TEXAS
Health and Human Services

Texas Department of State Health Services

Wastewater-Based Monitoring of Respiratory Diseases

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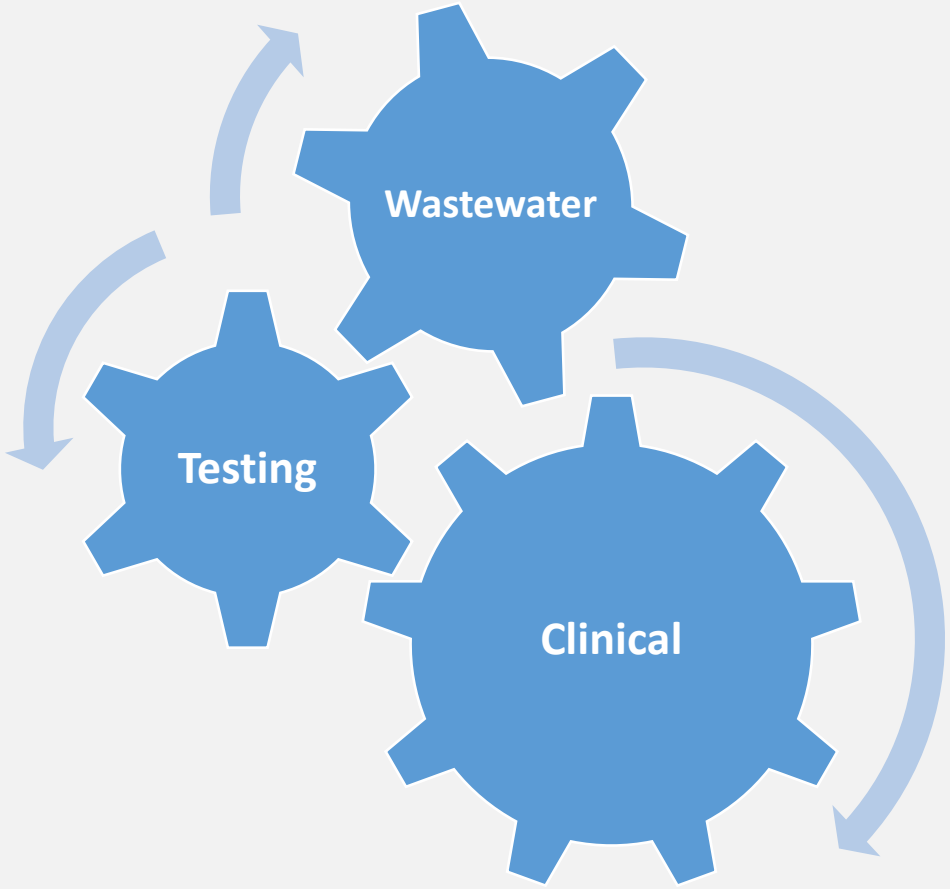
Challenges in Traditional Disease Surveillance

Underreporting

Delayed Reporting

Geographic Gaps

Complementary Systems



Wastewater-based disease monitoring complements existing surveillance systems by providing:

- An efficient community sample
- Data for communities where timely testing is underused or unavailable
- Geographic flexibility
  - County-level sewersheds
  - Zip-code level sewersheds
  - Facility-level sewesheds

Definitions

Wastewater	Includes water from household, building, or industrial use that may contain human fecal waste – aka sewage.
Wastewater-Based Surveillance	Systematic sampling and analysis of wastewater to **monitor** microbes, chemicals, or other analytes.
Wastewater-Based Epidemiology	The science of relating microbes, chemicals, or other analytes in wastewater to the distribution and determinants of health-related states or events.

Evolution of Wastewater-Based Disease Monitoring

1854: John Snow tracks water sources and cholera cases to a single water pump in London

1930s: First used to detect typhoid bacilli within sewage in Britain

1940s: Track and contain polio outbreaks in the United States

1990s: Polymerase Chain Reaction (PCR) established as the gold standard of wastewater pathogen detection

2000s: Used to detect illicit substances in river surface water and in wastewater in Italy

2010s: Significant amount of Norovirus detected in wastewater 2-3 weeks prior to a surge of cases in Sweden

2020s: COVID-19 pandemic renews interest in wastewater sampling for pathogen detection and surveillance

Present: CDC National Wastewater Surveillance System (NWSS) routinely monitors for pathogens of concern

