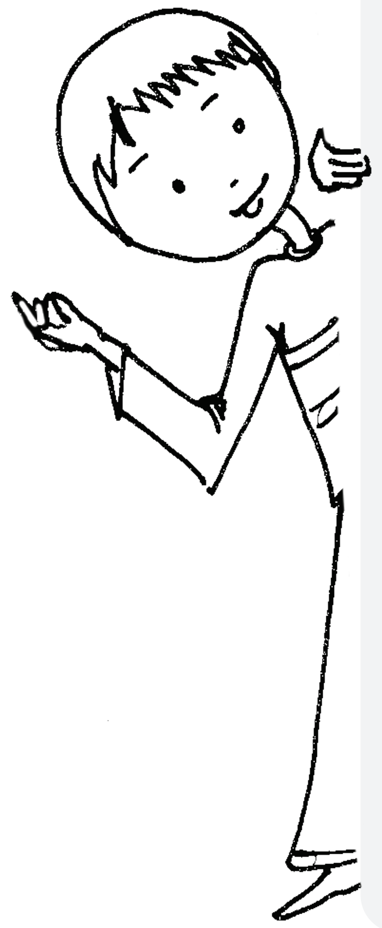
Environmental Surveillance for COVID-19 - A Playbook

A guide to conduct city-wide wastewater surveillance for SARS-CoV-2

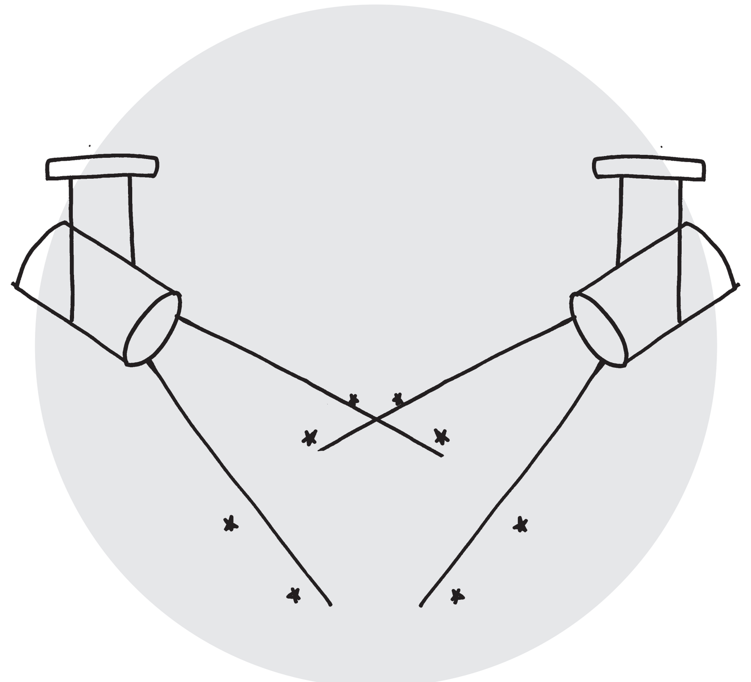


What is a Playbook?

A playbook includes "process workflows, standard operating procedures, and cultural values that shape a consistent response—the play."

It borrows from some of the Aristotelian elements of the play -

Plot	The arrangement of events or incidents on the stage. The plot is composed of "clearly defined problems for characters to solve."
Character	The agents of the plot. The People.
Theme	The reason for the play. The Purpose.



Foreword

Shri Tushar Giri Nath, IAS, Chief Commissioner
Bruhat Bengaluru Mahanagara Palike

The Precision Pandemic Health Surveillance (PPHS) initiative incubated by Swasti - a public health agency headquartered in Bengaluru, is a city-wide wastewater surveillance initiative, set up as an Early Warning System in Bengaluru city for COVID outbreaks. The 'Precision Health Platform' in Bengaluru, the first of its kind in Asia, working with the Bruhat Bengaluru Mahanagara Palike (BBMP) and the Bangalore Water Supply and Sewerage Board (BWSSB) tests wastewater from sewer and open drains to identify clusters of new infections.

This initiative tests community wastewater, to trace the presence of SARS-CoV-2 virus in the population. The city of Bengaluru adopted this initiative and scaled it across all 198 wards, to help officials track the novel coronavirus at an early stage, even among asymptomatic persons, along with conducting genomic surveillance.

We are happy that Swasti and the #COVIDActionCollab supports this initiative in Bengaluru and that we have a COVID-19 Expert Committee that provides inputs, analysis and insights to policymakers for targeted prevention, surveillance and management. This may be considered by other cities as a way to enhance their city's response not only to SARS-CoV-2, but also to other pathogens of public health importance like typhoid, cholera and other enteric bacteria.

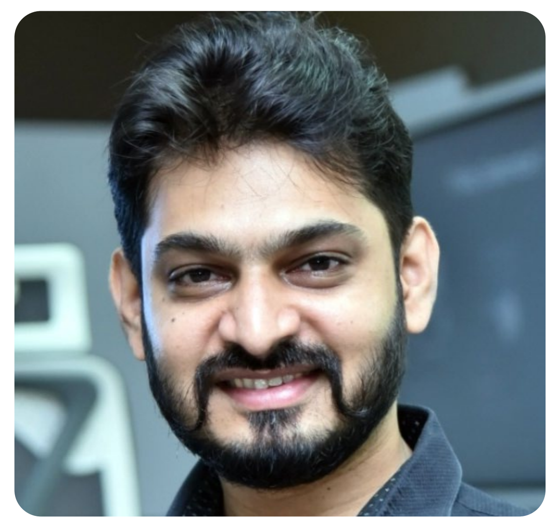
Shri DR KV Thrilok Chandra, IAS, Special Commissioner (Health & Information Technology)
Bruhat Bengaluru Mahanagara Palike

Over the past year, with the Precision Health Platform, Bengaluru scientists have demonstrated that testing wastewater can serve as a cost-effective early warning system, often predicting an increase in COVID-19 infections even before the number of official cases has risen.

With the platform, the early signs of SARS-CoV-2 presence in localities can be analysed in tandem with other relevant surveillance data so that city administration takes-up proactive steps to reduce human casualties and provide timely humanitarian and health services to the community. Results and findings of wastewater testing are added to existing public health surveillance systems of the local government. Thus, the city administration gets a comprehensive view about the situation and can develop a strategy to address the emerging issues.

This kind of surveillance would be useful to all cities and we would be happy to share our learnings to help support and guide on the same.

Shri Dr. Bhaskar Rajakumar, Officer on Special Duty, Covid War Room
Bruhat Bengaluru Mahanagara Palike



COVID-19 pandemic management was new to most of us. Understanding of the virus behaviour and disease spread patterns was of prime importance for effective surveillance. Researchers and scientists from Precision Health Platform along with teams from BBMP and BWSSB initiated wastewater surveillance and genomic sequencing in mid 2020. This has helped us as an early warning system to keep the necessary resources ready for impending rise in cases, and also target the surveillance activities in specific locations of expected rise.

We are exploring the possibilities of extending the learnings from waste water surveillance activities in Bengaluru, beyond COVID-19 to monitor many other diseases and health concerns.

From the desk of Skoll Foundation

Dr. Nancy Messonnier, Executive Director,
Pandemic Prevention & Health Systems

Kathie Paul Wilkerson, Analyst,
Portfolio & Investments

The past two years have shown us that sound surveillance systems are critical to prevent pandemics and ensure governments are equipped to respond to outbreaks. Yet, in resource-constrained settings access to accurate and timely data on disease trends can be scarce, making public health decisions difficult. Environmental or wastewater surveillance can provide a low-cost method to track prevalence of disease at the community level.

Dr. Nancy Messonnier
@skollfoundation

When sustainably integrated into a well-functioning comprehensive system for disease surveillance, wastewater surveillance can complement traditional detection pathways as an essential component of early warning systems and tool for active outbreak monitoring. It is particularly relevant for surveillance of disease in resource-constrained environments which typically concentrate underserved and otherwise marginalized populations (e.g., urban slums) and where mass individual testing is unavailable.

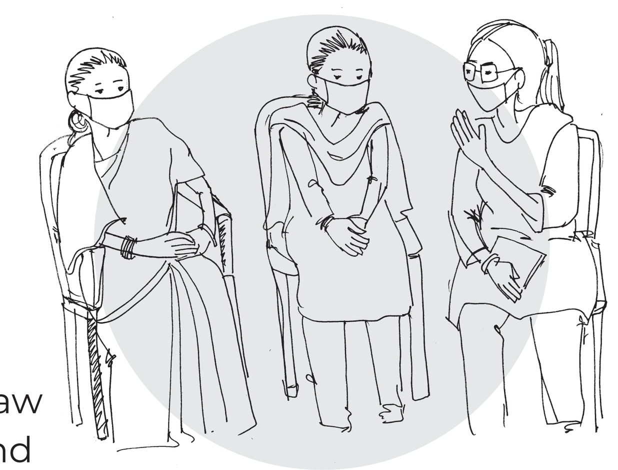
Despite some successful applications for the surveillance of polio, and considerable opportunities to apply it elsewhere, wastewater based environmental surveillance has remained an underinvested space in low- and middle-income settings. The global COVID-19 crisis pandemic challenged us to innovate and increased momentum for environmental surveillance.

Kathie Paul Wilkerson
@skollfoundation

The Precision Heath team seized this window of opportunity. It built a platform of wastewater open drain surveillance aimed to support the local municipal government's understanding of the trends of new COVID-19 infections along with other pathogens of pandemic potential, illicit opioids, and anti-microbial resistance (AMR).

