UK Health Security Agency

EMHP Wastewater Monitoring Project

Jon Vodden
Project Director

Jon.Vodden@ukhsa.gov.uk

Environmental Monitoring for Health Protection

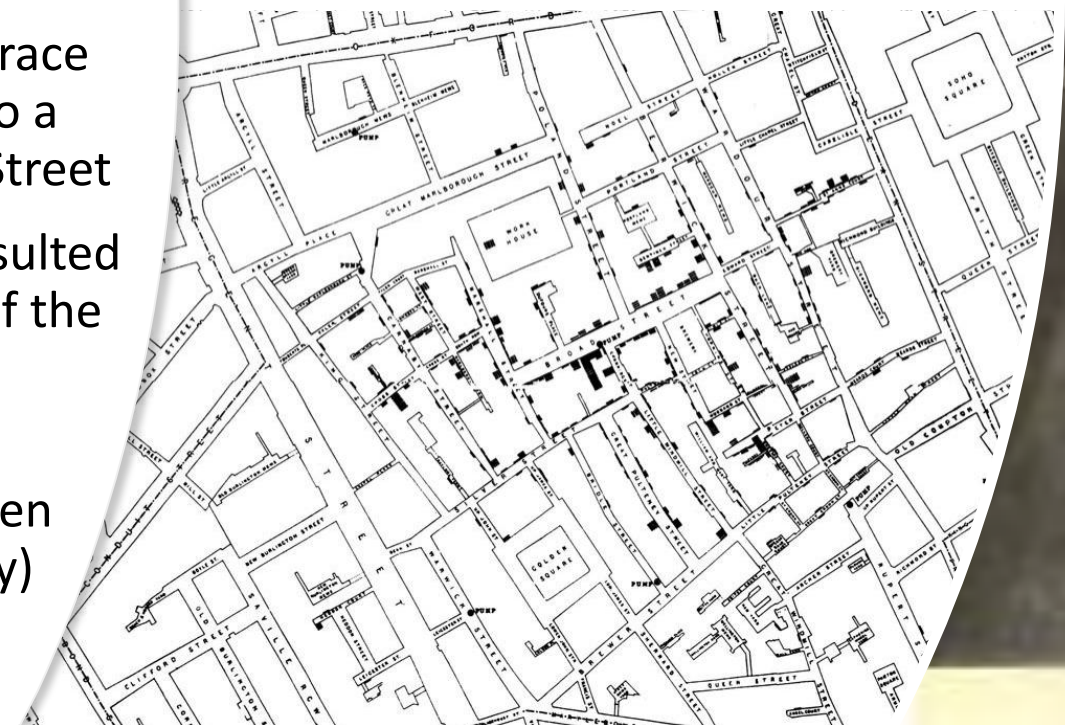
Who we are - Environmental Monitoring for Health Protection (EMHP)

- Part of UKHSA's Data, Analytics and Surveillance (DAS) directorate
- Created as part of a pandemic surveillance capability in response to the COVID-19 pandemic
- First established in June 2020.
- At peak, surveillance monitoring of over 70% of the population of England
  - collecting wastewater samples
  - testing and genomic sequencing - presence of COVID-19 and variants of concern (VOCs)/variants under investigation (VUIs)
  - From sewage treatment works, and network sites (significant points in the sewage network that serve 'communities') and 'near source' (e.g. specific locations such as care homes or food processing plants,)
- Insights used by wide range of stakeholders to inform national and local health protection decisions in unison with other surveillance data, such as where to undertake further testing
- Continues to be used in local and closed source settings

History: John Snow, Cholera and data

- 1854 London cholera outbreak
- A doctor named John Snow decides to map cholera cases
- The map was used to trace the cholera outbreak to a single pump at Broad Street
- Poor sanitation had resulted in the contamination of the groundwater
- The beginning of Epidemiology (how often disease occurs and why)

[The John Snow Society]



The EMHP wastewater monitoring programme

December 2019

SARS-CoV-2, the novel coronavirus which causes the COVID-19 disease and pandemic, is thought to have emerged in Wuhan, China

February-March 2020

Fragments of SARS-CoV-2 virus detected in wastewater samples

COVID-19 wastewater monitoring research projects started

Retrospective analysis of wastewater samples suggests COVID-19 spread in countries earlier than seen with clinical testing (e.g., in Italy and Brazil as early as November-December 2019)

UK Health Security Agency

The EMHP wastewater monitoring programme

July 2020

Wastewater monitoring at 44 sewage treatment works began, covering ~30% of the population in England

November - December 2020

Network sites (in sewer locations) added at 9 large cities across England to monitor SARS-CoV-2 at a higher population resolution

January 2021

Sequencing of extracted RNA from wastewater begins to be used to identify and monitor variants and subvariants of the disease as it evolves

UK Health Security Agency

The EMHP wastewater monitoring programme

January 2021 – March 2022

Wastewater monitoring to quantify and qualify SARS-CoV-2 and its variants was scaled to cover ~72% of England's population. Datasets were published monthly on Gov.UK.

