TRACKING CORONAVIRUS IN SEWAGE — ANTICIPATED DEVELOPMENTS

by David Jonas Bardin - updated 30 June 2020 [davidbardin@aol.com] **DRAFT**

I share updates of this paper with (a) utilities; (b) public health experts; (c) state and local decision-makers; (d) Congressional appropriators; and (e) other interested people and organizations because surveillance of wastewater may usefully gauge community-level trends in SARS-CoV-2. **Subject to further updates**, developments may influence (or set context for) assessing *community* (as contrasted with *individual*) extent of coronavirus.

1a.1) On **May 21**, the **Water Research Foundation** (WRF) hosted a Virtual **Congressional Briefing** ("attended" by 1,171) on ENVIRONMENTAL SURVEILLANCE OF COVID-19 GENETIC FINGERPRINT IN SEWERSHEDS. [1] Presenters stressed collaboration engaging (a) utilities (b) health authorities (national, state, local) (c) labs and (d) researchers. They flagged resource needs.

1a.2) WRF posted slides from its **International Summit** on COVID-19 and Sewershed Monitoring held April 27-30 which convened expert presenters and four working groups. [2] Summit described early warnings and determination of trends as first uses of sewage monitoring.

1a.3) On **June 22**, WRF posted "Wastewater Surveillance of the COVID-19 Genetic Signal in Sewersheds" - a 27-page Report explaining advice of global experts and the four working groups. [3] **Current feasibility** of such surveillance varies for different uses, experts concluded (Report, pages 7-8): [4]

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[1] See https://www.waterrf.org/event/virtual-congressional-briefing-environmental-surveillance-genetic-fingerprint-covid-19. Presenters were: Peter Grevatt, PhD, CEO, The WRF;
Daniel Gerrity, PhD, Principal Research Scientist, Southern **Nevada** Water Authority (**SNWA**)
Jim Pletl, PhD, Director of Water Quality, Hampton Roads Sanitation District (**HRSD** in **VA**), and
Ken Williamson, PhD, Research and Innovation Director, Clean Water Services (**CWS** in **OR**).

[2] See https://www.waterrf.org/event/virtual-international-water-research-summit-covid-19.

[3] See https://www.waterrf.org/sites/default/files/file/2020-06/COVID-19_SummitHandout-v3b.pdf. Report sets out tasks and membership of each working group (at pages 3 and 1). Co-chairs were:
— Working Group 1 (Develop best practices and standardized procedures for collection and storage of wastewater samples). Co-chairs: Chuck Gerba, Univ. of Arizona; Jim Pletl, Hampton Roads Sanitation District [**HRSD**]; Daniel Gerrity, Southern Nevada Water Authority [**SNWA**]; Alice Fulmer, WRF.
— Working Group 2 (Develop best practices for the use of tools to identify the genetic signal of SARS-CoV-2 in wastewater samples). Co-chairs: Krista Wigginton, Univ. of Michigan; Frederic Been, KWR Water Research Institute; Joan Rose, Michigan State Univ.; Christobel Ferguson, WRF.
— Working Group 3 (Develop recommended approaches for the use of data on the genetic signal of SARS-CoV-2 to inform trends and estimates of community prevalence): Co-chairs: Chuck Haas, Drexel Univ.; Doug Yoder, **Miami-Dade** Water and Sewer; Gertjan Medema, KWR Water Research Institute; Vanessa Speight, Univ. of Sheffield; John Albert, WRF.
— Working Group 4 (Develop strategies to communicate implications of wastewater surveillance results with public health community, elected officials, wastewater workers, and the public). Co-chairs: Jim McQuarrie, Metro Wastewater Reclamation District; Cathy Bernardino Bailey, Greater Cincinnati Water Works; Dan Deere, Water Futures; Lexie Vean, WRF.

[4] "Use of wastewater surveillance to assess increasing trends in occurrence of COVID-19, especially in early detection, has been successfully demonstrated. While the use of wastewater surveillance to identify a decrease in disease occurrence is also technically feasible, it may be complicated by the persistence of fecal shedding of SARS-CoV-2 RNA long after individuals have recovered from infection. In other words, wastewater surveillance is an effective leading indicator of COVID-19 emergence but may be a lagging indicator of subsidence, at least relative to clinical data. .... Although the assessment of the prevalence of community infection was identified as the highest priority use case, Summit participants found that there are additional variables that need to be evaluated for wastewater surveillance to be effectively used in such a manner.". Report page 7.

