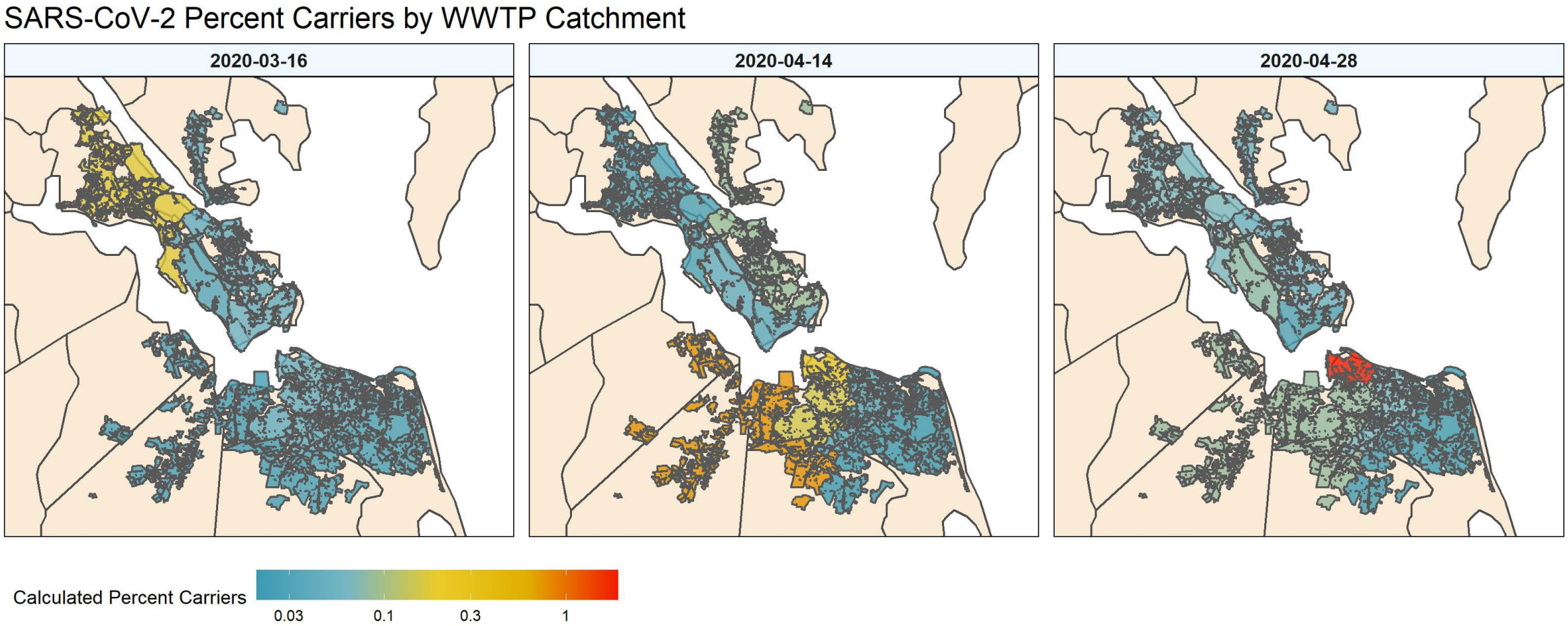
HRSD COVID-19 Study

- Sampled influent of 9 major facilities, pump stations and treatment facility effluent, starting March 11
- 180 samples analyzed using PCR to measure genetic signal
- Not an infectivity study
- Trends in prevalence evident at different plants serving different portions of the Hampton Roads population
- Sensitivity of plant influent monitoring can detect 1 in 10,000 occurrence or better

Percent Carriers By Plant



Community Prevalence Time Series



HRSD COVID-19 Monitoring Investment

- 1 Manager with expertise in PCR, microbiology and wastewater; 10-20 hours per week
- 2 fully trained analytical specialists; 12 hours per week
- 2 fully trained sample collection specialists; 36 hours per week
- Equipment: $70k (digital PCR), $70k (automated RNA extractor)
- Supplies: wastewater concentrator, portable refrigerated samplers
- Cost/sample: $100/sample

Wastewater Surveillance Considerations

- Only a tool to support event management
- Community social and clinical information critical
- **Requires partnership with local/state health professionals**
- Site-specific circumstances define approach
  - Central or decentralized system
  - Gravity vs. force mains
  - Timing with event
  - Industrial contributions
  - Population stability – military, commuting, tourism, etc.

