Supporting the Health of Kansans by Monitoring Wastewater for Diseases

John Anderson, MSc, PhD

Director of Genomic and Wastewater Epidemiology

November 14th, 2024

Kansas Department of Health and Environment
Division of Public Health

Learning Objectives

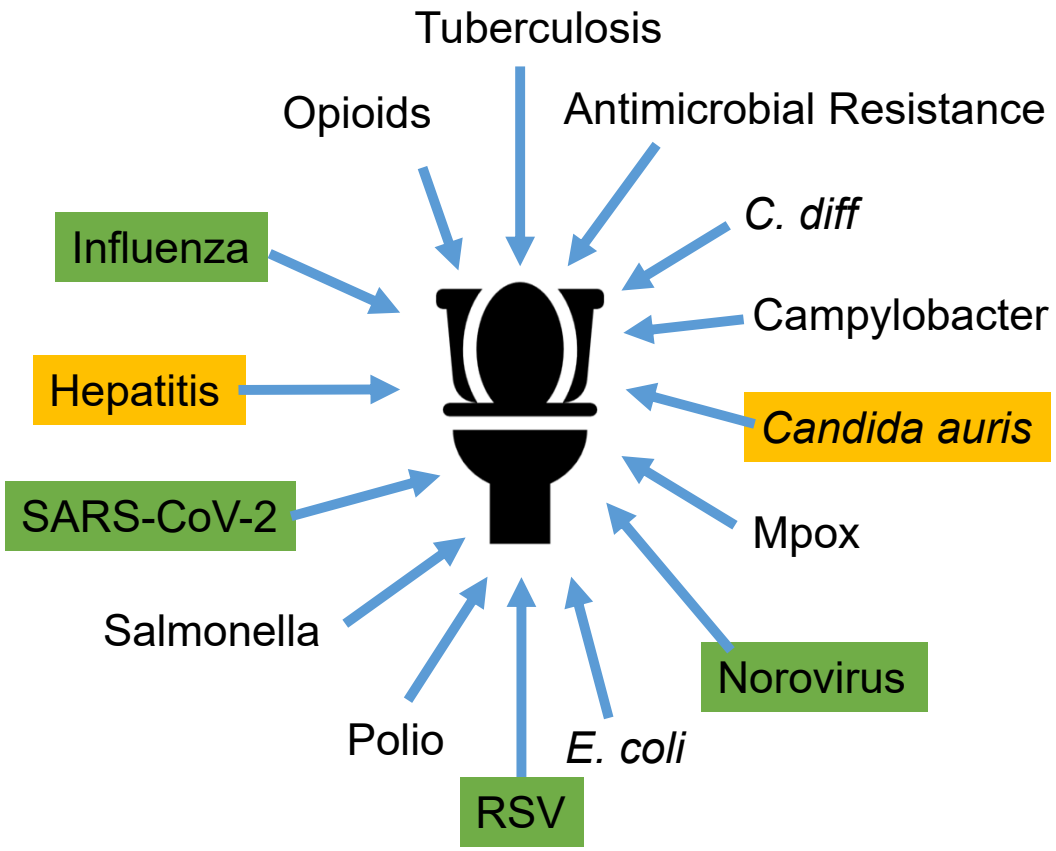
1. Why Monitor Wastewater

2. Implementation of Wastewater Monitoring in Kansas
   - Process and Distribution
   - Coordination with Correctional Facilities

3. Trends in Disease Concentration in Wastewater
   - Data Normalization and Model Development
   - Sequencing SARS-CoV-2 from Wastewater
   - Responding to Surges of Disease in Wastewater

4. Next Steps

Why Monitor Wastewater?



- Just like a doctor can test a patient's stool to understand a patient's health, we can use a community's wastewater to understand a community's health.
- Wastewater picks up patients who are asymptomatic, test at home, or cannot test.
- **Advanced notification system for public health and health care with an expected 4-to-6-day lead time for SARS-CoV-2.**
- Identify areas that need support for vulnerable populations that may not have access to testing and health care.
- Streamline disease management and testing in congregate facilities such as prisons.
- Sequencing of samples can identify circulating variants and antimicrobial markers.