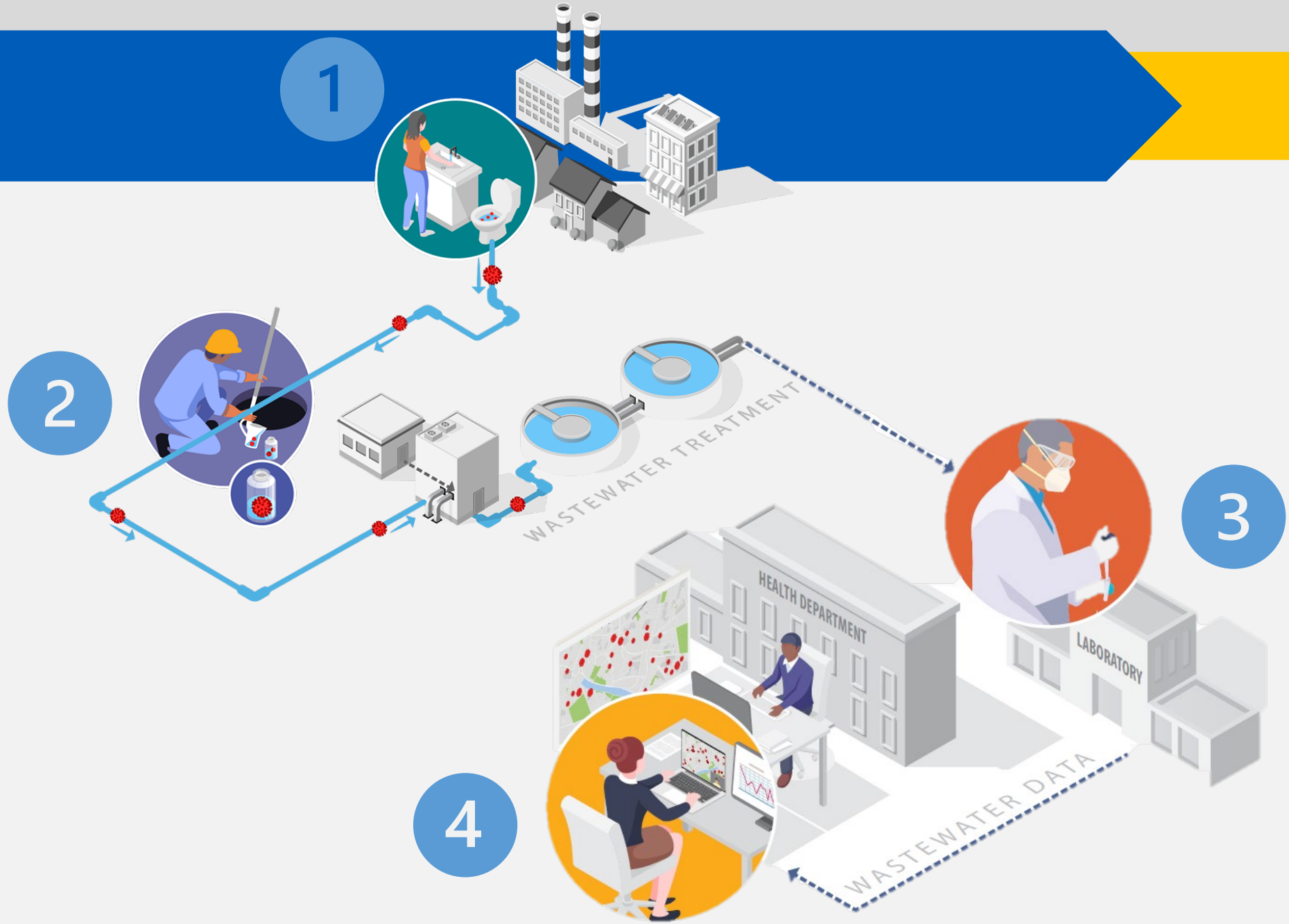
Current Applications

Risk Assessment

Temporal or Spatial Variations

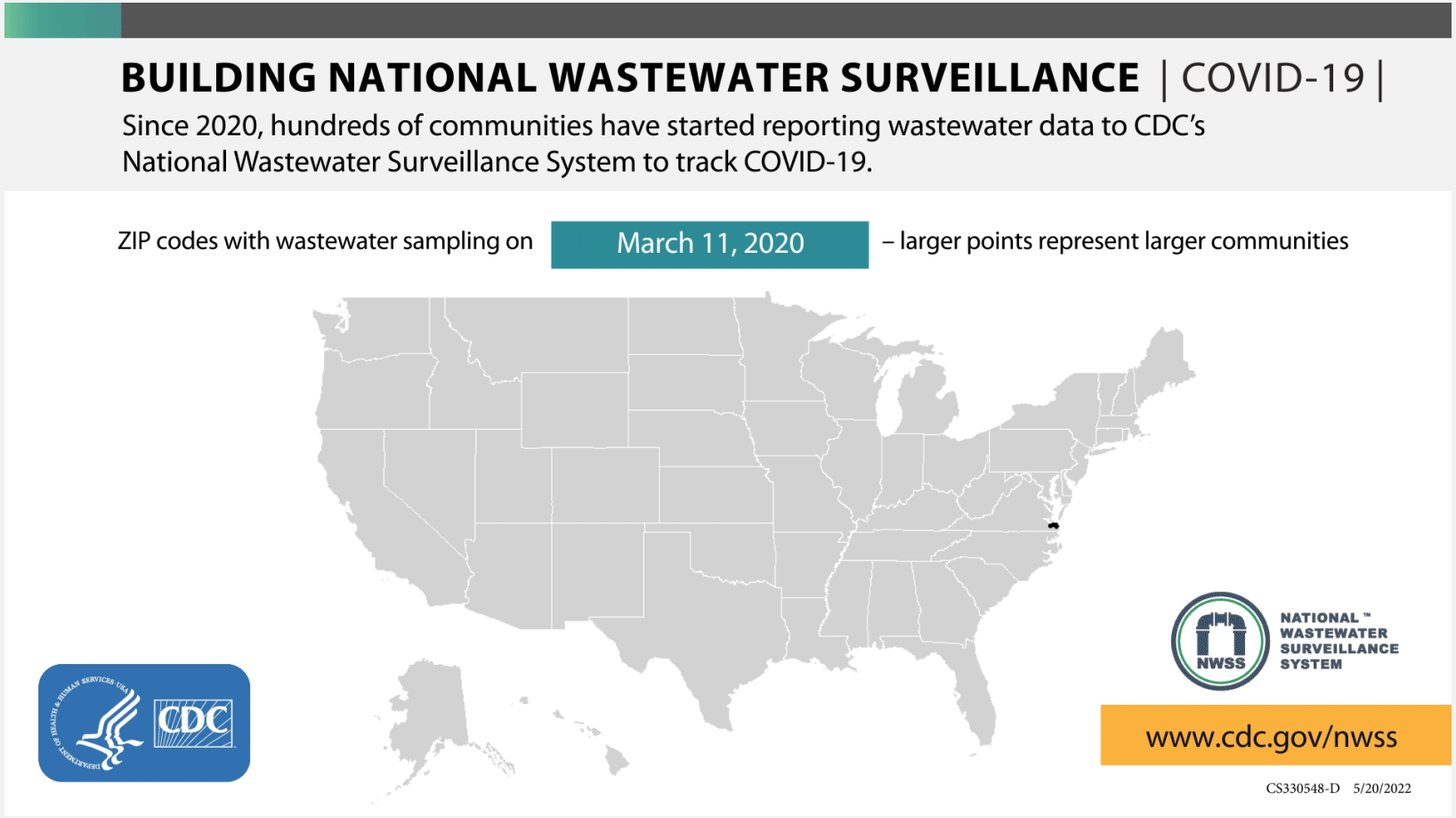
Early Warning Systems

