FREQUENTLY ASKED QUESTIONS ABOUT WASTEWATER SURVEILLANCE
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THE BASICS

What is wastewater surveillance and why is it useful for COVID-19 and other public health targets?

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Wastewater surveillance involves systematic sample collection, processing, and analysis followed by interpretation of wastewater data to inform public health practice. Wastewater and other forms of environmental surveillance (e.g., monitoring of air, soil, or high-touch surfaces) can be valuable complements to more traditional public health tools such as syndromic surveillance and clinical testing.

Before 2020, wastewater surveillance had already been in practice for decades (e.g., to facilitate the eradication of polio), but the COVID-19 pandemic further magnified its value. People infected by SARS-CoV-2 shed viral material in their bodily fluids, including feces, which allows for the detection of SARS-CoV-2 RNA in wastewater. Similarly, detection of other RNA or DNA targets (e.g., monkeypox virus DNA) is possible due to shedding by infected individuals. People who are asymptomatic or only mildly symptomatic may not know they are infected or seek clinical testing by a healthcare provider. And widespread access to at-home rapid antigen testing for COVID-19 has led to reduced clinical testing and reporting of COVID-19 cases, thereby creating a public health surveillance 'blind spot'. Because wastewater surveillance does not require people to seek testing from a healthcare provider and can be representative of large portions of a community, it gives public health officials a way to detect and characterize infection trends in a non-invasive, timely, and cost-effective way. In North America, community-level wastewater surveillance can provide coverage for the approximately 80% of U.S. households (US EPA, 2008) and 90% of Canadian households served by municipal wastewater collection systems (Statistics Canada, 2020).

What exactly is detected in the wastewater for wastewater surveillance programs?

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For COVID-19, wastewater surveillance programs target the genetic material, specifically the RNA, of SARS-CoV-2, which is the virus that infects people and causes COVID-19. In many cases, wastewater surveillance programs search for the same fragments of the SARS-CoV-2 genome targeted by clinical tests that rely on polymerase chain reaction (PCR) By targeting specific fragments, or genes, PCR-based methods can be highly specific to the target of interest (e.g., SARS-CoV-2) and quantitative, thereby allowing for the determination of wastewater concentrations. Raw data are often reported as "gene copies" (or "gc") per volume of wastewater analyzed (gc/L). It is relatively easy to adapt PCR-based methods to other targets of public health interest, including monkeypox virus DNA and antibiotic resistance (AR) genes. In fact, many wastewater surveillance programs simultaneously monitor for the RNA of pepper mild mottle virus (PMMoV), which is an indicator of human fecal contamination. See the answer to the FAQ on ***What is normalization and how is it used by NWSS?*** for more information on the use of PMMoV to normalize wastewater data. The use of wastewater concentrations to estimate infection totals is still an evolving science, but trends in wastewater concentrations have successfully indicated when community transmission is increasing, decreasing, or plateauing.

Early in the COVID-19 pandemic, wastewater surveillance programs typically focused only on detecting and quantifying SARS-CoV-2 RNA. As the pandemic progressed and the virus mutated, it became increasingly important to also characterize the variants circulating in the community. In response, some wastewater surveillance programs targeted different fragments of the SARS-CoV-2 genome that could distinguish variants of interest or concern. Some also implemented a more flexible genome sequencing approach to identify important changes in the SARS-CoV-2 RNA present in wastewater samples. See the answer to the FAQ on ***What is next generation sequencing and how does it work?*** for more information on genome sequencing.

It's important to keep in mind that detection of nucleic acid fragments (DNA or RNA) in wastewater doesn't necessarily mean the wastewater contains infectious forms of those targets. For example, as explained in the answer to the FAQ on ***What is the latest PPE guidance for handling wastewater during an outbreak?*** and described in detail in Sobsey (2021), researchers have not detected infectious SARS-CoV-2 in untreated wastewater, despite detecting relatively high concentrations of SARS-CoV-2 RNA. However, influent wastewater does contain infectious forms of other pathogens so it is important to take proper precautions when implementing wastewater surveillance. Wastewater surveillance programs may eventually incorporate culture-based methods for detection of some targets of public health interest, including *Candida auris* and other antibiotic resistant pathogens. In contrast with PCR-based methods, culture-based methods can detect and quantify viable and potentially infectious forms of the pathogens of interest.

Where are wastewater samples taken?

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Wastewater samples for surveillance efforts can be taken from many different types of locations, such as the influent to a water resource recovery facility (WRRF), a pumping station or manhole within the WRRF collection system, a manhole or building cleanout that captures sanitary flows from a specific facility (such as a university dormitory, prison, nursing home, or homeless shelter) or even community pit latrines. The EPA provides examples of COVID-19 wastewater surveillance at many of these types of locations in their Compendium of US Wastewater Surveillance to Support COVID-19 Public Health Response. In most cases, wastewater utilities play a role in sampling program design, if not also in sample collection, as described in the answer to the FAQ on ***What is the wastewater utility's role in NWSS and wastewater surveillance generally?***.

Who should participate in wastewater surveillance?

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Everyone! The more utilities—whether small, medium, or large—participate in NWSS, the more useful the wastewater information will be for protecting public health. For more information on getting started, please see:

- ***How do I start working with my health department?***
- ***What are ELC and NWSS Wastewater Coordinators and how do I get in touch with them?***
- ***How can I obtain ELC funding through my health department?***
- ***How much does it cost to participate in a wastewater surveillance program?***

What do public health officials do with wastewater data?

Last updated May 31, 2022
Communities—whether cities, neighborhoods, or facilities—that participate in wastewater surveillance use the data in several ways, and ultimately this decision is up to the relevant public health entity. These public health entities would not have access to this critically important information were it not for the participation of wastewater utilities in sampling design and sample collection efforts.

Examples of how communities have used wastewater SARS-CoV-2 trends include:

- **Confirm clinical testing data** — Are infections truly decreasing/increasing? Or is clinical testing not capturing all of the infections? Is additional clinical testing required in some communities?
- **Alert public health earlier** — Studies have shown that wastewater data can indicate disease trends up to two to 14 days before clinical testing data (D'Aoust et al. 2021; Feng *et al.* 2021; Kumar *et al.* 2021; Nemudryi *et al.* 2020; Peccia *et al.* 2020; Wu *et al.* 2020). That can give public health officials important time to respond to increasing COVID-19 transmission or let them know that public health measures are working and COVID-19 levels are decreasing.
- **Indicate presence of variants of concern** — Wastewater may be the first indication that a variant of concern is present in a community. For example, wastewater in the California cities of Merced and Sacramento tested positive for Omicron before it showed up in nasal swabs in those counties.
- **Shape public health policies** — Are public health measures in place actually helping to reduce community transmission?
- **Direct resources where they are needed** — Which communities have the highest levels of transmission, and how can resources be better allocated to them to reduce disease spread?