The Outcomes of Wastewater Surveillance in Kansas

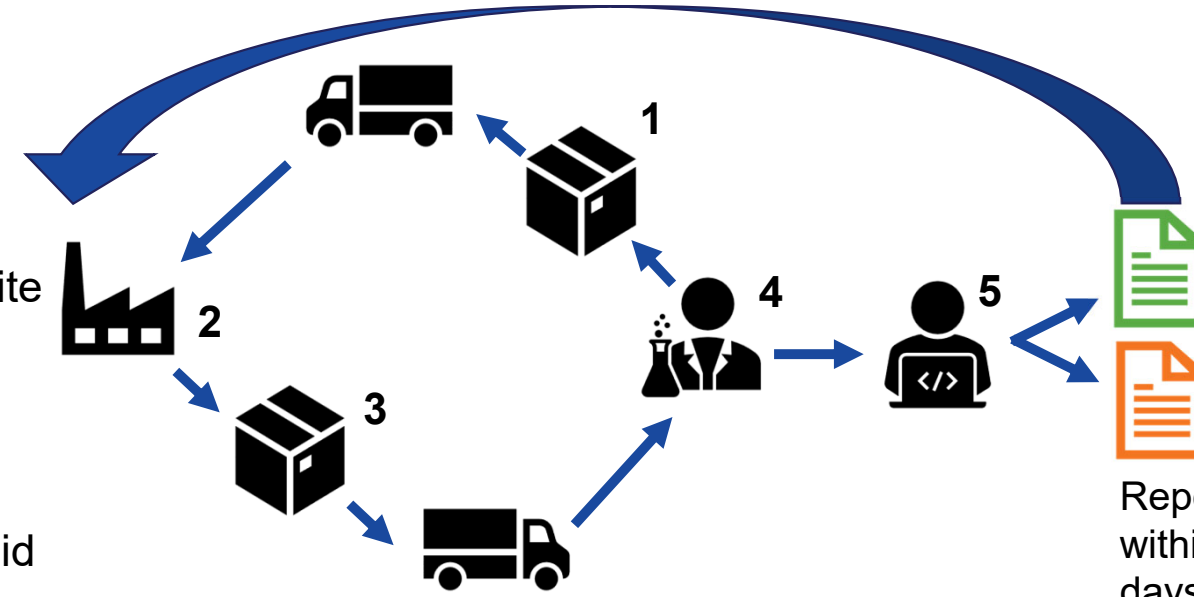
By building a network of communities that share wastewater samples:

1. KDHE will work with communities to interpret the data to improve awareness of the diseases circulating within them.
2. At-home tests and non-reportable diseases will not restrict our understanding of disease prevalence.
3. New pathogens can be identified in wastewater because we already have a network of communities sharing wastewater samples.
4. Wastewater surveillance can be used as an advanced warning system for community leadership and hospitals.

Wastewater Monitoring Process and Distribution

Sample Collection, Delivery and Measurement

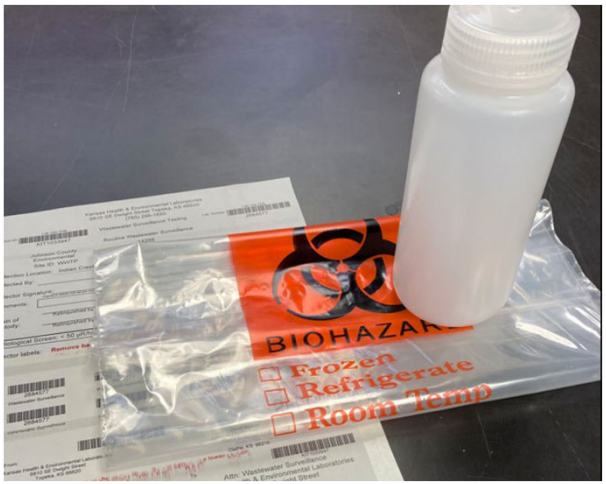
1. **KHEL**: Collection bottles, shipping boxes, and shipping labels are sent to facilities.
2. **Facilities**: Collect composite samples twice/week in the bottles provided.
3. **Facilities**: Overnight the samples back to KDHE using the boxes and prepaid shipping labels or courier.



Reports released within two business days of sample collection.

4. **KHEL**: Extracts and measures SARS-CoV-2 and other pathogens in the samples.
5. **KDHE**: Epidemiologists analyze the data and prepare the data to be shared.
6. **KDHE**: Data are distributed to submitting facilities, local stakeholders and the public using static reports and interactive dashboards (in development).

Sample Collection in Six Steps



Kansas Health & Environmental Laboratories
6810 SE Dwight Street Topeka, KS 66620
(785) 296-1620

Collection ID: Lab Use Only
KIT1034000

Wastewater Surveillance Testing

Lab Number: Lab Use Only

Routine Wastewater Surveillance

Anytown USA	KS2000000	Z8400
Site ID: WWTP	Identification: Flow Rate: 3)	**Collect On: 04/08/2024**

Collection Location: Test Site

1) Collected By: _____ Date: 4) _____ Time: 5) _____ AM / PM (Circle one)

2) Collector Signature: _____ ~~Chlorine Residual:~~ _____ ~~FREE~~ ◯ ~~Total~~ ◯
(Signature attests that sample was collected in accordance with regulations)

Comments: _____

Chain of Custody:
_____ Relinquished by Date: _____ Time: _____ _____ Received by Date: _____ Time: _____
_____ Relinquished by Date: _____ Time: _____ _____ Received by Date: _____ Time: _____

Laboratory use only

Radiological Screen: < 50 µR/hr _____ Receipt Temperature: _____

Collector labels: **Remove barcode label and attach to sample container.**
Please return the entire form. Do not detach the lower section.

