Virginia Wastewater Surveillance Program: Community of Practice Meeting

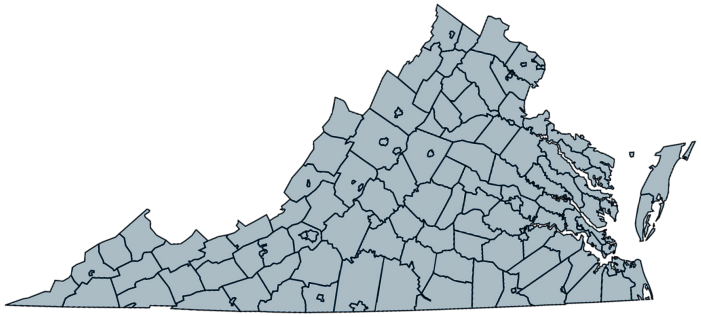
WWS Team
VDH | Office of Environmental Health Services
June 29, 2022

VDH VIRGINIA DEPARTMENT OF HEALTH

Agenda

- **Updates & Funding Opportunities**
- **Topic(s) of Interest:**
  - Tracking wastewater to understand infectious disease epidemiology
- **Open Discussion**

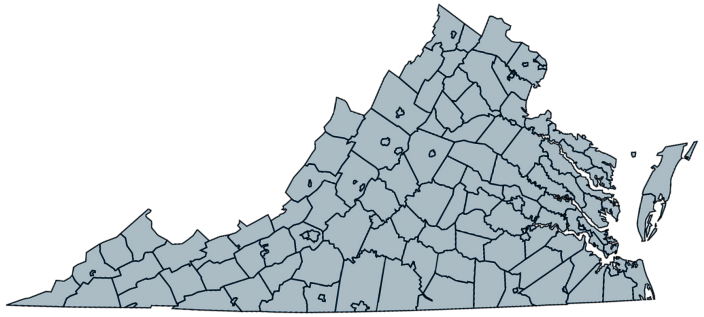
Programmatic Updates



Weekly **SARS-CoV-2 monitoring** at influent to **25 wastewater treatment plants** statewide started on **September 13: 41 weeks!**

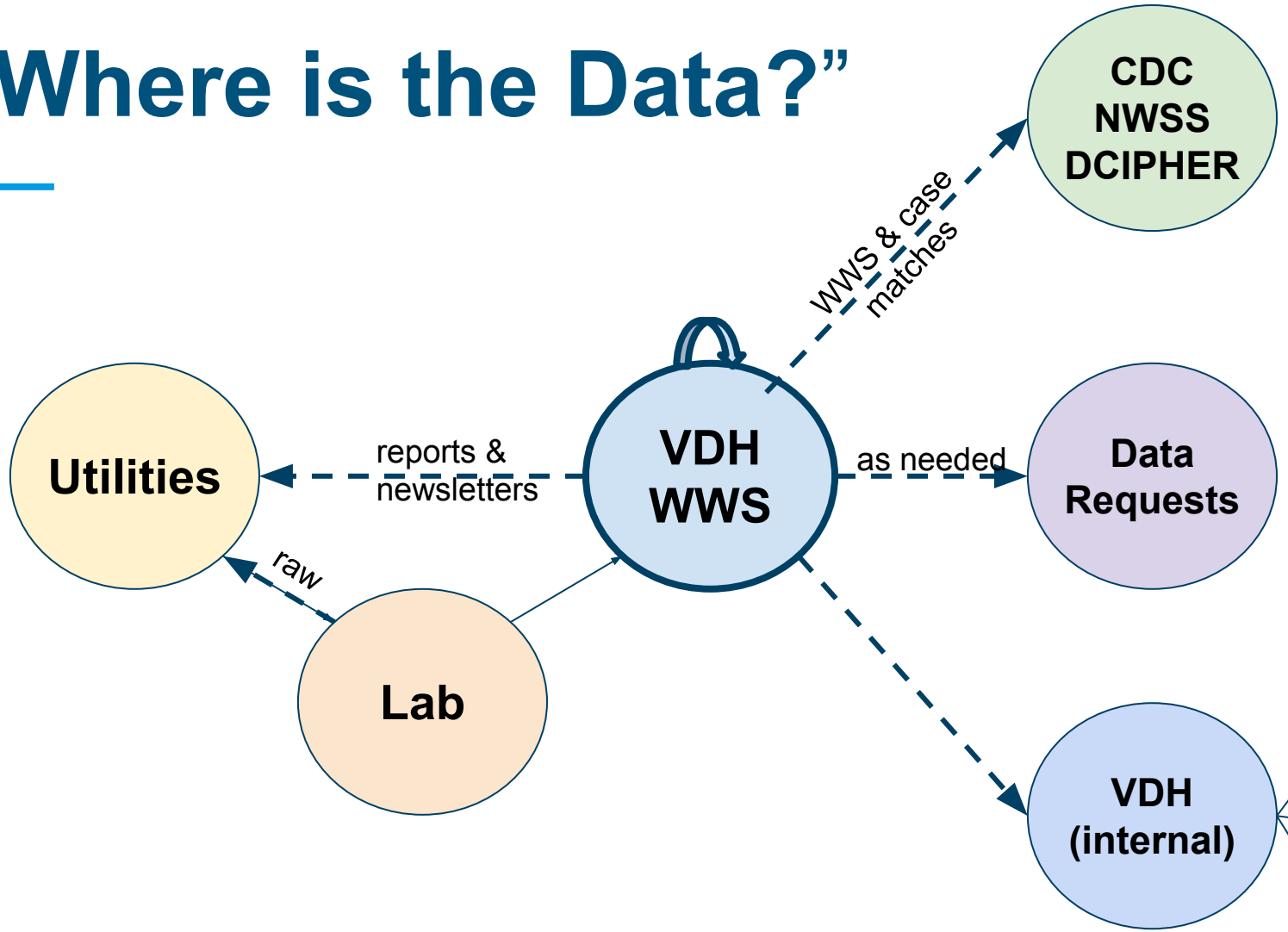
- Weekly results sharing with:
  - Utilities
  - Health Department Partners
  - Environmental Health Managers
  - DCIPHER
- Updated Internal Working Dashboard Now!

Funding Opportunities/ Updates

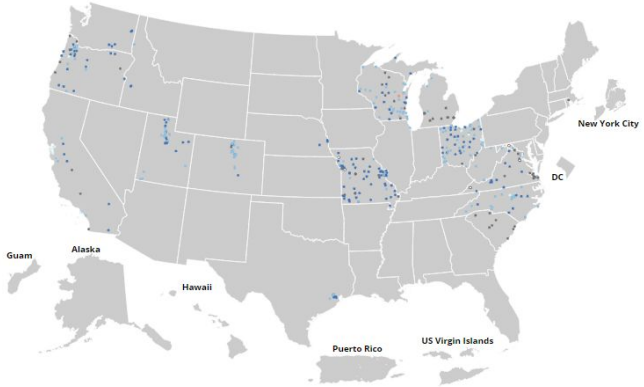


- **BP4 Proposal to CDC**
  - Next Funding Cycle-announcement around the corner
- **CDC-Biobot Commercial Sampling**
  - Multiple sites enrolled from Virginia
  - Must not be currently involved in CDC NWSS
  - Sampling: twice/week
- **WEF Autosampler** Program-Still accepting applications
- **Localized Projects**
  - Started 8 new sites in SW Virginia

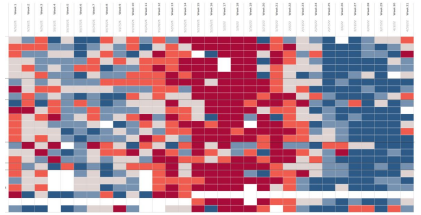
“Where is the Data?”

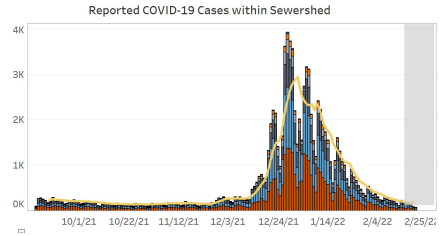


CDC COVID-19 Data Tracker



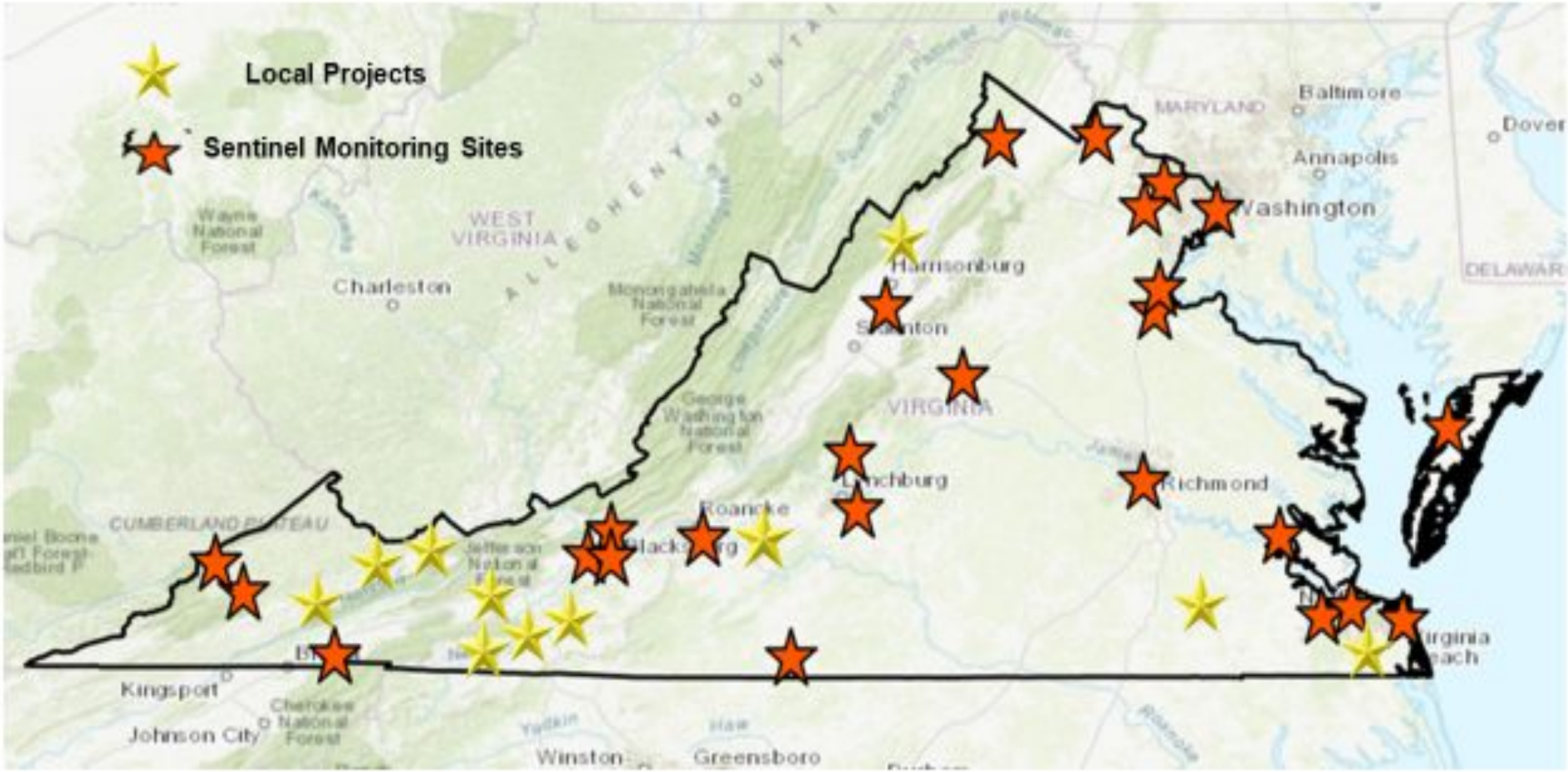
<u>Ad hoc requests for</u>:
researchers, concerned citizens, etc.