Please see the following dashboards for examples of how health departments are using wastewater to answer these questions:

- Colorado Department of Public Health and Environment
- Michigan Department of Environment, Great Lakes and Energy with Michigan Department of Health and Human Services
- Missouri Department of Health and Senior Services
- North Carolina Department of Health and Human Services
- Utah Department of Environmental Quality

What should I tell my elected officials and the public about wastewater surveillance?

Last updated November 3, 2022
It's helpful to start with the basics: what is wastewater surveillance, why has it been useful during COVID-19, what else it has been and can be used for besides COVID-19, and what the National Wastewater Surveillance System is all about. Find more resources on our Utility Roadmap page or in our Infographic Library.

What is the National Wastewater Surveillance System (NWSS)?

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The National Wastewater Surveillance System (NWSS) is a new public health tool for understanding COVID-19 spread in a community. NWSS was initiated by the Centers for Disease Control and Prevention (CDC) and the US Department of Health and Human Services

(HHS), in collaboration with multiple federal agencies. While the initial focus is on COVID-19, NWSS is designed to be a long-term addition to CDC's public health surveillance infrastructure. NWSS is a flexible system that can be adapted to changing public health needs, such as tracking antimicrobial resistance, guiding emergency response, responding to emerging infections, and preparing for bioterrorism and future pandemics.
The CDC maintains a NWSS website, which includes guidance on sampling strategy, testing methods, data reporting and analytics, and public health interpretation and use of wastewater surveillance data.

What is the wastewater utility's role in NWSS and wastewater surveillance generally?

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The wastewater utility plays four important potential roles in any NWSS wastewater surveillance program: (1) identification of, and collaboration with, the appropriate health department partner; (2) development of a wastewater sampling plan in coordination with the health department partner; (3) ongoing collection of wastewater samples, including sample packaging for transport to the analytical laboratory as well as administrative tasks related to the completion of the sample chain of custody; and (4) documentation of sample-related data per the sampling plan, which can include wastewater treatment plant and sewershed service area, number of people served by the utility, treatment processes, types of samples collected (hourly or flow-weighted composites) and wastewater flow rates during sample collection. For some wastewater surveillance programs, utilities play a larger role by performing the analysis of the wastewater samples or paying for these analyses to be performed by an outside, commercial laboratory. This is not typical, however, and is certainly not expected for NWSS efforts.

DEFINITIONS

How is "wastewater surveillance" different than "wastewater-based epidemiology"?

Last checked June 2, 2022
In practice, wastewater surveillance and wastewater-based epidemiology are used interchangeably. However, epidemiology specifically refers to "the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems". Wastewater surveillance can help identify where a health problem is occurring (the distribution) but does not explain why (the determinants) or how to control the problem. As such, it is only one—very important—component of epidemiology.

Why is the word "surveillance" used?

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The use of the term "surveillance" is consistent with the fact that wastewater surveillance is another example of "public health surveillance", or the "ongoing,

systematic collection, analysis, and interpretation of health-related data essential to planning, implementation, and evaluation of public health practice".

THE FUTURE

What will NWSS be expanding to after COVID?

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NWSS was designed to inform diverse disease surveillance strategies, including:

- **Core** surveillance for endemic or common diseases, such as flu or antibiotic resistance, to provide regular and consistent updates at minimal cost
- **Emergency** surveillance of sporadic but expected diseases (such as shigellosis or polio) for rapid response during outbreaks, emergencies, and natural disasters to provide acute, timely updates
- **Pandemic preparedness** surveillance to evaluate the potential for rare, unexpected diseases such as typhoid, Ebola, or Mpox

Currently, NWSS targets include both SARS-CoV-2 and Mpox virus. The CDC will be expanding the list of core targets in 2023 and 2024 to include pathogen and antibiotic resistance targets, as well as normalization and process controls, as follows:

- Pathogen targets
    - Respiratory
        - SARS-CoV-2
        - Influenza A and B
        - Respiratory syncytial virus
    - Enteric
        - Adenovirus 40/41
        - Norovirus GI and GII
        - Shiga-toxin-producing *E. coli*
        - *Campylobacter*
    - Emerging pathogens
        - *Candida auris*
        - Mpox (non-variola orthopox)
- Antibiotic resistance genes
    - Carbapenemases
    - Extended-spectrum beta-lactamases
    - Colistin resistance
    - Vancomycin resistance
- Normalization and process controls
    - Pepper mild mottle virus (PMMoV)
    - CrAssphage
    - Bovine coronavirus

This expanded NWSS panel is expected to be rolled out by the end of 2024, and health departments will communicate with their partners which of these targets they intend to include in their own programs. Any data generated from this new panel will be integrated into DCIPHER for real-time access by health departments and will also be shared on a public NWSS dashboard.

COLLABORATIONS

What types of settings can be monitored using wastewater surveillance?

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During the pandemic, more than 3,000 COVID-19 wastewater surveillance programs have cropped up around the globe, as illustrated on this map from the University of California Merced. These include surveillance efforts in many different settings, such as:

- Cities and regions (Gerrity et al. 2020; Gonzalez et al. 2020; Medema et al. 2020; Miyani et al. 2020)
- Neighborhoods (Spurbeck et al.2021)
- University/college campuses (Bivins and Bibby 2021; Harris-Lovett et al. 2021)
- Correctional facilities
- Airplanes and cruise ships (Ahmed et al. 2020)
- Hospitals (Acosta et al., 2021)

Another good summary of wastewater surveillance programs is available via the W-SPHERE data repository, which aims to serve as a global data center and provide wastewater surveillance data in reusable formats.

How does CDC work with health departments for NWSS?

Last updated November 3, 2023
CDC works directly with health departments to implement NWSS. In this case, a "health department" can be a state health agency, a city health department, a tribal health entity, or a territorial health organization. CDC funds these health departments for NWSS activities through the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases Cooperative Agreement (ELC) program (this program is described more in the answer to the ***How does ELC funding work?*** FAQ). CDC is also currently funding NWSS activities through a long-term commercial wastewater analysis contract to support communities that want to participate in NWSS but do not have access to analytical services. See more information about the commercial testing contract in the answer to ***What is the NWSS commercial testing contract and who is the current contract?*** FAQ.

