

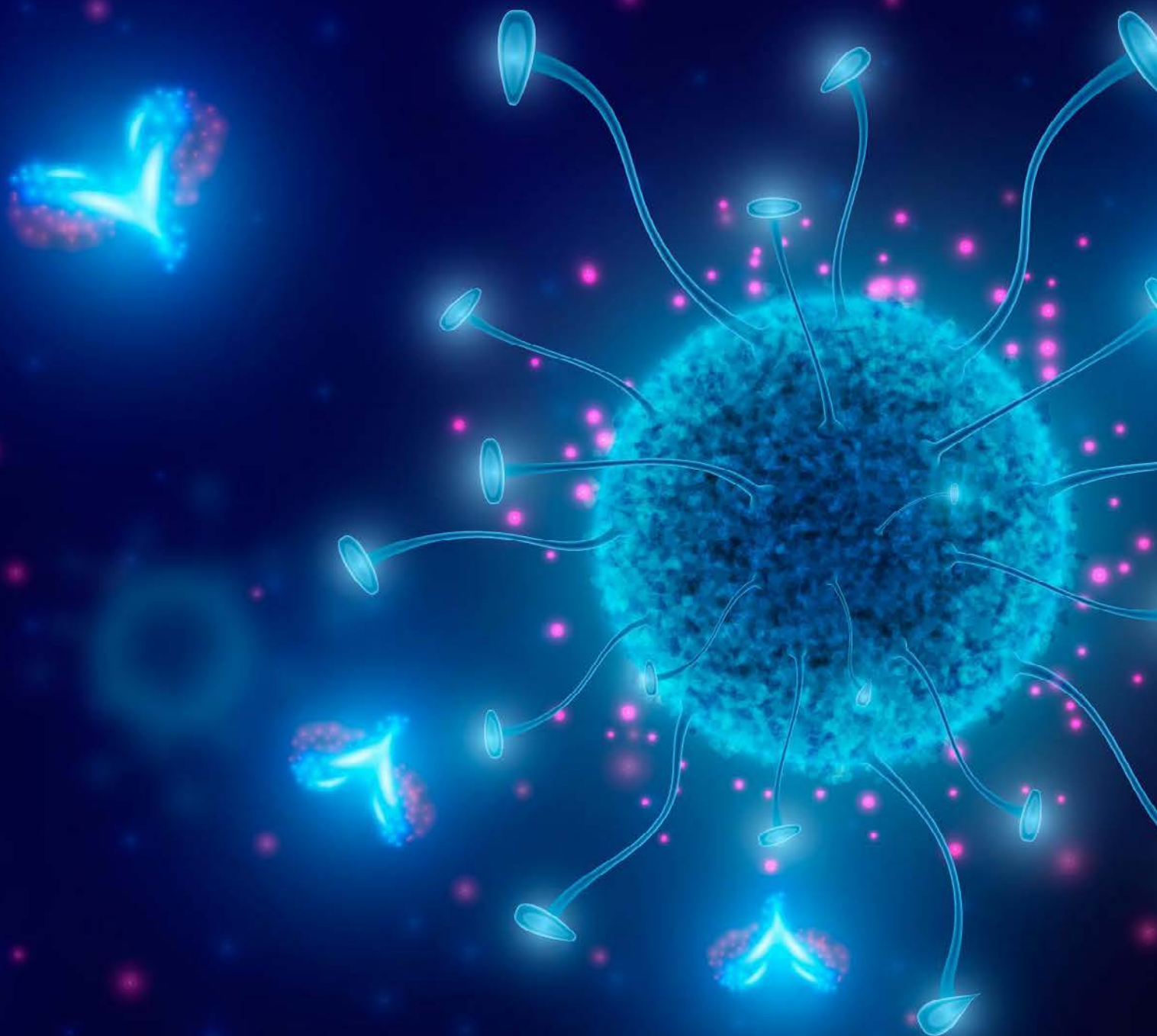


# **PATHOGEN GENOMIC SURVEILLANCE STRATEGY FOR ZAMBIA**

**2025 - 2029**

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2025 - 2029



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## FOREWORD

Zambia is scaling up genomic surveillance capabilities for emerging and re-emerging diseases with epidemic and pandemic potential. The Pathogen Genomic Surveillance Strategy for Zambia will support efforts to expand capabilities end-to-end from identification of priority pathogens and use cases, sampling, sample collection, laboratory processes, genome sequencing, data analysis, data storage, data sharing, and data utilization for public health decision-making under the One Health approach. Cross-cutting issues include the genomic surveillance network, workforce development and retention, robust supply chain, laboratory quality management systems, and respectful and trusted partnerships.

With the development and implementation of the Pathogen Genomic Surveillance Strategy for Zambia, and realizing the transformative potential of genomics, Zambia embarks on a visionary journey to harness the power of scientific advancement for improved public health outcomes. Our dedication to using genomic data to improve disease prevention, transform healthcare, and influence public health security going forward is reflected in this strategy. This national strategy draws upon and is aligned with global and regional initiatives, including the World Health Organization (WHO) Global Surveillance Strategy for Pathogens with Pandemic and Epidemic Potential (2022–2032) and the Africa Centres for Disease Control and Prevention (CDC's) Pathogen Genomic Surveillance Policy Framework. In Zambia, there are various disease-specific surveillance and control programs that could benefit from a unified national genomic surveillance program. This provides an opportunity for integration of pathogen genomic surveillance into broader national surveillance programs.

The Pathogen Genomic Surveillance Strategy for Zambia aims to establish a consistent, sustainable and unified approach for integrating pathogen genomics into the health systems and surveillance programs in the country. It identifies strengths, weaknesses, opportunities, and threats related to pathogen genomic surveillance and proposes actionable interventions. It provides a basis for harmonized planning, resource mobilization and allocation, and implementation of pathogen genomic surveillance initiatives across the One Health

spectrum. Integration of pathogen genomics within the human, animal, and environmental health sectors is critical to address zoonotic and cross-species disease threats in Zambia and regionally. Moreover, the Pathogen Genomic Surveillance Strategy for Zambia serves as a guide to addressing the specific challenges and issues unique to Zambia. These include infrastructure limitations, supply chain bottlenecks, technological gaps, human resource constraints, data sharing and governance issues, and the need for staff skills capacity building. This strategy paves the way towards more effective pathogen genomic surveillance in Zambia and beyond through a coordinated approach.

Successfully implementing the Pathogen Genomic Surveillance Strategy for Zambia requires inclusive and transparent collaboration among stakeholders, a clearly defined focus on public health priorities, and a national approach to support for strengthening all facets of genomics capacity. Major enablers include technical solutions for data integration and analysis, standardized bioinformatics analysis methods, and national regulations, policies, data sharing, and material-transfer agreements (MTAs) that promote nationally integrated surveillance systems. Training of non-public health officials in biosafety and biosecurity and public health officials to interpret and act on genomic data is crucial. Evaluation of the cost effectiveness of Pathogen Genomic Surveillance Strategy for Zambia will provide a benchmark and evidence for sustainable investment in genomics in Zambia, regionally and globally.

## ACKNOWLEDGEMENTS

The government of Zambia through the Zambia National Public Health Institute (ZNPHI) would like to express sincere appreciation for all stakeholders who participated in the development of the Pathogen Genomic Surveillance Strategy for Zambia. The expertise and unwavering dedication of participants have been crucial in creating this document. We especially appreciate the generous funders, Africa CDC, African Society for Laboratory Medicine and the United States (US) CDC whose support made the development of the document possible. Furthermore, the government

of Zambia wishes to express gratitude to individuals who offered expert opinions and invaluable comments during the review of this document. Their insights played a crucial role in shaping Zambia's plan to incorporate the use of genomics in managing diseases and pathogens with pandemic and epidemic potential. These contributions are vital for ensuring effective and timely public health actions of high quality.

A full list of Contributors to the strategy is provided in Annex 7.



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## EXECUTIVE SUMMARY

Genomics is fundamentally recognized as an integral component of public health, disease intelligence, and laboratory systems. Its implementation is anticipated to enhance end-to-end capacities, including sample collection and management, diagnostics, data analysis, data sharing, and utilization of data for public health actions. The Pathogen Genomic Surveillance Strategy for Zambia outlines the overarching goal, objectives, and strategic actions required, with a strong emphasis on securing commitments from the Government of Zambia, cooperating partners, and stakeholders at both the national and international levels for successful implementation. The strategy not only serves as an anchor but also complements initiatives that aim to strengthen national, regional, and global cooperation for genomic surveillance.

The expected outcomes of the specific actions are enumerated along with a roadmap for implementing the specific interventions over five years (2025 to 2029). Review of this strategy document will be conducted in 2027 in line with other national strategic documents. Through the implementation of the Pathogen Genomic Surveillance Strategy for Zambia, benefits of pathogen genomics in public health systems will be harnessed,

and capacities and capabilities built for early confirmation and characterization of disease outbreaks and unknown diseases. This strategy also recognizes the profound importance of integrating pathogen genomics into Zambia's public health systems. This approach will revolutionize the country's collective capacity for surveillance and response to disease outbreaks, and significantly enhance its clinical care capacities. The development of national policies guiding the integration of pathogen genomics into disease surveillance allows Zambia to identify its priorities, requirements, and context-specific approaches and ensure that pathogen genomics contributes to a resilient public health system that adapts to new challenges.

Given that the applicability of genomic surveillance extends beyond pandemic and epidemic scenarios, the strategy seeks to establish linkages with other programs focused on disease and pathogen control, incorporating surveillance networks with a One Health approach. These linkages play a critical role in comprehensively strengthening essential public health laboratory functions associated with genomics and bioinformatics.



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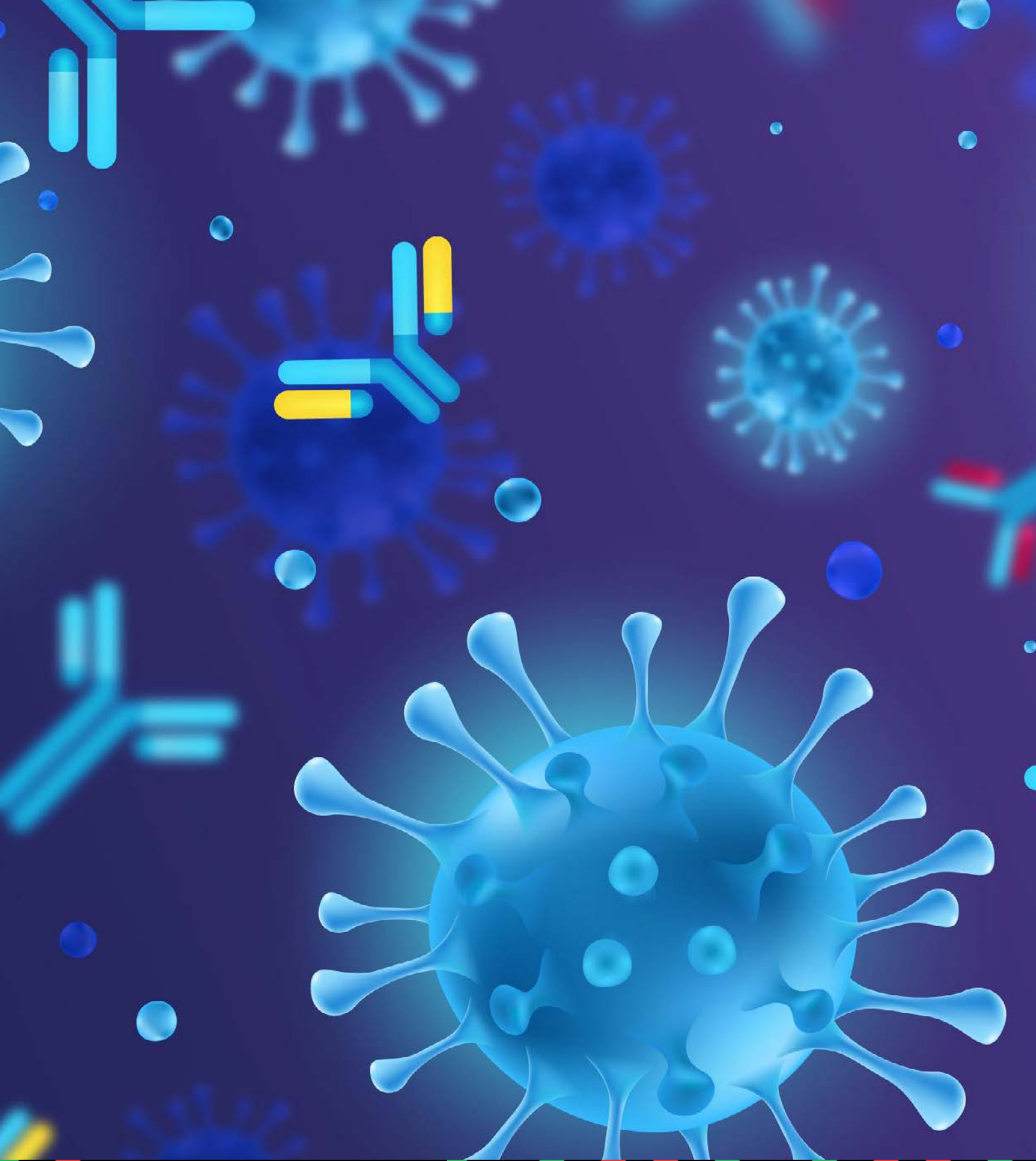
## ABBREVIATIONS AND ACRONYMS

|          |                                                                      |
|----------|----------------------------------------------------------------------|
| NHRTI    | Act of Parliament as National Health Research and Training Institute |
| AIDS     | Acquired Immune Deficiency Syndrome                                  |
| AMR      | Antimicrobial Resistance                                             |
| CDC      | Centers / Centres for Disease Control and Prevention                 |
| CIDRZ    | Centre for Infectious Disease Research in Zambia                     |
| CHAZ     | Churches Health Association of Zambia                                |
| COVID-19 | Coronavirus Disease 2019                                             |
| CVRI     | Central Veterinary Research Institute                                |
| DNA      | Deoxyribonucleic Acid                                                |
| EQA      | External Quality Assessment                                          |
| GWAN     | Government Wide Area Network                                         |
| HIV      | Human Immunodeficiency Virus                                         |
| IDSR     | Integrated Disease Surveillance and Response                         |
| M&E      | Monitoring and Evaluation                                            |
| MOA      | Memorandum of Agreement                                              |
| MOH      | Ministry of Health                                                   |
| MOU      | Memorandum of Understanding                                          |
| MTA      | Material-Transfer Agreement                                          |
| NGS      | Next-Generation Sequencing                                           |
| NHSP     | National Health Strategic Plan                                       |
| NMPDP    | National Multi-Pathogen Diagnostics Program                          |
| PCR      | Polymerase Chain Reaction                                            |
| QMS      | Quality Management System                                            |
| RNA      | Ribonucleic Acid                                                     |
| SARS     | Severe Acute Respiratory Syndrome                                    |
| SOP      | Standard Operating Procedure                                         |
| SWOT     | Strengths, Weaknesses, Opportunities, and Threats                    |
| TB       | Tuberculosis                                                         |
| TWG      | Technical Working Group                                              |
| TSS      | Technical Support and Supervision                                    |
| UNZA SVM | University of Zambia, School of Veterinary Medicine                  |
| US       | United States                                                        |
| WGS      | Whole Genome Sequencing                                              |
| WHO      | World Health Organization                                            |
| ZAMRA    | Zambia Medicines Regulatory Authority                                |
| ZGSC     | Zambia Genomic Surveillance Consortium                               |
| ZMA      | Zambia Medical Association                                           |
| ZNPHI    | Zambia National Public Health Institute                              |
| ZNPHRL   | Zambia National Public Health Reference Laboratory                   |
| ZRA      | Zambia Revenue Authority                                             |

