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.

WASTEWATER SURVEILLANCE FOR COVID-19 – A REGIONAL EFFORT

Rachel Poretsky
microbe@uic.edu

Wastewater Based Epidemiology

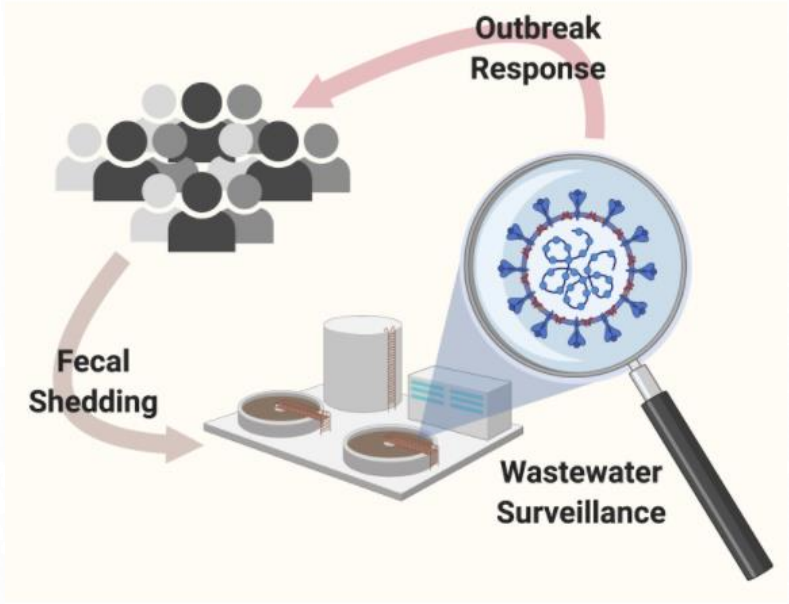


Image credit: Bivens & Bibby

- 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?

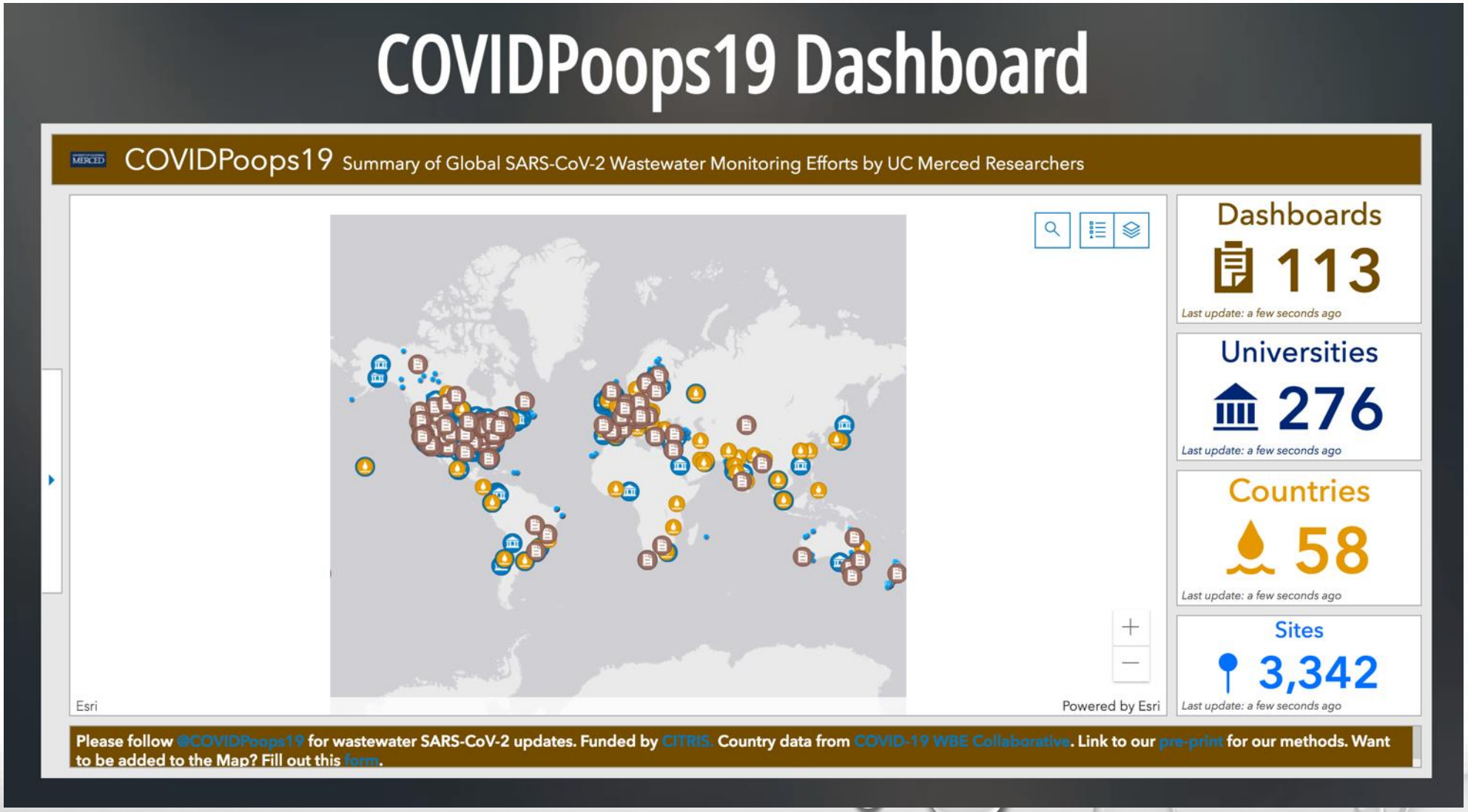
WBE can detect the virus several days before people show symptoms

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



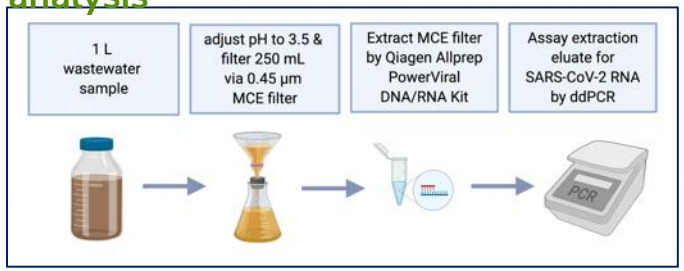
https://www.covid19wbec.org/covidpoops19

WASTEWATER SURVEILLANCE LANDSCAPE

WWTP sampling

Transport at <4°C

Laboratory analysis*



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

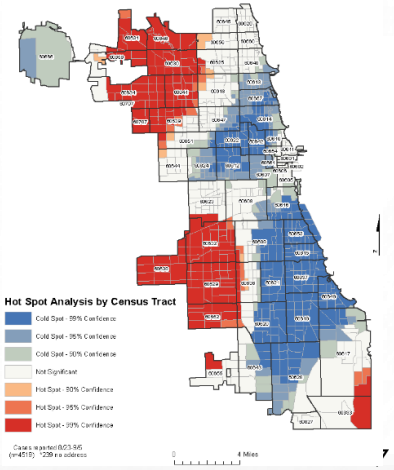
Necessary for large urban areas

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

Data & Modeling

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

Integrate results with public health decision and communication systems.



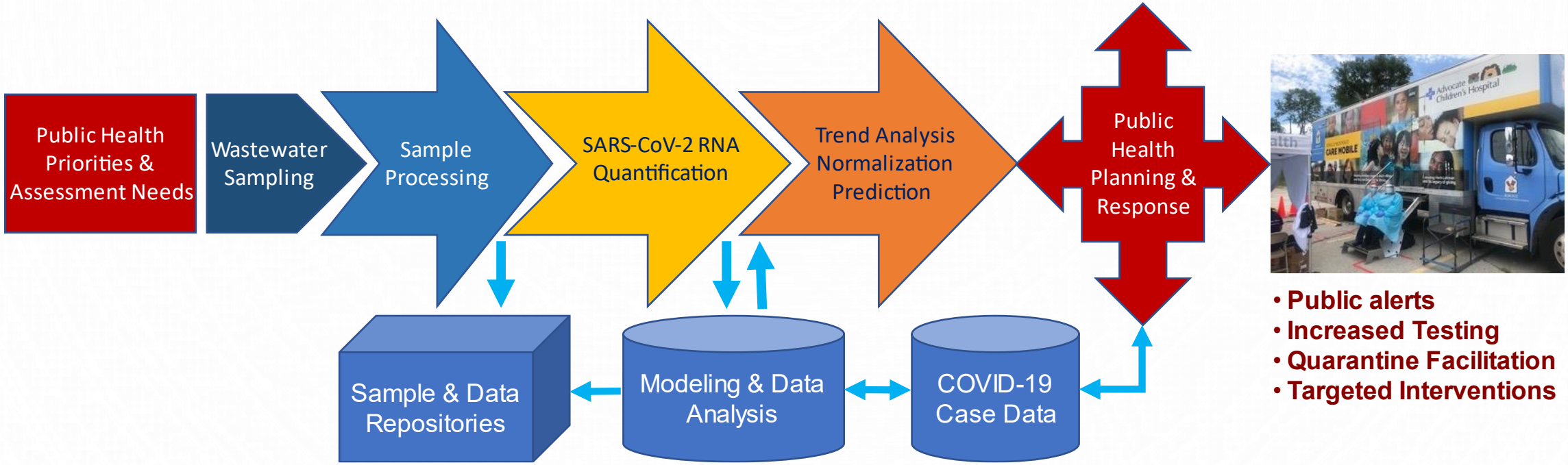
Necessary for public health impact

Manhole and sewer map figures from Biobot.io

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



- **Public alerts**
- **Increased Testing**
- **Quarantine Facilitation**
- **Targeted Interventions**

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

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)

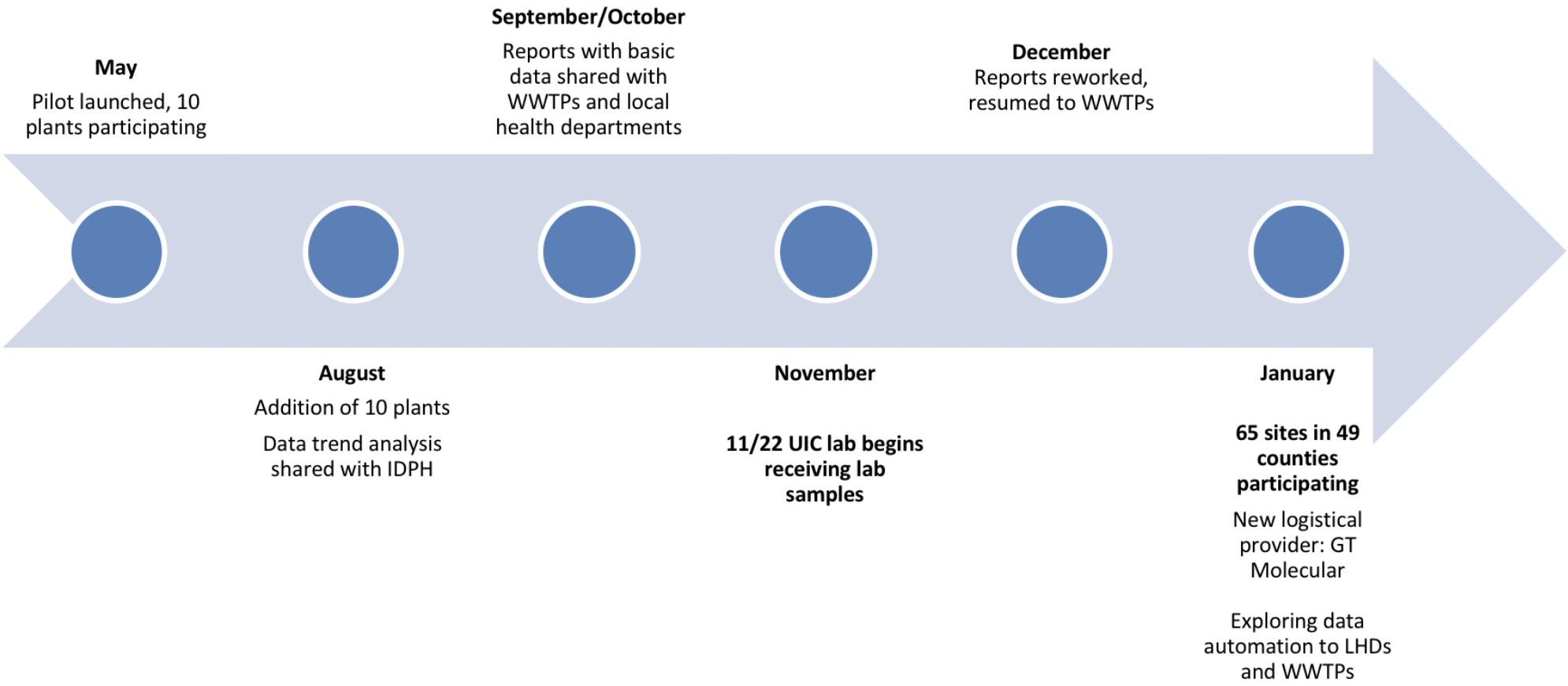
Abstract
COVID-19 has had an enormous impact on public health and the economy of Illinois. Infectious disease transmission is particularly a problem for high-density urban environments. While COVID-19 is thought of as a respiratory disease, the SARS-CoV-2 virus infects multiple body sites, including 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)

WALDER FOUNDATION

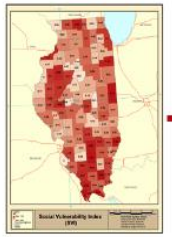
TIMELINE


May
Pilot launched, 10 plants participating
August
Addition of 10 plants
Data trend analysis shared with IDPH
September/October
Reports with basic data shared with WWTPs and local health departments
November
11/22 UIC lab begins receiving lab samples
December
Reports reworked, resumed to WWTPs
January
65 sites in 49 counties participating
New logistical provider: GT Molecular
Exploring data automation to LHDs and WWTPs

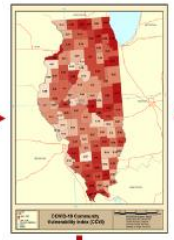
VULNERABILITY ASSESSMENT

Selection & Scaling

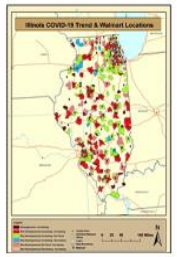
Social Vulnerability



CDC COVID-19 Vulnerability (simple model)

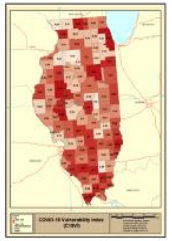


COVID-19 Trends



Largest population centers by region and county

Counties Not Sequencing



Adjusted COVID-19 Vulnerability (ML model)

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

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.