Trends/changes in occurrence (for early detection of occurrence/reemergence and for tracking impact of medical and social interventions):
- Very feasible, when curves are *increasing*.
- Somewhat feasible, when curves are *decreasing*.

Assessment of community prevalence:
- May or may not be currently feasible to track disease prevalence in the community, to identify areas of concern, as well as areas that are not impacted by the virus to estimate level of infection in a community.

Risk assessment:
-May or may not be currently feasible to assess risk to utility workers and those exposed to raw sewage. [5]

Viral evolution:
- Not feasible at this time: Source tracking virus (emergence of genetic variants and their locations). [6]

1b) On **May 27**, Water Science and Technology Board (**WSTB**) of **National Academies** of Science, Engineering and Medicine (**NASEM**) hosted "a panel discussion with experts on public health and wastewater monitoring to discuss the potential value of data on SARS-CoV-2 in wastewater to inform public health management and what is needed to build a useful surveillance network" [7] — convened by WSTB Chair Catherine Kling, **Cornell U**. Dyson School of Applied Economics & Management — entitled "Wastewater Monitoring for COVID-19 Disease Surveillance." [8]

1c) On **June 30**, WRF awarded to **Trussell Technologies** WRF project 5089 (Laboratory assessment project) moving forward from June 5 Request for Qualifications (RFQ). [9] WRF and Trussell must now work out contract scope of work. (See http://www.trusselltech.com.)

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[5] CDC is pursuing these and other issues. See "CDC Announces BAA in Response to COVID-19" at https://govreporter.com/cdc-announces-baa-in-response-to-covid-19/.

[6] "The viral evolution use case aims to characterize and track changes in the viral genome across time, ... This type of analysis requires sequencing of longer gene sequences than are currently being targeted for wastewater surveillance. Hence, this use application will necessitate collaboration with laboratories with special analytical capability to amplify sufficiently long regions of viral RNA to determine single nucleotide polymor- phisms and point mutations that accumulate over time. The majority of laboratories proposing to implement wastewater surveillance for the genetic signal of SARS-CoV-2 are currently using either quantitative polymerase chain reaction (qPCR) or digital droplet PCR, both of which target relatively short sequences of RNA and would be unlikely to include sufficient material to track whole genome changes of the virus. However, as sampling and molecular methods advance, it may be possible for additional laboratories to use wastewater surveillance to help assess the evolution of infectious micro-organisms within a community." Report page 8.

[7] See https://www.nationalacademies.org/events/05-27-2020/water-science-and-technology-board-spring-2020-meeting?mc_cid=aced4b19b0&mc_eid=9c2cf98f53. Watch again: https://livestream.com/accounts/7036396/events/9143805.

[8] Panel considered decades of related experience, successful application to coronavirus in Europe and proposed expansion there to 100 "sentinel" cities, interest of many USA sewage authorities (e.g., 30 in Colorado alone), usefulness of current methods to identify trends and provide early warnings quickly and cost-effectively, opportunities to enhance methods, resource needs, leadership needs, as yet un-bridged "cultural" gaps. — David Sedlak, **UC Berkeley**, Moderated. Panelists were:
— Gertjan Medema, KWR Water Research Institute, **Holland**
— Vincent Hill, **Centers for Disease Control and Prevention**
— Barry Liner, **Water Environment Federation**
— Mark Gold, **California** Natural Resources Agency
— Nicole Rowan, **Colorado** Department of Public Health and Environment
— Krista Rule Wigginton, **University of Michigan**.

[9] WRF had sent out RFQ for a team to assess existing laboratory methods to perform statistical analyses for coronavirus with comparable and repeatable test results. RFQ submissions were received on June 19.

WRF's RFQ goals included: project start week of July 13 and final deliverable week of August 31. [10] RFQ appended a list of 56 interested USA laboratories. RFQ states:

> The key questions to be answered by this project are:
> 1. Which laboratory methods are best-suited for producing reliable quantitative genetic signals for SARS-CoV-2?
> 2. To what extent are laboratories able to reproduce sample results by following documented QA/QC procedures?
> 3. Which steps within a given method are most critical to ensure accuracy and precision?
> 4. What is the limit of detection for the recovery of a genetic signal for SARS-CoV-2 in wastewater and how does it vary across the available methods?

