



Metropolitan Water Reclamation District of Greater Chicago

**Welcome to the January
Edition of the 2022
M&R Seminar Series**

NOTES FOR SEMINAR ATTENDEES

- All attendees' audio lines have been muted to minimize background noise.
- A question and answer session will follow the presentation.
- Please use the "Chat" feature to ask a question via text to "All Panelists."
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar has been approved by the ISPE for one PDH and pending approval by the IEPA for one TCH. Certificates will only be issued to participants who attend the entire presentation.

RACHEL S. PORETSKY, PH.D.
ASSOCIATE PROFESSOR
UNIVERSITY OF ILLINOIS AT CHICAGO
DEPARTMENT OF BIOLOGICAL SCIENCES



Rachel hails from the great urban microbial hotspot of Brooklyn, NY. She obtained a B.S. in Biology from Brandeis University in 1999 and a Ph.D. in Marine Sciences from the University of Georgia in 2008. She was a postdoc at Caltech in Geology and Planetary Sciences and at Georgia Tech in Environmental Engineering. She has done pioneering work looking at genes and gene expression of microbial communities in the open ocean, freshwater lakes and rivers, and wastewater. She is currently an Associate Professor in Biological Sciences at the University of Illinois at Chicago, where she has been since January 2013.

The background of the slide is white with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance. They are located in the top-left, top-center, and bottom-right areas of the slide.

WASTEWATER SURVEILLANCE FOR COVID-19 – A REGIONAL EFFORT

Rachel Poretsky
microbe@uic.edu

Wastewater Based Epidemiology

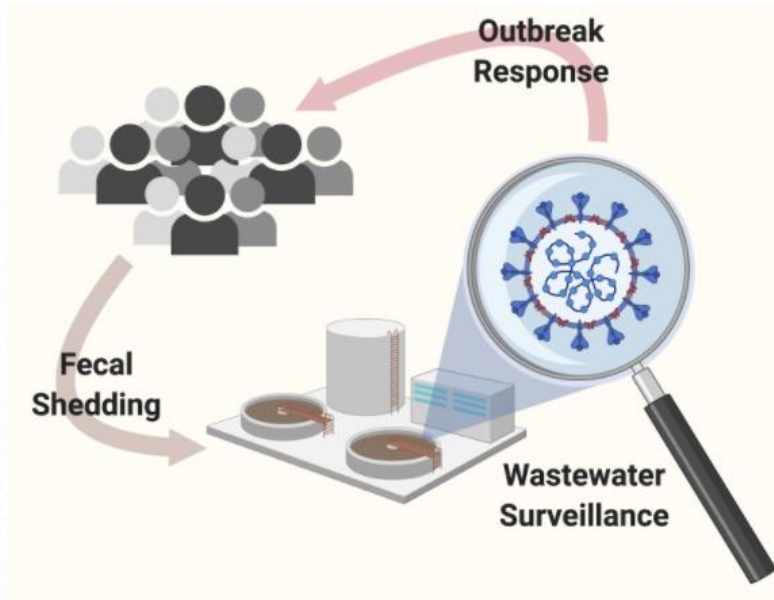


Image credit: Bivens & Bibby

- Wastewater is a composite biological sample
- Everyone contributes
- SARS-CoV-2 RNA is shed in stool in pre-symptomatic, symptomatic and asymptomatic infection
- Can provide a broader picture of community infection than clinical data alone.
- Public health officials can see changes in community infection levels from wastewater **over a week prior to those levels manifesting in testing data.**
 - e.g., in MO, when they see a 40% increase in waterwater levels, 70% of the time, they see known cases increase 25% a week later.

Did you know?



WBE can detect the virus several days before people show symptoms



One infected individual theoretically is detectable among 100 to 2,000,000 people



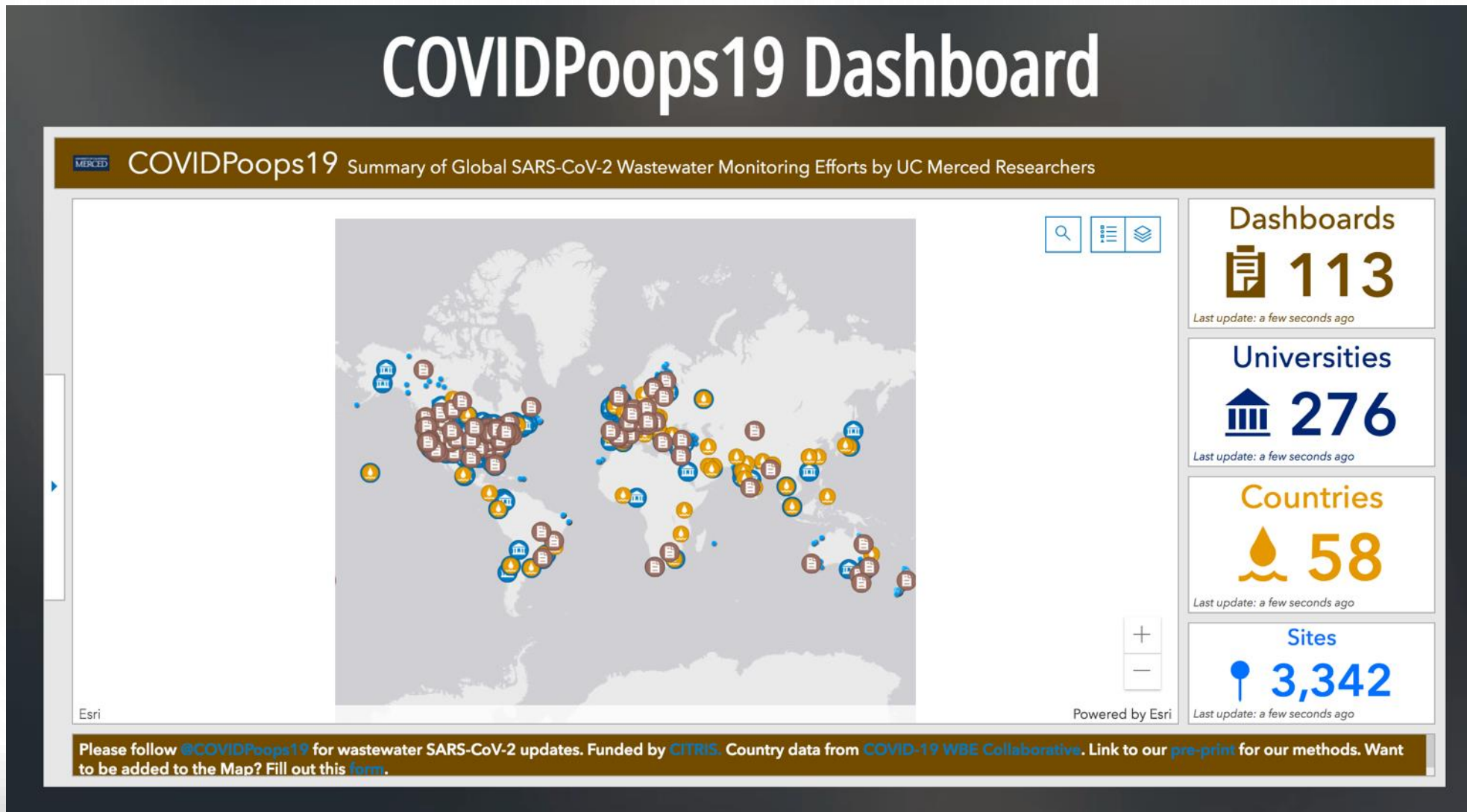
Epidemiological trends (from diagnosed cases) can be verified daily without testing patients



WBE cost-effectively complements clinical surveillance where resources are limited and could save up to US\$ 1 billion

REGULAR SAMPLING OF WASTEWATER IS UNDERWAY AT WWTPS NATION- AND WORLD-WIDE

COVIDPoops19 Dashboard



WASTEWATER SURVEILLANCE LANDSCAPE



WWTP sampling



Transport at <4°C

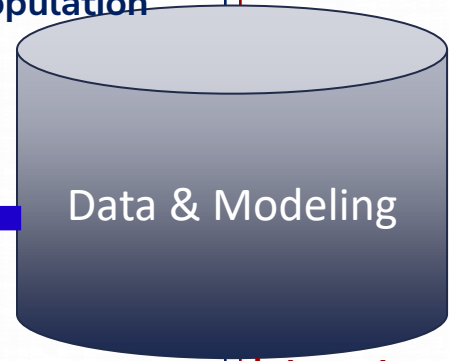


In-sewer sampling to monitor specific areas of the city. Select areas based on desired spatial resolution and population coverage

Necessary for large urban areas



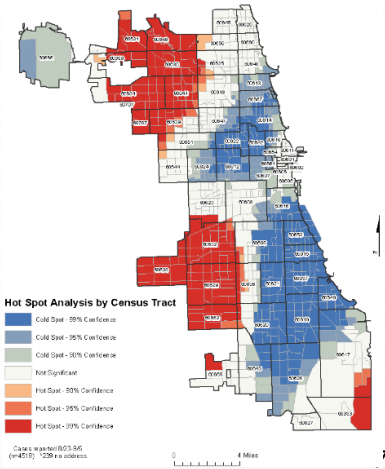
Population distributions and sewer flow models to select optimal sampling points.



Analyze results with health, demographic, and other data for specific public health questions.



Integrate results with public health decision and communication systems.

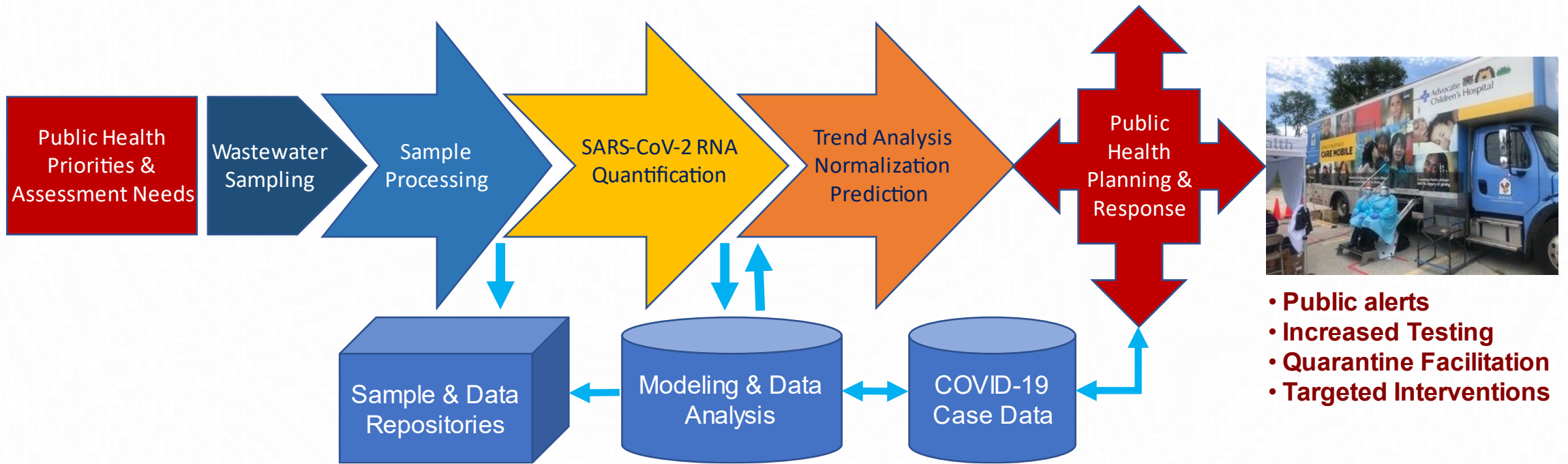


Necessary for public health impact

Program overview

- GOALS:
 - DELIVER ACTIONABLE INFORMATION TO PUBLIC HEALTH DECISION-MAKERS
 - MONITOR AND IDENTIFY TRENDS IN COVID-19 INFECTION LEVELS AND SARS-COV-2 VARIANTS OF CONCERN
 - ESTABLISH A NETWORK FOR PANDEMIC PREPAREDNESS
- PARTNERSHIP BETWEEN LPHS AND DISCOVERY PARTNERS INSTITUTE (UNIVERSITY OF ILLINOIS)
 - MULTI-INSTITUTION SCIENCE TEAM INCLUDES UIC, ARGONNE NATIONAL LAB, AND NORTHWESTERN

SYSTEM VIEW



OUR TEAM INCLUDES EXPERTISE IN WASTEWATER MONITORING, MICROBIAL ECOLOGY, MODELING, AND DATA SCIENCE



Chicago River



Lake Michigan



Neighborhoods



WWTP effluent outfall

FIVE INTEGRATED TEAMS

- **SAMPLING STRATEGY DESIGN AND IMPLEMENTATION**

- HARKNESS, CURRENT; GRIPPO, ANL

- **PATHOGEN DETECTION METHODS & URBAN MICROBIAL ECOLOGY**

- PORETSKY, UIC; OWENS, ANL, SHRESTHA, UIC

- **DATA ANALYSIS AND MODELING**

- PACKMAN, NU; LEISMAN, NU; MANGAN, NU; GARCIA, UIUC

- **DATA INTEGRATION, MANAGEMENT, AND SHARING**

- CATLETT, DPI; TIWARI, DPI

- **PUBLIC HEALTH PLANNING AND RESPONSE**

- JASMIN, CDPH, DOREVITCH, UIC



Northwestern
University



Current

DPI SEED GRANT



Discovery Partners Institute
SPECIAL PROGRAMS

PROGRAM: DPI Research and Development Cluster Seed
Grants

DEADLINE: 5/30/2020

#7331

PI

| Name | Department | Email | Phone |
|-----------------|---------------------|-----------------|-------|
| Rachel Poretsky | Biological Sciences | microbe@uic.edu | |

Tracking SARS-CoV-2 in Chicago Area Waterways and nearshore Lake Michigan
2020 DPI SEED GRANT PROGRAM

Rachel Poretsky (University of Illinois, Chicago), Abhilasha Shrestha (University of Illinois School of Public Health, Chicago), Aaron Packman (Northwestern University), George Wells (Northwestern University), Ahmed Abokifa (University of Illinois at Chicago), Maria C. Negri (Argonne National Laboratory), Sarah Owens (Argonne National Laboratory)

Abstract

COVID-19 has had an enormous impact on public health and the economy of Illinois. Infectious disease transmission is particularly a problem for high-density urban environments. While COVID-19 is thought of as a respiratory disease, the SARS-CoV-2 virus infects multiple body sites, including the gut, and is excreted in feces. Recent studies have shown that tracking SARS-CoV-2 RNA in wastewater is a useful strategy for monitoring disease prevalence at whole-city-scale. The last comprehensive evaluation of near-shore microbial contamination in the Great Lakes was conducted by the International Joint Commission in 1918. Today, key questions remain unanswered:

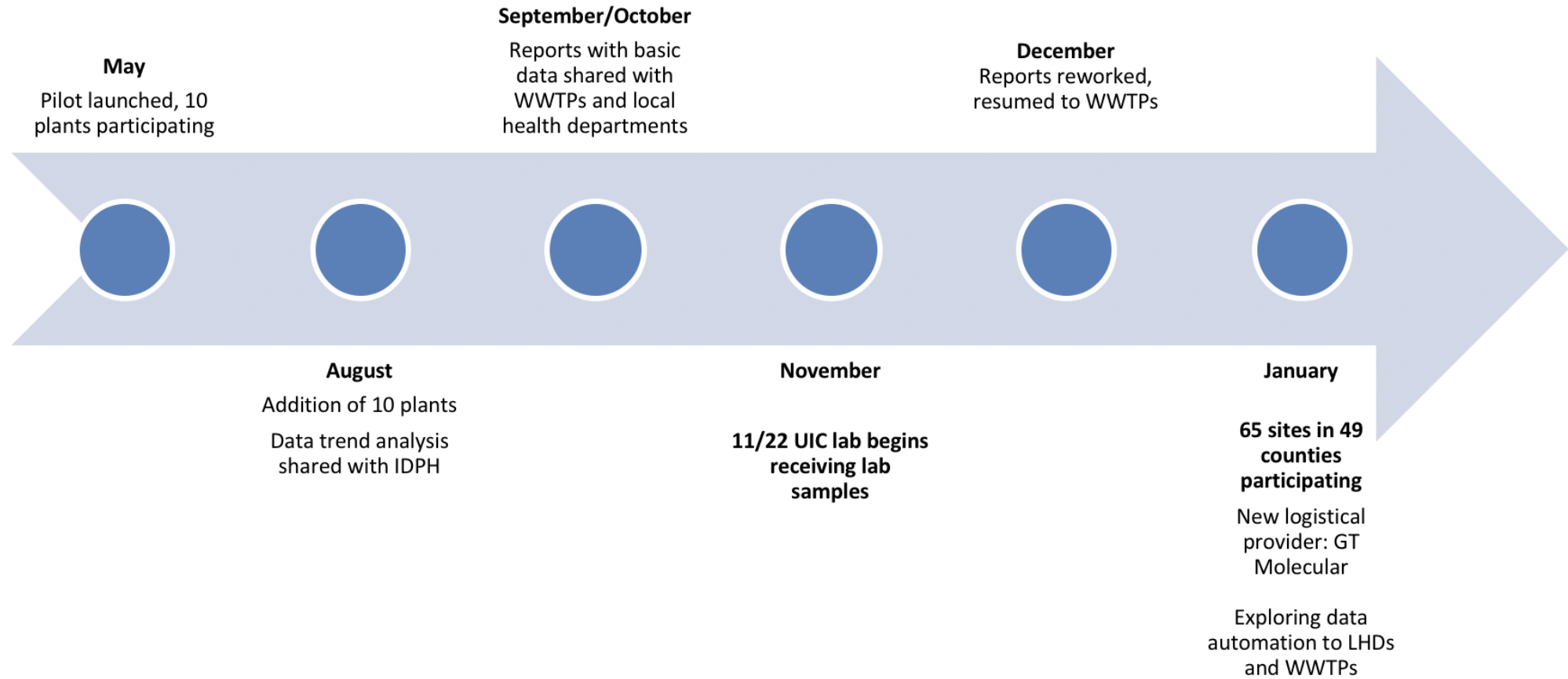
- How do urban sources and natural ecosystem dynamics affect pathogen distributions?
- Is it possible to track infections and predict disease outbreaks by monitoring urban waterways?
- What actions are needed to make nearshore water quality safe and sustainable?