March 2022

Wastewater surveillance paused as part of HMG's 'Living with Covid' policy

April 2022 to date

Discrete HMG and local government funded surveillance undertaken whist the programme develops longer-term sustainable strategy

Spring/summer 2022

Detection of Poliovirus in wastewater leading to policy change offering 1m children (1-9 years) being offered Polio vaccine and surveillance extended

UK Health Security Agency

Wastewater Surveillance – Variants

- Whole genome sequencing of wastewater samples followed by identification of signature mutations allows for spatiotemporal identification of SARS-CoV-2 Variants of Concern and Variants Under Investigation (VOC/VUIs)
- Surveillance Programme in England from January 2021 to March 2022 identified signature mutations of the successive wave of variants (from Alpha to Omicron) in wastewater samples
- Sequencing capacity and analysis reached ~2,000 samples a week in collaboration with Universities and other Government agencies
- Up to 3 samples were collected and sequenced from about 470 sites across England every week
- Results were used, in conjunction with clinical testing, in national surveillance of VOC/VUIs and informed local management of outbreaks

NEOF
NERC ENVIRONMENTAL OMICS FACILITY

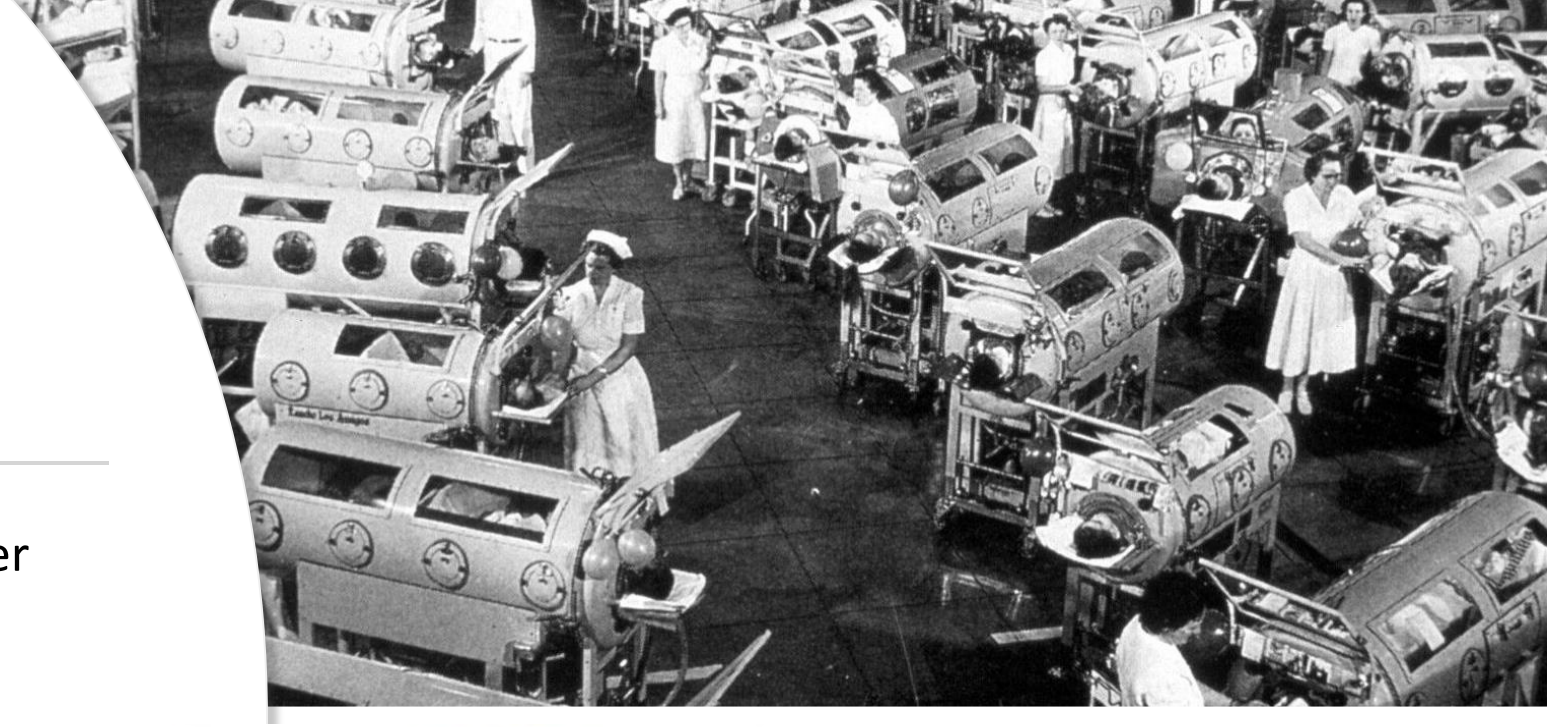