For Skoll, supporting the Precision Health Platform in Bengaluru was an ideal opportunity to invest in social innovation that helps build the systems for environmental surveillance in the city of Bengaluru with a highly collaborative entrepreneurial effort across multiple stakeholders including public, private, academic sectors. The potential for broader, longer-term impact beyond COVID and beyond Bengaluru was equally compelling. The Precision health team rose to the challenge, establishing a system for disease surveillance and integrating it with local authorities' decision-making processes all while promoting equity and transparency, and broadly encouraging the development of sewage surveillance as an emerging field for COVID-19 and other diseases of public concern.

Effective pandemic prevention and response require strong health systems, government leadership, and investments in long-term solutions. Building on the successes of this pilot, we are eager to see environmental surveillance become an integrated component of surveillance systems that support public health decision making across India and beyond.



Continued partnership with governments as stewards of the public health infrastructure will be of utmost importance for sustainability and ownership. We are excited to watch new opportunities for proximate social innovators to engage and support the leadership of local governments and their public health priorities.

Surveillance and health systems strengthening go hand in hand. We invite you to draw inspiration from initiatives like Precision Health that chose to embrace this duality and push the boundaries of innovation to build better health systems.

Introduction

@angelachaudhuri

It gives me so much joy to see the culmination of intense hours of experimentation, discussions, illnesses, phone calls, missed meals and review meetings leading to this Environmental Surveillance for COVID-19 Playbook - a summary of all our lessons in Asia's first city-wide mixed source wastewater surveillance for COVID-19.

In March 2020, the world had realised that COVID-19 was going to affect everyone, the group of organisations I work with - the Catalyst Group knew that COVID-19 was going to hit far and wide; that it would affect the most vulnerable disparately and that we needed a diverse and large set of partners to collaboratively respond; and hence was born #COVIDActionCollab.

In the early days of the pandemic, we wanted to solve for (1) shortage of test kits (2) early warning system. So when we read the article in Nature by scientists at KWR Water in the Netherlands who reported detecting genetic material called RNA from SARS-CoV-2 in wastewater, correlating this with the prevalence of disease at different times; it inspired us to step into several conversations inside the country and across countries to understand if sewage might similarly provide early warning signals about the spread of COVID-19 in India.

We decided to take a chance, and with our partners at Molecular Solutions - armed with some bottles, an ice box and protective clothing, we began to experiment – going out into the city to see what we could collect, and what it contained.

We found SARS-CoV-2 in these wastewater samples – and we realised that with consistent efforts, our measurements could predict peaks in COVID-19 infections seven to ten days ahead of time.

By March 2021, the Government of Karnataka and Skoll Foundation were willing to bet on us, as we endeavored to scale this initiative city-wide, and this became a first of its kind globally.

Every morning between 06:00 and 07:00, sample collectors head out to 46 open drain and 23 sewershed sites across the city – selected for their ability to catch a representative sample from a significant slice of Bangalore's population.

Each site is visited twice a week, and the turnaround time for processing samples is less than 24 hours. All this powered by a digital backbone- that brings data from the "drain to the dashboard", which is communicated over Twitter every week day.

Precision health platform- Bengaluru has provided three early warnings of COVID-19 infection spikes – the latest of which occurred in late December 2021. Variant testing was rolled out in early June 2021 and helped determine which variants of SARS-CoV-2 were circulating and in roughly what proportions. BA 2.10 Omicron was found in early January.

Obviously, such an ambitious undertaking of this kind needed eminent champions, well-wishers and resources. It was with foresight and a progressive mindset that the Bengaluru City Commissioners office commissioned an exercise like this. PCMH Wellness navigated and coordinated a number of partners and local government agencies to help balance hot priorities and keep the uptick of political will; Molecular Solutions, National Center for Biological Sciences, Tata institute of Genomics collaborated and experimented on the laboratory protocols and bioinformatics; the CDD Society, Neshaju Envirotech and Biome Trust shared their intimate knowledge of wastewater and sewage systems protected us from failures, Catalyst Management Services set up the digital architecture and modelling and Swasti , a glocal public health catalyst designed the initiative and took charge of analysis, communication and advocacy; convening the diverse partners on behalf of #COVIDActionCollab. My deep gratitude to Skoll Foundation who took the risk of financing this innovation and believed in us, when it was just a fledgling of an idea, previously unproven. My hat-tip to WHO who championed this cause not just in India but worldwide and released critical documents encouraging all countries to seriously consider investing in this system. I would like to especially thank the USAID/India Health Office for their encouragement and support in exploring collaborations and partnerships that led to Precision Health being what it is today.

This past year, the results of Precision Health told us beyond a doubt that cities without sophisticated drainage systems can still adopt environmental surveillance as a cost-efficient and powerful tool for public health surveillance and planning and certainly for pandemic preparedness. It would help the city target its resources and actions in a timely manner. And we know if this can work in Bangalore, it can work across cities in India and in other parts of the world.

In the next phase, we are increasingly looking into typhoid, cholera, rotavirus – those pathogens that can be isolated and identified through wastewater surveillance, and are amongst the biggest killers in our country – and, of course, the hidden pandemic, which is antimicrobial resistance.

We hope that this playbook informs and inspires other cities to take up environmental surveillance. You know where to find us, we have your back.

Dr.Angela Chaudhuri

Partner
Swasti, The Health Catalyst

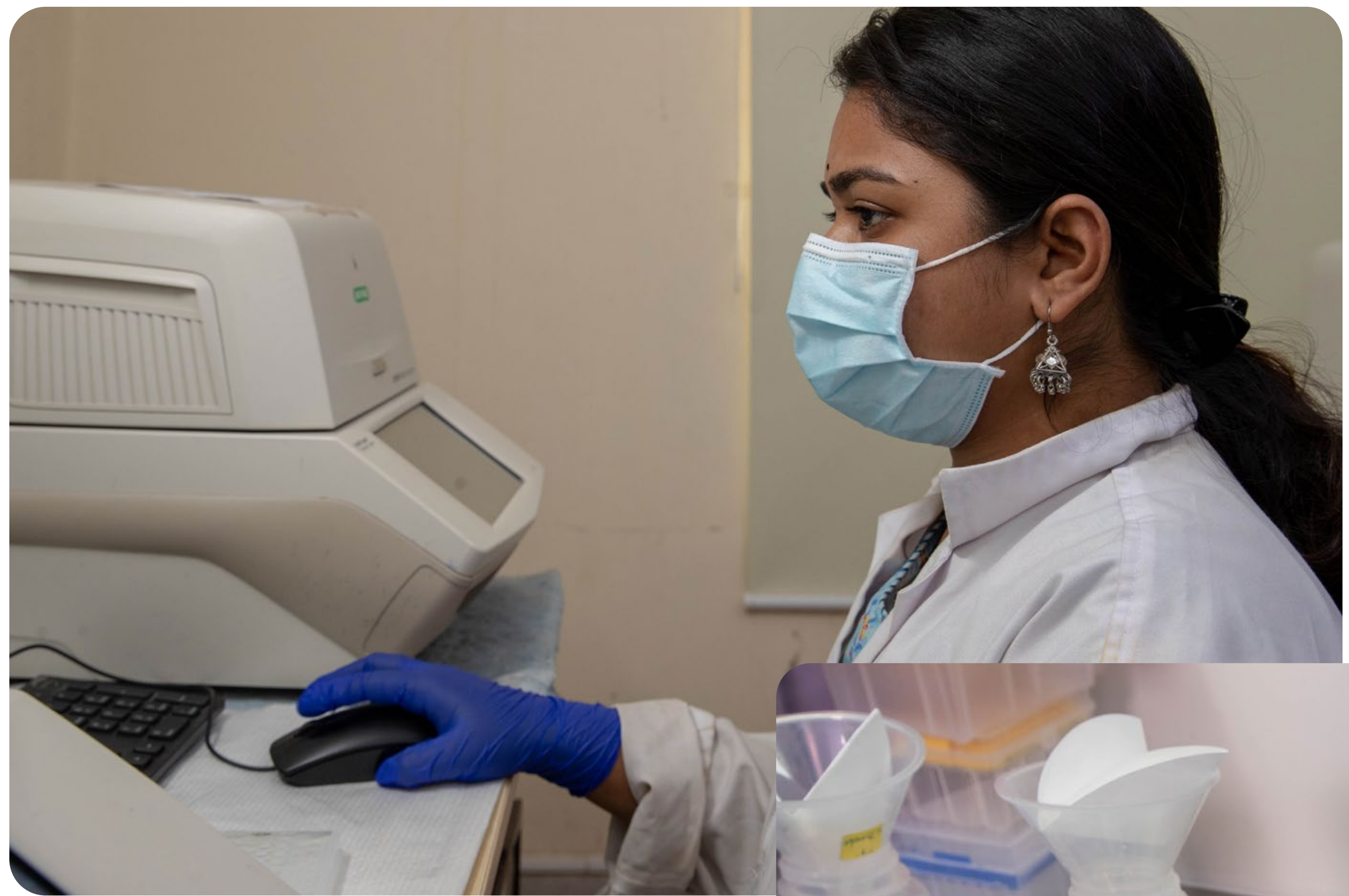
This Environmental Surveillance for COVID-19 Playbook is thus a result of critical learnings surfaced by Swasti while running the pilot and setting up the city wide Precision Health Systems.

Through the Environmental Surveillance Initiative, we learnt

How quickly can test results be returned?	**How reliable are the wastewater testing results, given temperature fluctuations, rainfall, and flow?**	**What thresholds should trigger policy actions such as expanding individual testing or tightening restrictions?**	**Which agencies, institutions, and funding must come together to deploy surveillance in a sustainable way?**

This Playbook builds upon the same and structures how Early Warning Systems of Sewage Surveillance can be setup in locations that have sewered connections, open surface and underground drains and centralised sewage systems.