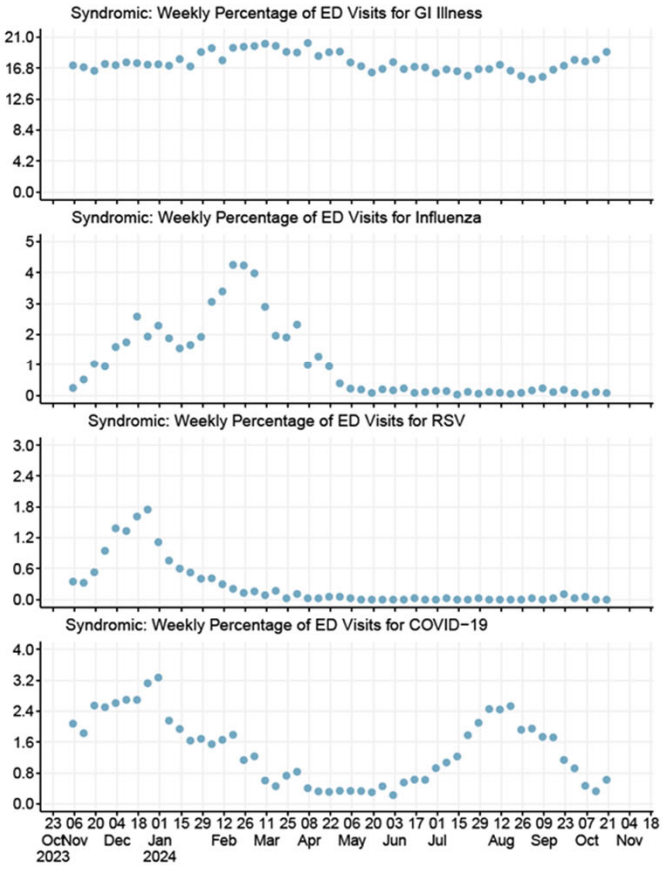
1. Collect a 24-hour composite.
2. Fill out a paper submission form:
   - Collector's Name (print)
   - Collector's Signature
   - Flow Rate from your autosampler
   - Collection Date
   - Collection Time
3. Apply the provided barcode to the sample bottle.
4. Place the bottle and form in a plastic biohazard bag.
5. Ship the sample back using prepaid shipping labels or through KDHE's courier.
6. Every time we receive a bottle, we send you a new one.

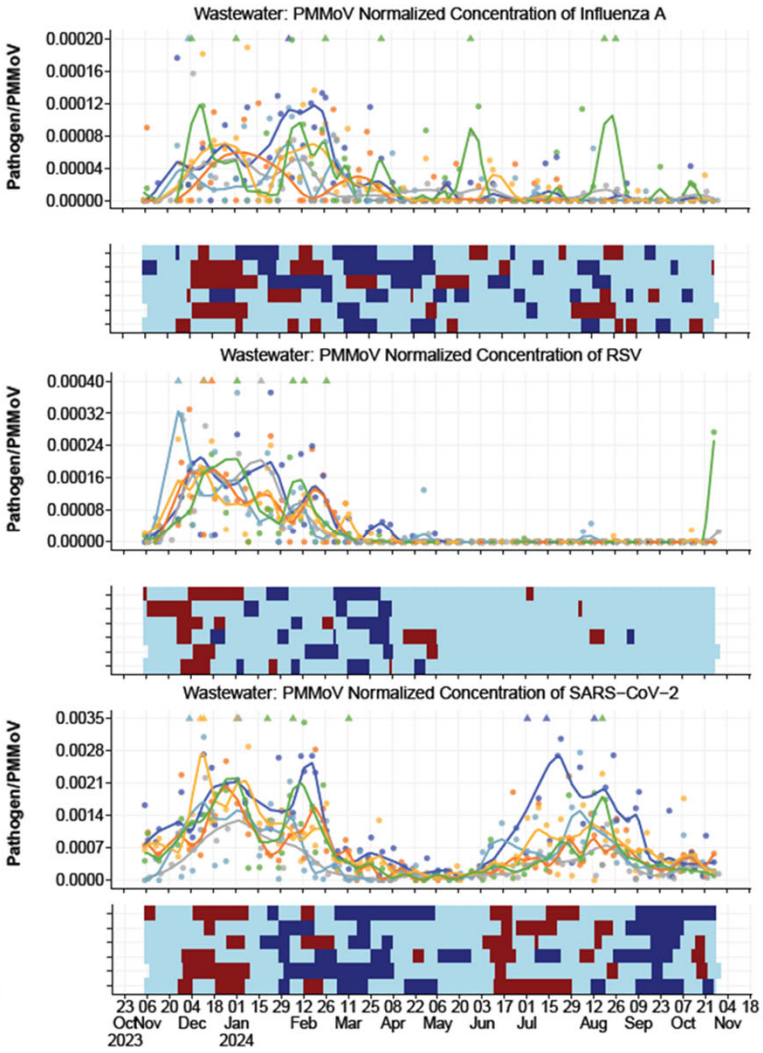
KDHE Reports for Stakeholders

- Reports that summarize the results of wastewater surveillance are sent to teams who are involved with wastewater surveillance.

