WASTEWATER-BASED SURVEILLANCE FOR PUBLIC HEALTH:

KNOWLEDGE TO ACTION SERIES

CASE EXAMPLE

BRITISH COLUMBIA CENTRE FOR DISEASE CONTROL

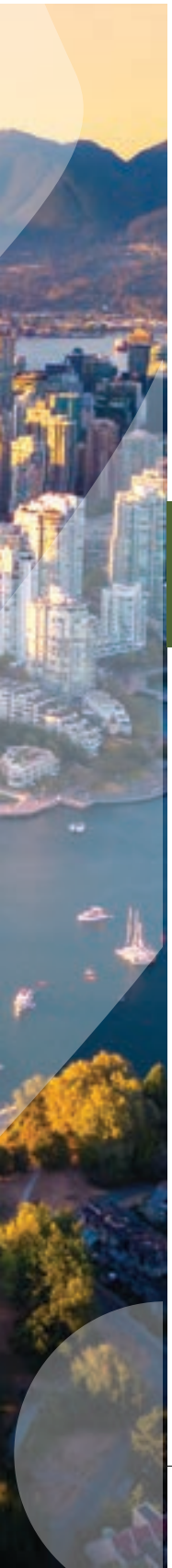
Shared Hallways Support Strong Partnership in British Columbia

KEY TAKEAWAYS

1 **Partnership:** Strong relationships make good partnerships, which has been essential for the development of a robust wastewater-based surveillance (WBS) system at the provincial level in BC. Academia, public health and municipalities all have roles to play in the development and implementation of a WBS system that is effective and sustainable for both managing infectious disease emergencies and anticipating future population health issues.

2 **Data for decision-making:** Communicating data in a timely, accessible and meaningful manner is central to supporting effective decision-making. Having unbiased WBS information at the population level and the development and use of dashboards to share this information have been critical for effective decision-making by community leaders.

3 **Sustainability**: WBS is an important addition to clinical surveillance, but the lack of core funding puts this important tool at risk. Further investment in the WBS system and the development of a standardized approach are needed to ensure Canada is ready for the next pandemic emergency.



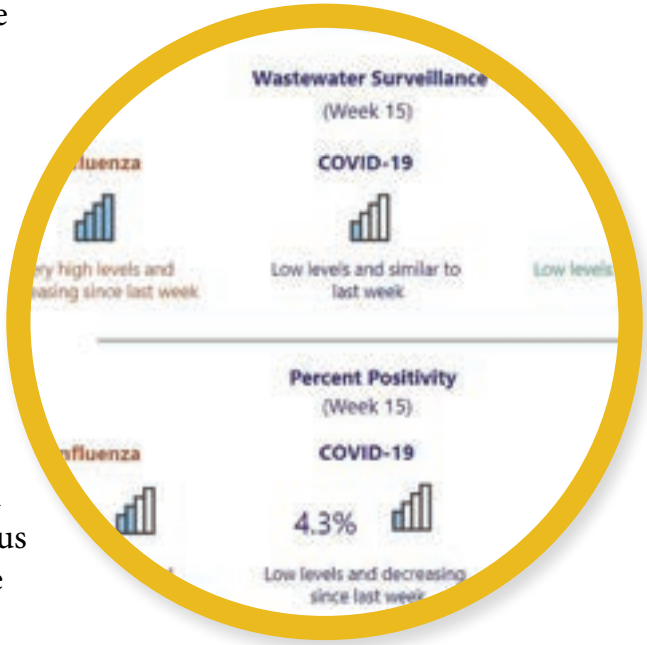
BC CENTRE FOR DISEASE CONTROL

The British Columbia Centre for Disease Control (BCCDC) provides health promotion and prevention services, as well as analytical and policy support, to government and health authorities across the province. This includes diagnostic and treatment services to reduce communicable and chronic disease, preventable injury and environmental health risks.

Provincial wastewater surveillance program

Samples collected from wastewater treatment plants (WWTP) in urban regions across the province are sent to the Public Health Lab (PHL) at BCCDC for testing. There are 12 participating WWTPs, five covering Vancouver and the Lower Mainland, three on Vancouver Island, three in the southern interior, and one in the north. These WWTPs treat wastewater from about 64 percent of BC's population.