Wastewater Surveillance Considerations

- PCR sample prep and analytical methods are not standardized
  - Can affect use of data
  - Comparability in data sets within and between studies uncertain
- Data Interpretation
  - Asymptomatic infection, “true” prevalence
  - Connecting PCR data to infection prevalence
  - Presence/absence, detection
  - Quantitation

Wastewater Surveillance Considerations

- Many moving parts and uncertainty require collaboration
  - Community of Practice
    - Help standardize method
    - Develop monitoring framework
    - Answer questions
    - Drive consensus
    - Municipal network of labs
    - Possibly perform event “drills”, Norovirus

Research Priorities

- Characterize viral shedding magnitude and variability
- Inter-lab study of sample prep and analytical methods
  - Define performance standards, quality objectives
  - Avoid prescriptive methods to facilitate adoption
- Convert PCR info to a metric for infectivity
- Small epidemiological studies with random sampling of population
  - Understand contribution of asymptomatic individuals to load
  - Needed to reliably translate wastewater data to community prevalence
- Wastewater exposure risk
  - Liquid
  - Aerosols
  - Solids

Federal Role in Wastewater Surveillance

- Facilitate health professional – wastewater partnerships
- Support analytical method guidance development
- Sampling/analytical safety standards
- Fund research
- Fund pilots to demonstrate utility
  - Link data, community action and results