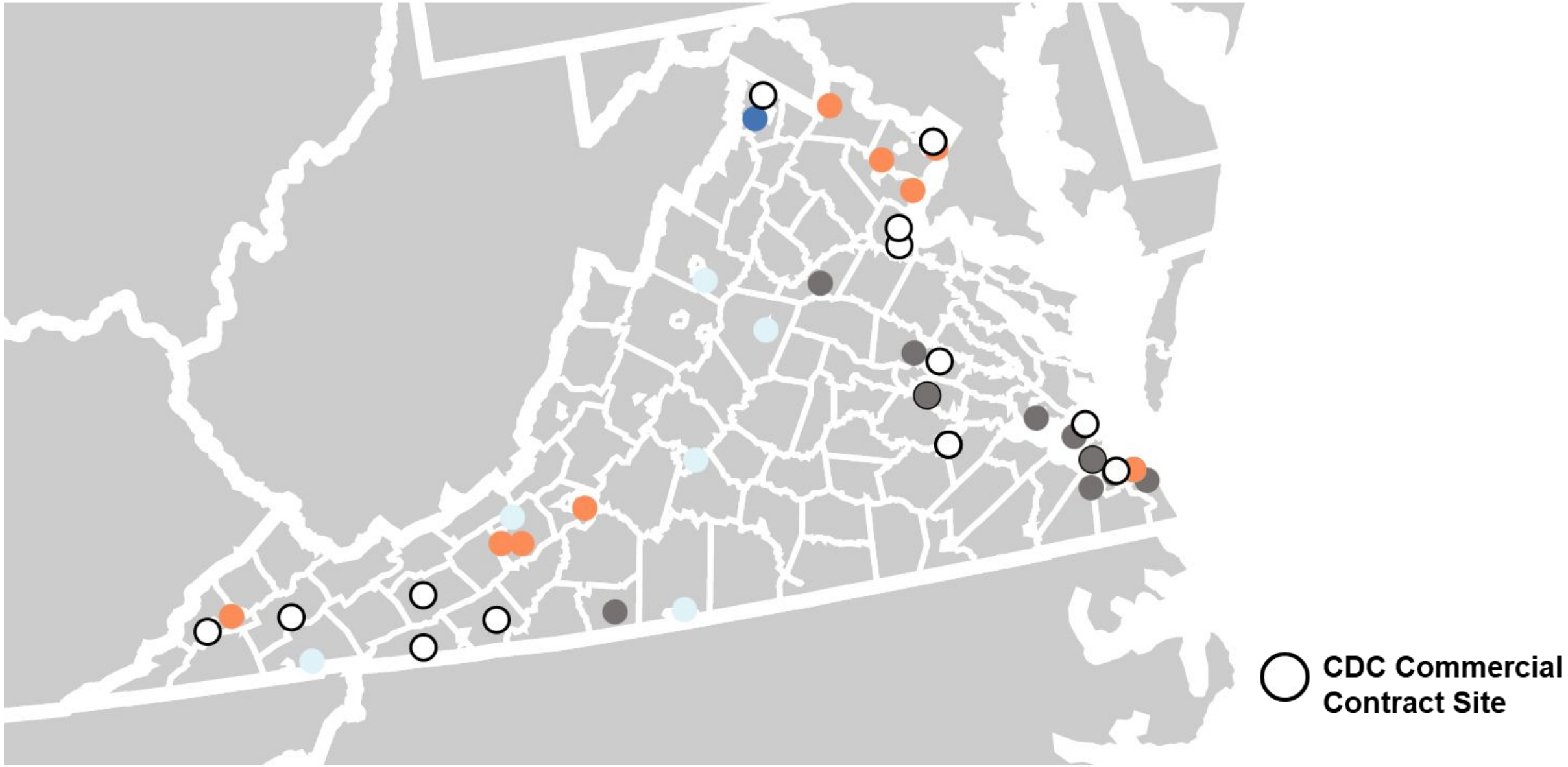


(In progress)

Sentinel Monitoring Sites and Localized Projects



COVID Data Tracker



Targeted Tracking Wastewater to Understand Infectious Disease Epidemiology

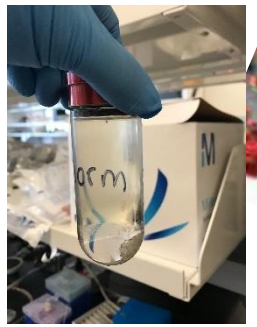
Dr. Amy J. Mathers MD, D(ABMM)

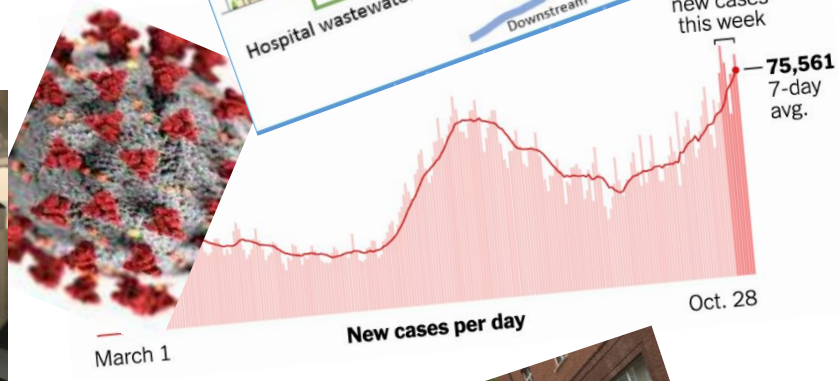
Associate Professor of Medicine and Pathology
University of Virginia School of Medicine Division of Infectious Diseases & International Health
Medical Director Antimicrobial Stewardship
Associate Director of Clinical Microbiology

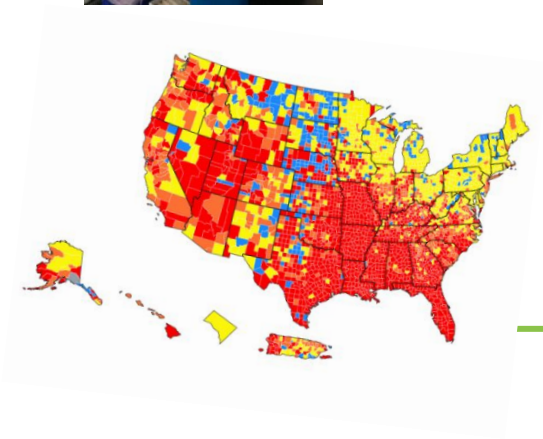
Tracking wastewater to understand infectious disease epidemiology

Virginia WWS Community of Practice Discussion

Amy Mathers, MD, D(ABMM)
Associate Professor of Medicine and Pathology
University of Virginia
June 29th, 2022







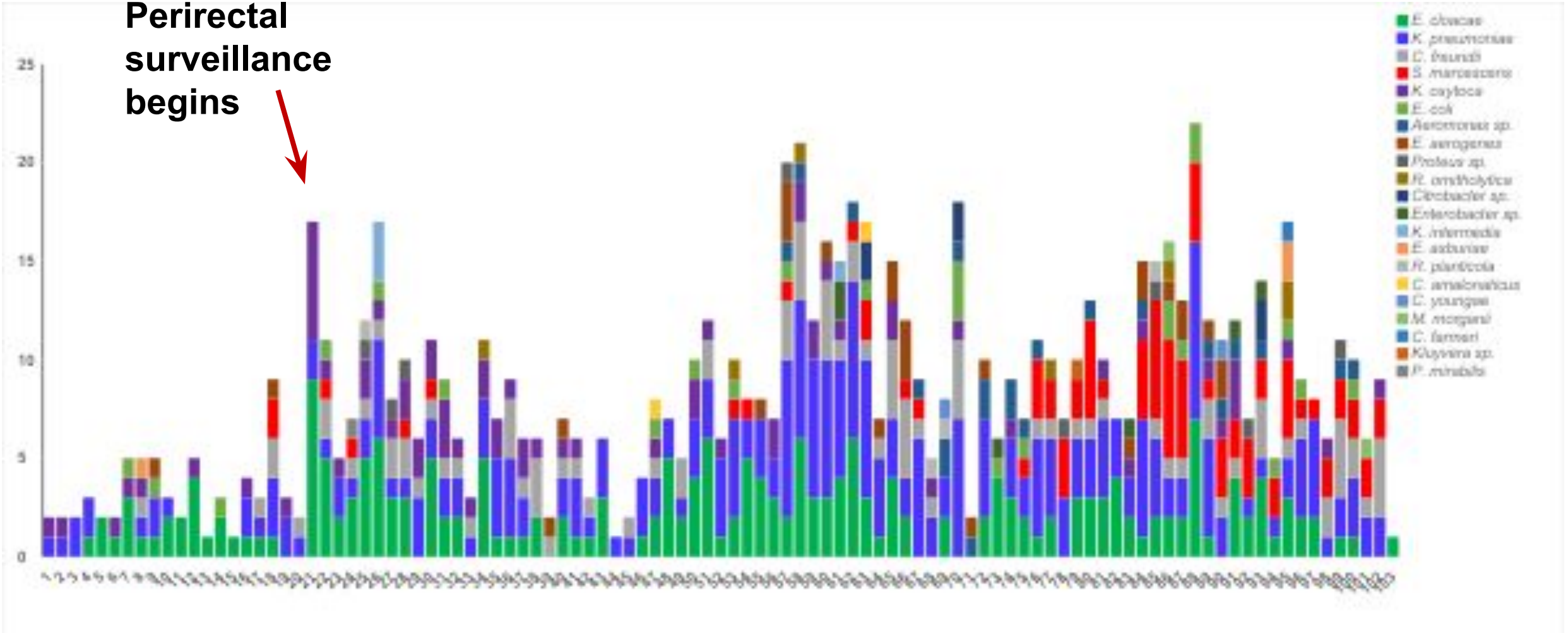
Klebsiella pneumoniae carbapenemase (KPC)

