Legal and ethical implications of wastewater monitoring of SARS-CoV-2 for COVID-19 surveillance

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ABSTRACT

Scientists have observed that molecular markers for COVID-19 can be detected in wastewater of infected communities both during an outbreak and, in some cases, before the first case is confirmed. The Centers for Disease Control and Prevention and other government entities are considering whether to add community surveillance through wastewater monitoring to assist in tracking disease prevalence and guiding public health responses to...
the COVID-19 pandemic. This scientific breakthrough may lead to many useful potential applications for tracking disease, intensifying testing, initiating social distancing or quarantines, and even lifting restrictions once a cessation of infection is detected and confirmed. Yet, new technologies developed in response to a public health crisis may raise difficult legal and ethical questions about how such technologies may impact both the public health and civil liberties of the population. This paper describes recent scientific evidence regarding COVID-19 detection in wastewater, identifying public health benefits that may result from this breakthrough, as well as the limitations of existing data. The paper then assesses the legal and ethical implications of implementing policy based on positive sewage signals. It concludes that the first step to implementing legal and ethical wastewater monitoring is to develop scientific understanding. Even if reliability and efficacy are established, limits on sample and data collection, use, and sharing must also be considered to prevent undermining privacy and autonomy in order to implement these public health strategies consistent with legal and ethical considerations.

KEYWORDS: monitoring, privacy, public health, quarantine, sewage, surveillance

The COVID-19 pandemic has challenged civil society worldwide in unprecedented ways and has revealed the need for real-world solutions to dire health and economic concerns. During the initial phase of the pandemic, many state and local officials implemented extensive efforts to achieve social distancing and ‘flatten the curve’ of the outbreak through expansive stay-at-home orders and related restrictions. These restrictive measures have been important for controlling the spread of disease, but have also imposed a severe social and economic burden on many people. By contrast, the federal government has ordered the continued operations of meat processors, even while various groups worried about safety measures and testing to do this safely. As government officials and communities throughout the United States consider how to emerge from these broadly applicable restrictions while protecting the public health and how to most efficiently identify hot spots of disease that may lead to the reimposition of restrictions and disease tracking, approaches that allow rapid community surveillance of SARS-CoV-2—the virus that causes COVID-19—will be essential and are under consideration by the Centers for Disease Control and Prevention (CDC). SARS-CoV-2 surveillance might be used to guide decisions

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1 Sarah Mervosh, Denise Lu & Vanessa Swales, See Which States and Cities Have Told Residents to Stay at Home NY. TIMES, https://www.nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html (accessed Apr. 20, 2020); Spencer Bokat-Lindell, Was Your State Ahead of the Coronavirus Curve?, NY. TIMES, https://www.nytimes.com/2020/04/09/opinion/was-your-state-ahead-of-the-coronavirus-curve.html (accessed Apr. 9, 2020).
2 Donald J. Trump, Executive Order On Delegating Authority Under The DPA With Respect To Food Supply Chain Resources During The National Emergency Caused By The Outbreak Of COVID-19, https://www.whitehouse.gov/presidential-actions/executive-order-delegating-authority-dpa-respect-food-supply-chain-resources-national-emergency-caused-outbreak-covid-19/ (accessed Apr. 28, 2020).
3 Coronavirus Update (as of April 30, 2020), N. Amer. Meat Inst., https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/meat-poultry-processing-workers-employers.html (last visited May 1, 2020).
4 See Betsy Woodruff Swan et al., CDC Eyes Tracking Coronavirus Through Human Waste, POLITICO, https://www.politico.com/news/2020/05/01/cdc-human-waste-coronavirus-222253 (accessed May 1, 2020).
about where and when to impose or relax more targeted restrictions on movement and activity. In the face of still inadequate testing (and the enormous cost of doing extensive, complete, and repeated testing until the epidemic is wiped out), use of a new technology, community monitoring of SARS-CoV-2 in wastewater, may provide an efficient means of measuring the disease at a community-wide or more targeted level.