Public Health Policy

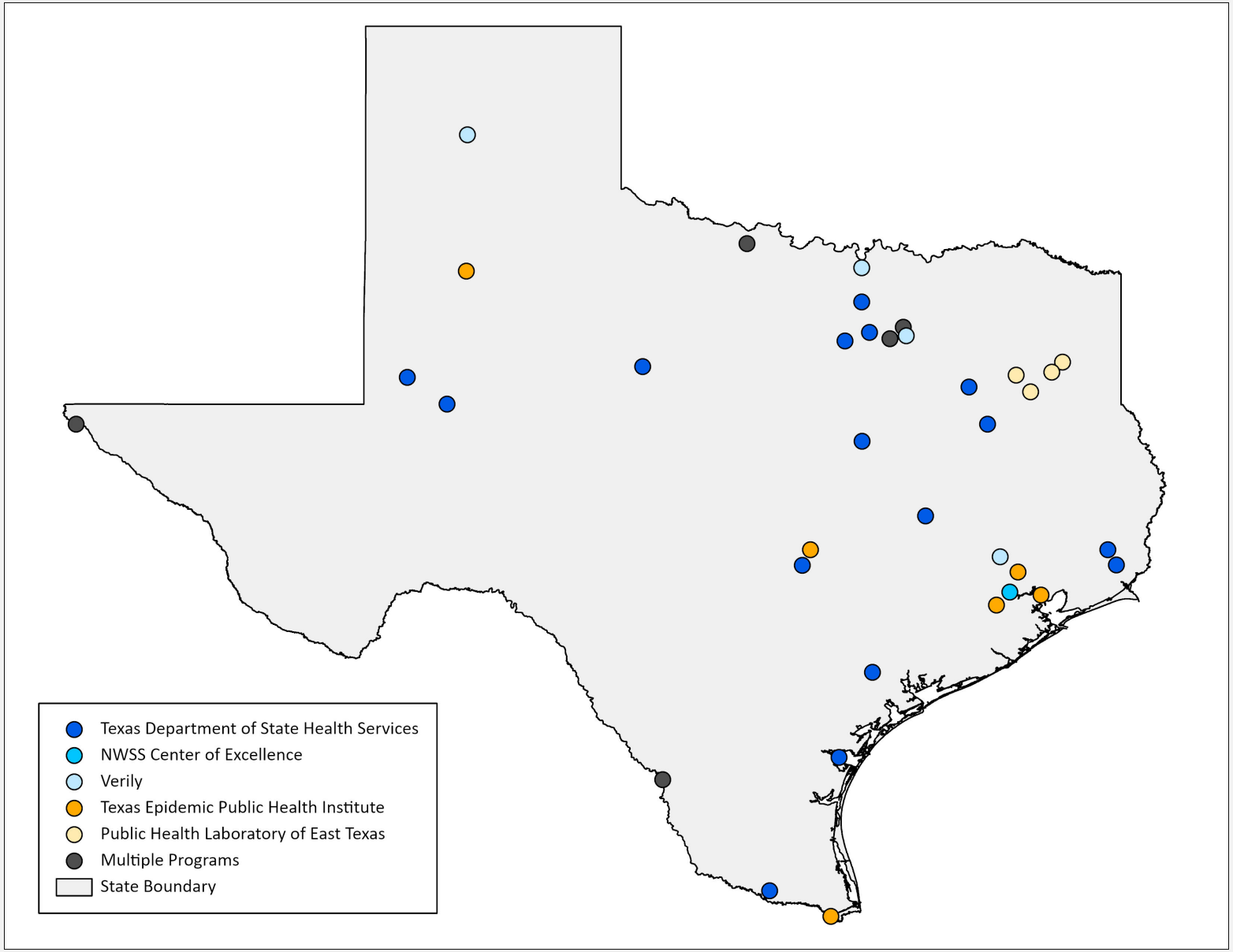


https://www.cdc.gov/nwss/pdf/Wastewater-COVID-infographic-h.pdf

National Wastewater Surveillance System (NWSS)



