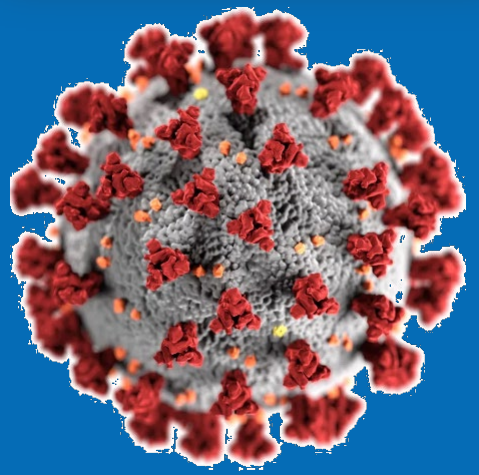
EPA
United States
Environmental Protection
Agency

Wastewater Surveillance
Raw Sewage = Raw Data

Dan Murray / Bruce Smith
U.S. EPA, Office of Research and Development

January 27, 2022



Wastewater Surveillance

Illicit Drugs in Municipal Sewage

Proposed New Nonintrusive Tool to Heighten Public Awareness of Societal Use of Illicit-Abused Drugs and Their

Christian G. Daughton

DOI: 10.1021/bk-2001-07

Publication Date: July 30,

Environmental Health Perspectives • VOLUME 116 | NUMBER 8 | August 2008

Estimating Community Drug Abuse

Ettore Zuccato, Chiara Chiabrando, Sara Castiglioni, R

Department of Environmental Health Sciences, Istituto di Ric

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NEWS & ANALYSIS | INFECTIOUS DISEASE

Israel's Silent Polio Epidemic Breaks All the Rules

Leslie Roberts

+ See all authors and affiliations

Epidemiol. Infect. (2012), **140**, 1–13. © Cambridge University Press and World Health Organi

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doi:10.1017/S095026881000316X

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REVIEW ARTICLE

Role of environmental poliovirus s

polio eradication and beyond

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RESEARCH ARTICLE

Applied and Environmental Science

Check for updates

Research

Environmental surveillance of poliovirus

Dakar, Senegal (2007-2013)

Abdou Kader Ndiaye[1,&], Pape Amadou Mbathio Diop[1], Ousma

Retrospective Surveillance of Wastewater To Examine Seasonal Dynamics of Enterovirus Infections

Nichole E. Brinkman,[a,b] G. Shay Fout,[a] Scott P. Keely[a,b]

SARS-CoV-2 in Sewage

- **Virus is shed in feces by individuals with symptomatic and asymptomatic infection**
- **Variable SARS-CoV-2 load in feces: 10^3-10^7 RNA copies/gram[1]**
- **Approximately 75-80% US is served by municipal sewerage systems[2]**
- **SARS-CoV-2 has been detected in raw sewage**
  - US, Europe, Australia, Africa, etc.
  - Up to 10^7 RNA copies/L[3]
- **Low risk of wastewater as vehicle for transmission**
  - Limited reports of infectious virus in feces[4,5]; none from sewage
  - No additional risk to wastewater workers[6]
  - Treatment and disinfection are likely effective

Photo credit: https://www.usgs.gov

[1]Foladori et al. 2020. Science of the Total Environment 743:140444; [2] USEPA. 2016. EPA-830-R15005; [3]https://www.lacsd.org/civicax/filebank/blobdload.aspx?blobid=%2022002; [4]Xiao et al., Emerging Infectious Diseases, 26(8), 1920-1922; [5] Zhou et al. 2020. Nature Medicine 26:1077-1083; [6]https://www.osha.gov/SLTC/covid-19/solid-waste-wastewater-mgmt.html

Wastewater-based SARS-CoV-2 Surveillance

- Complements existing COVID-19 surveillance systems
- Advantages
  - Non-invasive
  - Pool of individuals
  - Asymptomatic and symptomatic individuals
  - Inexpensive
  - Data for communities where individual testing data are underutilized or unavailable
  - Scalable
  - Unbiased
  - Can be a leading indicator of changes in community-level infection