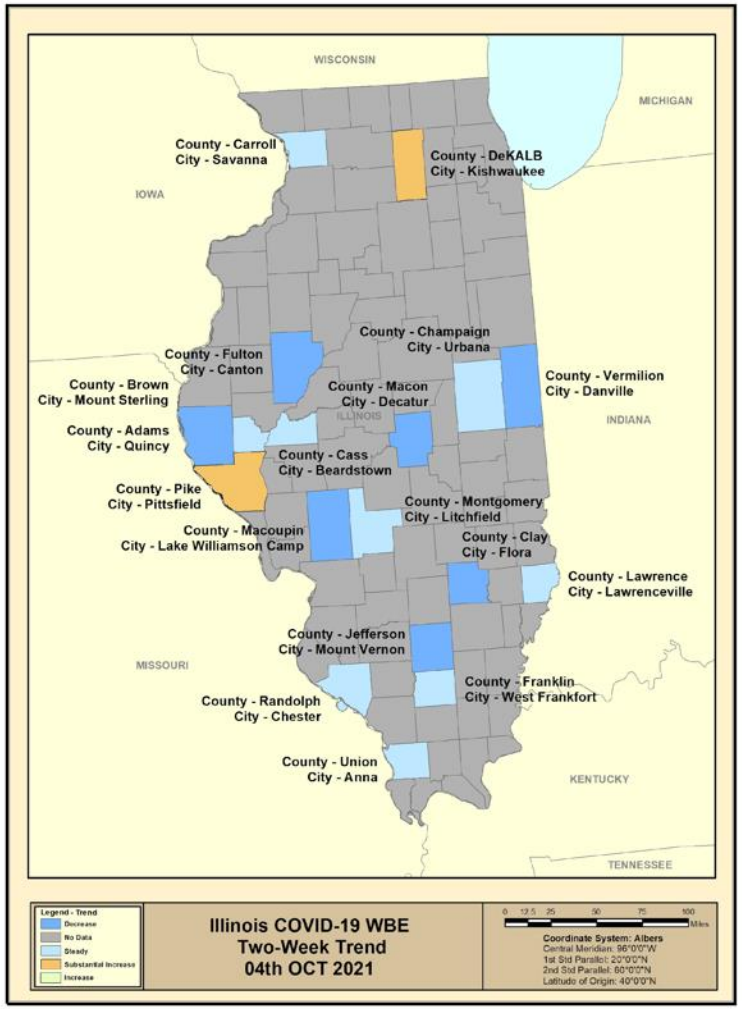
Illinois is 58,000 square miles with 102 counties, over 1,000 WWTPs, and nearly 1,000 rural communities with fewer than 10k residents. Sampling from all WWTPs would omit a significant number of even smaller communities using private septic systems, and moreover would be extremely expensive.

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.

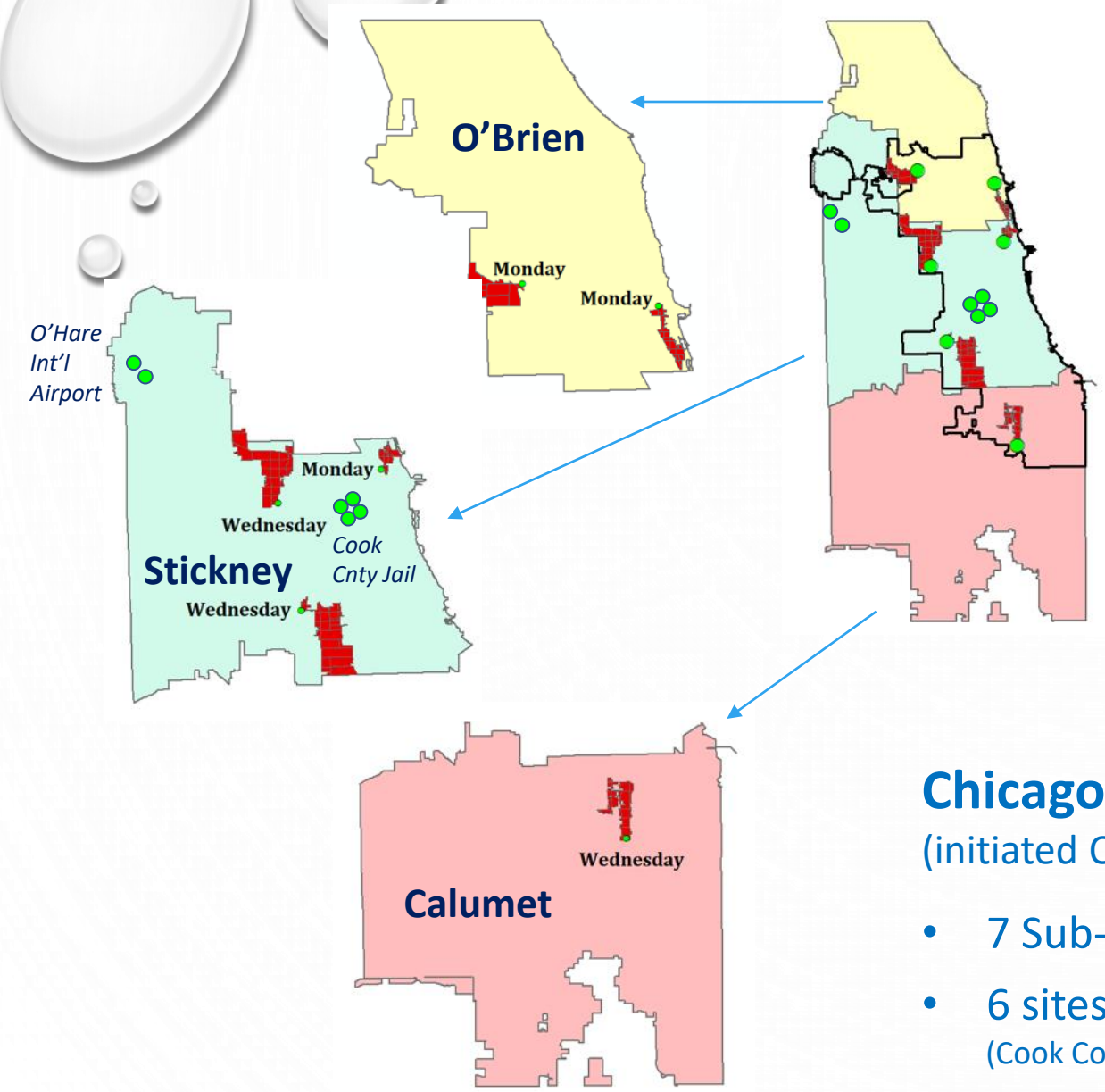
Sequencing, done in only some counties in 2020, was also factored into the initial roll-out of WBE in the 35 most vulnerable counties.

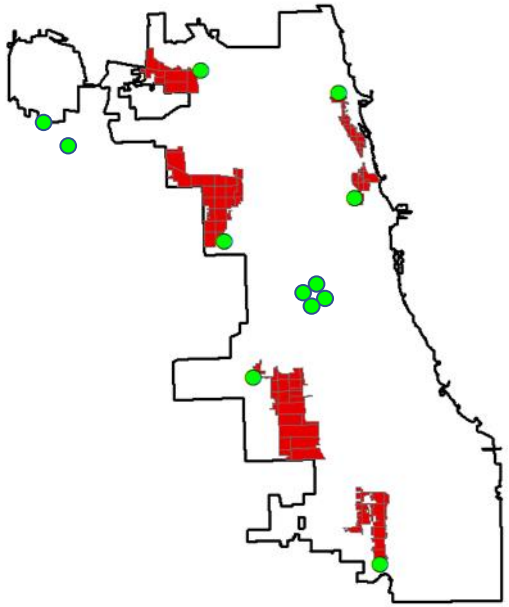
Multiple sampling schemes were evaluated, including (a) largest 8 population centers in each of Illinois' 11 COVID-19 recovery regions, and (b) all communities with population >20k. Both approaches left vast rural areas unexamined.

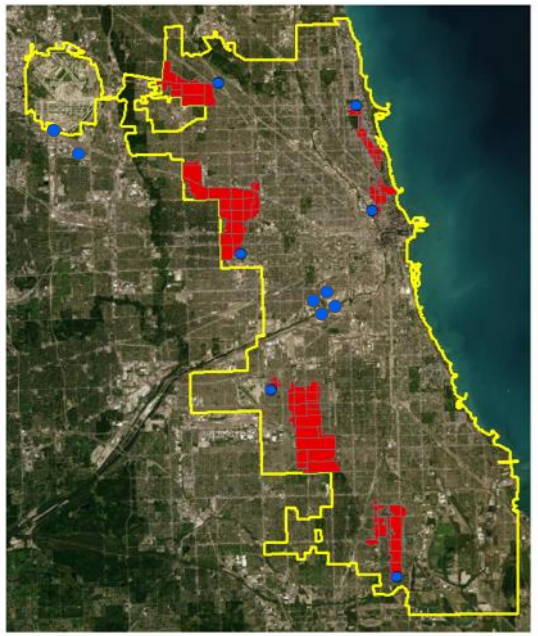
The 2021 plan is to grow from 20 WWTPs as of June 2021 to 50 in September and 150 in January 2022, representing the largest population centers in each of Illinois' 102 counties.



IDPH
ILLINOIS DEPARTMENT OF PUBLIC HEALTH







HEALTHY CHICAGO
CHICAGO DEPARTMENT OF PUBLIC HEALTH

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**

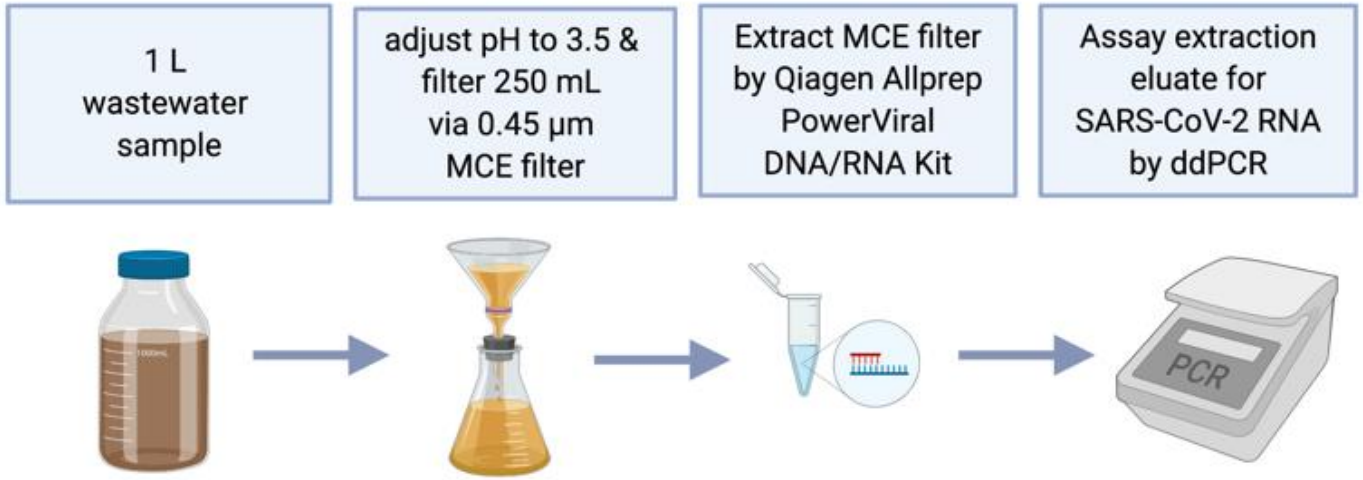
Charlie Catlett

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

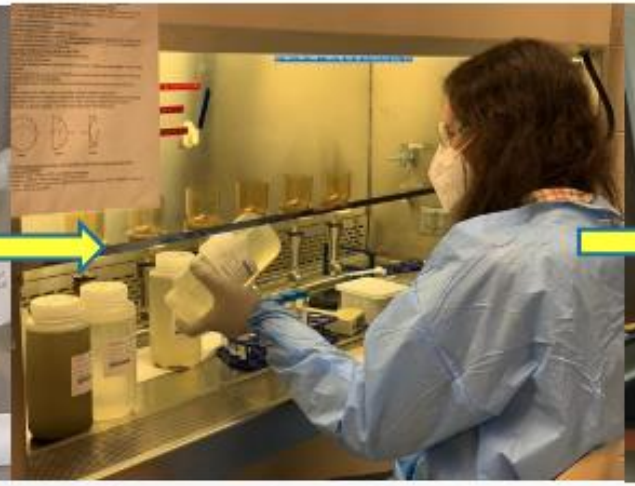


Analysis of wastewater samples to determine the concentration of SARS-CoV-2 RNA. Changes in concentration indicate rise or fall in COVID-19 infections within the sewershed.

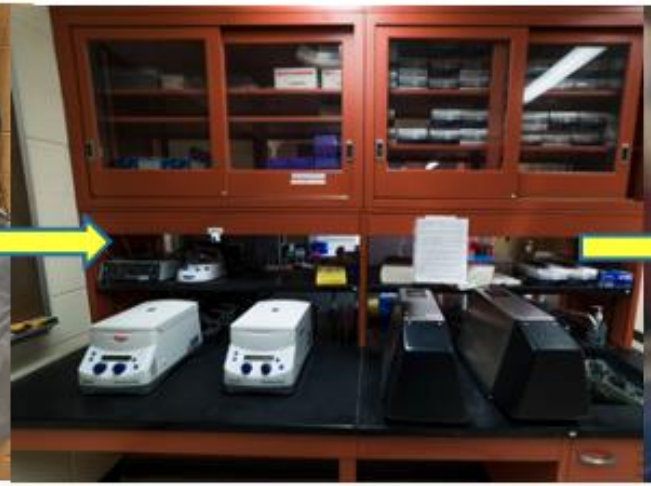
Genetic sequencing can also be done on positive samples to discover new mutations, variant strains, or new pathogens.