THE Water Research FOUNDATION

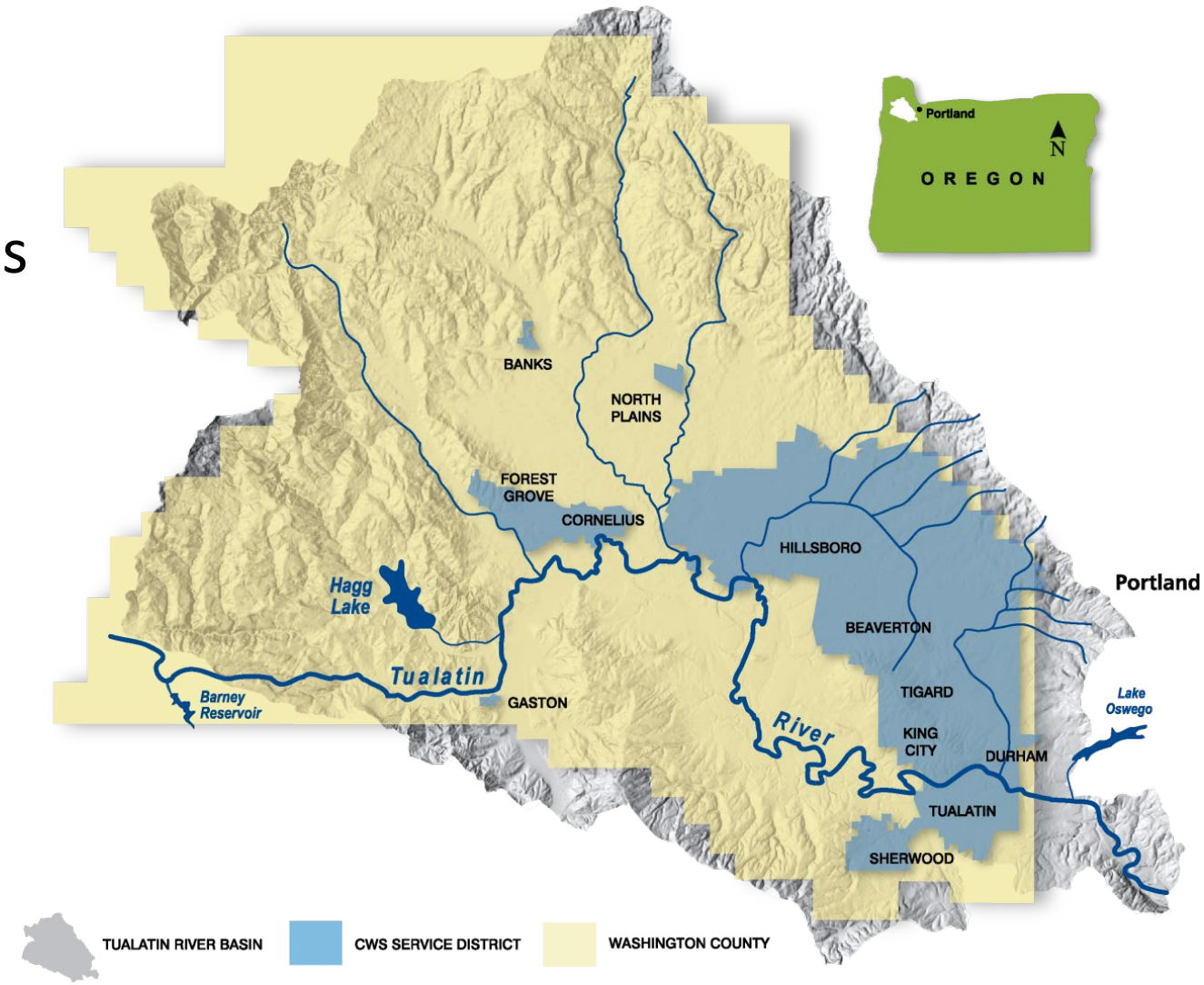
Kenneth Williamson, PhD, PE

Research and Innovation Director

Clean Water Services

Clean Water Services

- Public utility serving 613,000 residents west of Portland
- 4 Water Resource Recovery Facilities
- 1,982 miles of collection system
- 90% of flow residential; 10% industrial
- State's fastest growing county
- Oregon's first confirmed case of COVID-19: Feb 28, 2020