- It is intended for scalability and replication.
- Scientists, Researchers, NGOs, CBOs, Governments, International Aid Agencies may use the lessons learned and integrate them into future interventions and programs.
- The Playbook addresses the problem statement or in the word of plays - the plot and breaks down the how and the why for each step. Like many other playbooks, this traces the 4 Ps - Plot, Purpose, People and Places and spans 3 Acts - Planning, Implementation and Evaluation.
- The pull out pages are the Standard Operating Procedures that cover Sample Collection and Lab Processes.
- The annexure provides a range of Tools and Notes that cover Checklists, Forms, Using Tech and Training Documents.



Plot: Problem Statement

Without a robust surveillance system, public health response is largely reactive and not preventive and proactive. This leads to inefficient clogged supply chains at its least and lives lost at its worse.

The public health infrastructure while in continued development, has gaps in the access of healthcare, health financing and overall health infrastructure. One such gap is observed in public health surveillance. Most of the systems established in public health surveillance are associated with data and information collected from several healthcare records and surveys. However, there are several other avenues which still remain unexplored in the country. As a result, we have limited resources in the public health surveillance system.

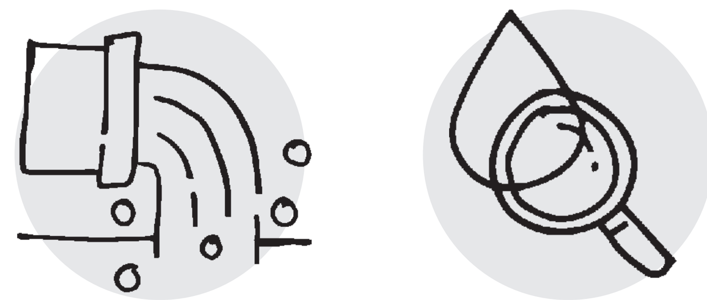
There are typically 2 pronged issues:

- A hurdle in the comprehension of what an environmental surveillance system can and cannot do.
- A lack of identification of the diverse players involved for environmental surveillance systems to be meaningful in design and impactful in delivery / outcome

There is a lack of evidence-based decision-making platforms or tools in the public health surveillance system at the city and state level, which may facilitate better control measures of disease spread in the case of outbreaks.

As a result, public health response remains pigeonholed and dependent on theoretical predictive indices without an agile component that can help localized response.

No One is safe till EveryOne is safe



Wastewater Surveillance under Precision Pandemic Surveillance Initiative is aimed to support the local municipal administration to understand the trends of COVID infections within the community. It can be utilised as an Early Warning System that indicates an outbreak by detecting sentinel from the wastewater.

We have learnt that

1. A functional / impactful Early Warning System NOT ONLY solves for the science but ALSO for the communication.
2. It demonstrates how the data can be presented and shared to
   - Help administrative decision making
   - Generate proof points for Public Health Communication
   - Inform risk metrics at community, city and district levels depending on the sewage systems.
3. Environmental surveillance findings needs to be part of a sense making platform where other sources of data are used to make a comprehensive finding report. It is one marker among many - but one of the most agile and cost efficient ones.
4. Diverse set of stakeholders are absolutely essential for Early Warning Systems to be functional.

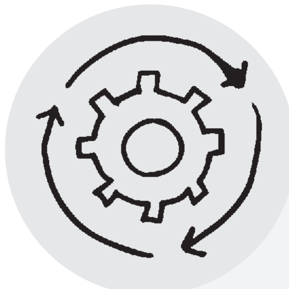
Purpose and Objective

The COVID-19 Wastewater Surveillance Playbook is a guiding document to help organizations to set up and implement the wastewater surveillance system for SARS-CoV-2 virus detection in partnership with local government and other partners.

The playbook outlines the detailed steps required to initiate and conduct wastewater surveillance in any given city. In this playbook you will find

Wastewater surveillance and monitoring system as an effective public health surveillance tool to detect and track the trends of SARS-CoV-2 in the community

Set of activities conducted for the wastewater surveillance



Checklists, Tips & Tricks, Standard Operating Procedures and Further Reading Links

The playbook divides the entire process into 3 Acts and 4 scenes, which are as follows:

1

Act 1. Scene 1: PLANNING

Act 1. Scene 2: SET UP

2

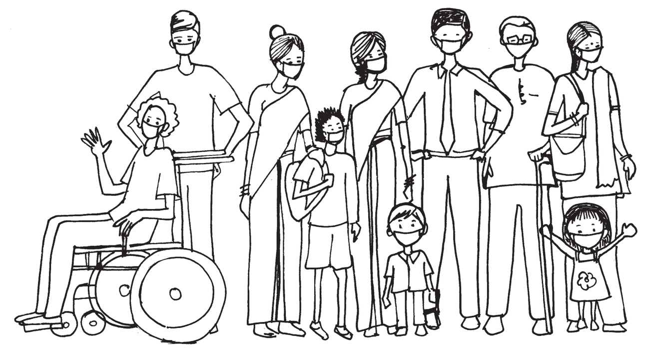
Act 2: IMPLEMENTATION

3

Act 3: EVALUATION

PEOPLE

Who are the people?



Solve for the science

Scientists
- Molecular Biologists
- Genome Experts
- Ecological Experts
- Water & Sanitation Experts

Enable the environment.
Take scaled action

Govt Administrators
- City Administrators
- Public Health
- Stats
- Water & Sewage and Pollution boards

Strategic Communication

Communication Specialists

Support effective understanding and communication

Data Scientists
Data Visualisers

Inform national, state and sub-provincial policy making

Public Policy

Inform/ validate case loads
Inform on clinical presentations

Clinicians

Role Matrix

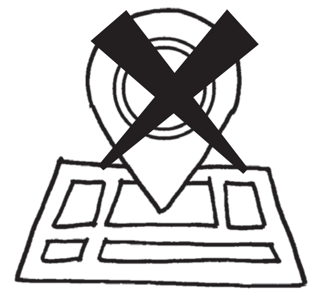
Role Title	Anchoring Organization / Institution	Local Government (LG)
Coordination	Orientation and capacity building of partners; Regular updates on insights.	Designation of officials as Point of Contact (PoC) for better communication and coordination with the team.
Insights to action	Create and develop better data visualization and interpretation platforms from the obtained data and information to help local governments in faster decision-making and actions on disease control.	Integration of Early Warning System and environmental surveillance with other surveillance tools for better evidence based decision making.
Communication	Create and develop communication tools to avoid misinterpretation and misleads from the data and dashboard.	Set up and include the initiative members in regular dialogues for updates and insights from the initiative.
Learning	Create and develop learning platforms on environmental surveillance hosting and organizing through webinars, seminars and workshops.	Create suitable conditions and climate for the Precision Health platform to be used for other infectious diseases and use cases in multiple domains.
Sustenance and flexibility	Create advocacy channels for the platform in the city which can be utilized by other sectoral works.	Linking the platform with other departments to support intersectoral initiatives.
Research	Explore new technologies and innovations on environmental surveillance, such as autosamplers, bio-sensors, etc.	Support research works in the field of environmental surveillance through inviting global researchers.

Places

This methodology can be deployed at

- **Sewered connections**
- **Underground drains**
- **Centralized sewage systems**

E.g. Urban / Semi-Urban



This methodology cannot be deployed at

- **Decentralized sewage systems**
- **Areas with open defecation**

E.g. Rural Areas

Process Workflow

PLANNING

- Expectation setting with city administrators
- Partner Identification, role defining and contract finalization
- Site selection and sampling strategy
- Connecting to the data management system
- Set up Digital Architecture