COG UK
COVID-19 GENOMICS UK CONSORTIUM

Cefas

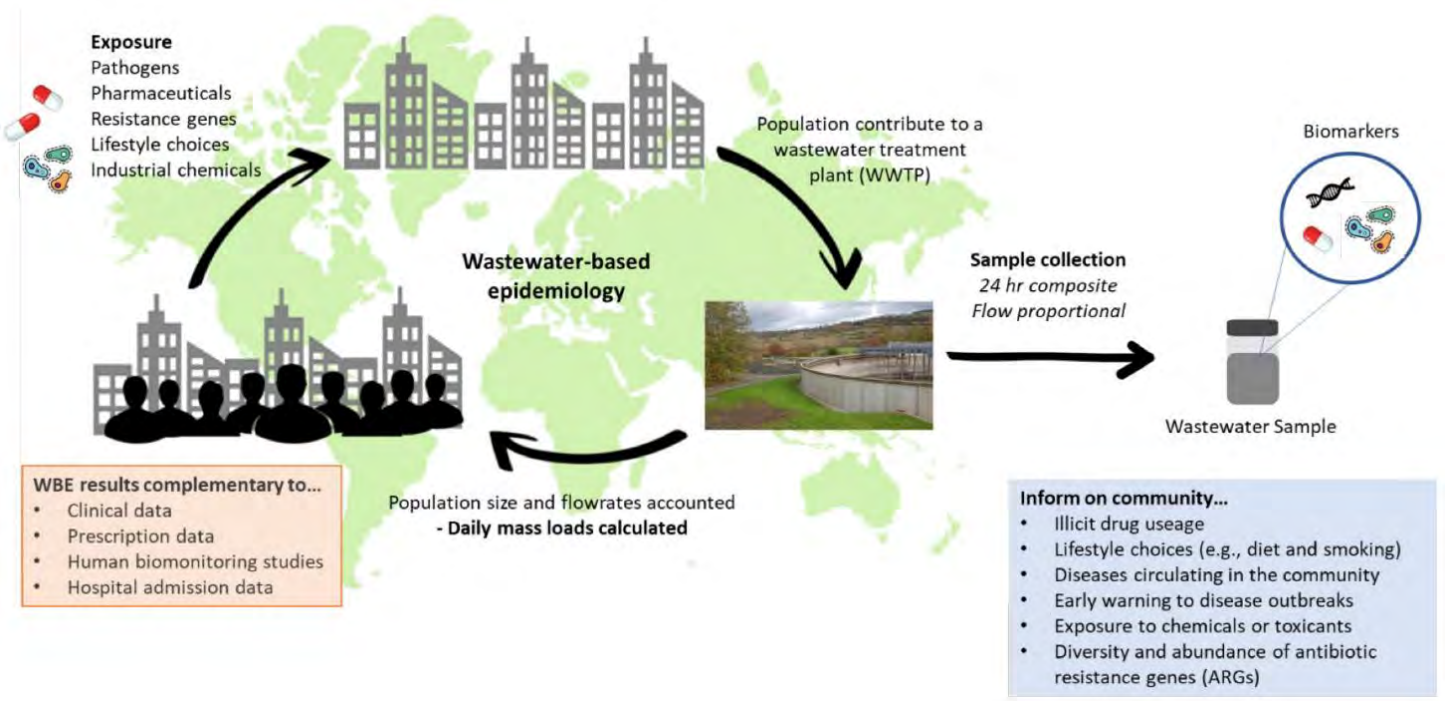
UNIVERSITY OF EXETER

University of Nottingham
UK | CHINA | MALAYSIA

Public Health



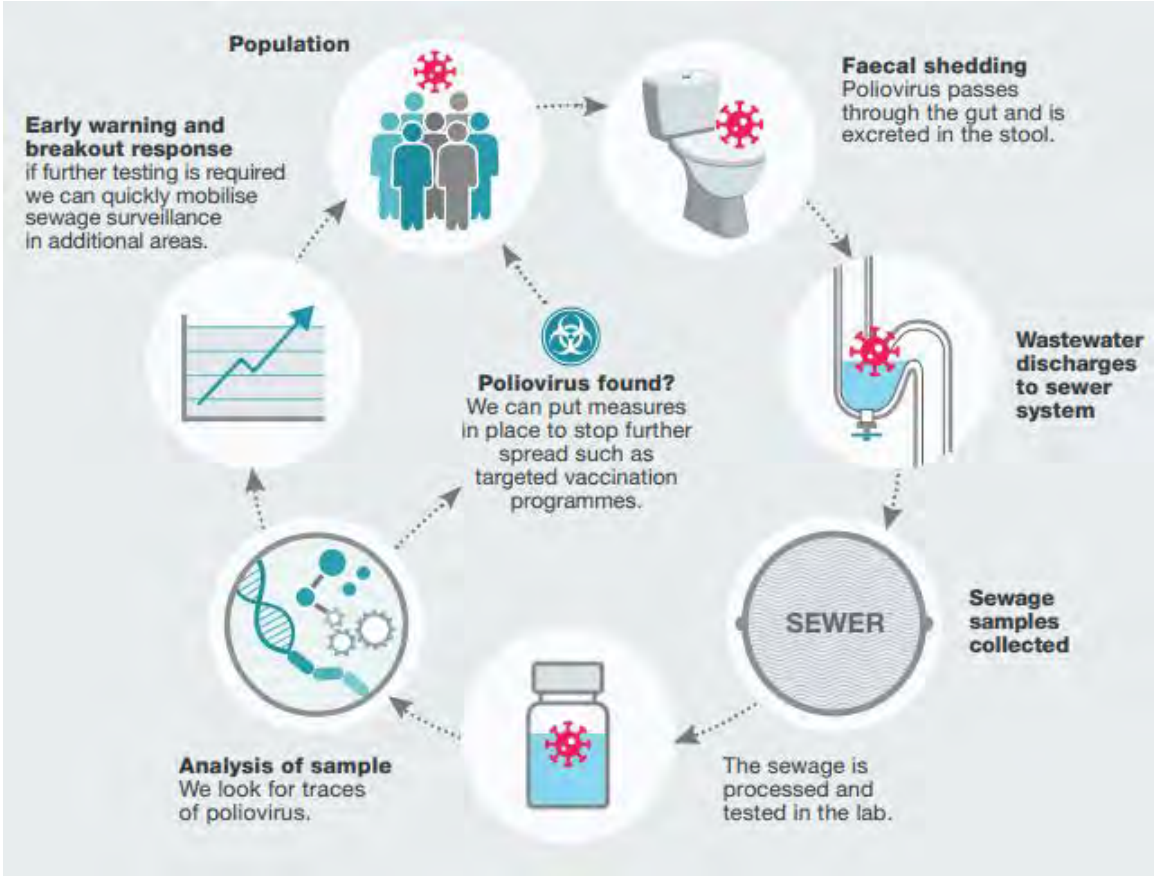
- Wastewater monitoring is considered a valuable tool, which can fill gaps in other public health surveillance systems
- As part of the UK's commitment to the WHO Global Polio Eradication Initiative, routine sewage surveillance for wild type and vaccine-like polio viruses is undertaken.
- Poliovirus is difficult to detect by clinical testing as most cases are asymptomatic and the main symptom (flaccid paralysis) is not specific