- Community reports are sent to:
  - Local health department
  - City/County officials
  - Wastewater treatment plant

- Correctional facility reports are sent to:
  - Staff collect samples
  - KDOC leadership
  - Other staff as requested
  - KDHE BDCP





Wastewater Surveillance in the United States

- CDC's National Wastewater Surveillance System (NWSS) collects data from state run programs, CDC Contracts, and SCAN and currently has ~1,400 sites across all states.
  - KDHE tests for: SARS-CoV-2, Influenza A/B (including H5), Norovirus, and RSV
  - Funds states to perform wastewater surveillance.
  - covid.cdc.gov/covid-data-tracker/#wastewater-surveillance

NWSS NATIONAL ™ WASTEWATER SURVEILLANCE SYSTEM

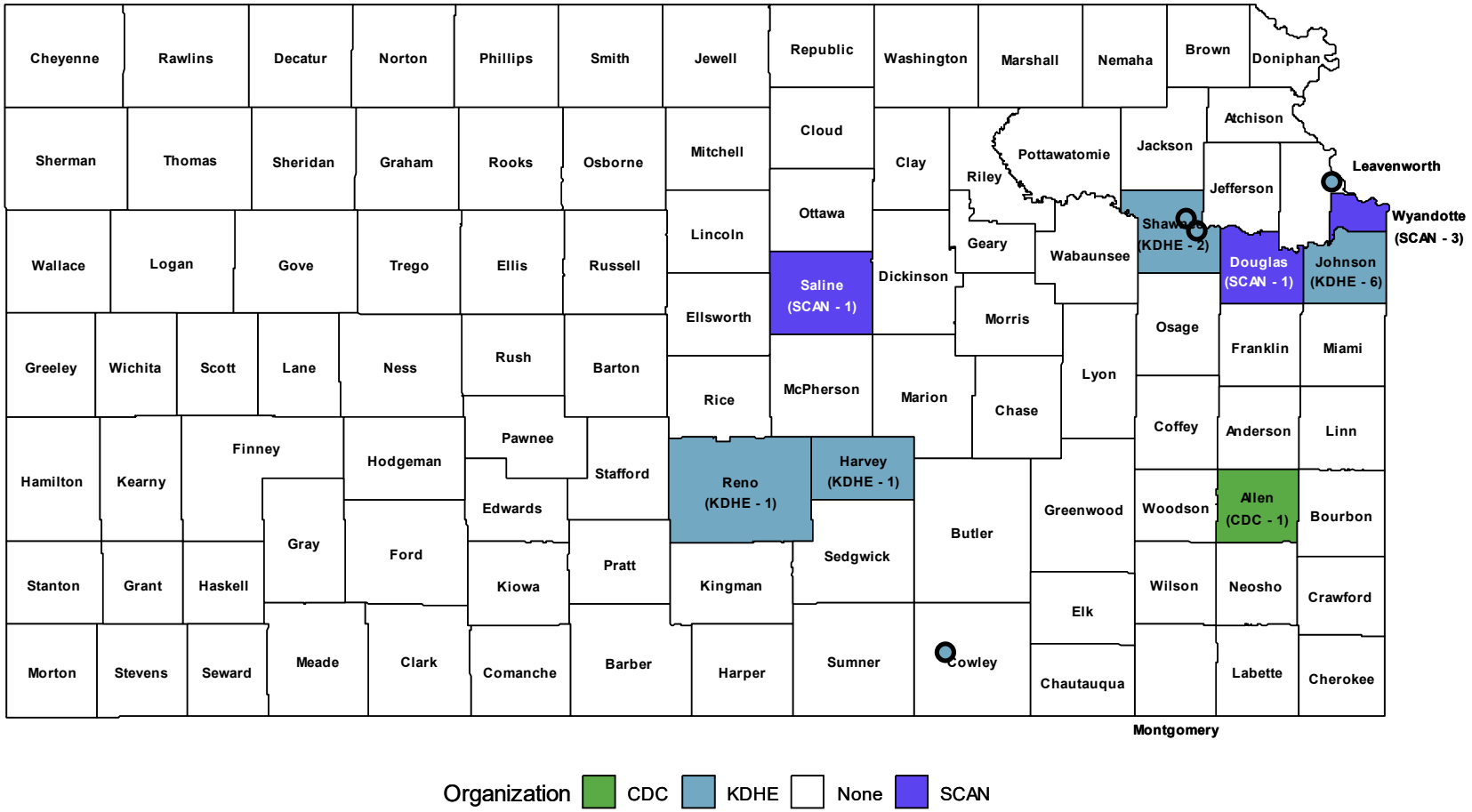
- Biobot does not report how many sites they work with.
  - Commercial company that charges jurisdictions for testing.
  - Company was first focused on Opioids and pivoted during the pandemic.
  - biobot.io/