As of late 2023, 55 jurisdictions (48 states [all but ND and VY], five cities [Chicago, Houston, Philadelphia, New York, and Washington DC], and two territories [Guam and Puerto Rico]) have received funding from CDC for NWSS-related wastewater surveillance.

How do I start working with my health department?

Last updated May 31, 2022
Start by reaching out to the NWSS Wastewater Coordinator (see ***What are ELC and NWSS Wastewater Coordinators and how do I get in touch with them?***) in your relevant jurisdiction and expressing your interest. Most of these coordinators are in state health departments. If your jurisdiction is not already funded for NWSS activities, reach out instead to the ELC coordinator

or even the CDC NWSS team. More information is provided in the answer to ***How does ELC funding work?***

FUNDING

What is the NWSS national testing contract and who is the current contractor?

Last updated April 9, 2024
Since 2020, the U.S. Health and Human Services (HHS), including the CDC, has contracted with commercial laboratories to provide wastewater testing for SARS-CoV-2 and, more recently, Mpox virus. Because they enable utilities to participate in NWSS without having to pay for sample kits or analyses, these contracts are designed to complement the efforts of state and local health departments by filling gaps in wastewater testing coverage. All contracts awarded so far, as well as any amendments to those contracts, are shown in the table at this link. The most recent commercial testing contract is between the CDC and Verily Life Sciences LLC (Verily) that provides twice-weekly testing for:

- SARS-CoV-2 (quantitative levels and sequencing)
- Mpox (quantitative levels)
- Flu A (quantitative levels)
- Flu B (quantitative levels)
- RSV (quantitative levels)

Note that WastewaterSCAN, for which Verily is a partner, is entirely separate from the NWSS national testing contract. WastewaterSCAN is not funded by the CDC. Also, any free testing being offered by Biobot (such as through the "Biobot Network") is also separate from the NWSS national testing contract.

How does ELC funding work?

Last updated August 11, 2022
To facilitate participation in NWSS, CDC provides funding to health departments (HDs) for wastewater surveillance activities through the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases Cooperative Agreement (ELC). The ELC "provides financial support and technical assistance to the nation's HDs to support their efforts to detect, prevent, and respond to emerging infectious diseases". ELC funding is available to HDs in 64 US jurisdictions, including:

- All 50 states
- Five large cities: Chicago, Houston, New York City, Philadelphia, and Washington DC
- One county: Los Angeles County
- Eight territories: American Samoa, Federated States of Micronesia, Guam, Marshall Islands, Northern Mariana Islands, Palau, Puerto Rico, and US Virgin Islands

In support of the COVID-19 response, the ELC has awarded more than $43 billion to health departments, including $99,965,415 to support the implementation of NWSS programs through the ELC.
In July 2022, CDC awarded $64,162,932 to support NWSS activities in 46 states, 5 cities, and 2 territories. ELC funds can be used to pay for autosamplers and other items that support utility participation in wastewater surveillance programs. Utilities should coordinate directly with their relevant health department to find out more. If you're not sure who to reach out to at your

health department, please email us and we'll put you in touch with your Wastewater Coordinator.

What are the NWSS Centers of Excellence?

Last updated January 31, 2024

In August 2022, NWSS established Centers of Excellence (CoEs) to support the continued development of wastewater surveillance for public health. Since then, NWSS has funded four CoEs to serve as leaders in wastewater surveillance implementation and coordination:

- California, led by the California Department of Public Health
- Colorado, led by the Colorado Department of Public Health and Environment in partnership with the University of Denver
- Houston, led by the Houston Health Department in partnership with Houston Public Works and Rice University
- Wisconsin, led by the Wisconsin State Laboratory of Hygiene

The NWSS CoEs are distinct from the 16 Centers of Excellence for Wastewater Epidemiology established by Ceres Nanosciences, which were supported by an $8.2 million award from the National Institutes of Health Rapid Acceleration of Diagnostics (RADx) Initiative.

The NWSS CoEs were selected based on the proposer's ability to implement the following training, consultation, and research activities:

1. Develop and conduct trainings to strengthen the knowledge base of, improve data collection, analysis, and interpretation of wastewater surveillance, and improve information systems in other health departments/jurisdictions.
2. Develop, deliver, or consult with other health departments/jurisdictions for in-person and online courses (including live learning courses).
3. Conduct in-person/remote site visits and reverse site visits with other health departments/jurisdictions.
4. Develop wastewater surveillance metrics that help prioritize sites for public health actions.
5. Participate in consultations with other health departments/jurisdictions (e.g., in response to requests for technical assistance, peer-to-peer exchanges of ideas, etc.).
6. Disseminate resources to improve wastewater-based disease surveillance knowledge, decision making, and information systems in other health departments/jurisdictions, e.g., by posting to CDC NWSS DCIPHER.
7. Make wastewater surveillance resources available to the public, e.g., by posting to public-facing websites.
8. Work with wastewater utilities and the Water Environment Federation (WEF) to identify effective, efficient, and timely ways to capture and share wastewater treatment plant and wastewater collection metadata with health departments.
9. Engage with wastewater utilities to understand emerging needs and improve utility retention.
10. Evaluate laboratory analytic workflows for current surveillance target organisms to improve data quality, assay sensitivity, and inter-lab comparability.
11. Conduct pilot implementations of laboratory methods under consideration for inclusion in core NWSS surveillance testing. These assays may include quantification methods for human fecal markers or potential future surveillance target organisms.
12. Develop communications packages to communicate appropriate public health information with public health leadership, civic leadership, and the public. These tools should use wastewater surveillance data at different scales of sampling (e.g., centralized

treatment plants, upstream sampling locations, and facility-level testing) to ensure each group has sufficient information to enable them to act.

13. Conduct message testing to identify the most effective communication strategies to 1) ensure the implementing partners receive and understand the information and 2) feel prepared to use this information to act.
14. Develop upstream sampling plans to enhance public health utility of data generated at centralized wastewater treatment plants.
15. Determine the most effective geographic scale (i.e., treatment plant, sub-sewershed, facility, etc.) and sampling frequency for wastewater testing for different surveillance targets. Considerations can include lab capacity, cost, historic disease trends, and other jurisdictional needs.

Please email us or the NWSS team with any questions about the CoEs.

What are ELC and NWSS Wastewater Coordinators and how do I get in touch with them?

Last updated June 2, 2022

Each state, city, and territorial health department eligible for ELC funding has an ELC Coordinator who manages applications for annual ELC funding for programs including wastewater surveillance and other aspects of HD operation. Moreover, any state, city, or territorial health department that has already received ELC funding for NWSS activities either has hired, or is in the process of hiring, a NWSS Wastewater Coordinator who coordinates with wastewater utilities for wastewater surveillance activities. Please email or call WEF for the name of your ELC Coordinator or Wastewater Coordinator, as applicable.