BASIC LABORATORY WORKFLOW

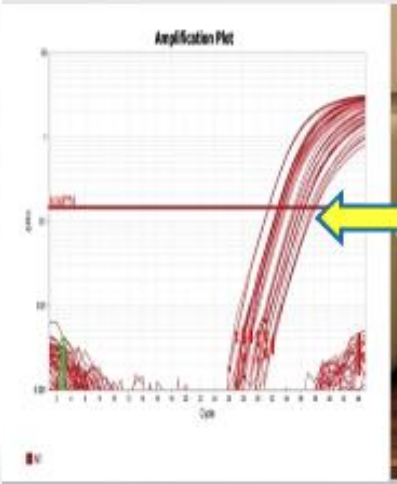
Sample Receiving



Concentration & Filtration

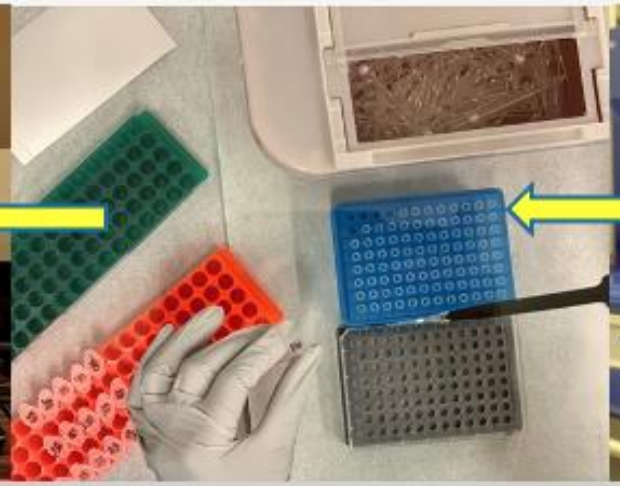


RNA Extraction

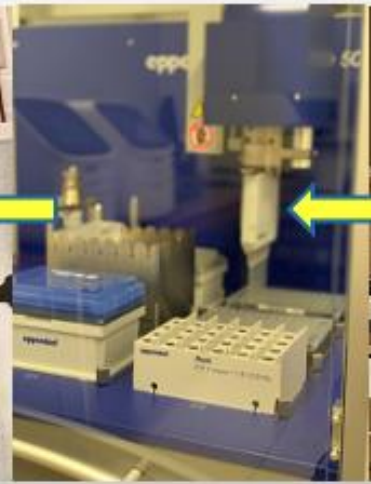


Results

qPCR/ DNA Amplification



Sample Plating



Master Mix Loading

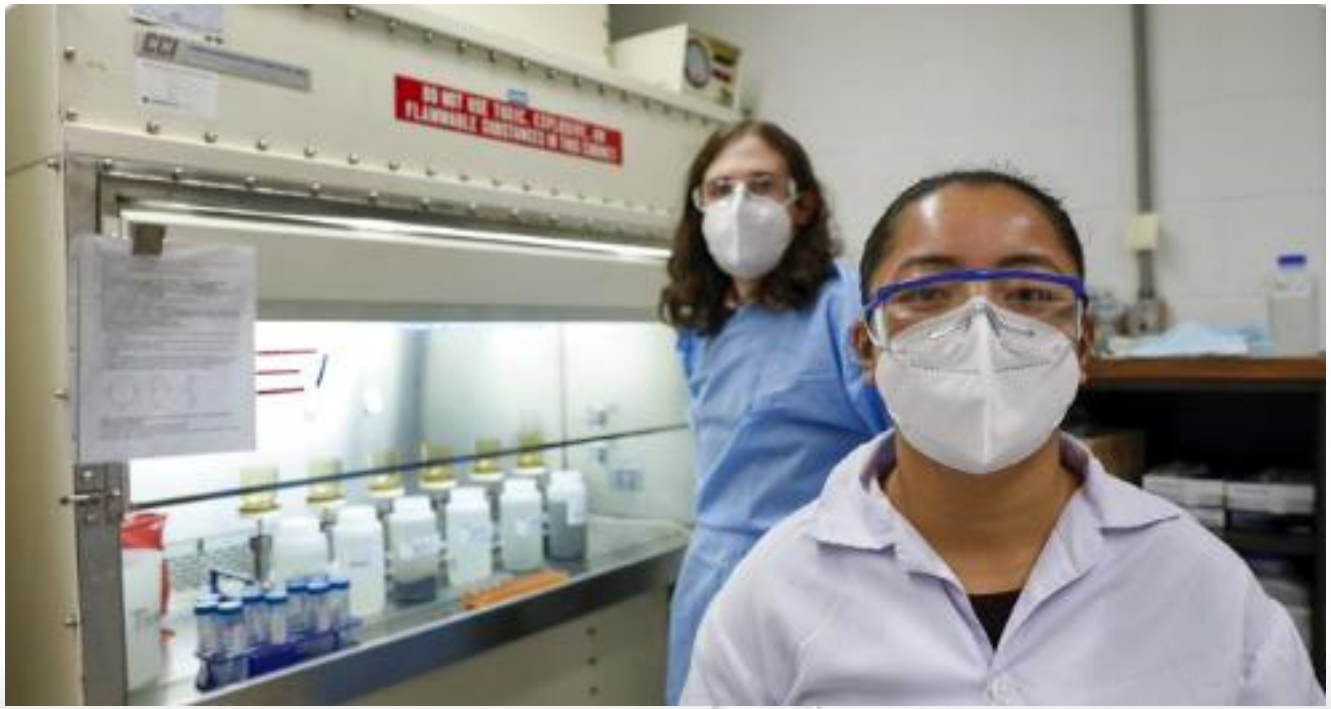
Master Mix Preparation

Abhilasha Shrestha (UIC)

ENVIRONMENT NEWS

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

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



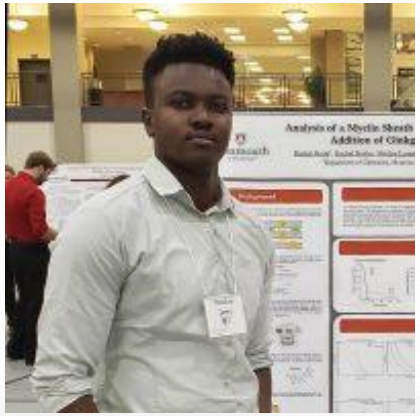
COOK COUNTY JAIL

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

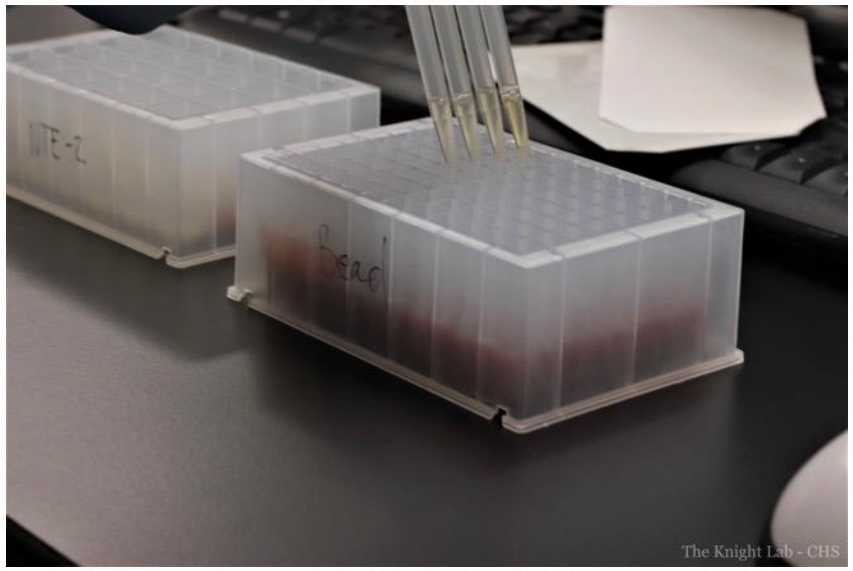
SCALING AND AUTOMATION



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

CONCENTRATION WITH NANOTRAP MAGNETIC VIRUS PARTICLES

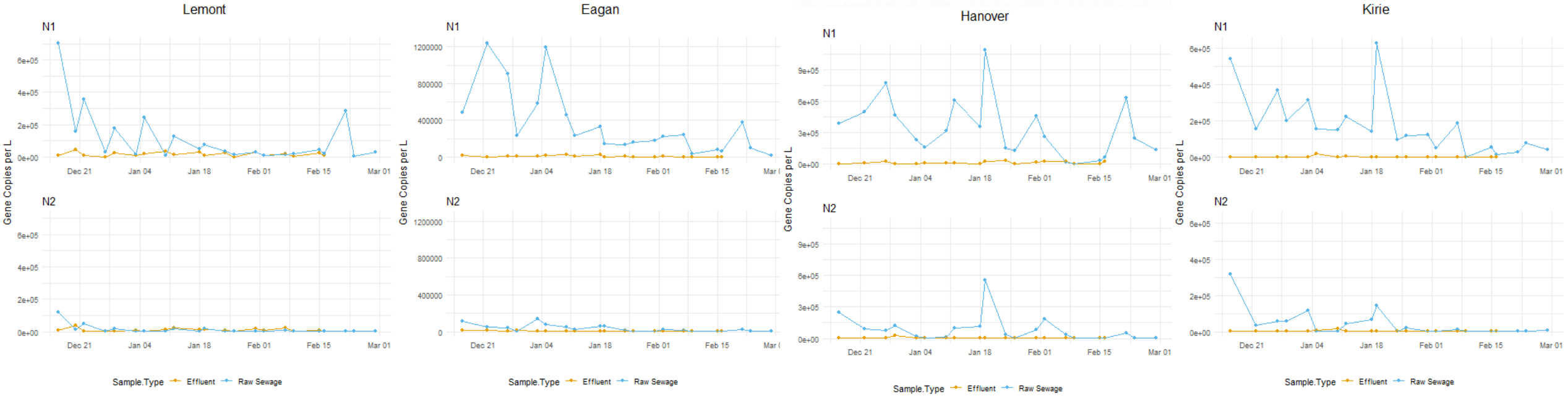
RNA EXTRACTION USING THE MAGMAX MICROBIOME AND VIRAL/PATHOGEN KIT ON THE KINGFISHER



QUANTIFICATION WITH QIACUITY DIGITAL PCR

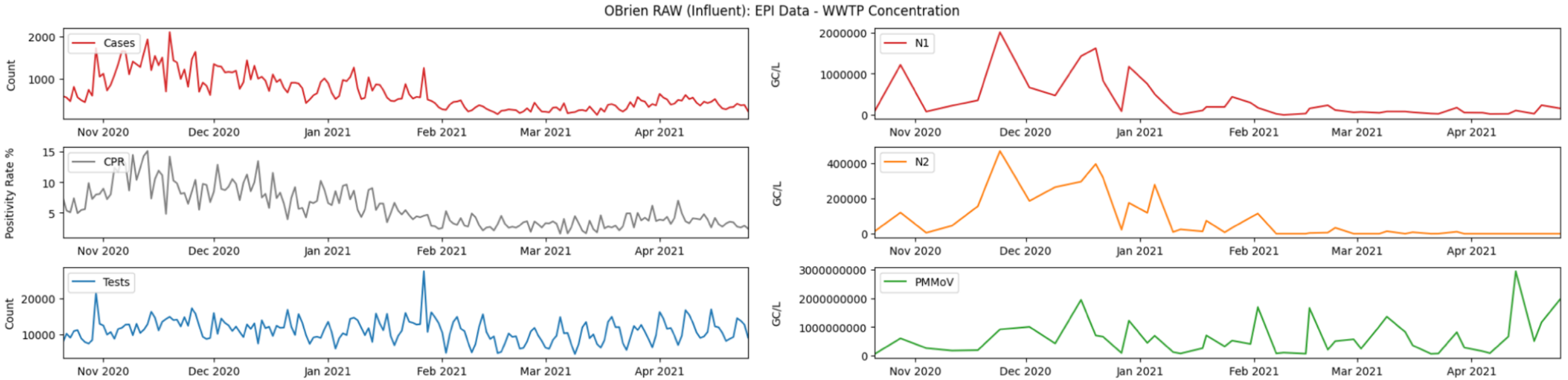
- CURRENT TARGETS:
  - N1
  - N2
  - BCOV
  - PMMOV
  - SPECIFIC VOC/VOI TARGETS
- POSSIBLE ADDITIONS:
  - BRSV OR OTHER INHIBITION CONTROL
  - E GENE