SET UP

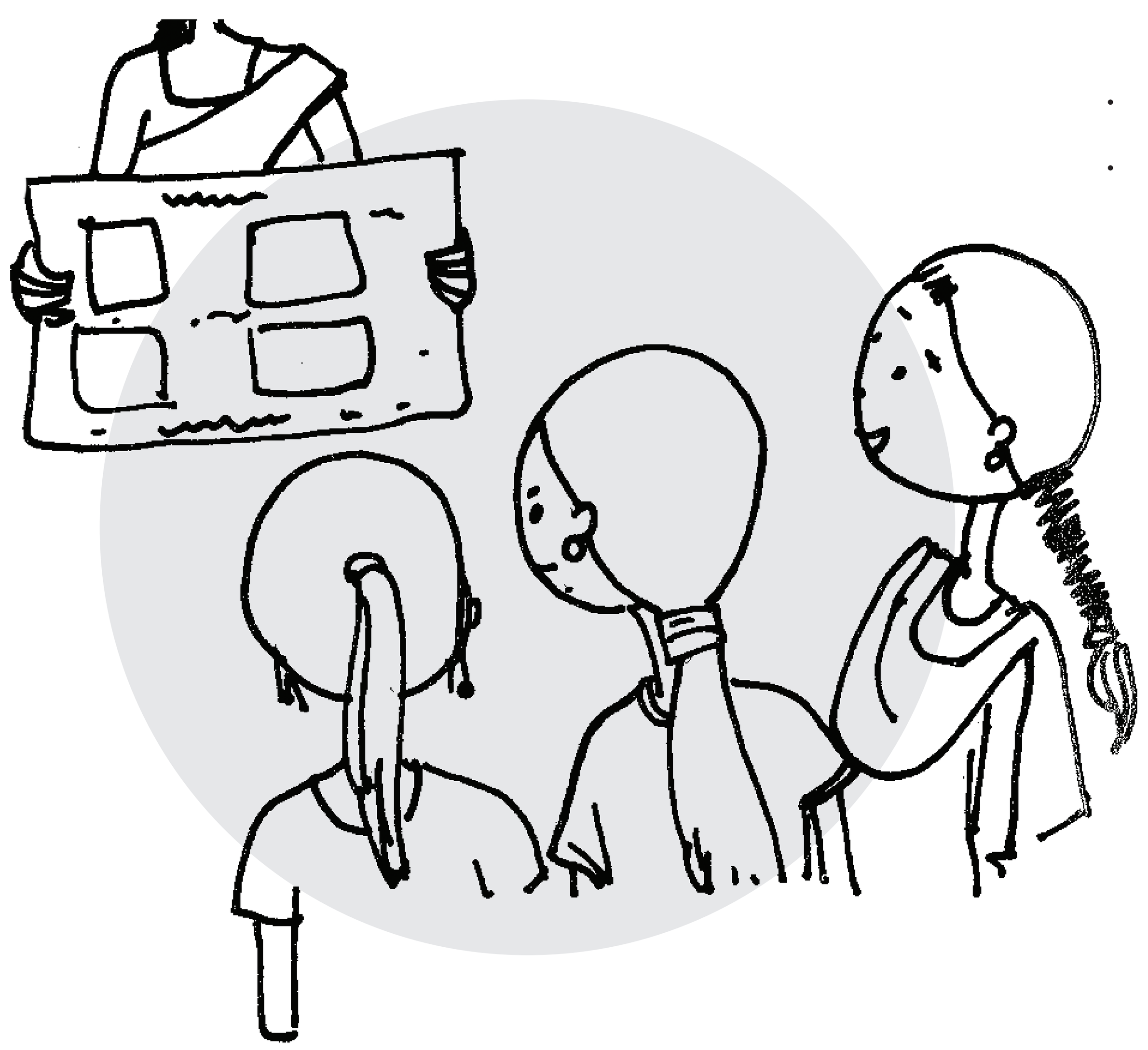
- Resource allocation and deployment
- Recruitment and training of the staff
- Route planning and sample collection plan

IMPLEMENTATION

- Sample collection and transportation
- Sample processing & testing
- Sample test analysis
- Data reporting and visualization
- Periodical review
- Periodical audits
- Communications and reporting findings

EVALUATION

- Internal Evaluation
- External Evaluation



ACT 1 - SCENE 1
THE PLANNING PHASE

1 STEP 1 - Expectation setting with city administrators

This is the most critical step of setting up the wastewater surveillance program. City administrators have varying priorities and competing interests. It is important to clearly explain what the wastewater surveillance systems can and cannot do.

- How it would align and help the city?
- Who should be the point of contact; and
- What cadence should be set for regular and systematic information flow and review meetings?

It is also important that other data relating to the same infection, be it SARS COV 2 or any others be communicated so that the analysis be robust. Additionally, it is helpful to agree on the dissemination plan and the open dashboards, and the report flow from the system to the administration.

As part of this, it is advisable to get prior permission (in writing) from the local government to collect samples from open drains from a relevant government department. Mostly, municipal corporation is the main agency for this.

2 STEP 2 - Partner Identification, role defining and contract finalization

Tip & Suggestion: *It is advised that the payment terms in the contract TOR are deliver-based rather than periodical to be able to easily link the deliverables for the Partner's performance review.*

The contractual document with laboratory partner can also include quality parameter in order to ensure accuracy of the sample tests.

- COVID -19 Wastewater surveillance requires various roles in different field of operations such as sample collection, testing, analysis, data analytics and stakeholder engagement. It is important to identify partner/s with suitable credentials and relevant field experience in the above mentioned fields.
- The roles & responsibilities and deliverables need to be clearly defined in the contractual agreement/ MOU/ service contract with each partner.

Snapshot of different roles within the initiative

Partner	Roles
Project Management	Includes facilitation, documentation and reporting, communication, client management
Sample collection	Sample site selection; sample collection and transportation
Sample testing	Laboratory partner,sample processing and testing, technical and clinical support
Stakeholder Engagement	Sharing the findings and liasioning with Government stakeholders
Data Management & Analytics	Data Management and Analytics

3 STEP 3 - Site selection and sampling strategy

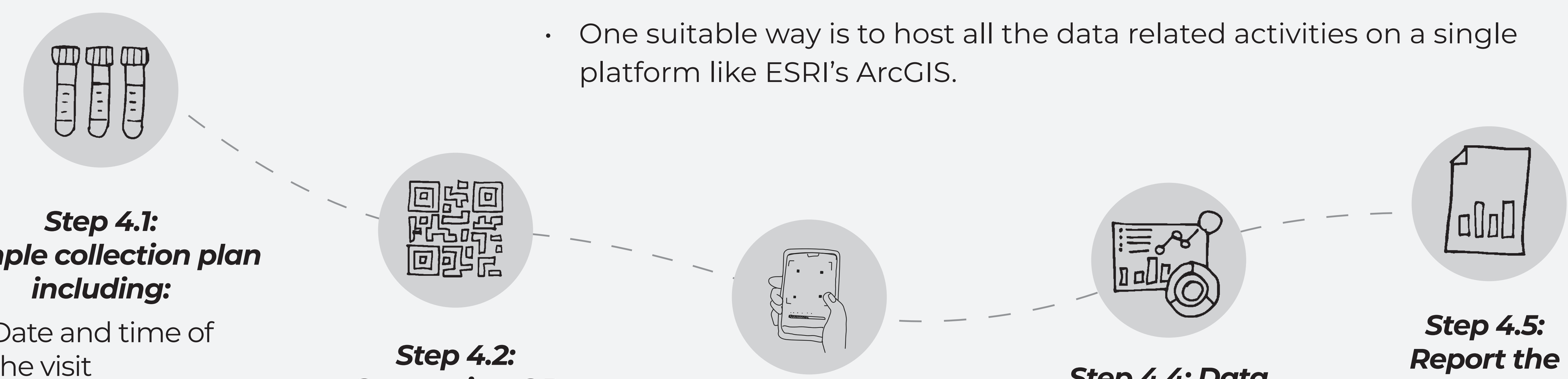
- A critical part of planning, the sites selection depends on the objectives of the initiative. The selection process involves mapping the sewage/ wastewater drain infrastructure of the city and developing the site selection strategy with support from local wastewater, sewer and drainage expert.
- After site selection, the sampling strategy can be developed, which is to include-
  - sampling frequency (advisable 2 times per week per site)
  - sampling time (suggested to be before 9 AM)
  - sampling technique (grab sampling for open drains),
  - sampling gear required, pre-sampling activities, etc.
- A step by step SOP document can be prepared by the wastewater experts and sample collection agency

Tip: *It is advisable to consult an expert from the local government in the selection of sites for wastewater sampling. The sampling strategy should include the source of wastewater from where samples will be collected. It may be either open drains, sewersheds or both. Note - Precision Health platform has developed Sample Collection SOP for open drains. Please contact Shirish Harshe at shirish@catalysts.org for details.*

4 STEP 4 - Connection to data management system

Data management system requires

- tools and applications to support data collection, storage, analysis and visualization.
- One suitable way is to host all the data related activities on a single platform like ESRI's ArcGIS.



Step 4.1: Sample collection plan including:

- Date and time of the visit
- Allocation of sites among sample collectors
- Geo-coordinates of the sites
- Sample number

Step 4.2: Generating QR code for sample identification including:

- Name of the initiative
- Site identifier
- Sample number

Step 4.3: Data Collection Tool development:

- QR code scanner
- Date and time
- Location of each site (Geo-coordinates)

Step 4.4: Data repository dashboard development

Step 4.5: Report the findings and insights

Processes	Sample Collection Plan	QR code for sample identification	Data Collection Tool	Data repository and visualization - online dashboard	Report findings and insights
Tool					
Data/Details captured	• Date and time of the visit • Allocation of sites among sample collectors • Geo-coordinates of the sites • Sample number	• Name of the initiative • Site identifier • Sample number	• QR code scanner • Date and time • Location of each site (Geo-coordinates)	• Web map of Bangalore on viral load trends • Time series graph on viral load trend for each site	• Dashboards on week-wise positive sites • Week-wise city-wide viral load trend
Significance/ usage	• Helps in review and evaluation • Helps in effective project management	• Check typos and data entry errors • Increase time efficiency • Easy to use • Helps identify each sample	• Digitized data collection • Facilitates data analytics and visualization • Easy to store and protect	• Facilitates data interpretation • Facilitates comprehensive view of the findings	• Facilitates possible actions for COVID infection control • Provides additional insights on infection spread within the city

Learning Vignette

6 things to remember when

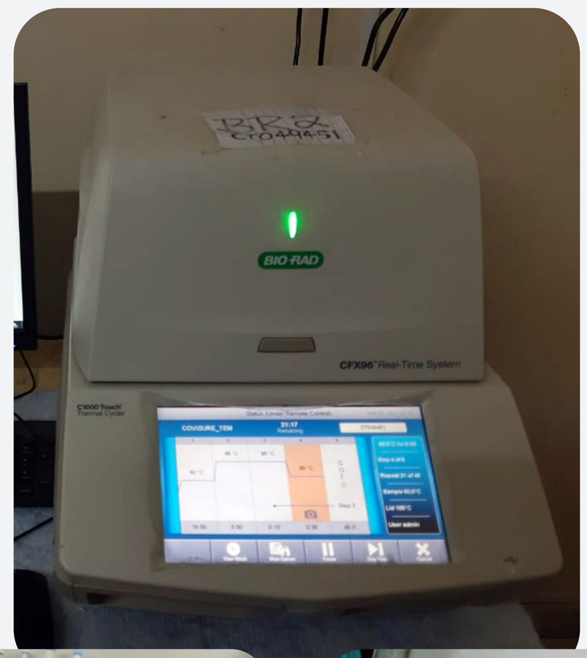
Recruiting and Retaining Sample Collectors. The Sample Collectors must maintain strict quality protocols and therefore it is important to invest time and resources in

- Explaining the why
- Training & Re Training
- Giving them the right tools
- Branding
- Inspection and re-issuance
- Sharing the findings and reinstating the why of the work

QR Code of interview with sample collector

ACT 2 - SCENE 2
THE SET UP

1 STEP 1 - Resource allocation and deployment

- Procurement of required supplies for sample collection and sample testing: Sample collection agency and laboratory partners will need to ensure all required equipment, supplies, chemical / reagents are procured and are in place well in advance before beginning implementation.
- Contract with vendors for smooth supply chain: The vendors for the supplies may be contracted to ensure timely replenishment in the case of transport restrictions.