Samples are collected two to three times per week. The BCCDC PHL tests the samples and shares SARS-CoV-2, influenza A, influenza B and respiratory syncytial virus (RSV) levels on the wastewater surveillance dashboard for respiratory surveillance.



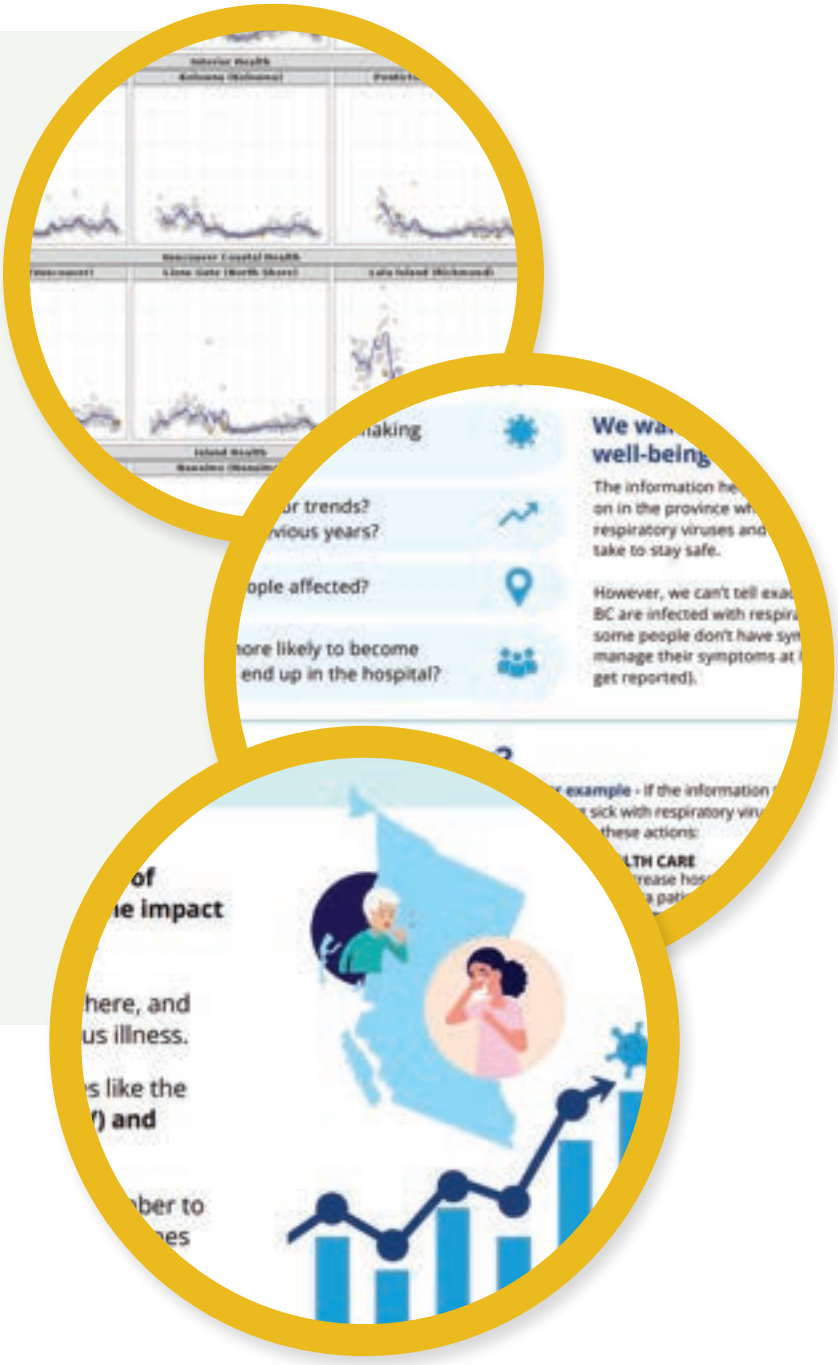
Wastewater dashboard:

https://bccdc.shinyapps.io/respiratory_wastewater/

This information helps to inform the general data tool for respiratory viruses, which is designed to make it easier to see which viruses are circulating in different communities and whether there are increases in infection or serious illness. The respiratory virus data tool consists of surveillance dashboards (including wastewater) and summary reports, with respiratory virus data updated weekly on Thursdays. The respiratory virus data tool webpage includes a simple five-slide explainer document to help people understand where the information comes from and what it means.