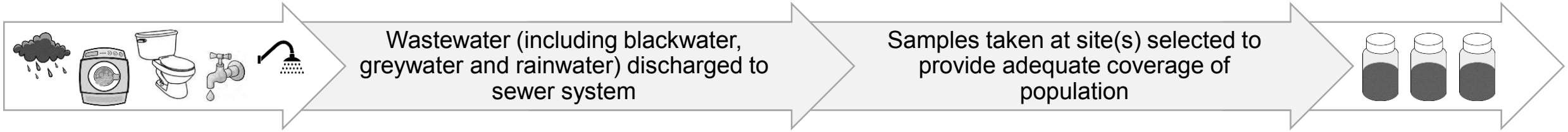
UK Health Security Agency

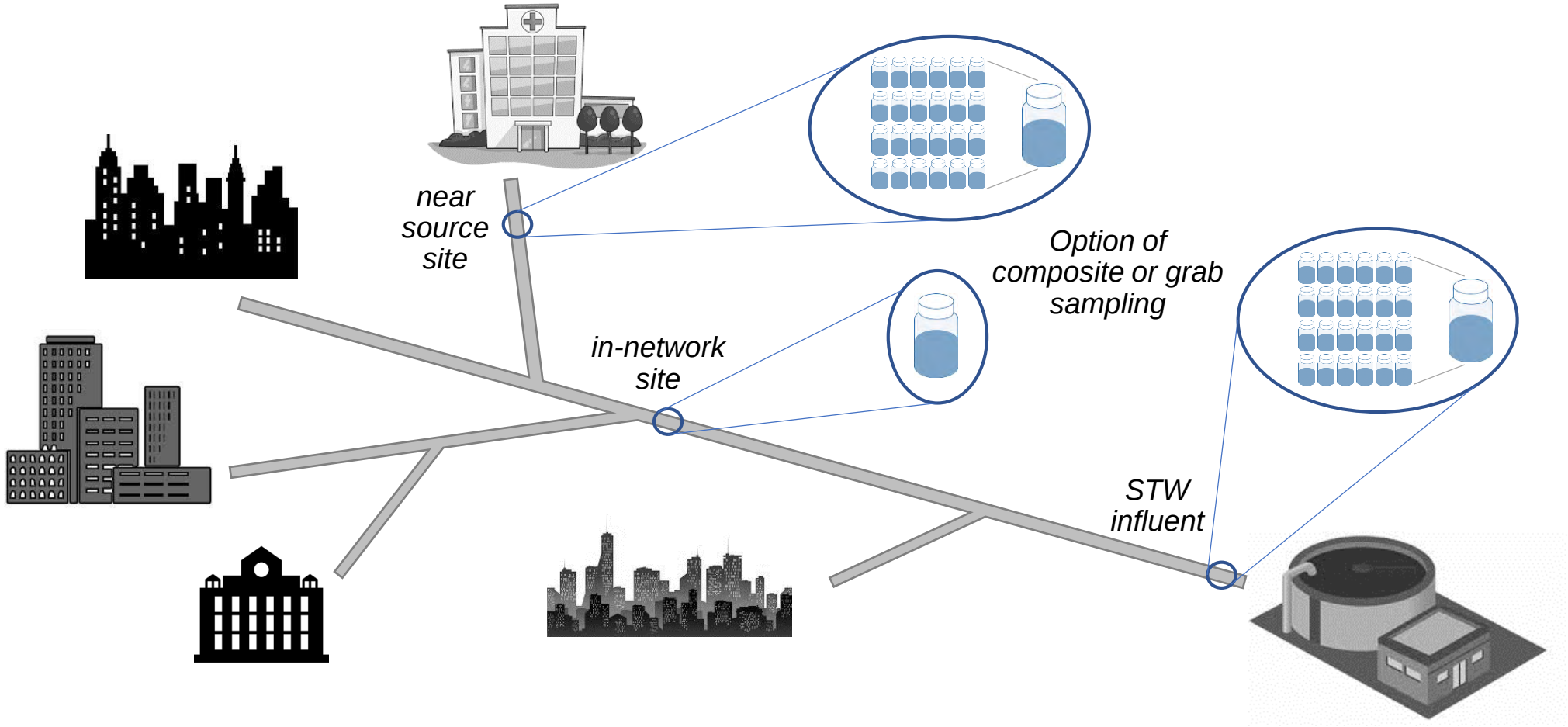
Poliovirus detection

- Vaccine-like type-2 poliovirus (PV2) isolates were found in sewage samples collected from a London sewage treatment works in February 2022
- This is unusual as all PV2 isolates identified since then are genetically related to each other.
- There are indications of person-to-person community transmission of poliovirus
- The level of PV2 found and the high genetic diversity among the isolates suggests there is virus transmission in 5 boroughs and possibly surrounding areas
- Public health notices and actions were taken as a response to the wastewater analysis in conjunction with population vaccination and risk analyses
- Surveillance is expanding to a range of areas outside of the capital



The sewer network and sampling





UK Health Security Agency

It all starts with a good sample

- WBE relies on good quality and consistent sampling
- A thorough monitoring design allows for correct sampling locations and methods to be implemented and ensure samples best represent the population
- When sampled correctly, WBE provides the possibility of a strong correspondence with the actual infection numbers
- When sampled poorly there is potential to miss valuable information and provide incorrect data