BIO BOT Biobot Analytics

- Sewer Coronavirus Alert Network (SCAN) currently has 147 sites.
  - Tests for SARS-CoV-2, Influenza A/B (including H5), RSV, HMPV, Norovirus, Mpox, Rotavirus, EVD68, *Candida auris*, Hep. A
  - Associated with Stanford and uses Verily to perform testing.
  - data.wastewaterscan.org/

WASTEWATER SCAN

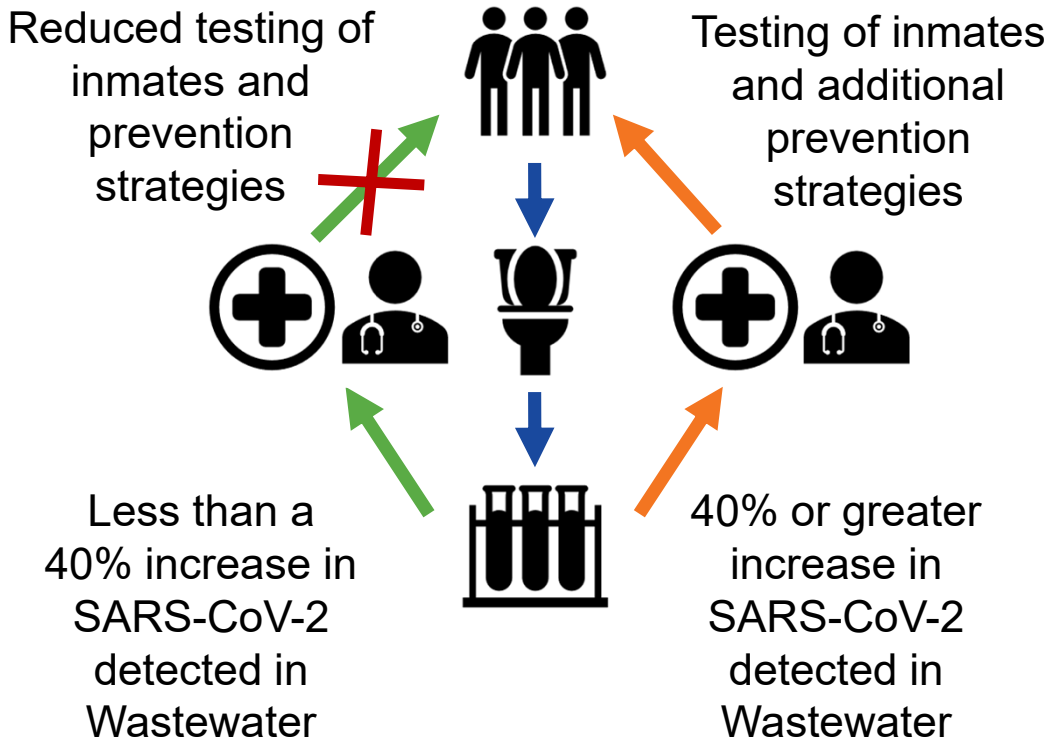
Current Sources of Wastewater Data in Kansas



Coordination with Correctional Facilities

Supporting Correctional Facilities with Wastewater Monitoring

- Correctional facilities test their inmates regularly to catch outbreaks before they get out of control.
- Other states and federal correctional facilities have found that the testing burden can be reduced through wastewater surveillance.
- In Missouri, if less than a 40% increase in SARS-CoV-2 is detected in the wastewater, then clinical testing and prevention strategies can be reduced.
- Wastewater surveillance for Hepatitis A and C is also funded to enhance surveillance.



Building Level Monitoring

- Autosamplers can be installed outside of buildings to collect wastewater for analysis.

- Wastewater can be collected as a “grab” sample that is composed of a single sample at a single timepoint, or a composite sample that contains many samples from many timepoints.