Here, we propose to assemble a science team from the University of Illinois at Chicago and key regional and national partners to assemble and deploy capabilities for SARS-CoV-2 surveillance in water. Team capability ranges from public health and infrastructure to water quality and ecology of microorganisms. Our multidisciplinary, cross-institutional team will develop new methods for detecting and tracing SARS-CoV-2 in Chicago-Area Waterways and the Lake Michigan lakeshore, use advanced data analysis to identify infectious disease dynamics, and develop surveillance tools to assess public health as the Illinois economy reopens. Understanding, modeling, and tracking pathogens such as the coronavirus responsible for the current pandemic will have far-reaching economic and societal impact.

WALDER FOUNDATION: PROTOTYPE CHICAGO CORONAVIRUS ASSESSMENT NETWORK NODE (PCANN)

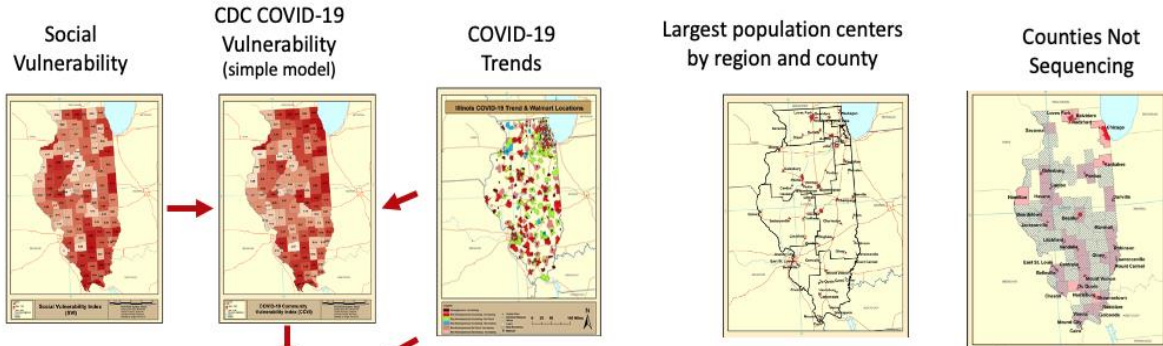
- **PROTOTYPE A WASTEWATER AND WATERWAYS SURVEILLANCE CAPABILITY FOR 12 MONTHS AS A PROOF-OF-CONCEPT WITH:**
 - WEEKLY SAMPLING AT 10-15 KEY LOCATIONS
 - EVALUATING AND OPTIMIZING METHODS FOR DETECTION AND GENETIC SEQUENCING OF SARS-COV-2
 - USING WASTEWATER NETWORK DATA TO BUILD MODELS TO IDENTIFY SOURCES AND QUANTIFY UNCERTAINTY
- **INVESTIGATE CRITICAL STRATEGIES NECESSARY TO IMPLEMENT A FULL-SCALE SURVEILLANCE CAPABILITY FOR SARS-COV-2 AND OTHER PATHOGENS**
 - OPTIMAL SAMPLING FREQUENCY, LOCATION SELECTION
 - EVALUATION OF ON-SITE DETECTION METHODS
 - UNDERSTAND LIMITATIONS AND CAPABILITIES OF MODELING AND SAMPLING, FOR INSTANCE, TO WHAT EXTENT WE CAN PINPOINT SOURCES (E.G. AREAS WITH 10K? 100K? 1K? POPULATION)

TIMELINE



VULNERABILITY ASSESSMENT

Selection & Scaling



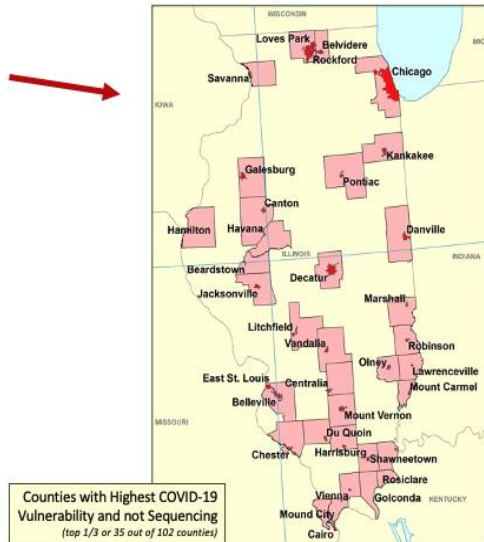
In very large areas such as counties and states with dozens to hundreds of WWTPs, sampling design is critical not only to ensure representative coverage but also to optimize for cost.

Illinois is 58,000 square miles with 102 counties, over 1,000 WWTPs, and nearly 1,000 rural communities with fewer than 10k residents. Sampling from all WWTPs would omit a significant number of even smaller communities using private septic systems, and moreover would be extremely expensive.

A county-level COVID-19 vulnerability index supports prioritization both initially and over time, particularly as we are in the process of adding data regarding (a) vaccinations, and (b) computational models with the goal of estimating asymptomatic or otherwise untested individuals who are not represented in public health data.



Adjusted COVID-19 Vulnerability (ML model)

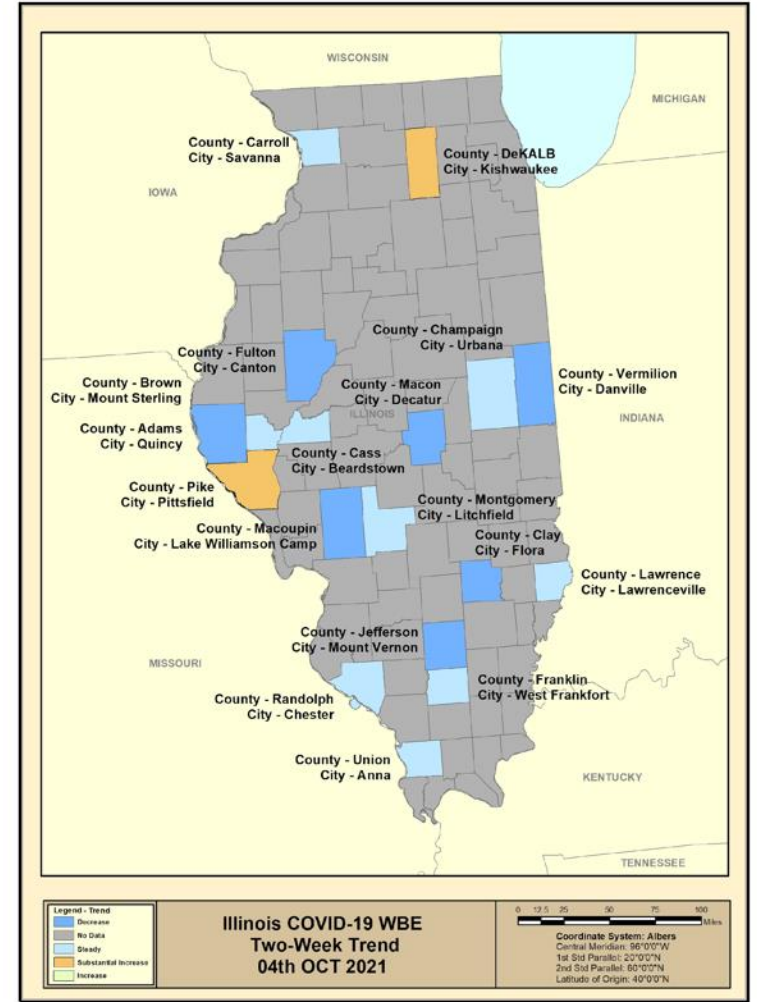


Counties with Highest COVID-19 Vulnerability and not Sequencing (top 1/3 or 35 out of 102 counties)

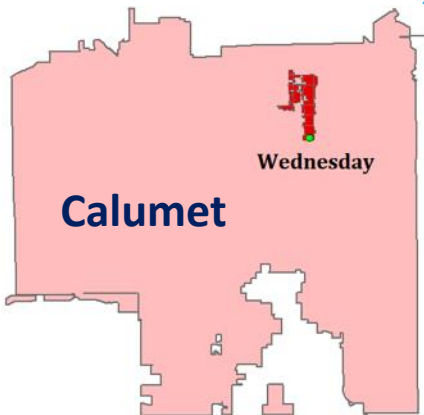
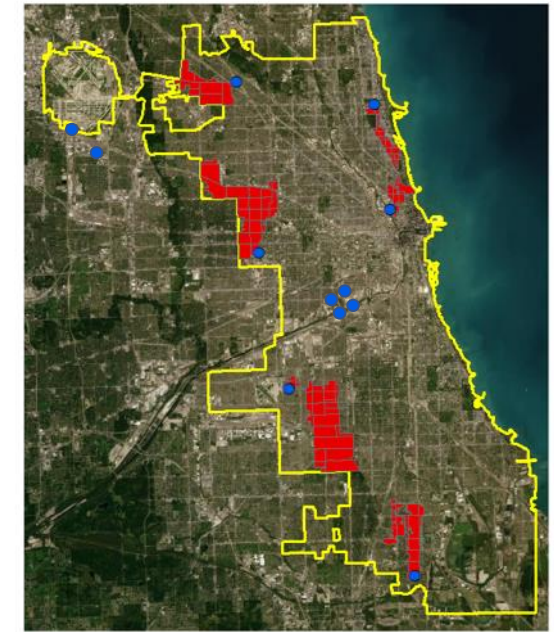
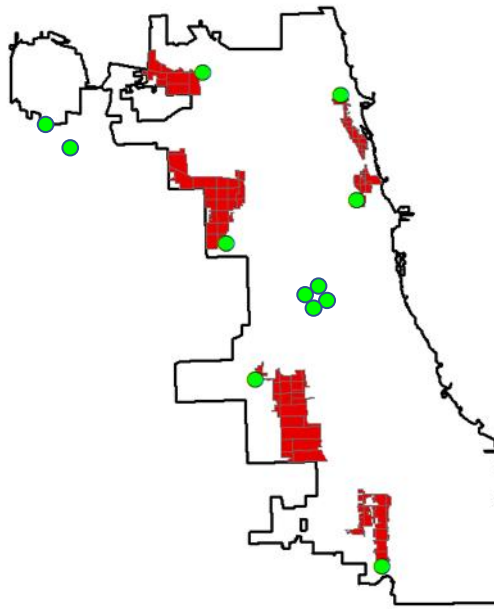
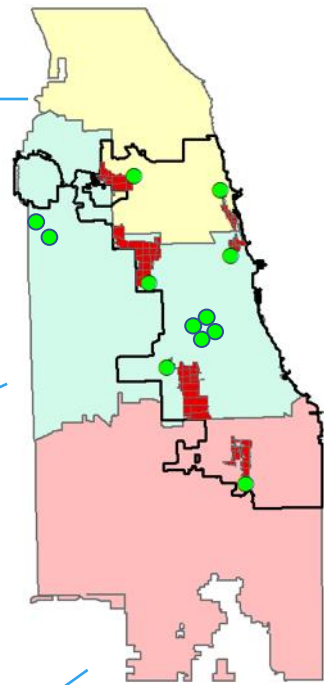
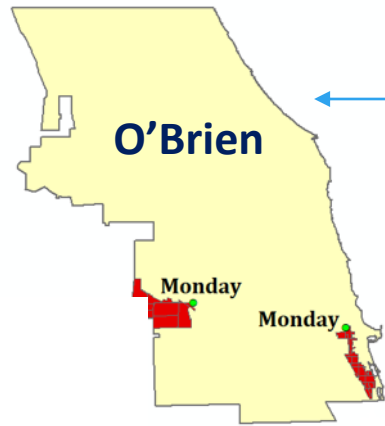
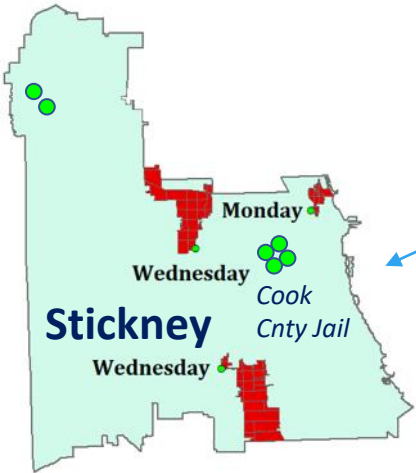
Sequencing, done in only some counties in 2020, was also factored into the initial roll-out of WBE in the 35 most vulnerable counties.

Multiple sampling schemes were evaluated, including (a) largest 8 population centers in each of Illinois' 11 COVID-19 recovery regions, and (b) all communities with population >20k. Both approaches left vast rural areas unexamined.

The 2021 plan is to grow from 20 WWTPs as of June 2021 to 50 in September and 150 in January 2022, representing the largest population centers in each of Illinois' 102 counties.



O'Hare Int'l Airport



Chicago Wastewater Surveillance System (initiated October 2020)

- 7 Sub-sewersheds (6 shown above plus N. Chatham)
- 6 sites serving 2 Facilities
(Cook County Jail, O'Hare International Airport)
- 5 WWTPs serving Chicago
(three primary WWTPs shown here)
- **18 sampling points total**

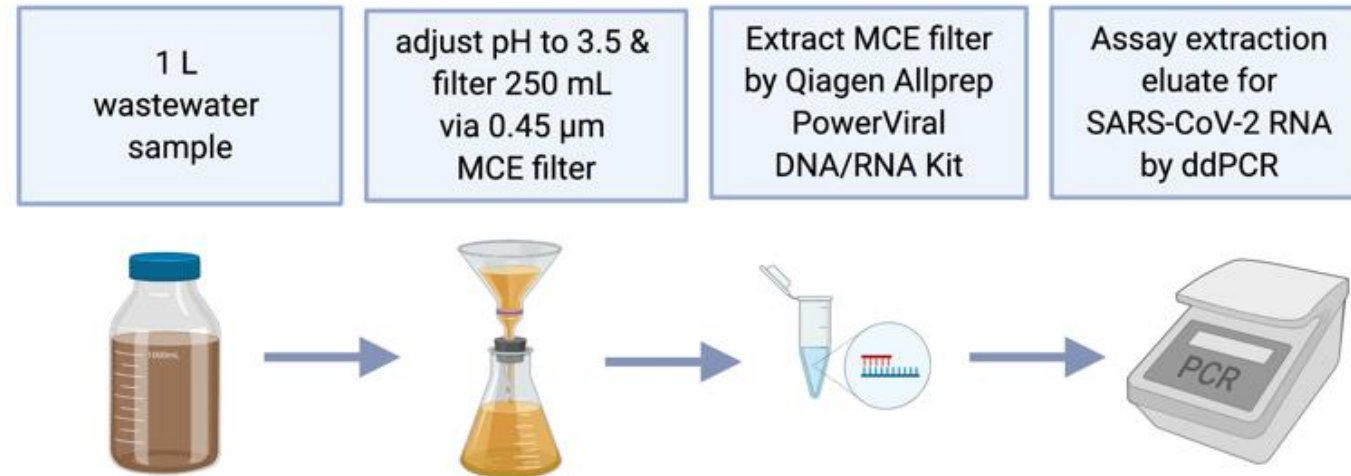
WORKING WITH WWTPS

- 49 MUNICIPALITIES IN 48 COUNTIES; 65 SITES SAMPLING NOW
- PLANTS PARTICIPATE ON A VOLUNTARY BASIS, ALL BUDGETARY COSTS COVERED BY PROGRAM
- SAMPLING 2X PER WEEK, CURRENTLY MONDAYS AND WEDNESDAYS
- COLLECTION KITS AND SHIPPING ORGANIZED BY GT MOLECULAR (PREVIOUSLY 120WATER)

BASIC LABORATORY WORKFLOW



Abhilasha Shrestha
UIC SPH



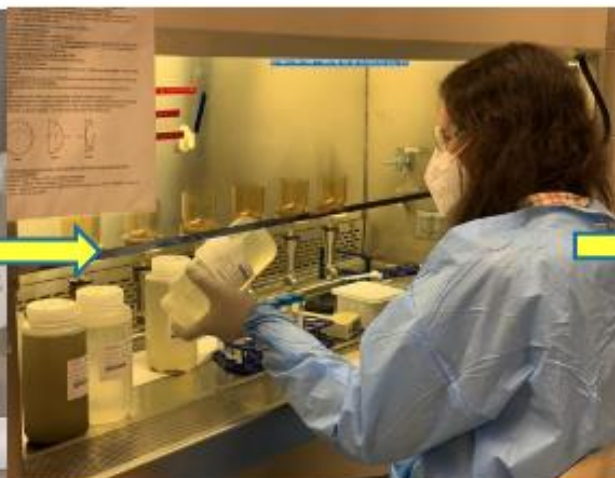
Analysis of wastewater samples to determine the concentration of SARS-CoV-2 RNA. Changes in concentration indicate rise or fall in COVID-19 infections within the sewershed.

Genetic sequencing can also be done on positive samples to discover new mutations, variant strains, or new pathogens.