[Both EPA and CDC were briefed on this project and asked to participate or advise as WRF's project unfolds, so WRF results are expected to fold into EPA-CDC project (1d.2, below).] [11]

1d) EPA's Cincinnati research center water lab is planning a multi-faceted project with Metropolitan Sewer District of Greater **Cincinnati** (**MSD**). **EPA** states: [12]

> 1d.1) "With an infectious disease like COVID-19, people may be contagious before they show any symptoms. Preliminary research indicates that monitoring wastewater for the presence of SARS-CoV-2 may be useful as a sensitive early indicator of low levels of infections in the community. Having an early warning system to alert public health officials about infection in a community would be helpful. Likewise, monitoring SARS-CoV-2 in wastewater may also provide an indication of decreasing levels of infection within a community.
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> 1d.2) "The genetic material of the virus that causes COVID-19 has been detected in feces from patients diagnosed with the disease, as well as in raw sewage. EPA researchers, working with researchers at **CDC** have identified a need for sensitive, standardized methods to detect and quantify SARS-CoV-2 in raw sewage, including infectious virus.
> "The researchers are developing, evaluating, and applying methods for concentrating and quantifying SARS-CoV-2 with molecular and live, or infectious, assays in wastewater. Once the methods are developed, they will use it to quantify the level of SARS-CoV-2 detected in raw sewage at wastewater treatment plants."
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> 1d.3) "Preliminary research from across the country and around the world indicates that monitoring wastewater for the presence of the genetic marker of SARS-CoV-2, its RNA, may be useful as a sensitive early indicator of low levels of infections in the community. Having an early warning system to alert public health officials about infection, or the lack of infection, could be helpful to direct resources, such as individual testing, to the communities that might need it most.
> "EPA researchers, working with **Ohio EPA**, **Ohio Department of Health**, and the **Cincinnati Metropolitan Sewer District**, are assessing a molecular approach and initiating a pilot monitoring effort to better understand factors affecting the virus in sewage. The results of this research are expected in summer of 2020."
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> EPA hybrid research and pilot project may check potential "hot spots", such as assisted living facilities and prisons. It was instigated by both **Governor of Ohio** and EPA's Office of R&D. [13]

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[10] See https://www.waterrf.org/sites/default/files/file/2020-06/RFQ_5089.pdf.

[11] On May 29, WRF had invited labs with minimal qualifications to participate. Initial responses were due June 2. The USA labs list can change and 21 international labs are interested.

[12] See https://www.epa.gov/healthresearch/research-covid-19-environment.

[13] Jay L. Garland, USEPA Office of R&D, June 16, 2020, "SARS CoV-2 Wastewater Monitoring: USEPA Office of Research & Development | Perspectives/Activities" — 22 slides presented to California Water Environment Association (CWEA).

1e) On **June 16**, National Instititute of Standards and Technology (**NIST**) hosted a webinar on "Measuring SARS-CoV-2 in Wastewater and Fecal Material: A Call for Standards". [14] NIST identified "unique measurement challenges and opportunities in three areas" the first being: "Biosurveillance of Wastewater: Local public health labs can monitor sewage treatment facilities to measure the rise and fall of COVID-19 in a community; potentially as a tool to help predict future waves of outbreaks." [15]

1f) On **June 29**, National Association of Clean Water Agencies (**NACWA**) published *Clean Water Utility Considerations for Epidemiological Surveillance of Wastewater for COVID-19 (SARS-CoV-2)* for member agencies. If individuals have questions about the document, please contact Emily Remmel, NACWA's Director of Regulatory Affairs by phone at 202-533-1839 or by email at eremmel@nacwa.org.

1g) Water Environment Federation (**WEF**) [16] .... [to be completed]

2) **SNWA**, a drinking water utility with its own in-house lab capable of qPCR analyses, has received liquid sewage samples from two local sewage utilities twice a week since the first week of March (plus extra samples for special studies). SNWA has analyzed 60 liquid samples and 20 sludge samples. See https://t.co/xMb4x2XdXC?amp=1.
— SNWA is a cooperative; its seven members serve 2.2 million people.