## GLOSSARY OF TERMS

|                                  |                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Antimicrobial Resistance (AMR)   | Occurs when microorganisms (such as bacteria, viruses, fungi, and parasites) develop resistance to antimicrobial agents, including antibiotics, antivirals, antifungals, and anti-parasitics.                                                                                                                                     |
| Bioinformatics                   | The scientific discipline of using computer tools to analyze biological datasets.                                                                                                                                                                                                                                                 |
| Deoxyribonucleic Acid (DNA)      | A double-stranded molecule that carries genetic instructions for development, function, growth, and reproduction of all known organisms and many viruses.                                                                                                                                                                         |
| DNA Sequencing                   | A method to determine the precise order of nucleotides (A, T, G, C) in a DNA or RNA molecule.                                                                                                                                                                                                                                     |
| Database                         | An organized collection of biological information, such as sequence data or annotations, stored for easy access (e.g., GenBank, European Molecular Biology Laboratory (EMBL)).                                                                                                                                                    |
| Genome                           | The complete set of genetic material in an organism, including all its genes and non-coding sequences.                                                                                                                                                                                                                            |
| Genomics                         | The study of the structure, function, and evolution of genomes.                                                                                                                                                                                                                                                                   |
| Genomic Surveillance             | The process of constantly monitoring pathogens and analyzing their genetic similarities and differences.                                                                                                                                                                                                                          |
| Gene Variant                     | A mutation or alteration in a gene that may lead to different phenotypes or diseases.                                                                                                                                                                                                                                             |
| High-Throughput Sequencing       | Modern sequencing methods capable of processing millions of DNA or RNA molecules simultaneously, also called next-generation sequencing (NGS).                                                                                                                                                                                    |
| Illumina Sequencing              | A widely used high-throughput sequencing technology that generates short reads by detecting fluorescently labeled nucleotides.                                                                                                                                                                                                    |
| Molecular Epidemiology           | A branch of epidemiology that uses molecular biology tools and techniques to study the distribution, determinants, and dynamics of diseases within populations. It focuses on understanding the role of genetic, environmental, and lifestyle factors at the molecular level in the development, spread, and control of diseases. |
| Mutation                         | A change in the DNA sequence that can affect the structure or function of a gene or protein.                                                                                                                                                                                                                                      |
| Next-Generation Sequencing (NGS) | Advanced sequencing technologies that allow for rapid and massive parallel sequencing of DNA or RNA.                                                                                                                                                                                                                              |

|                                 |                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Oxford Nanopore Sequencing      | A nucleic acid sequencing technology developed by Oxford Nanopore Technologies that uses nanopores (tiny biological or synthetic pores) to analyze nucleic acids. This technology enables the sequencing of long DNA or RNA strands in real-time by measuring changes in electrical current as the nucleic acids pass through the nanopore. |
| Pathogens of Epidemic Potential | Refers to the likelihood of a disease or bacteria, viruses, and other microorganisms spreading rapidly and causing significant harm to humans within a specified region.                                                                                                                                                                    |
| Pathogens of Pandemic Potential | Refers to bacteria, viruses, and other microorganisms that are likely highly transmissible and capable of wide, uncontrollable spread in human populations and that are highly virulent, making them likely to cause significant morbidity and/or mortality in humans.                                                                      |
| Priority Pathogens              | Microorganisms (including bacteria, viruses, fungi, and parasites) that health organizations have recognized as significant public health threats due to their high resistance to existing treatments, potential to cause severe disease outbreaks, and substantial impact on morbidity and mortality.                                      |
| Ribonucleic Acid (RNA)          | RNA is a single-stranded molecule that functions in various processes, including gene expression and protein production.                                                                                                                                                                                                                    |
| Whole-Genome Sequencing (WGS)   | Sequencing the entire genome of an organism to identify all genetic variations.                                                                                                                                                                                                                                                             |



# CHAPTER ONE



## 1.1. Introduction

### Country Profile

#### Geographical and demographical context

Zambia is a land-linked country located in the sub-Saharan region and borders eight countries namely: Tanzania, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, Angola, and the Democratic Republic of the Congo (Figure 1). The

country is characterized by a plateau, with varying terrain including mountains, valleys, and rivers. The country covers a geographical area of 752,612 square kilometers. Administratively, Zambia is divided into 10 provinces, subdivided into 116 districts, as of 31 December 2021. Its population, much of it urban, was estimated at 19.6 million (2021) with a rapid growth rate of 2.7 % per year (World Bank overview, 2024).

Figure 1: Map showing the geographical location of Zambia



## Economic and Social Context

Zambia's economy is highly dependent on mining and the export of metals such as copper, although the agriculture, manufacturing, and services sectors are also significant contributors. Zambia has a gross domestic product of approximately \$26.7 billion US dollars, with growth estimated at 4.0 % in 2023 (World Bank overview, 2024). However, the economy contracted in 2020, mainly as a result of the effects of the coronavirus disease 2019 (COVID-19) pandemic. Zambia's economy showed signs of recovery in 2021, with gross domestic product growth reaching 3.6 %. The International Monetary Fund forecasted growth of about 4.0 % in 2023, driven by improvements in copper production, mining sector reforms, and increased international investment. However, the growth remains fragile due to ongoing fiscal challenges, debt sustainability concerns, and the need for economic diversification (International Monetary Fund, 2023).

## Epidemiological Context

Zambia, like many other countries in sub-Saharan Africa, faces a complex epidemiological landscape influenced by both communicable and non-communicable diseases. The health challenges are shaped by a combination of socio-economic factors, access to healthcare, the country's geography, and environmental and climatic conditions.

Zambia continues to have a huge burden of disease, which is mainly characterized by high prevalence and impact of communicable diseases, particularly, malaria, HIV and AIDS, sexually transmitted infections, and tuberculosis, and high maternal, neonatal, and child morbidity and mortality. The country is also faced with a rapidly rising burden of non-communicable diseases, including mental health, diabetes, cardio-vascular diseases, injuries, and accidents. An emerging potential global threat from mpox is a recent development that warrants appropriate preparedness for the entire world, including Zambia. Although there has been some progress in most of the key areas of health service delivery and health support systems over the medium term, the

health status of Zambia's population, especially women and children, remains with challenges.

## Health Financing Context

The main sources of health financing in Zambia are government, cooperating partners, and out-of-pocket payments by households. Other sources include employer-financed schemes through health insurance companies and the newly introduced National Health Insurance Scheme. The Zambia National Health Strategic Plan (NHSP) outlines health financing priorities which aim to improve the sustainability and efficiency of public health financing. Public health spending is typically funded through domestic revenue, including taxes and external borrowing (NHSP, 2022).

## 1.2. Situation Analysis for Genomic Sequencing Capacity in Zambia

Generally, genomics sequencing in Zambia is still in the early stages, as its application had been somewhat limited to research institutions and disease-specific programs, such as HIV drug resistance. However, the current and future public health threats at the human-animal-environment interface present at the country, regional, and global levels demand a genomic surveillance system that encompasses all pathogens with epidemic and pandemic potential using a One Health approach. A coordinated pathogen genomic surveillance program can enhance the health of humans, animals, and ecosystems, support more effective local and public health initiatives, and strengthen international and regional responses to infectious diseases, particularly during epidemics and pandemics. In analyzing the current genomics sequencing situation in Zambia, this strategy focuses on seven priority areas, which are in tandem with the 2022 to 2032 WHO Global Genomic Surveillance Strategy (2022) and the Africa CDC Genomic Surveillance Policy Framework's (2021) core capacities that govern genomic surveillance of pathogens of public health significance.

Table 1: Strengths, Weaknesses, Opportunities, and Threats Analysis for Genomics Sequencing Implementation

| THEMATIC AREA 1: GENOMIC SEQUENCING PLATFORMS AND TECHNOLOGIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | WEAKNESSES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Availability of multiple platforms (Illumina, Oxford Nanopore, Sanger) to support genomic sequencing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>• Limited infrastructure to support NGS workflow</li> <li>• Lack of in-country capacity for maintenance and repair of equipment</li> <li>• Lack of External Quality Assessment (EQA) programs for genomic sequencing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                        |
| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>• Donor support</li> <li>• Change in technology</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>• Donor reliance</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| THEMATIC AREA 2: BIOINFORMATICS AND DATA STRUCTURES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Data infrastructure</b> <ul style="list-style-type: none"> <li>• Presence of technical working group (TWG) (ZGSC TWG/e-Health)</li> <li>• Existing electronic health record systems Laboratory, e.g., Disalab, District Health Information Software 2 (DHIS2) / Electronic Integrated Disease Surveillance Response system (eIDSR)</li> <li>• Availability biobank management information systems in some laboratories, e.g., Mosiac, Freezer pro, Disalab</li> <li>• Presence of central data repository at national level</li> <li>• Integration of systems for sustained health information exchange</li> <li>• Availability of laboratory information management system in country, e.g., Disalab.</li> <li>• Presence of informatics specialist in country to build capacity, e.g., Association of Public Health Laboratories informatics team</li> <li>• Leveraging on the existing capacity of the central data repository for HIV viral load, early infant diagnosis, human papilloma virus, and tuberculosis testing to develop a genomic surveillance repository</li> <li>• Availability of multiple reliable internet options</li> <li>• Government policy direction, commitment and investments in electronic systems</li> </ul> | <b>Data infrastructure.</b> <ul style="list-style-type: none"> <li>• Limited existing genomic data analysis infrastructure for the country</li> <li>• Limited specialized tools to share quality data across the genomic laboratory spectrum</li> <li>• Unavailability of central data repository for genomic data</li> <li>• Lack of an integrated genomics sequencing and analysis system</li> <li>• Absence of standardized laboratory test codes for pathogen genomic surveillance</li> <li>• Limited data storage servers for genomic data</li> <li>• Slow internet connectivity for health information exchange/data sharing</li> </ul> |
| <b>Bioinformatics</b> <ul style="list-style-type: none"> <li>• Political will to support bioinformatics programs</li> <li>• Availability of training programs</li> <li>• Availability of high speed servers/computers</li> <li>• Setting up of a specialized bioinformatics training center at ZNPHI</li> <li>• Collaborative and implementing international partners to build bioinformatics capacity in-country</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Bioinformatics</b> <ul style="list-style-type: none"> <li>• Inadequate funding for training, equipment, infrastructure, and data analysis tools</li> <li>• Limited number of trained bioinformaticians to meet the needs in the country</li> <li>• Non-availability of formal positions for bioinformaticians in the current staff establishments in local institutions</li> </ul>                                                                                                                                                                                                                                                         |

| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Partner funding to develop &amp; scale-up pathogen genomic surveillance strategy.</li><li>• Deliberate effort by government to roll out government wide area network (GWAN) in all institutions, e.g., Governance eServices.</li><li>• Political will to build capacity in bioinformatics.</li><li>• Availability of online pipeline databases for analysis</li><li>• Presence of partners to support setting up of data infrastructure.</li><li>• Strengthening other omics beyond genomics</li><li>• Availability of capacity to train more staff through partner support</li></ul>                                                                                                                                                                                                                                               | <ul style="list-style-type: none"><li>• Donor dependency</li><li>• Staff attrition</li><li>• Re-focusing of activities due to policy change</li><li>• Lack of security for data management systems</li><li>• Insufficient back up procedures/facilities</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| THEMATIC AREA 3: SURVEILLANCE PROGRAMS AND DATA UTILIZATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"><li>• Active surveillance programs: wastewater, mortality, environmental, and zoonotic diseases</li><li>• Sentinel surveillance programs: Severe acute respiratory illness, Influenza-like illness, pan-respiratory disease surveillance, antimicrobial resistance (AMR)</li><li>• Passive and case-based surveillance (clinical)</li><li>• Availability of umbrella protocol for future wastewater-based surveillance and / or research</li><li>• Existence of One Health strategy</li><li>• In-country sequencing capacity for pathogens of public health concern</li><li>• Whole-genome sequencing is included in the national tuberculosis guidelines</li><li>• Availability of culture facilities (laboratories) for phenotypic isolation of bacteria</li><li>• Able to leverage on multi-pathogen sequencing advancements</li></ul> | <ul style="list-style-type: none"><li>• Limited coverage</li><li>• Inefficient sample referral system</li><li>• Incomplete and inaccurate capturing of metadata</li><li>• Inadequate funding for genomic surveillance programs</li><li>• Inadequate laboratory capacity for microbiology</li><li>• Inadequate guidelines for genomic surveillance</li><li>• Inadequate integrated data capturing systems</li><li>• Inadequate electronic data capturing tools at subnational level (paper based systems in use)</li><li>• Inadequate dedicated surveillance officers</li><li>• Weak coordination across programs in genomic surveillance</li><li>• Delays in the sharing of data within and across sectors</li><li>• Limited access to data</li></ul> |
| <b>Data</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"><li>• Availability of surveillance guidelines for selected programs</li><li>• Availability of data management systems, e.g., Health Management Information Systems (HMIS), electronic Integrated Disease Surveillance and Response (eIDSR), SILAB</li><li>• Utilization of data to monitor disease trends to inform response</li><li>• Utilization of data to inform policy</li><li>• Availability</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"><li>• Multilateral partner support</li><li>• International regional collaboration and partnerships</li><li>• Political will</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>• Sustainability challenges due to donor dependency</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**THEMATIC AREA 4: WORKFORCE DEVELOPMENT FOR GENOMIC SEQUENCING**