Respiratory virus data tool:

http://www.bccdc.ca/health-professionals/data-reports/respiratory-virus-data#Key--trends



Not all the wastewater data collected is posted on the dashboard. The PHL at BCCDC works closely with research teams in the province to watch for new and emerging pathogens that could spread to BC. They look for unusual trends and the possibility of antimicrobial resistance in the pathogens they are monitoring.

"Wastewater is a reliable and cost-effective surveillance approach," says Dr. Natalie Prystajecky. "It started as a small research project [in 2018] and is now a program at BCCDC Public Health Laboratory" (BCCDC News, January 20, 2023).

"Wastewater is a reliable and cost-effective surveillance approach"

BRIDGING RESEARCH AND PRACTICE

Early in the COVID-19 pandemic, Dr. Natalie Prystajecky and her colleagues at BCCDC and University of British Columbia (UBC) were still trying to understand the SARS-CoV-2 virus. A paper from researchers in the Netherlands published a couple of months into the pandemic showed the benefit of testing wastewater to monitor the circulation of the virus in the population (Medema et al., 2020). At that time, researchers in BC were already monitoring wastewater for enteric diseases and they were excited to think that they could also monitor a respiratory disease like COVID-19.

Natalie describes how counterintuitive it seemed in the early days to monitor human feces in wastewater to look for respiratory viruses that don't replicate in the digestive tract. "SARS-CoV-2 proved that saliva and sputum get swallowed and into your digestive tract … which is why we can detect [respiratory viruses like] influenza A and RSV."

From left to right: Dr. Hind Sbihi, Dr. Natalie Prystajecky, Dr. Agatha Jassem and Dr. Linda Hoang are all involved in monitoring respiratory illnesses throughout B.C. with the BCCDC Public Health Laboratory. Source: http://www.bccdc.ca/about/news-stories/stories/2023/respiratory-data-tool (December 14, 2023)

Partners in learning

BCCDC, UBC and the Metro Vancouver municipal water department were already working together to better understand how to reduce pathogens to produce microbiologically safe drinking water. Natalie describes the value of the partnership:

> "There was a common interest … they wanted to see how much virus is removed during water treatment, and we were interested in developing methods to test for viruses in environmental samples. It made a lot of sense for us to work together, to partner and really work on developing those methods together … and we are still working on those."

Natalie doesn't remember how the partners got to know each other, but the relationships between labs brought people and organizations together. This was critical in the early days of the COVID-19 pandemic, as labs were oriented to essential work only.

At the beginning of the pandemic, universities were shut down as part of Public Health Orders. BCCDC had to send people home, stop doing wastewater analysis as a non-essential program, and focus on research directly pertaining to COVID-19.

But as time went on and public health leaders and researchers started to look back and explore ways to help with the COVID-19 response, the paper on wastewater monitoring by Medema and colleagues suggested this as a useful approach to explore (Medema et al., 2020). Natalie remembers being able to return to wastewater monitoring research:

> "There was enough evidence to suggest that maybe we should be trying this as well, so we got permissions to try it here in our lab as the methods we were using were very similar to what other people were trying out … [related to] ways of concentrating the virus and using PCR tests. It was a matter of adapting what we were already doing for enteric viruses and wastewater."

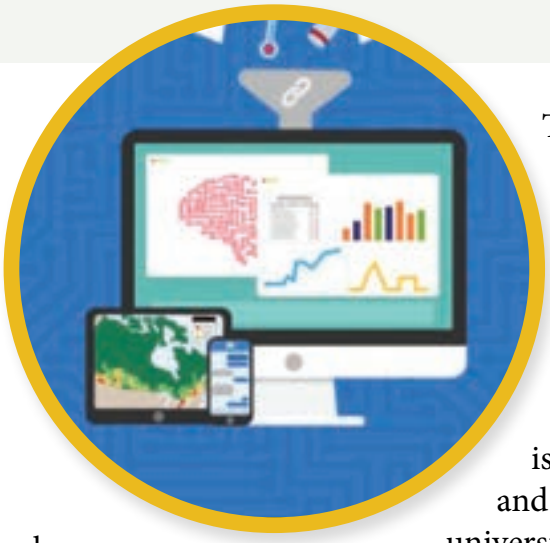
Seamless transition from research to service

Public health practitioners and decision-makers were very excited to receive and use WBS data, but the public was very interested as well. The data contributed to decision-making at the policy level as expected, but also at the level of individual health behaviours (i.e., decisions to wear a mask, take public transportation, etc.). At this point, it was clear to Natalie that WBS needed to transition from a research project to a public service to ensure the timely presentation of key information and clear messages about the implications for public health practice and personal health decisions.