BASIC LABORATORY WORKFLOW



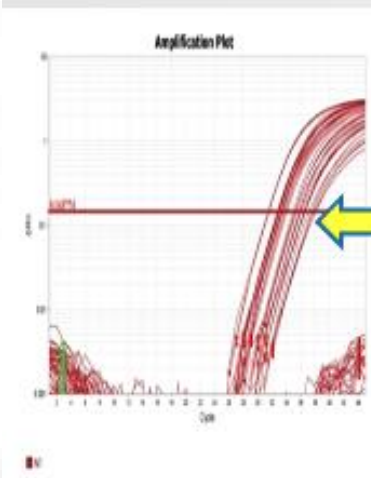
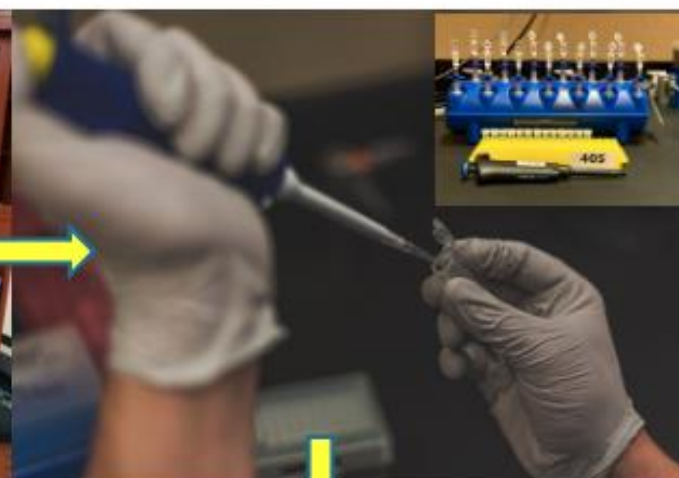
Sample Receiving



Concentration & Filtration



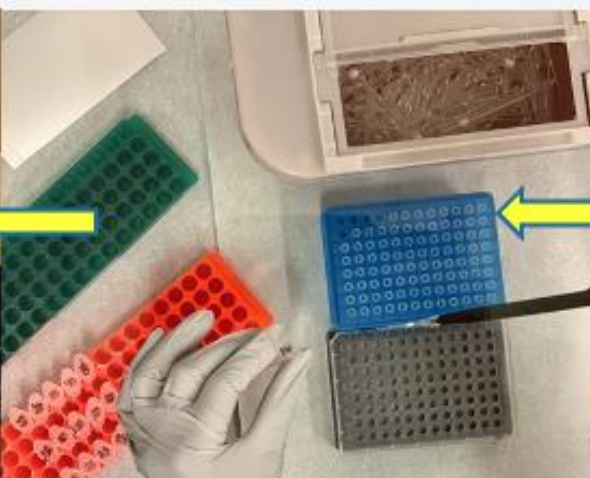
RNA Extraction



Results



qPCR/ DNA Amplification



Sample Plating



Master Mix Loading

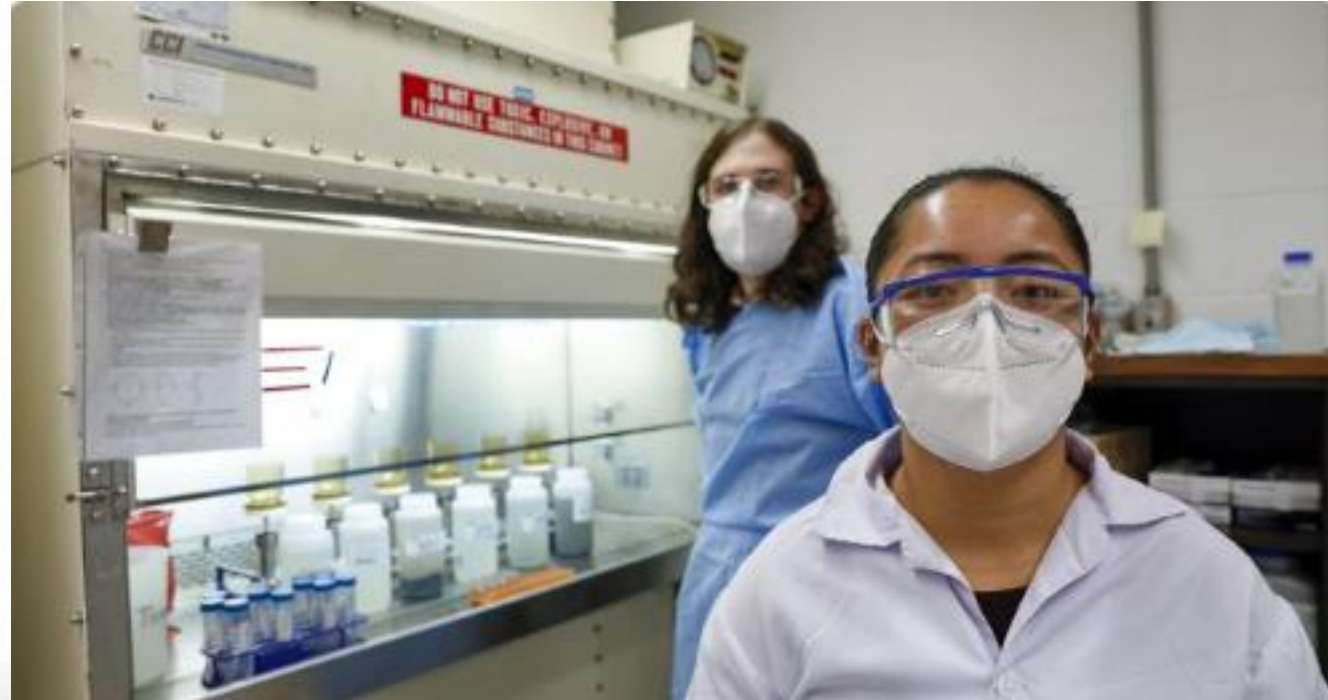


Master Mix Preparation

Every toilet flush reveals a clue in fight to stop COVID-19

By **MICHAEL HAWTHORNE**

CHICAGO TRIBUNE | NOV 17, 2020 AT 5:00 AM





TRENDING

[COVID Vaccine: How to Sign Up](#)

[Coronavirus Live Blog](#)

[2nd Dose: What to Know](#)

[NBC LX](#)

[Race in Chicago](#)

[Coronavirus Stats](#)

[Watch: 'Vaccinated State' Docuseries](#)



COOK COUNTY JAIL

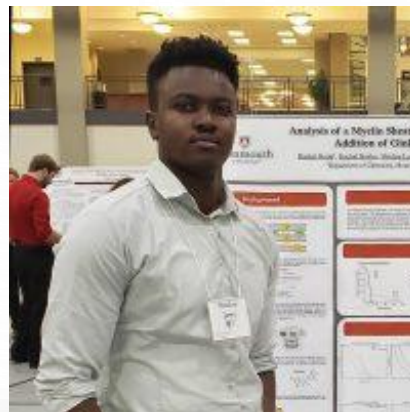
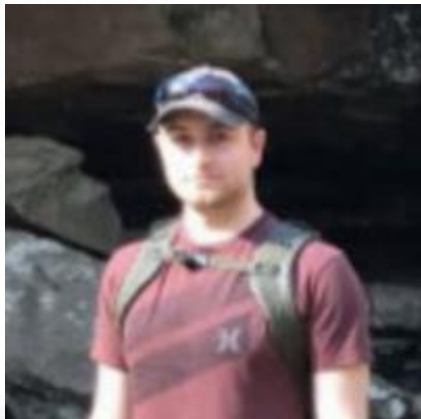
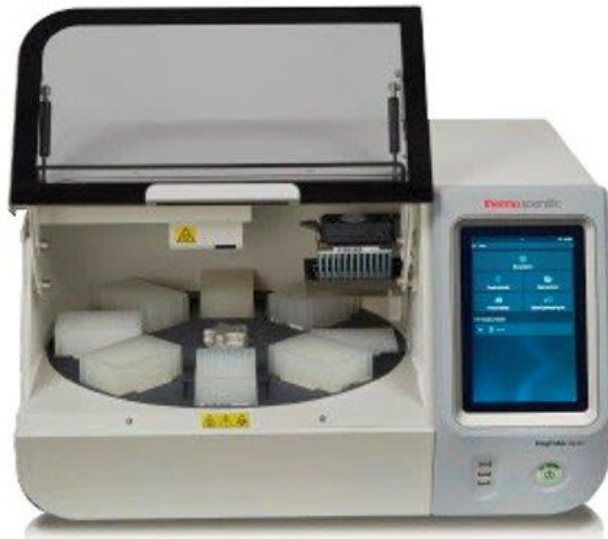
NBC 5 Investigates: Searching The Sewers For COVID-19 at the Cook County Jail

Officials at the Cook County Sheriff's office are hoping the sewers at the jail could lead to groundbreaking new clues in their battle against the deadly virus

Published March 3, 2021 • Updated on March 3, 2021 at 10:48 pm



SCALING AND AUTOMATION



SAMPLES ARRIVE AT THE LAB AND ARE DISTRIBUTED INTO 24-WELL PLATES FOR CONCENTRATION



CONCENTRATION WITH NANOTRAP MAGNETIC VIRUS PARTICLES



RNA EXTRACTION USING THE MAGMAX MICROBIOME AND VIRAL/PATHOGEN KIT ON THE KINGFISHER



QUANTIFICATION WITH QIACUITY DIGITAL PCR

- CURRENT TARGETS:

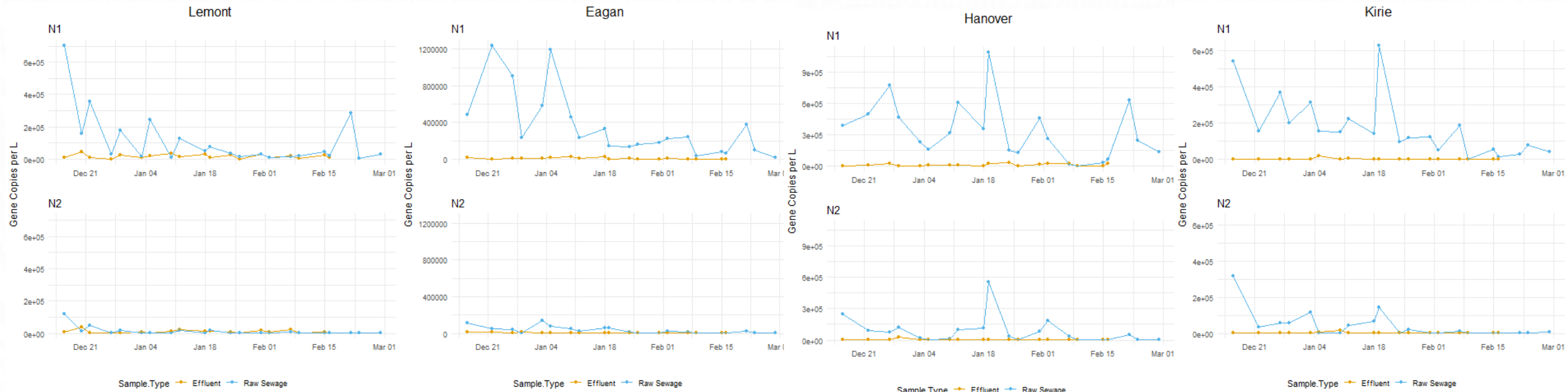
- N1
- N2
- BCOV
- PMMOV
- SPECIFIC VOC/VOI TARGETS

- POSSIBLE ADDITIONS:

- BRSV OR OTHER INHIBITION CONTROL
- E GENE

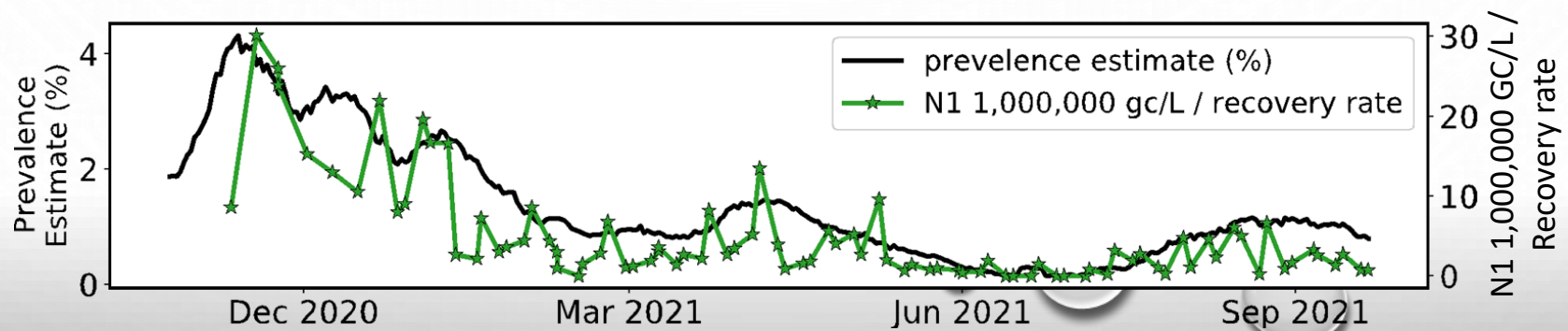
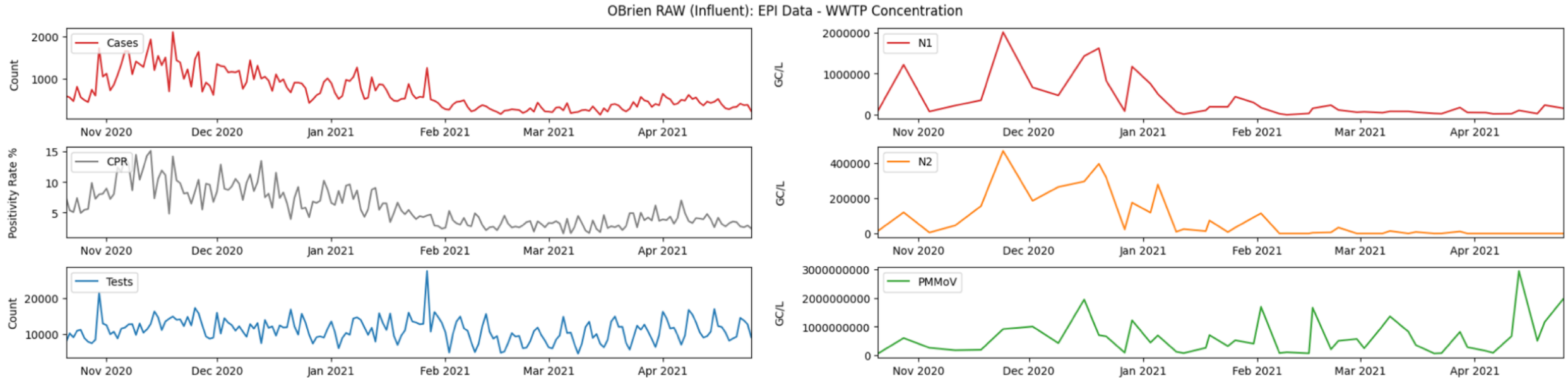


WWTP WEEKLY ANALYSIS

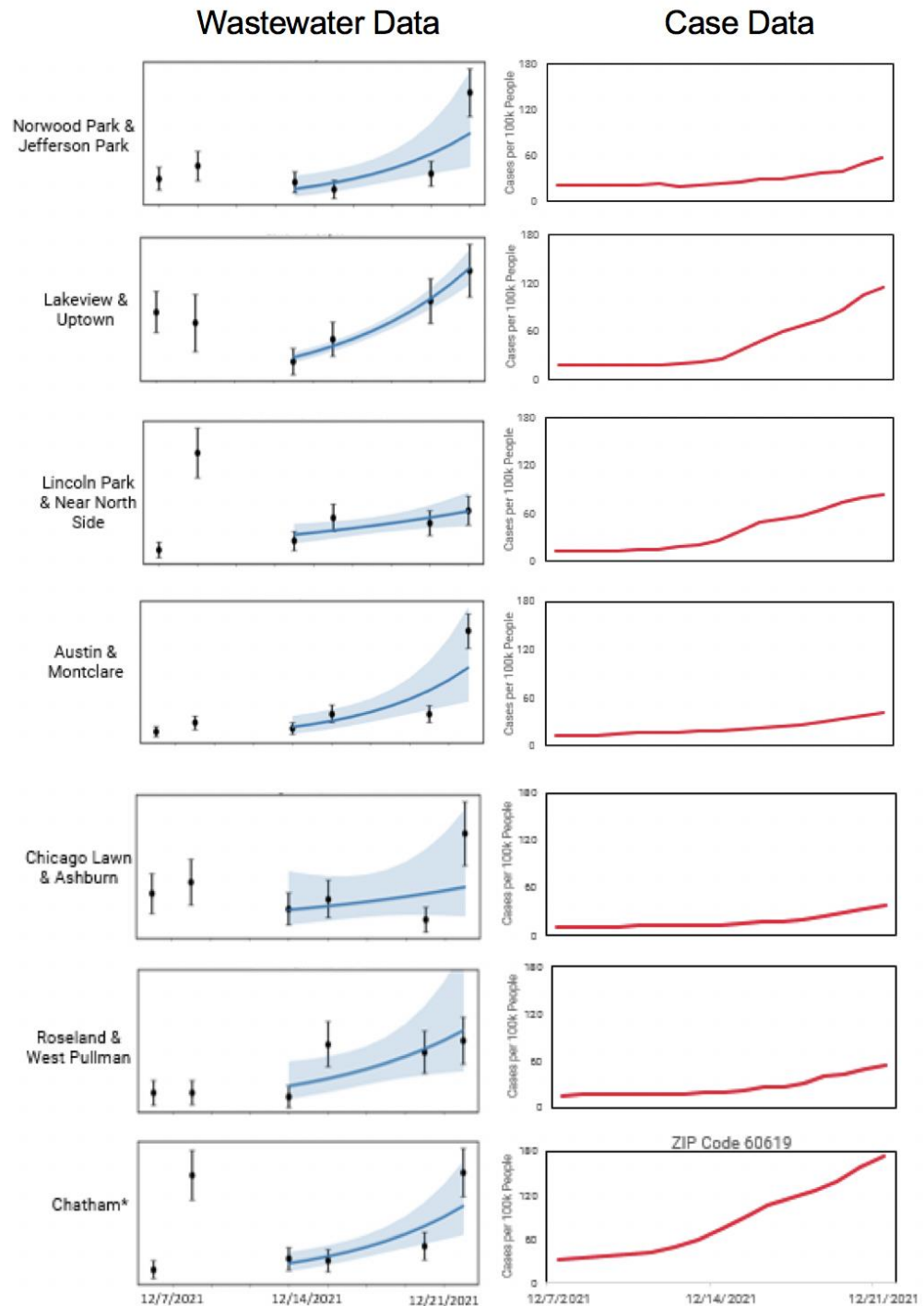


LINEAR CORRELATION BETWEEN CASES AND WASTEWATER CONCENTRATION AT 7, 10, 14, AND 28 DAYS

EPI Data [Cases, Test, Cases Positivity Rate (CPR)] WWTP Concentration [N1, N2 and PMMoV]

