Planning Better Wastewater Sampling For Better COVID-19 Insight

Introduction

Even with the most precise analytical techniques and instruments, representative sampling is still key to reliable wastewater monitoring — for pandemic monitoring, industrial-pretreatment compliance, event detection, stormwater-runoff monitoring, process control, or wastewater-discharge compliance monitoring. For wastewater treatment plants (WWTPs) facing specific challenges in monitoring the SARS-CoV-2 virus that causes COVID-19, using automatic sampling in support of rapid-turnaround qPCR testing can deliver a seven-day advantage over trend data from other forms of clinical testing.

That can make a difference between simply documenting a community's exposure and playing a key role in protecting its future by providing quantifiable information needed to generate better, more timely public-health guidelines. Also, the right guidance on how to navigate CARES Act funding can make it easier to finance and implement SARS-CoV-2 sampling and testing programs.

General Wastewater Sampling vs. Sampling For SARS-CoV-2

The root of SARS-CoV-2 wastewater sampling is to identify the virus' presence and relative concentration as an advance indicator of anticipated COVID-19 infections in a given population. Unlike other sampling that works well enough at a WWTP headworks or effluent pipe, SARS-CoV-2 sampling is best implemented at strategically targeted locations throughout a sewershed (Figure 1). Combining timely wastewater sampling and non-invasive qPCR testing to monitor specific sources—e.g., neighborhoods, senior-care facilities, penitentiaries, colleges/universities, or even individual dormitories at those schools—can identify potential growth in COVID-19 cases up to seven days before other testing does. That includes documenting the influence of asymptomatic and presymptomatic individuals regardless of whether they seek out clinical testing or not. The firsthand experience at the University of Denver is a prime example of how beneficial that can be.
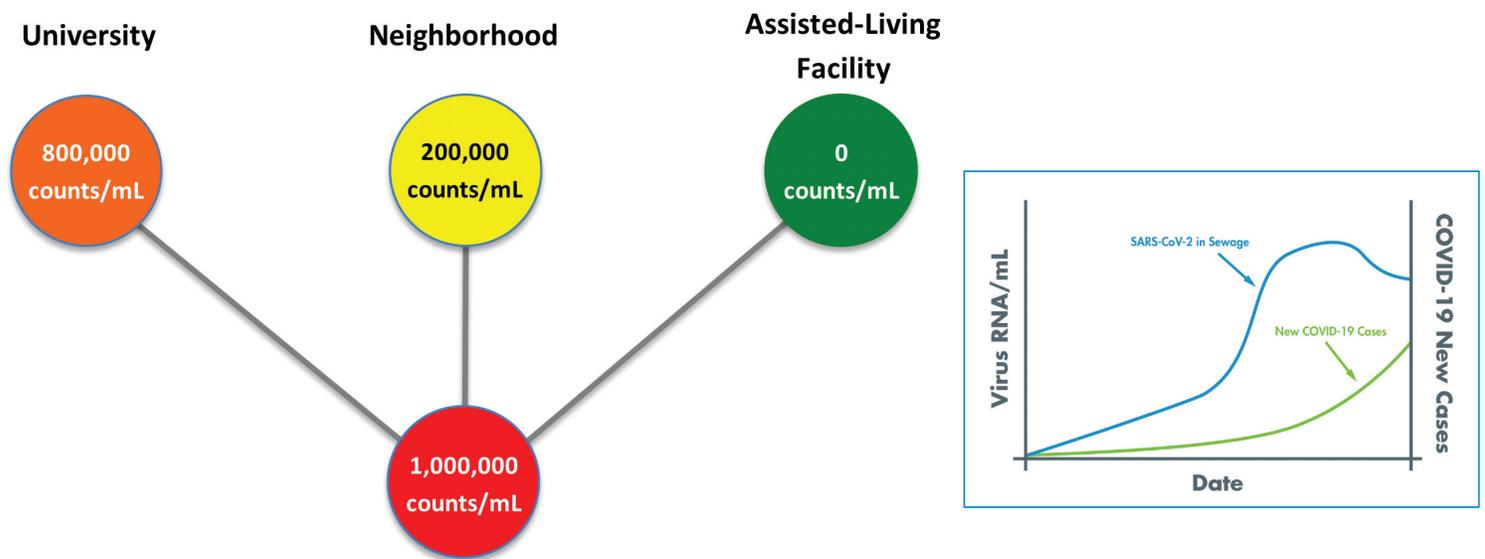

Figure 1. *Monitoring the presence of the SARS-CoV-2 virus at strategic locations throughout a sewershed—instead of at the WWTP headworks alone—provides a better picture of community exposure and the urgency to adjust public-health guidelines. The unit of measure—genomic count of RNA per milliliter (counts/mL)—does not correspond to specific numbers of people currently affected, but has demonstrated a strong correlation to the number of new COVID-19 cases occurring seven days later (inset). (Inset courtesy of LuminUltra)*

HACH®

Be Right™

Automatic Sampling's Advantages

Strategically located automatic sampling can be more helpful for quantifying evolving trends without increasing the number of field trips required. Capturing multiple samples into one composite-sample container at 15-minute increments enables a more representative view of SARS-CoV-2 trending at targeted locations, yet requires just one sample-retrieval trip per day. By contrast, a manual grab sample represents only an isolated snapshot at the specific time of sample retrieval (Figure 2). The same multiple-location, around-the-clock sampling benefits can apply to other types of wastewater monitoring as well.