In the flood of new research responding to the COVID-19 pandemic, scientists have discovered that molecular markers for COVID-19 can be detected in sewage of infected communities both during an outbreak and, in some cases, before the first case is confirmed. This scientific breakthrough may lead to many useful potential applications for tracking disease, intensifying testing, initiating social distancing or quarantines, and enabling the return to conditions status quo ante. New technologies like this one—developed in response to a public health crisis—raise difficult legal and ethical questions about how their use may impact both the public health and civil liberties of the population. This new technology has the potential to provide a useful alternative or supplement to individual testing for SARS-CoV-2 and to serve as a tool to assist in public health and economic decisions, but its potential uses also need to be evaluated from legal and ethical perspectives. Part I of this article describes recent scientific evidence regarding COVID-19 detection in wastewater and identifies the public health benefits that may result from this breakthrough. Part II turns to assessing the legal and ethical implications of implementing policy based on positive sewage signals.

I. THE SCIENCE AND UTILITY OF WASTEWATER MONITORING OF SARS-COV-2

A major challenge in the current COVID-19 pandemic has been to know where the disease and the virus that causes it, SARS-CoV-2, are present. The counts of confirmed cases show, in almost every major country, an initial exponential rise that seemed to occur regardless of public health measures put in place after the first cases are detected. According to the current models, this explosion in COVID-19 case counts suggests that many infections were already present in communities prior to the first case being confirmed. The reasons for this are varied, but include limited testing capability, giving tests only upon hospital admission with an already serious disease, personal choice or doctor’s advice not to be tested when the disease is mild, and even a significant lag in the time between collecting the sample and obtaining the test result (even

5 Jeffrey L. Ram, When Will the Covid-19 Epidemic Be “Over”? (accessed April 19, 2020).
6 Julie Appleby, Why It Takes So Long to Get Most COVID-19 Test Results, NPR: Health News (accessed Mar. 20, 2020).
7 N.Y.C. Dep’t of Health and Mental Hygiene, 2020 Advisory #8: COVID-19 Update for New York City (accessed Mar. 20, 2020).
8 Jay Barmann, 568 Grand Princess Passengers Refused COVID-19 Tests, at Government’s Urging (accessed Apr. 11, 2020).
9 Chris Wolfe, L.A. County Changes Guidelines for COVID-19 Testing (accessed Mar. 20, 2020).
10 Appleby, supra note 6.
Senator Rand Paul had to wait six days between providing a sample and getting his test results\(^\text{11}\). This gap in knowledge about when active infections first began to be present in American communities has made it difficult, in most cases, to adopt data-based public health measures in a timely manner prior to confirmation of ‘first cases’, when the initial rise in cases was already inevitable. Countries that proactively anticipated the pandemic, like South Korea, Hong Kong, Taiwan, and New Zealand, have fared better.\(^\text{12}\)

While many jurisdictions missed opportunities to impose social distancing prior to their first confirmed cases in the current phase of this pandemic,\(^\text{13}\) present fears about a second wave of disease\(^\text{14}\) suggest that developing methods to detect community presence of the virus may pay huge dividends in triggering early preventive measures and activating more intense testing in those locations. These methods may also be a boon to communities where cases of COVID-19 have not yet spiked, providing an opportunity to get ahead of the first wave of the outbreak even if widespread testing is not feasible.

Wastewater monitoring may be one such new community detection method. Recent research indicates that the coronavirus that causes COVID-19—SARS-CoV-2—not only infects the respiratory system but also infects the gastrointestinal system and ultimately appears in feces. Researchers found that a large amount of virus resides in the gastrointestinal tract, where it adheres to and is retained by epithelial cells that line the intestines and from which it is shed into feces.\(^\text{15}\) Clinical studies found SARS-CoV-2 was in feces in the majority of patients where this was studied. In fact, a positive signal for SARS-CoV-2 in feces was present in adults an average of 12 days after nasal–throat swabs turned negative and in pediatric patients, on average, more than 2 weeks after the virus had completely disappeared from throat swabs.