- Found primarily in *Enterobacterales* (majority of initial reports seen in *K. pneumoniae*)
- Ambler Class A serine β-lactamase
- Hydrolyzes all β-lactams; penicillins, extended spectrum cephlasporins, aztreonam and carbapenems
- Is inhibited by avibactam, vaborbactam, relabactam and other novel β-lactamase inhibitors
- Gene is contained on a mobile piece of DNA which bacteria share

Tn*4401*
(10 kb)

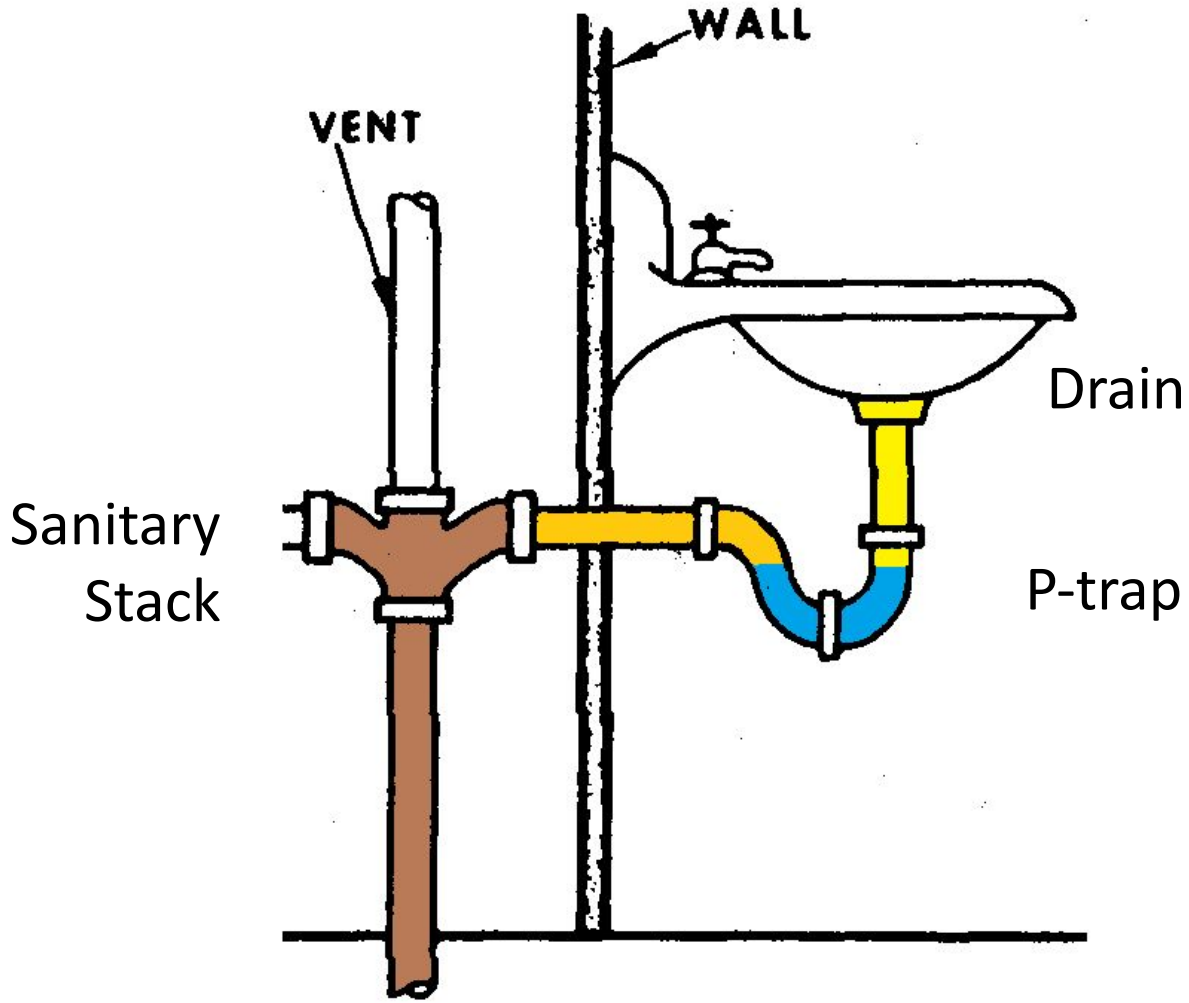
Yigit H et al. Antimicrob Agents Chemother. 2001 Apr;45(4):1151-61.

Incidence of KPC-producing Bacteria by Species in our institution

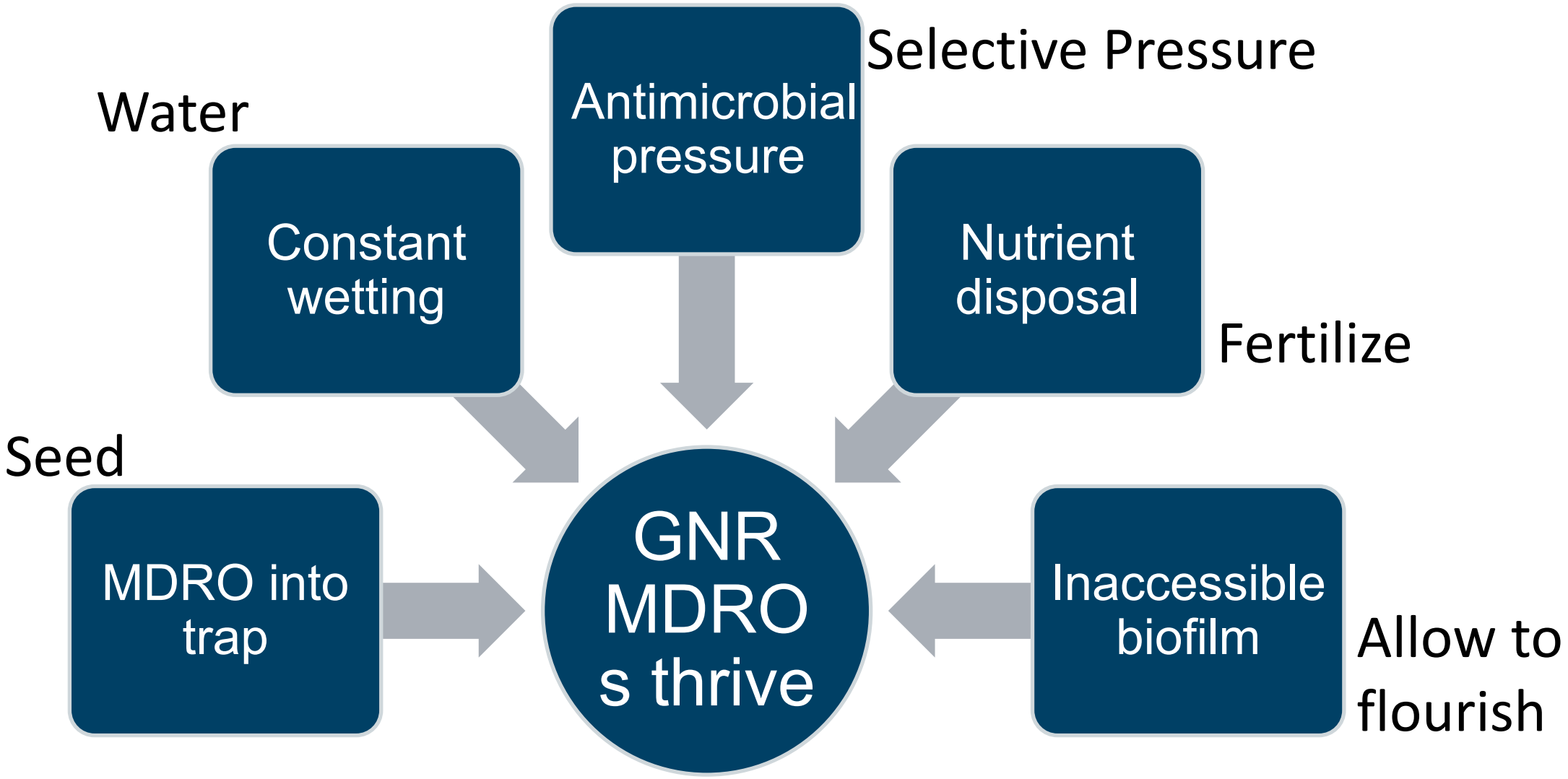


Consequential genes of drug resistance may make this issue much more notable and high risk

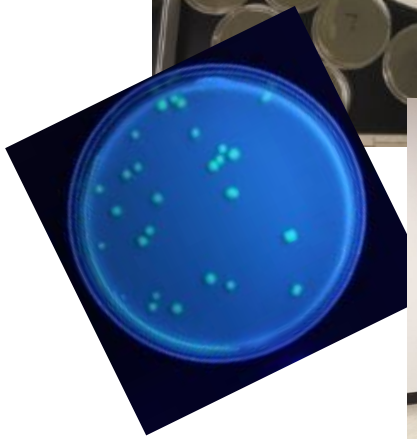
- Gaps remain in our knowledge of nosocomial transmission of ESBL/carbapenemase producing Enterobacteriaceae
- Increasing evidence that some patient acquisition may occur from colonized sink drains
- Sorting out transmission chains is not easy even with a clonal outbreak but especially across species with mobile genetic elements involved