Are wastewater utilities eligible for ELC funding?

Last updated August 1, 2022

Although utilities are not eligible to receive ELC funds directly, you are encouraged to work with your health department to determine whether their ELC funds can be used to support the purchase of autosamplers or other items that support utility participation in wastewater surveillance programs. Applications for the next round of annual ELC funding—including funding for wastewater surveillance—were due to CDC from each ELC-eligible jurisdiction on May 1, 2022. ELC funding issued in response to these applications is being distributed to 53 ELC-eligible jurisdictions starting in August 2022.

If you did not have a chance to coordinate with your health department for this round, it is still worth reaching out to the appropriate coordinator in your home jurisdiction to express your interest in participating in NWSS sampling. Please email or call WEF for the name of your ELC Coordinator or Wastewater Coordinator, as applicable, if you're not sure who to reach out to.

It may be helpful for you to develop a budgetary estimate of costs associated with labor, supplies, and even equipment – such as autosamplers or flow metering equipment – needed to effectively implement wastewater surveillance sampling for the expected duration of the wastewater surveillance program. Expand the answer to the FAQ below for more guidance on estimating costs.

How much does it cost to participate in a wastewater surveillance program?

Last updated January 18, 2023

The scope of your program will dictate which costs you'll incur when participating in a wastewater surveillance program as a utility. Below, we've provided some detailed information on different cost categories, as well as links to specific budgeting resources. **Have you participated in, or led, a wastewater program? If so, let us know what your costs were in this anonymous survey so we can improve the information provided here.**

Cost Categories

It's helpful to break out costs into different categories, not all of which will necessarily apply to every wastewater surveillance program, as follows: labor, equipment, supplies, analytical, and miscellaneous. Considerations for each of these categories are offered below. Note that the discussion below is organized around the assumption that your wastewater utility is *not* responsible for running the SARS-CoV-2 analysis in your laboratory.

Labor

Labor costs include all personnel time related to sample collection and project administration. For sample collection, personnel may be needed to: walk or drive to sampling locations; retrieve samples from autosamplers, manholes etc.; reset/manage/program autosamplers; package samples and fill out paperwork (the "chain of custody") for transport/shipment to the analytical laboratory; and/or courier/drop off samples for shipment/transport. Project administration labor may include time spent on data management and project management (*e.g.*, procurement, team coordination).

For a utility collecting wastewater samples from one water resource recovery facility influent sampling point where an autosampler is already set up and programmed to collect a daily 24-hour composite sample, the labor costs will be minimal: one staff member will need to spend about 15 to 45 minutes per sample collected. For a utility collecting samples from locations within the collection system (*e.g.*, manholes), a team of two staff members will need to spend about an hour per site for sample collection and autosampler management, not including travel time.

For budgeting purposes, sampling labor costs should be developed by estimating the total number of hours required for sample collection and using total, burdened labor rates. Project administration costs can be estimated as a percentage of total project costs (*e.g.*, 10 to 15%).

Equipment

One-time equipment purchases required to start up a wastewater surveillance program may include: autosamplers (if used for composite samples); peristaltic pumps (if used for grab samples); bucket dippers (if used for grab samples); flow meters to measure flow; meters (handheld or benchtop) to measure pH, temperature, and electrical conductivity; coolers to manage sample transport; certain personal protective equipment (PPE) items requiring a one-time purchase (*e.g.*, rubber boots); and/or any other items needed to equip the sampling team. In addition, it may be necessary to purchase a refrigerator to store samples before shipment. Although costs for each of these items will vary by location and equipment specifics, here are some typical values:

- Autosampler: about $8,000 to $9,500 for a compact, portable, battery-powered model including extra tubing, bottle arrays, strainers and an extra battery depending on the setting
- Peristaltic pump: about $1,500 to $1,750 with extra battery and tubing
- Bucket dipper: about $200 to $250 for 1-liter sampler
- Flow meter: will vary substantially, depending on installation specifics
- Handheld meter to measure sample pH, temperature, and electrical conductivity: about $800 to $1,000
- Cooler (reusable): about $40 to $60 for 48-quart with hinged lid

- Rubber boots: about $120 to $150 for a pair of steel-toe, knee-height rubber boots with oil-resistant soles
- Refrigerator: about $4,000 for a laboratory refrigerator, although a $300 model may be suitable as well

Supplies (or consumables)

Supplies will need to be purchased on an ongoing basis to support sampling activities. Depending on the scope of the wastewater surveillance program, these supplies may include:

- Disposable PPE, such as gloves, googles, and coveralls (for safety during sample collection)
- Hand sanitizer (for use in the field after sample collection)
- Sample bottles (for sample transportation/shipment)
- Ice packs (for sample transportation/shipment)
- Boxes (for sample transportation/shipment)
- Bags of ice (if needed for portable autosamplers)
- Paper towels (for clean up during sampling activities)
- Garbage bags (for clean up during sampling activities)
- Traffic cones (for traffic management during sampling activities, *e.g.*, at manhole in street)

Note that most commercial laboratories provide sample bottles, boxes (or small, disposal coolers), and ice packs at no additional cost (beyond the fee associated the SARS-CoV-2 analysis).

Analytical

Although paying for laboratory analysis is often outside the scope of a wastewater utility's participation in wastewater surveillance activities, it is helpful to understand which analytical costs might be part of a wastewater surveillance program. These include:

- PCR for:
    - SARS-CoV-2 quantification
    - Quantification of a fecal indicator (such as pepper mild mottle virus [PMMoV], crAssphage, F prophage) that can be used to normalize data
    - Measurement of targets specific to variants of concern
    - Any other pathogen target
- Next generation sequencing

The PCR cost, including quantification of both SARS-CoV-2 and a fecal indicator (but not targets specific to variants of concern) ranges from about $300 to $400 per sample, including sample bottles, ice packs, boxes/small coolers, shipping, and analysis.

Miscellaneous

In addition to labor, equipment, supplies, and analytical costs, there may be miscellaneous costs associated with wastewater surveillance programs, such as:

- Sample shipment, if not included in the analytical cost
- Vehicle mileage
- Police or traffic detail for sampling locations in the collection system in high-traffic areas

Note that the sample shipment costs, and the logistics involved in shipping samples, can be substantial. We recommend that you reach out to the shipping service early in the development of your wastewater surveillance program to plan ahead. We also recommend including a project contingency in your program budget to cover unforeseen costs.