Wastewater-Based Disease Monitoring in Texas

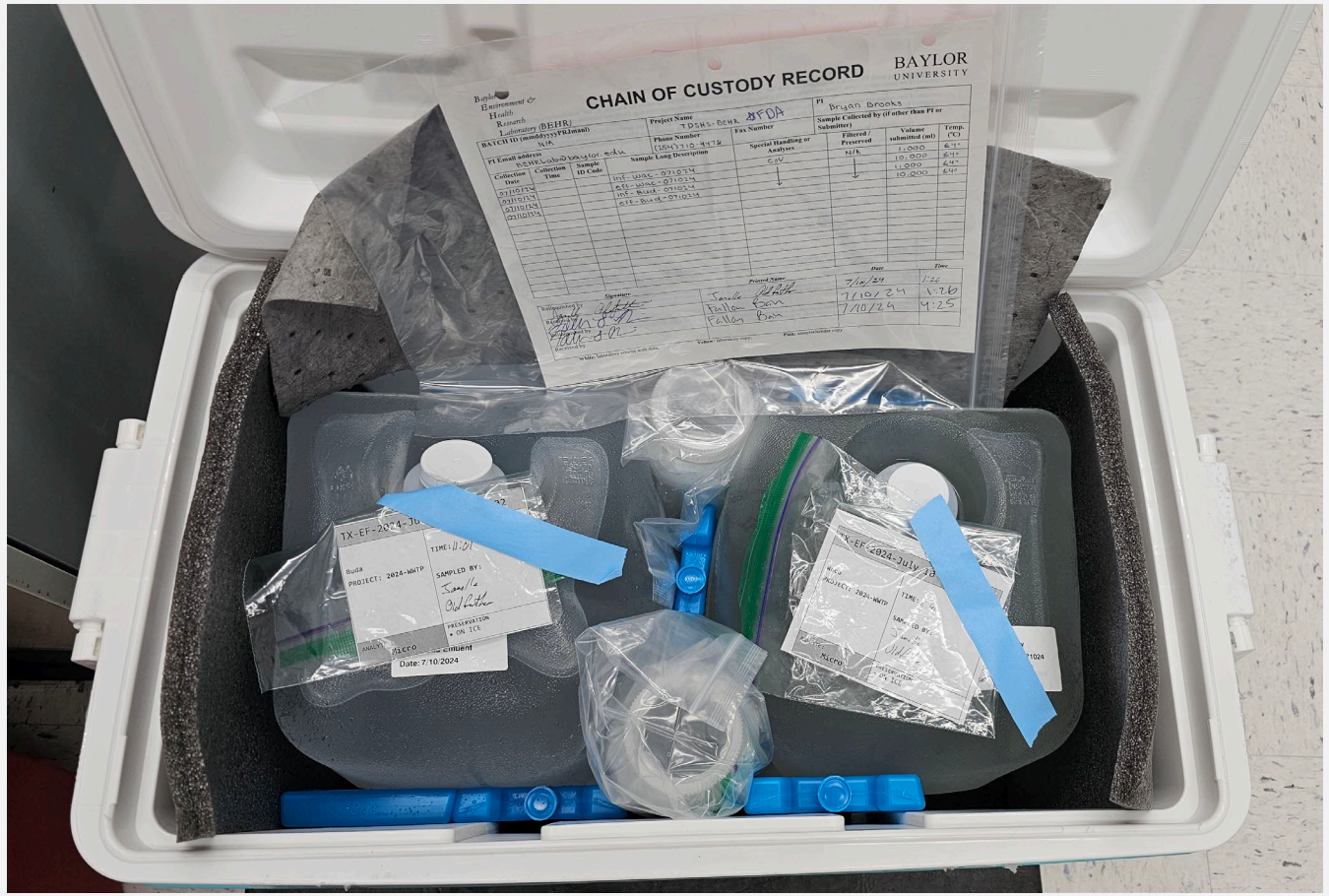


Sample Collection

Two 24-hour composite samples of influent (untreated) wastewater per week

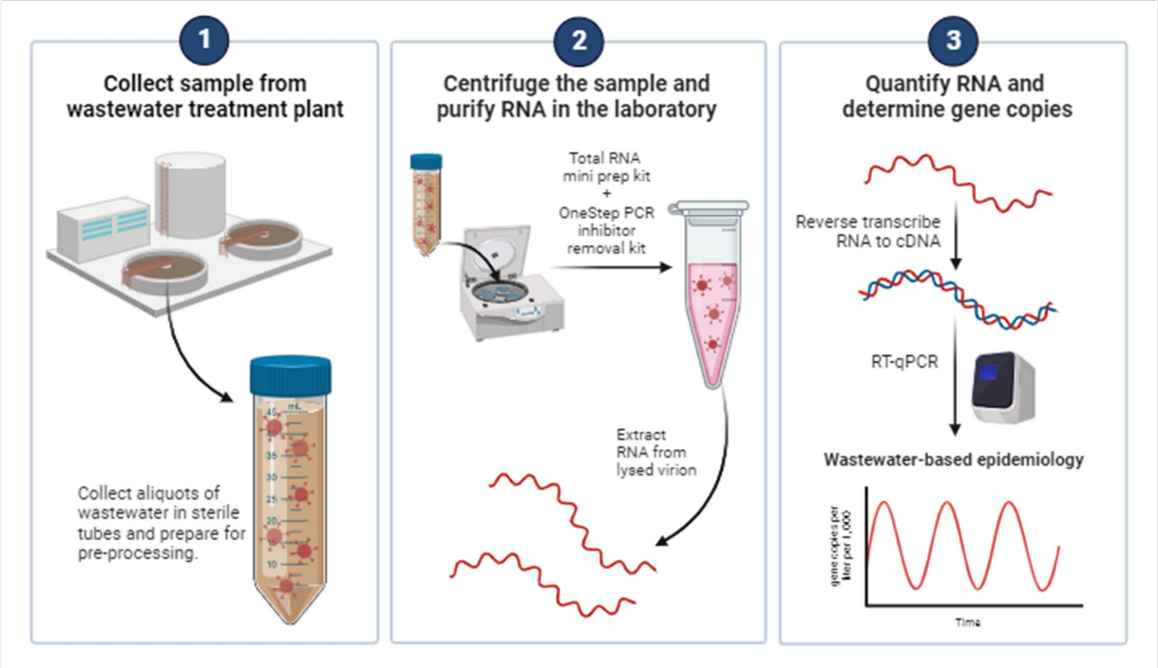
Sample Storage & Shipping

All shipping materials are provided to sites – collected samples are shipped overnight to the lab for analysis