Example of sampling strategies

Sewage treatment works

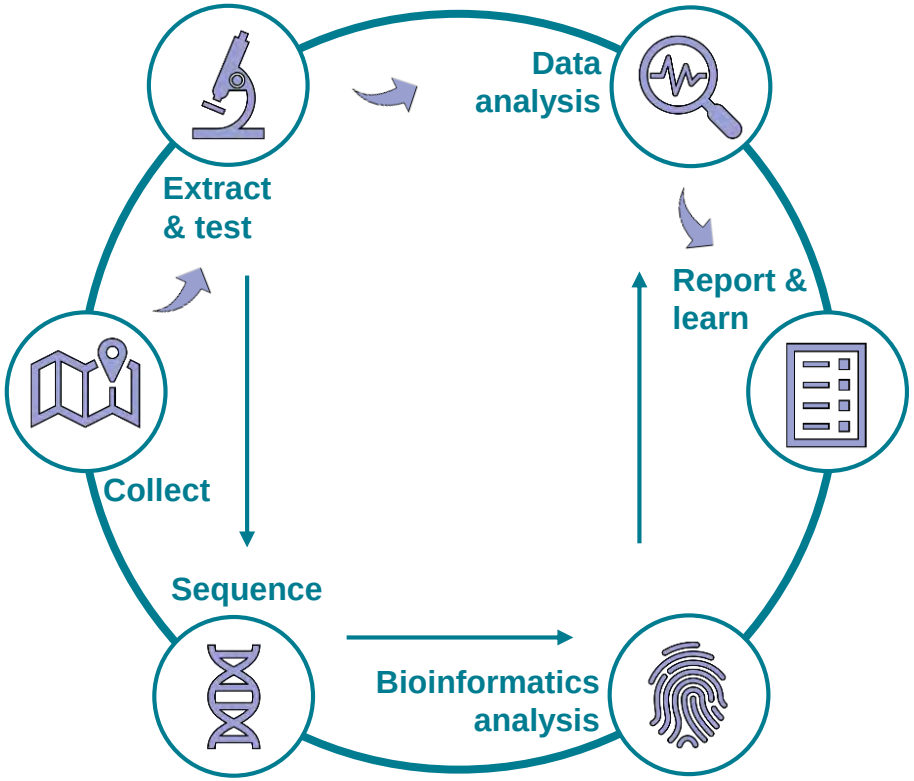
- Sample at inlet, after screen, but before grit chamber
- 24-hour composite sample collected with autosamplers where possible
- If not possible, then grab sample during peak flow
- Care needed to avoid cross-contamination of sample with tanker discharge
- Four days a week; Monday, Wednesday, Friday and Sunday
- Store samples below 4°C

Network sites

- Manholes within sewer network
- City sites with smaller population catchments
- Generally, grab samples during peak flow (7-9 am) due to access constraints on autosamplers
- Sampling method needs to follow Sampling Protocol to for consistency
- Four days a week; Tuesday, Wednesday, Thursday and Saturday
- Store samples below 4°C

Research: Working with Academia and Industry to improve insights

1. Winter readiness (Beyond COVID pathogen detection)	• Beyond COVID, rapid pathogen detection in a high throughput lab (< 4d) Influenza A/B, norovirus, respiratory syncytial virus, enterovirus D68, SARS
2. Chemical markers of population	• Using chemical markers to quantify infection population (< 3d, WWTP or network sourced)
3. Identifying clusters of SARS-CoV-2 mutations	• Bioinformatic tools and sequencing data to identify emerging mutations that may indicate novel variants.
4. Process improvements: optimised detection method in a high throughput environment	• Optimising COVID detection in a high throughput environment (< 4d SARS, < 7d variants)
5. WWA process improvements: No chill solutions	• Enable easier and more cost-effective transportation of wastewater samples to support sampling in remote areas/internationally.
6. Post-pandemic sensors	• Early sensor technologies for virus, bacteria and fungi detection, which can be integrated at WWTP.
7. Smart sampler use	• Intelligent samplers for wastewater applications.
8. Borders	• Design work for border surveillance system at ports, airports, and travel hubs to provide origin destination predictive modelling.



Moving forward

Environmental monitoring of wastewater can be used to detect:

- toxic substances in the environment, such as industrial substances, like mercury
- pharmaceutical use at the population level, for instance antidepressants and antibiotics
- infectious agents, like bacteria and viruses

Collection from an urban sewer

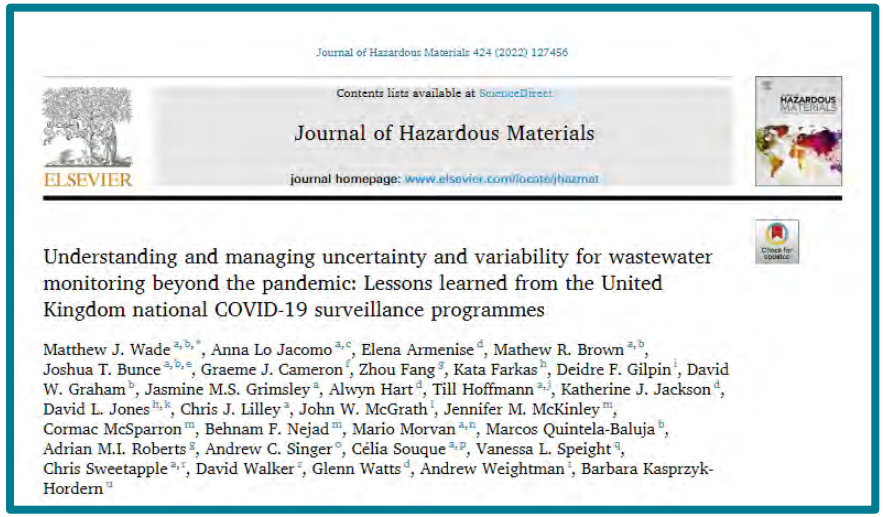

Wastewater treatment plants

Photo Credit: Arnold Jerocki/Getty (top), Getty (bottom)