Biobot Analytics survey

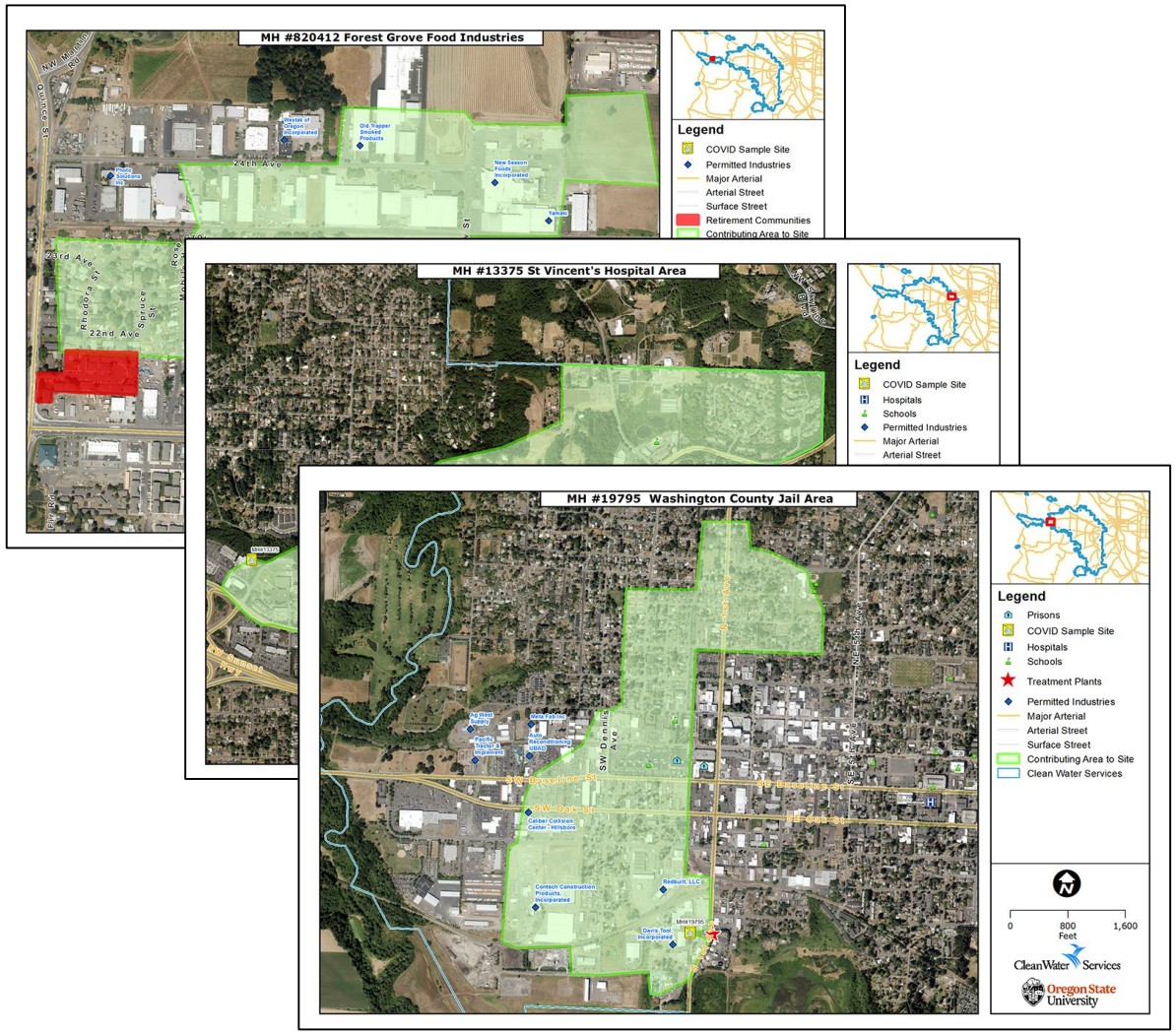
- National sampling data from more than 100 facilities
- Starting March 30, CWS has been providing weekly from each of our 4 facilities
- Broad community data
- Shows prevalence, trends

OSU/CWS collaboration

- Oregon State University/CWS collaborative research, Drs. Tyler Radniecki and Christine Kelly
- Two objectives:
  - Compare influent sample results to Biobot study, improve sampling and analysis techniques
  - Sample within selected areas of concern (micro-sewersheds) such as nursing homes, hospitals, food processing plants, prisons, schools, etc.
- Funded by NSF's Rapid Response Research (RAPID), Award No. 1519467, on April 27, 2020