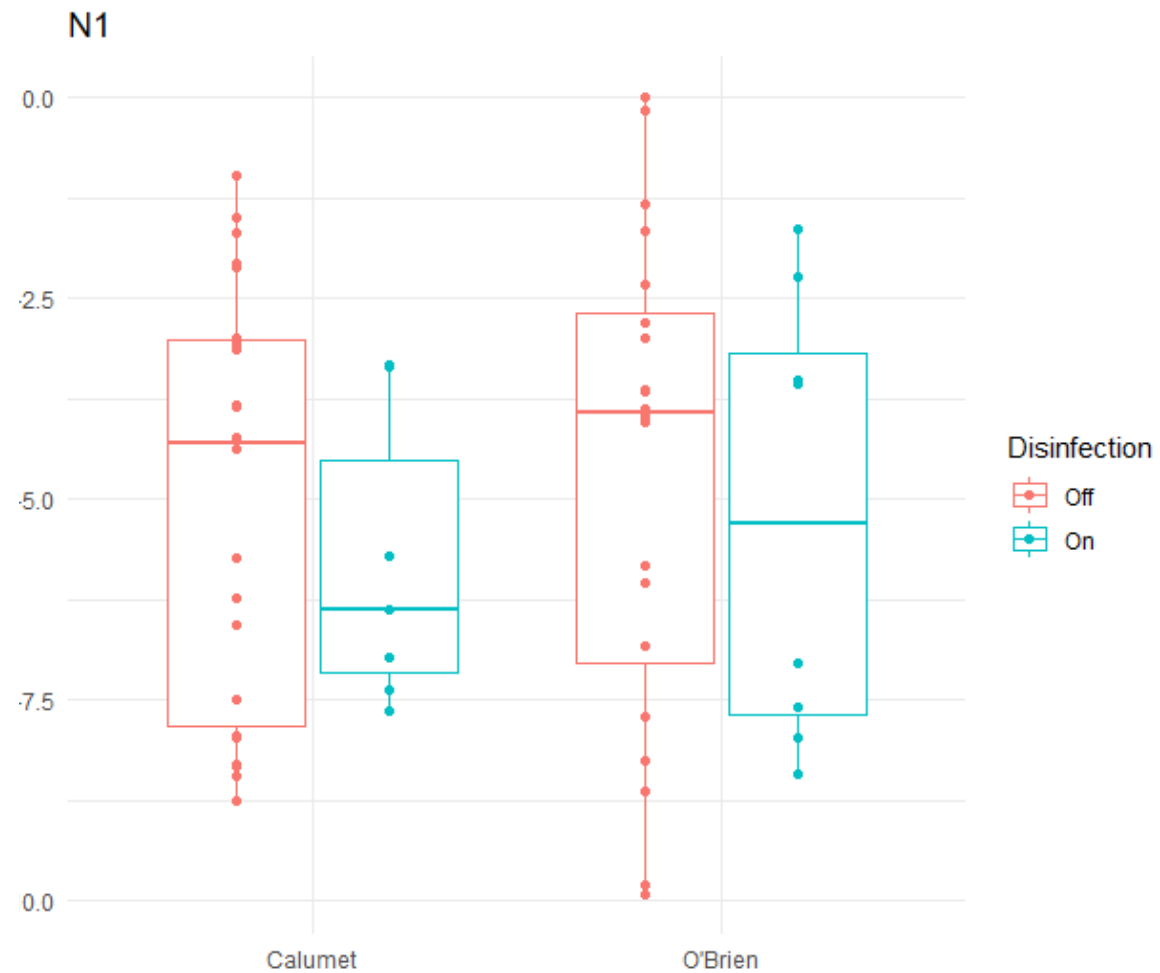
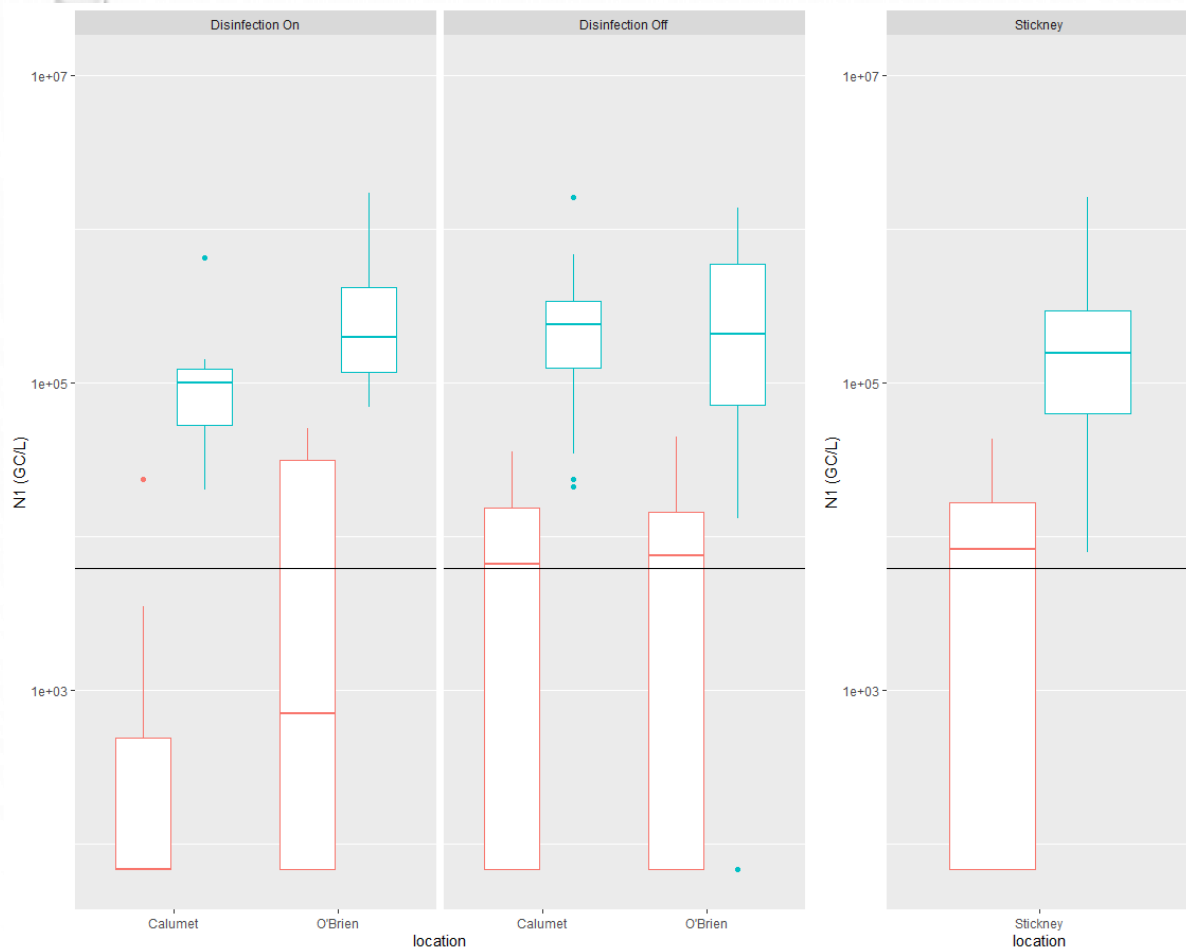


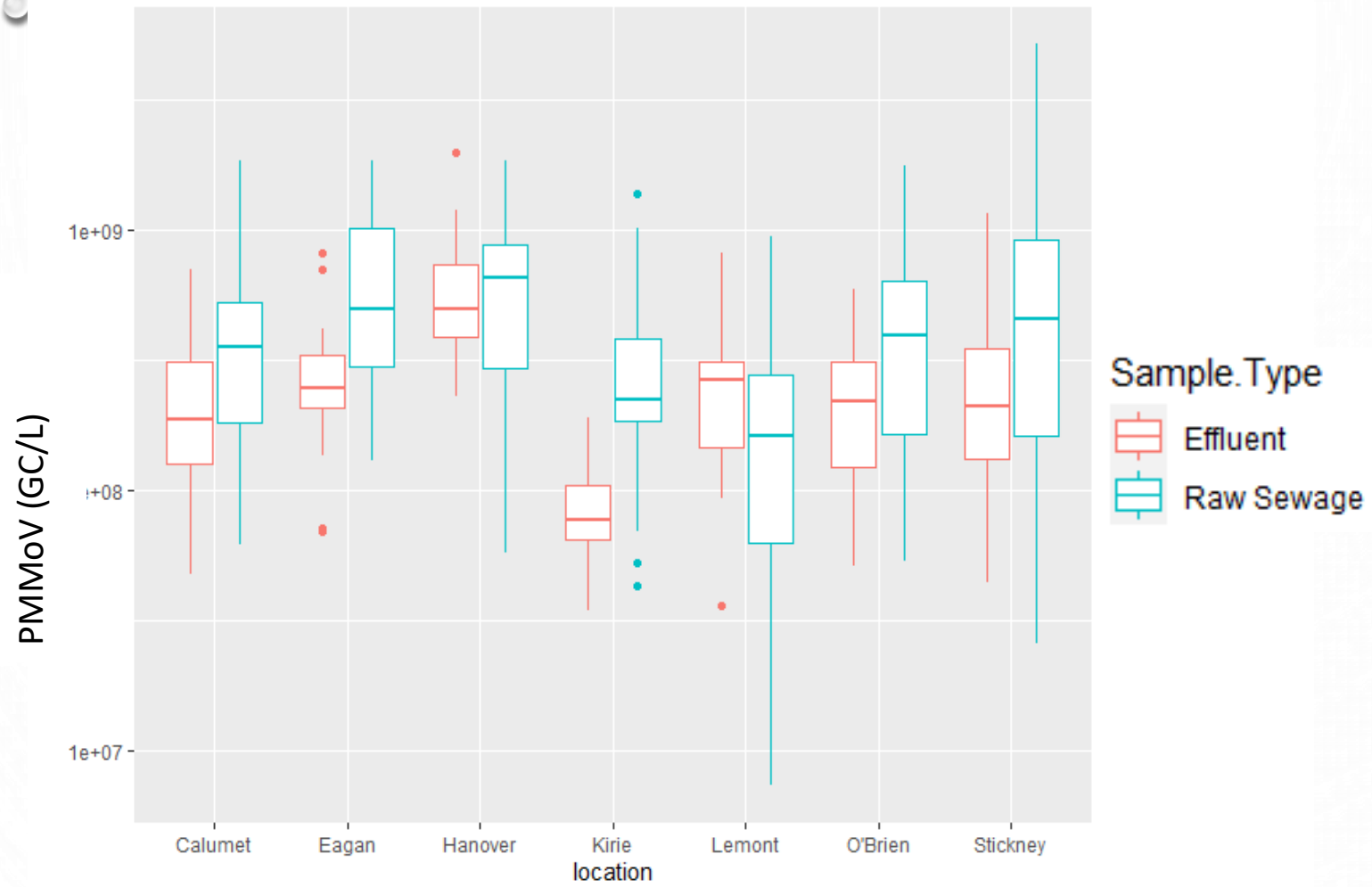
AMOUNT OF SARS-COV-2 IN WASTEWATER (LEFT) AND REPORTED CASES OF COVID-19 (RIGHT) FOR EACH CATCHMENT ZONE IN CDPH'S WASTEWATER MONITORING PROGRAM – CHICAGO, ILLINOIS, DECEMBER 2021