Ideal niche for antibiotic resistant bacteria to evolve and flourish

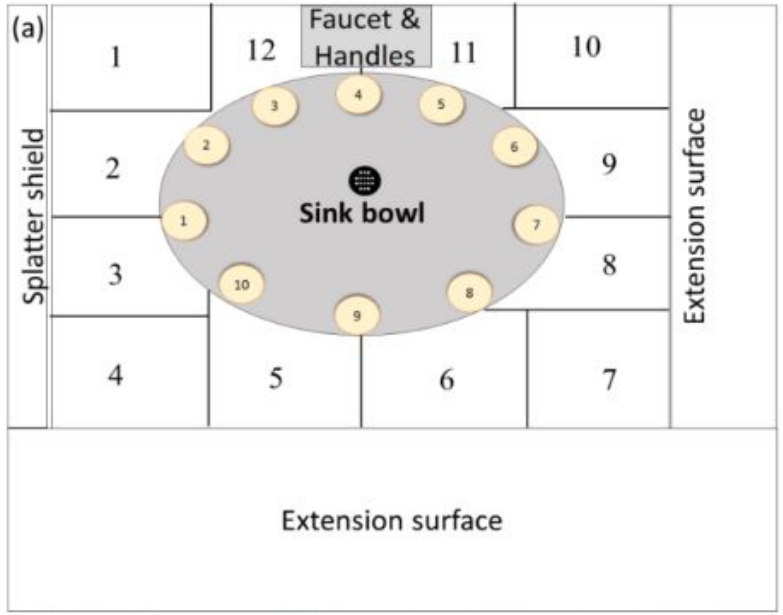


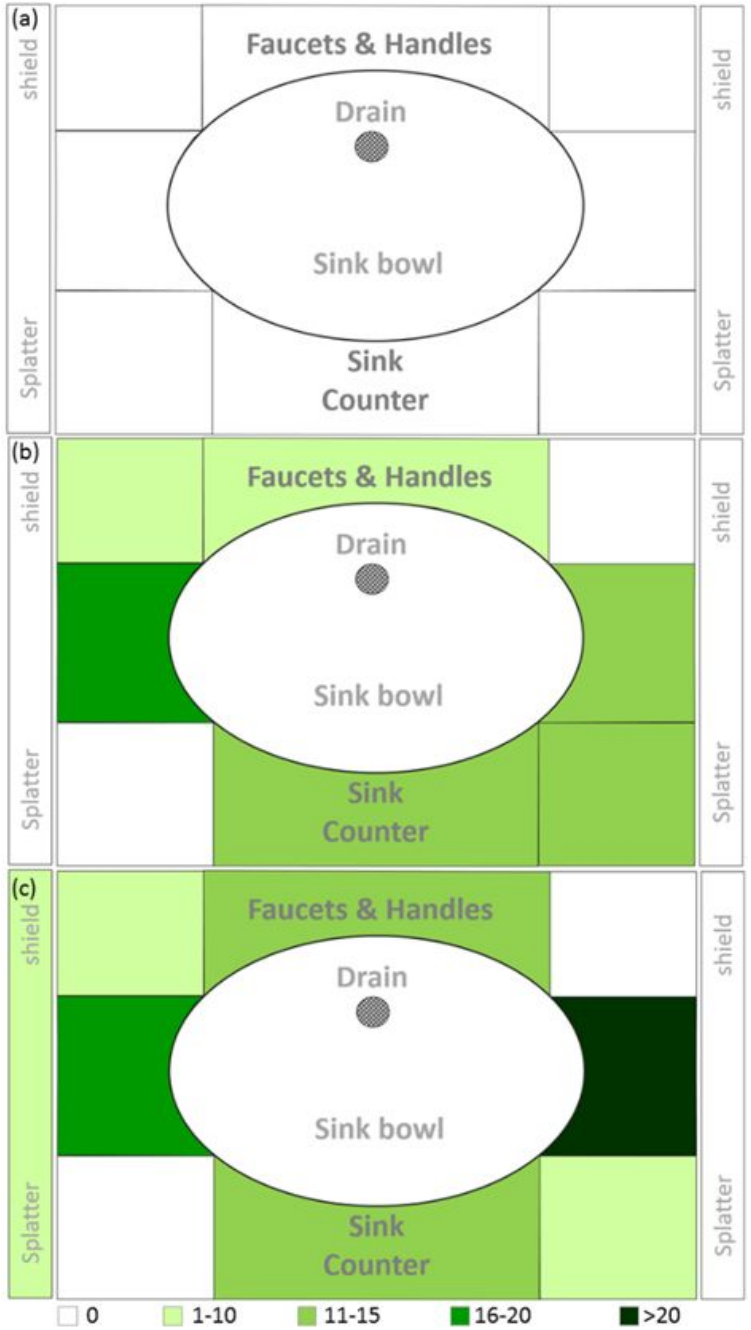
Sink Lab(s)



- Working with CDC
- Aim to understand microbial dynamics in controlled setting
- Looks to develop interventions
- Requests from standards, industry and other hospitals

When colonizing the drain or sink bowl GFP-*E.coli* dispersed onto the sink and surrounding counter top when hit with water





P-trap only colonized

Drain colonized

Drain Colonized (7d)

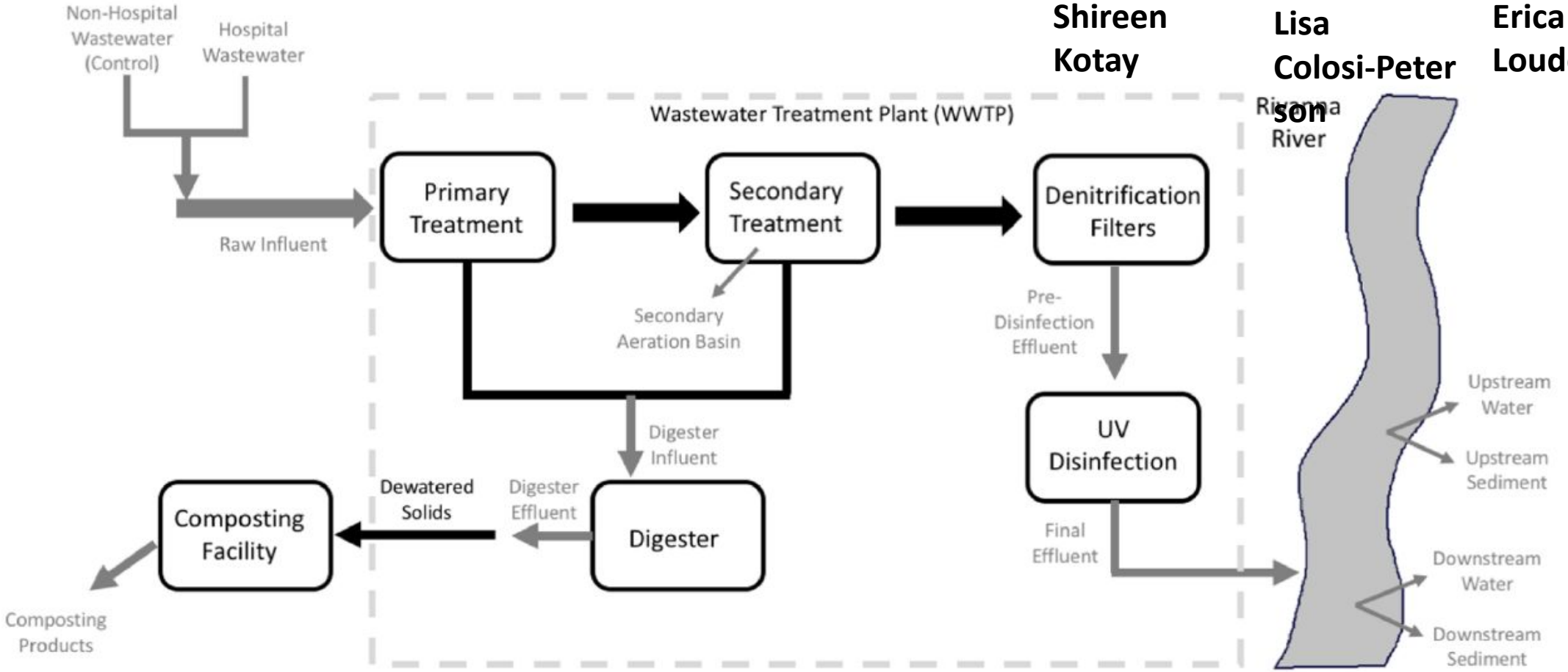
Kotay S et al. 2017. Appl Environ Microbiol 83:e03327-16

What happens to the KPCO when they leave the hospital?