Outline for Presentation

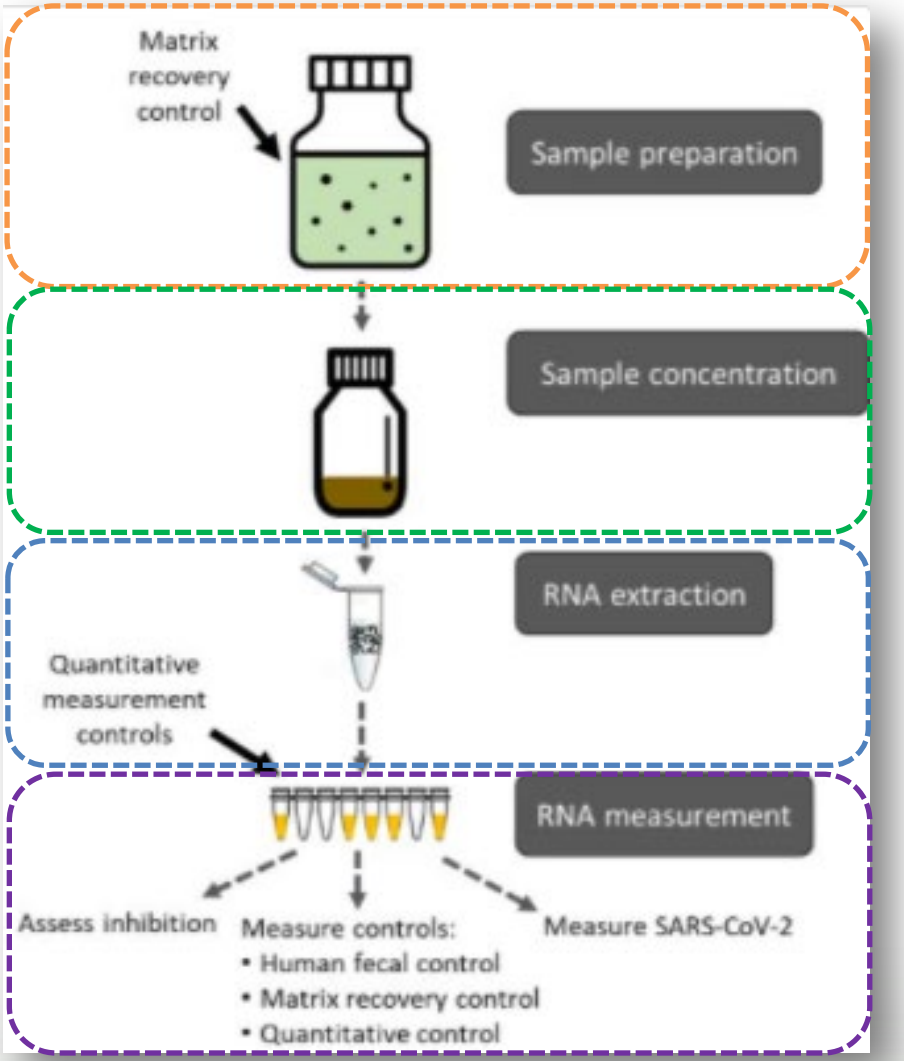
- Wastewater surveillance components
  - Analytical method development
  - Understanding “sewer dynamics” i.e., dilution and degradation in the sewer
  - Relating the sewer signal to community infection, vaccination and hospitalization rates
- Building a statewide network of sampling & linking to public health decisions
- Next Steps
  - Monitoring this pandemic
  - Preparing for the next potential pandemic

Method Considerations

Sample Type
Untreated wastewater
Primary sludge
Volume

Sample Preparation
Storage temperature
Homogenization
Additives
Matrix Spike
Clarification

Sample Concentration
Ultrafiltration
Electronegative membrane filtration
Polyethylene glycol (PEG) precipitation