__Tip:__ It is important to plan for space management beforehand, as the equipment and storage of samples may require additional physical space. Each item should be stored and used as per the guidelines.

2 STEP 2 - Recruitment and training of the staff


- Recruit and appoint required manpower for each activities
- Organize a thorough orientation session and conduct hands-on training for the new staff appointed to the initiative using the equipments and devices.

3 STEP 3 - Route planning and sample collection plan



The sample collection plan should include:

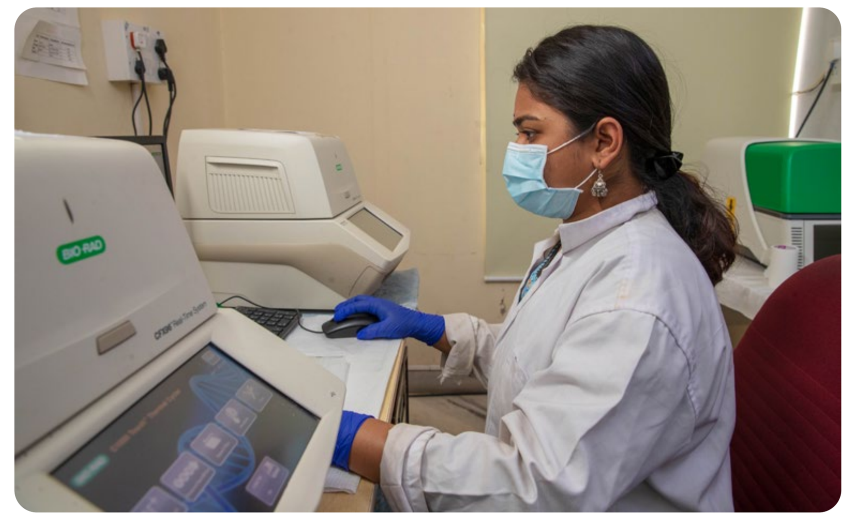
- Sampling strategy - where, when, and how to collect sample
- Sampling frequency
- Data to be collected during sampling
- Storage of samples
- Transportation of samples
- Time for sample delivery

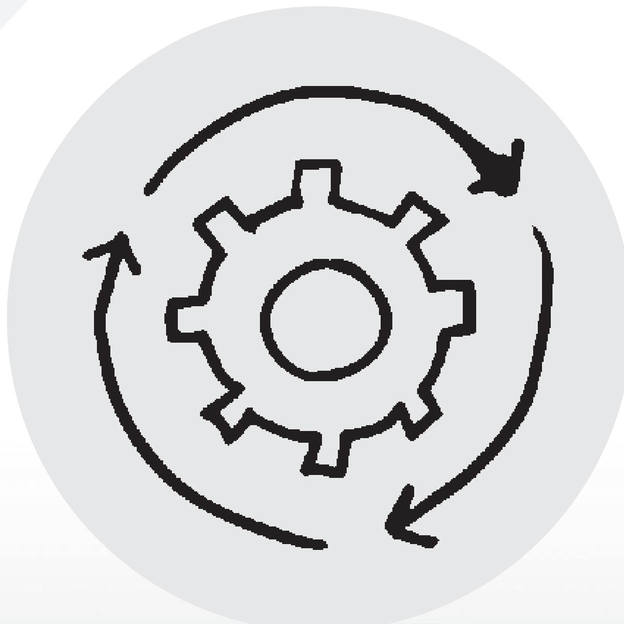
Most of the above points are covered in the sample collection SOP developed by Precision Health team. The remaining points, if any should be decided as per the objective and the wastewater drainage system in the city.

Learning Vignette

6 things to remember when

- **Logistics and Supply Chain Management:** Logistics and supply chain management is critical for a quick turnaround of sample results. Hence, ensuring stock of supplies and consumables is important.
- **Choose and test to determine the right products before bulk purchase:** The kits and devices used in the lab operations are designed for specific purposes. Hence, it is critical to test the procured products for sample processing and sample testing, before making a bulk order.
- **Test out the Cold Chain to ensure appropriateness:** As the samples are temperature sensitive, the entire cold chain has to be optimized to maintain the quality of the samples.
- **Continuous Power Supply:** The power supply in the lab is critical for maintaining sample integrity, time for processing and testing, so that the turnaround time can be maintained to give possible early warning signals.
- **Route maps for Traffic and Time:** The route mapping of all the sites from the lab has to be ascertained before the actual implementation, so that route and time can be scheduled accordingly for ensuring timely delivery.
- **Timings of partner institutes for smooth processes:** Each partner has a particular role to play and should be committed on the timings.



ACT 2 - SCENE 1
THE IMPLEMENTATION

Genomic Sequencing

A giant leap forward in Early Warning Systems

Genomic epidemiology using high-throughput sequencing of wastewater samples has provided insights into origin, spread, diversity and host-range of circulating lineages at the population level. Wastewater testing allows researchers to get a sense of how the virus is spreading – without having to sequence a bunch of individual tests. They can even see warning signs of a surge based on what's turning up underground.

Wastewater Based Epidemiology can detect variants earlier than in the community.

1 Step 1: SAMPLE COLLECTION & TRANSPORTATION
(3-4 hours)

Infected, symptomatic and asymptomatic person start to release viral genetic material few hours after the infection

Sampling preparation (bottles, equipments) and sample collection

Sample preservation and data collection - securing & disinfecting the bottles and labelling with details

Transportation to Laboratory

Sample securing & deliver- the samples are kept in 4°C once it reaches the lab

2 Step 2: SAMPLE PROCESSING & TESTING
(typically 2-3 hours)

Heat Treatment

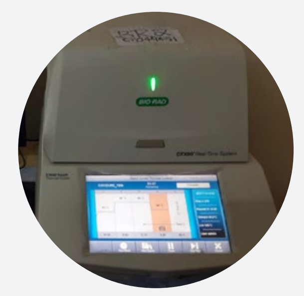
Filtration

PEG + NaCL Concentration

3 Step 3: SAMPLE TEST ANALYSIS
(typically 4-5 hours)

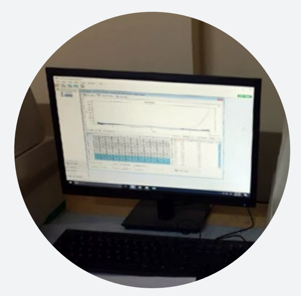
RNA Extraction

Preparation of Reaction mixture

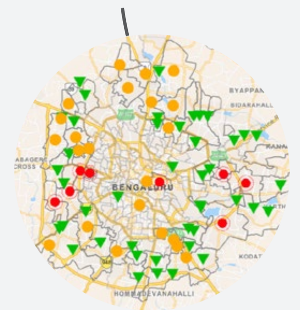


Quantification - Realtime PCR

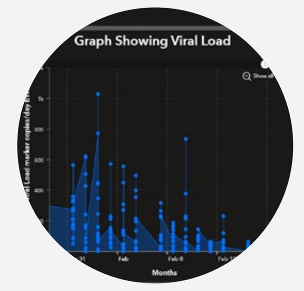
4 Step 4: DATA REPORTING & VISUALIZATION
(typically 4 hours)



CT Value and Viral Load Results



Context and Visualization



Analysis and data updation

5 STEP 5 - Periodical Reviews

- In order to regularly monitor the performance and implementation procedures, it is ideal to conduct weekly review with the team.
- The review involves updating on the activities conducted, challenges, if any, findings from the data analysis, new learnings and partnerships, etc.

6 STEP 6 - Periodical Audits

- It is recommended to audit the program once in a quarter so that corrective measures could be considered if needed.
- The audit mainly involves SOP compliance review, where in a checklist of each activity can be reviewed during site (sample collection site and laboratory) visit.

7 STEP 7 - Communication and reporting findings

- City government buy-in is necessary for translating any key findings from surveillance program into impactful action and insights which requires clear communication guidelines and liasioning with government stakeholders.
- Increasing level of virus in the city is communicated to the administration which can help public health officials target interventions.

