HRSD
Cleaning wastewater every day for a better Bay.

COVID-19 Surveillance using Wastewater-Based Epidemiology

September 17, 2020

Gonzalez, R., Curtis, K., Bivins, A., Bibby, K., Weir, M., Yetka, K., Thompson, H., Keeling, D., Mitchell, J. and Gonzalez, D., 2020. COVID-19 surveillance in Southeastern Virginia using wastewater-based epidemiology. *Water research*, p.116296.

HRSD's Pathogen Program

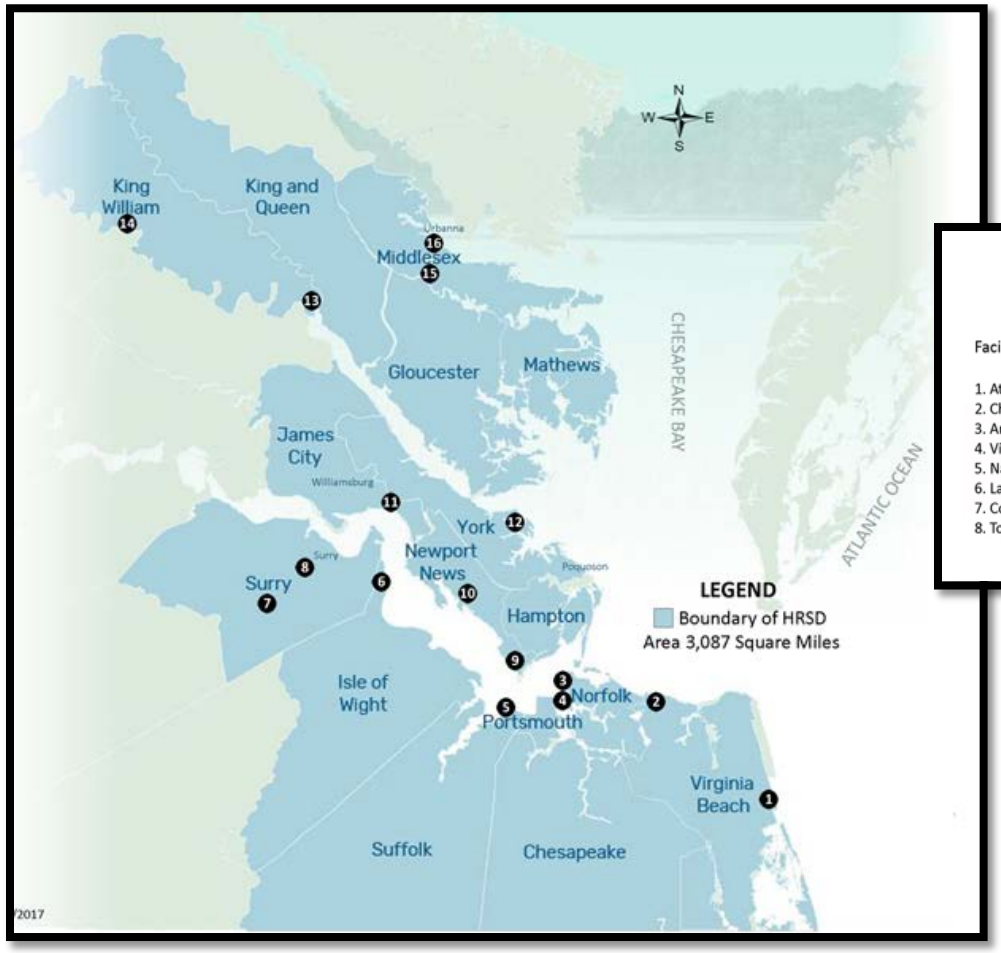
- **Core Focus Area**
  - Microbial Source Tracking
  - Quantitative Microbial Risk Assessment
  - Pathogen Quantification
  - Environmental Surveillance

- **Matrices**
  - Stormwater, Biosolids, Wastewater, Drinking Water, Shellfish

- **Capabilities**
  - Digital PCR
  - Quantitative PCR
  - Next generation sequencing
    - Illumina iSeq 100
    - Nanopore MinION
  - Culture:
    - Traditional FIB
    - Coliphage
    - GB-124

HRSD Service Area

HRSD provides service to 18 cities and counties of southeast Virginia, an area of over 3,087 square miles with a population of 1.7 million.



HRSD Service Area
A Political Subdivision of the Commonwealth of Virginia

Facilities include the following:

1. Atlantic, Virginia Beach
2. Chesapeake-Elizabeth, Va. Beach
3. Army Base, Norfolk
4. Virginia Initiative, Norfolk
5. Nansemond, Suffolk
6. Lawnes Point, Smithfield
7. County of Surry
8. Town of Surry
09. Boat Harbor, Newport News
10. James River, Newport News
11. Williamsburg, James City County
12. York River, York County
13. West Point, King William County
14. King William, KingWilliam County
15. Central Middlesex, Middlesex County
16. Urbanna, Middlesex County

Serving the Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, Williamsburg and the Counties of Gloucester, Isle of Wight, James City, King and Queen, King William, Mathews, Middlesex, Surry* and York
*Excluding the Town of Claremont

Treatment Plants

We operate nine major treatment plants and seven smaller plants in eastern Virginia, with a combined treatment capacity of 249 million gallons per day.