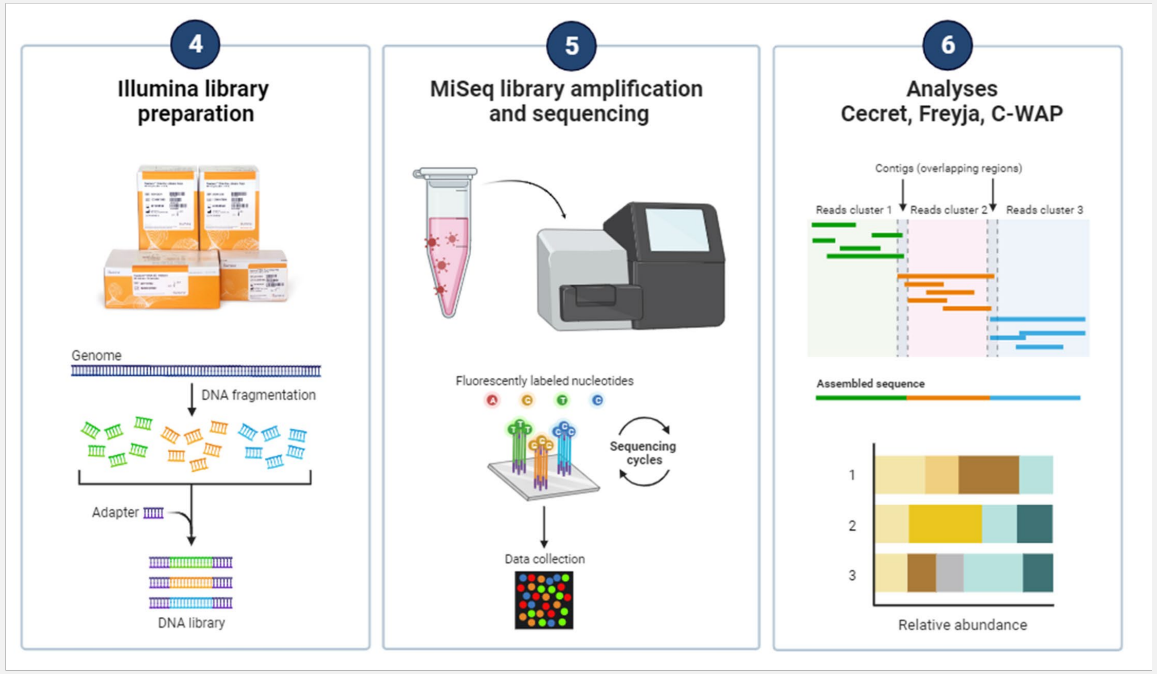


Sample Analysis

Quantitative Polymerase Chain Reaction (qPCR)



Next Generation Sequencing (NGS)

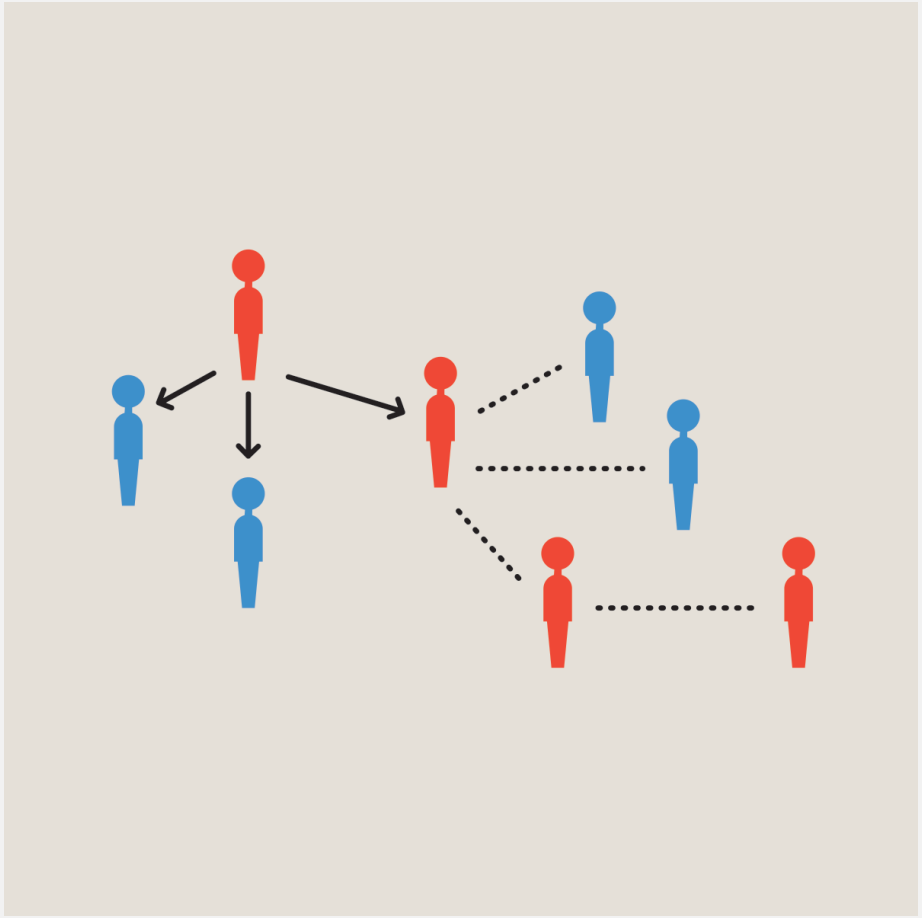


Illustrations created using BioRender

Case Studies

Pilot SARS-CoV-2 Surveillance in High Density Facilities, Texas DSHS

- High density populations (e.g., dormitories, long-term care facilities, prisons) are particularly vulnerable to rapid spread of respiratory diseases.
- Participating high density facilities received time-sensitive notifications from Texas DSHS about SARS-CoV-2 viral levels detected.
- Facilities deployed early testing, contact tracing, quarantine, and follow-up to mitigate transmission.