When choosing any automatic sampler, look for features that will impact the accuracy and convenience of day-to-day operation—e.g., options for composite sampling or multiple individual samples, PTFE tubing for maximum chemical resistance, easy programming, and an intuitive user interface to make sampling parameters easy to set up and execute.

MANUAL VS. AUTOMATED SAMPLING		
Type	**Advantages**	**Disadvantages**
Manual	Low capital cost	Increased variability due to sample handling
	Personnel can compensate for various situations	Inconsistency in collection
	Personnel can detect specific events or document unusual conditions	High cost of labor assuming composite or multiple grab samples are collected
	No maintenance	Repetitious and monotonous task for personnel
	Extra samples can be collected in a short time if necessary	
Automatic	Consistent samples	Maintenance for batteries and cleaning
	Decreased variability caused by sample handling	Potential for sample contamination
	Minimal labor requirement for sampling	Initial capital cost
	Capable of collecting multiple grab samples and multiple aliquot composite samples	Susceptible to plugging by solids

Figure 2. While every sampling approach has advantages and disadvantages, automated sampling makes it easier to satisfy the need for frequent, consistent sampling in SARS-CoV-2 testing applications. Portable automatic samplers provide added flexibility to access those advantages across a series of locations over time.

Sample Collection Options

Choosing the best sample-collection options depends on the application at hand—whether for SARS-CoV-2 or other testing applications.

- **Grab Sampling.** In addition to providing a limited snapshot perspective, time-consuming manual grab-sample collection distracts key personnel from other important WWTP duties. That problem compounds as the number of monitoring locations increases.

- **Composite Sampling.** Automatic sampling simplifies the collection of frequent small samples into one vessel throughout the course of a day, making it easier to generate an accurate perspective of virus presence with just a single sample-pickup. This is the most common, practical approach for SARS-CoV-2 evaluation.

- **Single- vs. Multiple-Bottle Automatic Sampling.** Even if an automatic sampler is initially evaluated for SARS-CoV-2 composite sampling, consider other options that can be advantageous for subsequent epidemiological wastewater testing, process-control monitoring, or National Pollutant Discharge Elimination System (NPDES) compliance monitoring. Automatic samplers that offer a choice of both composite-sample containers and single-sample bottles (Figure 3 next page) make it easier to adapt sample collection to the unique needs of specific applications.
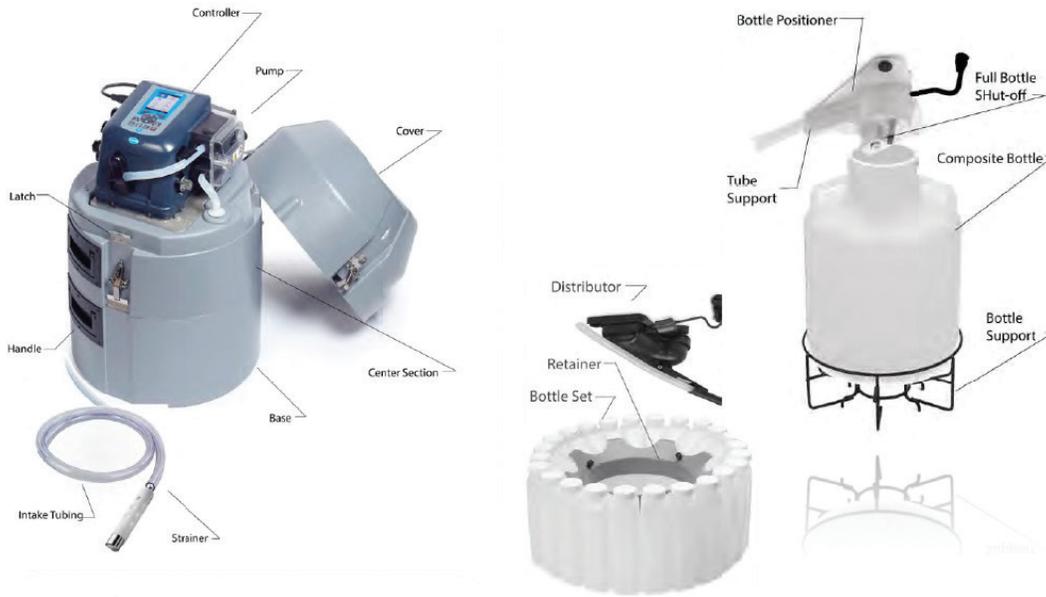
ANATOMY OF A PORTABLE SAMPLER