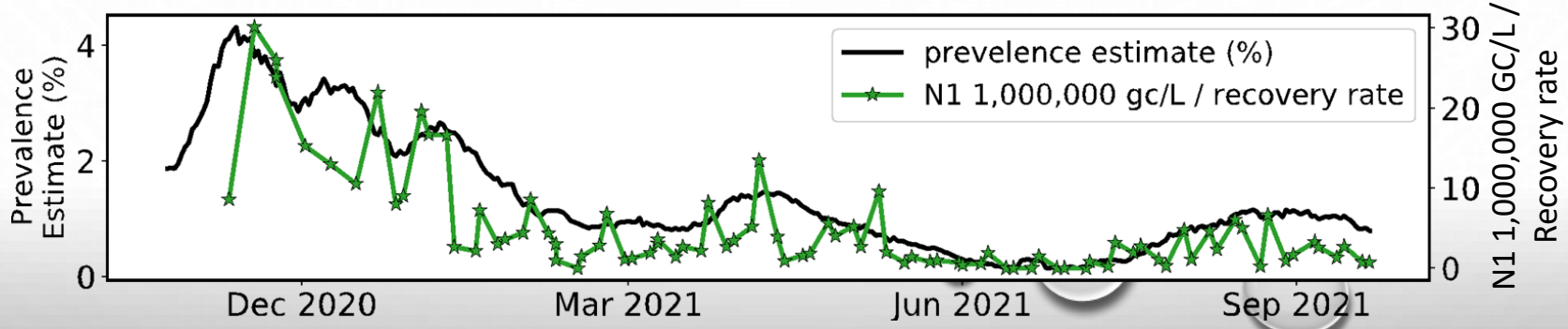
WWTP WEEKLY ANALYSIS



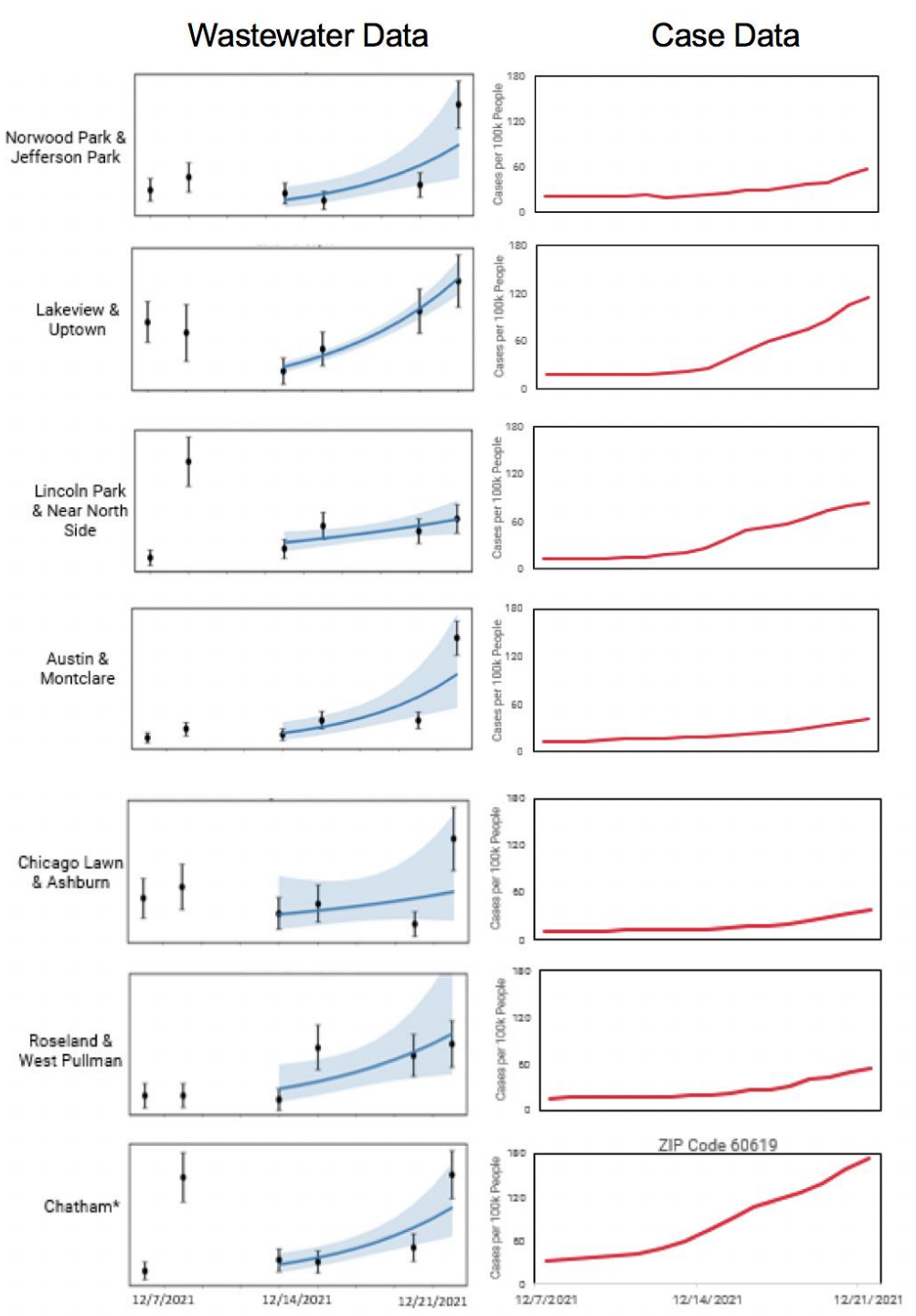
LINEAR CORRELATION BETWEEN CASES AND WASTEWATER CONCENTRATION AT 7, 10, 14, AND 28 DAYS

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

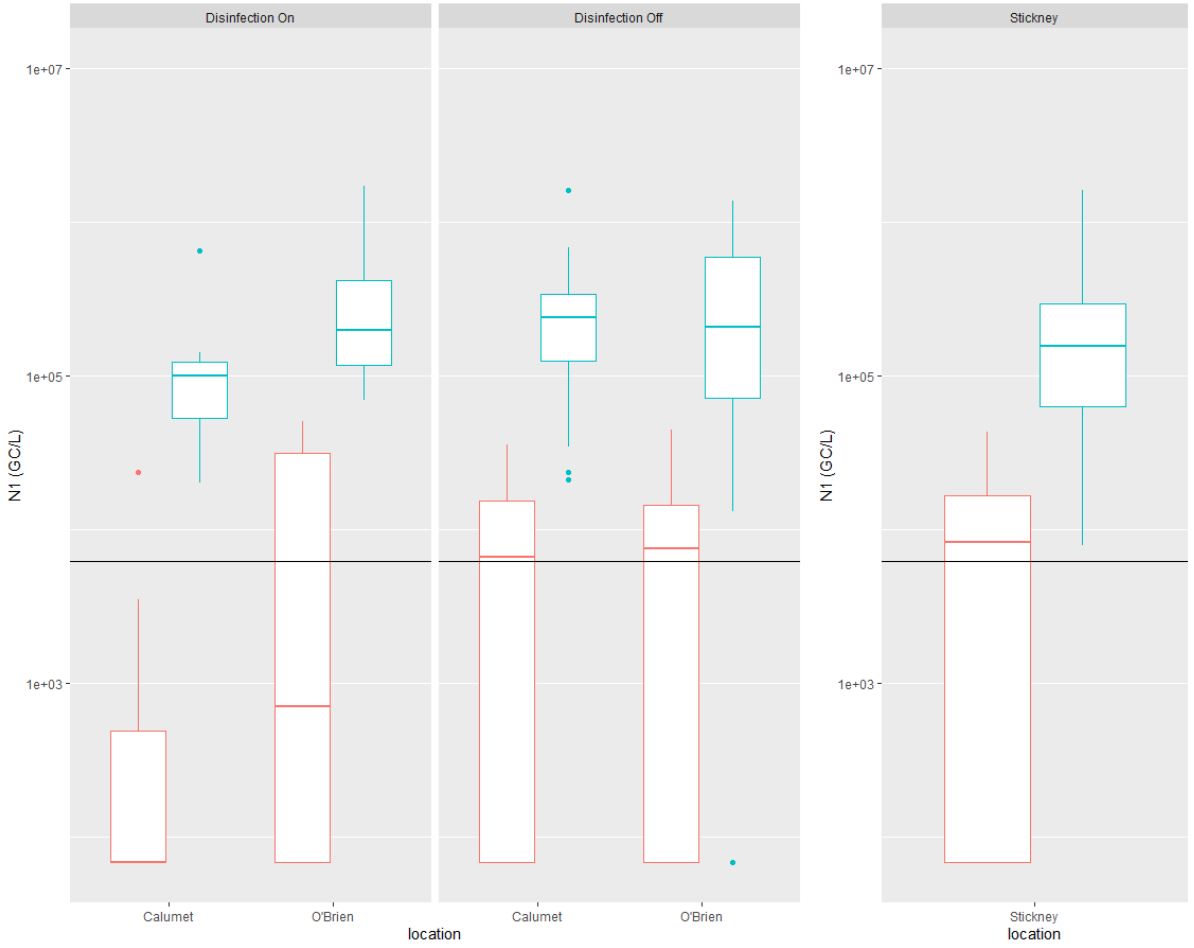




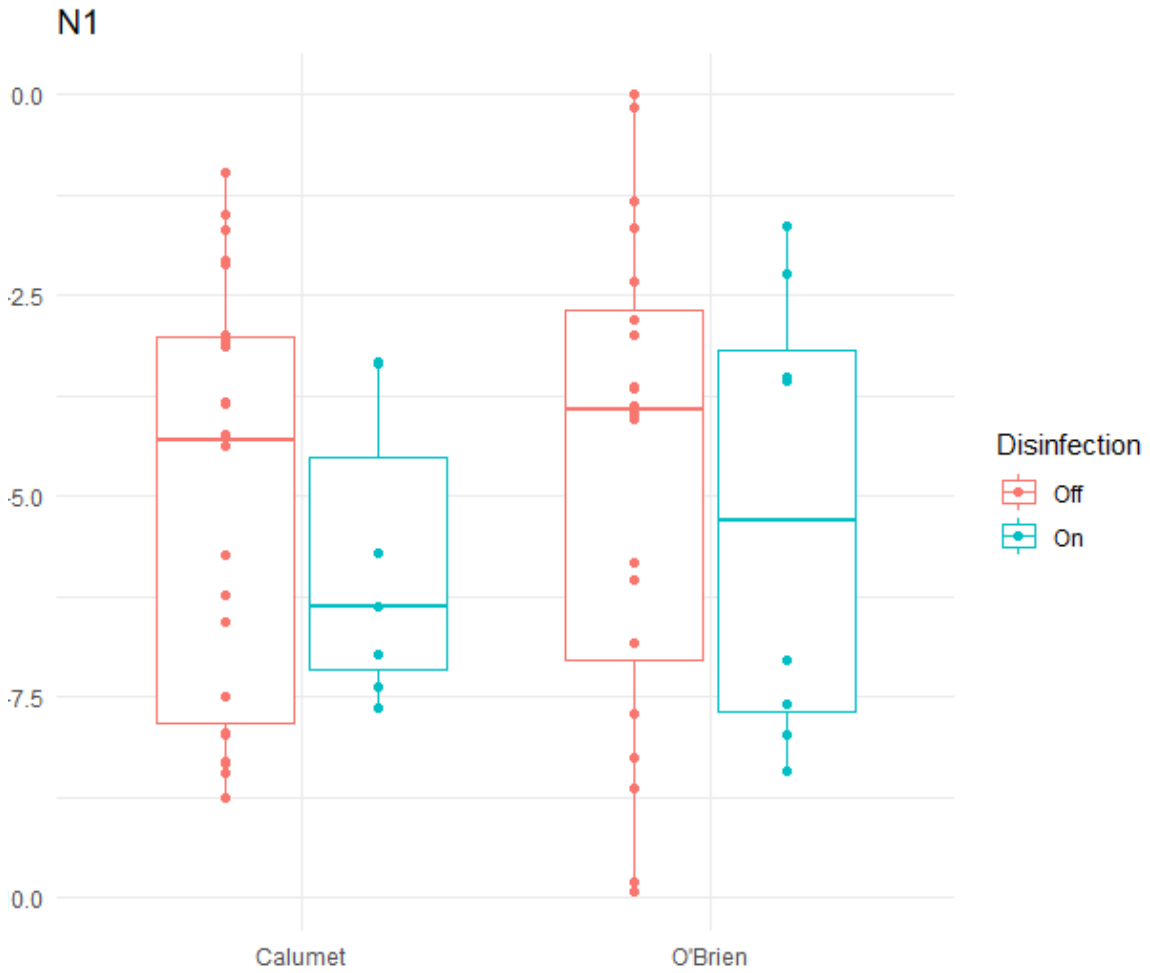
AMOUNT OF SARS-COV-2 IN WASTEWATER (LEFT) AND REPORTED CASES OF COVID-19 (RIGHT) FOR EACH CATCHMENT ZONE IN CDPH'S WASTEWATER MONITORING PROGRAM – CHICAGO, ILLINOIS, DECEMBER 2021

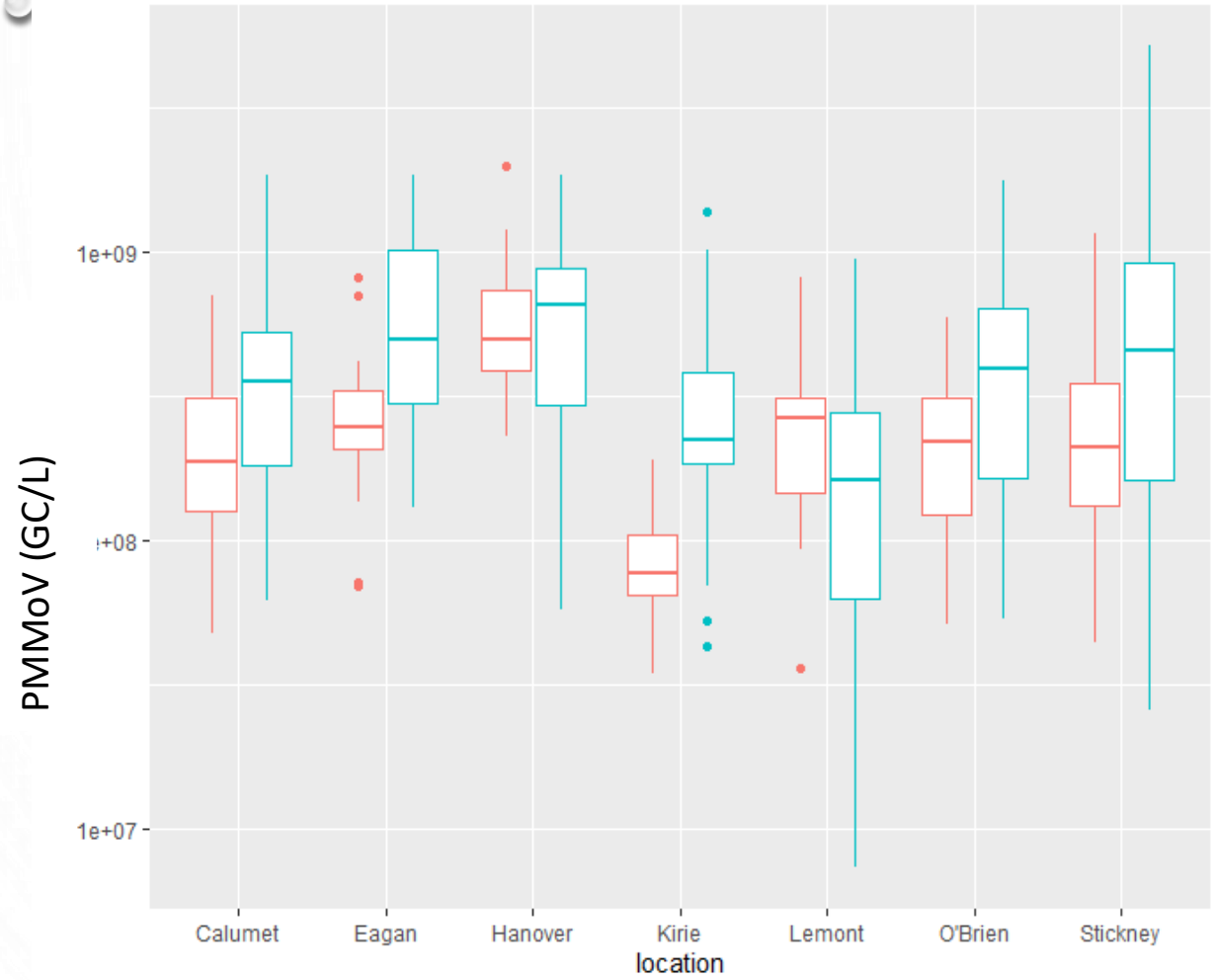


INFLUENT/EFFLUENT COMPARISONS



LOG OF THE RATIO OF GENE COPIES IN EFFLUENT:INFLUENT




PMMoV (GC/L)
1e+09
1e+08
1e+07
Calumet
Eagan
Hanover
Kirie
Lemont
O'Brien
Stickney
location
Sample.Type
Effluent
Raw Sewage