| STRENGTHS                                                                                                                                                                                                                                                                                | WEAKNESS                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Availability of National Multi-Pathogen Diagnostic Program</li> <li>• Availability of trained personnel in genomic sequencing</li> <li>• Availability of molecular epidemiology trainings</li> </ul>                                            | <ul style="list-style-type: none"> <li>• Shortage of trained bioinformaticians</li> <li>• Limited training programs in bioinformatics</li> <li>• Limited access to continuing education programs in genomic sequencing and bioinformatics</li> <li>• Lack of EQA programs for genomic sequencing</li> </ul> |
| OPPORTUNITIES                                                                                                                                                                                                                                                                            | THREATS                                                                                                                                                                                                                                                                                                     |
| <ul style="list-style-type: none"> <li>• Donor support</li> <li>• Availability of web-based bioinformatics tools</li> <li>• Availability of partners willing to support workforce development</li> <li>• Availability of academic institutions for collaboration and training</li> </ul> | <ul style="list-style-type: none"> <li>• Reliance on donors for trainings</li> <li>• Proprietary restrictions on web-based tools for workforce development</li> <li>• High staff attrition (brain drain)</li> </ul>                                                                                         |

**THEMATIC AREA 5: REAGENTS, CONSUMABLES, AND SUPPLY CHAIN**

| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Availability of local vendors</li> <li>• Established in-country supply management system</li> <li>• Existence of Network Information Management Systems (NIMS) platform</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• High cost of commodities</li> <li>• Prolonged delivery periods</li> <li>• Import permit, regulatory process bottlenecks (Zambia Medicines Regulatory Authority (ZAMRA), Zambia Revenue Authority (ZRA))</li> <li>• Routine procurement of reagents and consumables for genomic sequencing</li> <li>• Lack of in-country supply of axillary consumables, e.g., dry ice</li> </ul> |
| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>• Partner funding in reagent procurement</li> <li>• Leveraging on existing surveillance programs for procurement of reagents and consumables</li> <li>• Bulk procurement at regional, national (ZGSC) and continental level provides negotiating power for cheaper service acquisition</li> <li>• Local production through local companies</li> <li>• Research and development leading to production of local reagents and consumables</li> <li>• Collaboration of the ZGCS members on use of network information management systems through ZNPHI</li> <li>• Availability of international vendors</li> </ul> | <ul style="list-style-type: none"> <li>• Lack of sustainability plans beyond partner support</li> <li>• Supply chain disruptions during health emergencies</li> </ul>                                                                                                                                                                                                                                                     |

**THEMATIC AREA 6: SAMPLE REFERRAL SYSTEM**

| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Availability of integrated specimen referral guidelines</li> <li>• Existing partner support</li> <li>• Existing commercial couriers</li> <li>• Availability of motorcycles and motor vehicles</li> <li>• Availability of a coordinated national courier system</li> <li>• Existence of national TWG for couriers</li> <li>• Education and awareness among couriers and laboratory personnel on existing courier guidelines</li> </ul> | <ul style="list-style-type: none"> <li>• Low coverage of referral systems in hard-to-reach areas</li> <li>• Lack of regular maintenance of motor vehicles and motorcycles and bicycles</li> <li>• Poor biosafety and biosecurity practices in the courier system</li> <li>• Insufficient number of courier staff (motor vehicle drivers and motorbike and motorcycle riders) are available</li> </ul> |

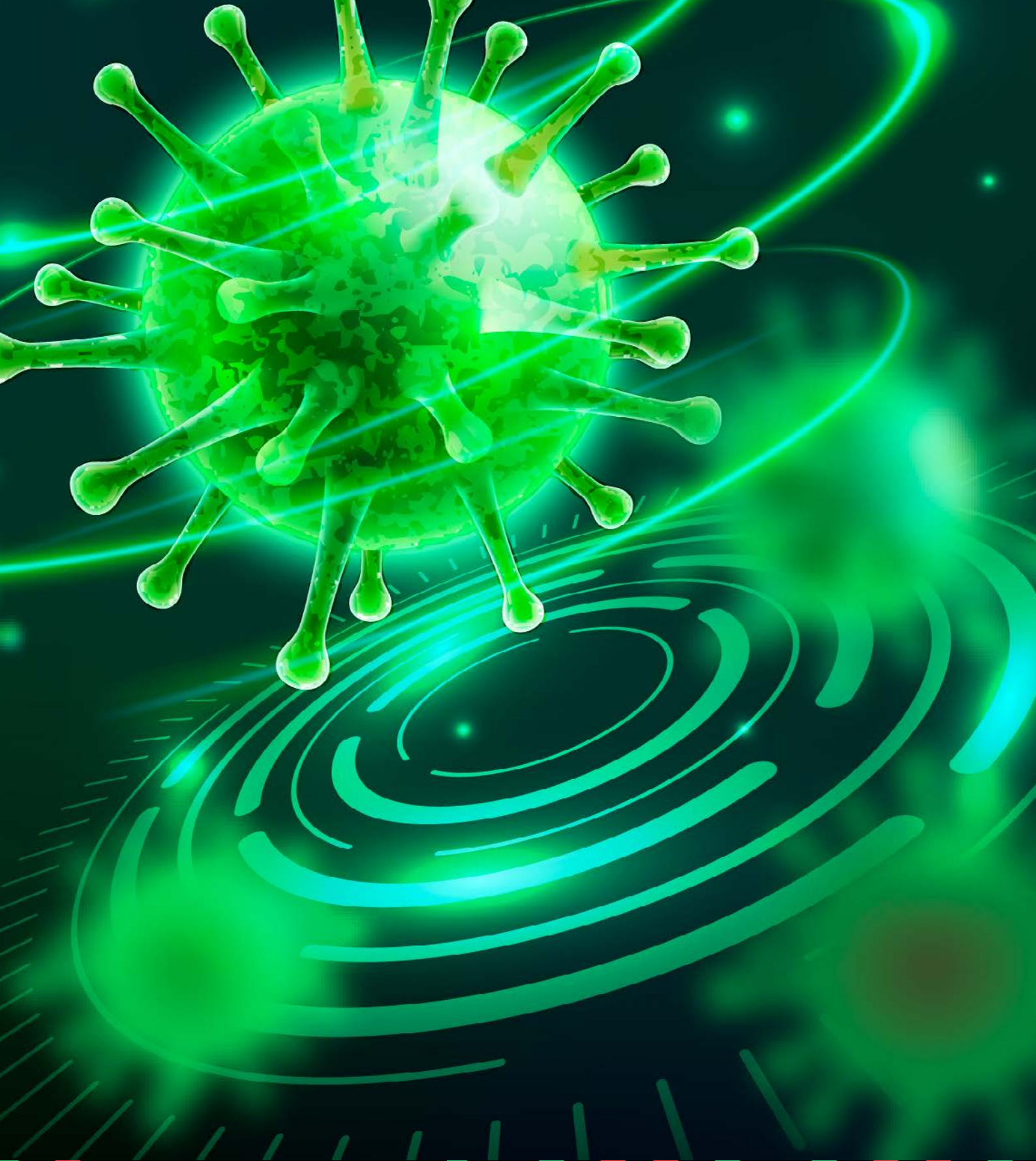
| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                           | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>• Of the available courier staff, only a limited number are trained in biosafety and biosecurity and sample management</li> <li>• Weak coordination of transport systems at district and provincial levels</li> <li>• Inadequate funding for inter-provincial specimen referral</li> <li>• Weak adherence to schedules for sample pickups</li> <li>• Inadequate number of motor vehicles, motorbikes and bicycles</li> <li>• Inadequate sample packaging materials and equipment</li> <li>• Inadequate temperature monitoring for samples</li> <li>• Inadequate sample cold storage capacity at facility level ( 80°C, 30°C)</li> <li>• Inadequate sample tracking and monitoring system</li> <li>• Inadequate technical support and supervision (TSS) in sample management</li> <li>• Currently no formal positions for courier drivers and riders in the staff establishment</li> <li>• Fuel shortages</li> <li>• Delays in supply chain</li> <li>• Inadequate funding for service and maintenance of motorcycles/vehicles, especially for facilities in remote areas</li> </ul> |
| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                       | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>• Usage of unmanned aerial vehicles</li> <li>• Available collaborations and partnerships between implementing and line ministries</li> <li>• Availability of a pool of courier staff</li> </ul>                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>• Donor dependence</li> <li>• Staff attrition of trained drivers/riders</li> <li>• Poor road network and infrastructure</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| THEMATIC AREA 7: LOCAL PRODUCTION OF REAGENTS AND SUPPLIES                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| STRENGTHS                                                                                                                                                                                                                                                                                                                                                                                                                           | WEAKNESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>• Availability of local vendors</li> <li>• Established in-country supply management system</li> <li>• Existence of Network Information Management Systems (NIMS) platform</li> </ul>                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Inadequate experts, infrastructure and equipment for the production of genomic sequencing reagent and supplies, e.g., primers</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| OPPORTUNITIES                                                                                                                                                                                                                                                                                                                                                                                                                       | THREATS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>• Local vendors available to supply and maintain water purification systems</li> <li>• Availability of regulatory agencies such as the Zambia Bureau of Standards (ZABS) and the Zambia Medicines Regulatory Authority (ZAMRA) which certify products and verify their content</li> <li>• Political will to promote/support local manufacturers, e.g., Presidential Delivery Unit</li> </ul> | <ul style="list-style-type: none"> <li>• Low demand for genomic sequencing reagents and supplies in the country</li> <li>• Monopoly on reagents supply</li> <li>• Competition with international manufacturing companies</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

## OPPORTUNITIES

- Availability of international companies that can support local companies in production of primers and dry ice
- Leverage on Africa CDC guidance on local production of diagnostic reagents and consumables and benchmark with other countries carrying out local production of diagnostics

## THREATS





## CHAPTER TWO



## 2.1. Strategic Vision

To establish and sustain a comprehensive national pathogen genomics ecosystem for effective detection, monitoring, and response to public health threats.

## 2.2. Goal

To develop and strengthen a comprehensive genomic surveillance system for improving public health response and health security by 2029.

## 2.3. Mission

To utilize cutting-edge technology and collaborative partnerships to support genomic surveillance for public health response.

## 2.4. Values

### Accountability

To uphold a standard of excellence in terms of ethics and governance in the operations and actions.

### Equity

To embody the conviction and application of fairness, which is a guiding framework shaping our responsibilities and engagements with others.

### Transparency

To commit to providing open, available, and easily accessible genomic data.

### Confidentiality

To value keeping data generated secure and only sharing within the provisions of this strategy.

### Accessibility

To ensure equitable access to data and resources by stakeholders while safeguarding against misuse, harm, and restriction to facilitate scientific progress in an ethical manner.

### Integrity

To uphold honesty, truthfulness, and accuracy when carrying out our mandate and dealing with our stakeholders

### Diversity

To value, respect and appreciate differences in the various players involved in the work under the one health approach.



## 2.5. Guiding Principles

### National Ownership

The national multi-pathogen genomic strategy document was developed through a consultative process with input from all stakeholders including representatives from ZNPHI; the Ministries of Health, Agriculture, Fisheries, and Environment; academia; research institutes; and in country and continental partners.

### Public Health Focus

Genomic tools are essential for preparedness for emerging and re-emerging diseases, outbreak detection, tracking AMR, and informing timely treatment and control measures for priority pathogens in Zambia and regionally.

### Multi-disciplinary partnerships

Partnerships at the local, national, regional, and global levels are essential for coordinated and collaborative surveillance efforts in Zambia.

### Equitability

A fair, objective, unbiased, and equitable approach is required for deployment of resources for pathogen genomics.

### Sustainability

Different funding models and a reliable supply chain are required to maintain genomic surveillance infrastructure and resources.

### Data Governance

Standards for data collection, storage, sharing, and analysis must be in alignment with national and African Union guidelines.

### One Health Approach

Integration of pathogen genomics within human, animal, and environmental health sectors is necessary to address zoonotic and cross-species disease threats in Zambia and regionally.