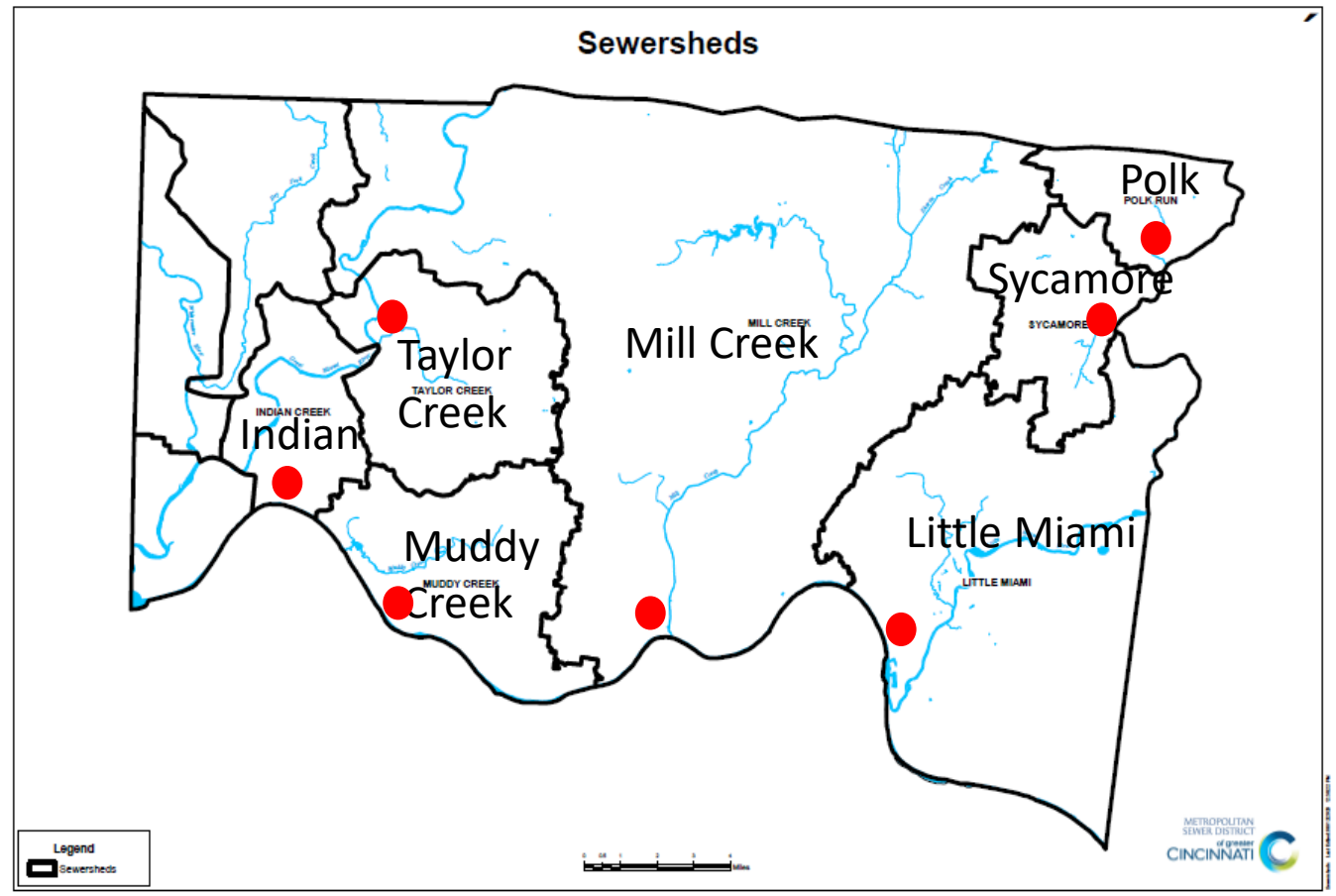
https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/wastewater-surveillance/testing-methods.html