Budget Development Resources
The following resources offer more specific guidance on how to develop a wastewater surveillance program budget for your utility:

- Online calculator (opens new window)
- Downloadable spreadsheet template (Utilities CoP membership is required to access this file)

What information should I be ready to share when I talk to my Wastewater Coordinator?
Last updated January 14, 2022
Your Wastewater Coordinator would be interested in knowing:

- The basics of your wastewater treatment system, such as population served, collection system area extent, number and size of your treatment facilities, samples collected for regulatory purposes, treatment used (e.g., lagoons);
- Whether you have performed any wastewater surveillance activities in the past;
- Where wastewater samples might be collected for a NWSS program;
- Number of operators/staff on-site and whether your staff are able to support sample collection, administration and shipping activities;
- Availability of autosamplers, if needed for program; and
- Whether you need any funding to facilitate your participation in NWSS sampling activities and, if so, what your funding request is.

Ideally, this will start a discussion with the Wastewater Coordinator about where it would be the most helpful to sample from a public health perspective.

OCCUPATIONAL HEALTH

What is the latest PPE guidance for handling wastewater during an outbreak?

Last updated November 28, 2022
Because wastewater contains a broad range of pathogens, handling wastewater carries inherent risk of exposure to biological hazards that can result in illness and disease. Therefore, protecting wastewater workers from occupational infections through engineering and administrative controls (e.g., task-specific job safety assessments), hygiene precautions, training, and personal protective equipment [PPE] is necessary to mitigate risks of pathogen exposure on a routine basis. During outbreaks, the concentrations of certain pathogens in wastewater may increase, but regular practices to protect workers from pathogen exposure would still be protective. A Blue-Ribbon Panel convened by WEF in April 2020 describes best practices in protecting wastewater workers from biological hazards.
In the case of the COVID-19 pandemic, the US EPA recommends workers follow routine practices normally used when handling untreated wastewater and "[n]o additional COVID-19–specific protections are recommended for employees involved in wastewater management operations, including those at wastewater treatment facilities". These routine practices include engineering and administrative controls, hygiene precautions, specific safe work practices, and the use of PPE. According to the CDC, this PPE should include the following:

- Goggles
- Protective face mask or splash-proof face shield
- Liquid-repellent coveralls
- Waterproof gloves
- Rubber boots

Workers should also follow basic hygiene practices and wash hands with soap and water *immediately after* removing PPE. CDC also recommends that wastewater workers be trained on disease prevention practices and consider vaccinations for tetanus, typhoid fever, polio, Hepatitis A and Hepatitis B.

It is important to note that detecting SARS-CoV-2 RNA in wastewater is not the same as detecting infectious SARS-CoV-2. As described in Ahmed *et al.* (2022), researchers have not been able to detect infectious SARS-CoV-2 in untreated wastewater, even though infectious SARS-CoV-2 can sometimes (but not always) be isolated from the feces of infected patients. Just because the SARS-CoV-2 RNA can be present at high concentrations does not mean that exposure to the wastewater can result in COVID-19 infections.

Does the risk of exposure to COVID-19 from wastewater vary by variant?

Last updated February 8, 2022

As described in Sobsey (2021), researchers have not been able to detect infectious SARS-CoV-2 in untreated wastewater, and therefore "… there is no credible evidence for the presence of infectious, replication-capable SARS-COV-2 in fecal wastes and waters such as those used for recreation, agricultural irrigation or drinking". Although no studies have been published on the infectivity of specific COVID-19 variants of concern in wastewater, there is no reason to think that a particular variant would behave substantially differently in wastewater than another variant.

SAMPLE COLLECTION AND SHIPMENT

What is the best way to collect samples?

Last updated February 8, 2022

There are many different approaches to sample collection and any sampling plan needs to establish where to sample (WRRF influent or out in the collection system), how often to sample, what to sample (untreated wastewater vs. primary solids), how to sample (grab vs. composite), and how to safely collect, store and ship samples. Each of these topis is addressed in detail on the NWSS website. Utility-specific information is important to consider when designing a sampling program. This includes information on the location of industrial dischargers in the collection system, whether the WRRF utilizes influent flow equalization, and the location of chemical (such as chlorine or ferric chloride) addition at the WRRF influent. It's important to find representative sampling locations that are practical and safe to access but are not confounded by chemical addition or other factors. It is also important to be consistent over time with the sampling approach, especially with respect to the "where", "what", and "how" of sample collection.

What is passive sampling?

Last updated January 14, 2022

Passive sampling of wastewater for COVID-19 is an alternative to traditional sampling techniques (composites and grabs) and involves deploying an absorbent material in the wastewater flow for a specified period of time to allow SARS-CoV-2 to associate with the material. At the end of the sample collection period, the material is transported to a laboratory for processing and analysis. Passive sampling can be done using cotton gauze, cotton

cheesecloth, cellulose sponges, electronegative filters, or tampons (Lugali *et al.* 2016; Hayes *et al.* 2021; Bivins *et al.* 2021) which can be placed inside a housing (such as a 3D-printed cage [Rafiee *et al.* 2021] or a colander [Schang *et al.* 2021]) or hung from a string (*e.g.*, a Moore swab [Sikorski and Levine 2020]). Studies suggest that passive sampling can give comparable results to composite and grab samples, while being cheaper and easier to deploy (Rafiee *et al.* 2021; Schang *et al.* 2021). However, a key limitation of passive sampling is that it does not yield quantitative results (gene copies per unit volume of wastewater) like composite and grab samples can.
It should be noted that passive sampling is not used for NWSS programs.

How do I program my autosampler?

Last updated February 8, 2022
This will depend on the make and model of your autosampler, and the best thing to do is consult the user manual for your particular autosampler. Here are links to the user manuals for some commonly used autosamplers:

- Endress+Hauser Liquistation CSF48
- Hach AS950
- Teledyne/ISCO 5800
- Teledyne/ISCO GLS
- YSI Xylem WS Series

What is needed to package and ship samples?