## 2.6. Goal, Objectives and Strategic Actions

Figure 2 gives an overview of the program plan, which is elaborated in subsequent sections

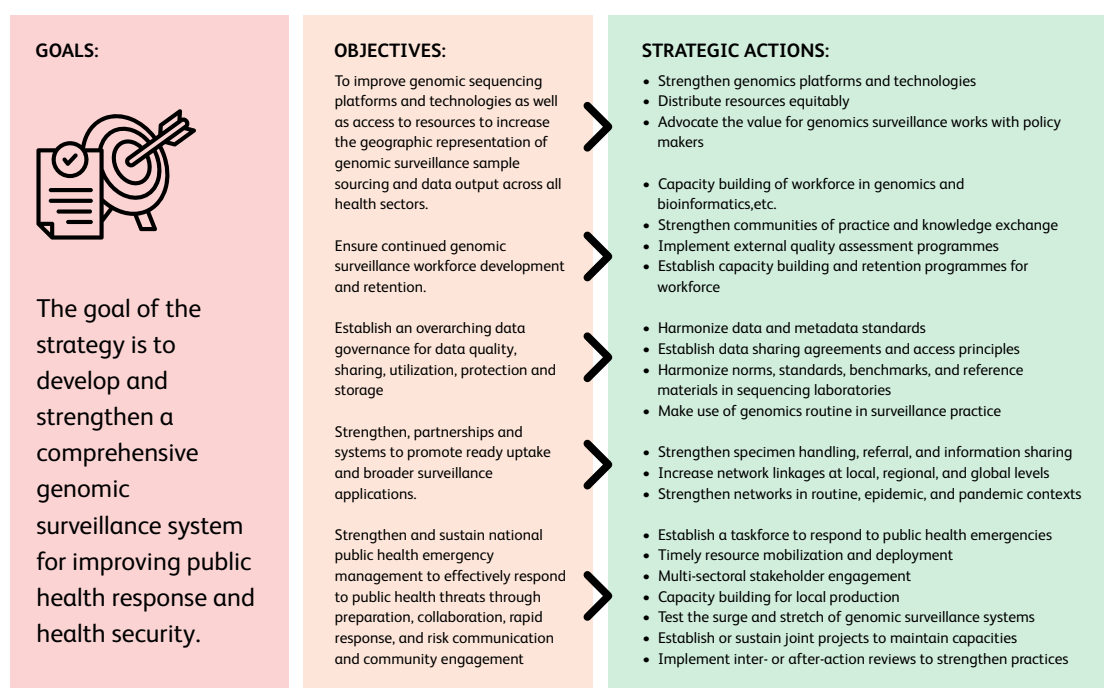


Figure 2: Goal, Objectives and Strategic Actions

## 2.6.1 Strategic Objectives

There are five objectives to support the attainment of the strategic goal. Each objective is driven by a set of strategic actions. Together, these objectives depict several sectors of the national health systems that will potentially contribute to the integration of the multi-pathogen genomic surveillance program within public health systems.

### 2.6.1.1 Objective 1. Acquire improved genomic sequencing platforms and technologies, and ensure access to resources, to increase the geographic representation of genomic surveillance sample sourcing and data output across all relevant sectors.

The ZGSC shall ensure equitable access to resources for all members of the pathogen genomic surveillance program for continued service availability. The ZGSC shall zone the service area for each sequencing laboratory to ensure geographic representativeness in service delivery. The list of priority pathogens shall be reviewed and updated in line with global and regional priorities.

### 2.6.1.2 Objective 2. Ensure continued genomic surveillance workforce development and retention.

The ZGSC shall assess the diversity of specialties within the consortium, to ensure the availability of a comprehensive range of expertise. Concurrently, workforce capacity must be fortified, focusing on prompt sequencing during outbreaks, to comprehend virulence and AMR. Genomics and bioinformatics shall be mainstreamed in the training curricula of academic institutions for sustainability. The ZGSC shall advocate for the establishment and retention of positions for the genomics and bioinformatics cadres in human resource structures.

### 2.6.1.3 Objective 3. Establish an overarching data governance for data quality, sharing, utilization, protection, and storage

The ZGSC shall ensure effective governance and legislation surrounding data sharing through establishment of clear guidelines for infrastructure requirements, including both long-term storage and immediate access needs. While sequencing laboratories may possess the initial capacity for data storage and analysis, the consortium shall ensure that a centralized repository is accessible to all stakeholders to streamline data management and analysis processes. Guidelines for custody and data-sharing shall be developed to delineate access permissions and usage terms. This approach will allow for a balance between local analysis capabilities at sequencing laboratories and more comprehensive analysis at the central level, fostering a collaborative bioinformatics community through a cloud-based system. A cohesive framework for data sharing shall be developed to facilitate scientific progress and uphold ethical standards and data integrity.

### 2.6.1.4 Objective 4. Strengthen partnerships and systems to promote uptake and broader surveillance applications.

The ZGSC shall ensure that the linkages between the sub-national and national levels are delineated by establishing focal points within various sectors to facilitate the flow of samples and information within the national genomic surveillance system. This will entail defining channels of communication post-sequencing to determine responsible parties for disseminating findings effectively. Furthermore, integration of diverse surveillance systems—encompassing the human health, animal, and environmental sectors—into the national genomics framework is crucial. Rapid dissemination of information to relevant stakeholders is essential for timely prevention, detection, and response. Implementation of this strategy through a 7-1-7 framework will

provide structure and efficiency to pathogen genomic surveillance.

#### 2.6.1.5 Objective 5. Strengthen and sustain national public health emergency management to effectively respond to public health threats through preparation, collaboration, rapid response, and risk communication and community engagement.

To mount an effective response to public health threats, the ZGSC shall:

- i. Establish a Task Force to respond to public health emergencies  
A Task Force shall be established to respond to an emergency. The composition of the Task Force considers required expertise ensuring diversity and representation from different sectors. The Task Force shall draft a comprehensive response plan outlining objectives, roles and responsibilities, protocols, and timelines for each phase of the emergency response (preparation, detection, containment, mitigation, and recovery).

- ii. Ensure timely resource mobilization and deployment  
The ZGSC shall ensure sourcing of adequate funds to respond to emergencies.

- iii. Promote multi-sectoral stakeholder engagement  
The ZGSC shall promote stakeholder engagement through the One Health approach to foster collaboration and ensure effective coordination in emergency response efforts.

- iv. Promote capacity building in local research and development

The ZGSC shall advocate for local research and development capacity to strengthen and promote domesticated supply chains of critical items that will enhance genomic sequencing activities.

Table 2: Objectives, Strategic Actions, and Activities

The objectives, strategies, and activities envisioned to be implemented in the five-year period are outlined in Table 2 below.

| <b>Objective 1.</b> Acquire improved genomic sequencing platforms and technologies, and ensure access to resources, to increase the geographic representation of genomic surveillance sample sourcing and data output across all health sectors. |                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Strategic Action                                                                                                                                                                                                                                 | Activities                                                                                                      |
| 1.1. Strengthen genomic sequencing platforms and technologies                                                                                                                                                                                    | 1.1.1. Conduct infrastructure needs assessment                                                                  |
|                                                                                                                                                                                                                                                  | 1.1.2. Develop guidelines for specialized laboratory infrastructure (including NGS)                             |
|                                                                                                                                                                                                                                                  | 1.1.3. Upgrade and or construct laboratories in line with the guidelines (including equipment and accessories)  |
|                                                                                                                                                                                                                                                  | 1.1.4. Procure reagents and supplies in bulk for genomic sequencing platforms and accessories in support of NGS |
|                                                                                                                                                                                                                                                  | 1.1.5. Procure service and maintenance contracts                                                                |

|                                                                                                  | 1.1.6. Build local capacity for service and maintenance of equipment and accessories (conduct mapping of biomedical engineers specialized in genomic sequencing equipment) |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                  | 1.1.7. Establish an integrated system for equipment service through the ZGSC                                                                                               |
|                                                                                                  | 1.1.8. Set up servers at each sequencing laboratory and a central server at ZNPHI for backup                                                                               |
|                                                                                                  | 1.1.9. Establish an equipment calibration and maintenance program                                                                                                          |
|                                                                                                  | 1.1.10. Advocate for domestic funding to reduce on over-dependence on donors                                                                                               |
| Strategic Action                                                                                 | Activities                                                                                                                                                                 |
| 1.2. Distribute resources equitably                                                              | 1.2.1. Conduct needs assessments in sequencing laboratories                                                                                                                |
|                                                                                                  | 1.2.2. Hold stakeholder engagement meetings                                                                                                                                |
|                                                                                                  | 1.2.3. Hold meetings for resource mobilization through grant applications                                                                                                  |
|                                                                                                  | 1.2.4. Engage suppliers to establish agreements for purchase of reagents and consumables                                                                                   |
|                                                                                                  | 1.2.5. Develop the resource allocation plan                                                                                                                                |
| Strategic Action                                                                                 | Activities                                                                                                                                                                 |
| 1.3. Advocate for the value of genomic surveillance with policy makers                           | 1.3.1. Stakeholder engagement with policy makers and partners                                                                                                              |
|                                                                                                  | 1.3.2. Stakeholder engagement with policy makers and partners focused on import permit waiver, i.e., ZAMRA, ZRA                                                            |
|                                                                                                  | 1.3.3. Disseminate genomic sequencing results at annual conferences                                                                                                        |
|                                                                                                  | 1.3.4. Use multimedia platforms to disseminate information                                                                                                                 |
| <b>Objective 2. . Ensure continued genomic surveillance workforce development and retention.</b> |                                                                                                                                                                            |
| Strategic Action                                                                                 | Activities                                                                                                                                                                 |
| 2.1. Train workforce in genomics and bioinformatics                                              | 2.1.1. Conduct training in genomic sequencing                                                                                                                              |
|                                                                                                  | 2.1.2. Conduct training in bioinformatics                                                                                                                                  |
|                                                                                                  | 2.1.3. Mainstream genomics and bioinformatics in curriculum of academic institutions                                                                                       |
|                                                                                                  | 2.1.4. Conduct technical assistance and twinning programs in genomics sequencing and bioinformatics                                                                        |
| Strategic Action                                                                                 | Activities                                                                                                                                                                 |
| 2.2. Strengthen communities of practice and knowledge exchange                                   | 2.2.1. Support collaborative research and use cases for genomics and bioinformatics                                                                                        |
|                                                                                                  | 2.2.2. Establish a community of practice for genomics and bioinformatics through symposiums                                                                                |

| Strategic Action                                                                                                                   | Activities                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| 2.3. Implement EQA programs                                                                                                        | 2.3.1. Develop a quality assessment framework                                                                       |
|                                                                                                                                    | 2.3.2. Develop and implement audit and assessment plans                                                             |
|                                                                                                                                    | 2.3.3. Enroll laboratories into proficiency testing programs                                                        |
|                                                                                                                                    | 2.3.4. Develop quality management systems to evaluate and monitor supplies                                          |
|                                                                                                                                    | 2.3.5. Develop remediation plans                                                                                    |
| Strategic Action                                                                                                                   | Activities                                                                                                          |
| 2.4. Establish capacity building and retention programs for workforce                                                              | 2.4.1. Develop retention strategies                                                                                 |
|                                                                                                                                    | 2.4.2. Establish capacity building initiatives                                                                      |
|                                                                                                                                    | 2.4.3. Develop scholarships and fellowships for staff development                                                   |
| <b>Objective 3. . Establish an overarching data governance to enhance data quality, sharing, utility, protection, and storage.</b> |                                                                                                                     |
| Strategic Action                                                                                                                   | Activities                                                                                                          |
| 3.1. Harmonize data and metadata standards                                                                                         | 3.1.1. Develop national guidelines for data and metadata                                                            |
|                                                                                                                                    | 3.1.2. Develop standardized data and metadata protocols                                                             |
|                                                                                                                                    | 3.1.3. Conduct training workshops on data standardization                                                           |
|                                                                                                                                    | 3.1.4. Implement a centralized data management system                                                               |
|                                                                                                                                    | 3.1.5. Conduct regular audits of data and metadata to ensure compliance with established standards                  |
| Strategic Action                                                                                                                   | Activities                                                                                                          |
| 3.2. Establish data sharing agreements and access principles                                                                       | 3.2.1. Develop Memorandums of Understanding (MOUs) and Memorandums of Agreement (MOAs)                              |
|                                                                                                                                    | 3.2.2. Adopt data sharing and access principles based on the Data Protection Act No.3 of 2021 of the laws of Zambia |
|                                                                                                                                    | 3.2.3. Develop genomic data sharing and access plan                                                                 |
| Strategic Action                                                                                                                   | Activities                                                                                                          |
| 3.3. Harmonize norms, standards, benchmarks, and reference materials in the sequencing laboratories                                | 3.3.1. Develop standard operating procedures (SOPs) for genomic sequencing laboratories                             |
|                                                                                                                                    | 3.3.2. Adopt standardized procedures for sample testing and reporting of results                                    |
|                                                                                                                                    | 3.3.3. Create a standard benchmark level for each sequencing laboratory                                             |
| Strategic Action                                                                                                                   | Activities                                                                                                          |
| 3.4. Make use of genomics in routine surveillance practice                                                                         | 3.4.1. Conduct TSS to strengthen laboratory capacity in genomic sequencing                                          |