3) **HRSD**, a wastewater utility which serves 1.8 million people in 18 cities & counties, is monitoring SARS-CoV-2 genetic material in eastern Virginia:
— HRSD has sampled sewage inflows at its 9 largest wastewater treatment plants (WWTPs) since week of March 9 (first utility to do so) and continued weekly monitoring since. It has also worked to develop and optimize methods. (Prior to outbreak of Covid-19, HRSD similarly monitored opioids in sewage.)
— HRSD has communicated sampling plans and results to the VA Department of Health (VDH).
— HRSD has had its own in-house lab for five or six years. Lab now uses RT-digital PCR method.
— (This project is not using HRSD lab's limited equipment for meta-genomic analysis.)
— HRSD management and board (Commissioners) support and encourage this program.
— HRSD has so far collected and tested 324 samples. At WRF Congressional Briefing, HRSD estimated its **costs** as $100/sample, not including cost of concentration (maybe $30 per sample). Its "Covid-19 Monitoring Investment" includes specialized **personnel** (1 Manager with expertise in PCR, microbiology, wastewater for 10-20 hours per week; 2 fully trained analytical specialists for 12 hrs/week; 2 fully trained

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[14] See https://www.nist.gov/news-events/events/2020/06/nist-hosted-webinar-measuring-sars-cov-2-wastewater-and-fecal-material. A recording of the webinar is available at that site. Another NIST webinar in 3 months is likely.

[15] Scott Jackson of NIST opened and closed. Presenters were:
Bharat Ramakrishna, OpenBiome, "Fecal microbiota transplantation: Responding to Covid19 pandemic";
Manoj Dadlani, CosmosID, "Overcoming the Validation Challenges of a Diagnostic for SARS-CoV-2 in Stool";
Katerina Papp, Water Quality R&D, ... [**SNWA**], "Wastewater Surveillance of SARS-CoV-2 in Southern Nevada: Challenges for Sample Collection, Processing, and Analysis": Abstract: "... Despite the tremendous potential for wastewater surveillance of SARS-CoV-2, there are multiple challenges associated with detection of its RNA in complex wastewater matrices, including ... co-concentration of inhibitory substances."
Kyle Bibby, University of Notre Dame, Title TBA
Aparna Keshaviah, Mathematica, "Testing Wastewater for SARS-CoV-2: Aligning Validation and Policy Needs". Abstract: "... Wastewater testing provides a new way to rapidly measure the viral exposure of thousands of people in a community. But given the novelty of approach, public health and public policy officials need to be confident that the method yields reliable information. ... Beyond intra-lab validation (to improve viral detection and quantification), approaches to explore include inter-lab validation (...), meta-regression (...), and data triangulation (...)."

[16] See www.Wef.org/coronavirus, https://wef.org/news-hub/wef-news/coronavirus-and-water-systems/ and https://wef.org/news-hub/wef-news/residuals-and-biosolids-issues-concerning-covid-19-virus/.

sample collection.specialists for 36 hrs/week) and **equipment** ($70k for digital PCR and $70k for automatic RNA extractor) and **supplies** (wastewater concentrator; portable refrigerated samplers).
— HRSD people were active in WRF's Virtual Summit in April. [17]
— HRSD Commission met on May 26. Agenda item 13 — "COVID-19 Wastewater Surveillance Study Briefing" — was presented to and discussed with HRSD's eight Commissioners (who are appointed by Governor of VA and serve at his pleasure).

> Agenda brief: "HRSD has been developing capabilities to perform microbial source tracking methods in-house over the past five years. This experience and knowledge gained by providing services to local jurisdictions positioned the Water Quality Department well to explore wastewater surveillance as a tool to inform health professionals here in Hampton Roads regarding the current COVID-19 event.
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> "Wastewater surveillance, in this case, is a monitoring approach that samples wastewater and analyzes the samples for genetic material specific to the SARS-CoV-2 virus. This information can be used to inform localities as they make decisions relative to whether this event is increasing or decreasing in magnitude and how these changes differ between localities over time. For example, health professionals could use this information, in combination with clinical data, to decide if and when changes can or should be made to approaches in place to mitigate the current event. In a long-term monitoring context this surveillance tool could be used to detect the onset of an event. Staff will provide a presentation to describe the current monitoring program and conclusions drawn thus far."