Since adult feces in most urban communities, at least, are flushed into sewerage systems for ultimate treatment and detoxification before release into the environment, one possible way to assess the total burden of active COVID-19 disease in a community might be to measure molecular signatures of SARS-CoV-2 in sewage. Indeed, a Dutch group, anticipating the spread of COVID-19, began molecular tests of sewage in five cities and at Schiphol airport three weeks prior to the first report of a case in the Netherlands on February 27.\(^\text{16}\) Using a primer/probe set published by the US Centers for Disease Control (CDC),\(^\text{17}\) the researchers found that all locations but one showed

\(^{11}\) Laura Litvan, *Rand Paul Defends Roaming Capitol Before Virus Results Returned*, Bloomberg Politics, https://www.bloomberg.com/news/articles/2020-03-23/senators-question-exposure-to-covid-19-after-paul-tests-positive (accessed Mar. 23, 2020).

\(^{12}\) Ram, *supra* note 5.

\(^{13}\) Britta L. Jewell & Nicholas P. Jewell, *The Huge Cost of Waiting to Contain the Pandemic*, N.Y. TIMES, https://www.nytimes.com/2020/04/14/opinion/covid-social-distancing.html (accessed Apr. 14, 2020).

\(^{14}\) Morgan McFall-Johnsen, Anthony Fauci’s Vision for Battling a 2nd Wave of Coronavirus in the Fall: Be Prepared as We Should Have Been in January, BUS. INSIDER, https://www.businessinsider.com/fauci-vision-be-prepared-d-new-waves-of-coronavirus-2020-4 (accessed Apr. 8, 2020).

\(^{15}\) Xingfei Pan et al., *Viral load of SARS-CoV-2 in clinical samples*, 20 LANCET INFECTIOUS DISEASES 411 (2020).

\(^{16}\) Gertjan Medema et al., *Presence of SARS-Coronavirus-2 in Sewage*, medRXIV PREPRINT, https://doi.org/10.1101/2020.03.29.20045880 (accessed Mar. 29, 2020).

\(^{17}\) Ctrs. for Disease Control & Prevention (CDC), 2019-NOVEL CORONAVIRUS (2019-Ncov) REAL-Time Rrt-Pcr Panel Primers and Probes, https://www.cdc.gov/coronavirus/2019-ncov/downloads/rt-pcr-panel-primer-probes.pdf (accessed Jan. 24, 2020).
positive detections of the virus by mid-March, and very interestingly, the first positive
signal in one of the cities (Amersfoort) was obtained on March 5,\textsuperscript{18} the day before the
first case of COVID-19 was confirmed there in two high school students.\textsuperscript{19} Studies
at MIT\textsuperscript{20} and elsewhere\textsuperscript{21} similarly confirmed the sensitive detection of SARS-CoV-2
markers in wastewater of municipalities where the disease is known to be occurring.

Scientists say their purposes for carrying out these studies included ‘to monitor the
circulation of the virus in the population’,\textsuperscript{22} ‘[to] detect . . . the virus in sewage . . .
as [an] early warning tool for increased circulation in the coming winter or unaffected
populations’,\textsuperscript{23} ‘[to] measure the presence . . . of infectious diseases when the capacity
for clinical testing is limited’,\textsuperscript{24} to obtain ‘population-wide data [to] help inform model-
ing efforts’,\textsuperscript{25} and ‘to detect pathogens in populations when investigations in humans
is difficult for logistic, ethical or economic reasons’.\textsuperscript{26} The question of whether the

Moreover, scientists and other commentators have additionally suggested that the
results of wastewater monitoring of SARS-CoV-2 may trigger actions that more directly
affect the movement and privacy of people. They aver that sewage-based data will
‘inform decisions surrounding the advancement or scale-back of social distancing and
quarantine efforts’,\textsuperscript{27} and that community monitoring ‘at the municipal or community
level . . . may allow for more granular detection of SARS-CoV-2 . . . to help pre-
emptively enact public health measures prior to the widespread onset of disease’.\textsuperscript{28}
Detecting SARS-CoV-2 through this method may precede confirmed reports of disease
by a week or two, such that ‘tracking viral particles in wastewater could give public-
health officials a head start on deciding whether to introduce measures such as lock-
downs’.\textsuperscript{29} If wastewater-based epidemiology can be applied at a community level, then
‘effective intervention can be taken as early as possible to restrict the movements of that
local population’.\textsuperscript{30} In addition, some technology developers suggest that ‘in the case
of asymptomatic infections in the community or when people are not sure whether