3.4.2. Conduct genomic surveillance awareness trainings

3.4.3. Conduct surveys on acceptability of genomic surveillance with end users

**Objective 4 . Strengthen partnerships and systems to promote uptake and broader surveillance applications.**

| Strategic Action                                                                                                                                                                                                                            | Activities                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1. Strengthen specimen handling, referral, and sharing                                                                                                                                                                                    | 4.1.1. Conduct specimen collection from sentinel or healthcare facilities                                                                                      |
|                                                                                                                                                                                                                                             | 4.1.2. Monitor the quality of specimens collected                                                                                                              |
|                                                                                                                                                                                                                                             | 4.1.3. Conduct data completeness audits for specimen referral                                                                                                  |
|                                                                                                                                                                                                                                             | 4.1.4. Develop or utilize existing digital platforms for sharing data and results                                                                              |
|                                                                                                                                                                                                                                             | 4.1.5. Conduct trainings in sample management                                                                                                                  |
|                                                                                                                                                                                                                                             | 4.1.6. Procure additional sample packaging equipment                                                                                                           |
|                                                                                                                                                                                                                                             | 4.1.7. Establish specimen exchange programs that facilitate the exchange of specimens between institutions                                                     |
| Strategic Action                                                                                                                                                                                                                            | Activities                                                                                                                                                     |
| 4.2. Increase network linkages at local, regional and global levels                                                                                                                                                                         | 4.2.1. Participate in online networking platforms and forums to connect, share information, and collaborate                                                    |
|                                                                                                                                                                                                                                             | 4.2.2. Initiate collaborative projects and hold exchange meetings, symposia, and other interactions that involve partners from different regions and countries |
|                                                                                                                                                                                                                                             | 4.2.3. Hold in-country stakeholder meetings                                                                                                                    |
|                                                                                                                                                                                                                                             | 4.2.4. Form partnerships with local and regional organizations; undertake exchange visits                                                                      |
| Strategic Action                                                                                                                                                                                                                            | Activities                                                                                                                                                     |
| 4.3. Strengthen networks in routine, epidemic, and pandemic contexts                                                                                                                                                                        | 4.3.1. Promote the establishment of bioinformatics and genomic sequencing networks                                                                             |
|                                                                                                                                                                                                                                             | 4.3.2. Conduct simulation exercises and drills                                                                                                                 |
| <b>Objective 5. Strengthen and sustain national public health emergency management to effectively respond to public health threats through preparation, collaboration, rapid response, and risk communication and community engagement.</b> |                                                                                                                                                                |
| Strategic Action                                                                                                                                                                                                                            | Activities                                                                                                                                                     |
| 5.1. Establish a taskforce to respond to public health emergencies                                                                                                                                                                          | 5.1.1. Develop the response plan                                                                                                                               |
| Strategic Action                                                                                                                                                                                                                            | Activities                                                                                                                                                     |
| 5.2. Timely resource mobilization and deployment                                                                                                                                                                                            | 5.3.1. Establish and strengthen regional / local capacity for production of molecular biology and genomic sequencing reagents and consumables                  |
|                                                                                                                                                                                                                                             | 5.3.2. Conduct needs assessment of production systems / capacity and market assessment for product demand                                                      |

|                                                                       | 5.3.3. Enhance scope of ZAMRA's monitoring of good manufacturing practices to include consumables and reagents used in molecular biology                              |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                       | 5.3.4. Advocate for capacity building for local entrepreneurs in design and production of genomic sequencing reagents and consumables through stakeholder engagements |
| Strategic Action                                                      | Activities                                                                                                                                                            |
| 5.4. Test the surge and stretch of genomic surveillance systems       | 5.4.1. Develop capacity for monitoring and evaluation of the implemented genomic surveillance systems                                                                 |
| Strategic Action                                                      | Activities                                                                                                                                                            |
| 5.5. Establish or sustain projects to maintain capacities             | 5.5.1. Integrate the genomic surveillance program into existing systems                                                                                               |
|                                                                       | 5.5.2. Develop diversified and sustainable funding strategies to support the program                                                                                  |
|                                                                       | 5.5.3. Regularly evaluate the effectiveness of the project in maintaining and utilizing genomic surveillance indicators                                               |
| Strategic Action                                                      | Activities                                                                                                                                                            |
| 5.6. Implement inter- or after action reviews to strengthen practices | 5.6.1. Hold an inter-action review meeting                                                                                                                            |
|                                                                       | 5.6.2. Hold an after-action review meeting                                                                                                                            |





## CHAPTER THREE

### 3.1. Governance

This strategy will be governed by the ZGSC as per governance structure in Figure 3. The ZGSC is a group of public and private institutions involved in genomic surveillance in Zambia, dedicated to monitoring and analyzing the genetic material of pathogens of epidemic and pandemic potential, utilizing advanced genomic sequencing technologies. The operations of the ZGSC will allow for the rapid sharing of information and timely public health interventions based on the following enablers:

#### i. Human resources:

Appreciation of talent and resources by actively seeking, retaining, and enhancing the diverse expertise necessary to operate an innovative genomics service will be prioritized. In this regard, career advancement to cultivate leaders in this field will be promoted both nationally and internationally.

#### ii. Sequencing facilities:

The aim is to enhance laboratory capabilities through facilitating advanced genomic sequencing technologies, as well as robust bioinformatic infrastructure. This includes integrating connectivity across digital platforms, data management, and analytics.

#### iii. Collaborations and partnerships:

A commitment to fostering collaboration across disciplines to integrate data and expertise, facilitating informed clinical and public health decision-making, will be prioritized. Development and implementation of a national pathogen genomics ecosystem will be leveraged on local, national, and global partnerships under the One Health approach.

#### iv. Research, knowledge management, and its translation into clinical and public health benefit:

The aim is to optimize the influence of pathogen genomics on public health by leveraging on robust academic connections and research environments. This will enable innovative technologies and practices to directly shape clinical and public health interventions, ensuring a tangible impact on healthcare outcomes.

#### v. Diagnostic laboratories:

The well-structured national laboratory diagnostic network will be utilized for: (a) diagnostic capacity for clinical metadata collection and identification of samples to be sequenced, (b) sample referral system for sample movement to sequencing laboratories, (c) coverage for geographical representation, (d) primary sample storage, and (e) laboratory quality management systems.

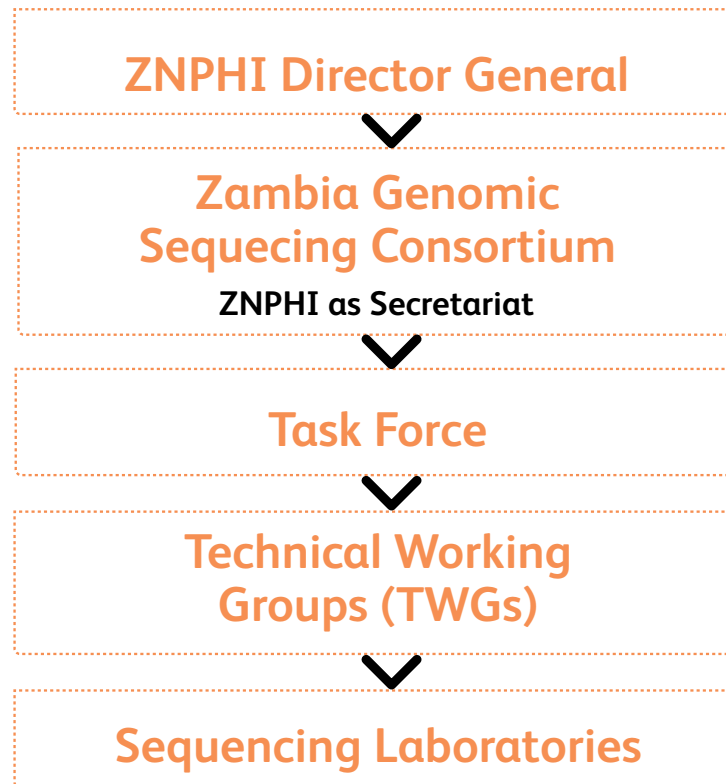
#### vi. Existing national legal provisions and international agreements:

The strategy will be guided by existing legal provisions, which include the Zambia National Public Health Act No. 19 of 2020, Animal Health Act No 27 of 2010, National Health Research Act No 2 of 2013, Data Protection and Use Act No 3 of 2021, Public Health Act Cap 295 of 1995, and other relevant legislation, as well as regional and international agreements.

#### vii. Monitoring and evaluation:

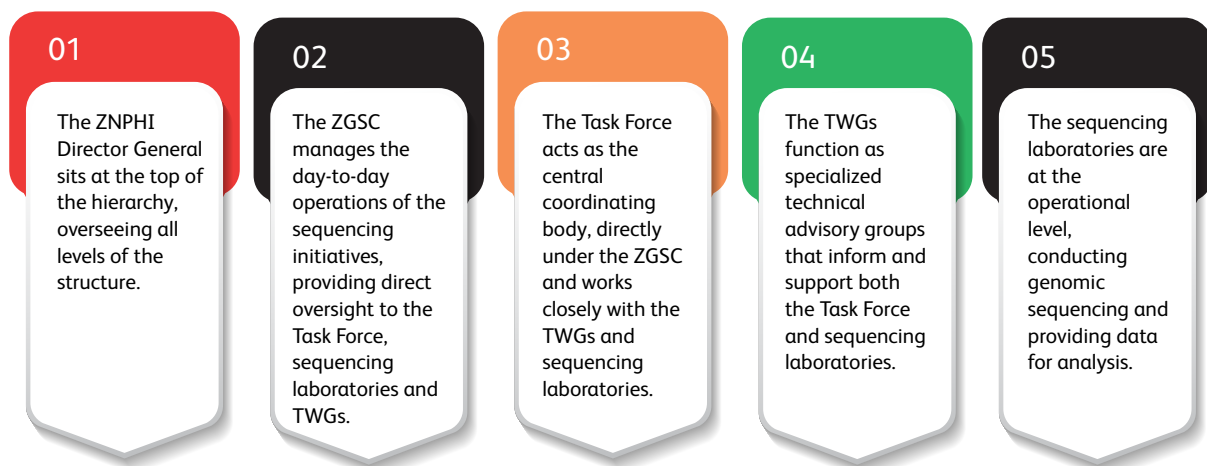
A robust monitoring and evaluation (M&E) framework will be established for successful implementation, providing data-driven insights, facilitating continuous learning, fostering accountability and stakeholder engagement, and facilitating performance improvement throughout the lifecycle of this genomic strategy.

Figure 3: ORGANIZATIONAL STRUCTURE OF THE ZAMBIA GENOMIC SEQUENCING CONSORTIUM (ZGSC)



### 3.2. Organizational Structure of the ZGSC

The flow chart description is as follows:



### 3.2. Roles and Responsibilities & E officers, program managers

- 3.2.4.4.1. Develop and implement an M&E framework
- 3.2.4.4.2. Orient and train TWGs in M&E
- 3.2.4.4.3. Report regularly on performance of genomics sequencing
- 3.2.4.4.4. Develop an implementation plan

#### 3.2.4.5. TWG for Emergency Preparedness and response

*Members drawn from: Surveillance experts, epidemiologists, laboratory scientists, One Health team*

- 3.2.4.5.1. Conduct onsite response readiness assessments
- 3.2.4.5.2. Be responsible for preparation and implementation of preparedness and response plans
- 3.2.4.5.3. Coordinate inter-action review meetings

#### 3.2.4.6. TWG for capacity building local solution and innovation

*Members drawn from: Private sector, academics, policy makers*

- 3.2.4.6.1. Promote the establishment of local capacity for production of oligonucleotides, dry ice, nuclease free water and molecular grade ethanol to support pathogen genomic surveillance
- 3.2.4.6.2. Advocate for local suppliers/ manufacturers of reagents and consumables for genomic surveillance
- 3.2.4.6.3. Strengthen local capacity in maintenance, calibration and servicing of equipment in sequencing laboratories

#### 3.2.4.7. TWG for Research and Development

*Members drawn from: academics, researchers, policy makers*

- 3.2.4.7.1. Coordinate implementation of operational and collaborative research
- 3.2.4.7.2. Conduct research for diagnostics, vaccines and therapeutic development, utilizing data generated from genomic surveillance program
- 3.2.4.7.3. Prioritization of research areas related to genomic sequencing
- 3.2.4.7.4. Promote dissemination of finding in peer review journals, technical reports and policy briefs to inform public health policy and practice
- 3.2.4.7.5. Promote grant application to support research in genomic surveillance
- 3.2.4.7.6. Responsible for capacity building in research

#### 3.2.5. Sequencing laboratories

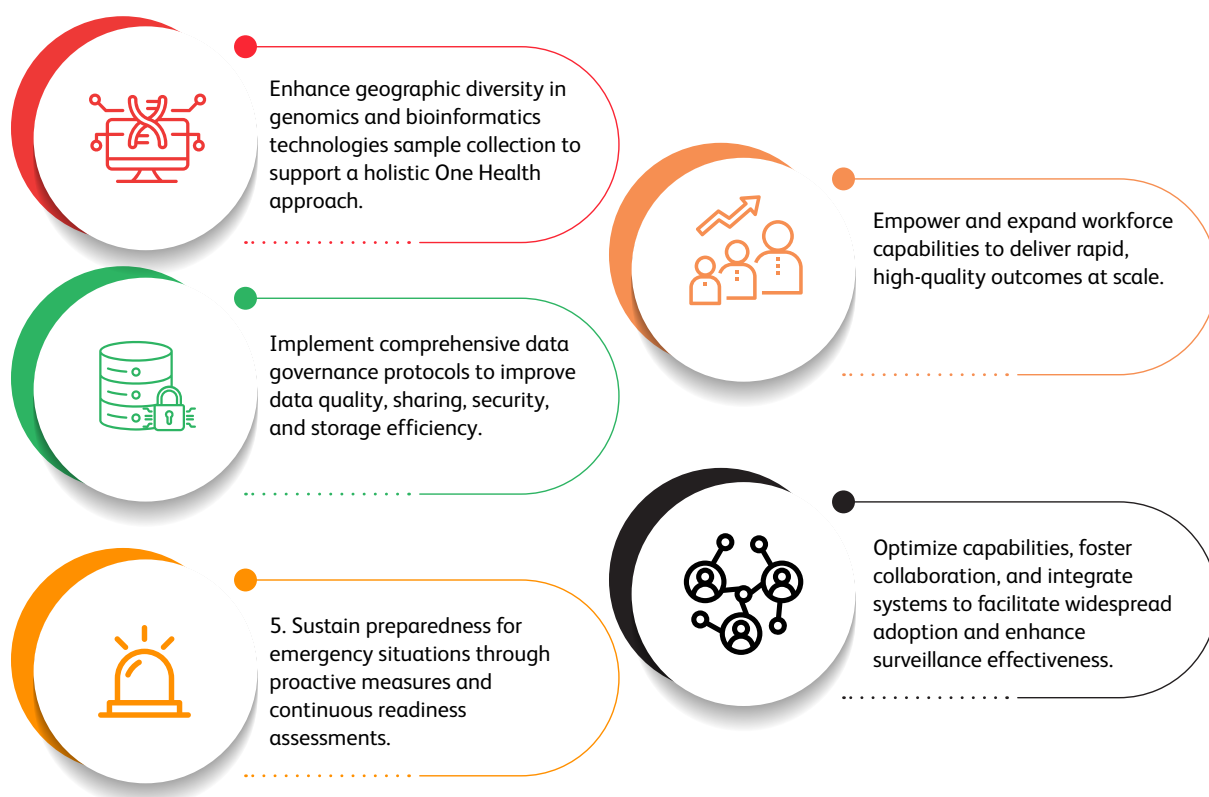
- 3.2.5.1. Conduct genomic sequencing of pathogens
- 3.2.5.2. Conduct bioinformatics analysis of sequence data
- 3.2.5.3. Capacity building in Trainers of Trainers in sequencing
- 3.2.5.4. Provide repository and Bio-banking services to the consortium
- 3.2.5.5. Provide reports to the consortium



## CHAPTER FOUR

## 4.1. Monitoring and Evaluation

Monitoring and evaluation (M&E) are key to driving the achievement of the Strategy's results hierarchy and understanding progress towards it. The Strategy's key measure of success is equitable access and effective application of genomics in public health systems within Zambia through a comprehensive One Health approach by 2026. For cross-cutting aspects of this Strategy, several high-level measures will also be monitored to ensure access to genomic surveillance. Measures include the following:



The Consortium, through the appropriate partner and/or stakeholder, shall facilitate monitoring of strategy's implementation and conduct necessary reviews and course corrections.