https://esllibrary.s3.amazonaws.com/uploads/lesson/esl_thumbnail/3302/95_Contact-Tracing.png

Case Studies

Pilot Wastewater Alert Program, Houston Independent School District

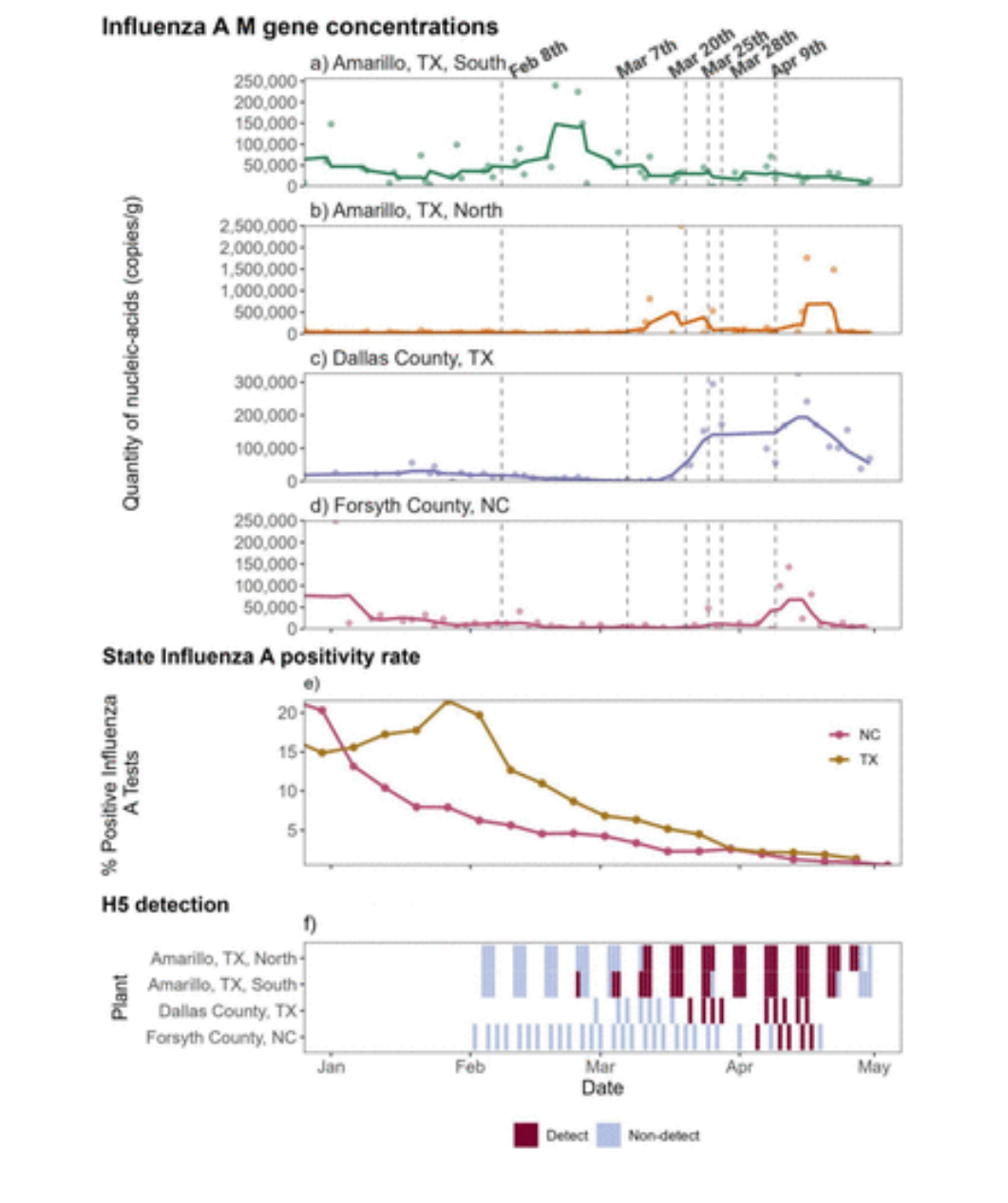
- Infections caused by respiratory viruses in school-aged children are likely underreported – many children likely to be asymptomatic or mildly symptomatic.
- Participating local school campuses receive time-sensitive text or email messages from Houston Health Department about SARS-CoV-2, Influenza A/B, and RSV viral levels detected.

https://www.hou-wastewater-epi.org/educational-resources/schools-and-neighborhoods

Case Studies

Detection of hemagglutinin H5 influenza A virus sequence in municipal wastewater solids at wastewater treatment plants with increases in influenza A in Spring, 2024

- Prospective influenza A (IAV) RNA monitoring at 190 wastewater treatment plants across the US.
- Increases in IAV RNA concentrations at 59 plants in spring 2024, after the typical seasonal influenza season.
- Increases coincident with the identification of highly pathogenic avian influenza (subtype H5N1) circulating in dairy cattle in the US.