Last checked July 3, 2023
Although the specific packaging needs will depend on the laboratory to which wastewater samples are being sent, packaging and shipping supplies may include:

- Chain of custody form (see this example form that can be used as a template; Utilities CoP membership is required to access this file: join today!)
- Sample bottle(s) (plastic, usually 50 to 200 mL)
- Biohazard bag in which to place sample bottle(s), sometimes with an absorbent pad; usually two bags are used so that the sample can be double-bagged (one plastic bag inside the other), with the absorbent pad placed with the sample bottle(s) in the inner plastic bag
- Ice pack(s) to keep the samples cool during shipment or transport (note: if you are out of ice packs or don't have any, you can consider putting water in a Ziploc bag or a sample bottle and freezing ahead of time to create a makeshift ice pack) or ice (placed inside a plastic bag)
- Small Styrofoam cooler or bubble mailer with an outer cardboard shipping box or a reusable cooler that can be sealed and shipped on its own

How quickly does the sample need to arrive at the lab for SARS-CoV-2 (or other virus) results to be valid?

Last updated January 15, 2023
It's preferable to send wastewater samples priority overnight so that they arrive at the lab the day after sample collection. It's also preferable to keep the wastewater sample cool (close to 4°C). The viral signal in wastewater degrades over time, and the rate of degradation differs

across viral targets and depends on the temperature at which the sample is stored. For SARS-CoV-2, Markt et al. (2021) found little degradation of the SARS-CoV-2 signal in wastewater samples stored at 4°C for nine days. Brunet et al. (2023) compared the persistence of different SARS-CoV-2 RNA biomarkers (N1, N2, E, ORFlab, and RdRP genes) and found that all biomarkers were consistently detected after six days when stored at 4°C but complete signal loss occurred after 13 days at 12°C and six days at 20°C . Freezing samples is not recommended: it's possible that freeze/thaw cycles can lead to substantial loss of viral signal from wastewater.

What are the most common challenges associated with sample collection?

Last updated May 25, 2022
The initial identification of sampling locations—if those locations are not at the influent to a WRRF—can be challenging due to uncertainties related to the extent of the sewershed captured by the sampling location and access and safety considerations associated with sampling at manholes or pumping stations. The management of sample transportation can also be challenging because it requires tracking coolers and bottles and taking time to get the samples where they need to be, whether at a shipping (FedEx, UPS) drop-off location or a nearby laboratory. For rural areas, a shipping drop-off location may be a long drive from the WRRF. The management of portable autosamplers, especially if deployed in manholes, is another challenge due to the potential for clogged intake tubing, dead batteries, and programming issues.

What are some strategies for managing shipment logistics?

Last checked November 3, 2023
Although a laboratory -- whether a commercial laboratory or a public health laboratory -- will work with its partner utilities to iron out sample shipment logistics, some strategies employed to facilitate the successful, ongoing shipment of wastewater samples include:

- Preprinting a stack of the chain of custody forms with most information already filled in; see this example form that can be used as a template.
- Prefreezing enough ice packs for an entire week or two of sample collection.
- Setting up recurring pickups with the shipping company. Here are links with more information on how to set regular pickups with the more common shippers, including: DHL, FedEx, and UPS.
- Using a sample courier to transport samples either to a nearby laboratory or to a shipment dropoff location. Although there are many courier options, Mercury is the courier currently supporting the Phase 3 commercial testing contract for NWSS. Local public health and environmental laboratories are also likely to have the name and contact information for local courier options.

Is wastewater considered a hazardous material?

Last updated August 5, 2022
When shipping wastewater domestically within the US, sewage is not considered a hazardous material. Hazardous materials are regulated under the Resource Conservation and Recovery Act (RCRA), passed in 1976. According to the EPA, RCRA "... created the framework for America's hazardous and non-hazardous waste management programs. Materials regulated by RCRA are known as 'solid wastes'. Only materials that meet the definition of solid waste under RCRA can be classified as hazardous wastes, which are subject to additional regulation." Domestic Sewage

and Mixtures of Domestic Sewage are specifically excluded from the definition of solid waste under 40 CFR §261.4(a)(1) and, therefore, aren't considered hazardous wastes under RCRA. That said, many programs are designating wastewater samples as "UN3373, Biological substances, Category B" for shipment. Category B substances are infectious substances, including those transported for diagnostic or investigational purposes (such as for wastewater surveillance), that are "not in a form generally capable of causing permanent disability or life-threatening or fatal disease in otherwise healthy humans or animals when exposure to it occurs". APHL's Packing and Shipping Guidance for Biological Substances, Category B Specimens offers instructions on how to package Category B substances for shipment.

What metadata are required for NWSS samples?

Last updated July 3, 2023

As described on the CDC's NWSS website, and specifically in the NWSS metadata file, health departments are required to include the following sample collection metadata when they upload SARS-CoV-2 wastewater data to the DCIPHER database. Utilities can provide most of this information once at the outset of the program, but would need to provide the last items for each sample collection event.

- **reporting_jurisdiction** – The CDC Epidemiology and Laboratory Capacity (ELC) jurisdiction, most frequently a state, reporting these data (2-letter abbreviation)
- **county_names** – 5-digit numeric FIPS codes of all counties and county equivalents served by this sampling site
- **zipcode** – ZIP code in which the sampling site is located
- **population_served** – Estimated number of persons served by this sampling site (i.e., served by this wastewater treatment plant or, if 'sample_location' is "upstream", then by this upstream location)
- **sample_location** – Sample collection location in the wastewater system, whether at a wastewater treatment plant (or other community level treatment infrastructure such as community-scale septic) or upstream in the wastewater system
- **sample_location_specify** – If 'sample_location' is "upstream", specify the collection location in the wastewater system; an arbitrary name may be used if you do not wish to disclose the real name
- **institution_type** – If the sample represents wastewater from a single institution, facility, or building, specify the institution type; otherwise, specify "not institution specific"
- **wwtp_name** – The name of the Wastewater Treatment Plant (WWTP) to which this wastewater flows. If this wastewater does not flow to a WWTP, specify an identifiable name for the septic or other treatment system to which this wastewater flows. An arbitrary name may be used if you do not wish to disclose the real name.
- **wwtp_jurisdiction** – State, DC, US territory, or Freely Associated State jurisdiction name (2-letter abbreviation) in which the wastewater treatment plant provided in 'wwtp_name' is located
- **capacity_mgd** – Wastewater treatment plant design capacity. This should be the capacity for which the plant is permitted.
- **sample_type** – Type of sample collected, whether grab or composite. If composite, also provide the duration of sampling and type of composite, as listed in the Value Set (e.g., "24-hr flow-weighted composite"). A grab sample is defined as an individual sample collected without compositing or adding other samples, regardless of whether the sample matrix is liquid wastewater or sludge

- **sample_matrix** – Wastewater matrix from which the sample was collected
- **sample_collect_date** – The date of sample collection; for composite samples, specify the date on which sample collection *began*; note that this may be different than samples are dated for permit compliance: permits may require that sample dates correspond to the date sample collection *ends*
- **sample_collect_time** – The local time of sample collection; for composite samples, specify the time at which sample collection *began*
- **flow_rate** – Wastewater volumetric flow rate at the sample collection location over the 24-hr period during which the sample was collected. If only an instantaneous flow measurement is available, it may be reported in units of million gallons per day.