## 4.2. Goal of the Monitoring and Evaluation Plan

The goal of the M&E plan is to establish a system that is robust, comprehensive, fully integrated, harmonized, and well coordinated to guide how the implementation of the strategic plan is monitored and to evaluate its impact.

## 4.3. Monitoring and Evaluation Framework Matrix

The logical framework presented in Table 3 summarizes the monitoring and evaluation matrix and adheres to the conventional programmatic M&E structure, encompassing processes or

activities, outputs (results at the program level), outcomes (results at the population level), and impacts and goals (desired long-term effects). Appendix 1 elaborates on the logical framework, illustrating the interconnections among activities, outputs, outcomes, and goals, along with the associated assumptions/risks, indicators, and means of verification used to gauge progress and results.

Table 3: Logical Framework

| <b>GOAL: TO DEVELOP AND STRENGTHEN A COMPREHENSIVE GENOMIC SURVEILLANCE SYSTEM FOR IMPROVING PUBLIC HEALTH RESPONSE AND HEALTH SECURITY BY 2029.</b>                                                                                           |                                                                                                                                            |                                                                                                                                    |                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Outcome 1.</b> Acquire improved genomic sequencing platforms and technologies, and ensure access to resources, to increase the geographic representation of genomic surveillance sample sourcing and data output across all health sectors. |                                                                                                                                            |                                                                                                                                    |                                                                                                                             |
| <b>Strategic Actions and Activities</b>                                                                                                                                                                                                        | <b>Output Indicators</b>                                                                                                                   | <b>Means of Verification</b>                                                                                                       | <b>Assumptions and Risks</b>                                                                                                |
| <b>Strategic Action 1.1. Strengthen genomic sequencing platforms and technologies</b>                                                                                                                                                          |                                                                                                                                            |                                                                                                                                    |                                                                                                                             |
| 1.1.1. Conduct infrastructure needs assessment                                                                                                                                                                                                 | Completion of a comprehensive infrastructure needs assessment report<br>Number of laboratories assessed.                                   | Assessment reports and records of assessed laboratories and their condition.                                                       | Assumption: The availability of accurate data from laboratories and stakeholders.                                           |
| 1.1.2. Develop guidelines for specialized laboratory infrastructure (including NGS)                                                                                                                                                            | Availability of approved guidelines for specialized laboratory infrastructure, including NGS.                                              | Official document containing the approved guidelines and minutes or reports from stakeholder consultation meetings.                | Stakeholders (e.g., lab experts, policymakers) will actively engage in consultations.                                       |
| 1.1.3. Upgrade and or construct laboratories in line with the guidelines (including equipment and accessories)                                                                                                                                 | Number of laboratories successfully upgraded or constructed.<br>Number of new laboratory equipment and accessories procured and installed. | Construction / renovation contracts, completion certificates.<br>Inventory records showing equipment procurement and installation. | Delays due to unforeseen construction challenges or financial constraints leading to incomplete upgrades.                   |
| 1.1.4. Procure reagents and supplies in bulk for genomic sequencing platforms and accessories in support of NGS                                                                                                                                | Quantity of reagents and supplies procured in bulk.<br>Percentage of required reagents and supplies delivered on time.                     | Procurement records and invoices and delivery receipts and supplier contracts.                                                     | Disruptions in the supply chain, delays in deliveries, or shortages of specific reagents could impact laboratory operations |
| 1.1.5. Procure service and maintenance contracts                                                                                                                                                                                               | Percentage of equipment covered under maintenance agreements.                                                                              | Signed service contracts or agreements and maintenance logs and service reports.                                                   | Potential delays or issues with contract negotiations could result in gaps in maintenance coverage.                         |

|                                                                                                                                                                            |                                                                                                    |                                                                                                                                                                                             |                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.1.6. Build local capacity for service and maintenance of equipment and accessories (conduct mapping of biomedical engineers specialized in genomic sequencing equipment) | Number of biomedical engineers trained and mapped.                                                 | Training attendance records and certificates.                                                                                                                                               | Difficulty in attracting skilled professionals or low participation in training programs may limit local capacity building.                                                                              |
| 1.1.7. Establish an integrated system for equipment service through the ZGSC                                                                                               | Number of equipment service requests processed through the system.                                 | System documentation and implementation reports and service logs and tracking reports.                                                                                                      | ZGSC will have the necessary infrastructure and support to implement the system.                                                                                                                         |
| 1.1.8. Setup servers at each sequencing laboratory and a central server at ZNPHI for backup                                                                                | Number of servers set up at sequencing laboratories and at the ZNPHI central location.             | Installation and configuration reports for each server and data backup logs and test results.                                                                                               | Sufficient information technology infrastructure and resources will be available for server setup.                                                                                                       |
| 1.1.9. Establish equipment calibration and maintenance program                                                                                                             | Percentage of equipment successfully calibrated within the scheduled time.                         | Calibration records and maintenance logs.                                                                                                                                                   | Necessary resources for calibration and maintenance (e.g., calibration tools, technical expertise) will be available.                                                                                    |
| 1.1.10. Advocate for domestic funding to reduce on over-dependence on donors                                                                                               | Number of meetings or advocacy events held with government stakeholders to secure funding.         | Records of meetings and advocacy efforts.                                                                                                                                                   | Government and local stakeholders will be receptive to funding advocacy efforts.                                                                                                                         |
| <b>Strategic Action 1.2. Distribute resources equitably</b>                                                                                                                |                                                                                                    |                                                                                                                                                                                             |                                                                                                                                                                                                          |
| 1.2.1. Conduct needs assessments in sequencing laboratories                                                                                                                | Needs assessment conducted                                                                         | Needs assessment reports                                                                                                                                                                    | Genomic sequencing capacity and implementation is at different levels across laboratories. Participating laboratories are willing to be objectively assessed and subsequently supported to address gaps. |
| 1.2.2. Hold stakeholder engagement meetings                                                                                                                                | Number of stakeholder engagement meetings held                                                     | Meeting reports                                                                                                                                                                             | There is limited involvement of stakeholders in genomic surveillance.                                                                                                                                    |
| 1.2.3. Hold meetings for resource mobilization through grants applications                                                                                                 | Number of grant proposals to support genomic sequencing submitted                                  | Grant applications and budget allocation                                                                                                                                                    | There is inadequate funding support for genomic sequencing.                                                                                                                                              |
| 1.2.4. Engage suppliers to establish agreements for purchase of reagents and consumables                                                                                   | Number of suppliers engaged and agreements signed for the procurement of reagents and consumables. | Signed supplier agreements and contracts, procurement records and invoices detailing reagent and consumable orders and delivery receipts confirming the supply of reagents and consumables. | The suppliers will deliver reagents and consumables according to the agreed-upon specifications and timeline.                                                                                            |
| 1.2.5. Develop the resource allocation plan                                                                                                                                | Resource allocation plan developed                                                                 | Approved resource allocation plan                                                                                                                                                           | There are strong partnerships with health organizations and government agencies.                                                                                                                         |

**Strategic Action 1.3. Advocate for the value of genomic surveillance with policy makers**

|                                                                                                                 |                                                                                           |                                                                                                         |                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.3.1. Stakeholder engagement with policy makers and partners                                                   | Number of meetings held with policy makers and partners                                   | Meeting reports                                                                                         | Engagement efforts will influence policy development, implementation, or adaptation to support genomic sequencing initiatives and address barriers.                                                                               |
| 1.3.2. Stakeholder engagement with policymakers and partners focused on import permit waivers, i.e., ZAMRA, ZRA | Number of meetings or discussions held with policymakers and partners (e.g., ZAMRA, ZRA). | Meeting minutes or reports documenting the engagement with ZAMRA, ZRA, and other stakeholders.          | Policymakers and relevant authorities (e.g., ZAMRA, ZRA) will be receptive to the engagement and open to facilitating import permit waivers and stakeholders will cooperate and provide timely responses to requests for waivers. |
|                                                                                                                 | Number of import permit waiver requests submitted and approved.                           | Records of waiver requests and approval notifications from relevant authorities.                        |                                                                                                                                                                                                                                   |
|                                                                                                                 | Percentage of import permit waivers successfully processed within the required timeframe. | Correspondence or official communication confirming the successful processing of import permit waivers. |                                                                                                                                                                                                                                   |
| 1.3.3. Disseminate genomic sequencing results at annual conferences                                             | Number of conferences where genomics sequencing results have been disseminated            | Conference reports                                                                                      | Appropriate data are generated for publication and resources are available to support participation in conferences and meetings                                                                                                   |
| 1.3.4. Use multimedia platforms to disseminate information                                                      | Online genomics resource centers developed                                                | Genomics-based websites and media platforms                                                             | Appropriately skilled data curators, and supporting technology available                                                                                                                                                          |

**Outcome 3. Ensure continued genomic surveillance workforce development and retention.**

| Strategic Actions and Activities                                                                    | Output Indicators                                                                                                                            | Means of Verification                                                             | Assumptions and Risks                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.1.1. Conduct training in genomic sequencing and bioinformatics                                    | Number of personnel trained in genomics sequencing and bioinformatics                                                                        | Training reports                                                                  | With the scale up of genomics and bioinformatics, there are inadequate skills in genomics and bioinformatics.                                                                                                     |
| 2.1.2. Conduct training in bioinformatics                                                           | Number of personnel trained in bioinformatics                                                                                                | Training reports                                                                  | There will be sufficient qualified trainers and resources to conduct high-quality bioinformatics training and participants will have the necessary background and readiness to engage in bioinformatics training. |
|                                                                                                     | Percentage of trained individuals who demonstrate competence (e.g., via assessments or practical application).                               | Results of post-training assessments, feedback surveys, or practical evaluations. |                                                                                                                                                                                                                   |
| 2.1.3. Mainstream genomics and bioinformatics in the curriculum of academic institutions            | Proportion of academic institutions that have integrated genomics in their curriculum                                                        | Approved curriculum, training reports                                             | There are sufficient numbers of training experts available, sufficient training slots available, and facilitators and students are committed.                                                                     |
| 2.1.4. Conduct technical assistance and twinning programs in genomics sequencing and bioinformatics | Number of participants capacitated in genomics sequencing and bioinformatics through technical assistance, fellowships and twinning programs | Activity reports, training reports                                                | Capacity building aligns with current and future needs in genomics sequencing and bioinformatics.                                                                                                                 |

**Strategic Action 2.2. Strengthen communities of practice and knowledge exchange**

|                                                                                     |                                                    |                                 |                                                                                                |
|-------------------------------------------------------------------------------------|----------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------|
| 2.2.1. Support collaborative research and use cases for genomics and bioinformatics | Number of publications and policy briefs generated | Publications and policy reviews | Genomics and bioinformatics have a wide range of application across sectors.                   |
| 2.2.2. Establish a community of practice for genomics and bioinformatics            | Community of practice established                  | Activity reports                | There is willingness to share information and active participation of communities of practice. |

**Strategic Action 2.3. Implement external quality assessment programs**

|                                                                                  |                                                                              |                                                                                             |                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.3.1. Develop a quality assessment framework                                    | Availability of the quality assessment framework                             | Finalized and signed off framework document                                                 | There is funding available for stakeholder meetings to develop the framework, and print and distribute it.                                                                                                                                         |
| 2.3.2. Develop and implement audits and assessment plans                         | Proportion of scheduled audits and assessments conducted                     | Audit and assessment reports                                                                | Auditors and appropriate standardized audit/assessment tools available                                                                                                                                                                             |
| 2.3.3. Enroll laboratories into proficiency testing programs                     | Number of laboratories enrolled into proficiency testing programs            | EQA performance reports                                                                     | Laboratories have the necessary equipment, expertise, and personnel to perform genomic and sequencing tests effectively.                                                                                                                           |
|                                                                                  | Number of laboratories participating in the proficiency testing program      | EQA performance reports                                                                     |                                                                                                                                                                                                                                                    |
| 2.3.4. Develop quality management systems (QMS) to evaluate and monitor supplies | Completion of a QMS document for supplies evaluation and monitoring.         | Finalized and approved QMS documentation outlining the evaluation and monitoring processes. | Adequate resources (personnel, technology, and expertise) will be available to develop and implement the QMS and suppliers will cooperate with the monitoring and evaluation processes and provide required documentation for quality assessments. |
|                                                                                  | Number of supply chains or suppliers integrated into the QMS for monitoring. | Reports showing the results of evaluations conducted on supplies.                           |                                                                                                                                                                                                                                                    |
|                                                                                  | Percentage of supplies evaluated and monitored under the new system.         | Supplier performance reports or audits demonstrating adherence to the QMS.                  |                                                                                                                                                                                                                                                    |
| 2.3.5. Develop remediation plans                                                 | Availability of remediation plans                                            | Finalized and signed off remediation plans                                                  | Stakeholders are committed to continuous Improvement.                                                                                                                                                                                              |