Atlantic Treatment Plant

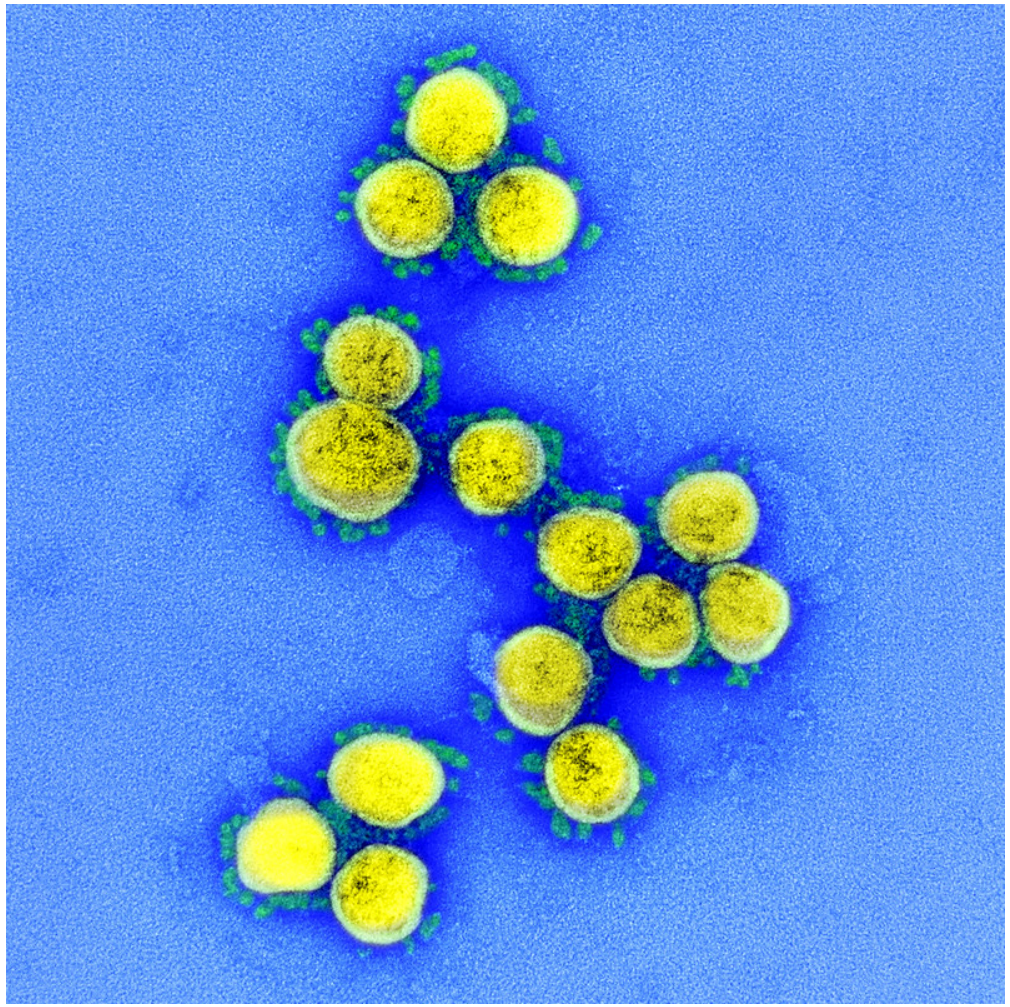
Mission

We protect public health and the waters of Hampton Roads by treating wastewater effectively.

Vision

Future generations will inherit clean waterways and be able to keep them clean.

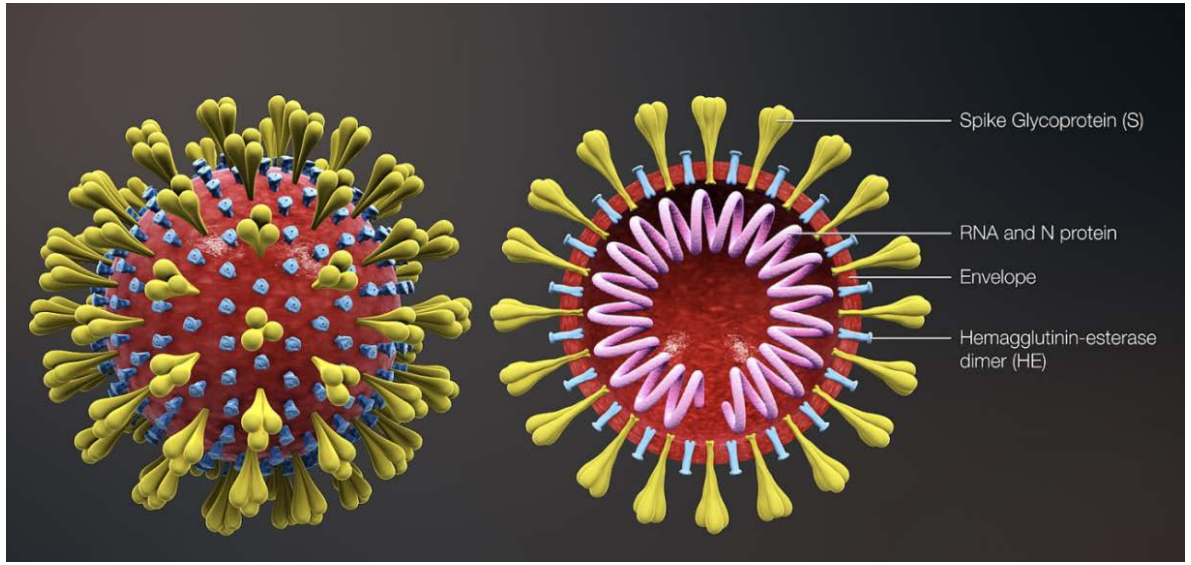
Portsmouth, Virginia before HRSD was created in 1940. Raw sewage was discharged to open area waterways and ditches.