Shireen Kotay

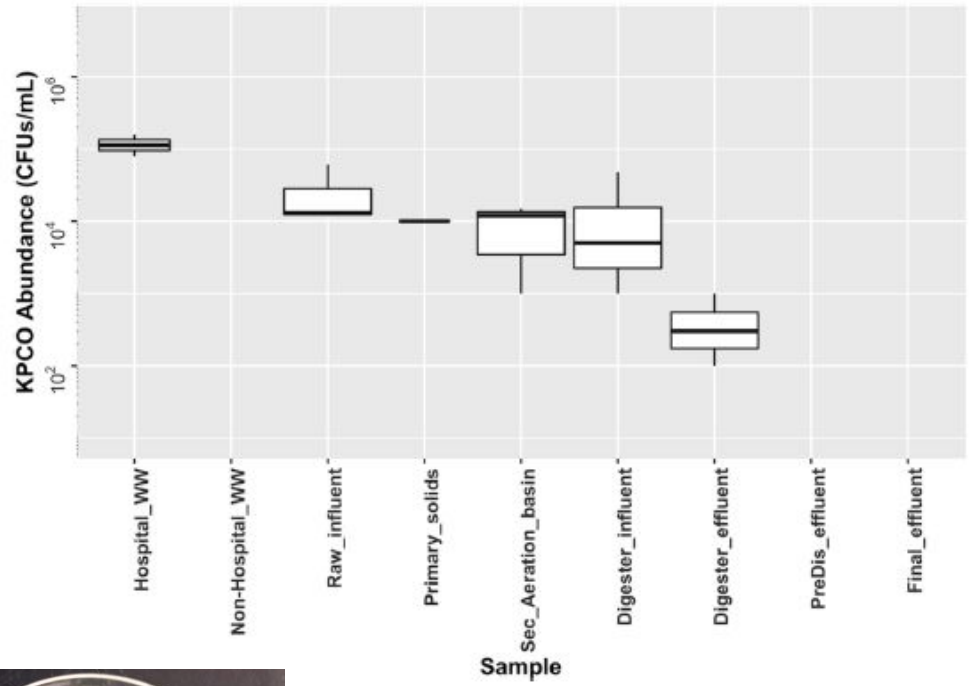
Lisa Colosi-Peterson

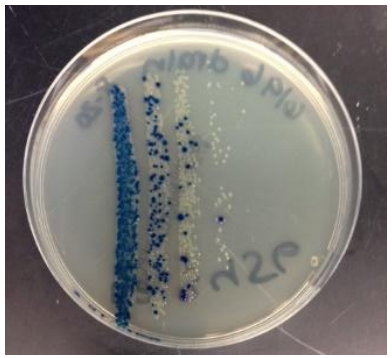
Erica Loudermilk

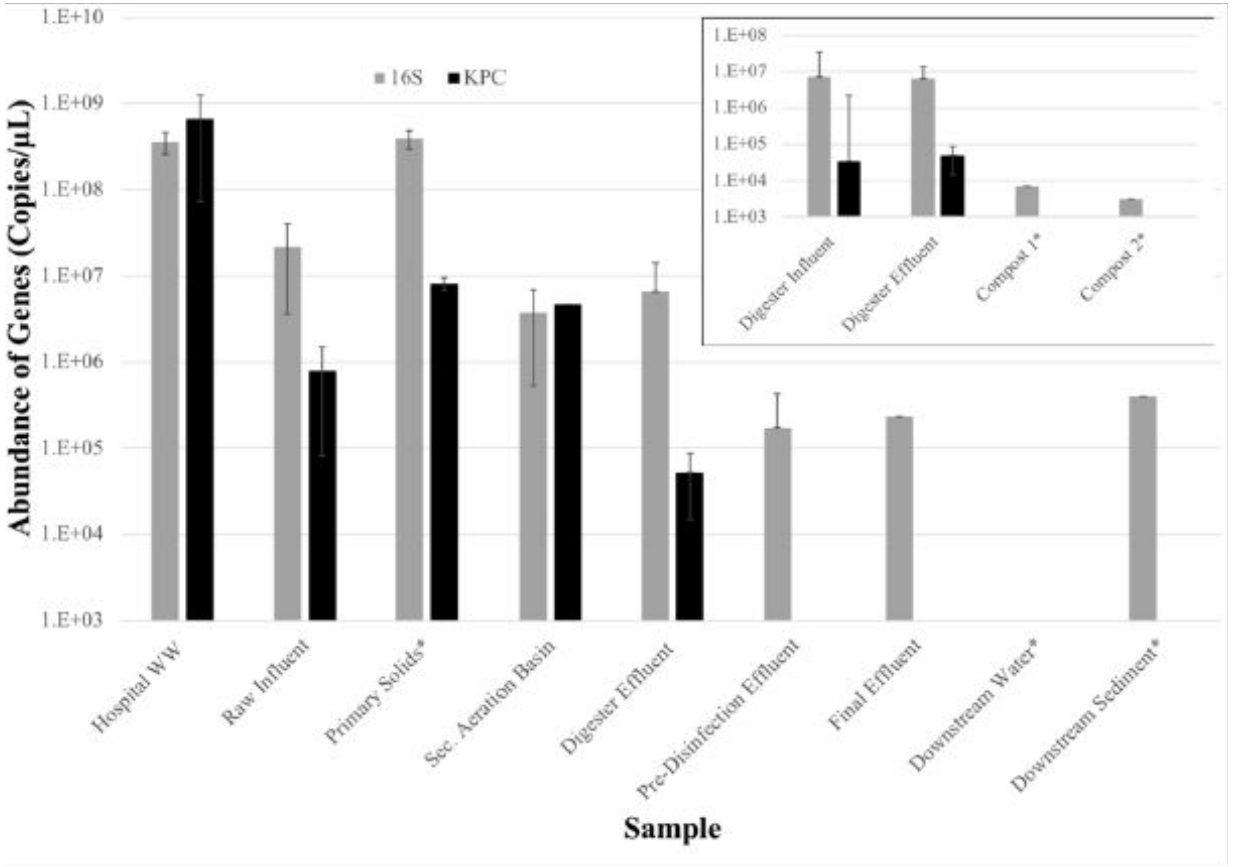


Water Research 213 (2022) 118151

Culture and qPCR align for KPCO
WW works well to eliminate *bla*$_{KPC}$ and KPCO







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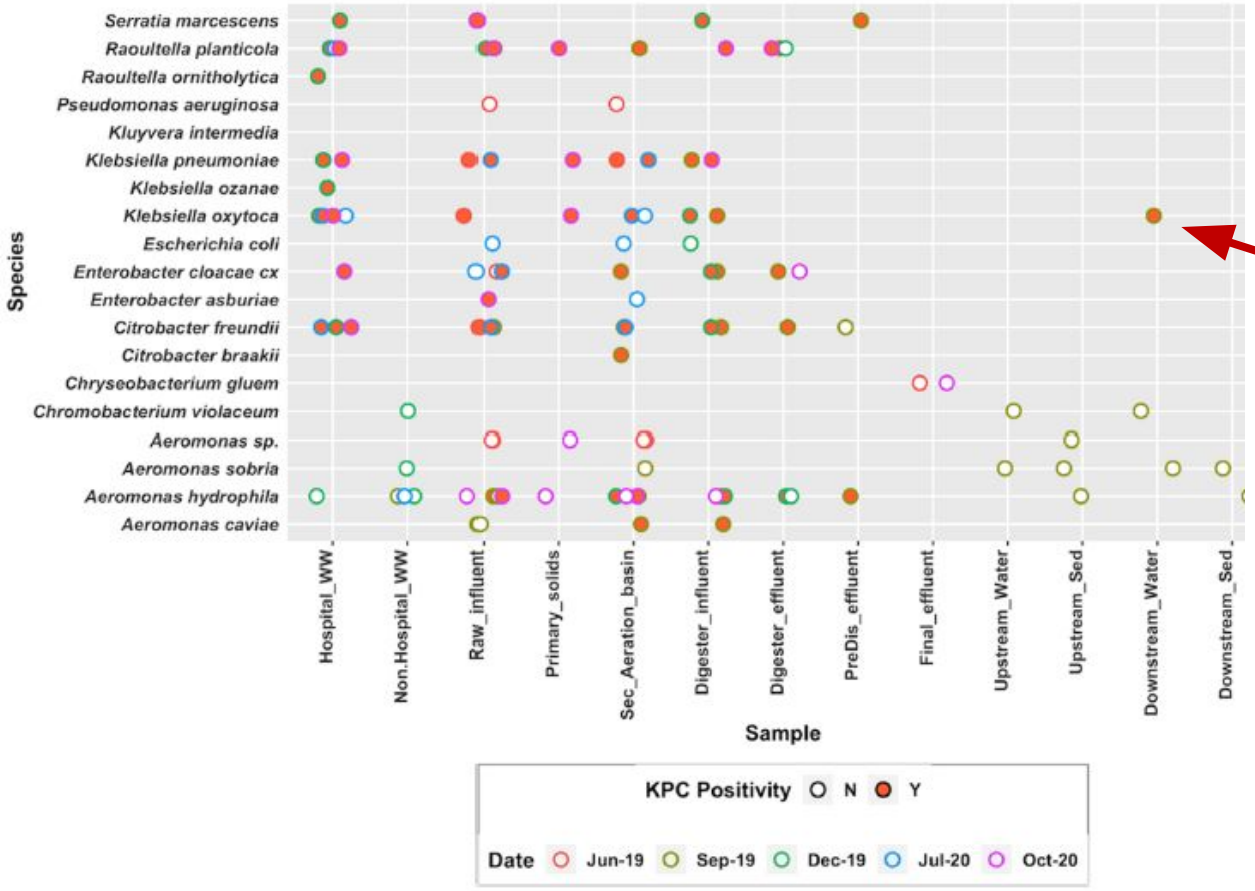
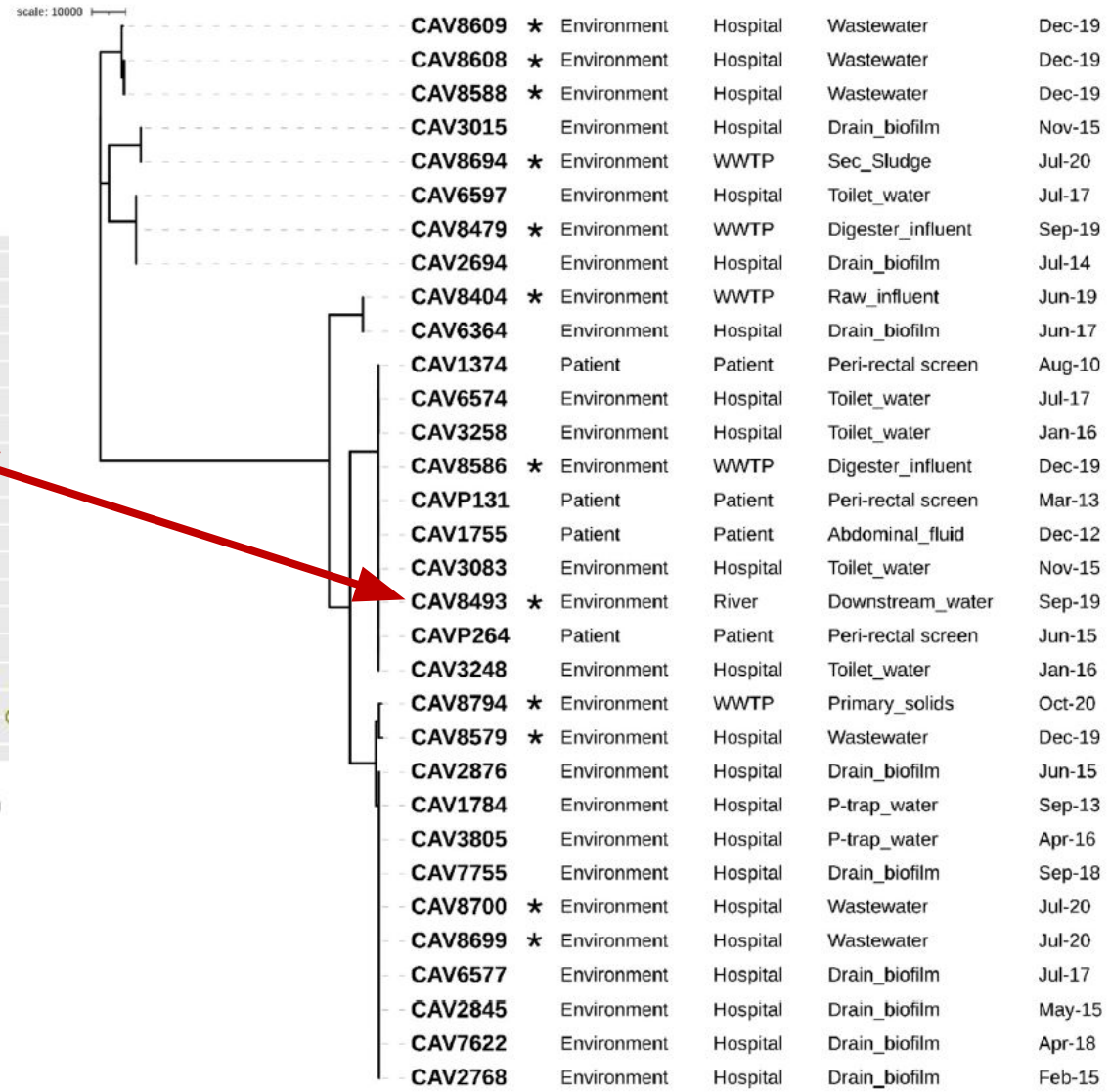
Culture data from across the continuum diverse KPCO