Nucleic Acid Extraction
Silica columns
Magnetic beads
Precipitation

RNA/DNA Measurement
RT-qPCR
RT-ddPCR
Genetic targets

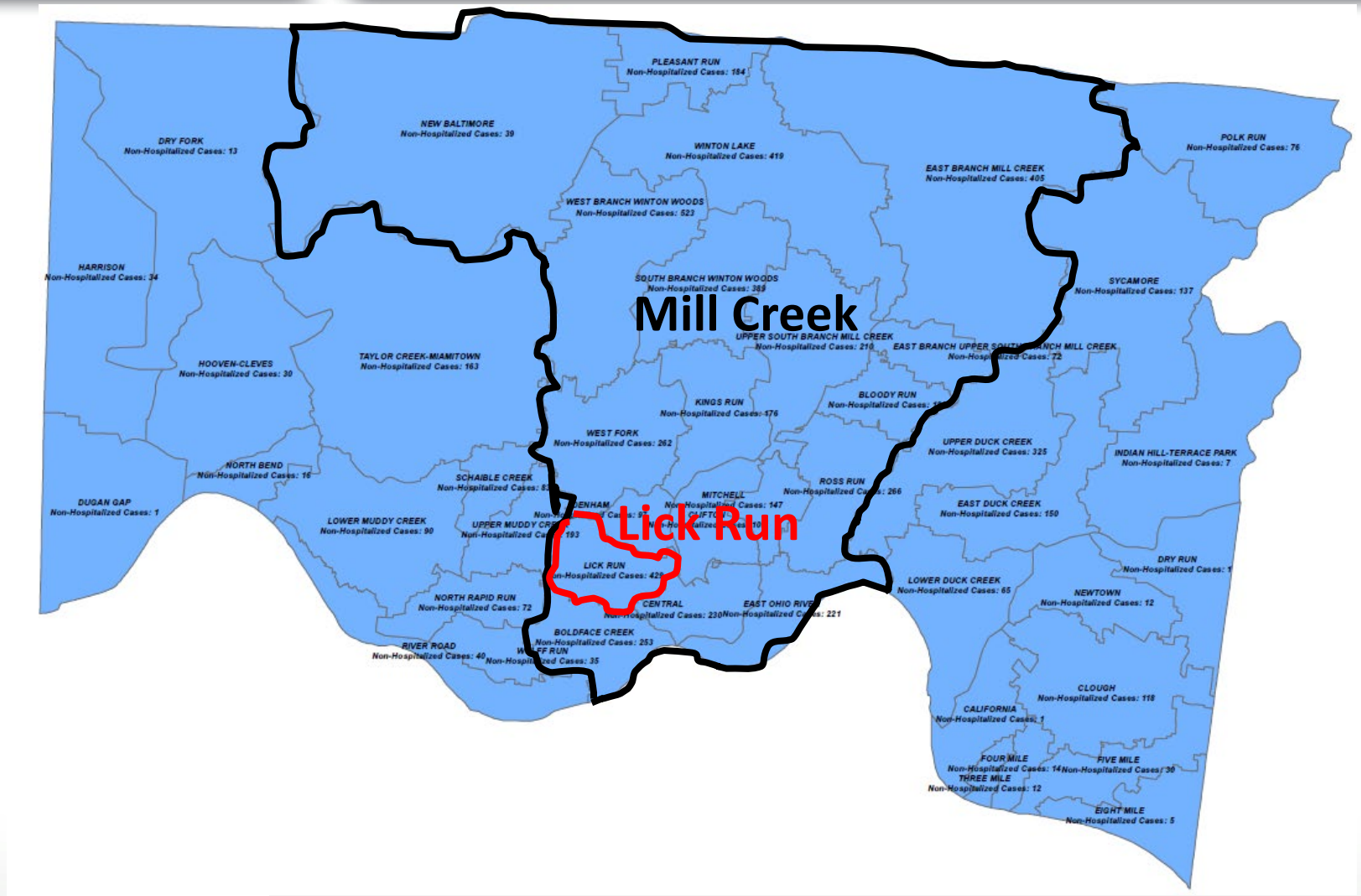
Other Considerations
Biosafety
Supply Chain issues
Practicality (time, equipment)
QA/QC

Metropolitan Sewer District of Cincinnati



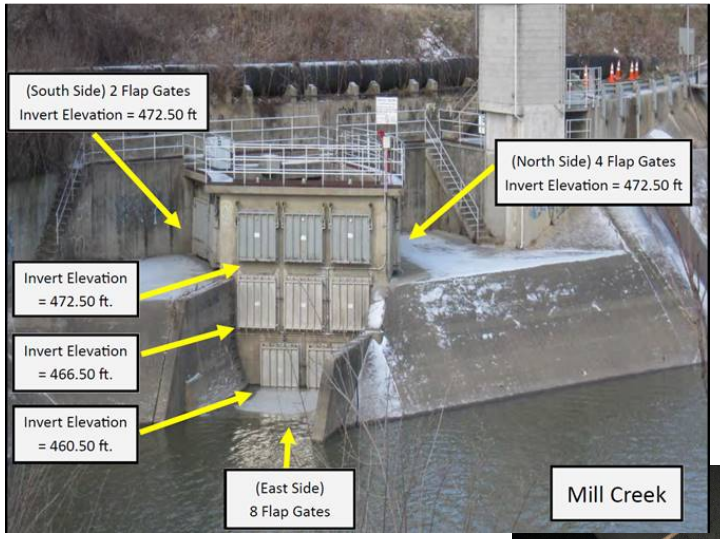
Sewershed	MGD	% Industrial	% Combined	Dilution
Mill Creek	118	5.0	40	0.5:1
Taylor Creek	3	0	0	1.8:1