UK Health Security Agency

Publishing our work

We publish both the data generated from wastewater monitoring and our findings from the work conducted in collaboration across HMG agencies and with academia, industry, and international partners



Journal of Hazardous Materials 424 (2022) 127456

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Understanding and managing uncertainty and variability for wastewater monitoring beyond the pandemic: Lessons learned from the United Kingdom national COVID-19 surveillance programmes

Matthew J. Wade [a,b,*], Anna Lo Jacomo [a,c], Elena Armenise [d], Mathew R. Brown [a,b], Joshua T. Bunce [a,b,e], Graeme J. Cameron [f], Zhou Fang [g], Kata Farkas [h], Deidre F. Gilpin [i], David W. Graham [b], Jasmine M.S. Grimsley [a], Alwyn Hart [d], Till Hoffmann [a,j], Katherine J. Jackson [d], David L. Jones [h,k], Chris J. Lilley [a], John W. McGrath [l], Jennifer M. McKinley [m], Cormac McSparron [m], Behnam F. Nejad [m], Mario Morvan [a,n], Marcos Quintela-Baluja [b], Adrian M.I. Roberts [g], Andrew C. Singer [o], Célia Souque [a,p], Vanessa L. Speight [q], Chris Sweetapple [a,r], David Walker [c], Glenn Watts [d], Andrew Weightman [i], Barbara Kasprzyk-Hordern [q]

www.thelancet.com/microbe Vol 2 January 2021

Comment

Francis Hassard, Lian Lundy, Andrew C Singer, Jasmine Grimsley, *Mariachiara Di Cesare

Innovation in wastewater near-source tracking for rapid identification of COVID-19 in schools

COVID-19 is one of the biggest global public health challenges of the century with almost 42 million cases and more than a million deaths to date. Until a COVID-19 feasibility of this approach. A promising, non-invasive tool that can support the COVID-19 response is the use of wastewater-based epidemiology to enable the

Published Online October 30, 2020 https://doi.org/10.1016/S2666-5247(20)30193-2

Journal of Water & Health

IWA PUBLISHING

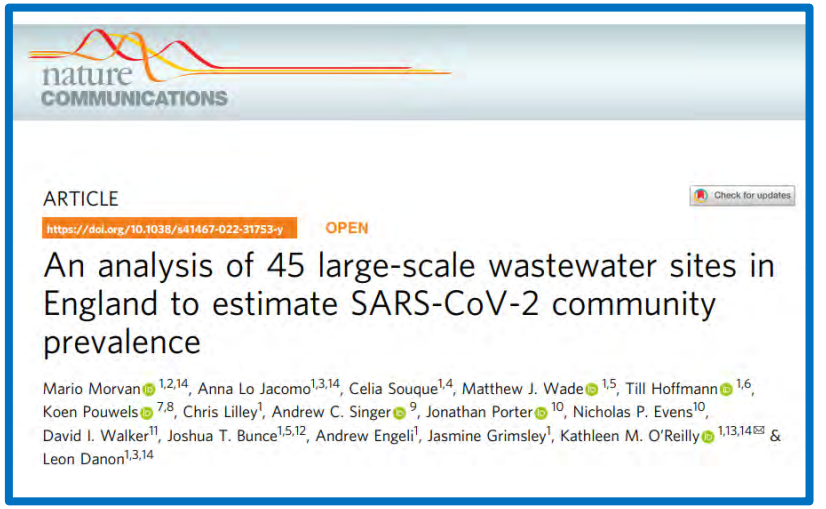
© 2022 The Authors

Journal of Water and Health Vol 00 No 0, 1 doi: 10.2166/wh.2022.026

Research needs for optimising wastewater-based epidemiology monitoring for public health protection

Katie Robins [a,b], Anne F. C. Leonard [a,c,*], Kata Farkas[d], David W. Graham[b], David L. Jones[d,e], Barbara Kasprzyk-Hordern[f], Joshua T. Bunce[a], Jasmine M. S. Grimsley[a], Matthew J. Wade[a,b], Andrew M. Zealand[a] and Shannon McIntyre-Nolan[a,g]