— Meeting minutes (with audio file) attach agenda (including quote above) and slides which quantified CDC diagnostic panel for each of 9 sites, week by week, for 10 weeks. (They also provide one composite for comparative purposes.) HRSD's original Goal was: Regional study that fully captures the rise and fall of COVID-19 cases. Later, its two Study Objectives were: 1. describe the trends in SARS-CoV-2 occurrence; and 2. assess the 'true' prevalence of COVID-19. [18]
— HRSD is preparing a report for publication.

3a) On June 3, **VDH and HRSD** publicly presented goals and results. [19] **VDH** summarized:

- Surveilling wastewater for COVID 19 may provide some additional information to inform re-opening decisions or signal a resurgence of the disease.
- In order for the wastewater surveillance to be useful, it has to be widespread, frequent and long term.

4) **CWS** is collaborating with Oregon State University (OSU) in research to track evidence of COVID-19 in Washington County's sewage collection and treatment system. (They have $100k of National Science Foundation awarded research funds.) CWS lab staff has begun collecting targeted micro-sewershed samples from 20 sites within this system. CWS concentrates samples and sends to OSU for analysis and interpretation. CWS will collect samples weekly for 52 weeks. This research will analyze genetic evidence of COVID-19 in wastewater, determining how/if/when any virus presence breaks down in wastewater systems and will examine specific local sources like hospitals, schools, retirement homes. (See https://www.opb.org/news/article/oregon-coronavirus-tracing-through-sewer-pipes/.)
— Principal Co-Investigators are OSU's Drs. Tyler Radniecki and Christine Kelly.
— Oregon Health Authority (**OHA**) favors expansion of OSU/CWS project to 30 plants in Oregon over two years to track spread, recession, and any new wave of infections.
— CWS serves ~610,000 residents in suburban communities west of Portland, Oregon.

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[17] Director of its Water Quality Department addressed plenum.

[18] See https://www.hrsd.com/sites/default/files/assets/Documents/pdfs/Commission_Minutes/2020/05-26-2020DRAFTCommissionMinutes.pdf. Agenda for Item 13 at page19 of 264; presentation slides (Attachment #7) at pages 202-216 of 264. In audio file, Item 13 ran ~9:46 am to ~10:28 am.

[19] For slides and choice of Zoom or YouTube recording of June 3 webinar, see http://www.vawarn.org/news/21/covid-19-bi-weekly-webinars/.

— CWS 5-member Board of Directors consists of the five elected Washington County Commissioners. [20]

4a) **Bergen County Utilities Authority** (in NJ) is collaborating with Columbia University in research, similar CWS/OSU research, which was described in AECOM's June 18 webinar [see paragraph (9.1)].

5) **Utah** Department of Environmental Quality (**DEQ**) completed a 5-week pilot project, coordinated with Utah **DOH**, and continues to take sewage samples from 10 wastewater treatment plants (WWTPs) for analysis at three academic labs which use RT-qPCR methods. DEQ has posted a description and a dashboard displaying results. [21] Excerpts [emphasis added]:
— Scientists at the University of Utah, Utah State University, and Brigham Young University developed a uniform method to measure the genetic material of the virus in sewage entering treatment plants:
- The laboratory method includes the same processes used for most clinical COVID-19 diagnoses.
- Virus concentrations were coupled with wastewater flow and service area populations to estimate viral concentrations in units of SARS-CoV-2 copies/100,000 people per day.
- This metric provides an indicator of changes in community infection rates in each treatment plant's service area.

— Utah DOH is analyzing pilot project data and will determine whether sewage sampling can help in the *overall* Covid-19 response.
— Next step is to figure out how to use information *in communities* as state expands program to more WWTPs. (Utah has 29 WWTPs that treat 1 million gallons per day or more and 130 smaller WWTPs.)