Marlene K. Wolfe, Dorothea Duong, Bridgette Shelden, Elana M. G. Chan, Vikram Chan-Herur, Stephen Hilton, Abigail Harvey Paulos, Xiang-Ru S. Xu, Alessandro Zulli, Bradley J. White, and Alexandria B. Boehm *Environmental Science & Technology Letters* **2024** *11* (6), 526-532 DOI: 10.1021/acs.estlett.4c00331

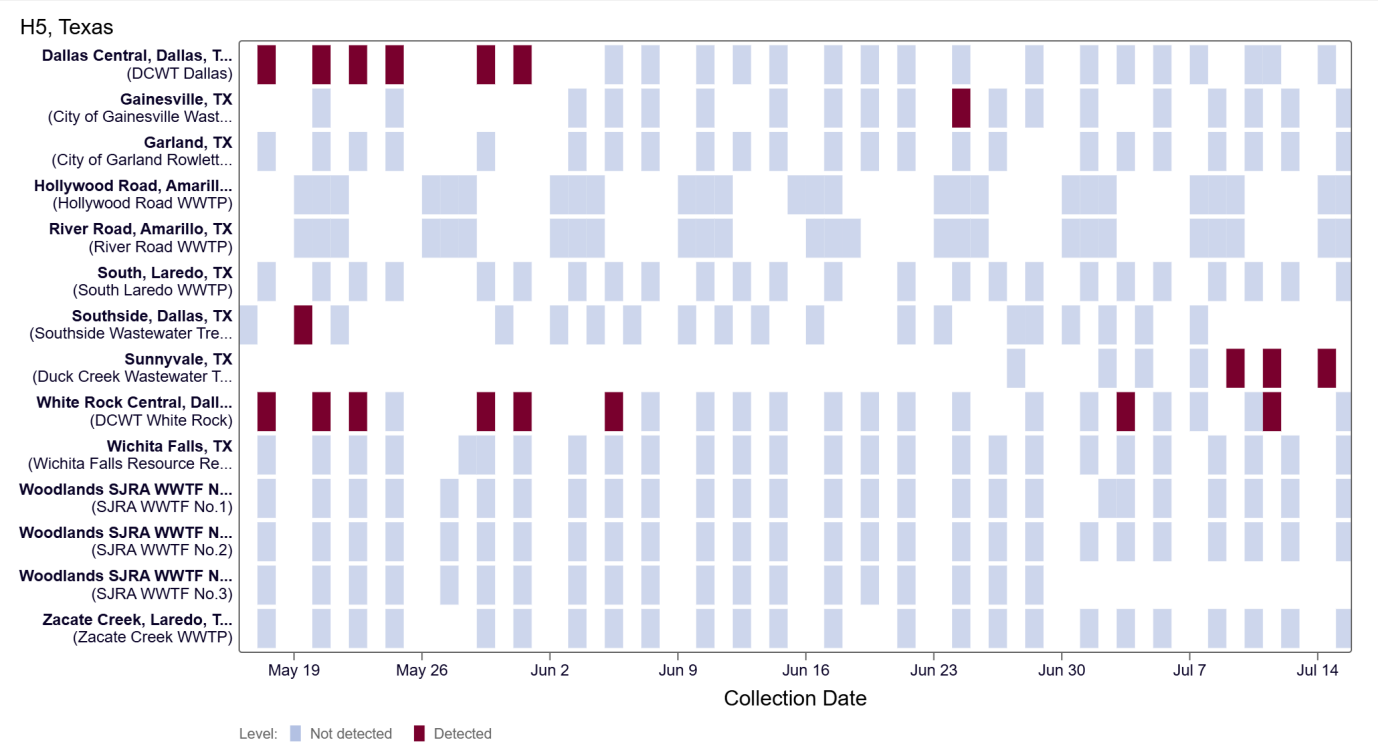
https://pubs.acs.org/doi/10.1021/acs.estlett.4c00331

Case Studies

Highly Pathogenic Avian Influenza (HPAI) A (H5) Source Investigations; CDC, WastewaterSCAN, and DSHS

Wastewater surveillance for influenza A viruses, including influenza A(H5) viruses, is being used to better understand the current highly pathogenic avian influenza (HPAI) A (H5N1) outbreak.

- H5-specific wastewater testing has been deployed in some sites and may expand before the start of the 2024–25 respiratory virus season.



Data is publicly available at https://data.wastewaterscan.org/

Investigation of H5 Signals in Wastewater

Time Period: May 12 - July 13																		
State	Site Name	Site number	Influenza A level detected (a)	H5 detected (a)	Evidence of human influenza activity based on other surveillance systems (b)	# of samples tested/time frame (a)	# of samples positive for H5 (a)	Setting (c)	Dairy operation within sewershed (d)	Active livestock cases within sewershed (e)	Active poultry cases within sewershed (e)	Identified input from milk processing (d)	Identified input from meat processing (d)	Type of wastewater system (f)	Suspected input from wild birds (f)	Identified input from septic trucks (f)	Identified input from wash trucks (g)	State fair or animal event during time of high detection (g)
State	*Site Name*	*XX of County Name*	*High/Moderate /Other*	*Yes/No*	*Yes/No/Unclear*	*xx/week*	*x of xx*	*Rural or urban*	*Yes/No*	*Yes/No*	*Yes/No*	*Yes/No*	*Yes/No*	*Open or Closed*	*Yes/No*	*Yes/No*	*Yes/No*	*Yes/No*
TX	Site A	01-Dallas	Low; High	Yes	No	2 to 3 per week	6 of 22	Urban	No	No	No	Yes	Yes	Closed	Yes	No	Yes	No
TX	Site B	02-Dallas	Low	Yes	No	2 to 3 per week	1 of 19	Urban	No	No	No	Yes	No	Closed	Yes	No	Yes	No
TX	Site C	03-Dallas	Low	Yes	No	2 to 3 per week	8 of 22	Urban	No	No	No	Yes	No	Closed	Yes	Yes	No	No
TX	Site D	04-Dallas	Low	Yes	No	2 to 3 per week	2 of 6	Urban	No	No	No	Yes	Yes	Closed	Yes	No	No	No
TX	Site E	01-Cooke	Low; High	Yes	No	2 to 3 per week	1 of 18	Urban	No	No	No	No	No	Closed	No	Yes*	Yes	No