INFLUENT/EFFLUENT COMPARISONS

LOG OF THE RATIO OF GENE COPIES IN EFFLUENT:INFLUENT







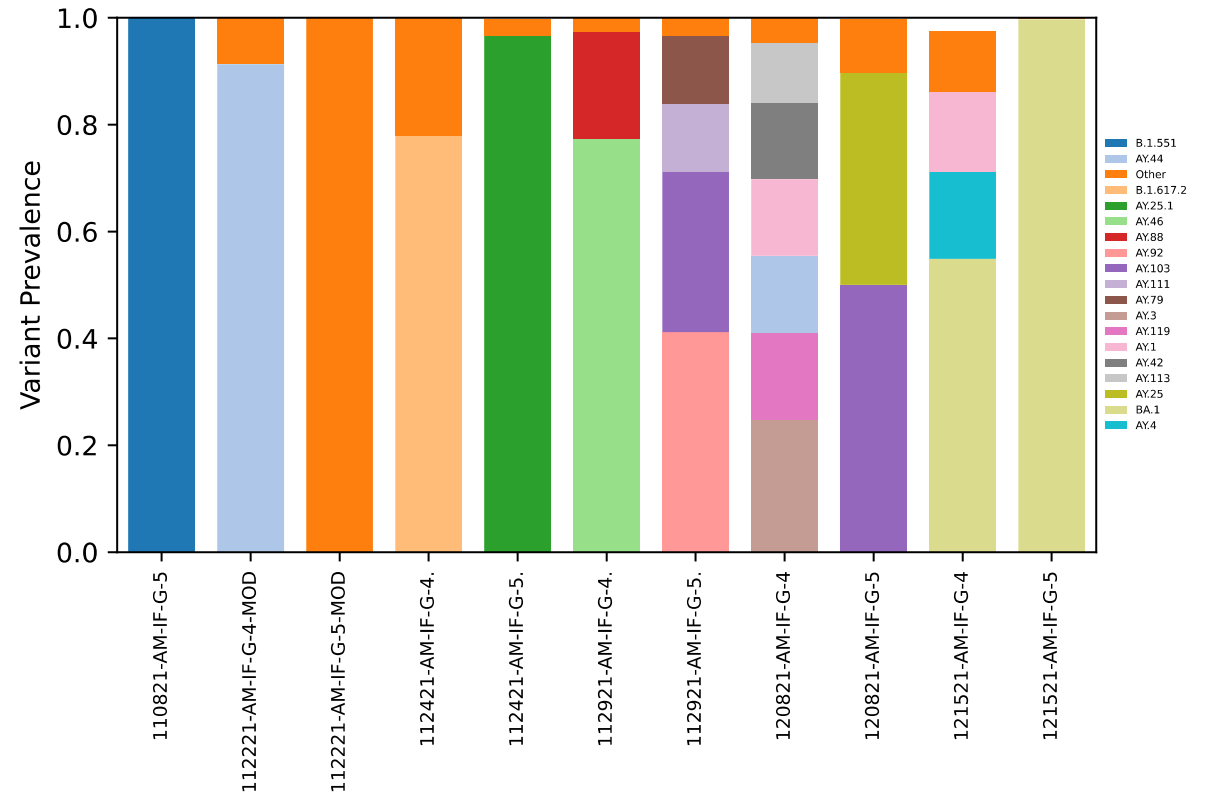
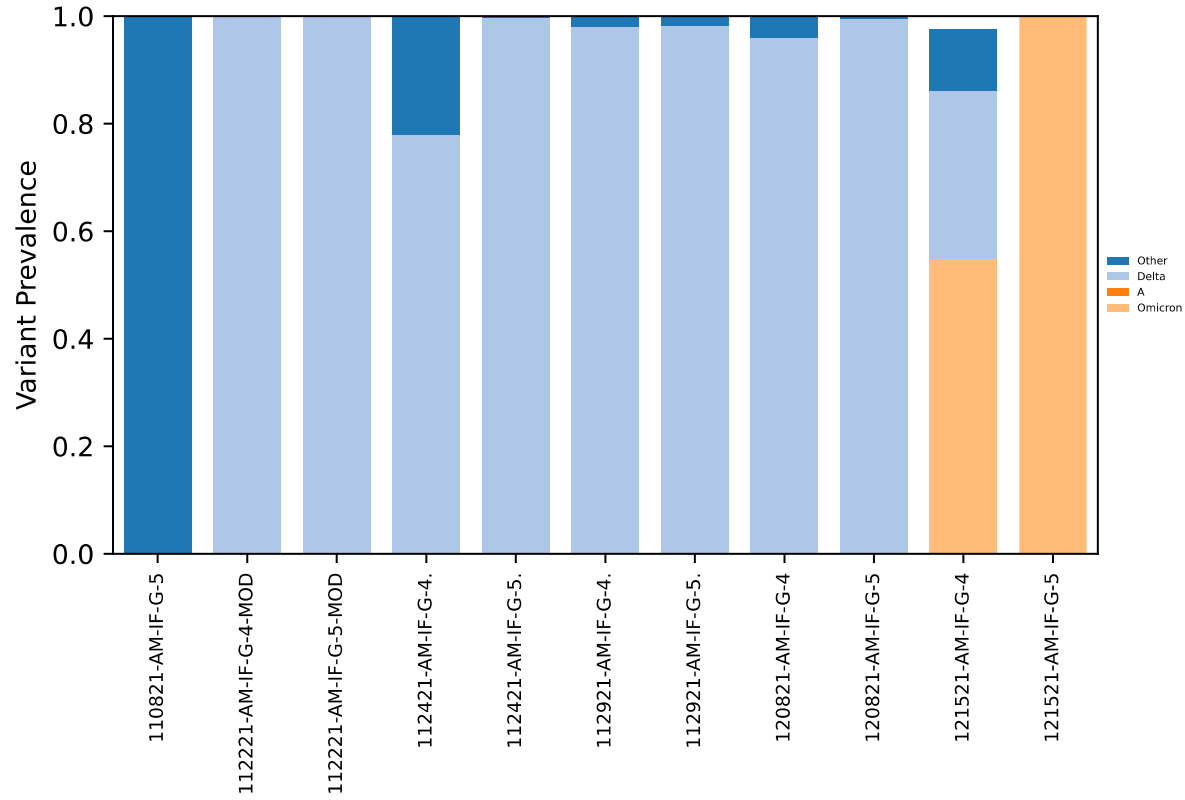
| SampleID | Date | Location | Summary | Lineages | % genome |
|----------------|-------------|----------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------|
| 122021-2-C-1 | Dec 20 2021 | Lawrenceville STW | Delta:0.9929273116878702 | AY.39.2,AY.103,AY.83,AY.39.1 | 52.66 |
| 122721-38a-C-1 | Dec 27 2021 | North Shore Waukegan | Omicron:0.7559539999989502,Other:0.1075828762975933,Delta:0.09653145 | BA.1,B.1.1,AY.1,AY.103,B.1.1.266,B.1.1.16,B.1.1.105,B.1.1.194,AY.118,B.1.1.13 | 99.73 |
| 122721-20b-C-1 | Dec 27 2021 | Crystal Lake - WWTP 3 | Delta:0.5261727487253679,Omicron:0.4616400000106274 | BA.1,AY.1,AY.118,AY.25,AY.103,AY.25.1,AY.100 | 99.65 |
| 122721-13b-G-1 | Dec 27 2021 | Mount Sterling - South WICC | Omicron:0.9994710000000098 | BA.1 | 26.02 |
| 122721-22b-C-1 | Dec 27 2021 | Bloomington West Plant 3 | Omicron:0.6201802438292863,Delta:0.3700467989933304 | BA.1,AY.1,B.1.1.529,B.1.617.2 | 95.55 |
| 122821-29-C-1 | Dec 28 2021 | Batavia | Omicron:0.7293154490108266,Delta:0.1669973939566766,Other:0.06941914 | BA.1,AY.1,AY.39,B.1.1.529,B.1.1.155,B.1.1.168,B.1.1.16,AY.100,B.1.1.194,B.1.1.376,B.1.1.360 | 99.21 |
| 122721-4 | Dec 27 2021 | SMH000072456, 5258 W Congress PKWY | Omicron:0.9301707292453638,Other:0.049437904909949114 | BA.1,B.1.268,B.1.1.266,B.1.325,B.1.96,B.1.163,B.1.115,B.1.194,B.1.305 | 49 |
| 122721-6 | Dec 27 2021 | SMH000111150, 124th and Wentworth | Other:0.9922242385395911 | B.13,B.1.1.227,B.1.1.115,B.1.552 | 19.39 |
| 122721-38b-C-1 | Dec 27 2021 | North Shore Gurnee | Omicron:0.588831999998957,Delta:0.23112139693656303,Other:0.14161913 | BA.1,AY.103,B.1.1,AY.39,AY.39.1,B.1.1.137,B.1.1.376,B.1.1.194,B.1.1.16,B.1.105,B.1.163,B.1.1.360,B.1.1.263 | 99.34 |
| 122721-20a-C-1 | Dec 27 2021 | Crystal Lake - WWTP 2 | Delta:0.4582901483270559,Omicron:0.40782800000295955,Other:0.1018830 | BA.1,AY.39.1,AY.25,AY.1,AY.103,B.1.1,B.1.1.244,B.1.1.266,B.1.1.376,B.1.1.194,B.1.1.360,B.1.1.43,AY.3.1,B.1.533 | 99.71 |
| 122721-27-C-1 | Dec 27 2021 | Macomb | Delta:0.8934125071805445,Omicron:0.07320080000105733,Other:0.0037106 | AY.103,AY.100,BA.1,AY.122,AY.44,AY.83,B.1.1.194 | 99.73 |
| 122721-21b-C-1 | Dec 27 2021 | Moline - North Slope | Omicron:0.6144437506640783,Delta:0.36150839409358926 | BA.1,AY.103,AY.39.1,AY.25.1,AY.44,AY.100 | 99.79 |
| 122721-13a-G-1 | Dec 27 2021 | Mount Sterling - North | Delta:0.9936162980452679 | AY.119.2,AY.119 | 99.39 |
| 122721-4-C-1 | Dec 27 2021 | Savanna STW | Omicron:0.7247288479925463,Delta:0.2615782731286323 | BA.1,AY.113,B.1.1.529,AY.83,AY.84 | 88.77 |
| 122721-16-G-1 | Dec 27 2021 | City of Anna | Delta:0.8459042831654237,Omicron:0.1494762452247048 | AY.1,AY.103,BA.1,AY.46.4 | 61.4 |
| 122921-4 | Dec 29 2021 | SMH000072456, 5258 W Congress PKWY | Omicron:0.998699999993619 | BA.1 | 98.91 |
| 122721-26-C-1 | Dec 27 2021 | Naperville | Omicron:0.7568750399552324,Delta:0.22548613953422578 | BA.1,AY.103,AY.126,AY.25 | 99.75 |
| 122721-30-C-1 | Dec 27 2021 | Kankakee | Omicron:0.8931615562560458,Delta:0.10107281141845906 | BA.1,B.1.1.529,AY.44 | 97.43 |
| 122721-24-C-1 | Dec 27 2021 | Peoria | Omicron:0.6911936972248872,Delta:0.24333214883149668,Other:0.0293529 | BA.1,AY.103,AY.44,B.1.1.45,AY.25,B.1.1.194,AY.1 | 99.73 |
| 122721-25-C-1 | Dec 27 2021 | Effingham | Delta:0.9421418720991106,Other:0.022947589252609542 | AY.3,AY.103,AY.39,AY.39.1,B.1.1.376,B.1.1.294,B.1.1.194,B.1.1.115,B.1.1.360,B.1.533,B.1.1.440,B.1.1.192 | 97.09 |
| 122721-15-C-1 | Dec 27 2021 | Quincy | Delta:0.7412837799801812,Omicron:0.2083099999995461,Other:0.0134650 | AY.103,BA.1,AY.119,AY.1,AY.25,B.1.1.194,B.1.1.168,B.1.1.440,B.1.1.376,B.1.1.360,B.1.251 | 99.49 |
| 122921-6 | Dec 29 2021 | SMH000111150, 124th and Wentworth | Omicron:0.9992949654443495 | BA.1 | 87.68 |
| 010322-6 | Jan 03 2022 | SMH000111150, 124th and Wentworth | Omicron:0.999435999992736 | BA.1 | 98.14 |
| 010522-4 | Jan 05 2022 | SMH000072456, 5258 W Congress PKWY | Omicron:0.9993174907347248 | BA.1 | 99.53 |
| 122721-19-G-1 | Dec 27 2021 | City of Flora | Delta:0.9938790754076352 | AY.39,AY.1,AY.106,AY.103 | 43.51 |
| 122721-13c-G-1 | Dec 27 2021 | Mount Sterling - South Flume | Delta:0.985995613651697 | AY.25,AY.6,AY.83,AY.4.5,AY.116,AY.46.4,AY.60 | 69.36 |
| 122721-9-C-1 | Dec 27 2021 | Danville SD STW | Omicron:0.7130729999963006,Delta:0.26466154466265157,Other:0.0017429 | BA.1,AY.1,AY.100,B.1.1.194 | 99.79 |
| 122721-17-C-1 | Dec 27 2021 | Urbana and Champaign Sanitary District | Omicron:0.8495773650592706,Delta:0.13980217104729398 | BA.1,AY.1,AY.39.1 | 99.12 |
| 122721-22c-C-1 | Dec 27 2021 | Bloomington South Plant 4 | Delta:0.6292984099827833,Other:0.3365212258999838 | AY.126,B.1.1.241,AY.103,B.1.1.16,B.1.1.194,B.1.1.300 | 95.96 |
| 122721-34-C-1 | Dec 27 2021 | Christian County | Delta:0.5226958952991413,Omicron:0.46058520006749404 | AY.1,BA.1 | 94.99 |
| 122721-5-C-1 | Dec 27 2021 | City of Canton WTP | Omicron:0.8685078362001961,Delta:0.10905079585579634,Other:0.0127714 | B.1.1.529,B.1.617.2,B.1.401,B.1.552,B.1.1.395 | 55.63 |
| 122721-32-G-1 | Dec 27 2021 | Freeport | Omicron:0.7328230236971917,Delta:0.11560939090678224,Other:0.1137057 | BA.1,B.1.1.367,AY.25,AY.103,B.1.1.506,B.1.617.2,B.1.1.289,B.1.1.222,B.1.1.158,B.1.1.77,B.1.105,B.1.552 | 99.79 |
| 122721-14-C-1 | Dec 27 2021 | Pittsfield | Delta:0.9364216334251471,Other:0.018843023340822503,Omicron:0.003668 | AY.122,AY.44,AY.103,AY.1,AY.39.1,B.1.1,B.1.1.194,BA.1,B.1.1.16,AY.113,B.1.1.360,B.1.1.168,B.1.552 | 99.08 |
| 122721-6-C-1 | Dec 27 2021 | Decatur SD STW | Delta:0.9636485845303302,Other:0.018051750138202087 | AY.1,AY.44,B.1.1.194,B.1.533,B.1.1.227,B.1.1.115,AY.4.5 | 80.47 |
| 122721-11-C-1 | Dec 27 2021 | Chester WWTP | Delta:0.7030464426265294,Other:0.26176231675364453 | AY.103,B.1.1,AY.1,B.1.1.194,B.1.1.461,B.1.1.158,B.1.1.115,B.1.1.360,B.1.1.168,B.1.105,B.1.1.514,B.1.1.266,AY.79 | 95.49 |
| 122721-21a-C-1 | Dec 27 2021 | Moline - South Slope | Omicron:0.6040405146053005,Delta:0.31359284583989233,Other:0.0423347 | BA.1,AY.113,AY.39.1,AY.100,AY.103,B.1.1.200,AY.44,B.1.1.155,B.1.1.61,B.1.1.529,B.1.1.381,B.1.1.194,B.1.1.360,B.1.1.43,B.1.1.376 | 99.79 |
| 122721-35-C-1 | Dec 27 2021 | Belvidere | Delta:0.5585457721077643,Omicron:0.3736339999962246,Other:0.03253154 | BA.1,AY.1,AY.103,AY.25,B.1.1.376,B.1.1.194,B.1.1.360,AY.3.1,B.1.251 | 99.55 |
| 122721-31b-C-1 | Dec 27 2021 | Belleville West | Omicron:0.8040528576452289,Delta:0.18203755999265658 | BA.1,AY.1,AY.25,AY.5.1 | 99.72 |
| 122721-28-C-1 | Dec 27 2021 | Four Rivers (Rockford) | Omicron:0.5806380972150695,Delta:0.2893439240334991,Other:0.09511699 | BA.1,AY.100,AY.103,AY.43,B.1.1.376,B.1.1.63,B.1.1.61,B.1.1.168,AY.25,B.1.1.194,B.1.1.360,B.1.251,B.1.442 | 99.79 |
| 122721-31a-C-1 | Dec 27 2021 | Belleville East | Omicron:0.9742851514157266,Delta:0.02345599205985341 | BA.1,AY.113 | 97.28 |
| 122721-38c-C-1 | Dec 27 2021 | North Shore Clavey Rd | Omicron:0.9988104910346033 | BA.1 | 93.18 |
| 122721-33-C-1 | Dec 27 2021 | Galena | Other:0.5926562908366051,Delta:0.3710954683803818 | AY.25.1,B.59,B.1.1.169,B.1.1.95,B.1.1,AY.25,B.1.1.289,B.1.1.16,B.1.533,B.1.1.194,AY.4.5,AY.84,B.1.1.360,B.1.1.115,B.1.1.158 | 91.83 |
| 122721-22a-C-1 | Dec 27 2021 | Bloomington West Plant 1 | Omicron:0.8013159999982549,Delta:0.13670143442099125,Other:0.0265174 | BA.1,B.1.617.2,B.1.1.61,B.1.1.249,B.1.1.16,B.1.1.194,B.1.105,B.1.1.360 | 98.52 |
| 122721-7-C-1 | Dec 27 2021 | Beardstown SD STW | Delta:0.9170425551026733,Other:0.04798606018877718 | AY.103,B.1.617.2,B.1.1,AY.117,B.1.1.376,B.1.1.194,B.1.1.360,B.1.1.311,B.1.1.168,B.1.251 | 98.81 |
| 122721-42-C-1 | Dec 27 2021 | Centralia | Delta:0.7152739450397091,Other:0.2360852695055372,Omicron:0.0119539 | AY.1,B.1.1,AY.39,AY.126,AY.25,B.1.1.61,B.1.1.529,AY.39.1,B.1.1.194,B.1.1.155,B.1.1.16,B.1.1.376,BA.1,B.1.1.360,B.1.533,B.1.1.266 | 98.85 |

| SampleID | Date | Location | Summarized | Lineages | % Genome |
|-------------------------|----------|-------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 121221-SW-IF-C-4 | 12/12/21 | Stickney WSRW | Delta', 0.9623830213051965, 'Other', 0.022974393959072813 | [AY.25'AY.103'AY.39.1'B.1.1.166'] | 99.13 |
| 121221-SS-IF-C-4 | 12/12/21 | Stickney STRAW N/S | Delta', 0.9956110806294091 | [AY.3'] | 91.55 |
| 121221-SW-IF-C-5 | 12/12/21 | Stickney WSRW | Delta', 0.9953243255716636 | [AY.1'AY.25'AY.84'AY.100'AY.79] | 98.28 |
| 121221-SS-IF-C-5 | 12/12/21 | Stickney STRAW N/S | Delta', 0.9948259352077815 | [AY.25'AY.119'AY.113] | 96.17 |
| 121321-DN-IF-G-4 | 12/13/21 | CCJ Division 9 | Delta', 0.9967084427841892 | [AY.127'AY.4'AY.111'AY.3'AY.44] | 67.67 |
| 121321-DV-IF-G-4 | 12/13/21 | CCJ Division 5 | Delta', 0.9964232212849967 | [AY.103'AY.120] | 99.58 |
| 121221-CL-IF-C-4 | 12/12/21 | Calumet Raw | Omicron 0.5083, Delta 0.4741, Other 0.001786 | [BA.1'AY.39'B.1.1.194] | 90.67 |
| 121221-CL-IF-C-5 | 12/12/21 | Calumet Raw | Delta 0.99197 | [AY.29'AY.29.1'AY.103] | 83.3 |
| 121321-DT-IF-G-4 | 12/13/21 | CCJ Division 10 | Delta', 0.9957089334410146 | [AY.106'AY.119'AY.103] | 73.89 |
| 121321-HR-IF-G-4 | 12/13/21 | ORD H&R (Domestic) | Delta', 0.996029985266763 | [AY.44] | 77.63 |
| 121521-DD-IF-G-4 | 12/15/21 | CCJ Division 11 (Pod D) | Omicron', 0.969149000064265, 'Delta', 0.024932042924142295 | [BA.1'AY.103'AY.126] | 99.73 |
| 121421-SS-IF-C-5 | 12/14/21 | Stickney STRAW N/S | Delta', 0.803160933307286, 'Omicron', 0.1909762495523256 | [AY.1'BA.1'AY.100] | 98.48 |
| 121521-HR-IF-G-4 | 12/15/21 | ORD H&R (Domestic) | Delta', 0.6632839051380953, 'Omicron', 0.3065826611320511, 'Other', 0.006549709915301962 | [AY.119.2'BA.1'B.1.1.529'AY.1'B.1.1.168' B.1.1.194'B.59] | 99.48 |
| 121521-DR-IF-G-4 | 12/15/21 | CCJ Divison 3-Annex | Other', 0.6476469861135056, 'Omicron', 0.33333300000089167 | [B.1.1.161'B.1.1.529'BA.1'B.1.1.155' B.1.1.55'B.1.1.134'B.1.1' B.1.1.95'B.1.1.189'B.1.1.166'B.1.1.43' B.1.1.137'B.1.173' B.1.1.148'B.1.1.116'B.1.1.61'B.1.1.8' B.1.1.249'B.1.1.41' B.1.1.231'B.1.1.107'B.1.1.440]" | 60.02 |
| 121421-SW-IF-C-5 | 12/14/21 | Stickney WSRW | Delta', 0.5699630646926965, 'Omicron', 0.4061915302409561, 'Other', 0.008567830337437582 | [BA.1'AY.39'AY.1'AY.44'AY.25'AY.100' AY.39.1'B.1.1.168' B.1.1.189'B.1.1.180] | 98.75 |
| 121421-SS-IF-C-4 | 12/14/21 | Stickney STRAW N/S | Delta', 0.9928775115312484 | [AY.1'AY.3'AY.118'AY.3.1] | 97.38 |
| 121421-SW-IF-C-4 | 12/14/21 | Stickney WSRW | Delta', 0.5384928616171272, 'Omicron', 0.4362323911714828, 'Other', 0.008199025984812704 | "[BA.1'AY.3'AY.25'AY.119'AY.119.2' AY.1'B.1.1.529'AY.3.1' AY.126'B.1.1.168'B.1.1.398]" | 99.57 |
| 121421-CL-IF-C-4 | 12/14/21 | Calumet Raw | Delta', 0.6935884452494929, 'Other', 0.28361547283129046 | [AY.1'B.1.617.2'B.1.1'AY.39.1'AY.39' B.1.1.256'B.1.1.220' B.1.1.194] | 98.51 |
| 110721-OB-IF-C-5 | 12/13/21 | O'Brien RAW | Delta', 0.9935556476790272 | B.1.617.2'AY.39.1'AY.25'AY.43'AY.82] | 86.94 |
| 121421-CL-IF-C-5 | 12/14/21 | Calumet Raw | Delta', 0.6268102159623133, 'Omicron', 0.3130919999594933, 'Other', 0.047289298368427726 | [AY.113'BA.1'AY.103'B.1.1.49] | 98.1 |
| 121421-OB-IF-C-4 | 12/14/21 | O'Brien RAW | Delta', 0.7409705636767627, 'Other', 0.24456354165662658 | [AY.122.1'B.1.1.155'AY.110'AY.103' AY.39'B.1.173] | 88.92 |