By September 2020, a business case for WBS was made and funding was provided by the province, allowing the PHL to take over the testing of samples from the research lab. This was greatly facilitated by the co-location of the two labs, both under the direction of Dr. Natalie Prystajecky. Natalie describes how helpful it was to have the teams working across the hall from each other.

Seamless transition from research to service

"The staff that were working on the university side, they were adhering to the same standards of quality validation … they basically developed the assay the exact way we would develop assays in the routine [service] lab. The way it was validated … and written up was done the exact same way." Natalie continues, "my research staff were training my clinical staff … but we still had to build the infrastructure, so we hired new staff and got a bit more equipment. We also had to transition from Excel spreadsheets [used in the research lab] to our clinical reporting service, to make it work for wastewater. But the technical aspects of moving it over were pretty seamless."



And both labs benefited from continuing to work together. The public health lab provided a very strong quality and safety framework. When there was a surge in samples for testing the researchers were able to help process samples, and they provided technical training for new staff. The researchers and trainees also benefited from being able to learn in the unique context of an actual public health emergency – not to mention the time and paperwork challenges associated with working with a government partner.

The research and public health structures already in place made the close collaboration possible. BCCDC is a program of the Provincial Health Services Authority (PHSA) in BC. The board of PHSA is very supportive of research and having relationships with universities. UBC has an arm focused on analytics for public health (UBC Centre for Disease Control) co-located in the BCCDC building. This enables faculty to run both clinical labs and research labs, with a smooth process for managing human resources.

Natalie describes what an advantage this is for public health labs in BC and Canada.

This collaborative structure and approach can slow the process of developing tools to analyze and display the data. Natalie points out that this slowed the process somewhat in BC, "but it was seamless to go to scaling up … [all the partners were ready], we were doing it together."

"I think Canada, for the most part, has [public health] microbiologists with academic affiliations and many have a research program. I'd say it's not the same at all in many countries … and I think that's one of the strengths of the public health system here."