6) **Maryland** Department of the Environment (**MDE**) has initiated a pilot project, coordinated with MD Department of Health (**MDH**). On **June 11** MDE awarded contract to CosmosID, which uses qPCR methods and does meta-genomic analyses. MDE seeks to sample at four WWTPs (both urban and rural) over 90 days, with 24 samples for each to generate time series. MDE's [estimated] budget is $50,000.
— See **May 22** RFQ: "Pilot Study of COVID-19 viral load in waste water." [22] RFQ states;
- Globally and nationally leaders are seeking tools to help inform decision making to manage the Covid19 pandemic. "As we are poised to reopen economies across the globe, environmentalsurveillance of sewer sheds is an innovative, yet proven approach that holds great promise as an early, community level indicator of the presence of COVID-19 - when such an indicator is desperately needed."
- MDE "is seeking pathogen detection to develop a testing regime to serve as an early warning system for leadership to tune regional and statewide strategies to control the spread of Covid-19 disease."

6a) **Frederick County MD** Division of Utilities and Solid Waste Management has contracted to send sewage samples for 13 weeks to CosmosID.

7) **Fairfax County VA** is gathering information to determine feasibility of a pilot project. They will be coordinating with VDH. Fairfax may sample sewage reaching its own largest WWTP, which treats ~40% of Fairfax sewage. It is exploring contracting with HRSD lab to analyze such samples at cost (pursuant to HRSD's Municipal Assistance Program for VA entities).

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[20] CWS previously participated in Biobot Analytics'a national research with other utilities, doing weekly composite samples at each of their four water resource recovery facilities for 12 weeks (beginning week of March 30). Peak RNA in CWS samples jibed with health statistical data.

[21] See https://udwq.shinyapps.io/pilot-ww-virus-db/ and https://ksltv.com/439221/water-quality-engineers-detect-coronavirus-through-sewage/.

[22] See https://emma.maryland.gov/bare.aspx/en/fil/download_public/3D2A5372-F1E9-4E64-86EB-7F36D273AB3C?file_context%5Brfp%5D=25154.

7.1) Some 20% of **Fairfax** sewage, treated at **AlexRenew**'s WWTP, will be sampled for academic research consortium led by NC State U. [23] DC Water treats ~25% of Fairfax sewage. See (7b).

7a) **DC Water and Sewer Authority** (a.k.a. DC Water), which transports and treats sewage from MD and VA as well DC, has "decided to move ahead with a broad national look at this issue." [24] **DC Water**, DC **DOH**, and Department of Energy and Environment (**DOEE**) have not yet sorted out their respective roles.
— Since April, DC Water has been saving and freezing unprocessed weekly intake samples at its WWTP.
— DC Water has agreed to provide samples to academic research consortium led by NC State U. [25]
— On June 3 DC Advisory Neighborhood Commission (ANC) 3D asked Mayor to give "serious consideration" to enhancing person-by-person testing and contact tracing" as surveillance tools "by testing for Covid-19 in sewage." [26] — On June 8, ANC 3/4G approved a Resolution Requesting that DC Water and the District DOH Examine and, If Feasible, Implement Sewage Testing for Covid-19. (See: https://anc3g.org/wp-content/uploads/2020/06/ANC-DC-Water-Sewage-Testing-Resolution-6-8-20.pdf.)
— On June 16, ANC 3F approved a Resolution on Coronavirus Testing of Sewage. [27]

7b) **City of Toledo OH Department of Public Utilities**, in order to implement a 10-week pilot project, in collaboration with **Lucas County DOH**, contracted on June 10 with CosmosID in Rockville, MD, for sewage sampling and testing and help with project design and results interpretation.

7c) **State of Ohio** Wastewater Monitoring Effort:
• Timeline
—Governor Devine asked what it would take to develop a state based wastewater effort on Memorial Day
—**Ohio EPA**, **ODH**, **Ohio Water Resource Center** (in coordination with state university system researchers) are implementing a Phase A surveillance plan [with following goals:]
• Testing to begin in July
• ~ 50 sites at least weekly
• Initial focus on major metropolitan areas and other at risk communities
—Bringing environmental scientists, wastewater engineers, and public health professionals together to develop meaningful data. [28] (I understand Ohio Legislature plans to fund out of CARES.)

8) **Miami-Dade** [County]WASD has sampled sewage inflows at three of its WWTPs weekly since March 25, sending 24-hour composite samples to Biobot Analytics lab in MA for qPCR analyses and receiving results a week later. Results for first 15 samples varied substantially, including some spikes with weekly variations of 6 or 7 times prior week results. [29]
— WASD advises that this variability raised doubts as to accuracy of viral results.
— For these reasons, Miami-Dade has not used reported data as basis of decisions.