Source: NIAID

- Novel Coronavirus disease 2019
- Viral agent: severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
- high infectivity, relatively high asymptomatic ratio in the population, and potential to result in serious health complications

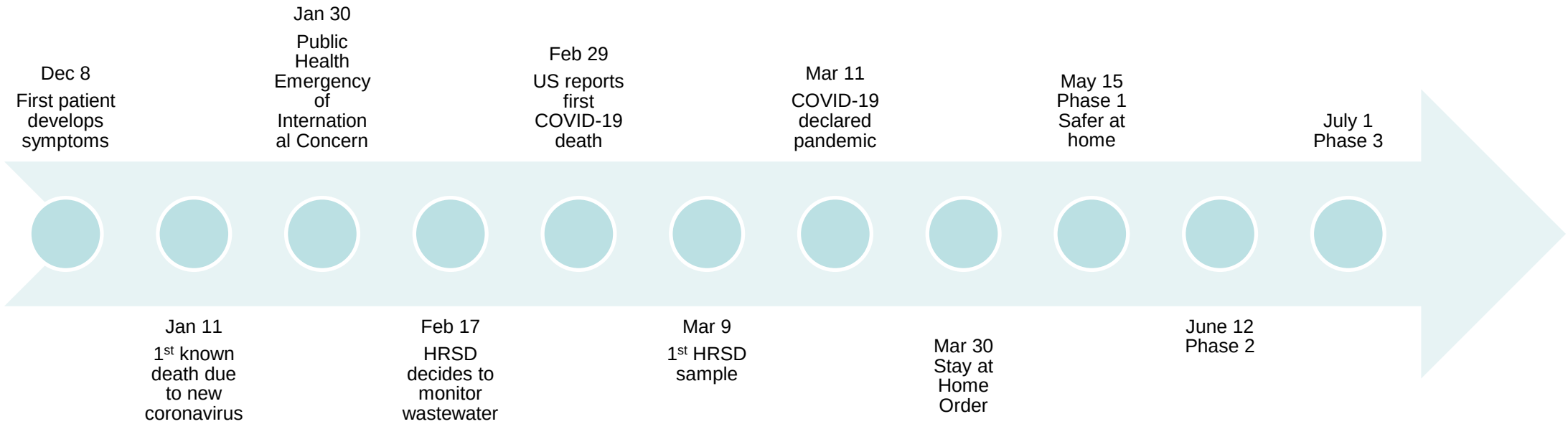
COVID-19 in Water



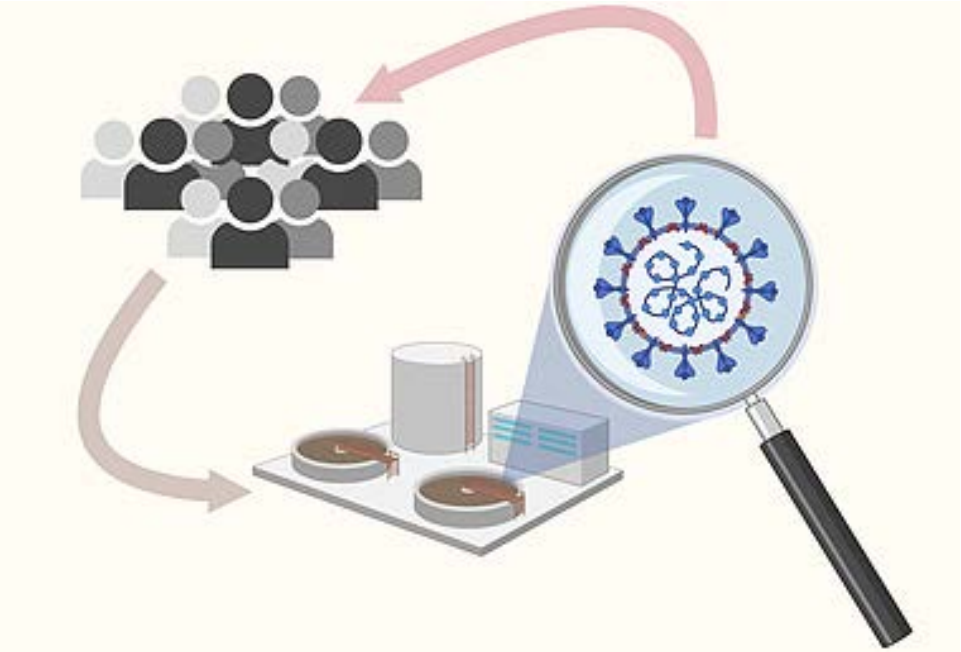
Source: https://commons.wikimedia.org/wiki/File:3D_medical_animation_corona_virus.jpg

- More susceptible to disinfection and environmental stressors than enteric viruses
- Unlikely to be viable in wastewater
  - Not a risk to operators
  - Not a risk to lab personnel
- Unlikely to make it through WWTP

COVID-19 Timeline



Wastewater-Based Epidemiology



- Observe community-level trends through biomarkers in raw wastewater

- Past studies:
  - Pharmaceuticals
  - Illicit drugs
  - Industrial chemicals
  - Emerging contaminants
  - Population health markers

Wastewater-Based Epidemiology

Euro Surveill. 2018 Feb 15; 23(7): 17-00237.
doi: 10.2807/1560-7917.ES.2018.23.7.17-00237
PMCID: PMC5824128
PMID: 29471623

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

Environmental Microbiology

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

Maria Hellmér, Nicklas Paxéus, Lars Magnius, Lucica Enache, Birgitta Arnholm, Annette Johansson, Tomas Bergström, Heléne Norder
D. W. Schaffner, Editor

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]

Source: polioeradication.org

COVID-19 Wastewater-Based Epidemiology

Environmental Science & Technology Letters

pubs.acs.org/journal/estlcu

Lett

Presence of SARS-Coronavirus-2 RNA in Sewage and Correlation with Reported COVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands

Gertjan Medema,* Leo Heijnen, Goffe Elsinga, Ronald Italiaander, and Anke Brouwer

ELSEVIER

Science of The Total Environment

Volume 743, 15 November 2020, 140621

First detection of SARS-CoV-2 RNA in wastewater in North America: A study in Louisiana, USA

Samendra P. Sherchan [a], Shalina Shahin [a], Lauren M. Ward [a], Sarmila Tandukar [b], Tiong G. Aw [a], Bradley Schmitz [c], Warish Ahmed [d], Masaaki Kitajima [e]

Environmental Science & Technology

pubs.acs.org/est

Viewpoint

Wastewater-Based Epidemiology: Global Collaborative to Maximize Contributions in the Fight Against COVID-19

Aaron Bivins, Devin North, Arslan Ahmad, Warish Ahmed, Eric Alm, Frederic Been, Prosun Bhattacharya, Lubertus Bijlsma, Alexandria B. Boehm, Joe Brown, Gianluigi Buttiglieri,

ELSEVIER

Science of The Total Environment

Volume 728, 1 August 2020, 138764

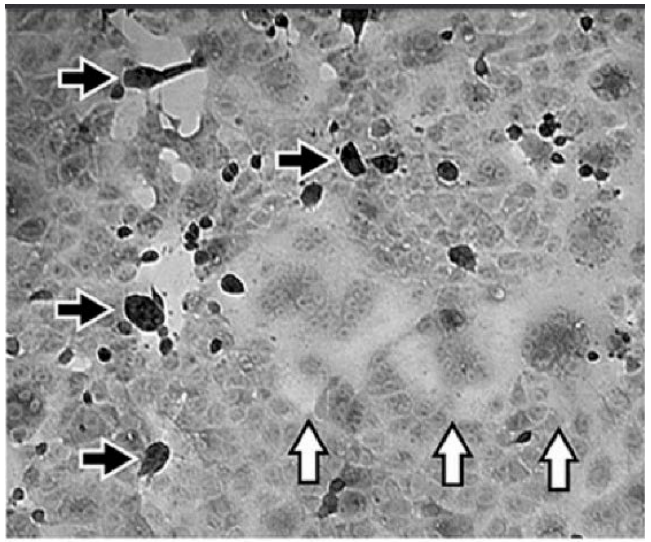
First confirmed detection of SARS-CoV-2 in untreated wastewater in Australia: A proof of concept for the wastewater surveillance of COVID-19 in the community

Warish Ahmed [a], Nicola Angel [b], Janette Edson [b], Kyle Bibby [c], Aaron Bivins [c], Jake W. O'Brien [d], Phil M. Choi [d], Masaaki Kitajima [e], Stuart L. Simpson [f], Jiaying Li [d], Ben Tscharke [d], Rory Verhagen [d], Wendy J.M. Smith [g], Julian Zaugg [b], Leanne Dierens [b], Philip Hugenholtz [b], Kevin V. Thomas [d], Jochen F. Mueller [d]

HRSD

Culture-based Method

- Determines infectivity
- Requires BSL3
- VERO E6 cells (a monkey kidney cell line)



PCR-based Method

- Does not differentiate between viable and non-viable virus
- ‘scent of a virus’
- BSL2+ recommended
- RT-qPCR, RT-dPCR

Matsuyama, S., Nao, N., Shirato, K., Kawase, M., Saito, S., Takayama, I., Nagata, N., Sekizuka, T., Katoh, H., Kato, F. and Sakata, M., 2020. Enhanced isolation of SARS-CoV-2 by TMPRSS2-expressing cells. Proceedings of the National Academy of Sciences, 117(13), pp.7001-7003.

Goal:

Regional study to describe the rise and fall of COVID-19 cases in the community

Specific Objectives:

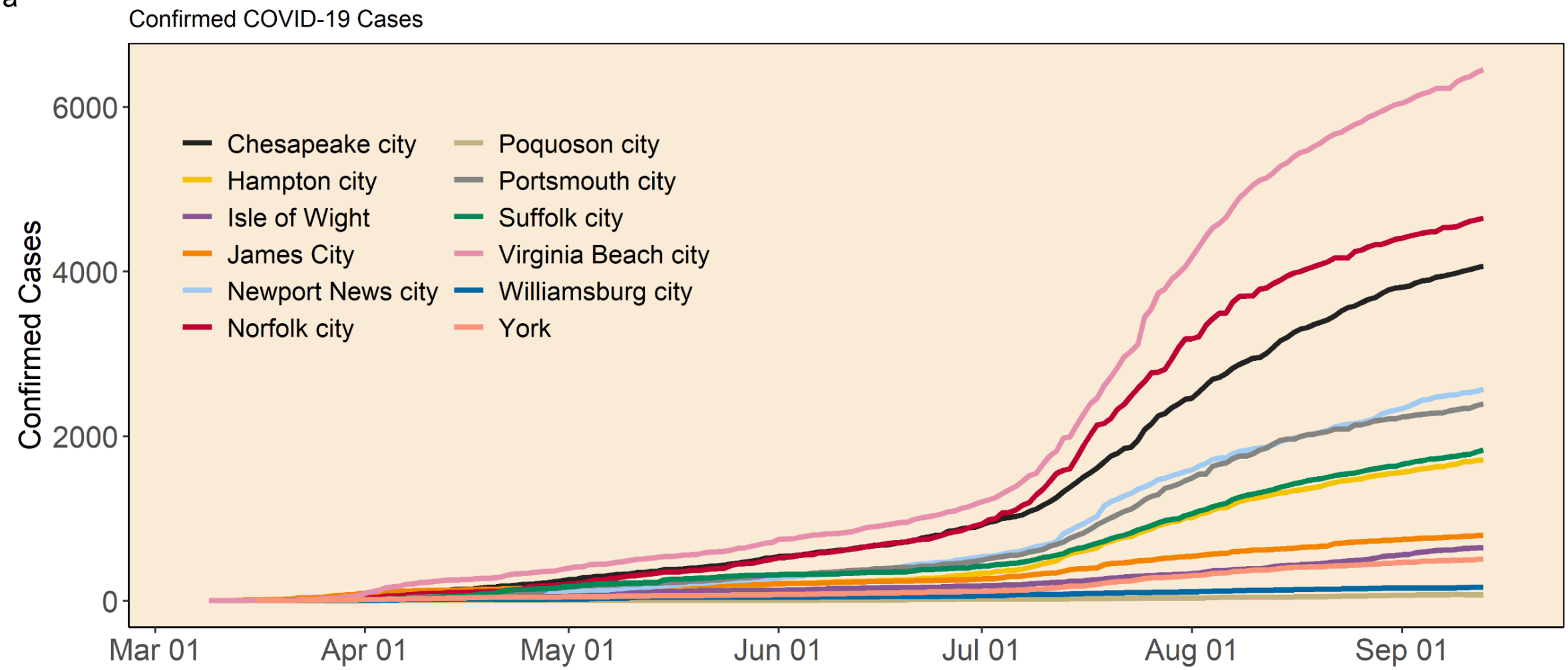
1. detect SARS-CoV-2 in wastewater
2. describe the trends in SARS-CoV-2 in wastewater
3. determine if wastewater is a leading indicator of new clinical COVID-19 cases