ANALYSIS

What is the most common analytical technique used for wastewater surveillance?

Last updated January 14, 2022
Wastewater surveillance can encompass a wide range of substances from illicit drugs to pharmaceuticals, counterfeit medications, population biomarkers, industrial chemicals, antimicrobial resistance genes, and viruses. The analytical technique used during a given wastewater surveillance program, then, will depend on the type of substance being tracked. For drugs, pharmaceuticals, population biomarkers, and industrial chemicals, mass spectrometry (MS) approaches are often used due to the method's high sensitivity and selectivity. MS can be coupled with either liquid chromatography or gas chromatography. For pathogens, such as SARS-CoV-2, and antimicrobial resistance genes, PCR is the most common analytical technique. See the answer to ***What exactly is PCR and how does it work?*** for more information.

What exactly is PCR and how does it work?

Last updated February 8, 2022
Polymerase chain rection (PCR) and reverse transcriptase (RT)-PCR (for the detection of RNA viruses) are molecular methods suitable for detection of low levels of pathogen nucleic acid in wastewater samples. PCR involves amplification of specific gene sequences followed by detection of the amplified gene. Quantitative PCR (qPCR) is the most widely used PCR method for pathogen detection (Girones et al. 2010) because it allows quantification (not just detection) of a specific gene target. To date, qPCR has been used for quantification of a wide range of viral pathogens (Blinkova et al. 2009; Hellmer et al. 2014), including SARS-CoV-2 (Alygizakis et al. 2021), and a diverse range of antibiotic resistance genes (Karkman et al. 2016; Pazda et al. 2019).
Digital PCR offers an alternative to qPCR. It may minimize interferences from PCR inhibitory substances (Sedlak, Kuypers, and Jerome 2014) and be particularly useful for quantifying low levels of pathogen in wastewater (Jahne et al. 2020).

What is next generation sequencing and how does it work?

Last updated February 8, 2022
Sequencing, in general, is the "process of determining the nucleic acid sequence – the order of the nucleotides" in DNA (or RNA). Next generation sequencing (NGS), specifically, involves sequencing millions of nucleic acid fragments in parallel and then using bioinformatics to piece

together the fragments. As a result, NGS is beneficial in wastewater surveillance for identifying specific pathogen strains (those with slightly differing nucleic acid sequences) responsible for outbreaks (Gwinn et al. 2019).

It's helpful to think of NGS in terms of an analogy to music. Think of a song as an organism (human or microbiological), the complete notes for that song as the organism's genome, and different measures (short sequences of notes) in the song as nucleic acid fragments. Now consider a situation where several different measures from disparate songs are all jumbled together—but you need to identify which songs are represented. NGS is the process of rapidly identifying those measures and piecing together which songs each measure came from to make sense of the mixture of notes. Even if all the measures for "Hey Jude" aren't present in the jumble, you may find enough of them to give you confidence that it was, in fact, one of the songs present in the mix. NGS can be used for identifying SARS-CoV-2 variants in wastewater because it detects specific mutations in the viral genome (i.e., measures in the song).

INTERPRETING RESULTS

Who is supposed to interpret the wastewater results?

Last updated May 12, 2023

Ultimately, health departments—a state or county public health agency, a city health department, a tribal health entity, or a territorial health organization—are responsible for interpreting and using wastewater surveillance data to inform public health decisions. For NWSS wastewater surveillance programs for COVID-19, much of this interpretation is based on the data analytics embedded into CDC's DCIPHER platform. Expand the answer to the next FAQ below to find out more about .

However, some wastewater surveillance programs opt to make their data public and downloadable, which gives the opportunity for school districts, universities, or other entities to use wastewater data to help inform their own public health responses. Here are some examples of how health departments are sharing wastewater data with the public:

- Colorado Department of Public Health and Environment
- Michigan Department of Environment, Great Lakes and Energy with Michigan Department of Health and Human Services
- Missouri Department of Health and Senior Services
- North Carolina Department of Health and Human Services
- Utah Department of Environmental Quality

Where does NWSS data go and how can the public get access?

Last updated June 2, 2022

NWSS wastewater surveillance data—whether from ELC-funded efforts or from the commercial wastewater testing contract—are uploaded to a shared portal (known as the Data Collation and Integration for Public Health Event Response, or DCIPHER for short) where they are evaluated by the NWSS analytic engine. The analyzed wastewater data are disseminated to the health departments via DCIPHER for public health action. While DCIPHER access is limited to health departments, NWSS data are available to the public via download from COVID Data Tracker or by making a public data request. To download data from COVID Data Tracker, you can either download metric-specific data by expanding the data table under the map or you can download all the historical metric data or all the historical concentration data. To make a public data request for historical wastewater concentration data and COVID incidence data, email the NWSS team with the subject line 'NWSS public data request.' Before you receive the data back from the NWSS team, you'll be required to sign a data use agreement.

Some NWSS data are excluded from COVID Data Tracker download and the public data request. This includes data from sewersheds with fewer than 3,000 people; data from sewersheds with missing population estimates; facility- or institution-specific data; sewersheds being monitored but without data being submitted to DCIPHER; data with quality issues; and data from Tribal sewersheds, unless they opt in to sharing their data. It is also possible for utilities to request that their data be excluded from public data requests and COVID Data Tracker. Utilities can do this by communicating their preference to their health department. The health department, in turn, would indicate in DCIPHER that the utility's data should not be made available publicly.

The table below summarizes which types of NWSS data are available to the public through either a data request to the NWSS team or by downloading from COVID Data Tracker.

Type of Data	Released via Public Data Request to NWSS Team	Released via Download from COVID Data Tracker	Not Released Publicly
Anonymized Sample Location Name (WRRF Name or Other Non-Facility/Institution Sampling Location Name)	☑	☑	
County Name and FIPS Code	☑	☑	
Wastewater SARS-CoV-2 Concentrations	☑	☑	
Wastewater SARS-CoV-2 Metrics, Including Trends, Percentiles, And Percent Change	☑	☑	
COVID-19 Case Incidence (Number of New Reported Cases) For Locations With 5 Or More Cases	☑		
Sewersheds With < 3,000 People or No Population Data			☑
Facility- Or Institution-Specific Data			☑
Sewershed Shapefiles			☑
COVID-19 Case Incidence (Number of New Reported Cases) For Locations With Fewer Than 5 Cases			☑
Laboratory Protocols			☑
Any Data for A Utility That Has Opted Out of Public Data Release			☑

What is normalization and how is it used by NWSS and ELC-funded jurisdictions?