\begin{footnotesize}
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\item\textsuperscript{18} Medema et al., \textit{supra} note 16, at 5.
\item\textsuperscript{19} Brett Walton, \textit{Virus Hunters Find Coronavirus Clues in Sewage}, \textit{Circle of Blue: Water News},
https://www.circleofblue.org/2020/world/virus-hunters-find-coronavirus-clues-in-sewage/ (accessed Apr. 3, 2020).
\item\textsuperscript{20} Fuqing Wu et al., \textit{Sars-Cov-2 Titers in Wastewater Are Higher than Expected from Clinically Confirmed Cases},
\textit{medRxiv preprint}, https://doi.org/10.1101/2020.04.05.20051540 (accessed Apr. 7, 2020).
\item\textsuperscript{21} RIVM, \textit{Novel Coronavirus Found in Wastewater}, https://www.rivm.nl/en/news/novel-coronavirus-found-in-
wastewater (accessed Apr. 12, 2020).; S. Wurtzer et al., \textit{Time Course Quantitative detection of SARS-CoV-
2 in Parisian Wastewaters Correlates with COVID-19 Confirmed Cases}, \textit{medRxiv preprint}, https://doi.
org/10.1101/2020.04.12.20062679 (accessed Apr. 12, 2020).
\item\textsuperscript{22} Medema et al., \textit{supra}, note 16, at 2.
\item Id. at 6.
\item Wu et al., \textit{supra} note 20, at 1.
\item Id.
\item Wurtzer et al., \textit{supra} note 21, at 3.
\item Wu et al., \textit{supra} note 20, at 7.
\item Id.
\item Smriti Mallapaty, \textit{How Sewage Could Reveal True Scale of Coronavirus Outbreak}, \textit{580 Nature},
https://www.nature.com/articles/d41586-020-00973-x (accessed Apr. 3, 2020), (quoting Tamar Kohn, virologist at the Swiss
Federal Institute of Technology in Lausanne).
\item Kang Mao et al., \textit{Can a Paper-Based Device Trace COVID-19 Sources with Wastewater-Based Epidemiology?}, \textit{54 EnvTL. SCI. & TECH.} 3733, 3734 (2020) (emphasis added).
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they are infected or not, real-time community sewage detection . . . could determine whether there are COVID-19 carriers in an area in a timely manner to enable rapid screening, quarantine and prevention.31 Thus, developers see wastewater monitoring methods as potentially leading to testing (compelled? Everyone in the sewage district? Answers to this are unstated) and to restricting movement, including social distancing and quarantines.

Wastewater monitoring may also affect public policy at the other end: deciding when public health mandated regulations of movement and testing may be relaxed. Eric Alm, the senior author in the recent MIT wastewater monitoring study,32 suggested that it may help ‘identify when the curve starts to level off [to] know when it’s appropriate to end quarantine’.33

The science underlying effective wastewater monitoring, and its relationship to public health efforts, is still developing. Existing data are currently inadequate for developing ‘epidemiological models that map the concentrations of virus RNA found in the sewer water to the likely number of local cases’.34 Moreover, despite its proclaimed public health benefits, municipalities may object to monitoring their sewage for disease-causing agents because ‘[n]obody wants to be the hot spot’.35 Indeed, somewhat in contradiction to the claim above that wastewater monitoring will reduce the need for testing individuals, scientists from the Queensland Alliance for Environmental Health Sciences in Australia have expressed concern that wastewater monitoring might ‘take away resources from the testing of individuals’.36 Finally, questions have been raised about whether the wastewater data collected to date ‘are representative for all age groups, right for all sexes, and for all types of how the disease is unfolding in the individual’37 or could with further study made to be so, as would be expected of a technique that may result in impositions on individual behavior.