Figure 3. *Portable automatic samplers can collect composite samples in a single large bottle (far right) or individual grab samples in a series of separate bottles (bottom center), depending on the objectives of the testing program. Choose job-matched sampling tubes, strainers, and control options appropriate for the task at hand.*

The Final Step: Guidelines For Good Sampling Protocols

Follow these general best practices and points of caution in using automatic samplers to generate representative sampling for appropriate wastewater applications. (NOTE: Applications affected by oil, grease, and volatile organics are not compatible with automatic sampling.)

- **Sample Collection.** When switching to automatic sampling, take note of proper set-up precautions to ensure reliable readings:

  1. Collect samples where the wastewater is well mixed, as close as practical to the mid-point depth in the flow channel (Figure 4).
  2. Ensure adequate flow rates in sampler tubing to transport suspended solids effectively—i.e., typically at least 2 feet per second in tubing of at least 0.25" diameter.
  3. Obtain a sufficient volume of sample to perform all required analyses, plus any additional needed for quality control. Individual portions of a composite sample should be at least 100 milliliters in order to minimize sampler solids bias.

Also, the Centers for Disease Control and Prevention (CDC) provide additional strategic guidelines specific to COVID-19 wastewater-surveillance sampling.
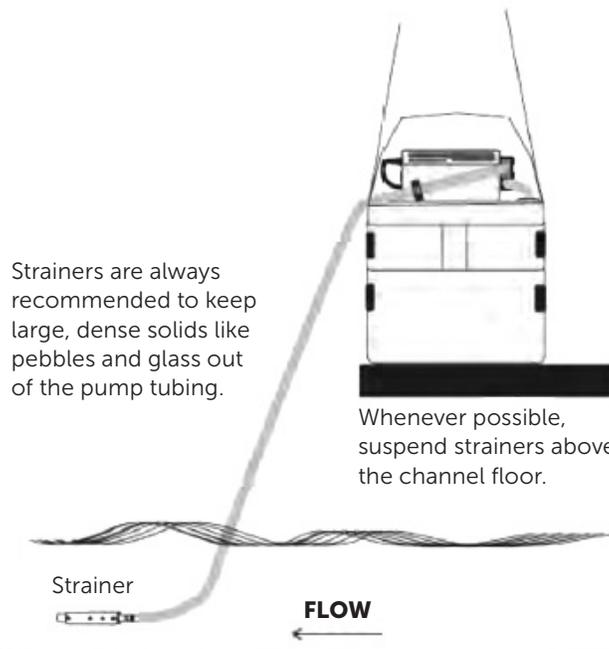
Figure 4. *Automatic sampling units should provide flexibility to match the needs of specific sampling programs—SARS-CoV-2, NPDES, etc.—including suitability for representative collection of toxic or conventional pollutants. Note the proper positioning of the hose and intake strainer suspended in the wastewater flow for collection of the most representative samples.*

Strainers are always recommended to keep large, dense solids like pebbles and glass out of the pump tubing.

Whenever possible, suspend strainers above the channel floor.

Strainer

FLOW

HACH®

- **Chain Of Custody.** Be sure to record all critical aspects of sampling—including the date, place, and time of sampling; sampler name; analyst name; date of analysis; analytical methods used; and analytical results. An automatic sampler should capture much of that data automatically.

- **Quality Assurance/Quality Control.** Being mindful of proper sample handling and analysis will provide higher confidence in test findings and the appropriate actions to take as a result.

- **Best Practices.** Adhere to these best practices to ensure accuracy and the most valuable insights from sampling and testing efforts.

  1. Use proper intake tubing materials and sizes (1/4" to 3/8") to suit the application. Where appropriate, choose PTFE over vinyl to prevent premature deterioration caused by sample chemistry or clean-in-place (CIP) solutions.

  2. Secure hose connections with appropriate hose clamps to prevent leaks or sample bypass. Avoid scoring barb fittings when removing tubing.

  3. Appropriately sized strainers should be weighted, as necessary, to maintain their appropriate position in high-velocity flows.

  4. Install sampler tubing with a good slope for drainage. Inspect tubing at least quarterly for damage, cracks, kinks, hardening, discoloration, or bloating. Route tubing so that it has no sags or coils that can trap water during the purge cycle and avoid placing the strainer on top of silt or sediment that can impede sample flow.

DOC040.53.10220.Mar21

HACH®

Be Right™