HRSD Monitoring

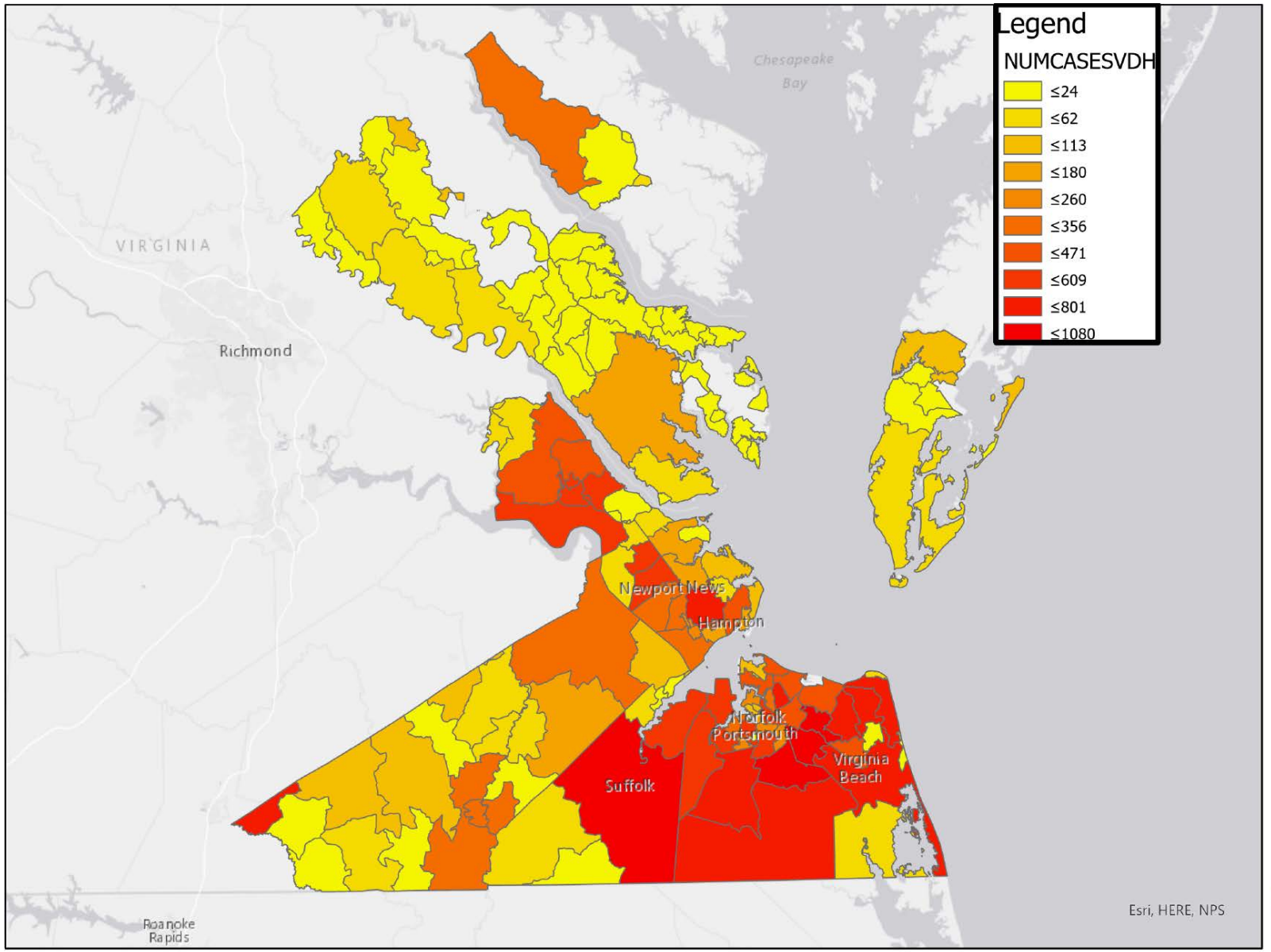
- Weekly monitoring of 9 major facilities
- 24-hr composite and grab samples
- 100 mL wastewater volumes
- RT-ddPCR quantification of CDC's clinical COVID-19 panel (N1, N2, N3 assays)