Note: *Interventions can be to increase clinical testing, increased vaccination efforts, increased awareness, etc.*

Learning Vignette

Weekly reviews of diverse expertise to make sense of the data

- Improve process efficiencies
- Understand and validate the information better
- Plan of communication to key stakeholders (*quote from Dr Varsha*)

ACT 3
THE EVALUATION

1 STEP 1 - Internal Evaluation

- Mid-term internal evaluation is to be conducted to assess the SOP compliance of each activity and understand the gaps (if any)
- Main activities could be:
  - SOP review for each activity; and its rationale
  - Questionnaire/checklist development for each activity and process
  - Visit the site to understand each process/activity vis'-a- vis' the SOP
  - Review and observe each activity of the process through the checklist
  - Report and document observations from the review visit as a part of Internal Evaluation.
- The findings from the evaluation are shared with the relevant team members responsible for adhering to the SOPs - in this case, the sample collection agency for sample collection SOP and lab technicians/laboratory partner for the sample testing SOP.

2 STEP 2 - External Evaluation

1 **Contracting the evaluator and setting expectations**

2 **Submission of work plan and methodology by the independent evaluator**

3 **Field visit and SOP review**

4 **Submission of final evaluation report**

The purpose of external evaluation is to obtain validation and endorsement from the external agency on the procedures of the initiative and on the realization of goals and objectives.

- In order to conduct external evaluation, the first step is to prepare the terms of reference (TOR) listing out the scope of program and evaluation followed by recruitment and orientation of the evaluator on the program.
- The responsibilities of the evaluator include conducting evaluation to assess the project operations and processes, develop a detailed report on the findings and a paper on environmental surveillance for SARS-CoV-2 as an important tool for early warning.

Tip: The rationale, gaps, effectiveness and efficiency of the project operations can be evaluated for its alignment with the overall objectives.

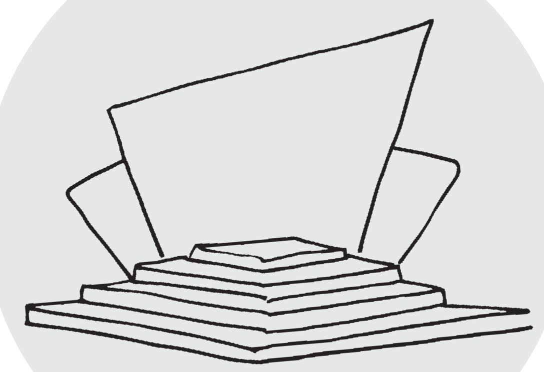
Learning Vignette

3 things to remember when Evaluating!

- Consider a team of evaluators that can deliver on diverse skill sets
- The Evaluation should cover both technical & scientific aspect and programmatic and operations, as both aspects are critical for the success of the initiative.
- The roadmap of the evaluation should include field and lab visit to understand the nature of the work.

"The purpose of the evaluation is to assess the rationale, gaps, effectiveness and efficiency of the project operations and its alignment with the overall objective. The evaluation will assess the planning, implementation, roles, and responsibilities of the partners, compliance, and adherence to guidelines and SOP, stakeholder's response and provide details on the effectiveness of the operations."

Shirish Harshe
Program Manager
Precision Health



STAGE DIRECTION

This section covers the Media Policy, introduces the Precision Health Dashboard, shares Limitations and challenges.

noun. *an instruction written into the script of a play, indicating stage actions, movements of performers, or production requirements.*

Media Policy

If this initiative is handled by agency/agencies other than the government, it is highly recommended to have a media policy signed and shared by all the partner agencies.

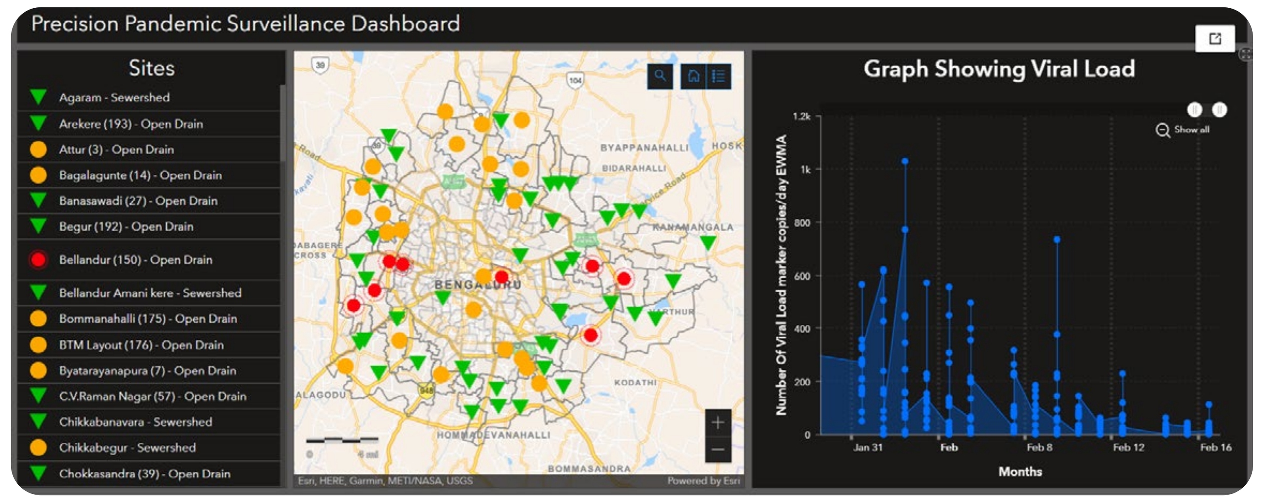
Any **pathogen of a pandemic potential** is likely to be a highly sensitive information.

Data sharing and **communicating on the trends** needs to be guided by a robust Media Policy. Here are 5 things to remember to include in the Media Policy around Environmental Surveillance.

- In case a journalist approaches a team member, the team member will need to connect the journalist to the designated individual in the team in charge of Media & PR decision making.
- All team members must seek expressed permission to be quoted or release document/press note to media from the designated individual in the team in charge of Media & PR decision making.
- No person in the platform shall communicate anything about the findings or the workings of the government based on the findings. All such communications will be directed to the appointed official of the respective government. (In Annexure, it is advised to list out the said officials)
- Only questions and information regarding the history, science, partners, funding, implementation may be shared by the Platform - www.precisionhealth.in
- The platform has one main channel of communication: Twitter under the handle @Precisi0nHealth, which reports on analysed de-constructed, anonymised data on the respective site.

Precision Health Dashboard

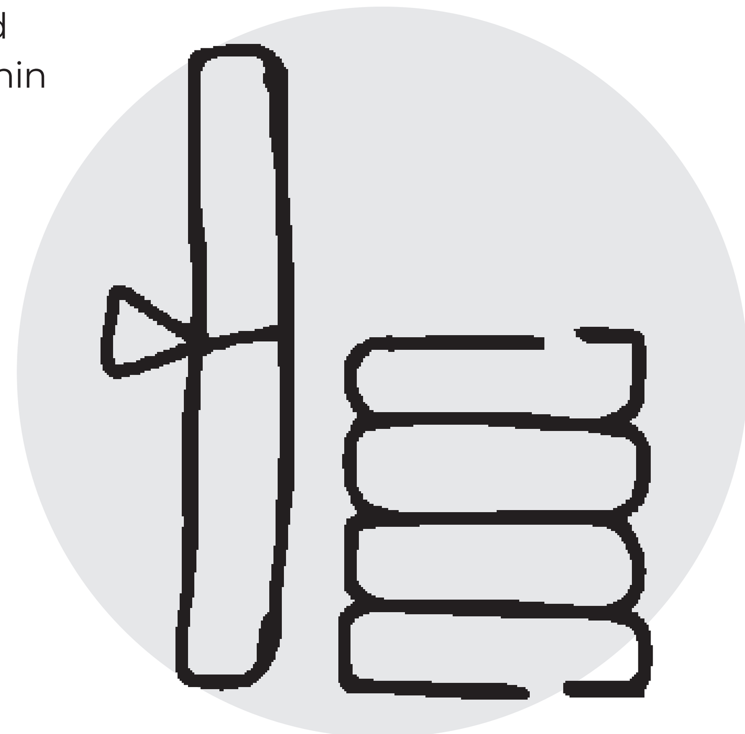
1. Real time updates through digital infrastructure at the backend will be suitable, as it will be uploaded as soon as the sample results data is recorded in the system.
2. Accessibility of the dashboard is subject to media and communication policy of the implementation agencies.
3. It is suggested to get the stakeholder on-board on public accessibility of the dashboard.
4. The color selection for the symbols used in the dashboard, especially in the map dashboard, should be neutral and accessible for people with color blindness.



Limitations and Challenges

The limitation of Environmental Surveillance initiative may be considered as follows:

1. The data from the wastewater surveillance system should be considered as only a signal of a city's trend of infection and not a precise identification of exactly which spots need containment. This system just facilitates an early warning which can be integrated within the conventional surveillance system for better visibility and monitoring.
2. There is limited awareness and understanding of potential uses of environmental surveillance for the public health planning and programming, hence often faced by less than desirable political will.
3. Wastewater has a lot of variability like rainfall or very high temperatures or the contamination of the water by added chemicals as effluents from small industries, it is possible that the RNA levels in the wastewater get diluted or degraded.
4. The estimation of affected population is limited to the infrastructure and availability of information related to this, hence hotspotting is possible only when this information is available.
5. As the chain of operations are closely linked with each other, the turnaround time is dependent of all the activities taken together. Hence, a slight glitch or aberration of a regular or routine activity will hamper the overall objective of the initiative, i.e. providing an early warning signal.



TIPS & TRICKS

Keep aside some time to conduct efficiency trials

For every process, have an independent quality assurance system - this could be a checklist. Some checklists are placed in Annexure for reference.

Supply chain and logistics blind spots are a reality. Use the insights from the early warning system to plan for possibility of choked supply chains in the event of a wave.

Participating, engaging and actively contributing to all other wastewater surveillance programs in the country and elsewhere ensures a consistent cycle of learning and troubleshooting.