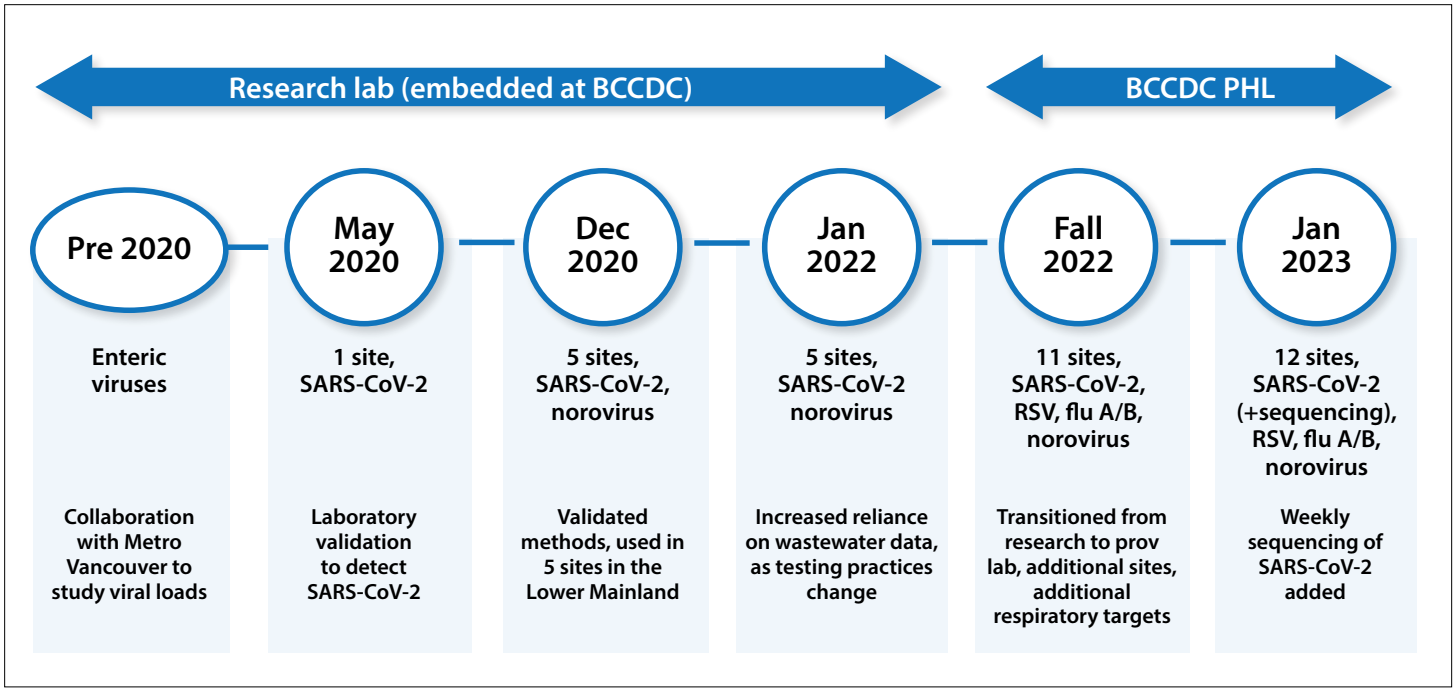


Figure 1: Evolution of WBS in BC for respiratory viruses (Source: BCCDC Presentation, August 2023)

Partnership with municipalities

The BCCDC had a direct relationship with municipal water programs and the wastewater treatment plants (WWTPs) supplying the samples early in the COVID-19 pandemic. As noted earlier, this was due to the pre-pandemic research project with Metro Vancouver looking at enteric viruses and water treatment. This established relationship allowed BCCDC to have a good understanding of how to talk about WBS with municipal partners and what their main concerns would be. The researchers were able to be clear about wanting 24-hour samples of a certain volume on specific days during the week. Being able to share a standard operating procedure developed with Metro Vancouver when talking to other potential municipalities provided a level of confidence that the researchers understood the context and would be a good partner. This included reinforcing that the municipalities are co-owners of the data.

"We [were clear] about data ownership," notes Natalie. "You know, we don't hold the data, we co-own the data. They are sending the sample to us, we analyze it, and everyone has a say in how it is displayed, how it is shared [even if it takes time] … a very partner-centric approach."

See Part 3 – Data Governance and Ethics for more information on community control of data.

When the project expanded outside of the Lower Mainland, the Regional Health Authorities (RHAs) were brought into the process early to provide guidance about potential municipal partners. The RHAs are also licensees, so they know the water utilities and have environmental health officers (EHOs) who have relationships with local staff. And each municipality needed to go through a slightly different process.

"In one utility, staff needed to go to Council, while in another utility the decision was made at a manager level. We gave lots of time and lots of presentations. We hired a person specifically to help with onboarding, to do presentations, just to make them feel comfortable … we had to be patient with the process," says Natalie. "One of the sites took a year to onboard … another site we bought them an autosampler because we didn't think they could get one."

Relationships are critical for making a WBS system work. Natalie describes how her team has ongoing relationships with public health practitioners in the field, providing support and shipping materials when there are outbreaks.

"Our main clients are environmental health officers and medical health officers … and I think my team are experts in relationships … they are not just sitting in the lab doing work. They are very experienced in supporting people to get samples to us."

COMMUNICATING DATA FOR DECISION-MAKING

Data on the whole community

The wastewater data collection started at the main WWTP in Metro Vancouver and expanded to include four additional sites. Because BCCDC has access to clinical case data as well, the team in the Public Health Lab (PHL) was able to partner with their epidemiology colleagues to map the cases to the 'sewershed' in which people live.

"We had this very beautiful graph in the early days," remembers Natalie. "We [were able] to show that they track together almost perfectly, and in fact, the wastewater data was little bit ahead of the clinical cases … the turning point was when the Omicron variant arrived [in November 2021] … and the clinical demand for testing exceeded what the system had available."

The wastewater data became valuable as an unbiased source of data on the prevalence of the SARS-CoV-2 virus in the population and could be used to monitor change over time.

Importance of dashboards

The way the public looks for and receives surveillance information changed dramatically because of the COVID-19 pandemic. People now expect to have immediate access to population data, which puts pressure on BCCDC and PHL to ensure data is disseminated in ways that are easy for the public to access and use.