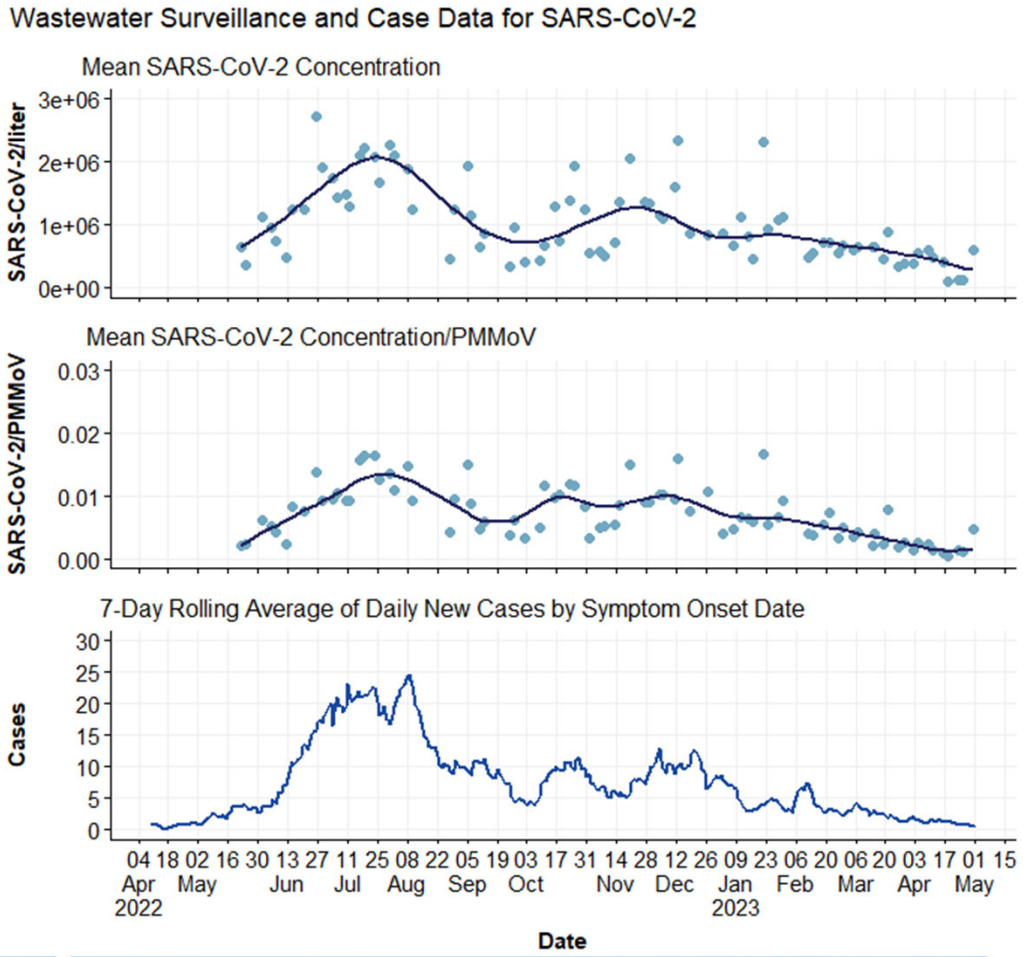
- To ensure that we capture a representative sample, most of our samples are collected as 24-hour composites that are a combination of samples collected every 30-60 minutes.

Building Level Monitoring

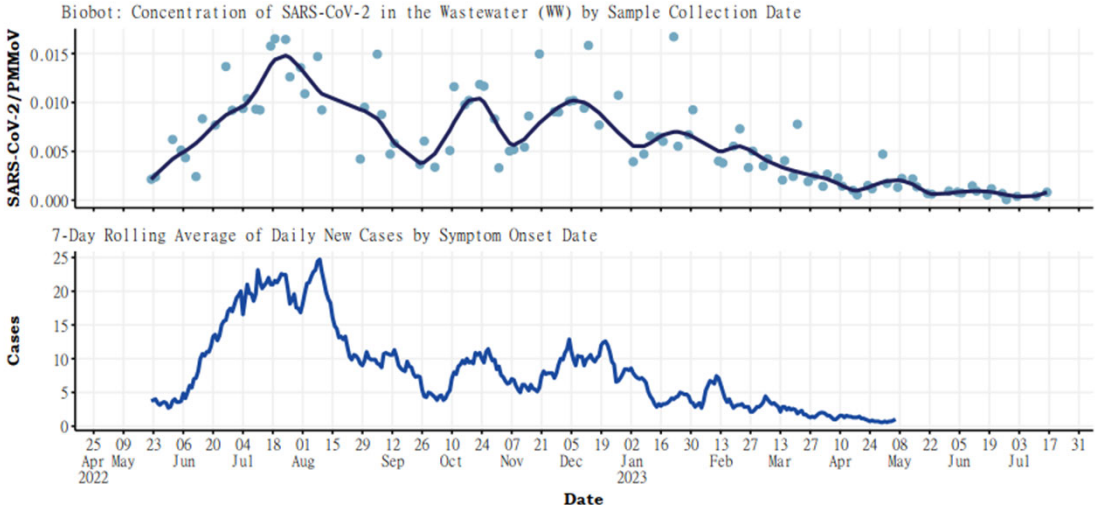
Normalization and Model Development

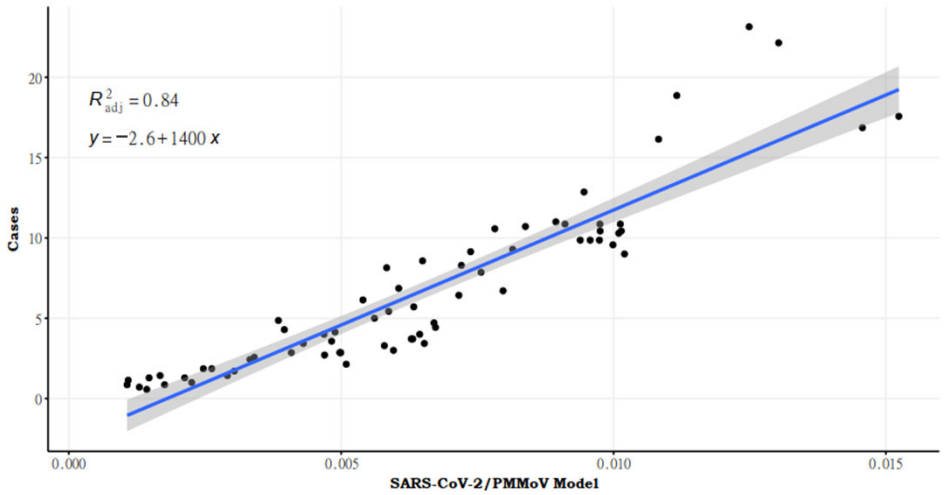
Normalization and Analysis of Wastewater Data