Sub-Sewershed Sampling: Cincinnati



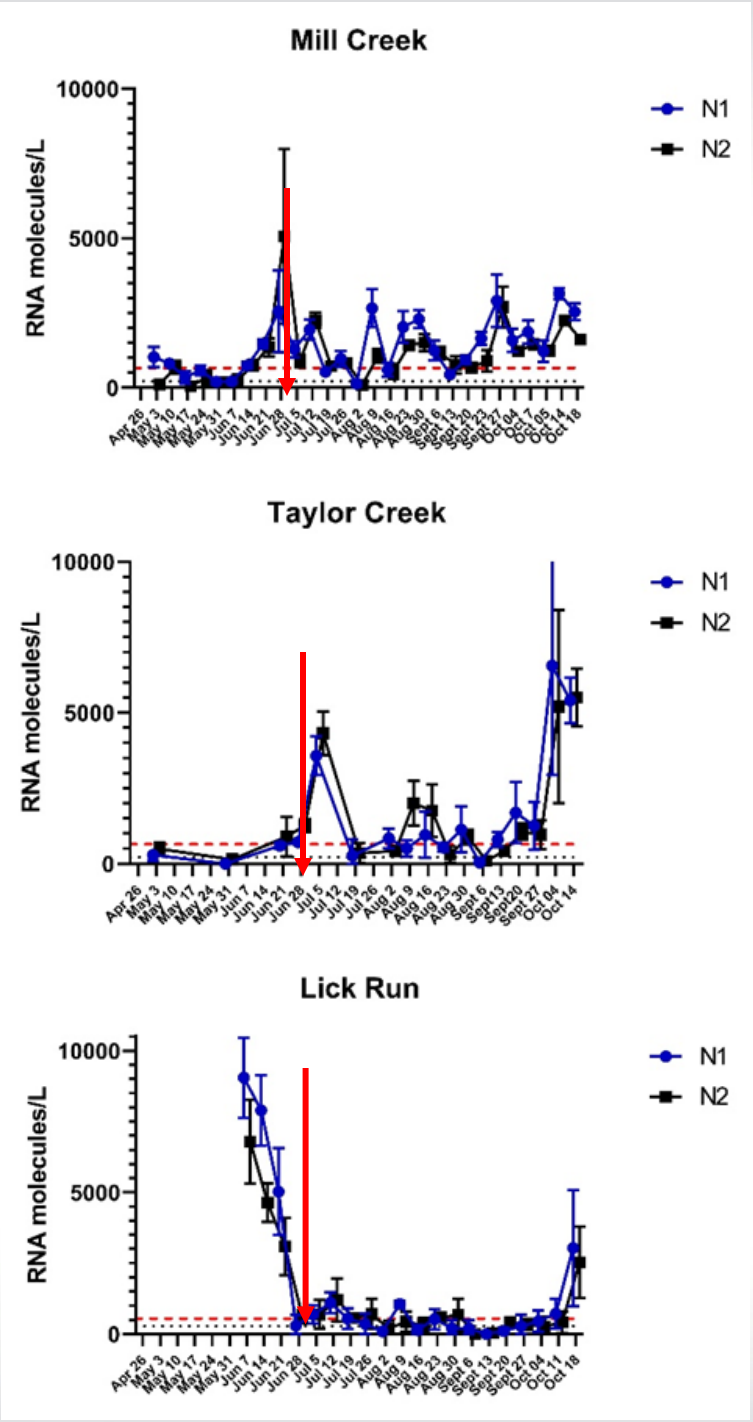
Sub-Sewershed Sampling – Lick Run

Combined Sewer Overflow



Remote Composite Sampler