Dashboards have become essential for communicating surveillance data, including WBS and information on respiratory diseases. There has been an increased focus on providing clear notes for guidance about what the data means each week, and the lab is supported by the BCCDC communication team to do the essential knowledge translation. They also have an analytics team that creates the dashboards.

Things have become more routine since the early pandemic, but there is still the need for evaluation of the effectiveness of dashboards. "It would be great to see an evaluation of our wastewater program generally, and specifically our wastewater dashboard," says Natalie. "I'd say in the public health world there hasn't been a good evaluation of wastewater testing effectiveness … but I think we will see those papers come soon."

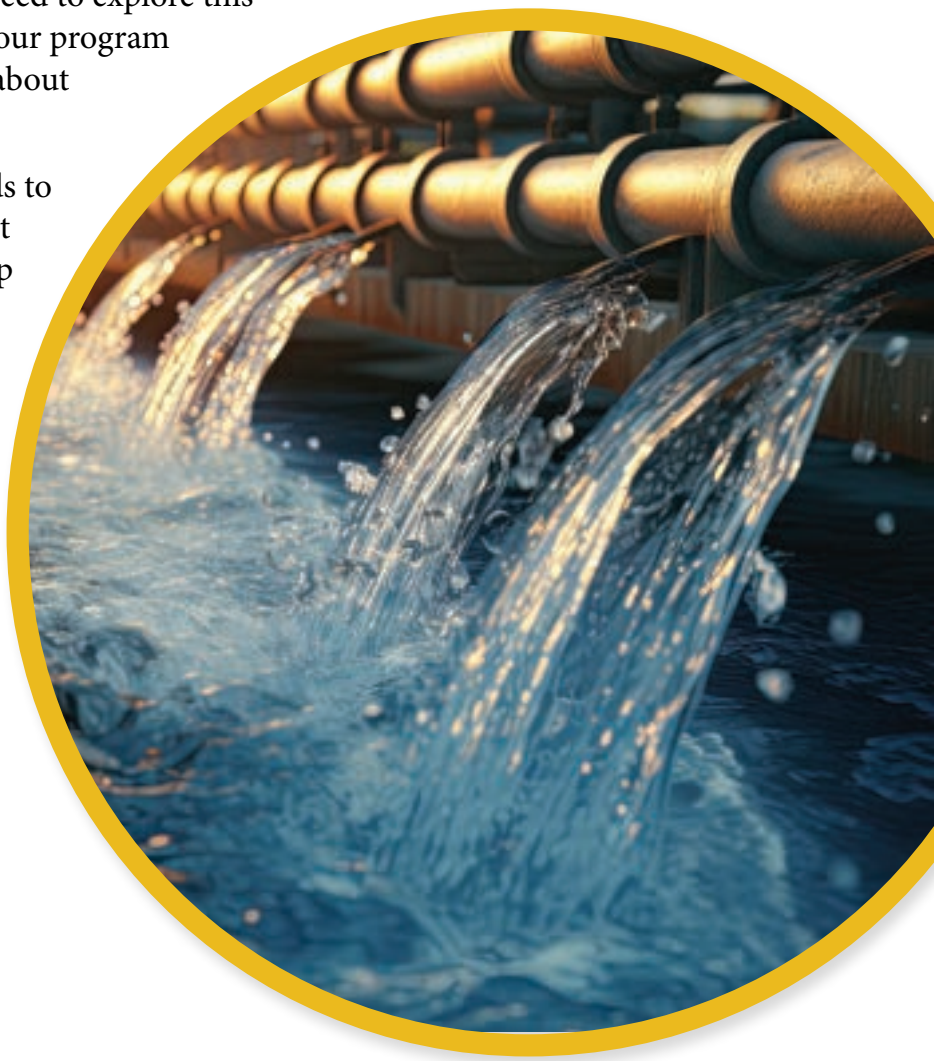
See Part 3 – Dashboards for Communication and Decision-Making for more information on principles for developing dashboards.

Ethics and small-scale systems

The BCCDC's mandate is to support public health intelligence at the provincial scale. Although it has had requests to sample work camps, and it did do a university residence project at one point early in the COVID-19 pandemic, it has avoided doing small systems research due to the potential harm of stigmatizing groups or facilities.