Last updated January 27, 2023
Wastewater surveillance for COVID-19 involves the quantification of specific SARS-CoV-2 nucleic acid sequences (“genes”) using PCR (see ***What is PCR and how does it work?***), with results reported as the number of gene copies per volume of wastewater (or number of gene copies per mass of primary solids). Wastewater gene copy concentrations can go up or down over time due to changes in COVID-19 prevalence in the community, but also due to dilution with non-sewage flows or other conditions in the sewer. Therefore, it may be helpful to adjust the wastewater SARS-CoV-2 concentration data to account for influences other than changes in disease prevalence so wastewater data can be meaningfully compared over time. As described on the NWSS website, one way to normalize wastewater concentration data is to multiple the concentrations (gene copies per volume) by wastewater flow (volume per time), to obtain gene “loads” (gene copies per time, where time is usually in days). Flow normalization is the approach recommended by NWSS. Alternatively, NWSS wastewater concentrations can be normalized to the concentration of a fecal indicator. Fecal indicators are organisms (e.g., pepper mild mottle virus) or compounds specific to human feces that can be measured and expressed as a concentration, thereby giving an indication of how much human fecal material is present in the wastewater.

The jurisdictions receiving ELC NWSS funding approach normalization in slightly different ways, as shown in this table.

ETHICS

What privacy concerns are inherent to wastewater surveillance?

Last updated January 14, 2022
Because wastewater data are not collected at the individual level, individual privacy is generally not a concern in wastewater surveillance programs. Group privacy, however, can be at risk in wastewater monitoring programs that capture wastewater from small sewersheds, with the ethical concerns increasing as “the number of contributing individuals in a community or institution is smaller” (Canadian Water Network 2020). For this reason, NWSS wastewater data collected from sewersheds with fewer than 3,000 people are not available to the public.

Are there ethical guidelines available for wastewater surveillance?

Last updated June 2, 2022
Wastewater surveillance is an example of a public health surveillance activity (see the answer to ***Why is the word 'surveillance' used?*** for more information). And in any public health surveillance activity, public health goals must be achieved without imposing harm on individuals or groups. In 2017, the World Health Organization (WHO) published public health surveillance guidelines built around four ethical principles:

- Common good: sufficient oversight from public health agencies is required to ensure that the benefits of surveillance are shared
- Equity: public health surveillance can help highlight the health concerns of disadvantaged communities

- Respect for persons: information about individuals and groups needs to be protected to minimize harm
- Good governance: governance structures need to be accountable and transparent and foster community engagement

The Canadian Water Network's COVID-19 Wastewater Coalition adapted 14 of the 17 original WHO guidelines to wastewater surveillance (see the Canadian Water Network 2020 and Hrudey et al. 2021) and determined that the following WHO guidelines, ***using the original WHO numbering***, are applicable to wastewater surveillance:

1. Countries have an obligation to develop appropriate, feasible, sustainable public health surveillance systems. Surveillance systems should have a clear purpose and a plan for data collection, analysis, use, and dissemination based on relevant public health priorities.
3. Surveillance data should be collected only for a legitimate public health purpose.
4. Countries have an obligation to ensure that the data collected are of sufficient quality, including being timely, reliable, and valid, to achieve public health goals.
7. The values and concerns of communities should be taken into account in planning, implementing, and using data from surveillance.
8. Those responsible for surveillance should identify, evaluate, minimize and disclose risks for harm before surveillance is conducted. Monitoring for harm should be continuous, and, when any identified, appropriate action should be taken to mitigate it.
9. Surveillance of individuals or groups who are particularly susceptible to disease, harm, or injustice is critical and demands careful scrutiny to avoid the imposition of unnecessary additional burdens.
10. Governments and others who hold surveillance data must ensure that identifiable data are appropriately secured.
11. Under certain circumstances, the collection of names or identifiable data is justified.
12. Individuals have an obligation to contribute to surveillance when reliable, valid, complete data sets are required and relevant protection is in place. Under these circumstances, informed consent is not ethically required.
13. Results of surveillance must be effectively communicated to relevant target audiences.
14. With appropriate safeguards and justification, those responsible for public health surveillance have an obligation to share data with other national and international public health agencies.
15. During a public health emergency, it is imperative that all parties involved in surveillance share data in a timely fashion.
16. With appropriate justification and safeguards, public health agencies may use or share surveillance data for research purposes.
17. Personally identifiable surveillance data should not be shared with agencies that are likely to use them to take action against individuals or for uses unrelated to public health.

Adherence to ethical principles during wastewater surveillance efforts can be achieved by engaging social scientists and public health professionals throughout the duration of the program and performing extensive outreach to communities to promote meaningful knowledge exchange (Coffman et al. 2021).

In addition to the Canadian Water Network's adaptation of the WHO guidelines, the European Monitoring Centre for Drugs and Drug Addiction published Ethical Research Guidelines for Wastewater-Based Epidemiology and Related Fields in 2016. This document identifies the potential ethical risks in wastewater research and suggests strategies to mitigate those risks.

How can wastewater surveillance support sustainable development goals and equity?

Last updated June 2, 2022
Wastewater surveillance has the potential to help achieve the UN Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages, specifically Target 3.3 (By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases) and Target 3.5 (Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol) because of the wide range of substances that can be measured in wastewater. Although CDC's current focus for the National Wastewater Surveillance System is on COVID-19, national wastewater surveillance will be expanded to other targets (such as genes from antibiotic-resistant bacteria, norovirus, respiratory syncytial virus, and others) in the future.

CASE STUDIES

What are some examples of successful application of wastewater surveillance for COVID-19?

Last updated April 9, 2024
A few examples for COVID-19 and other health concerns are shown on our Wastewater Data Use Examples page. A great place to start for case studies from early in the COVID-19 pandemic is the US EPA's Compendium of U.S. Wastewater Surveillance to Support COVID-19 Public Health Response. In addition, our podcast offers interviews with water professionals involved in COVID-19 wastewater surveillance programs. And here are some dashboards showing examples of how health departments have implemented wastewater surveillance:

- Colorado Department of Public Health and Environment
- Michigan Department of Environment, Great Lakes and Energy with Michigan Department of Health and Human Services
- Missouri Department of Health and Senior Services
- North Carolina Department of Health and Human Services
- Utah Department of Environmental Quality