Future Directions

Emerging Technologies

- Respiratory Pathogen Sequencing Panels
- Agnostic Sequencing

Integration with Existing Systems

- Forecasting Models

Policy and Strategies

- Right-sizing
- Sentinel Sites
- Novel Respiratory Pathogens

Final Thoughts

Advantages

- Specificity
  - Early detection using pathogen gene targets
- Logistics
  - Cost and time efficient
  - Independent of health behaviors
- Ethical Considerations
  - Confidential and less invasive
  - 80% of US households served by sewer system

Challenges

- Sensitivity
  - Limit of detection (PCR)
- Logistics
  - Burden on wastewater treatment staff
  - Shipping costs and delayed deliveries
- Ethical considerations
  - Privacy within small facilities
  - Use of data

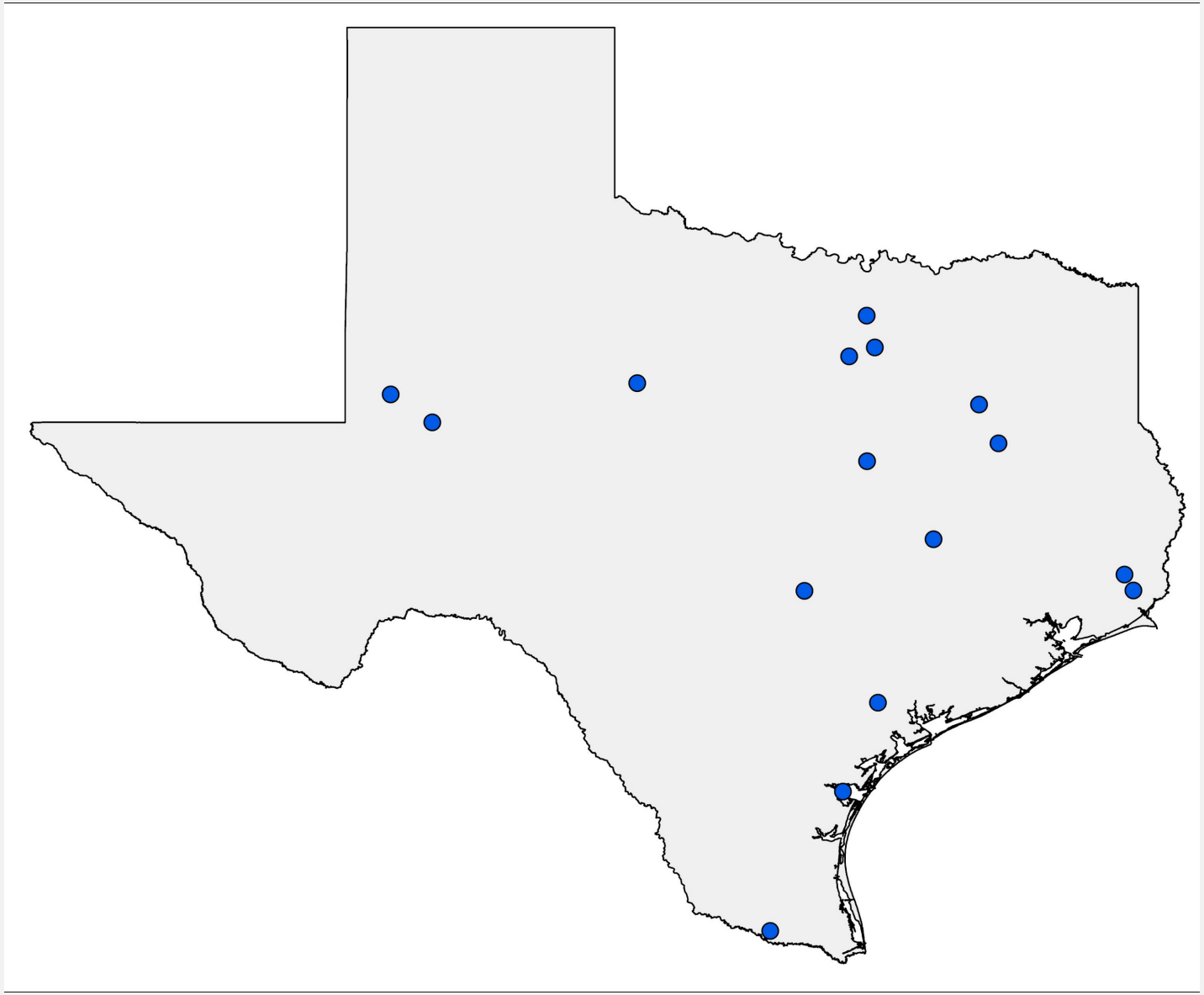
Join Our Network

Currently onboarding new municipal sites across the state of Texas.

Target pathogens include:

- SARS-CoV-2
- Influenza (A and B)
- RSV (A and B)
- Mpox (Clade I and Clade II)
- Norovirus (GI and GII)
- More to come, including H5

Email wastewaterepi@dshs.texas.gov for additional information.



Acknowledgements

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- CDC-RFA-CK19-190405CONT23
- CDC-RFA-CK-24-0002 BP1

Thank you!

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