Genome position
25563
24228
23593
23557
23525
23433
23403
23271
23063
22813
22783
21764
21177
21169
21108
19998
18525
18424
17140
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8179
8083
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7601
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6894
6790
6472
6052
5700
5563
5388
5354
5140
4457
4135
3874
3267
3140
3037
3011
2618
2597
2291
1059
992
682
241
H655Y
D614G
A570D
N501Y
ΔHV [69–70] del
SNP category
Identified
Not detected
NA
S103 May21 Stkny
S88 Apr21 Stkny
S36 Mar21 HnvrPk
S46 Mar21 Stkny
S48 Mar21 Stkny
S51 Nov20 OBrn
S52 Jan21 Calmt
S53 Mar21 OBrn

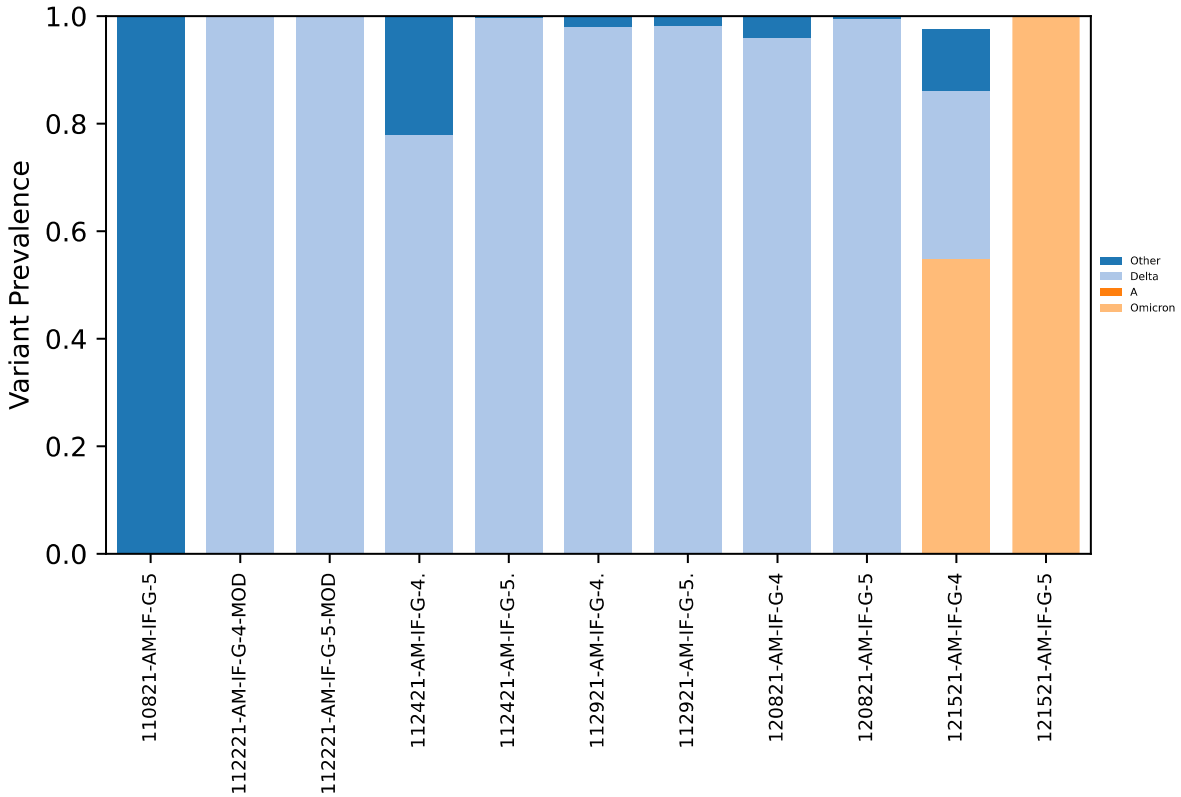
SampleID	Date	Location	Summary	Lineages	% genome
122021-2-C-1	Dec 20 2021	Lawrenceville STW	Delta:0.9929273116878702	AY.39.2,AY.103,AY.83,AY.39.1	52.66
122721-38a-C-1	Dec 27 2021	North Shore Waukegan	Omicron:0.7559539999989502,Other:0.1075828762975933,Delta:0.0965314576	BA.1,B.1.1,AY.1,AY.103,B.1.1.266,B.1.1.16,B.1.105,B.1.1.194,AY.118,B.1.1.376,B.1.1.360,B.1.1.43,B.1.161	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:0.0694191411	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:0.1416191305	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,B.1.1.192	97.09
122721-15-C-1	Dec 27 2021	Quincy	Delta:0.7412837799801812,Omicron:0.20830999999995461,Other:0.013465	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:0.0951169	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:0.8013159999882549,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:0.23608526950555372,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

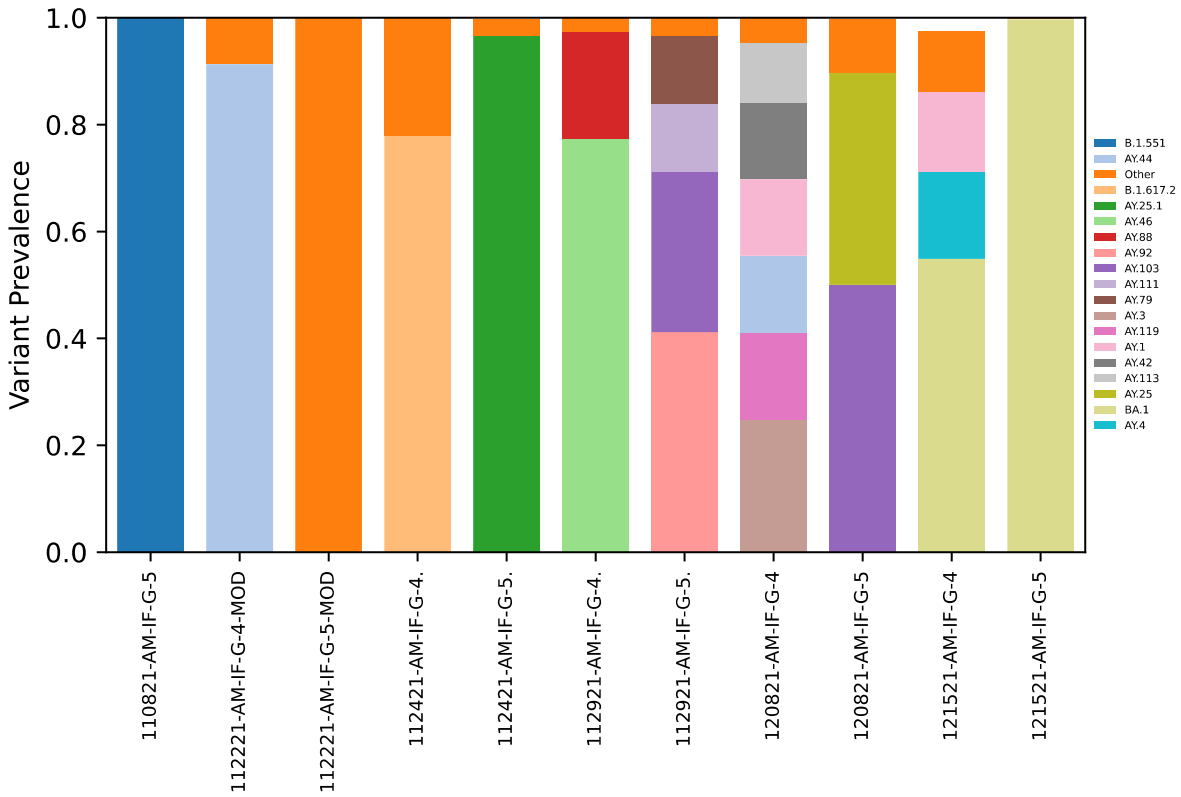
SampleID	Date	Location	Summarized	Lineages	% Genome
121221-SW-IF-C-4	12/12/21	Stickney WSRAW	Delta', 0.9623830213051965, 'Other', 0.022974393959072813	['AY.25' 'AY.103' 'AY.39.1' 'B.1.1.166']	99.13
121221-SS-IF-C-4	12/12/21	Stickney STRAW N/S	Delta', 0.9956110806294091	['AY.3']	91.55
121221-SW-IF-C-5	12/12/21	Stickney WSRAW	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 Divsion 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 WSRAW	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 WSRAW	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', 0.31309199999594933, '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', 0.07057	['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.1.1.1	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', 0.40062899999934376, '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', 0.023551	['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', 0.110663	['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