- Samples are time weighted composites collected over 24 hours
- Data are viral copies/liter of the original sample.
- The Pepper Mild Mottled Virus (PMMoV) is a plant pathogen that is found in human waste.
  - The more PMMoV in the sample, the more human waste in the sample.
- Due to variations in flow that result from changes in population water use (weekday vs. weekend) it is important to normalize data using a fecal load indicator like PMMoV
- Outliers are common in wastewater data and the fit between case and wastewater data is improved when outliers are removed.



Modeling Wastewater Data



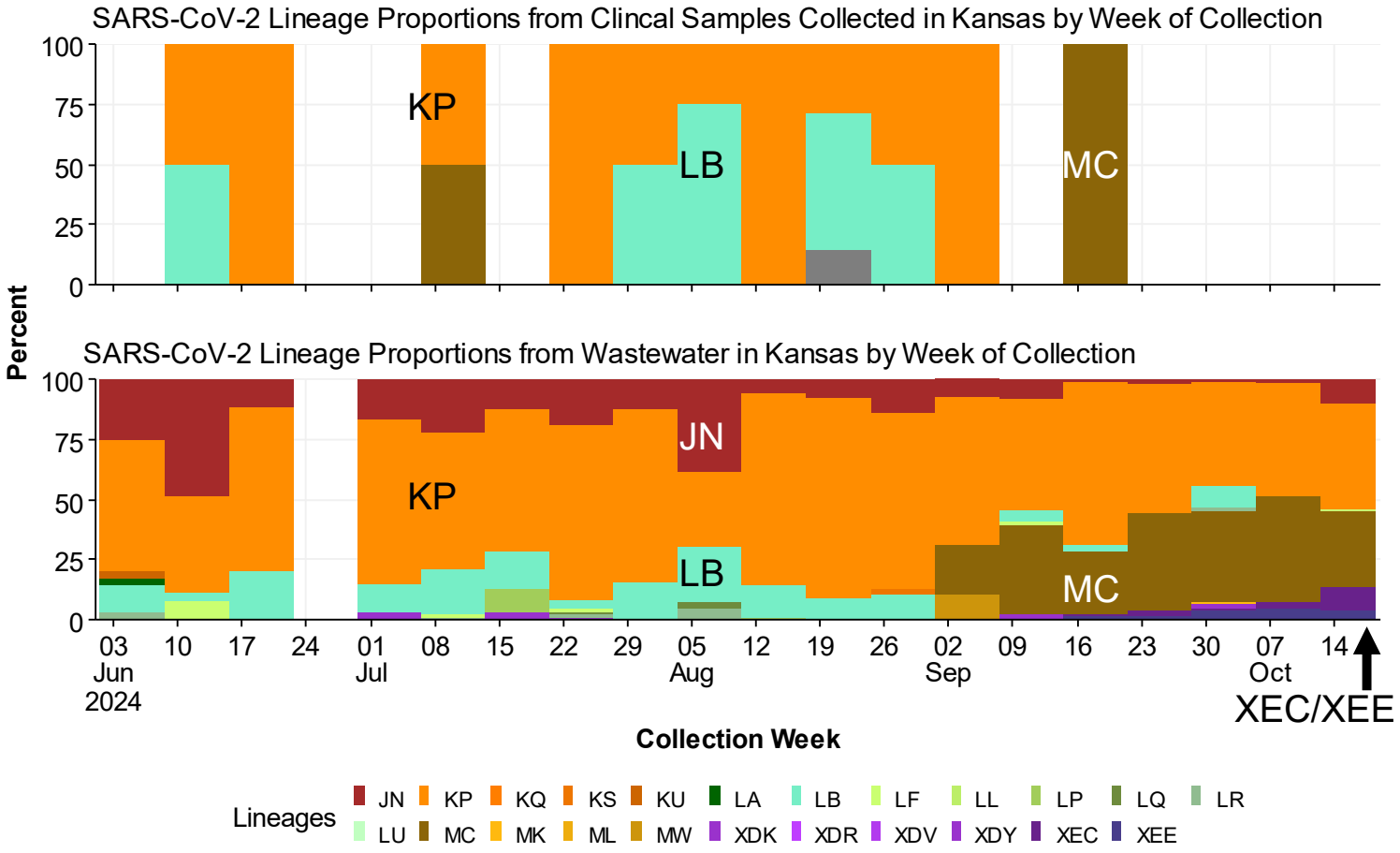


- From collaborations with other states, our team identified best practices for data analyses and create models that identify trends.