II. LEGAL AND ETHICAL IMPLICATIONS OF WASTEWATER SCREENING FOR SARS-COV-2

A. Issues with collection of wastewater data

The proposed use of wastewater screening to detect SARS-CoV-2 viral RNA has the potential to greatly enhance our technical capabilities to identify, track, pinpoint, and quantify the spread of COVID-19, but this application of public health surveillance would raise a number of legal and ethical questions. Efforts by state or local health officials to screen wastewater for SARS-CoV-2 would almost certainly come within the state’s broadly recognized police powers, which generally permit state and local governments to have broad authority to act and regulate to protect the health and welfare of the

31 Id. at 3734 (emphasis added).
32 Wu et al., supra note 20.
33 Gregory Barber, One Way to Potentially Track Covid-19? Sewage Surveillance, WIRED, https://www.wired.com/story/one-way-to-potentially-track-covid-19-sewage-surveillance/ (accessed Apr. 7, 2020).
34 Id.
35 Id. (quoting Dan Burgard, University of Puget Sound).
36 Mallapaty, supra note 29.
37 Chris Francescani & Nancy A. Anoruo, Sewage Analysis Suggests a New England Metro Area with Fewer than 500 Covid-19 Cases May Have Exponentially More, ABC News, https://abcnews.go.com/US/sewage-analysis-suggests-england-metro-area-fewer-500/story?id=70068740 (accessed Apr. 11, 2020).
population.\textsuperscript{38} While most public health surveillance focuses on identifying individual cases through testing, screening, reporting, and contact tracing, environmental hazard surveillance designed to detect contaminants or indications of a circulating pathogen in the air, water, or soil would similarly come within these broad state powers.

Nonetheless, wastewater surveillance may implicate privacy considerations and concerns about violating Fourth Amendment protections against unreasonable searches and seizures in some circumstances. Courts assessing wastewater surveillance under the Fourth Amendment have typically concluded that there is no reasonable expectation of privacy in wastewater ‘irretrievably flowing into the public sewer’.\textsuperscript{39} These cases have not, however, precluded all such expectations, particularly where individual, rather than corporate, interests are at issue.\textsuperscript{40} Moreover, recent judicial solicitude for Fourth Amendment claims in involuntarily shared, yet deeply sensitive, personal data suggests that some collections and analyses of wastewater, too, may constitute searches.\textsuperscript{41} The US Supreme Court has recognized that the collection and analysis of biological samples may intrude upon reasonable expectations of privacy and thus constitute searches governed by the Fourth Amendment.\textsuperscript{42} Somewhere along the spectrum from a whole catchment area, to a factory, to a nursing home (i.e., long-term care facility; see Supplement Fig. S1), to one house—as the data gleaned from wastewater sampling becomes more granular and individualized—the monitoring of wastewater may well implicate the Fourth Amendment.\textsuperscript{43} Even if the Fourth Amendment applies directly to wastewater collection, however, courts are likely to uphold such efforts for COVID-19 public health surveillance under the special needs doctrine, so long as they are reasonable.\textsuperscript{44} If reliability and efficacy of wastewater monitoring were established, the fact that the collection of samples through wastewater monitoring typically constitutes population-level surveillance and does not identify specific individuals would suggest the constitutionality of such a program.

Achieving a reasonable balance between privacy and public health goals is important for another reason as well. Biological surveillance through wastewater sampling implicates ethical concerns, including autonomy and beneficence. Individuals typically are entitled to autonomy to control access to one’s health status, which under a wastewater

\textsuperscript{38} See generally Lawrence O. Gostin and Lindsay F. Wiley, \textit{Public Health Law: Power, Duty, and Restraint} 307–313 (3d ed. 2016).

\textsuperscript{39} Riverdale Mills Corp. v. Pimpare, 392 F.3d 55 (1st Cir. 2004) (emphasis omitted); see also United States v. Spain, 515 F. Supp. 2d 860, 861 (N.D. Ill. 2007) United States v. Hajduk, 396 F. Supp. 2d 1216 (D. Colo. 2005).

\textsuperscript{40} See Riverdale Mills, 392 F.3d at 64 (noting that “[t]he commercial context is relevant; this may reduce Riverdale’s expectation of privacy somewhat”).

\textsuperscript{41} See Carpenter v. United States, 138 S. Ct. 2206 (2018).

\textsuperscript{42} See Schmerber v. California, 384 U.S. 757 (1966).