[a] UK Health Security Agency, Environmental Monitoring for Health Protection, Windsor House, Victoria Street, London SW1H 0TL, UK
[b] School of Engineering, Newcastle University, Cassie Building, Newcastle-upon-Tyne NE1 7RU, UK
[c] University of Exeter Medical School, European Centre for Environment and Human Health, University of Exeter, Cornwall TR10 9FE, UK
[d] School of Natural Sciences, Bangor University, Bangor, Gwynedd LL57 2UW, UK
[e] SoilsWest, Centre for Sustainable Farming Systems, Food Futures Institute, Murdoch University, Murdoch, WA 6105, Australia
[f] Department of Chemistry, University of Bath, 1 South, Bath BA2 7AY, UK
[g] Department for Environment, Food and Rural Affairs, London SW1P 4DF, UK
*Corresponding author. E-mail: anne.leonard@exeter.ac.uk



nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-022-31753-y OPEN

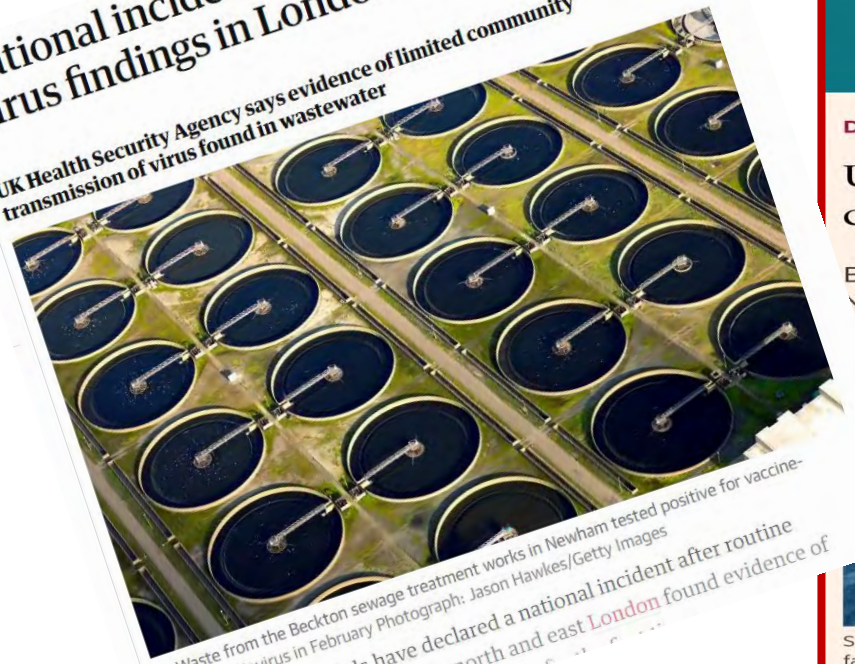
An analysis of 45 large-scale wastewater sites in England to estimate SARS-CoV-2 community prevalence

Mario Morvan [1,2,14], Anna Lo Jacomo[1,3,14], Celia Souque[1,4], Matthew J. Wade [1,5], Till Hoffmann [1,6], Koen Pouwels [7,8], Chris Lilley[1], Andrew C. Singer [9], Jonathan Porter [10], Nicholas P. Evens[10], David I. Walker[11], Joshua T. Bunce[1,5,12], Andrew Engeli[1], Jasmine Grimsley[1], Kathleen M. O'Reilly [1,13,14] & Leon Danon[1,3,14]

In the media

National incident declared over polio virus findings in London sewage

UK Health Security Agency says evidence of limited community transmission of virus found in wastewater



Waste from the Beckton sewage treatment works in Newham tested positive for vaccine-derived poliovirus in February Photograph: Jason Hawkes/Getty Images

Public health officials have declared a national incident after routine surveillance of wastewater in north and east London found evidence of

FINANCIAL TIMES

Your guide to a disrupted world

Start a 4-week trial

Disease control and prevention + Add to m

UK plans to track spread of coronavirus in sewage

British government looks to follow Netherlands by setting up wastewater testing programme

Scientists have found coronavirus's genetic fingerprint in faeces © FT montage; Getty Images; NIH

theguardian.com

Subscribe

The Guardian For 200 years

News Opinion Sport Culture Lifestyle

Coronavirus

'We're the poo crew': sleuths test for Covid by reading signs in sewage

Scientists in Exeter are identifying Covid through human faeces – this could be be expanded to monitor other diseases

Coronavirus – latest updates

itv

itvNEWS Your Area Sign In

Categories

INSIGHT

How our sewage is playing a key role in tracking the spread of Covid

WALES | SCIENCE | HEALTH

BANGOR UNIVERSITY

Thursday 10 February 2022, 1:14pm

Thank You

Any questions?