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[23] On May 12, NSF awarded $200,000 to this consortium. See https://www.nsf.gov/awardsearch/showAward?AWD_ID=2029025&HistoricalAwards=false.

[24] May 31, 2020, e-mail to Chairman of Advisory Neighborhood Commission (ANC) 3/4G.

[25] See footnote 22 for NSF grant to this academic research consortium.

[26] E-Letter dated June 3, signed by Chairman ANC 3D.

[27] Signed Resolution not yet posted. For draft see http://anc3f.com/wp-content/uploads/2020/06/ANC3F-Resolution-re-Sewage-Testing.docx.

[28] Slide 19 of EPA slides cited in footnote 12.

[29] On June 1 Biobot shifted most efforts from research to service mode, with all lab work now to be done in house (none at MIT lab). For links to "Recent articles" see https://www.biobot.io/media. Biobot has not yet posted its own summary of its national research project, but says it and its research collaborators intend to prepare a new paper on that research.

— Miami-Dade says these data support conclusion that community infection rates are several times higher than reported infections based on testing individuals.
— Local health officials are aware of WASD's sampling and testing and will be included in data sharing as results become available and methodology of sewer shed monitoring is perfected.
— WASD hopes that these methods can become an early warning system for the community and a very cost-effective system for verifying the status of community infection rates over time. This could be very important as a tool for managing restrictions on public interactions as the economy re-opens and infection rates potentially begin to climb again. More broadly, sewer shed monitoring could become a much more common public health indicator in the future, an entirely new role and point of collaboration between utility operators and public health agencies.
— WASD plans to write reports when its projects conclude.

9) **New York City**'s Department of Environmental Protection (DEP) began sending composite sewage samples a few months ago from some of NYC's 14 WWTPs to Stanford University in CA for analysis. Its Deputy Commissioner explains:

> "The COVID-19 pandemic has brought forth an opportunity for the New York City[DEP] to further enhance the services it provides for public health and environmental protection for all New Yorkers, and to advance our vision to become a world-class water and wastewater utility.
>
> "The DEP Bureau of Wastewater Treatment (BWT) is working to implement molecular monitoring techniques in sewage to help inform the City's COVID-19 response, and to prepare the City for future challenges of a similar nature. Similar work in Paris and Amsterdam identifying the genetic signal of the virus in the sewage make DEP's work a potentially valuable tool to identify hot spots and provide early-warning triggers for disease spread.
>
> "Our staff has been engaged with other national experts to define the state of the science and assess the role that tracking of CoV-SARS-2 RNA (the virus that causes COVID-19) may play in informing the difficult decisions that our public health professionals and elected officials will likely have to make over the course of the next few months and potentially well into next year.
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> "DEP's assessment to date finds that the analytical testing technology is well developed but still a rather rough tool. With further refinement, it may supplement the other epidemiological data that DOHMH collects, and drive decisions on medical resources and the rate of reopening of our economy. With additional work, we could eventually be able to estimate the population affected by the virus by monitoring sewage. This capability is still in its early stages. However, as epidemiological modeling tools are completed, tested, and validated, they could be a powerful tool that may provide an independent, actionable information source not just for this virus, but as for yet unknown pathogens in the future.
>
> "DEP is currently working in partnership with a team from NYU, Stanford University, and U. of Michigan to refine the analytical methods and deploy the ability to track the genetic material (RNA) from the CoV-SARS-2 in the City's wastewater. In addition, CUNY is serving a supporting function with the goal of expanding its role as capabilities and knowledge further develops in this specialized area. We also are closely coordinating with DOHMH to ensure that the data generated by DEP meets DOHMH stringent quality criteria and to help drive the difficult decisions that lie ahead.
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> "We are collecting samples from all 14 Wastewater Resource Recovery Facilities and sending them to Stanford University for analysis. More importantly, we have set up a team at our Newtown Creek Microbiological Laboratory to move to conducting this time-sensitive analysis in-house, eliminating delays and uncertainty caused by shipping samples. Our staff is committed to work as long as necessary to process and analyze the samples. To that end, we have staffing and equipment requests targeted to this need, which would allow DEP to play an important role in

> the fight against the impact of the coronavirus. This an important part of NYC DEP's core mission is to protect public health and enhance the environment for all New Yorkers."