| SampleID | Date | Location | Summarized | Lineages | % Genome |
|-----------------------|----------|-----------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------|
| 121521-AM-IF-G-5 | 12/15/21 | ORD AMC (International) | Omicron 0.5486, Delta 0.3125, Other 0.1138 | [BA.1'AY.4'AY.1'B.1.1.43'B.1.1'B.1.533'B.1.1.200'B.1.1.398'B.1.1.194] | 81.74 |
| 121521-AM-IF-G-4 | 12/15/21 | ORD AMC (International) | Omicron 0.9971 | [BA.1] | 98.76 |
| 122021-24-C-1 | 12/20/21 | Peoria | Delta', 0.6372435829834644, 'Omicron', 0.26954099995510294, 'Other', 0.0705 | [BA.1'AY.103'B.1.617.2'AY.25'AY.39'B.1.1.161'AY.25.1'AY.3'AY.1] | 99.79 |
| 122021-20a-C-1 | 12/20/21 | Crystal Lake - WWTP 2 | Delta', 0.9774958781725646, 'Omicron', 0.01483828119998105 | [AY.119.2'AY.1'AY.3.1'AY.103'AY.39'BA.1'AY.3'AY.25'AY.4.2]" | 99.6 |
| 122021-22a-C-1 | 12/20/21 | Bloomington West Plant 1 | Delta', 0.9829382423770715, 'Other', 0.0018284799782197739 | [AY.103'AY.39'AY.39.1'AY.3'B.1.1.168'AY.119.2'AY.1'AY.3.1'AY.103'AY.39'BA.1'AY.3'AY.25'AY.4.2]" | 98.23 |
| 122021-36-C-1 | 12/20/21 | City of Jacksonville | Delta', 0.9968089824402047 | [AY.3.1'AY.39] | 95.15 |
| 121321-4 | 12/13/21 | SMH000072456, 5258 W Congress PKWY | Delta', 0.8083138638818502, 'Omicron', 0.16646100000044706, 'Other', 0.01148 | [AY.103'AY.1'BA.1'AY.3'AY.3.1'AY.25.1'B.1.1.49] | 98.78 |
| 121321-5 | 12/13/21 | SMH000116477, 58th and Kostner Avenue | Delta', 0.9934443395493164 | [AY.46.6'AY.46'AY.84'AY.1'AY.44] | 97.11 |
| 121321-6 | 12/13/21 | SMH000111150, 124th and Wentworth | Delta', 0.5593233676197805, 'Omicron', 0.3957208872477154, 'Other', 0.018076 | [BA.1'AY.43'AY.113'AY.43.4'B.1.617.2'B.1.1.168'B.1.1.194'B.1.1.205'AY.1]" | 97.98 |
| 121321-7 | 12/13/21 | MHOL23-00116, Tuley Park | Omicron 0.507, Other 0.315, Delta 0.1567 | [BA.1'B.1.1.118'AY.25'AY.1'B.1.1.529'B.1.1.194'B.1.1.168] | 99.11 |
| 121421-1 | 12/14/21 | SMH000017048, 5556 N Marmora Ave | Omicron', 0.4006289999934376, 'Delta', 0.3592028457518342, 'Other', 0.21360 | [BA.1'AY.3'B.1.1'AY.1'B.1.1.172'B.1.1.168'B.1.1.194] | 99.79 |
| 121421-2 | 12/14/21 | SMH000025183, Int. Broadway and Clifton | Omicron', 0.5248155535168046, 'Delta', 0.4168509624648312, 'Other', 0.036725 | [BA.1'AY.103'AY.3'B.1.1.89'AY.39] | 99.79 |
| 121421-3 | 12/14/21 | SMH000062398, Int. Hobbie and Crosby | Delta', 0.6089280306065582, 'Omicron', 0.31516400000016226, 'Other', 0.05197 | [AY.100'BA.1'AY.126'AY.1'B.1.1.155'B.1.1.168'B.1.1.194] | 99.79 |
| 121521-4 | 12/15/21 | SMH000072456, 5258 W Congress PKWY | Omicron', 0.7257569999975289, 'Delta', 0.2402472874875911, 'Other', 0.009624 | [BA.1'AY.3'B.1.617.2'AY.1'AY.119'B.1.1.168'B.1.1.194'AY.100] | 99.73 |
| 121521-5 | 12/15/21 | SMH000116477, 58th and Kostner Avenue | Omicron', 0.8345039999992083, 'Delta', 0.15543064756268718 | [BA.1'AY.1'B.1.1.529] | 99.79 |
| 121521-6 | 12/15/21 | SMH000111150, 124th and Wentworth | Omicron', 0.6301459999824067, 'Delta', 0.28200675609646736, 'Other', 0.06241 | [BA.1'AY.43.4'AY.43.3'B.1.1'B.1.617.2'B.1.1.168'B.1.1.194'B.1.1.189]" | 99.73 |
| 121521-7 | 12/15/21 | MHOL23-00116, Tuley Park | Omicron', 0.8458870000013692, 'Other', 0.1064000393473556, 'Delta', 0.02355 | [BA.1'B.1.1'AY.1'B.1.1.168'B.1.1.98'B.1.1.194] | 99.56 |
| 121621-1 | 12/16/21 | SMH000017048, 5556 N Marmora Ave | Delta', 0.691684624973113, 'Other', 0.1702630181022245, 'Omicron', 0.1106630 | [AY.39.1'AY.1'B.1.1'AY.44'BA.1'B.1.1.168'B.1.1.194] | 99.44 |
| 121621-2 | 12/16/21 | SMH000025183, Int. Broadway and Clifton | Omicron', 0.8109242699060131, 'Delta', 0.17663214781168288 | [BA.1'AY.1'AY.100'B.1.1.529'AY.25'AY.118'AY.4.2] | 99.73 |
| 121621-3 | 12/16/21 | SMH000062398, Int. Hobbie and Crosby | Omicron', 0.5780538667857136, 'Delta', 0.40415238007907717 | [BA.1'AY.1'AY.3'AY.119'AY.3.1'AY.103'AY.118'AY.126] | 99.79 |
| 121321-38c-C-1 | 12/13/21 | North Shore Clavey Rd | Delta', 0.9946262546236195 | [AY.92'AY.122'AY.126] | 91.76 |

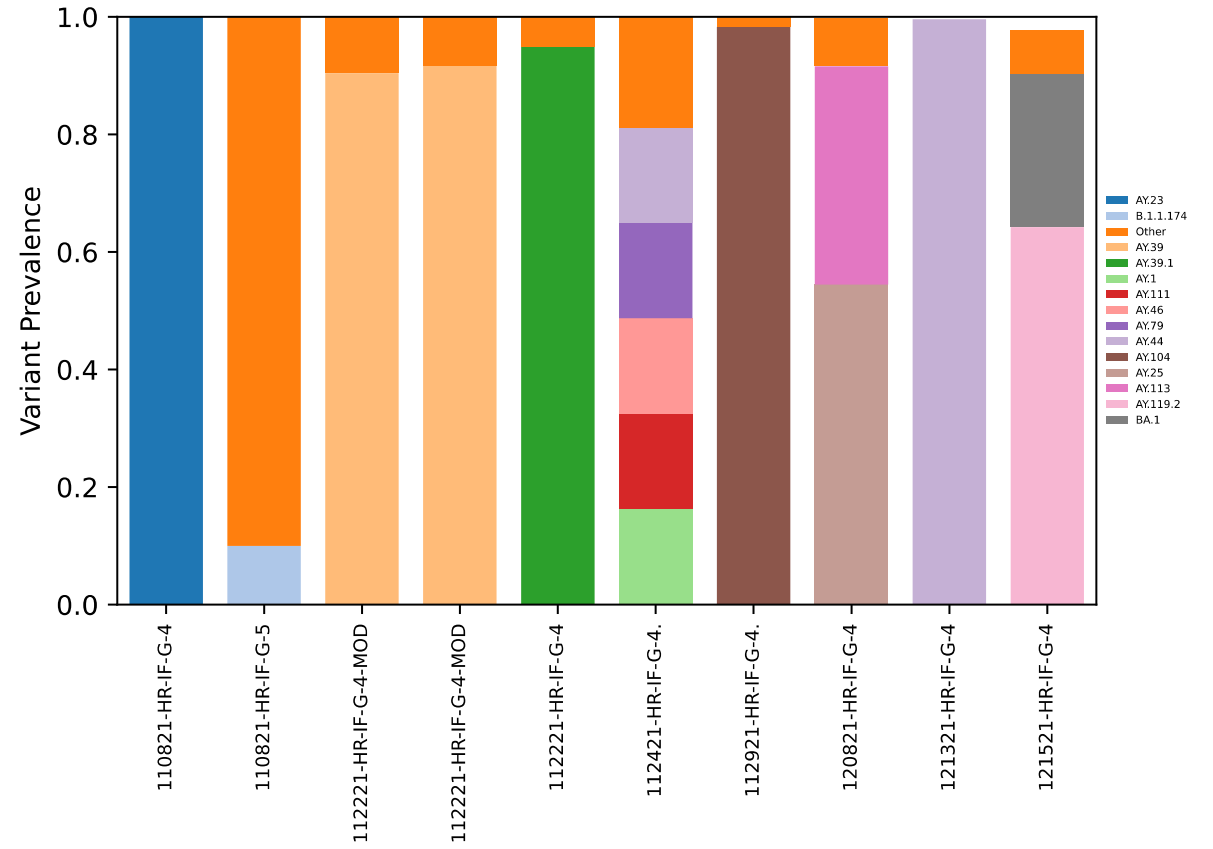
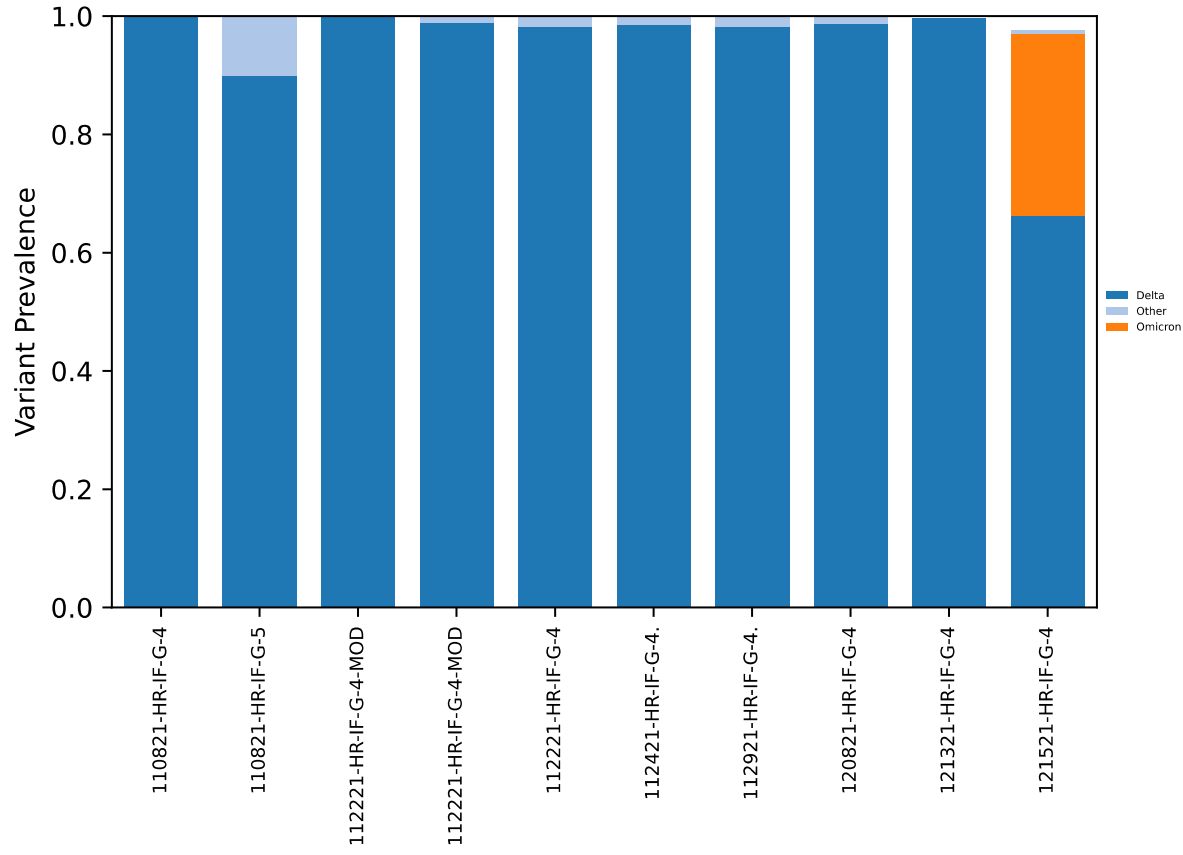
VOC% OVER TIME

ORD -INTERNATIONAL



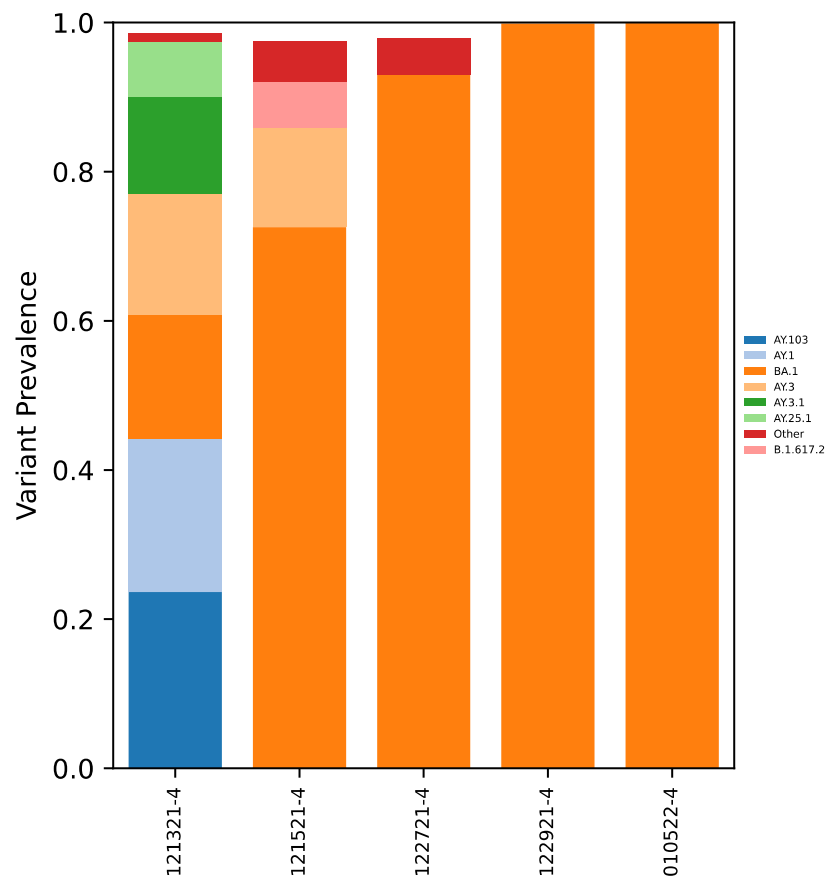
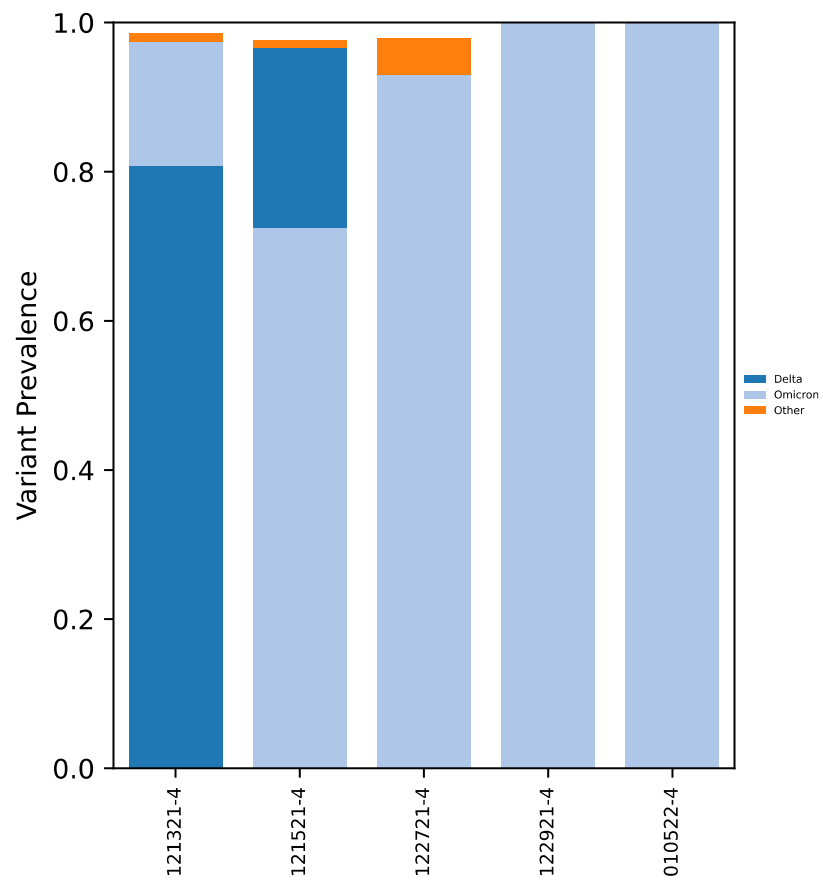
VOC% OVER TIME