\textsuperscript{43} See, e.g., Christopher L. Hering, Note, \textit{Flushing the Fourth Amendment Down the Toilet: How Community Urinalysis Threatens Individual Privacy}, 53 ARIZ. L. REV. 741 (2009) (arguing that at least some uses of community urinalysis technology should be deemed a Fourth Amendment search).

\textsuperscript{44} See Natalie Ram & David Gray, \textit{Mass Surveillance in the Age of COVID-19}, J. L. & BIOSCIENCES, at lsa023 (forthcoming 2020), \url{https://doi.org/10.1093/jlb/lsa023} (discussing the Fourth Amendment’s application to methods of mass surveillance related to COVID-19 and describing the special needs doctrine and its requirement for reasonableness); see also infra note 48–49 and accompanying text (describing the special needs doctrine and its deference to reasonable programmatic searches undertaken for non-law enforcement purposes).
screening program must be balanced against the utility and beneficence of protecting population health through more rapid disease detection.

B. Issues with use of wastewater data

Subsequent uses of the data collected through wastewater sampling to achieve other public health ends, however, may present additional legal and ethical concerns that go beyond merely collecting and monitoring the data. Public health authorities could decide to use evidence of the presence of SARS-CoV-2 in wastewater to pursue a number of intervention strategies. First, the information may be very useful in tracking the spread of the outbreak and identifying previously unrecognized areas where the infection is spreading. This tracking could enable better targeting of resources and supportive infrastructure to communities experiencing the health effects of COVID-19 and potentially serving as an early sentinel for a subsequent wave of the outbreak. Insofar as the collection and analysis of wastewater for SARS-CoV-2 monitoring does not run afoul of constitutional constraints, the use of that analysis for community support ought not raise any significant legal or ethical concerns either.

Second, public health authorities could use this information to justify increased testing among people living in homes or working at sites close to where the virus has been found in wastewater, or to implement neighborhood-wide screening programs in these areas. The use of these data to target resources to provide voluntary screening programs in areas with SARS-CoV-2 detection likely would not implicate legal concerns. Courts have long recognized that public health powers include the authority to conduct testing and screening programs. In addition, voluntary screening programs facilitate individuals’ autonomy and right to refuse testing. By contrast, a conditional screening program, which would require a person subject to a quarantine order to be tested prior to being able to leave their home would necessitate balancing the state’s use of police powers against the rights of a specific individual to refuse testing. A well-established legal precedent suggests that efforts requiring testing or treatment for a high-dangerous infectious disease fall within a state’s legal powers. If individuals refuse to cooperate, they would not be physically forced to get tested, but they might be subjected to other restrictions such as quarantine or reasonable monetary penalties. Refusing individuals are thus presented with a choice of complying with the testing or treatment, or being subjected to more restrictive powers. The implications of these more restrictive powers are discussed below.

Conditional screening requirements based on wastewater detection of SARS-CoV-2 may raise Fourth Amendment concerns. Courts are likely to uphold such requirements, so long as the regulatory framework for conditional screening strikes a reasonable balance between privacy interests and legitimate public health needs. Where the government undertakes surveillance activities primarily to advance public health purposes,

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45 See generally Amy L. Fairchild et al., Public Goods, Private Data: HIV and the History, Ethics, and Uses of Identifiable Public Health Information, 122 Pub. Health Rep. 7 (Supp. 1 2007).

46 See Gibbons v. Ogden, 22 U.S. (9 Wheat.) 1 (1824) (articulating a broad scope for state police powers, including “[i]nspection laws, quarantine laws, health laws of every description”); Jacobson v. Massachusetts, 197 U.S. 11 (1905) (upholding broad public health authority under state police powers).

47 See Jacobson, supra note 37 (upholding authority to mandate smallpox vaccination under state police powers).
courts have generally upheld such activities under the special needs doctrine. In this context, the government is not constitutionally required to secure a warrant before engaging in a search. Rather, courts will sustain public health programs so long as they reasonably balance between privacy interests and the legitimate government interest in preventing the spread of COVID-19. An individual’s interest in privacy against bodily intrusion, as well as regarding their potential COVID-19 status, would be balanced against the governmental interest in preventing the spread of the disease. Important programmatic features might affect the constitutional analysis, including whether and for how long biological samples would be retained, by whom, and with subsequent access for what purposes.