COVID-19 Cases in Hampton Roads

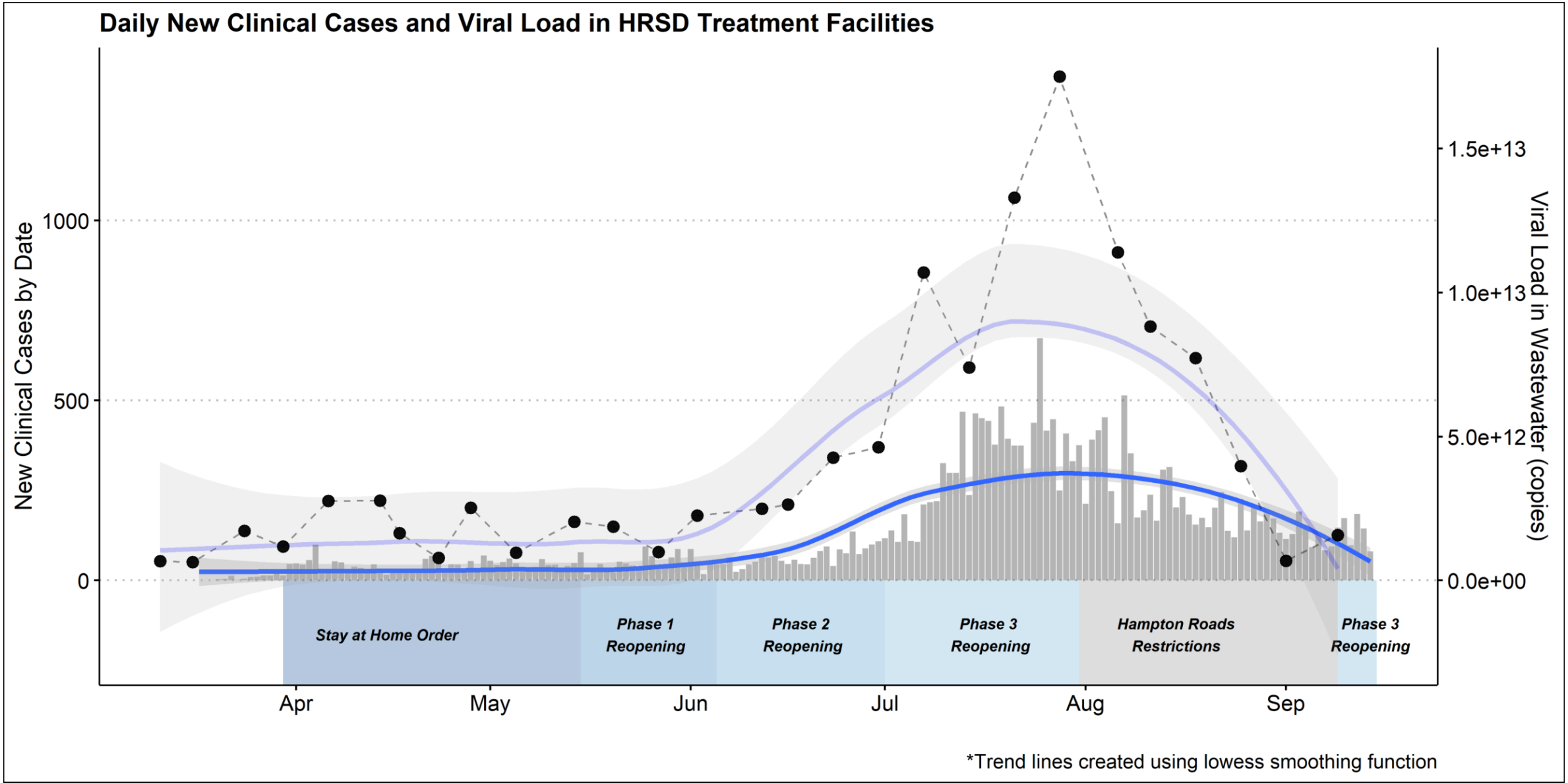
a



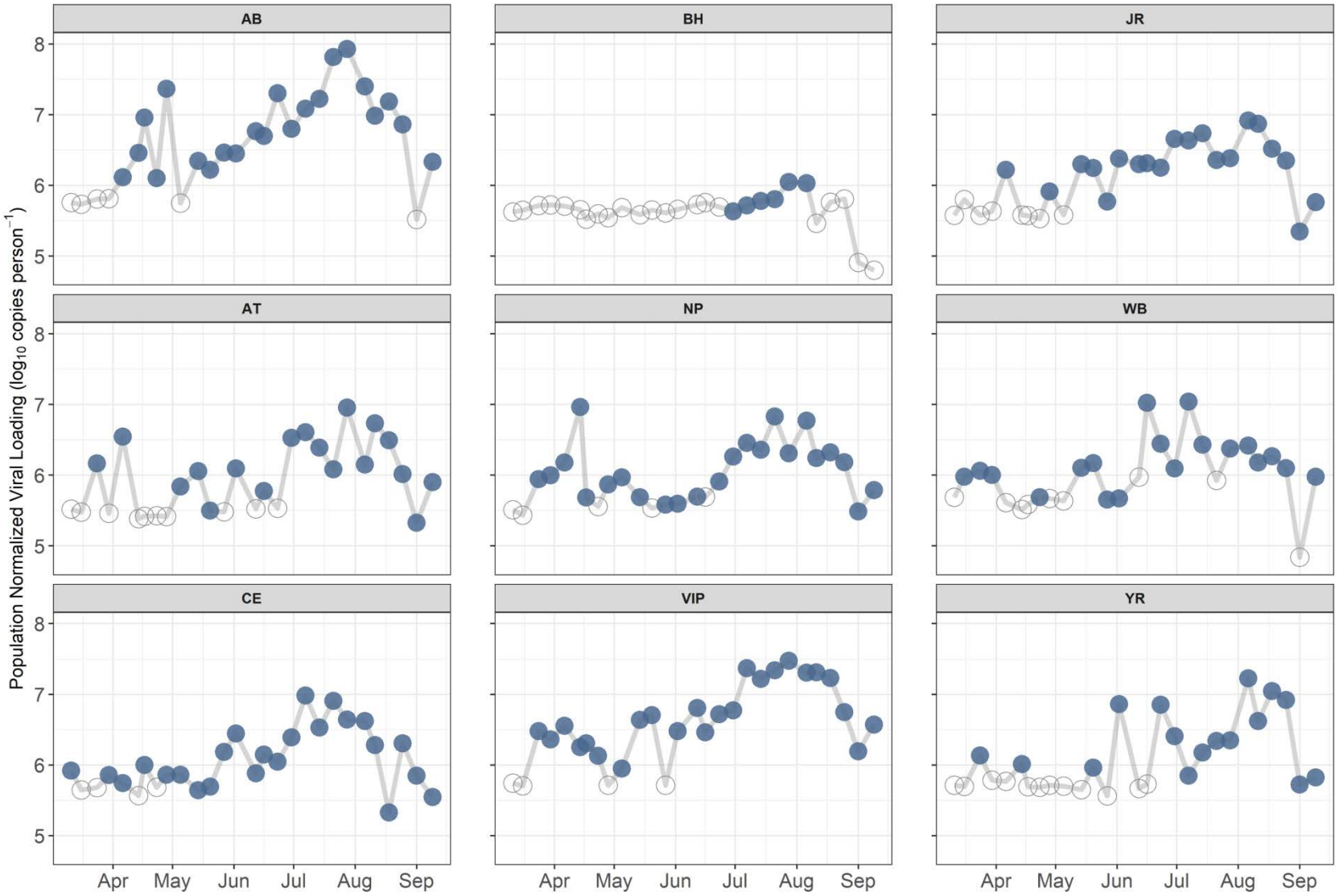
COVID-19 Cases in Hampton Roads

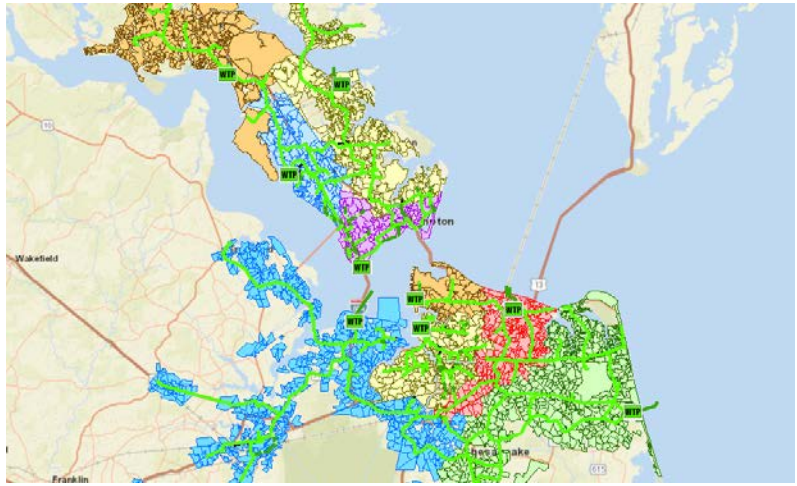


Regional Viral Load

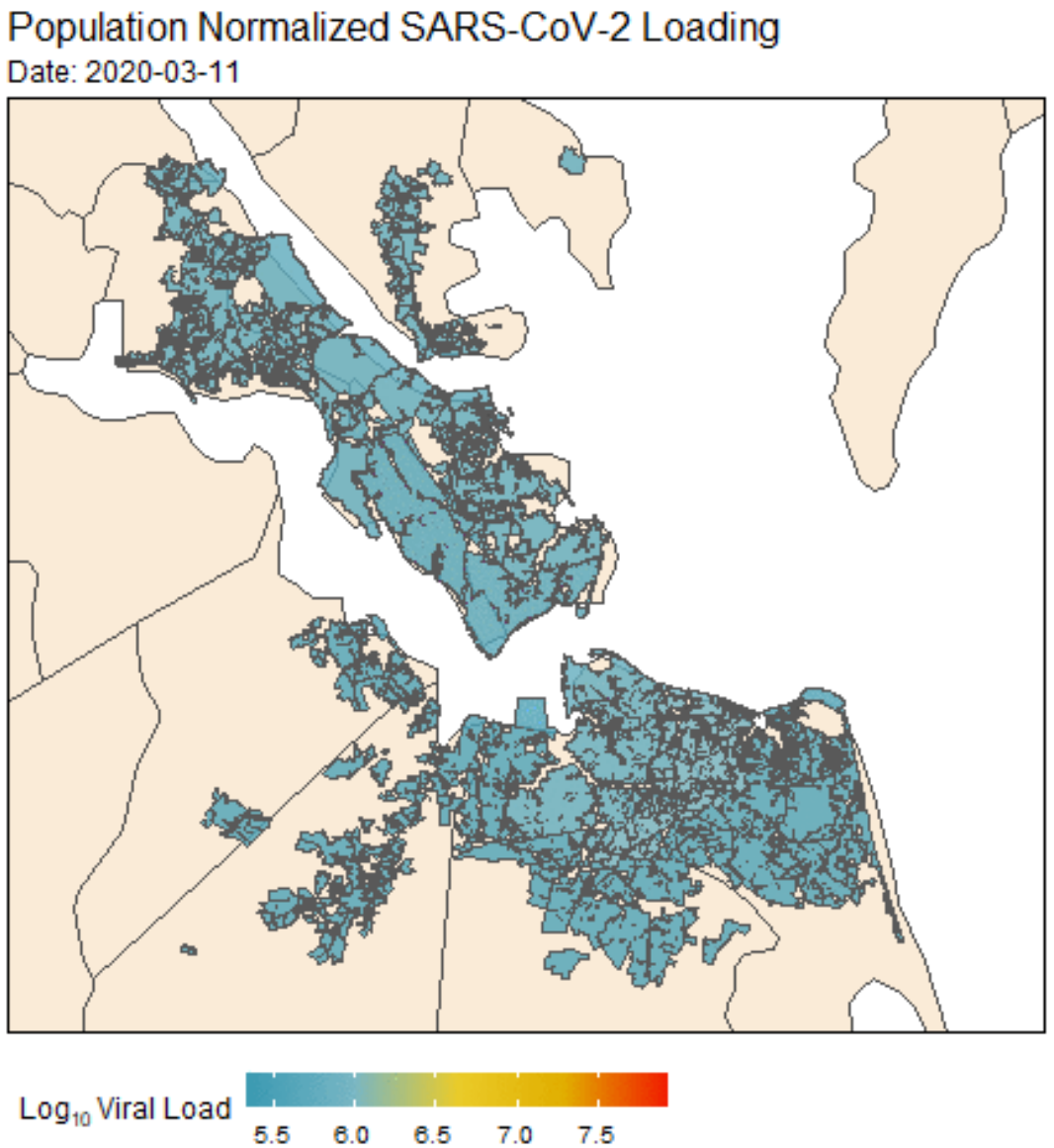