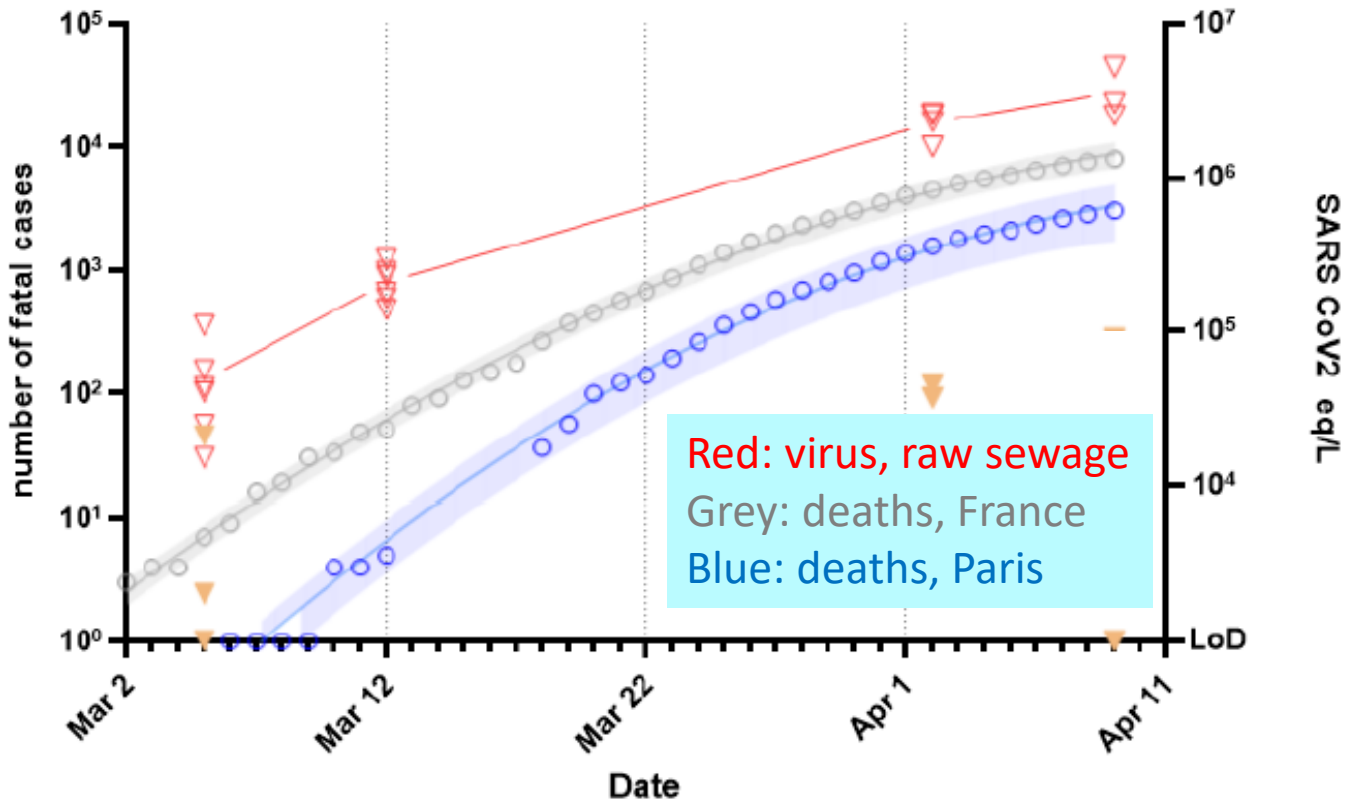
Sewershed sampling

- Targeted research at 21 sites
- Mix of land uses, business types & communities
  - Hospitals
  - Food industries
  - Jails
  - Nursing Homes
  - Schools
  - Retirement communities
  - Low-income communities
- Weekly data for 1 year



Added value of sewer surveillance

- Virus concentrations in wastewater must be correlated with a health response
- Collaboration is needed between water utilities and local, state and national health professionals



Wurtzer, et al., 2020

Expanding research partnerships

- **OSU Colleges of Public Health and Human Sciences, Science, Veterinary Medicine, and Agricultural Sciences-TRACE program**
  - Conduct testing for COVID-19 in Corvallis and Bend, Or, and compare with spatial and temporal virus signals in the sewershed

- **Oregon Health Sciences University (OHSU)**
  - Working to correlate public health tracing (symptomatic and asymptomatic infections, antibodies) results with sewage tracking results in Hillsboro, Portland and Lake Oswego, Or

- **Oregon Health Authority**
  - Proposal to expand OSU/CWS research to 30 treatment plants in Oregon over a two year period to track the spread, recession and any potential new waves of COVID-19 infections

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Q&A and Next Steps

Peter Grevatt, PhD

Chief Executive Officer

The Water Research Foundation

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Thank You!