• ORD DOMESTIC

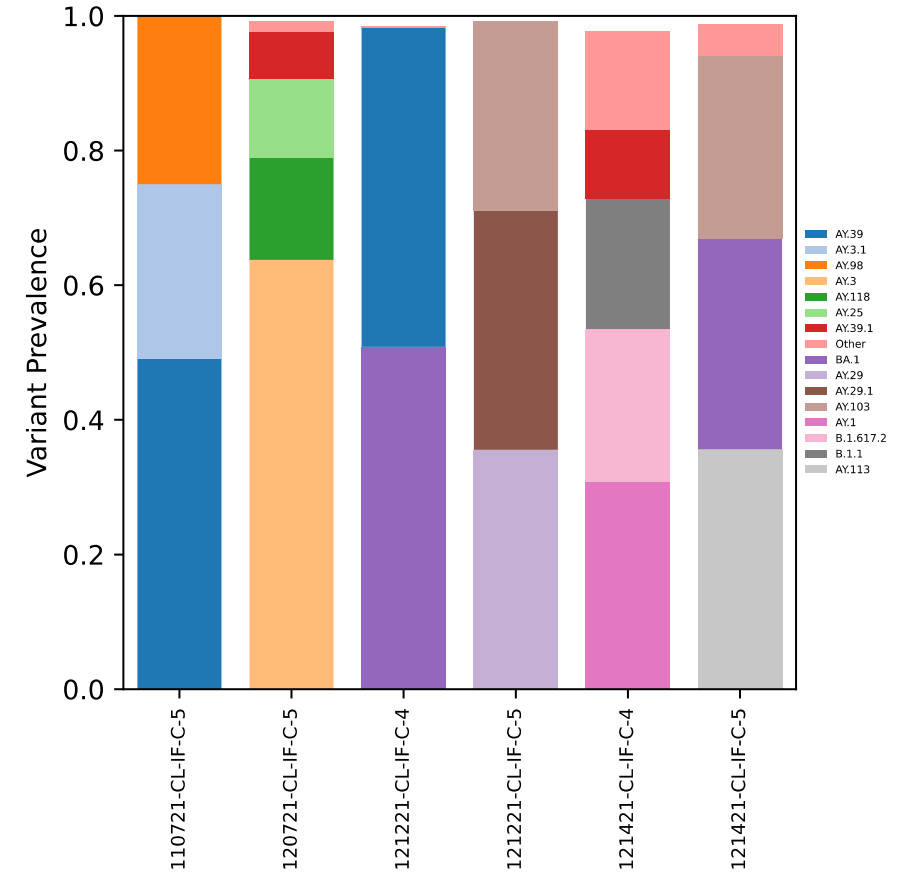
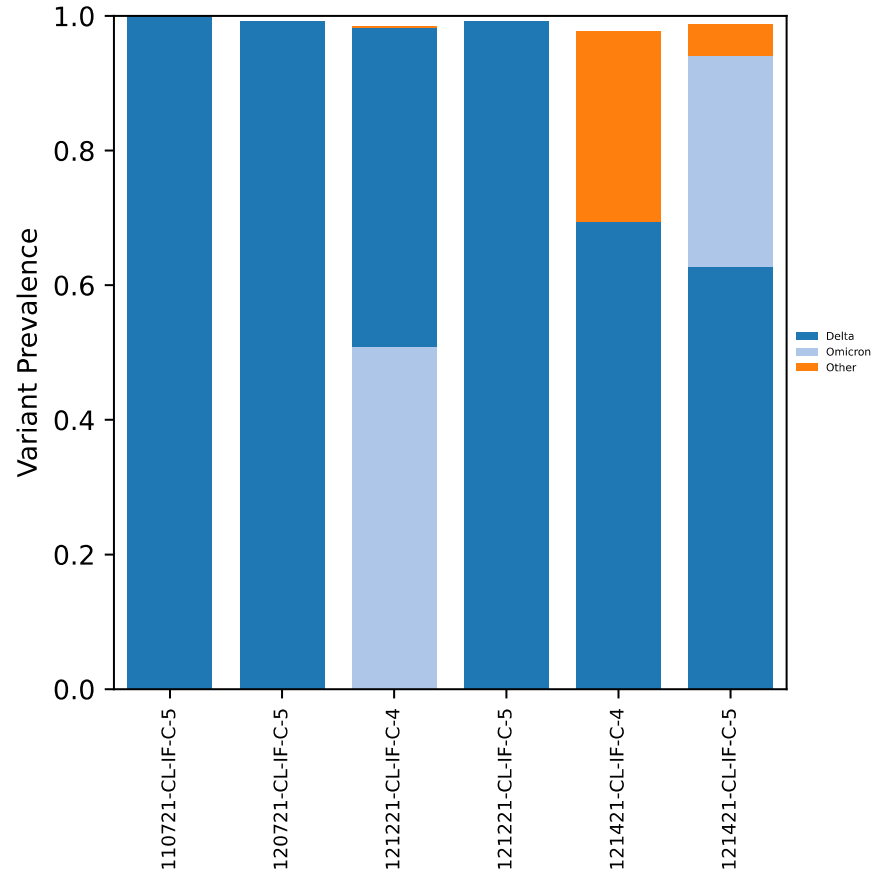


VOC% OVER TIME

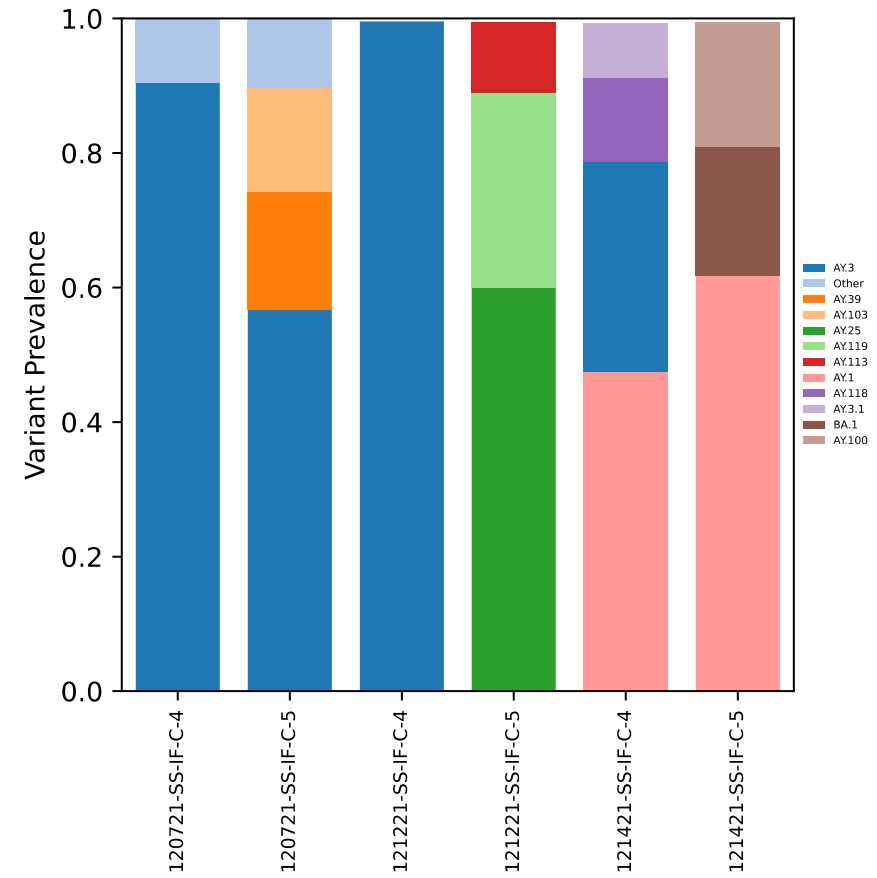
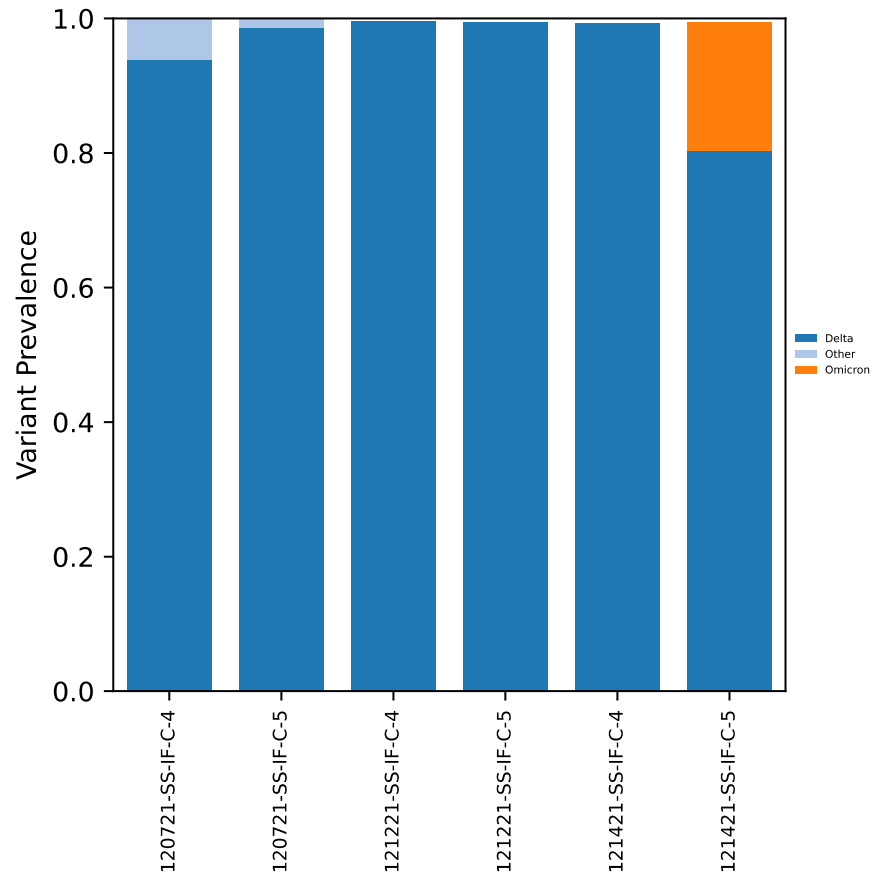
- SEWER 4, AUSTIN



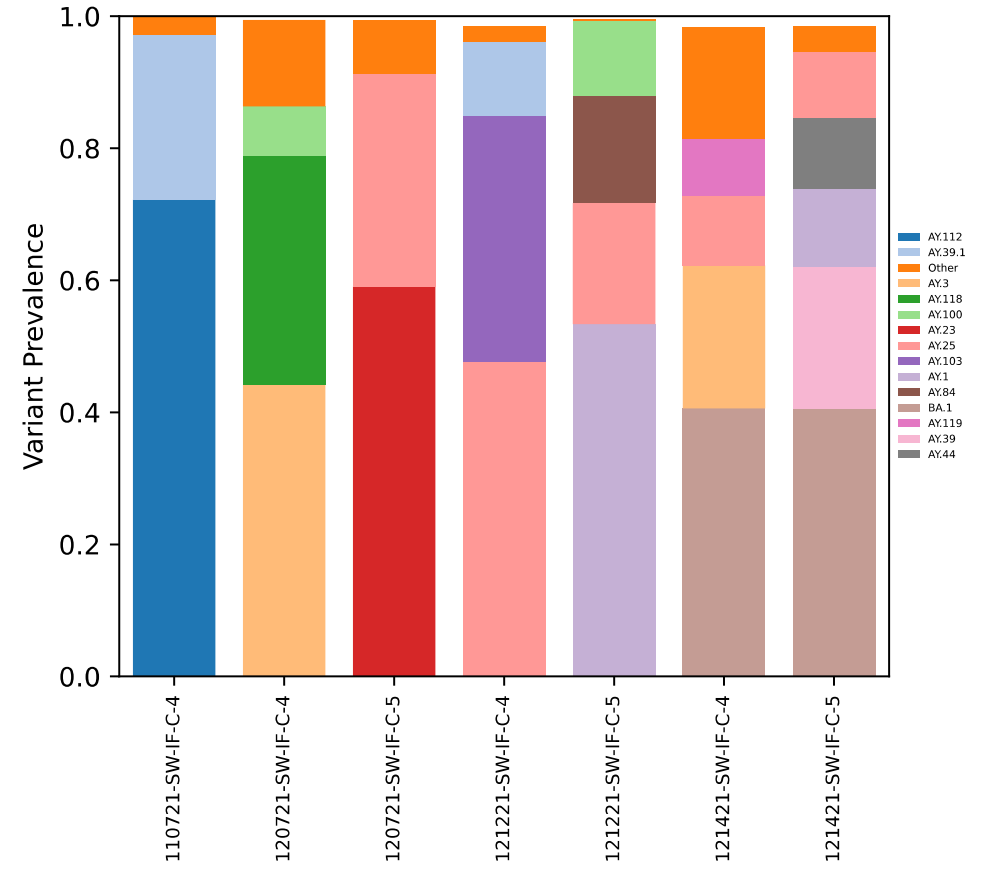
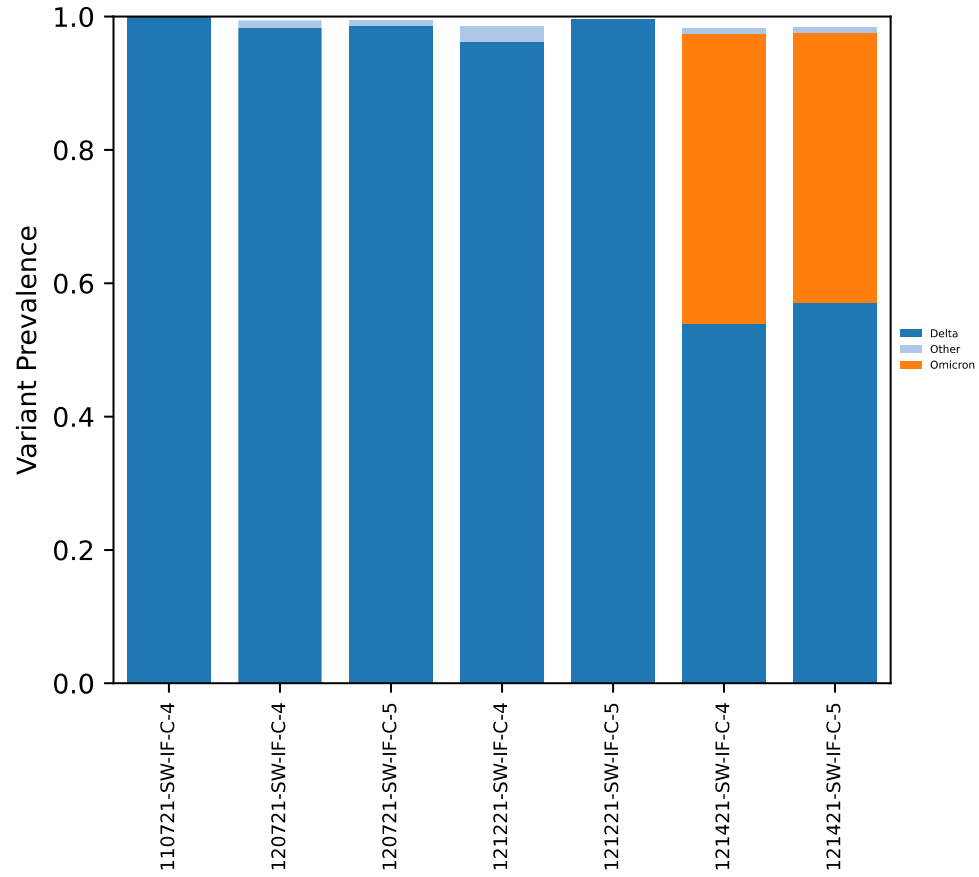
CALUMET