Third, public health authorities or government officials could use information about SARS-CoV-2 in the wastewater to justify the imposition of broad restrictive measures on a whole community in the form of a targeted stay-at-home order, or stricter restrictions such as a cordon sanitaire or mass quarantine order, without further individual testing. Quarantine powers restrict the movements of individuals until they can demonstrate they are not infected and do not pose a risk of spreading the disease to others. These powers—while granted to state and local officials through statutory authority and grounded in the state’s fundamental police powers—are a form of civil confinement and therefore must meet strict scrutiny standards. A key legal and practical issue is whether the results of wastewater testing for SARS-CoV-2 would be sufficient to meet the strict scrutiny standard, which demands compelling state interest and narrow tailoring between confinement and that interest. Courts have usually deferred to state imposition of quarantine powers on specific individuals, but mass quarantine orders would face more serious constitutional scrutiny.

Assuming that the science supports the connection between wastewater detection of SARS-CoV-2 and an increased risk of disease spread in nearby communities, temporary restrictions are likely to be upheld if challenged. The high risk posed by COVID-19 provides a compelling state interest to take steps to slow the spread of the disease and physical separation measures will likely be deemed to be sufficiently narrowly tailored under current circumstances. Indeed, currently even more widespread restrictions are being imposed through statewide stay-at-home orders in place in most states at the time of this writing. These restrictions assume the potential for community spread of COVID-19 in any community, because insufficient information is available to identify loci of infection and spread. However, the statewide stay-at-home orders—which

48 See, e.g., Skinner v. Ry. Labor Execs. Ass’n, 489 U.S. 602 (1989) (upholding compulsory drug testing for train conductors after a crash); Nat’l Treasury Emps. Union v. Von Raab, 489 U.S. 656 (1989) (upholding suspicionless drug testing for customs employees); Vernonia Sch. Dist. 47 J v. Acton, 515 U.S. 646 (1995) (upholding random drug testing for students engaged in after school activities). But see Ferguson v. Charleston, 532 U.S. 67 (2001) (invalidating drug screening program for pregnant women due to underlying law enforcement purpose).
49 See Ram & Gray, supra note 44 (discussing the special needs doctrine generally, as well as its application to other public health surveillance activities related to COVID-19).
50 See Vitek v. Jones, 445 U.S. 491–492 (1980); Addington v. Texas, 441 U.S. 418 (1979).
51 See Wendy E. Parmet, Quarantining the Law of Quarantine: Why Quarantine Law Does Not Reflect Contemporary Constitutional Law Norms, 9 WAKE FOREST J. L. & POLICY 1 (2019); Lawrence O. Gostin & James G. Hodge, Jr., US Emergency Legal Responses to Novel Coronavirus: Balancing Public Health and Civil Liberties 323(12) JAMA 1131–32 (Mar. 24, 2020).
include many exceptions to allow movement for essential personnel and activities—
are not nearly as restrictive as a quarantine order, which presumably would not allow
for similar exceptions.

Mass quarantines and sanitary cordons impose more severe restrictions. Mass quar-
antines could impose a prohibition on leaving home for residents of an identified area
unless they could demonstrate a lack of infection. Cordon sanitaire would prevent
groups within a geographically defined area from moving out of that area altogether
or passing some sort of screening test before being allowed to leave the restricted area.
These approaches are blunt impositions of governmental authority and therefore could
be constitutionally problematic. Past uses of sanitary cordons have been invalidated
for restricting movements of particular groups based on race or nationality. This
concern would be particularly acute with respect to the use of wastewater screening
to impose substantial restrictions on movement. If such restrictions were targeted only
at urban neighborhoods with sufficient density to detect SARS-CoV-2 in wastewater,
the practical effect might be imposing restrictions disproportionately on areas that
are populated predominantly by people of color. Government officials must avoid
discriminatory applications of restrictive powers. Beyond their legal obligations, more-
over, government officials bear an ethical obligation to consider whether the impact
on the community is just when imposing restrictions and to support communities
disproportionately harmed by restrictive orders.