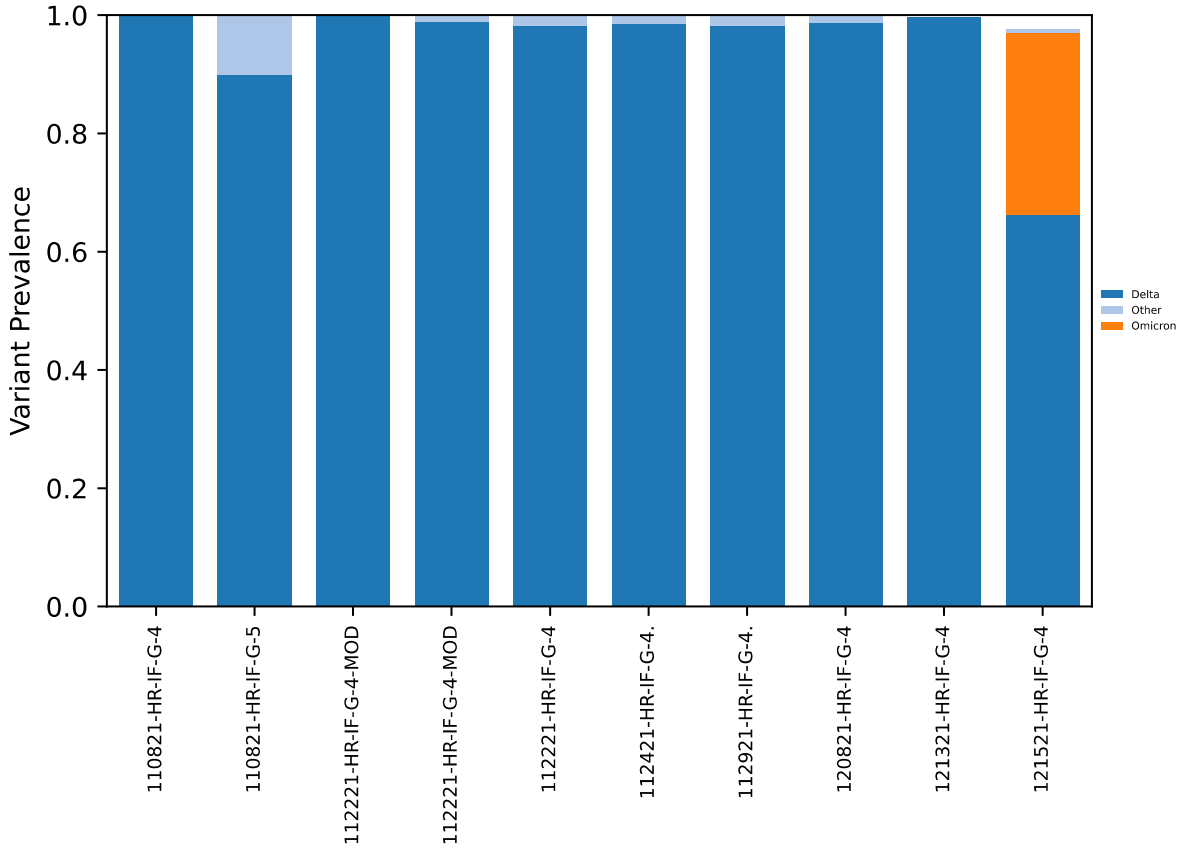
ORD –INTERNATIONAL

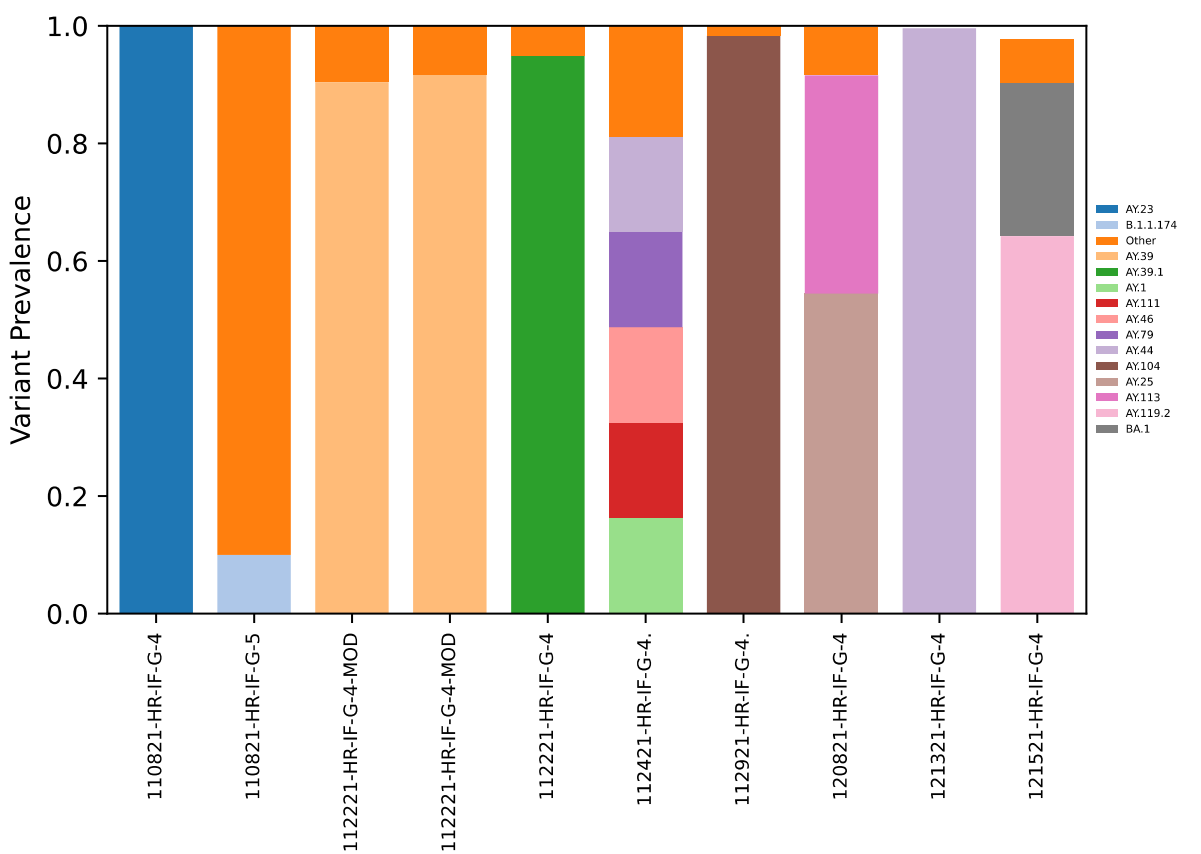




VOC% OVER TIME

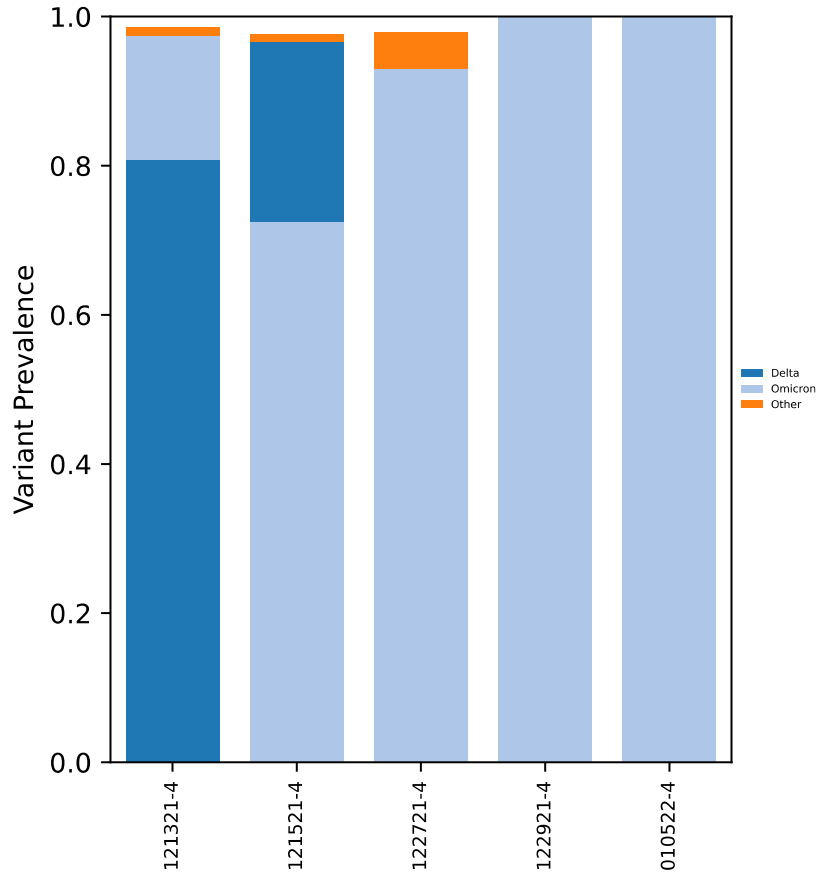
- ORD DOMESTIC

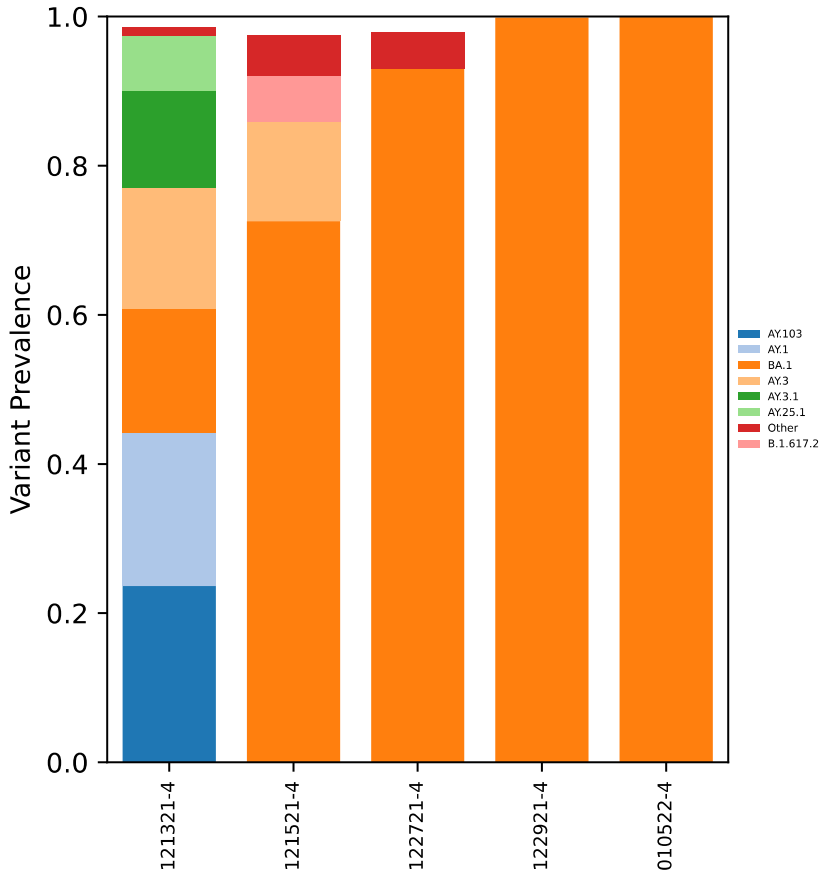




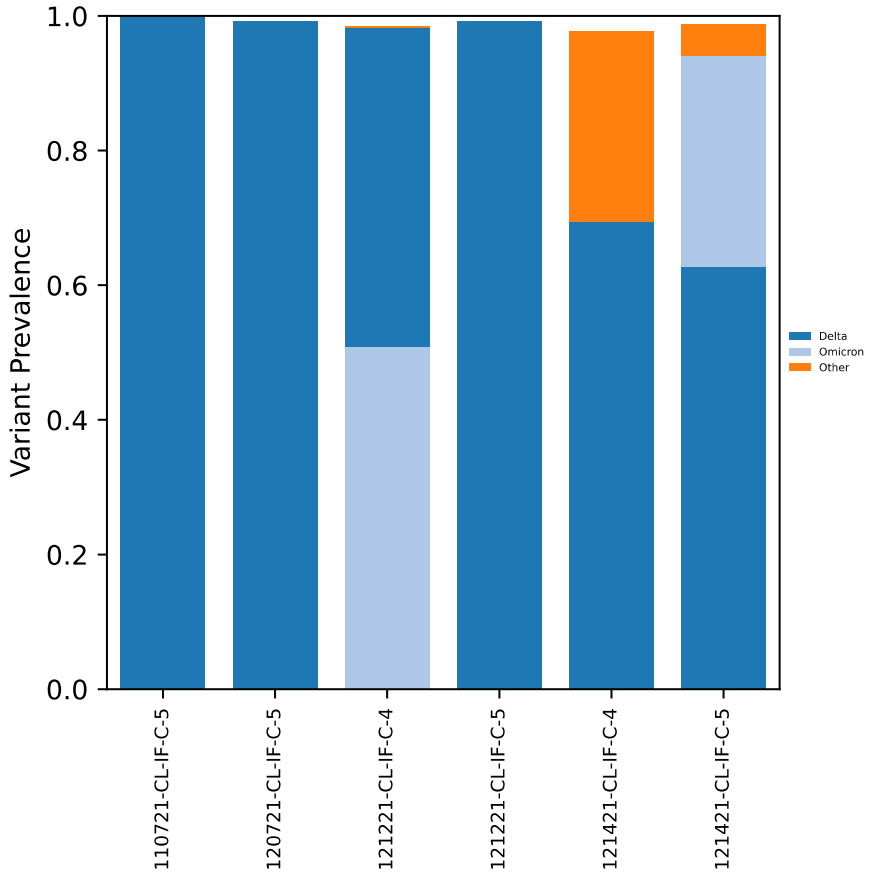
VOC% OVER TIME

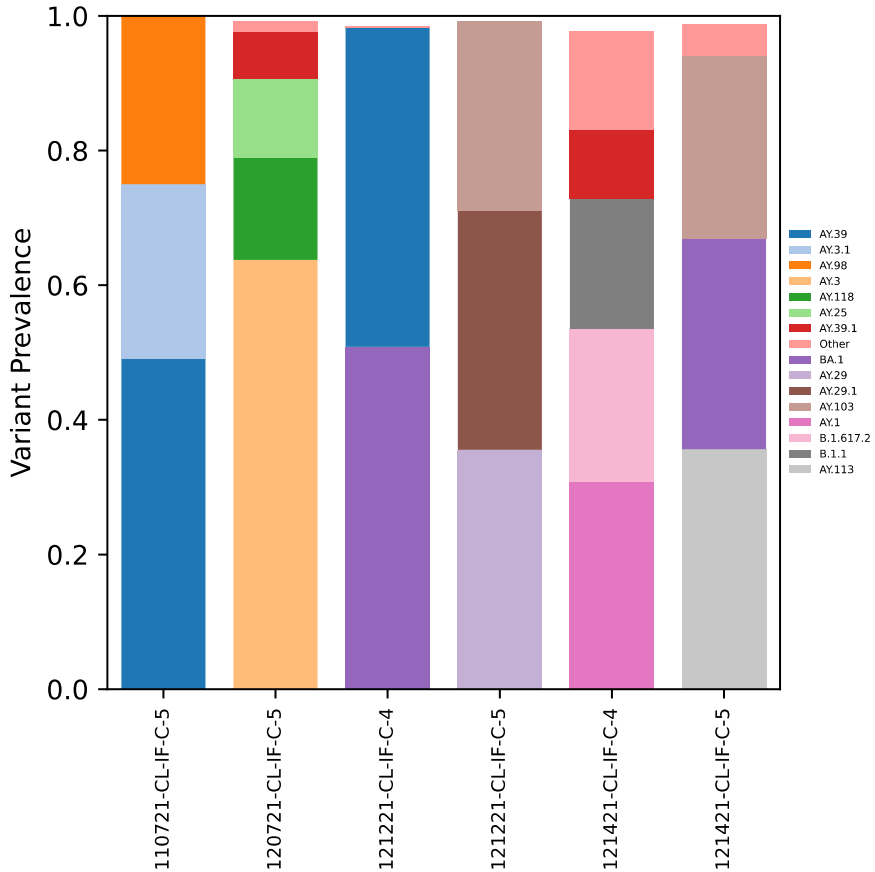
- SEWER 4, AUSTIN



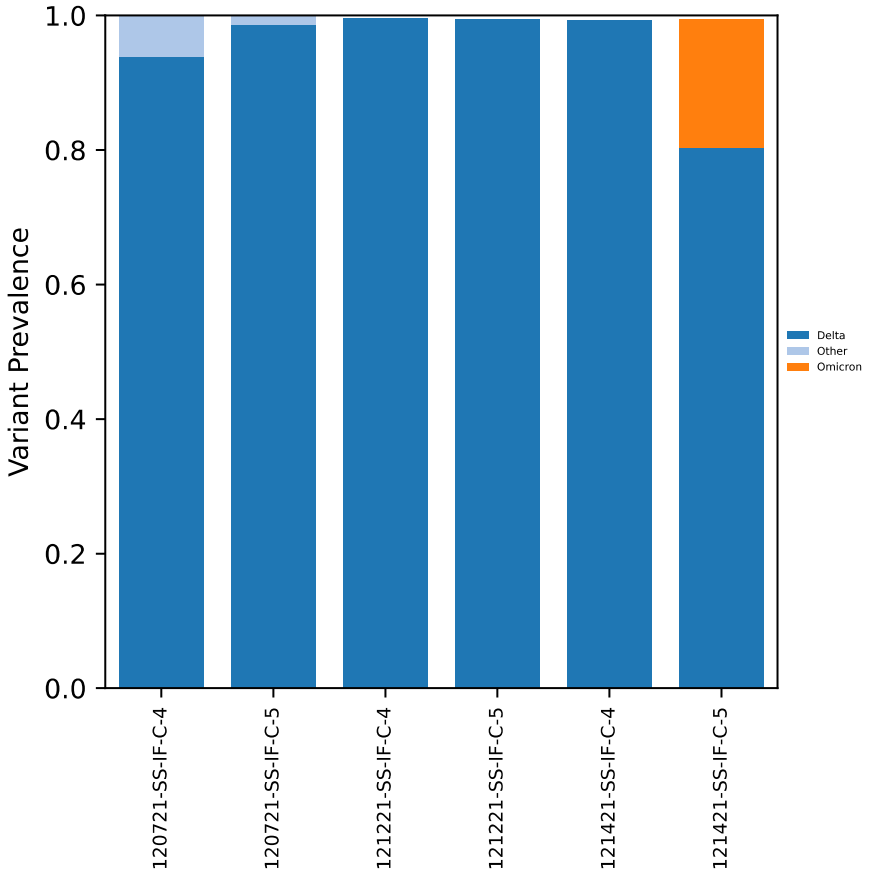


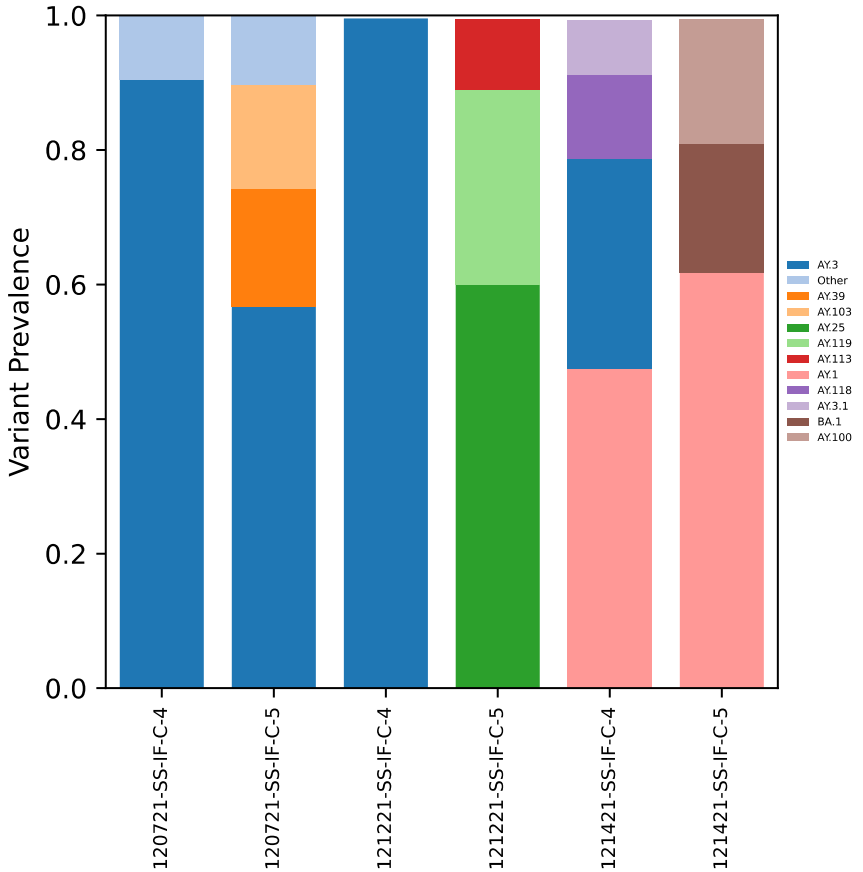
CALUMET


1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
Delta
Omicron
Other
110721-CL-IF-C-5
120721-CL-IF-C-5
121221-CL-IF-C-4
121221-CL-IF-C-5
121421-CL-IF-C-4
121421-CL-IF-C-5

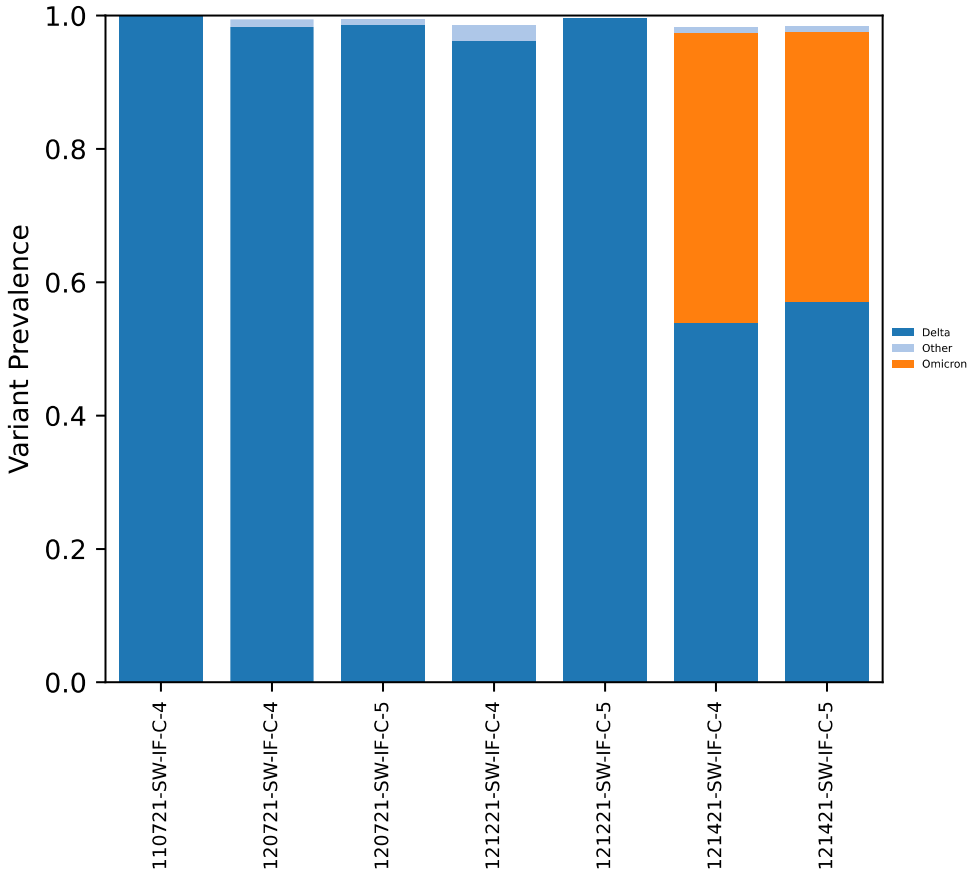

1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
AY.39
AY.3.1
AY.98
AY.3
AY.118
AY.25
AY.39.1
Other
BA.1
AY.29
AY.29.1
AY.103
AY.1
B.1.617.2
B.1.1
AY.113
110721-CL-IF-C-5
120721-CL-IF-C-5
121221-CL-IF-C-4
121221-CL-IF-C-5
121421-CL-IF-C-4
121421-CL-IF-C-5

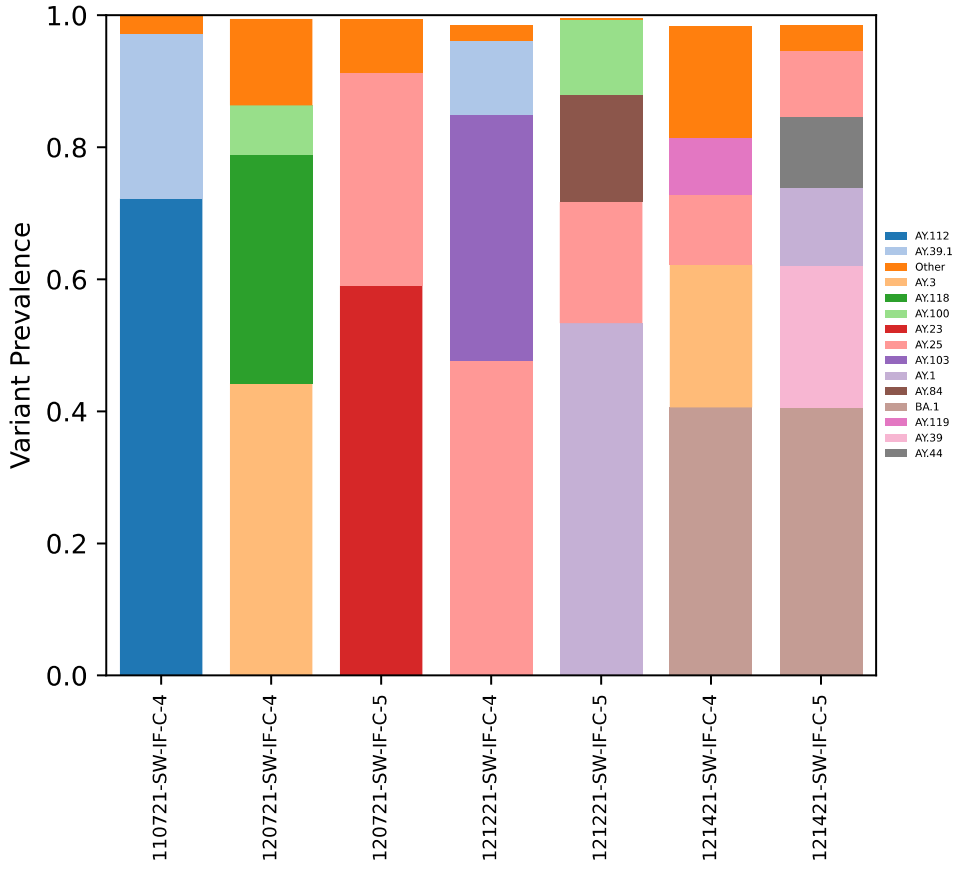