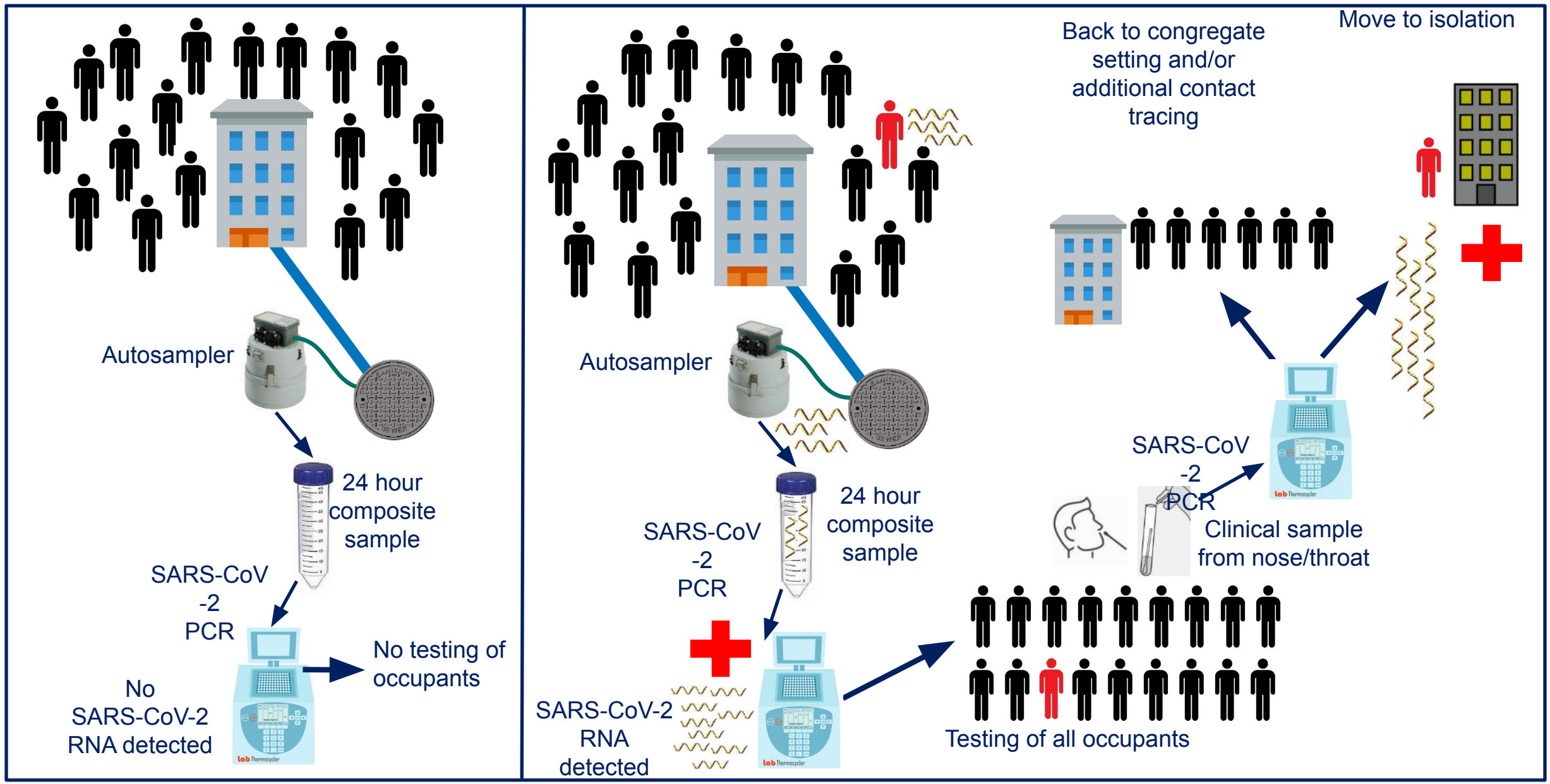
One KPC-*K. oxytoca* in downstream water identical to prior patient/hospital isolates



Need for massive surveillance on congregate living but not enough resources available to test everyone

- Early data was emerging that SARS CoV-2 RNA was detectable in stool and municipalities were beginning to monitor community level via waste water treatment plants
- Could this technology be used to detect new positives in a building without the challenges around specimen collection
- Different group of people doing the work and could be done passively
- May require different resources and personnel who are less taxed by the pandemic

Concept behind pooled wastewater testing



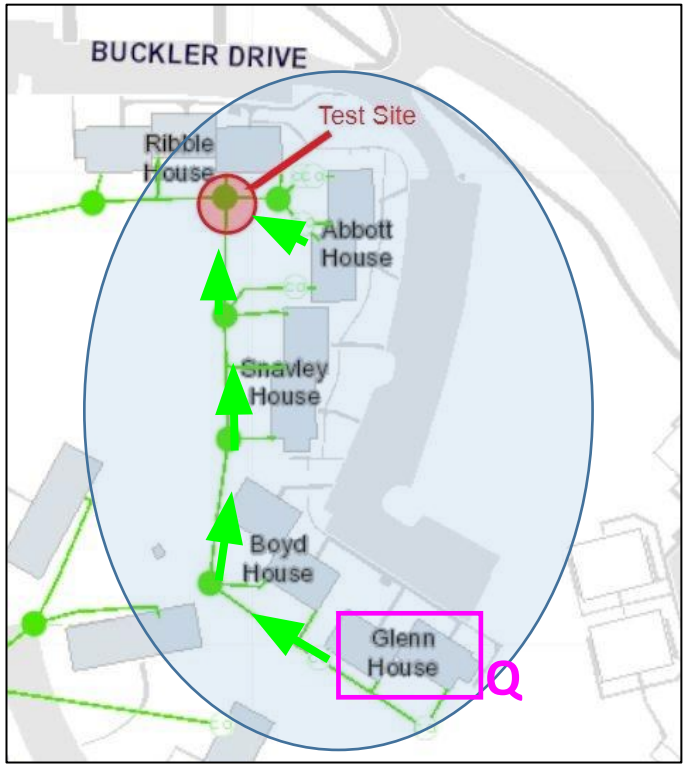
We did not know if it would work or how it should work (and/or if we could make it work)

- Was working on a collaboration with Lisa Colosi-Peterson for monitoring antimicrobial resistance in WW effluent
- Had established relationships with facilities within the health system and across campus
- Began discussions with a few groups had sprung up across the US who were looking to do a similar project (e.g. Syracuse U.)
- There were other groups on campus with interest in WW testing for predicting trends at a larger level
- Administration was very supportive of the effort






We know we can detect very few positives from a large group



Buildings flowing into collected sample.

Q Quarantine dorm

Sampled manhole

Wastewater flow

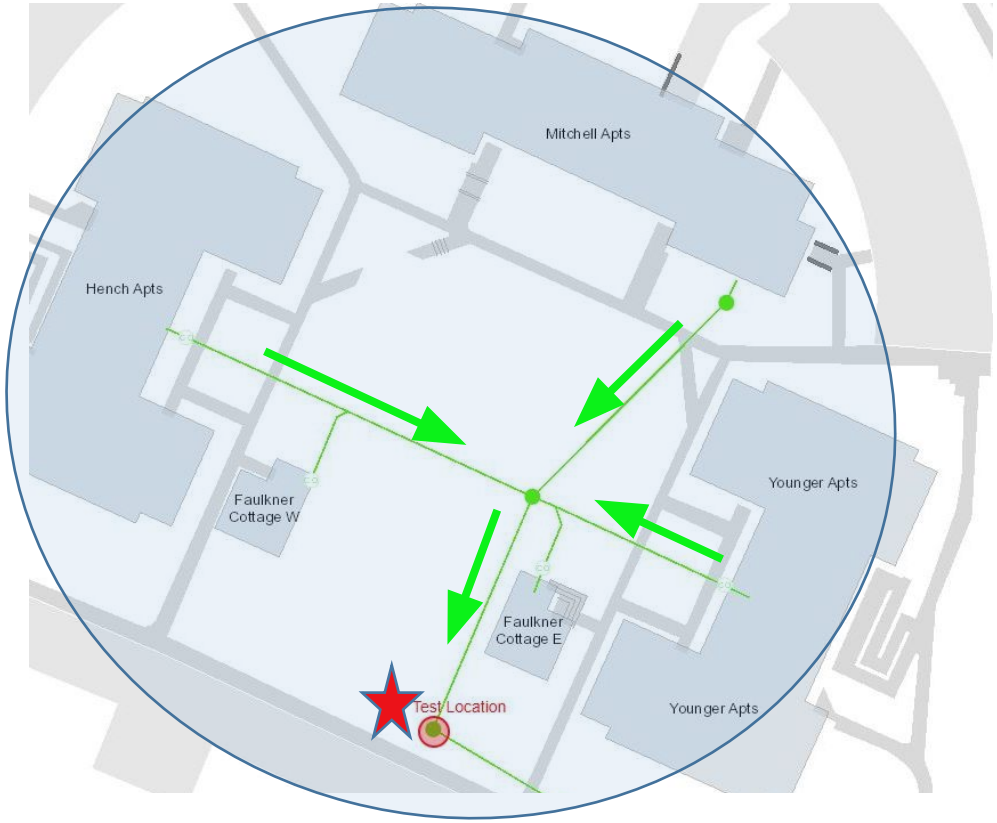
	Week								
	1	2	3	4	5	6	7	8	9**
Occupants tested positive*	2	1	0	0	0	0	0	0	0
Occupants testing negative	103	102	102	102	102	102	102	102	<102
Occupants in onsite quarantine	2	3	1	0	0	0	0	0	0
WBT result at [illegible] (Pos/Neg)	N/A								

Key: WBT yields positive result (+) even though no contagious occupants were in residence.