**Strategic Action 2.4. Establish capacity building and retention programs for workforce**

|                                                                   |                                                   |                                                                                |                                                                                                                        |
|-------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 2.4.1. Develop retention strategies                               | Availability of staff retention strategies        | Finalized and approved document on retention strategies                        | There is high attrition of staff within the health sector.                                                             |
|                                                                   | Number of staff retained                          | Human resource records                                                         |                                                                                                                        |
| 2.4.2. Establish capacity building initiatives                    | Number of capacity building initiatives available | Finalized and approved document on institutional capacity building initiatives | There is no or only limited capacity for development initiatives.                                                      |
|                                                                   | Number of people capacitated                      | Training database                                                              | There is staff commitment to build skills in genomics sequencing.                                                      |
| 2.4.3. Develop scholarships and fellowships for staff development | Number of scholarships and fellowships sourced    | Training Records                                                               | There is a need for professional development among staff members to enhance their skills, knowledge, and capabilities. |

**Outcome 3.** Establish an overarching data governance for data quality, sharing, utilization, protection, and storage.

| Strategic Actions and Activities                                                                                    | Output Indicators                                            | Means of Verification                              | Assumptions and Risks                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Strategic Action 3.1. Harmonize data and metadata standards</b>                                                  |                                                              |                                                    |                                                                                                                                                                                                               |
| 3.1.1. Develop national guidelines for data and metadata                                                            | Availability of national guidelines for data and metadata    | Approved national guidelines for data and metadata | There are no or only a limited number of policies and guidelines for data and metadata.                                                                                                                       |
| 3.1.2. Develop standardized data and metadata protocols                                                             | Number of standardized data and metadata protocols available | Approved standardized data and metadata protocols  | There is a need for standardization of data and metadata to ensure consistency, interoperability, and quality across the organization.                                                                        |
| 3.1.3. Conduct training workshops on data standardization                                                           | Number of training workshops on data standardization held    | Training database, Activity reports                | There is limited knowledge across partners on in-country capacity for data standardization.                                                                                                                   |
| 3.1.4. Implement a centralized data management system                                                               | Availability of a centralized data management system         | Activity reports                                   | The system is scalable to handle the increasing volume of data and user access over time and systems are interoperable.                                                                                       |
| 3.1.5. Conduct regular audits of data and metadata to ensure compliance with established standards                  | Number of scheduled audits conducted                         | Audit reports                                      | A robust data governance framework is in place, outlining policies, procedures, and responsibilities for data management and compliance.                                                                      |
| <b>Strategic Action 3.2. Establish data sharing agreements and access principles</b>                                |                                                              |                                                    |                                                                                                                                                                                                               |
| 3.2.1. Development of MOUs and MoAs                                                                                 | Number of MOUs and MOAs developed                            | Collaborative MOUs and MOAs approved               | There is willingness of stakeholders to share information, and stakeholders involved in the data sharing arrangement, support or are informed about the agreement.                                            |
| 3.2.2. Adopt data sharing and access principles based on the Data Protection Act No.3 of 2021 of the laws of Zambia | Availability of data sharing and access principles           | Program reports                                    | Regular audits and assessments are conducted to ensure ongoing compliance with the Data Protection Act and continuous improvement of data sharing practices.                                                  |
| 3.2.3. Develop genomic data sharing and access plan                                                                 | Availability of data sharing and access plan                 | Approved data sharing and access plan developed    | A comprehensive governance framework is established, including policies, procedures, and guidelines for genomic data sharing and access, addressing issues such as data access, privacy, and confidentiality. |

**Strategic Action 3.3. Harmonize norms, standards, benchmarks, and reference materials in the sequencing laboratories**

|                                                                         |                                                                                                                                                                                                |                            |                                                                                                                                                                         |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.1. Harmonize SOPs across ge-nomic sequencing laboratories           | Availability of SOPs                                                                                                                                                                           | Signed off SOPs            | SOPs are developed through a systematic process involving input from stakeholders, including laboratory, quality assurance, and management staff.                       |
| 3.3.2. Adopt standardized testing procedures results                    | Proportion of laboratories using standardized methods during testing procedures of similar pathogens<br>Proportion of laboratories meeting a mini-mum data quality scores for all test results | Audit reports              | There is a robust quality management system in place that supports the implementation and adherence to standardized testing procedures.                                 |
| 3.3.3. Create a standard benchmark level for each sequencing laboratory | Proportion of laboratories participating in EQA<br>EQA program inter- and intra-laboratory comparison scores                                                                                   | EQA reports<br>EQA reports | Laboratories have established quality control measures in place to validate and verify sequencing data, ensuring accuracy, reproducibility, and reliability of results. |

**Strategic Action 3.4. Make use of genomics in routine surveillance practice**

|                                                                                 |                                                                                              |                    |                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.4.1. Conduct TSS to strengthen laboratory capacity in genomic se-quencing     | Turnaround times (i.e., the time taken from sample receipt to the completion of se-quencing) | Laboratory records | There is limited capacity to support ge-nomic sequencing.                                                                                                                                                                     |
| 3.4.2. Conduct genomic surveillance awareness trainings                         | Number of planned trainings conducted                                                        | Training database  | Stakeholders recognize the potential bene-fits of genomic surveillance, including early detection of outbreaks, monitoring of dis-ease trends, identification of novel vari-ants, and informing public health interven-tions. |
| 3.4.3. Conduct surveys on acceptabil-ity of genomic surveillance with end users | Number of acceptability surveys conducted                                                    | Survey reports     | End users have a sufficient level of aware-ness and understanding of genomic sur-veillance and its implications.                                                                                                              |

**Outcome 4. Strengthen partnerships and systems to promote uptake and broader surveillance applications.**

| Strategic Actions and Activities                                                            | Output Indicators                                                                                                     | Means of Verifica-tion         | Assumptions and Risks                                                                                    |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Strategic Action 4.1. Strengthen specimen handling, referral and information sharing</b> |                                                                                                                       |                                |                                                                                                          |
| 4.1.1. Conduct specimen collection from sentinel or healthcare facilities                   | Percentage of sentinel sites or healthcare facilities routinely collecting relevant speci-mens for genomic sequencing | Laboratory infor-mation system | Health facilities and sentinel sites will comply with and cooperate in the speci-men collection process. |

|                                                                                                            |                                                                                                                          |                                                                                     |                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1.2. Monitor the quality of specimens collected                                                          | Proportion of specimens that meet quality standards for generating reliable genomic data                                 | Laboratory records                                                                  | Standardized protocols for specimen collection are being followed by all personnel to ensure consistency and minimize variability.                                                        |
|                                                                                                            | Proportion of samples that had appropriate storage temperatures at delivery                                              | Laboratory records                                                                  |                                                                                                                                                                                           |
|                                                                                                            | Proportion of samples delivered to the laboratory within the required time frame for testing                             | Laboratory records                                                                  |                                                                                                                                                                                           |
| 4.1.3. Conduct data completeness audits for specimen referral                                              | Percentage of specimens with complete associated clinical and epidemiological data.                                      | Data quality reports                                                                | Existing data governance policies and practices are assumed to be followed, ensuring that data management standards are in place and adhered to.                                          |
| 4.1.4. Develop or utilize existing digital platforms for sharing data and results                          | Proportion of sequenced data shared with ZGSC members and stakeholders compared to total generated data.                 | Laboratory reports                                                                  | The platform can scale to accommodate growing amounts of data and an increasing number of users without compromising performance.                                                         |
|                                                                                                            | Proportion of laboratories sharing sequenced data and results to designated repositories within 7 days after sequencing. | Laboratory information system                                                       |                                                                                                                                                                                           |
| 4.1.5. Conduct trainings in sample management                                                              | Number of training sessions conducted on sample management.                                                              | Training attendance sheets and registration records.                                | Training participants will be available and committed to attending the sessions and adequate training materials and qualified trainers will be accessible for conducting the sessions.    |
|                                                                                                            | Number of staff trained in sample management practices.                                                                  | Training materials (e.g., presentations, handouts).                                 |                                                                                                                                                                                           |
|                                                                                                            | Percentage of participants who pass post-training assessments (if applicable).                                           | Post-training assessment results or feedback surveys.                               |                                                                                                                                                                                           |
| 4.1.6. Procure additional sample packaging equipment                                                       | Number of additional sample packaging equipment units procured.                                                          | Procurement contracts, invoices, and delivery receipts for the packaging equipment. | The required packaging equipment will be available from reliable suppliers within the budget and timeline and the equipment will meet quality standards and be suitable for intended use. |
| 4.1.7. Establish specimen exchange programs that facilitate the exchange of specimens between institutions | Proportion of institutions actively involved in the exchange program                                                     | Program reports                                                                     | Laboratories are committed to participating in the exchange program and have the necessary resources.                                                                                     |

| Strategic Action 4.2. Increase network linkages at local, regional, and global levels                                                                                                                                              |                                                                                     |                                                  |                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.2.1. Participate in online network-ing platforms and forums to con-nect, share information, and collab-orate.                                                                                                                    | Number of participants actively contributing to discussions and sharing information | Program reports                                  | There is a collaborative environment where participants are open to sharing insights, providing feedback, and working together to solve complex genomic problems.                                                                                                                                            |
| 4.2.2. Initiate collaborative projects, such as symposiums, that involve partners from different regions and countries                                                                                                             | Number of collaborative projects initiated                                          | Project / meeting re-ports                       | There is effective project management and coordination mechanisms in place to man-age tasks, timelines, and deliverables.<br><br>There are plans in place to ensure the sus-tainability and continuity of the project be-yond initial phases, including long-term goals and potential future collaborations. |
| 4.2.3. Hold in-country stakeholder meetings                                                                                                                                                                                        | Number of in-country stakeholder meeting held                                       | Meeting reports                                  | There is representative participation by the different sectors.                                                                                                                                                                                                                                              |
| 4.2.4. Form partnerships with local and regional organizations, including exchange visits                                                                                                                                          | Number of partnerships formed with regional organizations                           | Membership certifi-cates, MOUs                   | There is support from key stakeholders within organizations for the partnership, including leadership and staff.                                                                                                                                                                                             |
|                                                                                                                                                                                                                                    | Number of partnerships formed with local organizations                              | Membership certifi-cate, MOUs                    |                                                                                                                                                                                                                                                                                                              |
| Strategic Action 4.3. Strengthen networks in routine, epidemic, and pandemic contexts                                                                                                                                              |                                                                                     |                                                  |                                                                                                                                                                                                                                                                                                              |
| 4.3.1. Promote the establishment of bioinformatics and genomic se-quencing networks                                                                                                                                                | Number of networks established                                                      | Reports from net-works / communities of practice | There is a recognized interest and need within the scientific community for such networks to facilitate collaboration and advance research in bioinformatics and genomic sequencing.                                                                                                                         |
| 4.3.2. Conduct simulation exercises and drills                                                                                                                                                                                     | Number of simulation exercises and drills conducted                                 | Simulation exercise and drills reports           | There is commitment to public health pre-paredness, with a focus on testing and refining response plans, protocols, and coordination mechanisms.                                                                                                                                                             |
| Outcome 5. Strengthen and sustain national public health emergency management to effectively respond to public health threats through preparation, collaboration, rapid response, and risk communication and community engagement. |                                                                                     |                                                  |                                                                                                                                                                                                                                                                                                              |
| Strategic Actions and Activities                                                                                                                                                                                                   | Output Indicators                                                                   | Means of Verifica-tion                           | Assumptions and Risks                                                                                                                                                                                                                                                                                        |
| Strategic Action 5.1. Establish a taskforce to respond to public health emergencies                                                                                                                                                |                                                                                     |                                                  |                                                                                                                                                                                                                                                                                                              |
| 5.1.1. Develop the response plan                                                                                                                                                                                                   | Availability of the rapid response plan                                             | Response plan                                    | All expertise responds to outbreaks in a coordinated way.                                                                                                                                                                                                                                                    |

**Strategic Action 5.2. Timely resource mobilization and deployment**

|                                                            |                                                                                 |                              |                                                                                                                             |
|------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 5.2.1. Development of harmonized budgets                   | Availability of harmonized budgets                                              | Approved budget              | Stakeholders are willing to share budgets to address emerging threats.                                                      |
| 5.2.2. Conduct joint planning meetings                     | Number of planning meetings held                                                | Meeting reports              | There is buy-in and general agreement among stakeholders to harmonize actions, leverage resources and foster collaboration. |
| 5.2.3. Conduct joint grant applications                    | Number of applications submitted                                                | Submitted grant applications | There is limited funding to support emerging health threats.                                                                |
| 5.2.4. Engage partners and stakeholders for budget support | Number of partners and stakeholders supporting the genomic surveillance program | Approved budget              | Stakeholders recognize the need to support emerging health threats.                                                         |

**Strategic Action 5.3. Capacity building for local production**

|                                                                                                                                                            |                                                                                                               |                                                                                                  |                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.3.1. Establish and strengthen regional laboratory capacity for the local production of genomic reagents and consumables                                  | Number of sites established and equipped to support local production of genomic reagents and consumables      | Program reports                                                                                  | There is expertise and funding available to support the initial setup and ongoing operations of the regional laboratories.                                                                                             |
| 5.3.2. Conduct needs assessment of production systems / capacity and market assessment for product demand                                                  | Completion of a comprehensive needs assessment report on production systems and capacity.                     | Finalized reports on the needs assessment and market demand analysis.                            | Relevant stakeholders will provide accurate and timely data during the assessment process.                                                                                                                             |
| 5.3.3. Enhance scope of ZAMRA's monitoring of good manufacturing practices (GMP) to include consumables and reagents used in molecular biology             | Number of consumables and reagents assessed under the new GMP monitoring scope.                               | Inspection and audit reports detailing the evaluation of consumables and reagents.               | ZAMRA will have the necessary resources (staff, training, equipment) to expand their GMP monitoring activities effectively and suppliers will cooperate with the enhanced monitoring and comply with GMP requirements. |
|                                                                                                                                                            | Expanded scope of ZAMRA's monitoring framework to include consumables and reagents used in molecular biology. | Revised GMP monitoring framework or guidelines with clear inclusion of consumables and reagents. |                                                                                                                                                                                                                        |
| 5.3.4. Advocate for capacity building for local entrepreneurs in design and production of genomic reagents and consumables through stakeholder engagements | Number of capacity building meetings held                                                                     | Program reports                                                                                  | There is sufficient local expertise or the ability to train personnel in genomic research and production techniques.                                                                                                   |