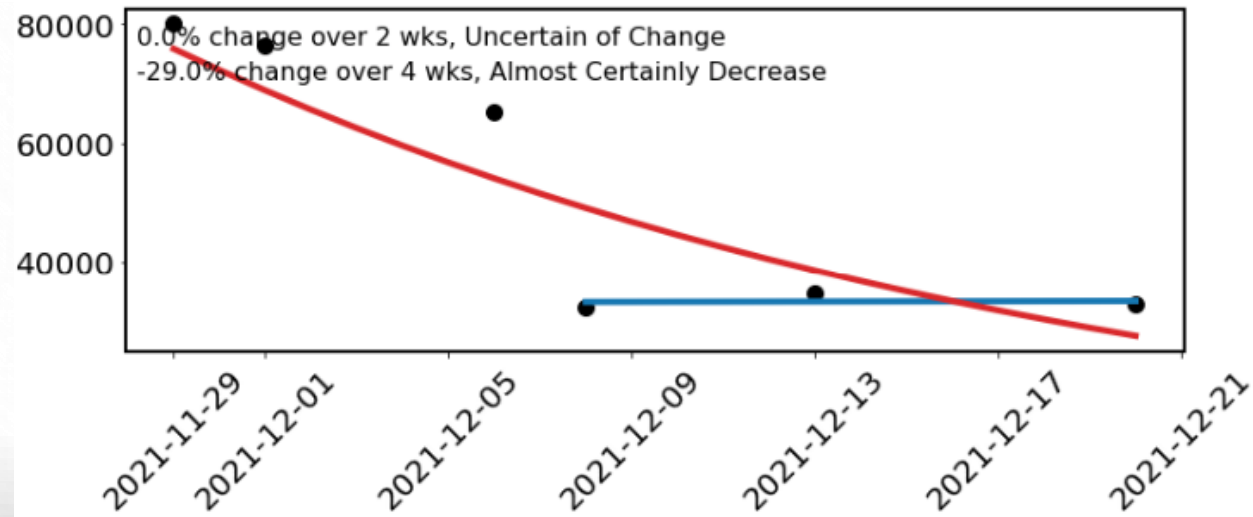
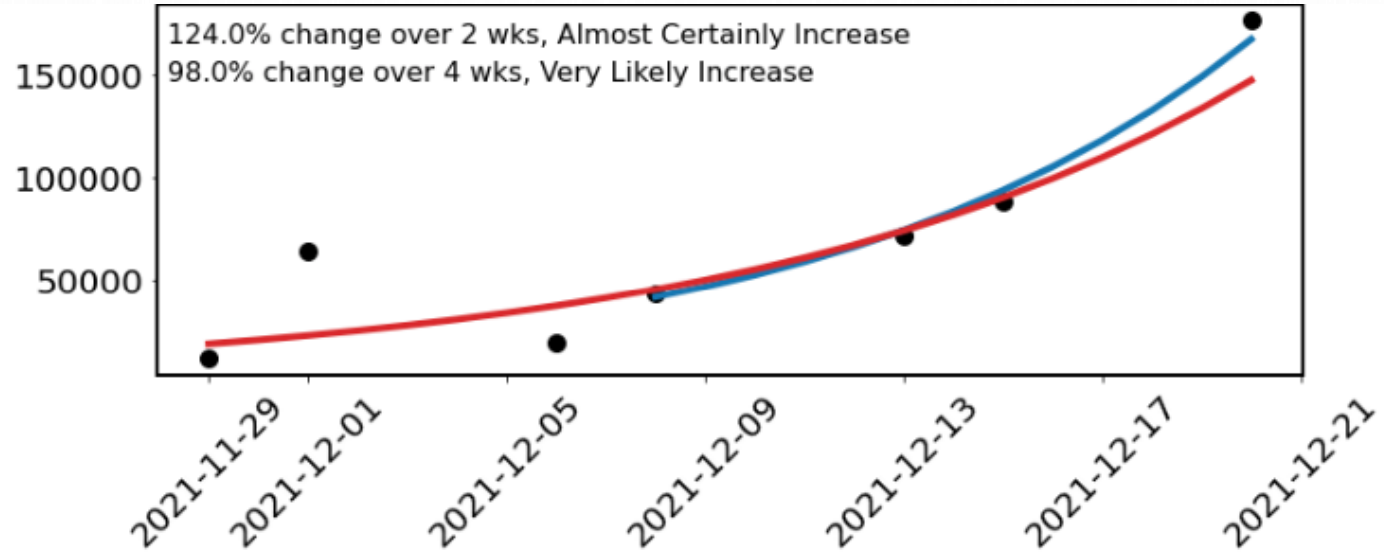
STICKNEY SS



STICKNEY SW



TRENDS OVER TIME



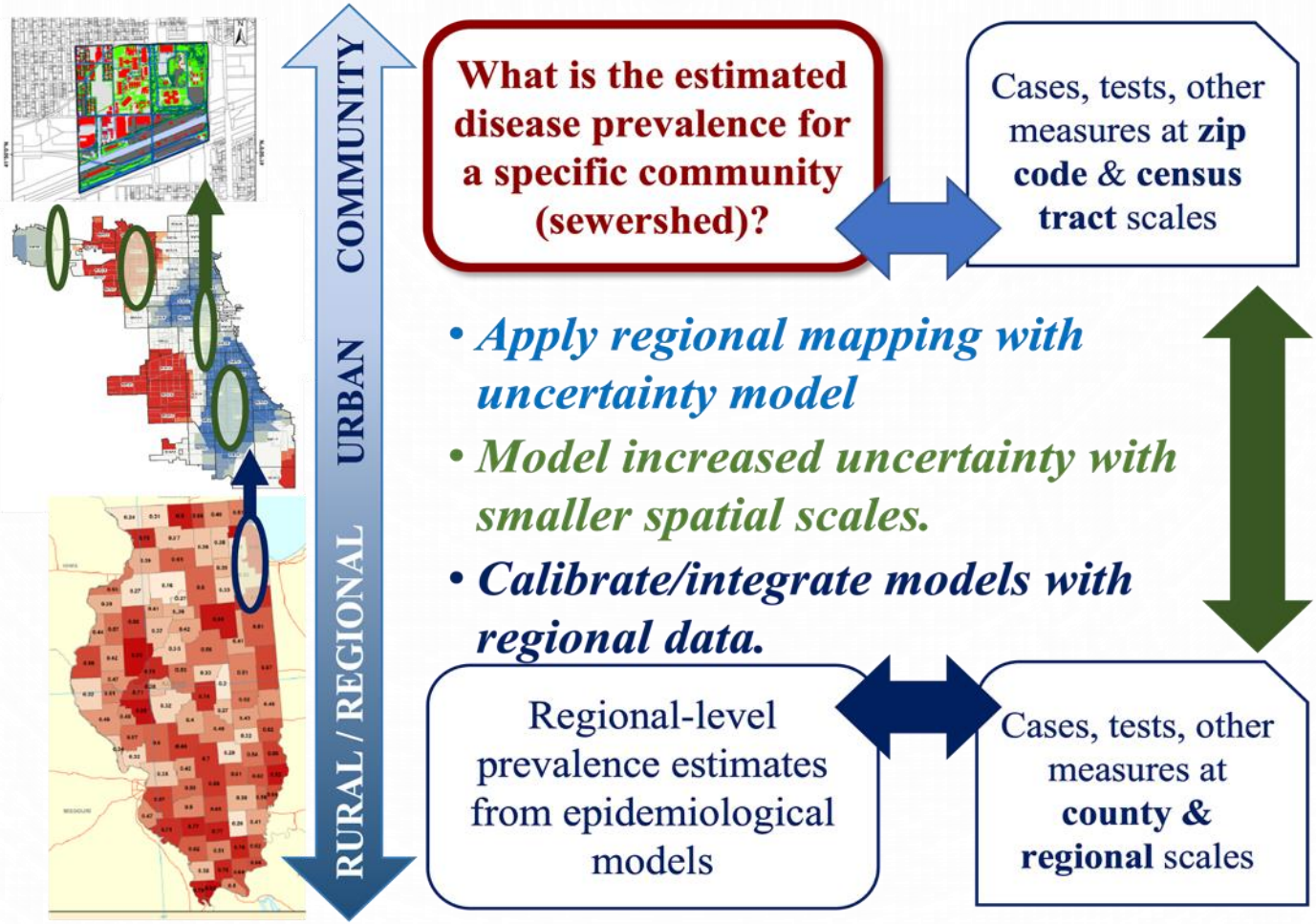
WHAT DO PUBLIC HEALTH AGENICIES DO WITH THE DATA?

- COMPLEMENTS EXISTING COVID-19 SURVEILLANCE SYSTEMS
 - IS NOT USED ALONE TO INFORM PUBLIC HEALTH ACTION
- WASTEWATER TRENDS ARE SHARED WITH DIRECTOR AND EPIDEMIOLOGISTS WEEKLY
- CAN HELP PROVIDE DATA TO IMPROVE LOCAL DECISION-MAKING (I.E., WHETHER TO DO SAMPLING IN SCHOOLS OR INCREASE TESTING)
- USED TO VALIDATE INCREASING HOSPITALIZATION NUMBERS DESPITE LOW CLINICAL TESTING NUMBERS
- COVER GAPS IN CLINICAL SEQUENCING COVERAGE
- HELPS TRACK VARIANTS

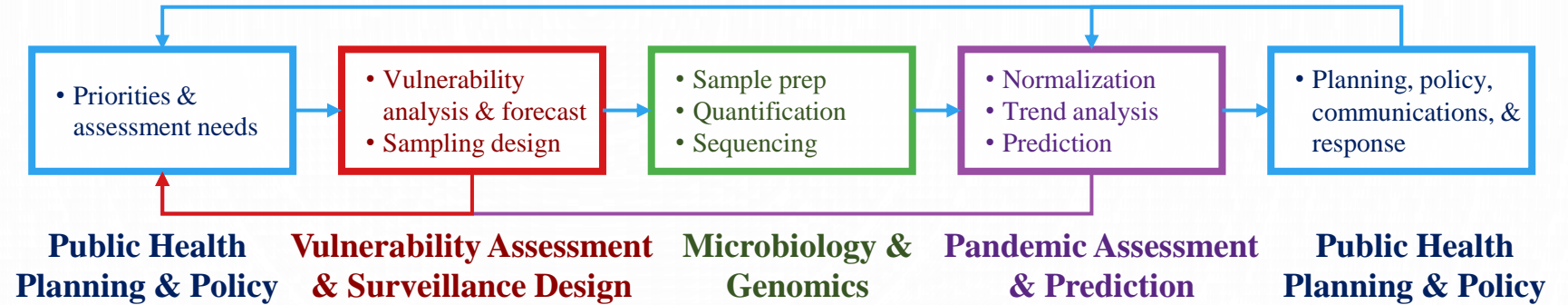
SHARING DATA EXTERNALLY

- DATA REPORTED MONTHLY TO COLLECTING UTILITIES
- SAMPLE DATA WILL BE UPLOADED TO CDC DATA COLLATION AND INTEGRATION FOR PUBLIC HEALTH EVENT RESPONSE (DCIPHER) FOR ANALYSIS AND REPORTING
- CDC IS PLANNING ON ADDING SOME SITUATIONAL AWARENESS FROM WASTEWATER DATA INTO THE COVID DATA TRACKER

FUTURE WORK



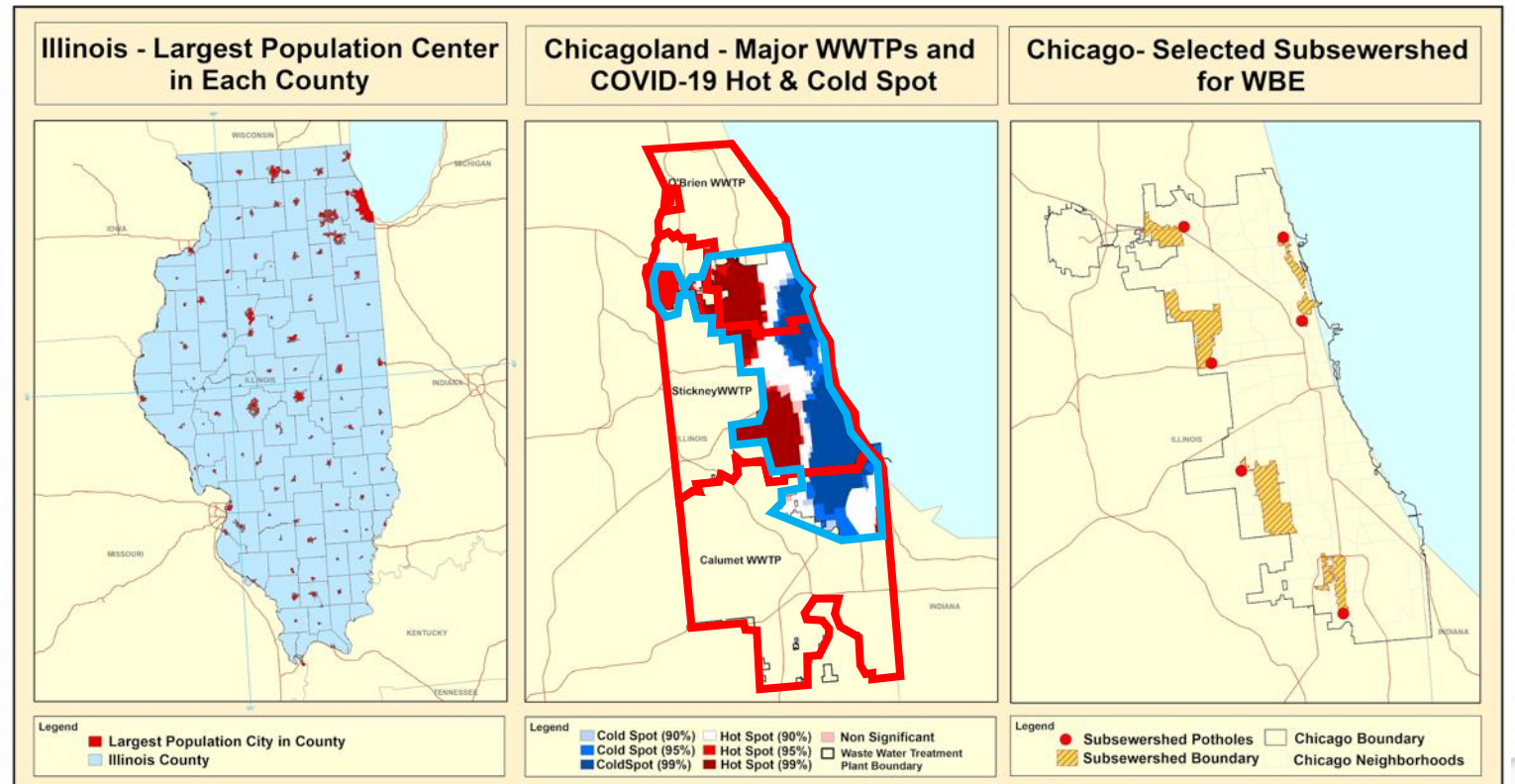
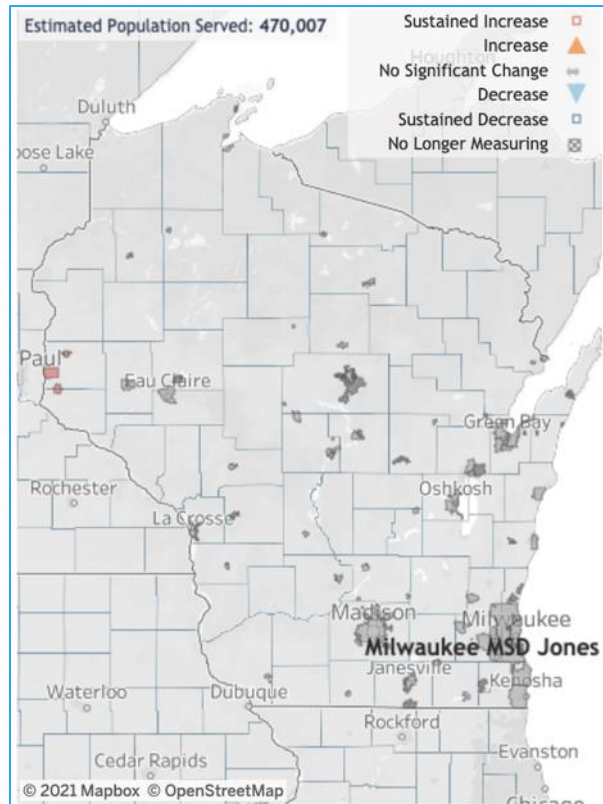
WBE Workflow



Research Agenda



UNIQUE CHALLENGES AT DIFFERENT SCALES



PIPP adds partners Sandra McLellan (UW-Milwaukee and State of Wisconsin wastewater surveillance with 70 WWTPs), Alexandra Boehm (Stanford, Co-PI of WBE RCN), and others.

APPLICATIONS BEYOND COVID-19

- TRACK INFECTIONS AND PREDICT DISEASE OUTBREAKS BY MONITORING URBAN AND WASTEWATER SYSTEMS.
 - INFLUENZA
 - FUTURE DISEASES
- MONITOR OTHER PUBLIC HEALTH CONCERNS IN URBAN WATERWAYS AND WASTEWATER
 - OPIOID USAGE
 - ANTIBIOTIC RESISTANCE
- DETERMINE WHAT ACTIONS ARE NEEDED TO MAKE NEARSHORE WATER QUALITY SAFE AND SUSTAINABLE

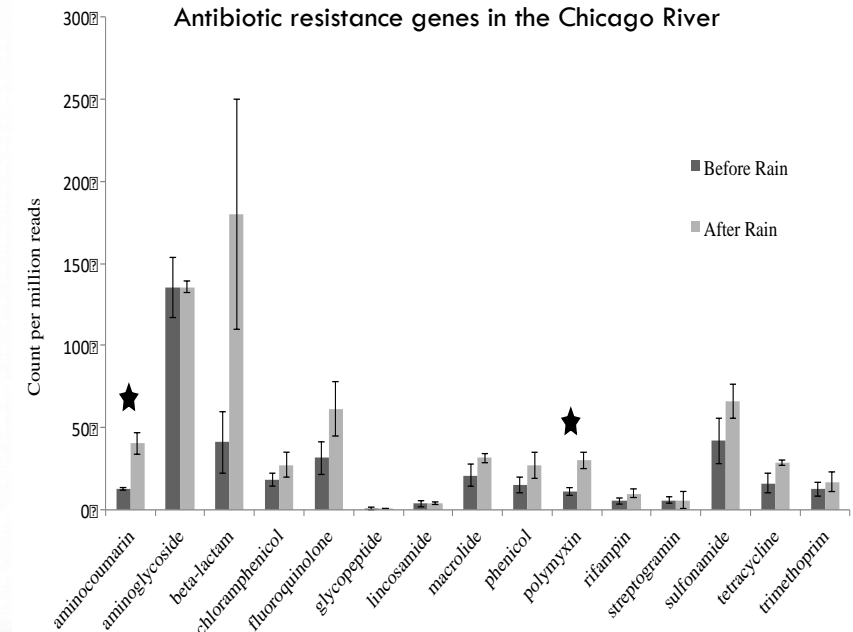
RESEARCH ARTICLE

Epidemiology of the silent polio outbreak in Rahat, Israel, based on modeling of environmental surveillance data

Andrew F. Brouwer, Joseph N. S. Eisenberg, Connor D. Pomeroy, Lester M. Shulman, Musa...



Antibiotic resistance genes in the Chicago River



Analyzing wastewater systems provides a way to understand community health in a way that provides rapid and sensitive analysis of an entire community but *does not convey any personally identifiable information.*