Openly share failures so solutions can be shared too. Environmental Surveillance and especially Sewage Testing is an evolving science and cross learning is critical for advancement and for the ultimate goal - saving lives.

Regular weekly team meetings with diverse experts to study the findings, discuss any red flags in the process or any perceived risks is critical. This also enables closing the loop on open items.

Ensure that the graph reads right and is giving the right message.

Ensure that the data visualization is colour blind friendly - using colour blind friendly palettes and symbols that correctly represent the finding.

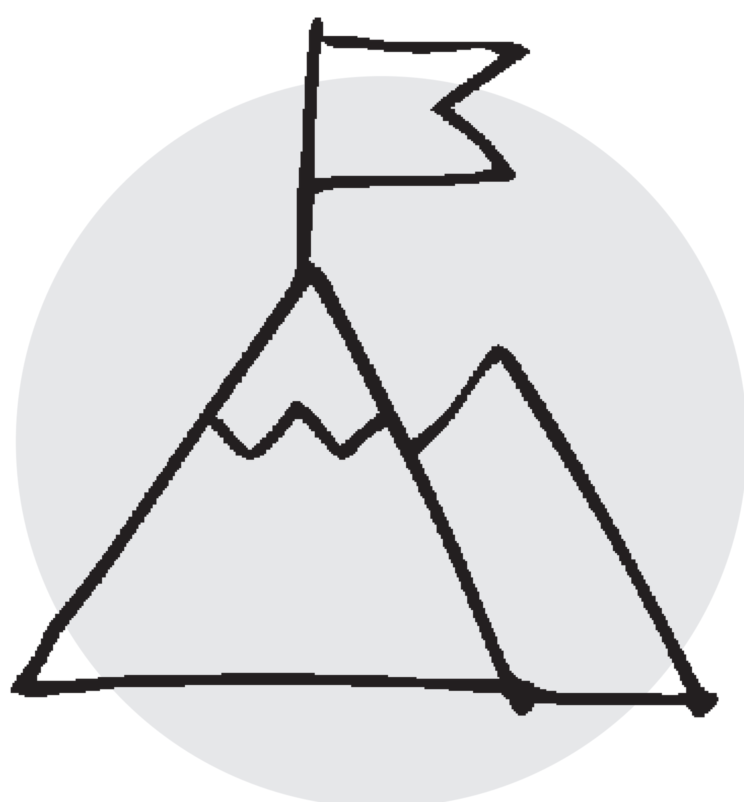
Appropriate branding and marking is essential to be able to establish quality and significance of the work.

Remember to de-risk using a robust media policy.

Partnerships for Success

Partners who intimately understand the ethos of environmental surveillance

1. Partner with an appropriately accredited Lab that can process wastewater safely, extract RNA, turn around in a timely fashion - with a reliable energy resource
2. Ensure to anchor and foster an enabling environment - Appropriate policy and regulatory approvals in place
3. Establish the cadence with partners of minimum weekly diverse sense making and analytical discussion before reporting
4. Leverage Media Platforms that the project team along with partners can control their own messaging on - for example Social Media Outreach and daily active social media
5. Secure a mandate of diversity of professionals along the continuum
6. Learning mindset and frequent closing the loop framework. This also involves being open to other signals and the changes in the eco systems. For instance - if there is a new infrastructural development in the city and another Sewage Treatment Plant is established - this could be an additional source of information.
7. Integrate into a platform along with partners - a surveillance system that is agile in nature - where other makers guide the action -reserving agency energy when there is little to no risk - but with scope of rapid scale up when risk is spotted twinned with appropriate adaptive resource allocation



CHECKLISTS

Wastewater Surveillance in Open Drains

Questions	Indicators to check	Rationale	Ideal indicator
Location - where to sample	• 1. Open and <10m drain • Has nearby human settlements	Accessible to collect the sample To get the representative samples	Site having better access to sample collection
When to sample	During peak hours; 7-9 AM	Represents the majority of pollution	Preferably before 8:30 AM
Sampling type	Grab Sampling Method	Easy to collect and economical	Grab Sampling Method
Number of sampling sites per drain	One sample per drain	Coverage of large number of localities with dwellings	Preferably a mouth of the drain; More than one per drain
Sampling frequency	Twice in a week	Two times sampling provides 3 days window -- to capture new infections from the population	Twice a week to capture new infections which might not be possible once a week
Tools, equipments and technology used	Bucket, rope, labelled bottles, PPEs-gloves, masks, overall, pH meter thermometer, sanitizers, disinfectants	Facilitates sampling process; provides safety measure to Sample Collector from possible infections.	Automated sampler could be a viable solution for sampling.
Mapping of catchment area	Conducted through visual inspections and google survey	To get the ideal sites for sampling	

Wastewater Surveillance in Manholes

Questions	Indicators to check	Rationale	Ideal indicator
Location - where to sample	Last manhole near to Inlet to STP / Pumping Station	Covers the major populations	Hyper localization of the area based on the population
Population coverage	HH covered per manhole	Helpful for granular findings of hotspots and target localities	Highest HH covered with each manhole
When to sample	During peak hours; 7-8:30 AM	Represents the majority of pollution	Preferably before 8:30 AM
Sampling type	Grab sampling	Easy to collect and economical	Grab sampling
Number of sampling sites	One site from a ward (selection based on the population)	Highest possible population coverage	Manhole directly connected with main sewer line.
Sample frequency	Twice in a week	Two times sampling provides 3 days window -- to capture new infections from the population	Twice a week
Tools, equipments and technology used	Bucket, rope, labelled bottles, PPEs-gloves, masks, overall, pH meter thermometer, sanitizers, disinfectants	Facilitates sampling process; provides safety measure to Sample Collector from possible infections.	Automated sampler could be a viable solution for sampling.

Wastewater Surveillance in Sewersheds

Questions	Indicators to check	Rationale	Ideal indicator
Location - where to sample	Manholes that are easily accessible and not obstruct the traffic	Majority of the city connected to underground drainage system and represents to majority of the population for core areas of city	Downstream of the Identified catchment area
When to sample	During peak hours; 7-8:30 AM	Represents the majority of pollution	Preferably before 8:30 AM
Sampling type	Grab Sampling	Easy to collect and economical	Grab Sampling
Number of sampling sites per drain	One sample per sewersheds	Covers all the HH connected with sewer lines in the city	Influent from the sewershed site.
Sampling frequency	Twice in a week	Two times sampling provides 3 days window -- to capture new infections from the population	Twice a week
Tools, equipments and technology used	cket, rope, labelled bottles, PPEs-gloves, masks, overall, pH meter thermometer, sanitizers, disinfectants	Facilitates sampling process; provides safety measure to Sample Collector from possible infections.	Automated sampler could be a viable solution for sampling.

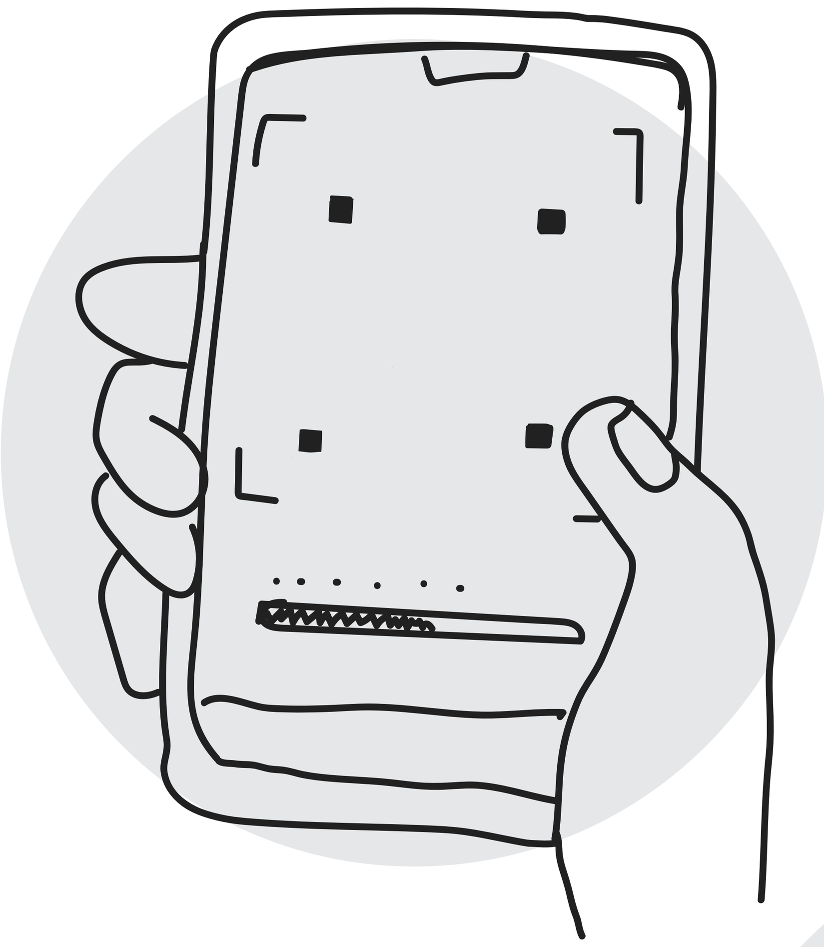
STANDARD OPERATING PROCEDURES (SOP)

SOP 1 - Sewage Sampling & Transportation

Scan for SOP

SOP 2 - Sample Testing

Scan for SOP



CLOSING NOTES

Provisioning of potable piped water and safe sanitation have been seen as one of the best disease prevention mechanisms. The advent of piped water supply in 1896 in Bengaluru and the beginnings of the piped sewerage network in the early 1900s have shown the city to be proactive in its water and wastewater management.