*positive occupants never retested

**occupants began moving out

When all occupants are testing negative we get a negative result initially



Buildings flowing into collected sample.

Sampled manhole

	Week		
	1	2	3
Total occupants	**66**	**66**	**66**
Occupants testing negative	**0**	**0**	**0**
WBT result at site (Pos/Neg)	**NA**	—	—

Sensitivity of 96.2% and a specificity of 100%.

However, the method could not distinguish new infectious cases from persistent convalescent shedding of SARS-CoV-2 RNA.

If the detection of convalescent shedding is considered a false positive, then the sensitivity is 100% and specificity drops to 45%.

Settled/tested workflow

24 hour collection

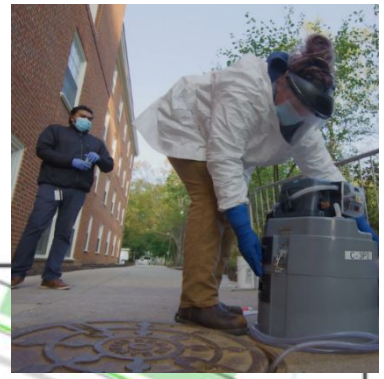
2 hour ultracentrifuge

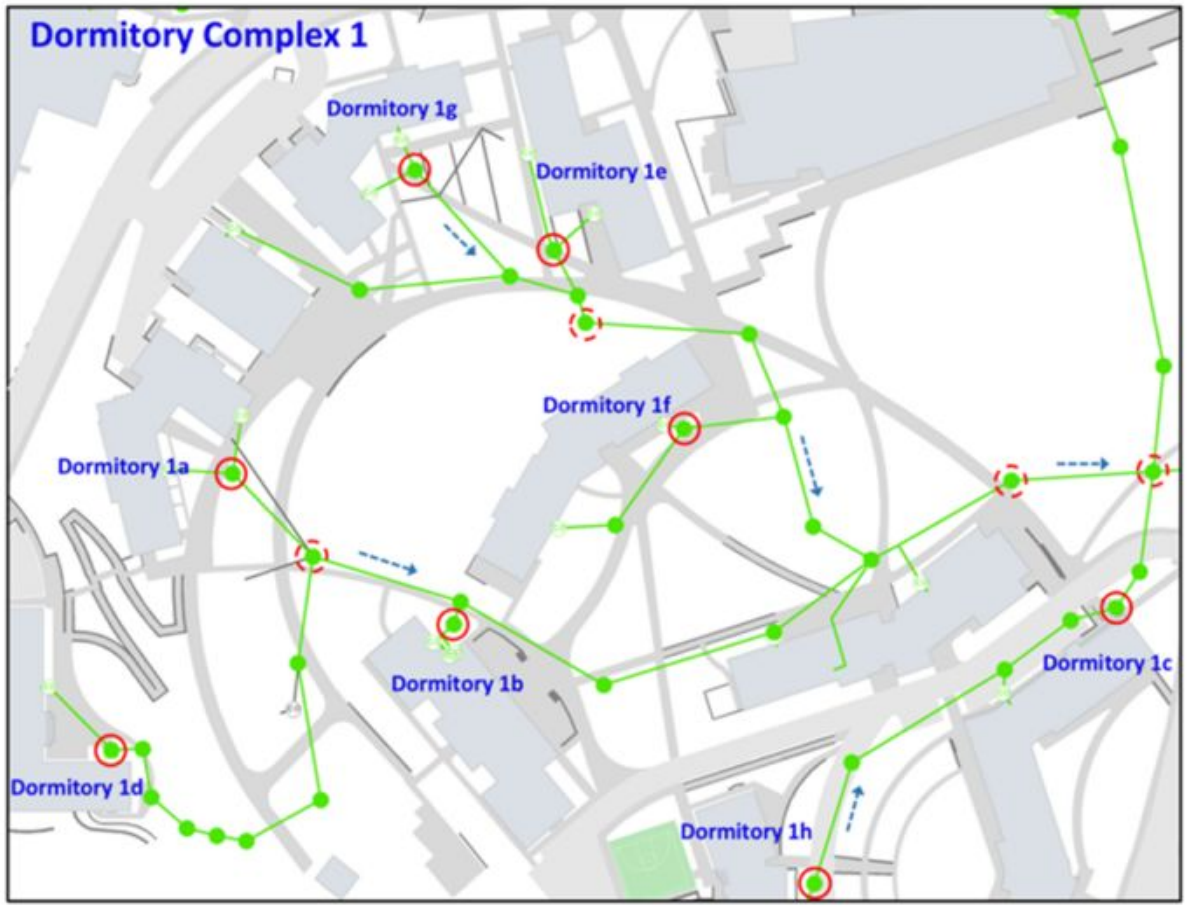
Extraction and amplification 6 hours
Using CDC EUA on the Applied Biosystems 7500

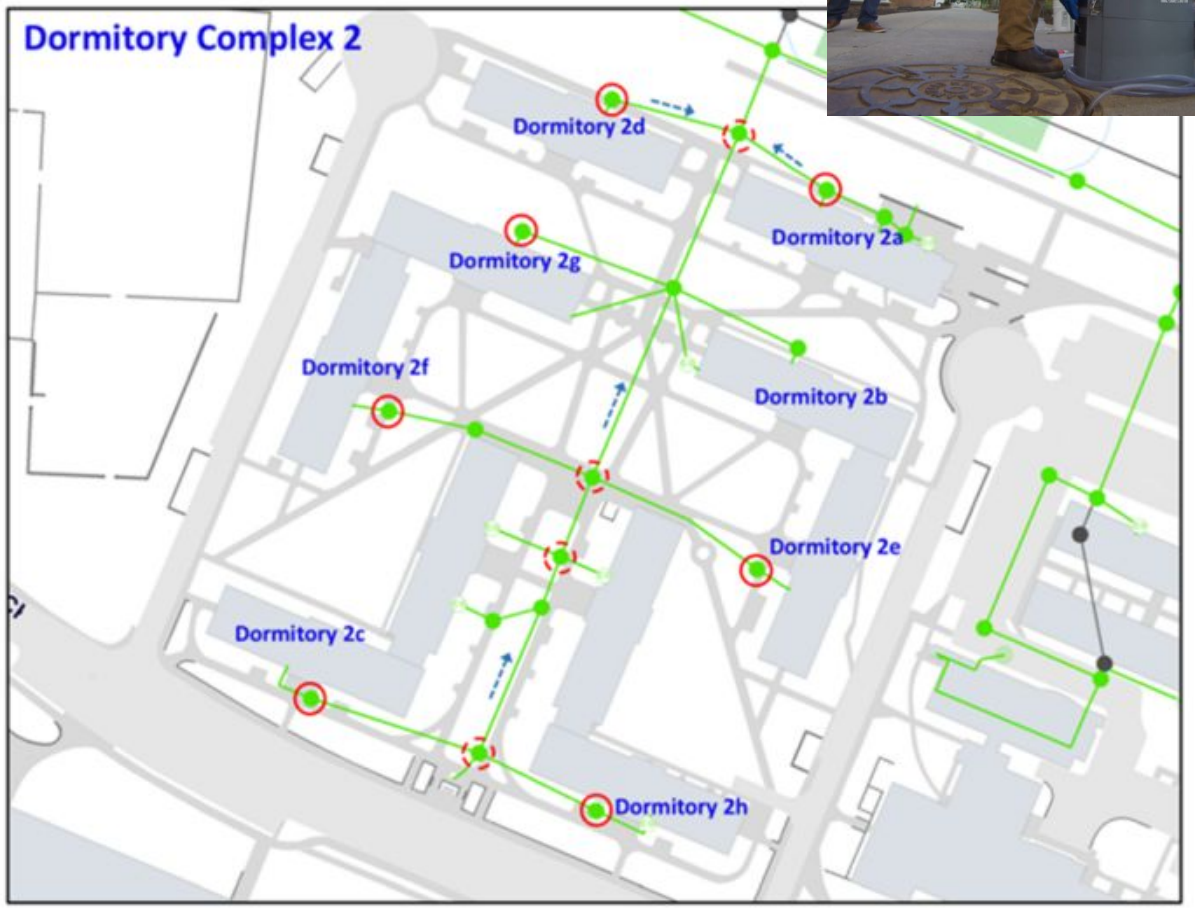
	Rp	N1	N2
Dorm A	29	27	31
Dorm B	26	32	31
Dorm C	ND	ND	30

By the time we decided to do it so had everyone else

We deployed 18 autosamplers daily to the dorms







First two weeks were very stressful but the WW testing helped limit outbreaks

Mid-September

- PP based on WW positivity @ Balz-Dobie with 10 cases detected
- Next day PP based on WW positivity @ Lefevre 3 cases detected.
- Next Day PP @Echols- 4 positive, @Kellogg – 7 positive

- Next week PP @Hancock – 9 positive
- Next Day PP @Page – 8 positive

Attempting to assess what the data means

Very difficult to interpret the data because of the convalescent shedding

Made an initial attempt at quantitation with the current method but difficult to normalize with molecular methods