STICKNEY SS


1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
120721-SS-IF-C-4
120721-SS-IF-C-5
121221-SS-IF-C-4
121221-SS-IF-C-5
121421-SS-IF-C-4
121421-SS-IF-C-5
Delta
Other
Omicron

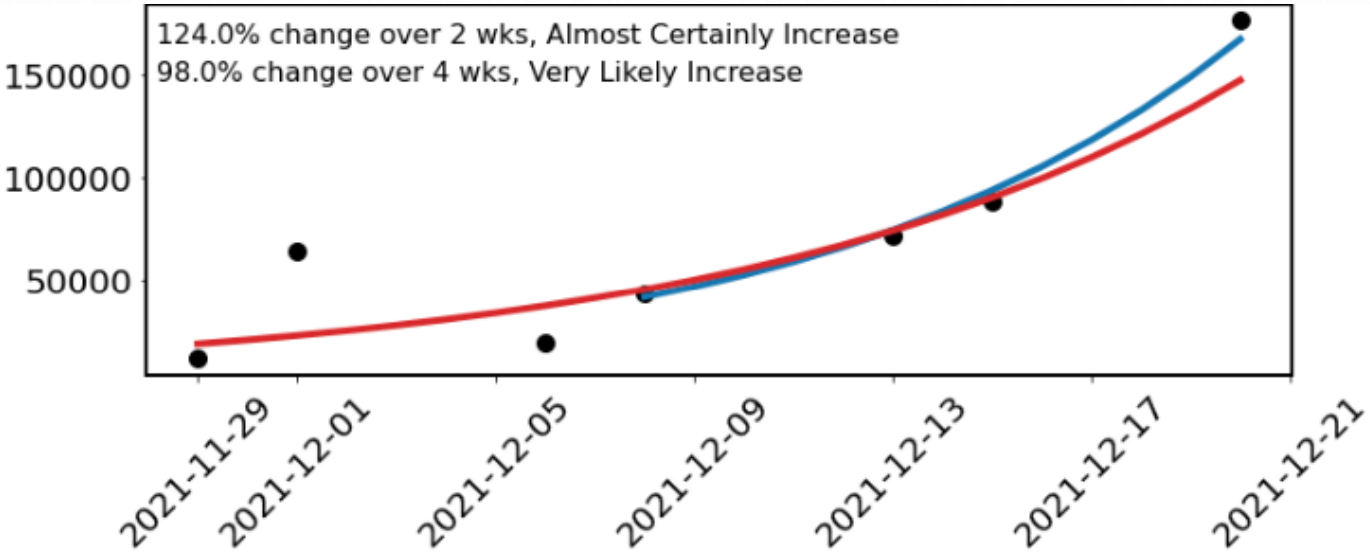

1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
120721-SS-IF-C-4
120721-SS-IF-C-5
121221-SS-IF-C-4
121221-SS-IF-C-5
121421-SS-IF-C-4
121421-SS-IF-C-5
AY.3
Other
AY.39
AY.103
AY.25
AY.119
AY.113
AY.1
AY.118
AY.3.1
BA.1
AY.100

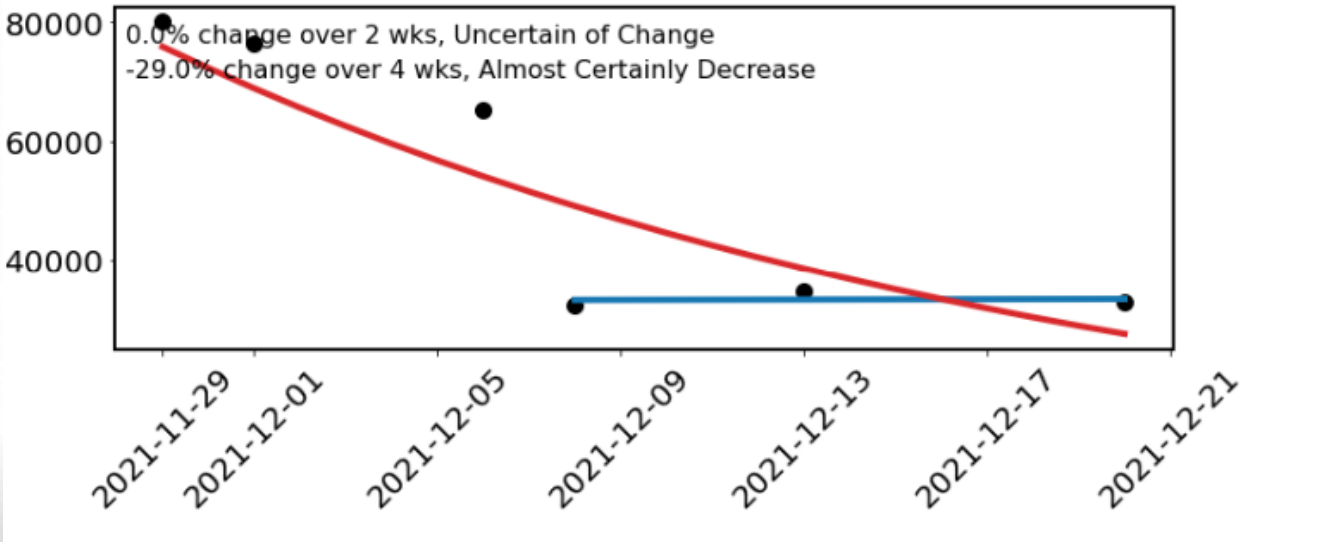
STICKNEY SW


1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
Delta
Other
Omicron
110721-SW-IF-C-4
120721-SW-IF-C-4
120721-SW-IF-C-5
121221-SW-IF-C-4
121221-SW-IF-C-5
121421-SW-IF-C-4
121421-SW-IF-C-5


1.0
0.8
0.6
0.4
0.2
0.0
Variant Prevalence
AY.112
AY.39.1
Other
AY.3
AY.118
AY.100
AY.23
AY.25
AY.103
AY.1
AY.84
BA.1
AY.119
AY.39
AY.44
110721-SW-IF-C-4
120721-SW-IF-C-4
120721-SW-IF-C-5
121221-SW-IF-C-4
121221-SW-IF-C-5
121421-SW-IF-C-4
121421-SW-IF-C-5