While the full coverage of the city with piped sewer network and the treatment of the collected sewage in the many decentralized sewage treatment plants are ongoing , the benefits of Environmental Surveillance through these sewage flows is clearly emerging as shown in this study. Not only the health of the population can be monitored in these wastewater flows but also a close monitoring of the treated wastewater will allow for its safe reuse in agricultural, environmental and other purposes since Bengaluru runs one of the largest programmes in the world for transfer of treated wastewater to fill lakes in the neighboring drought prone districts.

@rainwaterclub
@zenrainman

Vishwanath S, Advisor,
Biome Environmental Trust

I am a molecular biologist and biotech engineer working in the fields of public health and clinical diagnostics. For me, the wastewater based epidemiology for Covid-19 started off as a small project in April 2020. But in the ensuing months, this “small project” has grown to change my mindset and expand it. My team and I have now started actively thinking about urban and rural water systems and how they affect agricultural land and the livelihood of communities, rejuvenation of ground water and the transformation of ecological systems. We have started looking at wastewater with a great deal of fascination and respect- as a motorway of creatures large and small, including pathogens and antimicrobial resistance, as an indicator of community health, as a driver of soil health and as a source of innovation in therapeutics and diagnostics.

Thus, looking back over these past two years, with Covid-19 catalyzing such paradigm shifts in so many different aspects, I would credit this “small project” with catalyzing some of the largest transformations to my thinking and growth.

@shridhar_varsha

Dr Varsha Shridhar, CEO,
Molecular Solutions Care Health LLP

Wastewater-based epidemiology (WBE) for SARS-CoV-2 in Bangalore has focused on real-time surveillance as an early warning indicator of new waves of COVID-19. We have strived to combine epidemiological data with genomic surveillance to gain insights on how the virus populations are changing, and how the virus is evolving and emerging in the city. What we need now is to compare clinical and wastewater genomic surveillance data to gain insights into the SARS-CoV-2 genetic population structure circulating within a community, which might not be observed if relying solely on clinical cases.

@fishtiaq

Dr Farah Ishtiaq, Principal Scientist,
Tata Institute for Genetics and Society

As a practicing family physician, I receive early signals from patients on new or altered patterns of illness e.g. an increase in the number of people experiencing fever, diarrhea, body aches etc. This is often associated with enhanced anxiety within the community as well. Wastewater surveillance has proved to be a very valuable early warning system for me as a practitioner in terms of my conversations with patients, also sometimes choice of the best mode of care provision (telecare vs in-person visit), testing, and treatment decisions that are most appropriate at both the individual patient level and in terms of public health.

@RKPrasadMD

Dr. Ramakrishna Prasad, MD, MPH,
Physician - Family Medicine & Infectious Diseases, PCMH Restore Health & Wellness, LLP & President, Academy of Family Physicians of India (AFPI) - Karnataka

Ms. Sangita Patel, Director, Health Office
U.S. Agency for International Development in India

Since the onset of the pandemic, the U.S. Government, through USAID, has provided more than $216 million in COVID-19 relief to India providing life-saving treatments, disseminated public health messages, strengthened case-finding and surveillance, mobilized innovative financing mechanisms to bolster emergency preparedness, and helped keep India’s brave frontline health workers safe so they can continue to save lives. As of June 2022, these investments have benefited more than 120 million people in India since the start of the pandemic, including more than 320,000 health workers and more than 17,700 health facilities to respond to the pandemic, while helping to deliver more than 17.5 million vaccines through USAID-supported vaccination sites.USAID’s investments are contributing to health-systems strengthening, in partnership with the Government of India, to help address the current COVID-19 pandemic and prepare for future infectious disease outbreaks.

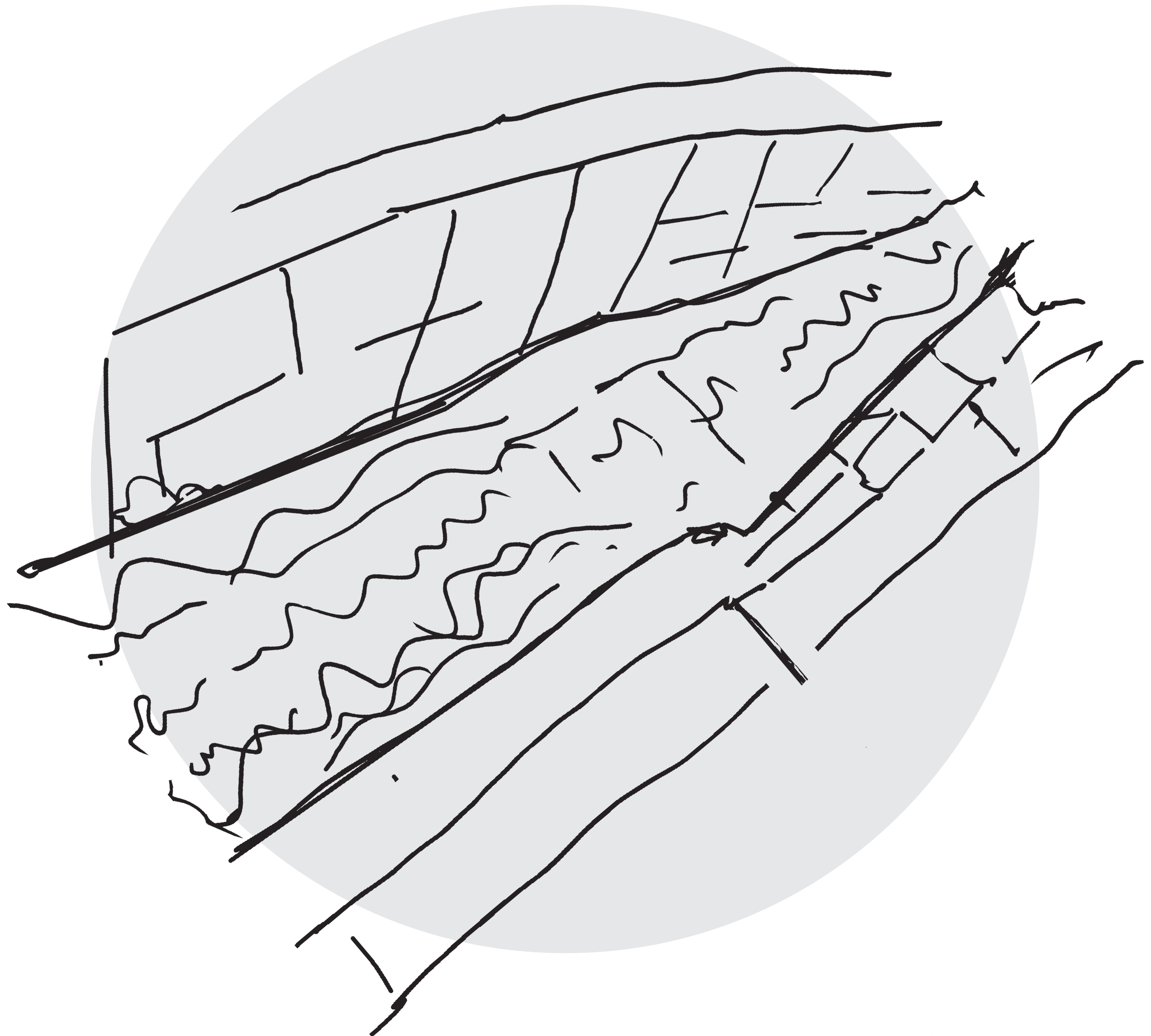
As part of this coordination, USAID supported the COVID Action Collaborative (CAC), an India-wide network of more than 350 organizations working together to provide relief and recovery and build resilience to India’s most vulnerable communities. Working with state governments, local institutions, and the private sector, CAC provides high-impact relief packages supporting livelihoods, enhancing social protection, and providing COVID-19 risk prevention and mitigation. These relief packages help vulnerable communities recover from the adverse effects of health and loss of livelihood caused by the pandemic and help build long-term resilience.

USAID is happy to support the Precision Health Initiative, an innovative solution that supports cities to conduct sewage tests to help identify infectious outbreaks before they spread widely. Early warning systems can help guide local COVID-19 response and provide policymakers with the information they need to better allocate resources. The Precision Health Initiative has the potential to be applied more broadly to monitor other infectious disease outbreaks, antimicrobial resistance, illicit opioid use, and pathogens.

USAID recognises the importance of innovations in solving health problems, particularly for the most vulnerable and marginalized. However, innovations are only as valuable as the people that intentionally use them, thus we applaud the team for creating this playbook to help others research and scale this important preparedness work.

Reading Materials

Document Title	Source	Link
Environmental surveillance for SARS-COV-2 to complement public health surveillance	WHO	https://www.who.int/publications/i/item/WHO-HEP-ECH-WSH-2022.1
Wastewater surveillance of SARS-CoV-2 Questions and answers (Q&A)	WHO	https://apps.who.int/iris/bitstream/handle/10665/353058/WHO-EURO-2022-5274-45038-64164-eng.pdf?sequence=4&isAllowed=y
Sample Collection SOP	Precision Health Platform	https://www.waterrf.org/sites/default/files/file/2020-06/COVID-19_SummitHandout-v3b.pdf
Sample Testing SOP	Precision Health Platform	Scan the code on page 32 to access
Wastewater Surveillance of the COVID-19 Genetic Signal in Sewersheds - Recommendations from Global Experts	The Water Research Institute	Scan the code on page 32 to access



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