~10L between 8-11 am
~500 ml every 15 min

Access to Sewer

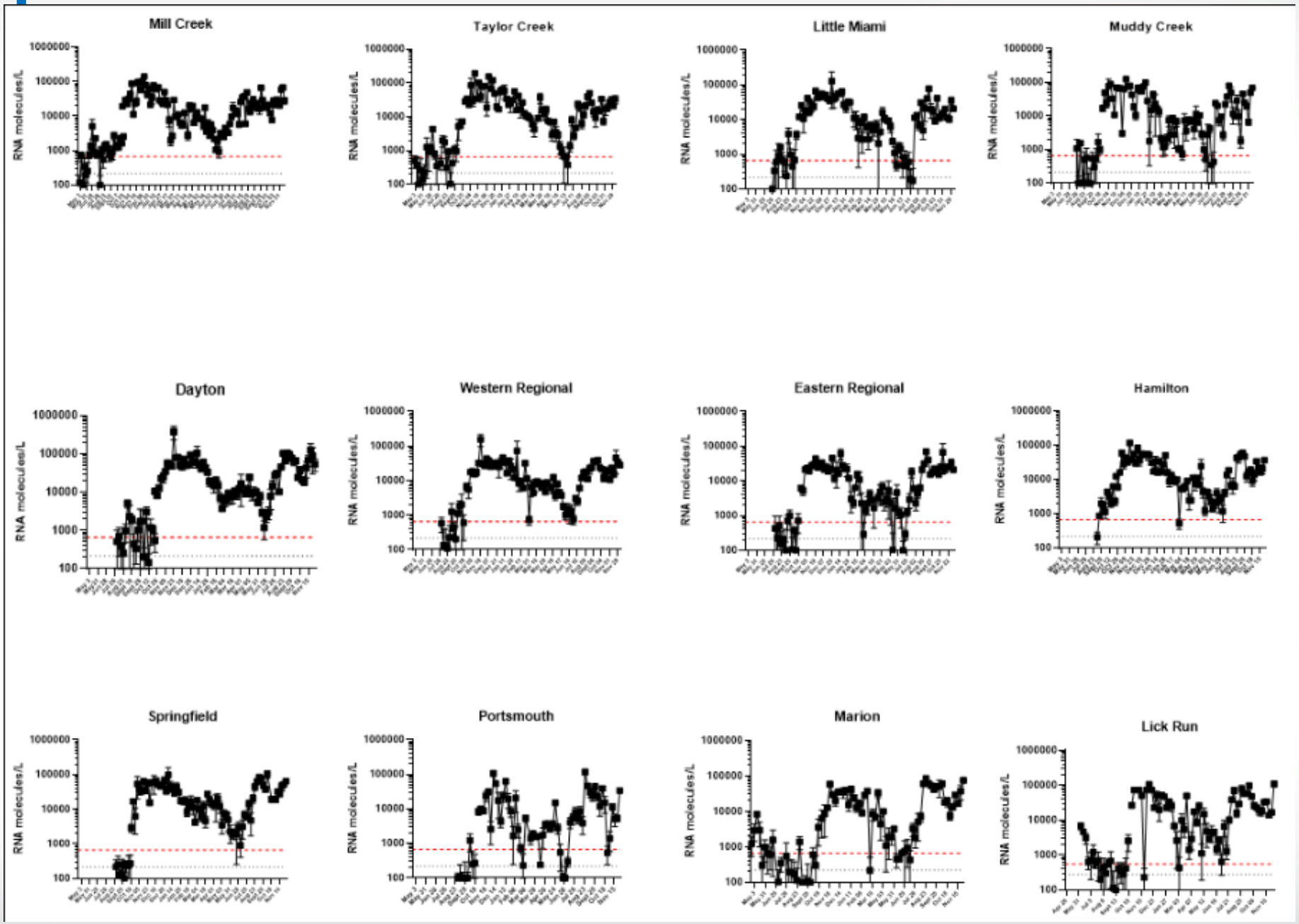


Different Views of Community Infection

Potential role of sentinel sites?