TRENDS OVER TIME





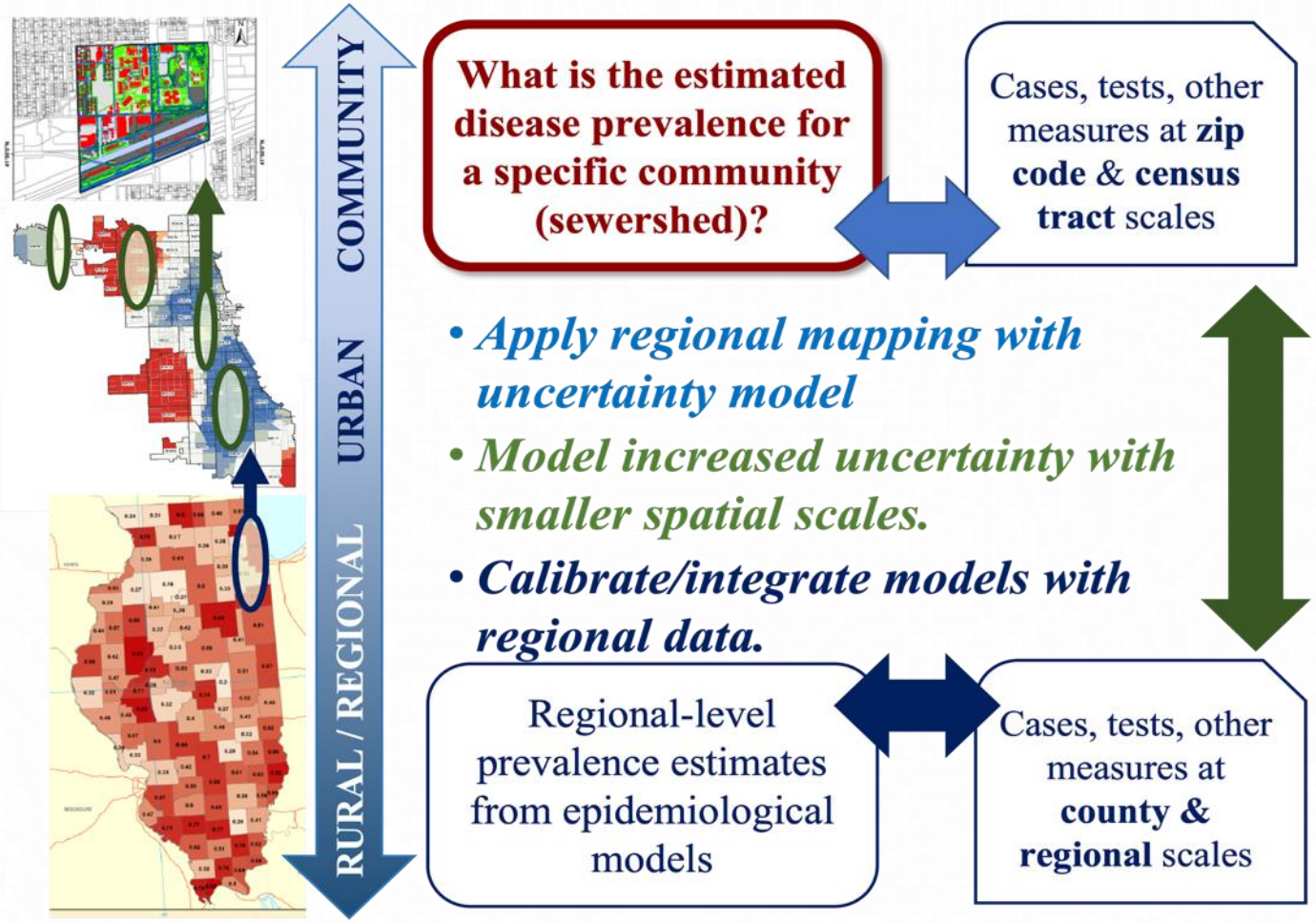
WHAT DO PUBLIC HEALTH AGENICIES DO WITH THE DATA?

- 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

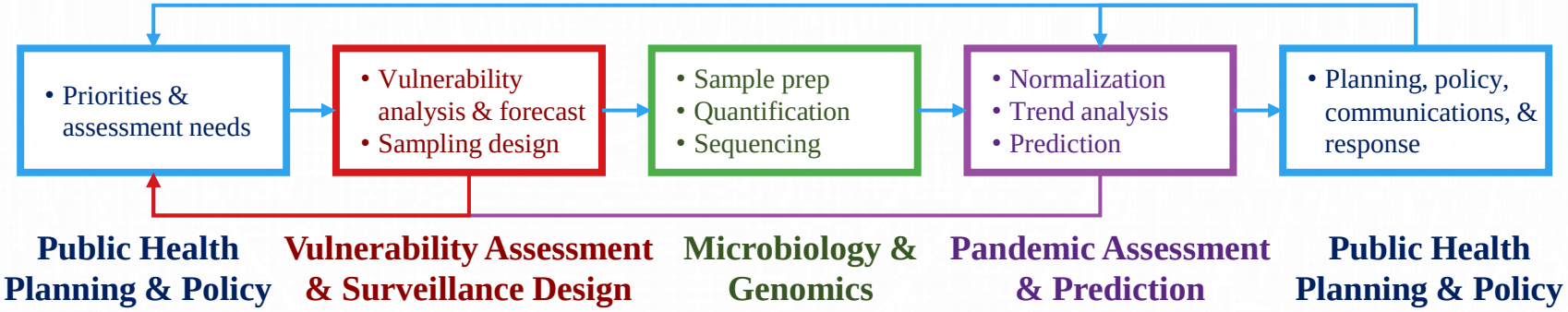
SHARING DATA EXTERNALLY

- 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

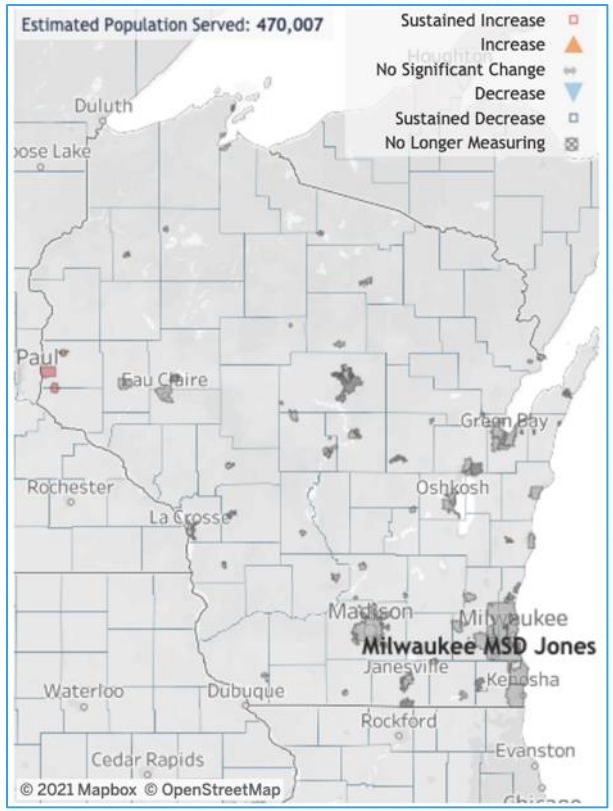

COMMUNITY
URBAN
RURAL / REGIONAL
What is the estimated disease prevalence for a specific community (sewershed)?
Cases, tests, other measures at **zip code** & **census tract** scales
• *Apply regional mapping with uncertainty model*
• *Model increased uncertainty with smaller spatial scales.*
• *Calibrate/integrate models with regional data.*
Regional-level prevalence estimates from epidemiological models
Cases, tests, other measures at **county & regional** scales

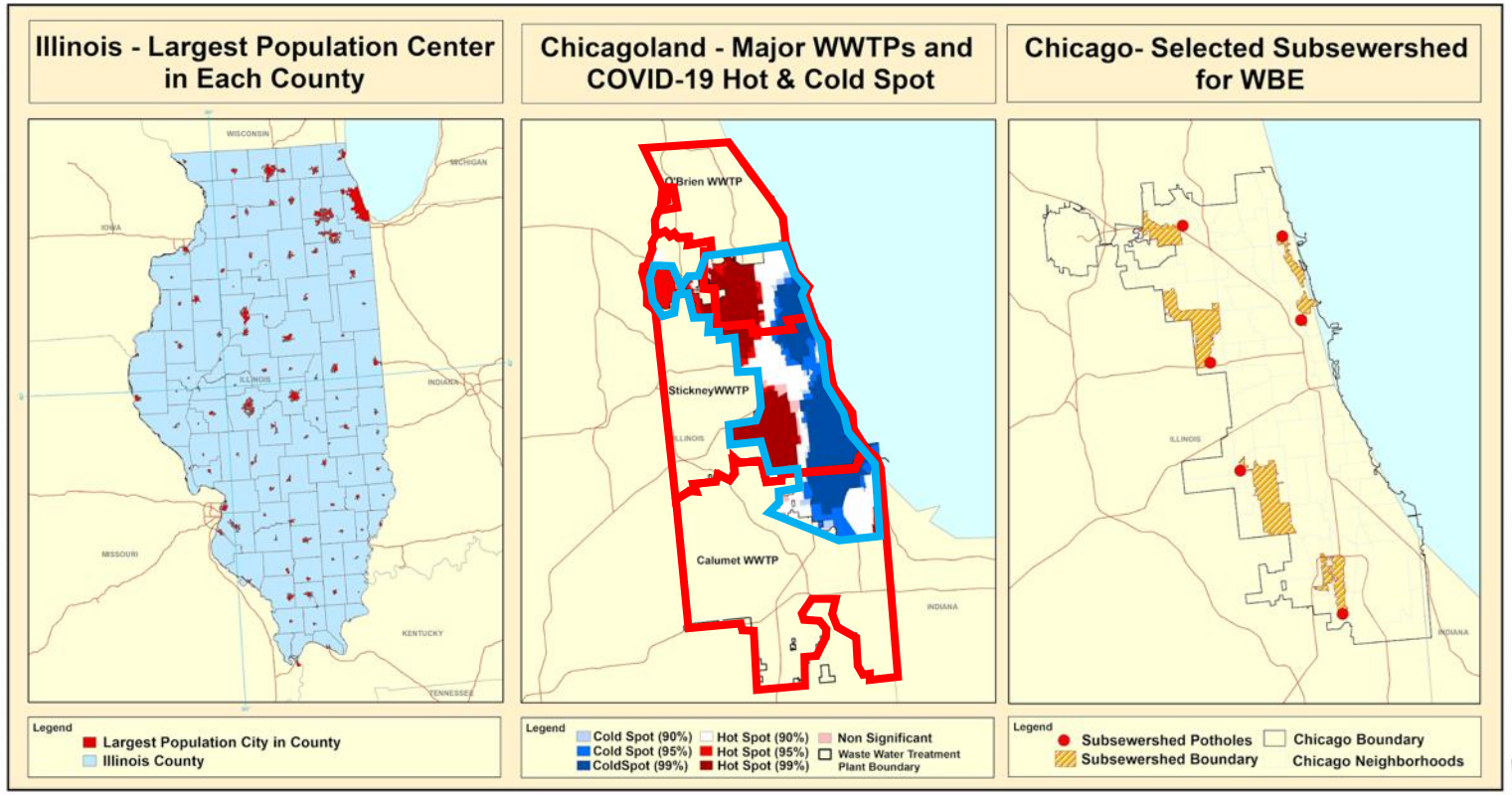
WBE Workflow



Research Agenda

UNIQUE CHALLENGES AT DIFFERENT SCALES

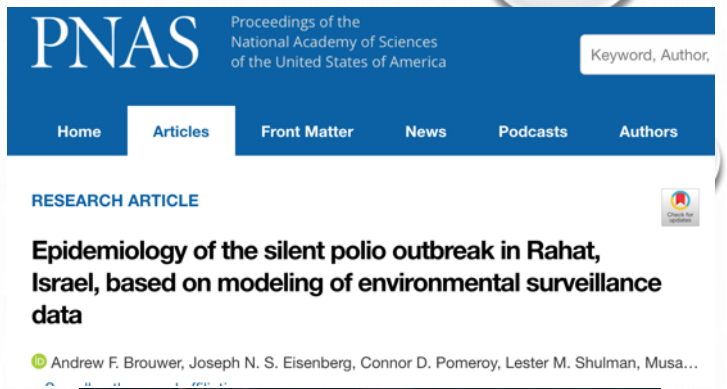




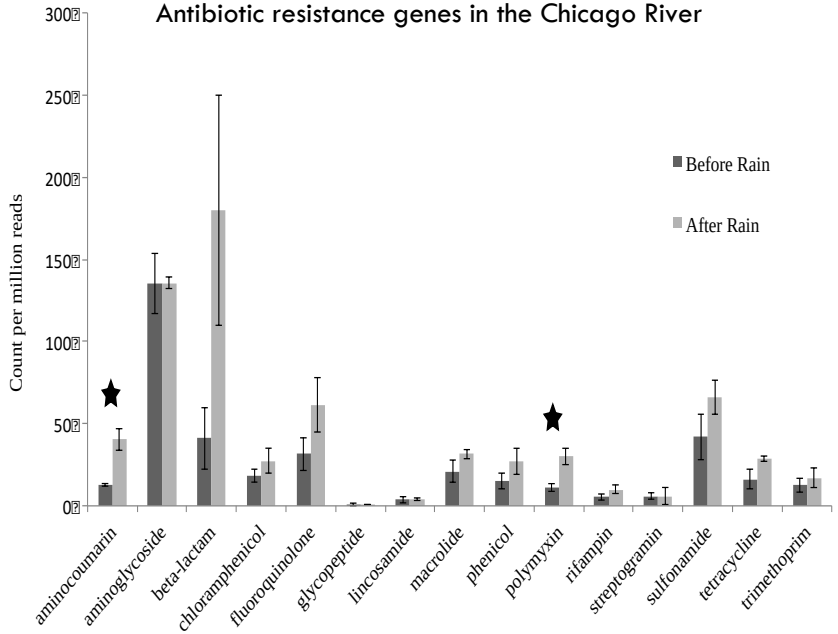
PIPP adds partners Sandra McLellan (UW-Milwaukee and State of Wisconsin wastewater surveillance with 70 WWTPs), Alexandra Boehm (Stanford, Co-PI of WBE RCN), and others.

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



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*.