[Letter dated May 28, 2020, to Hon. Gale A. Brewer, Manhattan Borough President (MBP), from Deputy Commissioner Pamela Elardo, P.E.]

9.1) At **AECOM**'s **June 18** webinar (EARLY WARNING: COVID-19 DETECTION IN WASTEWATER STREAMS), MBP Gale Brewer said that DEP should get $230,000 for a one-time purchase of needed new equipment and permission to fill three vacancies with experts needed to conduct the work — both of which she advocated to "get fast local testing" and "real time" results, as did City Council Health Committee Chairman Mark Levine. [See https://communications.aecom.com/earlywarningcovid19testing.]. DEP's old PCR machine can analyze only two samples a day.

10) Covid19 Wastewater-Based Epidemiology **Collaborative** (https://www.covid19wbec.org) lists 86 WBEC sites worldwide - of which 31 WBEC sites are in USA: HRSD, SNWA and 29 academic labs (often partnering with utilities, identified or anonymous). [30]

(11) **Syracuse University** and the **SUNY College of Environmental Science and Forestry** will routinely test dorm wastewater for the coronavirus when students return this Fall. "We could see changes in the signal in the wastewater a week before we see a signal in the health care system," said SU public health associate professor David Larsen. [31] Dorm sewage could contain RNA from both fecal and soap-and-water-wash shedding. (Other universities may be considering such WBEC steps.)

(12) **Actionable surveillance** opportunities (notably including pilot projects) should not be missed (in my opinion) to await long-term research (which I also value). Perfect can be enemy of the good. Although we don't know all the answers about wastewater-based epidemiology (WBE), the same is true of other epidemiological tools (such as individual testing and diagnoses) that decision-makers say they consider (and mass media endorse as "the science").

(13) Italy's National Institute of Health (**ISS**) in the Ministry of Health has periodically sampled and analyzed wastewater from several cities since 2007 as part of its environmental virology program. Last week, ISS disclosed detection of coronavirus RNA in 2019 samples taken from Turin and Milan sewage months before the first clinical diagnoses of Covid-19 disease in those cities. [32] I want to learn more about time lags between samplings and ISS analyses and whether Italy realized any early warning benefits.

Acknowledgements: William R. Harris, Mary D. Lasky (InfraGard); Rita Colwell, Joseph Cotruvo (CosmosID); Peter Grevatt, John Albert & Christobel Ferguson (WRF); Dan Gerrity (SNWA); Leila Rice, Jennifer Cascio, Ted Henifin, Jim Pletl, Jamie Mitchell, Raul Gonzalez & Kyle Curtis (HRSD); Marcia Degen (VDH); Mark Jockers & Ken Williamson (CWS); Ken Hoffman (Utah DEQ); Ben Grumbles & Suzanne Dorsey (MDE); Randy Bartlett (Fairfax Co. VA); Doug Yoder (Miami-Dade WASD); Barry Liner, Claudio Ternieden (WEF); Julia Anastasio (ACWA-US); Tommy Wells (DOEE); John Davies-Cole (DC DOH); David Gadis (DC Water); Jay Garland (EPA); Mariana Matus (Biobot); Aaron Bivins (Notre Dame U); G. Tracy Mehan III (AWWA); Randy Speck (ANC 3/4G); Chuck Elkins (ANC 3D); and Andrea Molod (ANC 3F); Karen Pallansch, Allison Deines (AlexRenew); Emily Remmel (NACWA); Kelly Stoll (AECOM); Pam Elardo (NYC DEP); and Dominic DiSalvo (Bergen County) provided valuable information & insights.

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[30] See https://pubs.acs.org/doi/10.1021/acs.est.0c02388 (June 12, 2020).

[31] See https://www.syracuse.com/coronavirus/2020/06/su-esf-will-test-sewage-dorm-by-dorm-to-track-coronavirus-spread.html.

[32] See https://www.bloomberg.com/news/articles/2020-06-19/italy-had-coronavirus-in-sewage-as-early-as-december-study-says.