Red Line – County Peak in Cases in Early July 2020

Temporal Trends of SARS-CoV-2 in Sewersheds



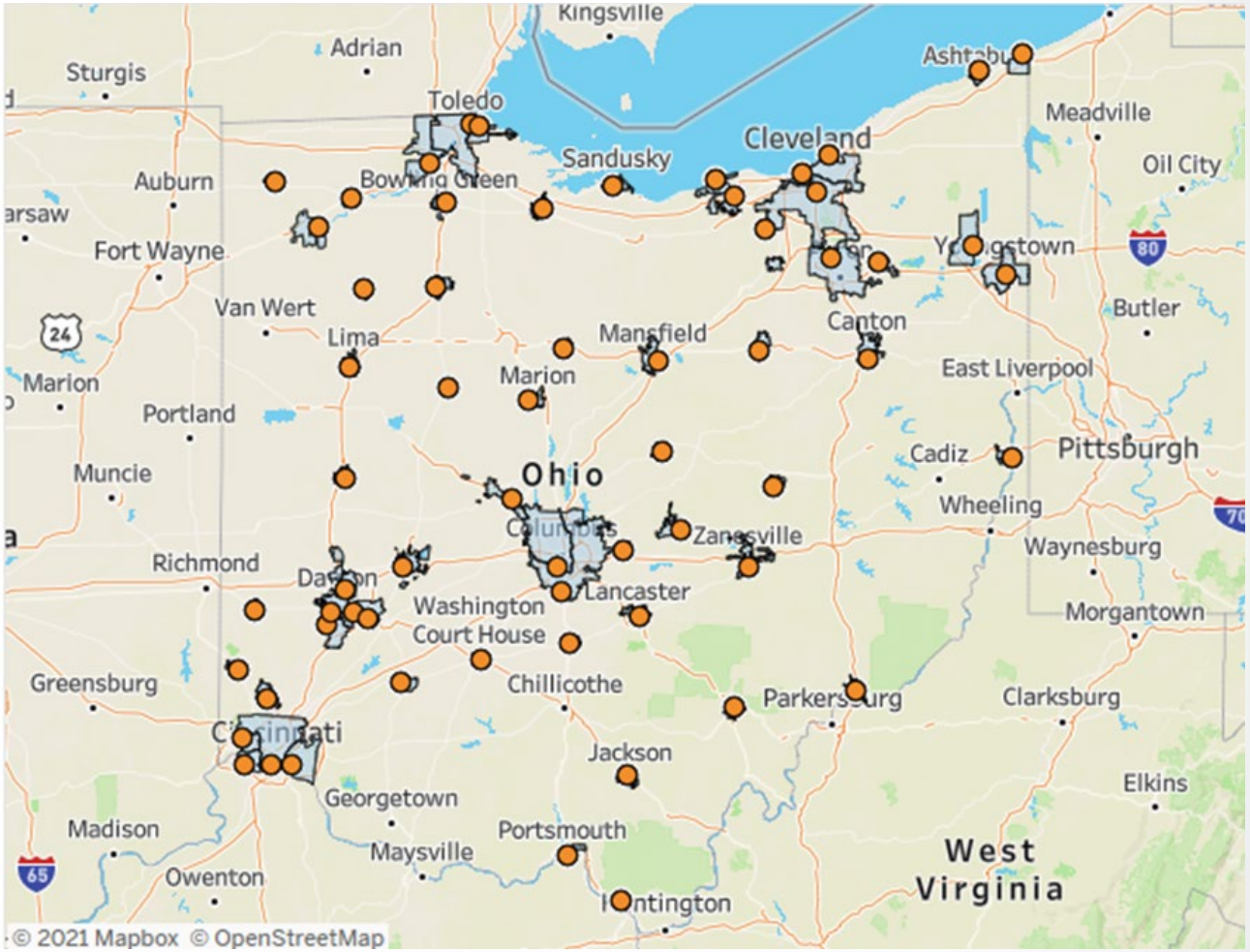
What do these data mean?

- If you want SARS-CoV-2 wastewater data to support public health decision making, you need to know:
  - Concentration of SARS-CoV-2 in wastewater
    - Measured concentration
    - Recovery Efficiency
    - Dilution
    - Decay
  - And how much SARS-CoV-2 shed in feces (uncertain)