The WBS work to date has been undertaken in collaboration with medical health officers in the community to make sure there is a good understanding of any unintended risks of doing the work. But Natalie notes that they will need to explore this further. "I think that in future parts of our program expansion we will have to be thinking about smaller populations."

Natalie also notes that not all data needs to be made public. In the context of a First Nations community, that has ownership and control of its own information as per the Principles of OCAP® (FNIGC, n/d), the community needs to decide whether they want to undertake WBS and how.



See Part 3 – Data Governance and Ethics for more information on OCAP principles.

LOOKING TO THE FUTURE

Funding

The diversity of the partnerships was central to being able to get the necessary resources to support a wastewater monitoring program for SARS-CoV-2. The money allocated by Metro Vancouver for studying enteric viruses was deployed to COVID-19, as well as a small grant from the BCCDC Foundation that was meant for that work as well. Additional partnerships with university researchers also brought in funding to develop research methods.

"It was the combination of those very small amounts of money and having the agents and people who already know how to do this work that got it going," says Natalie.

The downside of depending on research funding during a health emergency is that the system with independent researchers, staff and students is designed to meet the needs of the academic environment. Delivery of data and results is for the purpose of learning and publication, not to support time sensitive public health decisions. Simple things, like staff being on vacation, can create a serious delay in getting essential information to public health decision-makers and the public.

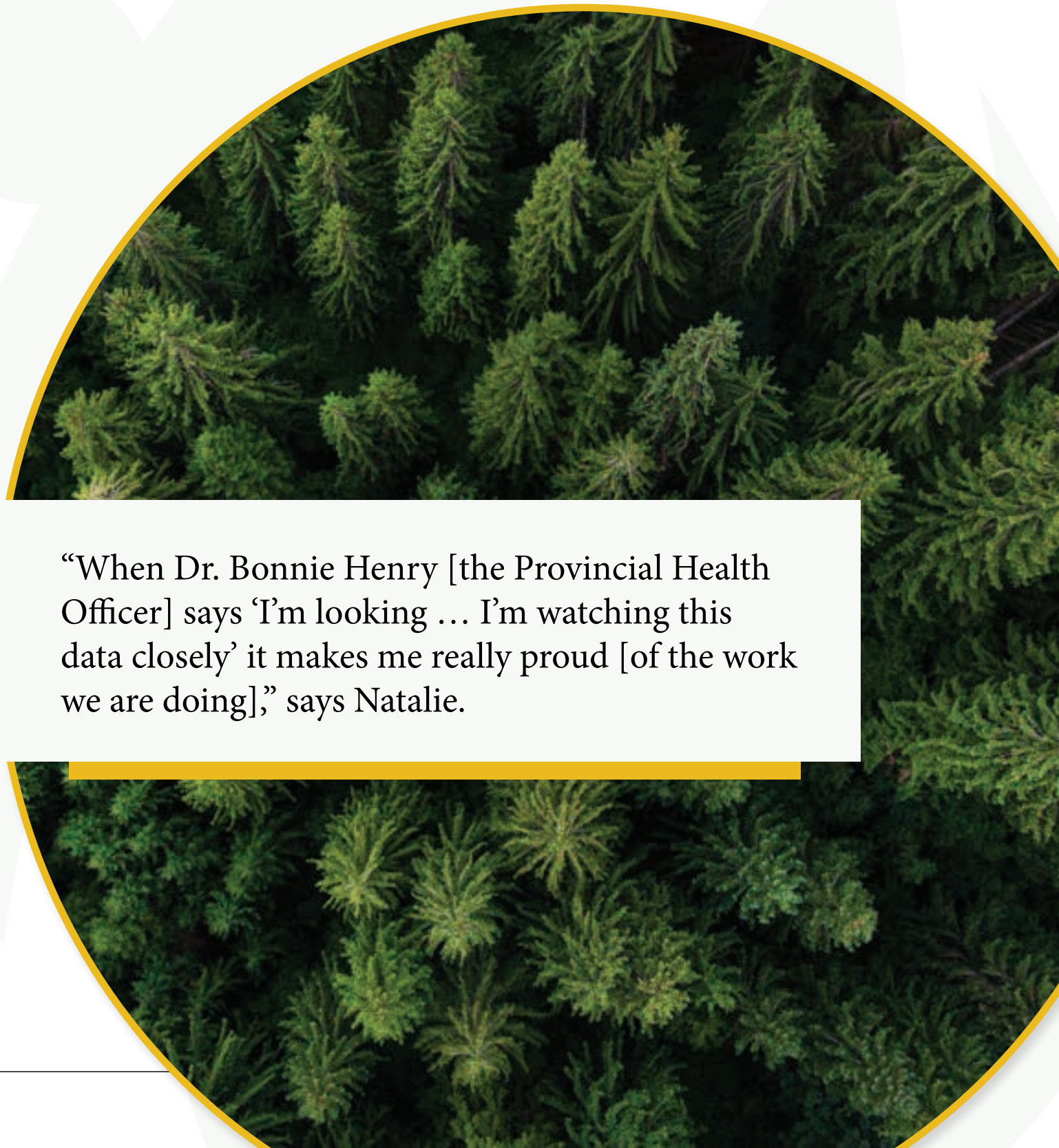
Natalie is concerned about the lack of base funding for WBS, both in BC and across the country. As she points out, WBS is not meant to replace existing clinical surveillance but is an important tool that is at risk of being cut back as pandemic-related funding declines. There is a National Wastewater Surveillance Committee, but there is still the need for standardization and investment.