It does seem that the data can only be interpreted in a series

So many factors the data did not always aligning with the results from the dorm occupant testing

Initial attempt at trying to understand signal strength and data interpretation

KEY:		
Negative	CT > 40	
Indeterminate		
+	CT 35-40	
++	CT 30-35	
+++	CT < 30	
Not sampled		
Failed	Did not pass QC	

McCormick results summary example date

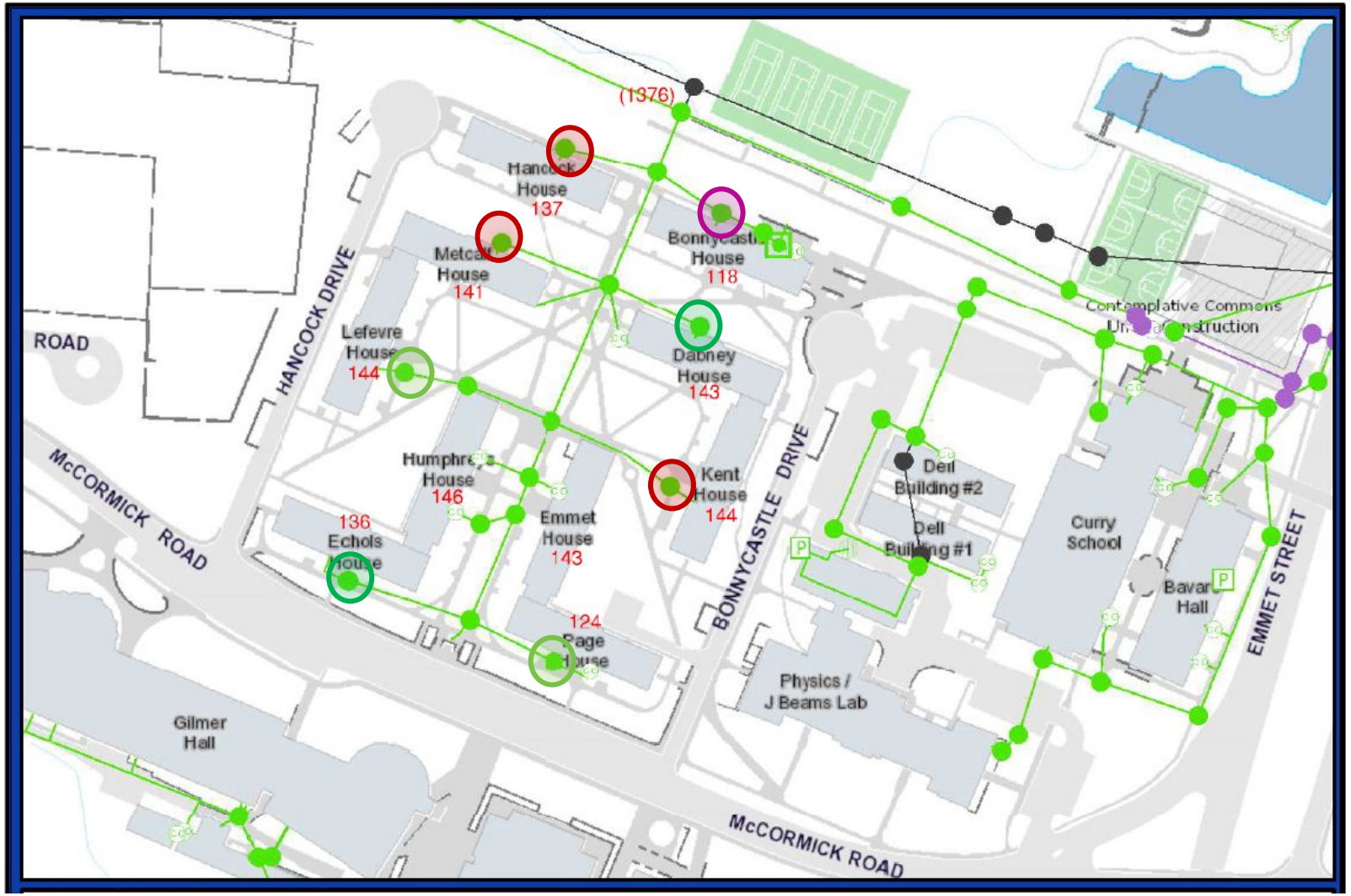
Strong positive signal X 2 days
+Bonnycastle

Positive signal monitoring*
+Hancock
+Metcalf
+Kent

Negative
+Echols
+Dabney

Not able to interpret results
+Page
+Lefevre

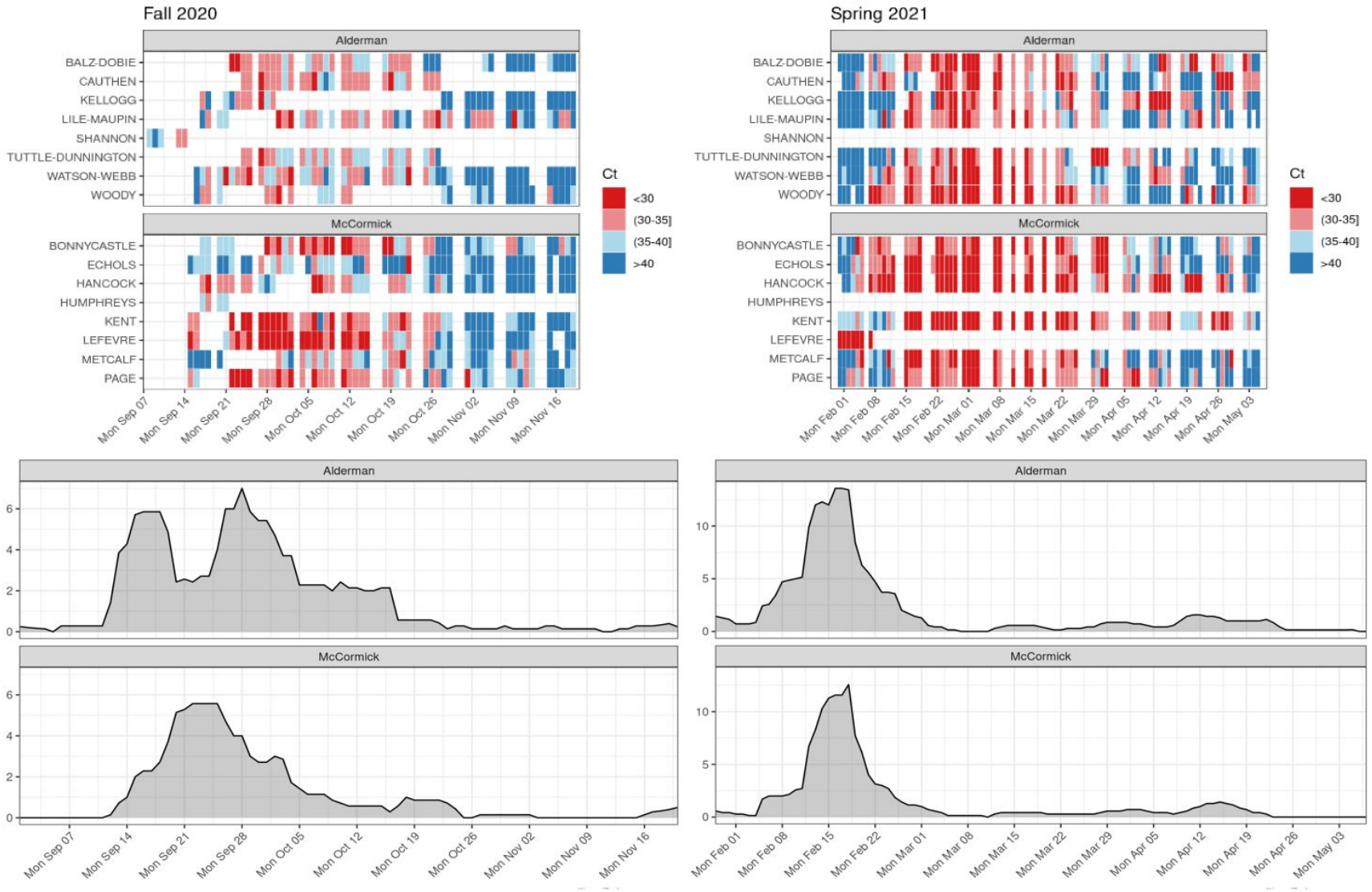
Not monitored
+Humphreys
+Emmett

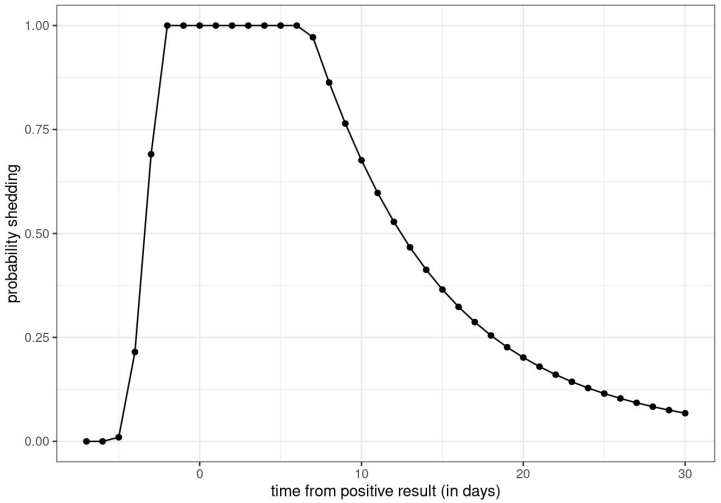


*Could be positive from prior shedding or new cases and trending results

Hall style dorms ~100-110 occupants

The use of the data was different in Fall and Spring





Mike Porter, Kawai Tanabe, Chris Holstege and Shireen Kotay

Summary

WW surveillance may have many use cases but looking forward to further method development and refinement through collaborations

Passive pooled testing approach at the building level with the advantage of not having all the specimen management issues and assiting in using targeted resources

WW surveillance may also be adapted for understanding AMR genes of consequence into the environment

Too many thanks to fit on a slide

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Many more microbiology, molecular and specimen management laboratory technologists and staff

Questions/ Open Discussion

See you Soon!

Send inquiries / topics to:

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