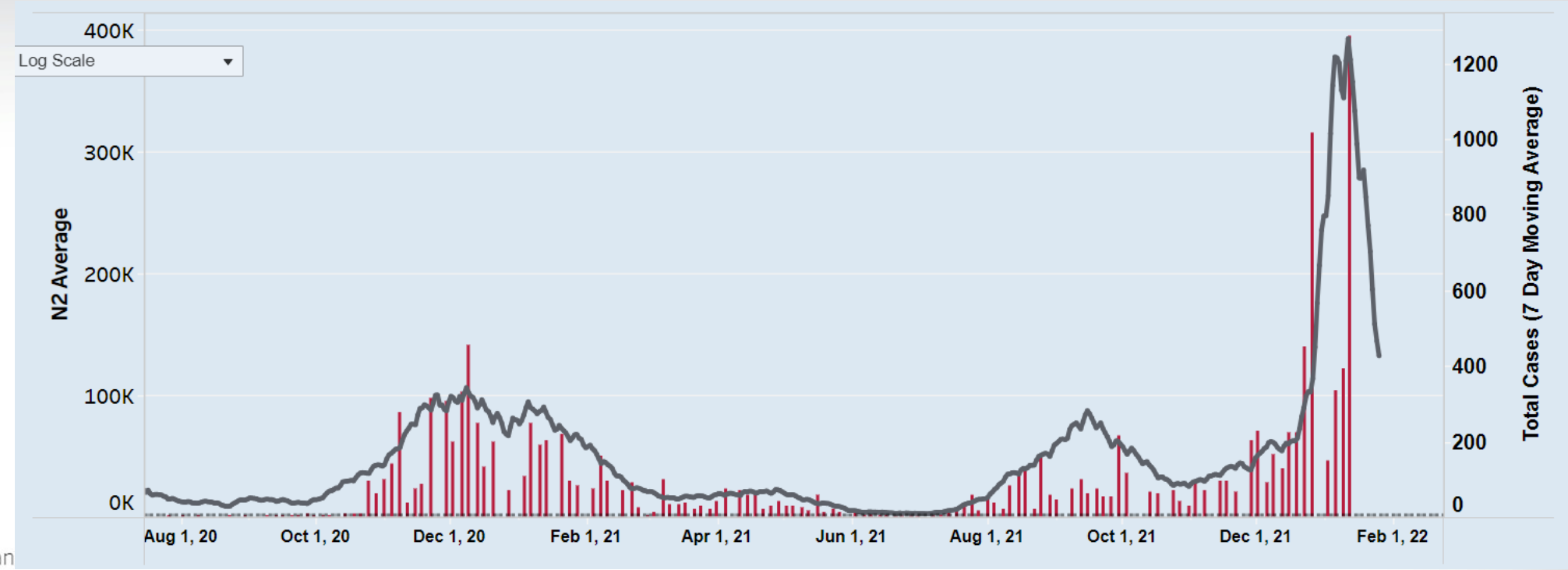
- Or focus on relative changes at a given site

Ohio Wastewater Monitoring Network

- Established by Governor DeWine in May 2020
- OEPA Funding - $2M
- ODH Led Effort
- Initially: 7 Large Cities, 15 Sampling Locations, 3 Laboratories (OSU, UT, U.S. EPA)
- Expanded to Medium & Small Cities, 4 Laboratories Added (BGSU, UA, KSU, Commercial Lab), Sampling Frequency 2/Week, 65 Sampling Sites



https://coronavirus.ohio.gov/wps/portal/gov/covid-19/dashboards/other-resources/wastewater



Wastewater Treatment Plant Locations an

Individual site example (Mill Creek) From dashboard

Ohio Public Health Applications

Development of toolkit for local health districts and utilities

- Additional messaging to public on best practices – social media, twitter

https://coronavirus.ohio.gov/wps/portal/gov/covid-19/healthcare-providers-and-local-health-districts/for-local-health-districts-and-governments

New focus on monitoring multiple sites on campus to support colleges/universities across state

Ohio is coordinating on data reporting approaches and with CDC on their National *Wastewater Surveillance System*

https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/wastewater-surveillance.html

Tracking the emergence of variants (Delta, Omicron)

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Summary

- **Analytical Method Development**
  - No standard method, many options available
  - Quality Control for assessing method performance (recovery efficiency, inhibition control)
- **Dilution/Degradation in Sewer System**
  - Ongoing comparison of different approaches to normalize for dilution
  - Use existing temperature dependent rates, targeted studies on industrial wastes
- **Relation of Sewer Signal to Infection rates**
  - Accounting for recovery efficiency, dilution, degradation
  - Need better data on shedding rates

Summary (cont'd)

- **Developing a network**
  - Linking wastewater utilities, environmental analytical labs, public health agencies
  - Network of labs to increase capacity if needed; build in QA/QC
- **Translating data to public health decisions**
  - Focus on trends or significant changes in the concentration to reinforce public messaging
    - As models to predict infection are refined
  - Early warning?
    - Relative turnaround time of individual and wastewater data key
    - Sentinel sites might be very useful, but attributes of these sites may vary across pandemic cycle
  - Targeted sampling to direct individual testing/actions
    - e.g., university dormitory monitoring

Next Steps

- Continue monitoring the current pandemic
  - [illegible]
  - [illegible]
- Be[illegible]
  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
    - Decay rates in sewer

Contact

QUESTIONS?

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