"There's a patchwork of how [WBS] is delivered across the country, and different methods and different interpretations … standardization is needed … [especially anticipating] other bugs in the future."

Vision for the future

Natalie dreams about having a 'compendium' of methods for WBS. "Having core funding and clear standards are critical … this is a huge opportunity to really build out the surveillance system and ensure it is in operational budgets."

It took a huge and diverse team of people to develop the WBS surveillance system in BC, which is now an important contributor to the provincial Respiratory Virus Data Tool. Natalie is proud of her team at BCCDC and UBC, and all of her public health colleagues across the province.



"When Dr. Bonnie Henry [the Provincial Health Officer] says 'I'm looking … I'm watching this data closely' it makes me really proud [of the work we are doing]," says Natalie.

For more information

See the ***Royal Society of Canada Policy Briefing*** for more information on WBS and BCCDC as a Canadian success story (Hrudey et al., 2022, pg. 87-88 and pg. 128-130).

References

First Nations Information Governance Centre (n/d). The First Nations Principles of OCAP®. Available from: https://fnigc.ca/

Hrudey, S. E., et al. (2022). Wastewater Surveillance for SARS-CoV-2 RNA in Canada. *Royal Society of Canada Policy Briefing*. 2022. Available from: https://rsc-src.ca/en/covid-19-policy-briefing/wastewater-surveillance-for-sars-cov-2-rna-in-canada

Medema, G., Heijnen, L., Elsinga, G., Italiaander, R., & Brouwer, A. (2020). Presence of SARS-Coronavirus-2 RNA in Sewage and Correlation with Reported COVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands. *Environmental science & technology letters*, *7*(7), 511–516. https://doi.org/10.1021/acs.estlett.0c00357

OTHER TOPICS IN THIS SERIES

PART 1: OVERVIEW

PART 2: CASE EXAMPLES

The case examples in this Knowledge-to-Action Series are stories told from the perspective of the Public Health practitioners most closely involved in the development and implementation of the WBS program in their region. They are intended to provide a deeper understanding of the organizational and community context, and key learnings related to interpretation and communication of information related to wastewater-based surveillance.

- BC Centre for Disease Control.
- Ottawa Public Health.
- Nunavik Board of Health and Social Services.

PART 3: WBS RESOURCES AND TOOLS

The resources and tools in this Knowledge-to-Action Series are intended to provide a summary of key information and communication topics for public health practitioners related to WBS. Each document includes core concepts with references and links to additional materials. There is also a set of reflection questions at the end for individuals and teams to consider when applying the concepts to the development and implementation of WBS programs.

- Data Governance and Ethics.
- Dashboards for Communication and Decision Making.

Wastewater-Based Surveillance for Public Health:
The Knowledge-to-Action Series. Part 2. Case Examples.
BCCDC. Shared Hallways Support Strong Partnership in British Columbia.

We would like to thank Dr. Natalie Prystajecky for sharing her knowledge and experience for this story. She has reviewed the story for accuracy. The perspectives and opinions expressed do not necessarily reflect those of her employer (BCCDC and UBC), or of CWN and NCCID.

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