Fourth, public health authorities could extend or reimpose community-wide social
distancing measures based on positive wastewater screening for SARS-CoV-2. In the
current crisis, such measures have included closing businesses, prohibiting gatherings
in affected areas, and limiting participation in activities deemed non-essential. Courts
are likely to be deferential to government-imposed restrictions along these lines.
However, if the presence of religious institutions in affected areas leads to contact trac-
ing and further restrictions specifically on those attending religious services, concerns
about privacy and discrimination could also arise.

Importantly, limiting fundamental rights—whether through quarantines or clo-
sures—requires the government to justify the necessity of restricting those rights, and
if less restrictive options exist those options should be implemented instead. Applying
substantial restrictions on movement, assembly, or other rights to a targeted commu-
nity based only on elevated detection of SARS-CoV-2 in wastewater may not withstand
constitutononal or ethical scrutiny once other more targeted and reliable testing capacity
becomes available, as wastewater detection may no longer be sufficiently narrowly
tailored to justify the restrictions. Both policymakers and courts bear responsibility to
determine the appropriate parameters of government restrictions of civil liberties and
to carefully evaluate the scientific basis for these limitations. Similarly, governments

52 See Jew Ho v. Williamson, 103 F. 10 (C.C.N.D. Cal. 1900) (invalidating a racially discriminatory mass
quarantine order in San Francisco for bubonic plague that only applied to Chinese-American neighborhoods).
53 See Emily A. Benfer & Lindsay F. Wiley, Health Justice Strategies to Combat COVID-19: Protecting Vul-
nerable Communities During a Pandemic, HEALTH AFF. BLOG, https://www.healthaffairs.org/do/10.1377/
hblog20200319.757883/full/ (accessed Mar. 19, 2020).
54 See, e.g., The Slaughter-House Cases, 83 U.S. (16 Wall.) 36 (1873) (upholding a state order moving slaughter-
house downstream in response to cholera outbreaks).
55 Lindsay F. Wiley & Steve Vladeck, COVID-19 Reinforces the Argument for “Regular” Judicial Review—Not
Suspension of Civil Liberties—In Times of Crisis, HARV. L. REV. BLOG, https://blog.harvardlawreview.org/covi
have an ethical obligation to pursue and implement less-restrictive interventions to stop the spread of COVID-19 where available.

III. CONCLUSION
Wastewater screening for SARS-CoV-2 could provide an important tool to detect new outbreaks of COVID-19 and to target resources to intervene to stop the spread of the disease; however, scientific research must establish the efficacy of such testing in identifying community-based COVID-19 infections before its use can be considered as the basis for public policy. Very little research on the efficacy of SARS-CoV-2 monitoring in sewage has been accomplished given the recent emergence of the disease and discovery of the virus in feces and sewage. We recommend further research to establish sensitivity and specificity of the technique, variation of the fecal and subsequent sewage signal among different people and different stages of the disease, and the presence and detectability of the signal in asymptomatic or presymptomatic people. The application of wastewater monitoring of the virus could be most useful for positioning resources and triggering public actions should the signal be shown to be a reliable early warning for infection. If a reliable relationship with the community recovery from COVID-19 infections can be established, wastewater data might also feasibly be used to indicate when areas are ready to relax restrictive measures or to detect a reversal or continuation of trends towards recovery.

Until reliability and efficacy are demonstrated, implementing wastewater screening for SARS-CoV-2 to target public health resources, to require testing, to impose restrictions on movement, or to remove restrictions based on an absence of virus in the wastewater is premature. Even if reliability and efficacy are established, we recommend that for efforts to implement wastewater screening for disease and other biological markers, legal and ethical considerations must be taken into account, including appropriate limits on sample and data collection, use, and sharing, so as to prevent unduly undermining privacy and autonomy, and to reduce the potential for problematic misuse of data or coercive interventions. As our scientific understanding of the connection between the presence or absence of SARS-CoV-2 in wastewater improves, however, these data could be the basis for scientifically informed decisions to implement public health intervention strategies consistent with the legal and ethical considerations.

SUPPLEMENTARY DATA
Supplementary data are available at JLBios online.

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