- The current wastewater model is ~67% accurate at identifying a trend and can predict up to 84% of the variation in case data with a 5-day lead time – every site is different though.

SARS-CoV-2 Sequencing in Clinical and Wastewater Samples

Sequencing of wastewater allows us to see the lineages circulating in communities when clinical samples are scarce.

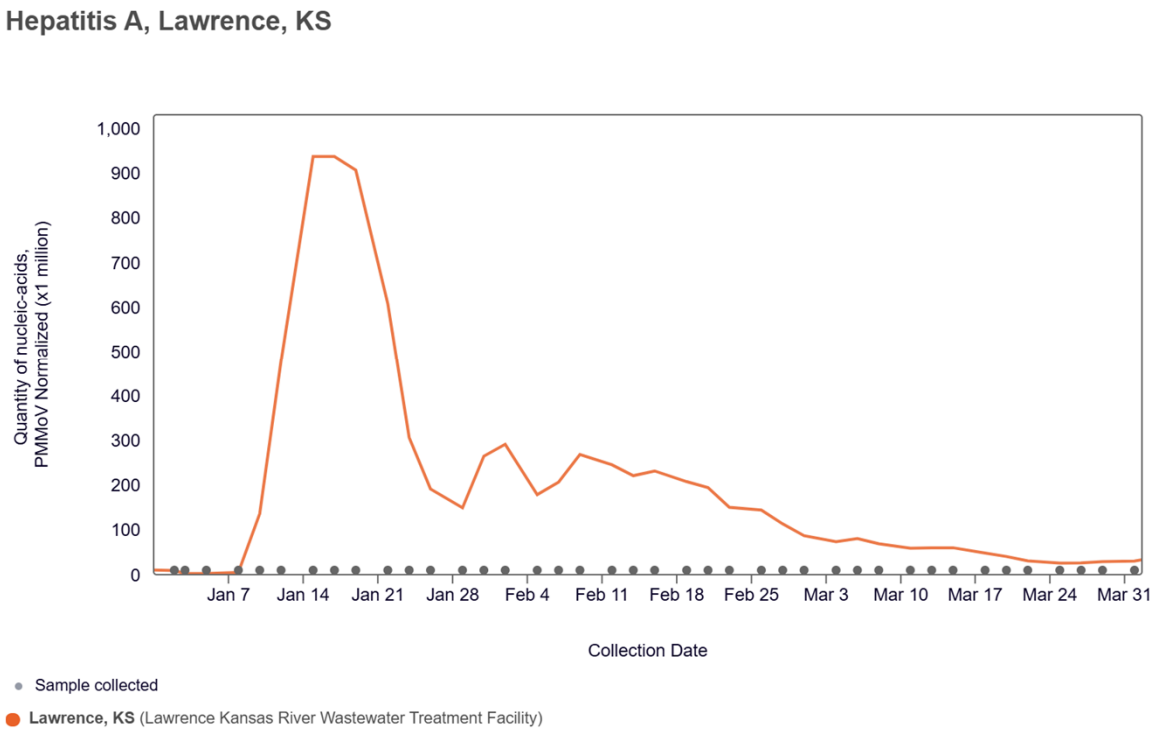


Responding to Surges of Disease in Wastewater - Hepatitis A

Disease Background

- Hepatitis A is a virus that causes inflammation of the liver that often presents as gastrointestinal symptoms.
- Vaccination is the best way to prevent hepatitis A infection.
- People infected with hepatitis A
  - Start shedding the virus in their waste two weeks before symptom onset.
  - Can transmit hepatitis A if they do not wash their hands after using the bathroom.

Responding to Surges of Disease in Wastewater – Hepatitis A



- After a surge in hepatitis A in the wastewater, the local health department coordinated a vaccination campaign to vaccinate people with the greatest risk of infection.
  - Subsequently, the hepatitis A concentration decreased in the wastewater and no additional cases of hepatitis A were identified.

Next Steps

- Wastewater surveillance in Kansas has been funded through 2028.

1. Enroll up to 20 total facilities that serve communities with populations greater than 3,000 residents, correctional facilities, and a long-term care facility in wastewater surveillance.
   - Support communities and facilities with personalized reports and collaboration on public health actions.
   - Support facilities with stipends (~$40/sample).

2. Perform surveillance of SARS-CoV-2, Influenza A (including H5), Influenza B, RSV, Norovirus, Hepatitis A, West Nile Virus (pilot), and *Candida auris*.

3. Set aside ~$30,000/year to respond to novel diseases
   - If novel disease surveillance is not needed, money will be used to pilot the detection of emerging diseases.

4. Create a dashboard that clearly illustrates the data, instructs users how to interpret the data, and what actions they can take to prevent disease.

Thank You/Questions

Contact information:
John Anderson, MSc, PhD
Director of Genomic and Wastewater Epidemiology
John.Anderson@ks.gov