Population Normalized SARS-CoV-2 Loading



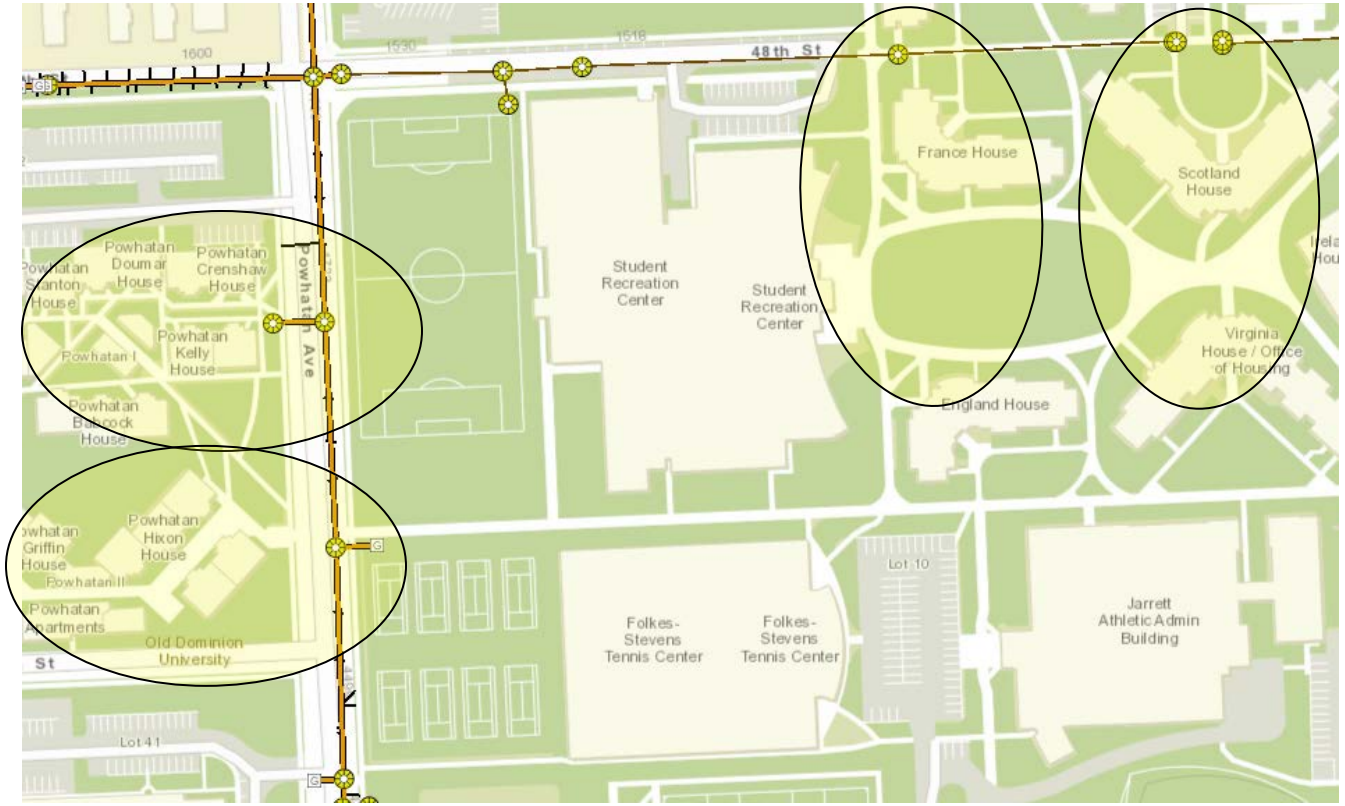


A Spatial Look at SARS-CoV-2 Loads



What Else?

- Special studies
  - Epidemiological modeling
  - Infrastructure modeling
  - SARS-CoV-2 strain sequencing
- University WW monitoring
- Targeted high-priority monitoring
  - Bases, hotels, high density residential areas, hospitals
- Multi-lab validations



Questions?

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