**Strategic Action 5.4. Test the surge and stretch of genomic surveillance systems**

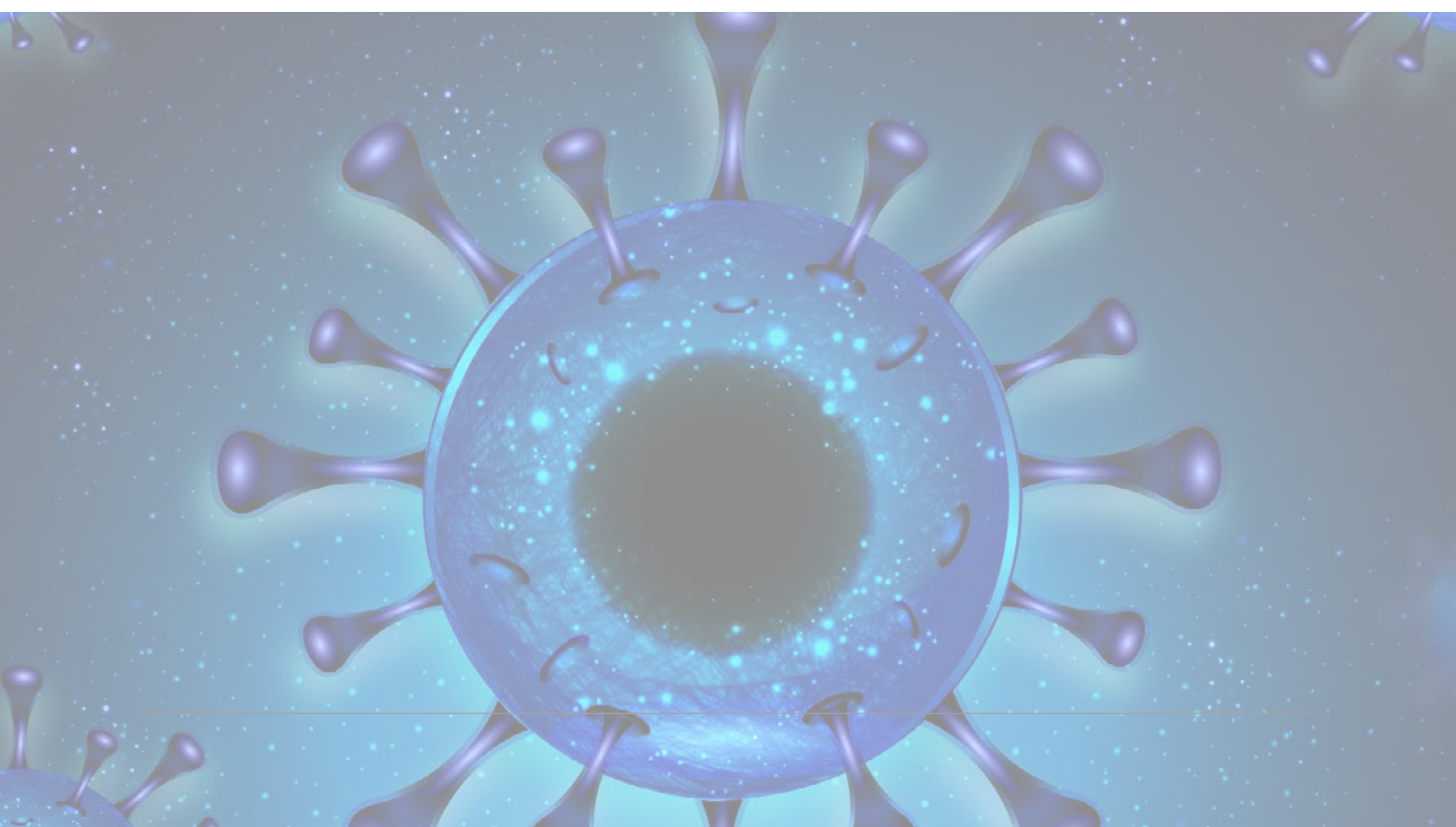
|                                                                                                       |                                                       |                    |                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.4.1. Develop capacity for monitoring and evaluation of the implemented genomic surveillance systems | Number of evaluations conducted and reports generated | Evaluation reports | There is active engagement and collaboration with stakeholders including public health agencies, researchers, and policy-makers to define evaluation metrics and goals. |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Strategic Action 5.5. Establish or sustain projects to maintain capacities**

|                                                                                                                         |                                                                                   |                    |                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.5.1. Integrate genomic surveillance program into existing systems                                                     | Integrate genomic surveillance program into existing national programs or systems | Program reports    | There is effective collaboration among stakeholders from different disciplines and sectors (e.g., health, research, policy) to coordinate efforts and maximize the impact of the genomic surveillance program. |
| 5.5.2. Develop diversified and sustainable funding strategies to support the program                                    | Percentage of total budget from different sources                                 | Approved budget    | There sustained commitment from stakeholders, including government agencies, healthcare providers, and research institutions, to prioritize genomic surveillance as a critical public health initiative        |
| 5.5.3. Regularly evaluate the effectiveness of the project in maintaining and utilizing genomic surveillance indicators | Number of evaluations conducted                                                   | Evaluation reports | Genomic surveillance findings are used to inform decision-making processes, such as public health interventions, policy development, or research priorities.                                                   |

**Strategic Action 5.6. Implement inter- or after-action reviews to strengthen practices**

|                                          |                                             |                 |                                                                                                                                                             |
|------------------------------------------|---------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.6.1. Hold inter-action review meetings | Number of inter-action review meetings held | Meeting reports | Action items, responsibilities, and timelines are clearly defined and agreed upon during the meeting, with follow-up mechanisms in place to track progress. |
| 5.6.2. Hold after-action review meetings | Number of after-action review meetings held | Meeting reports |                                                                                                                                                             |





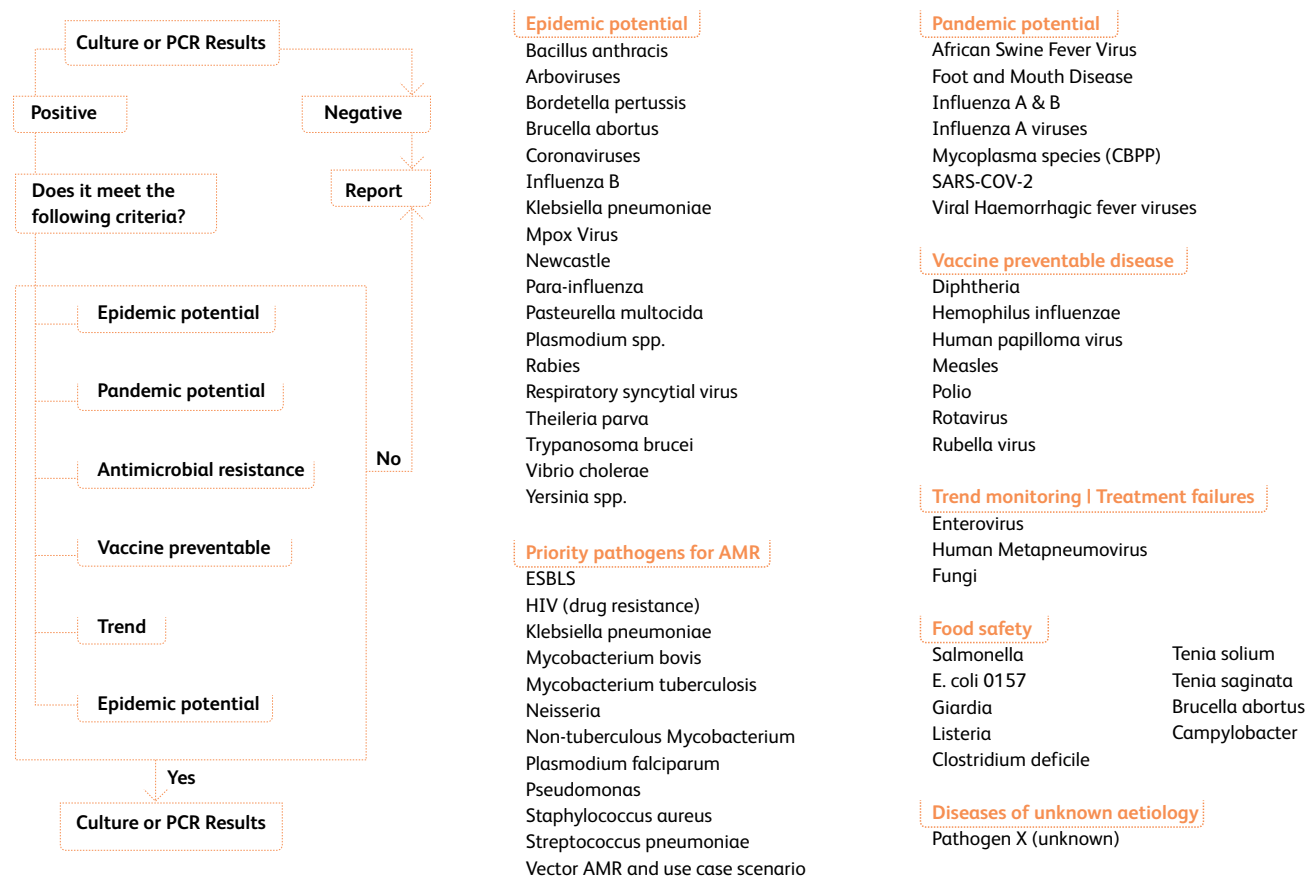
# ANNEXES



## Annex 1: Algorithm for sample selection for genomic sequencing

For ease of addressing pathogens for genomic sequencing, priority pathogens have been grouped into seven categories. These are: Epidemic potential, Pandemic potential, Priority pathogens for AMR, Vaccine-preventable disease, Trend monitoring/Treatment failures, Food safety, and Diseases of unknown

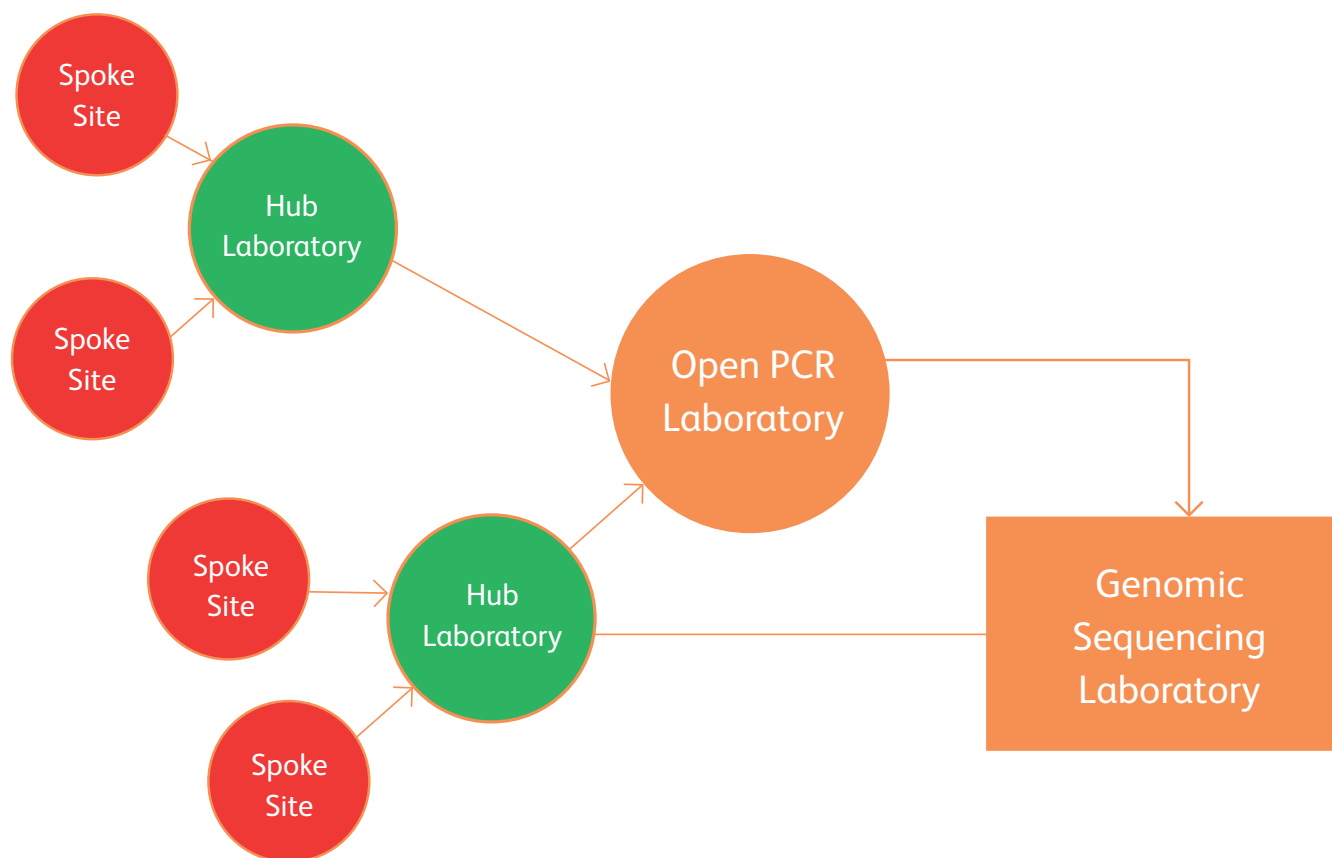
etiology. These pathogens have subsequently been distributed among the sequencing laboratories based on geographic location, institutional goals / priorities, and sequencing capability (infrastructure, instrument, etc).



## Annex 2: Algorithm for Sample flow

Samples for genomic sequencing will be obtained as outlined in the National Multi-Pathogen Diagnostics Program (NMPDP). This states that spoke sites will collect samples and ship them to hub laboratories for microbiology testing and/

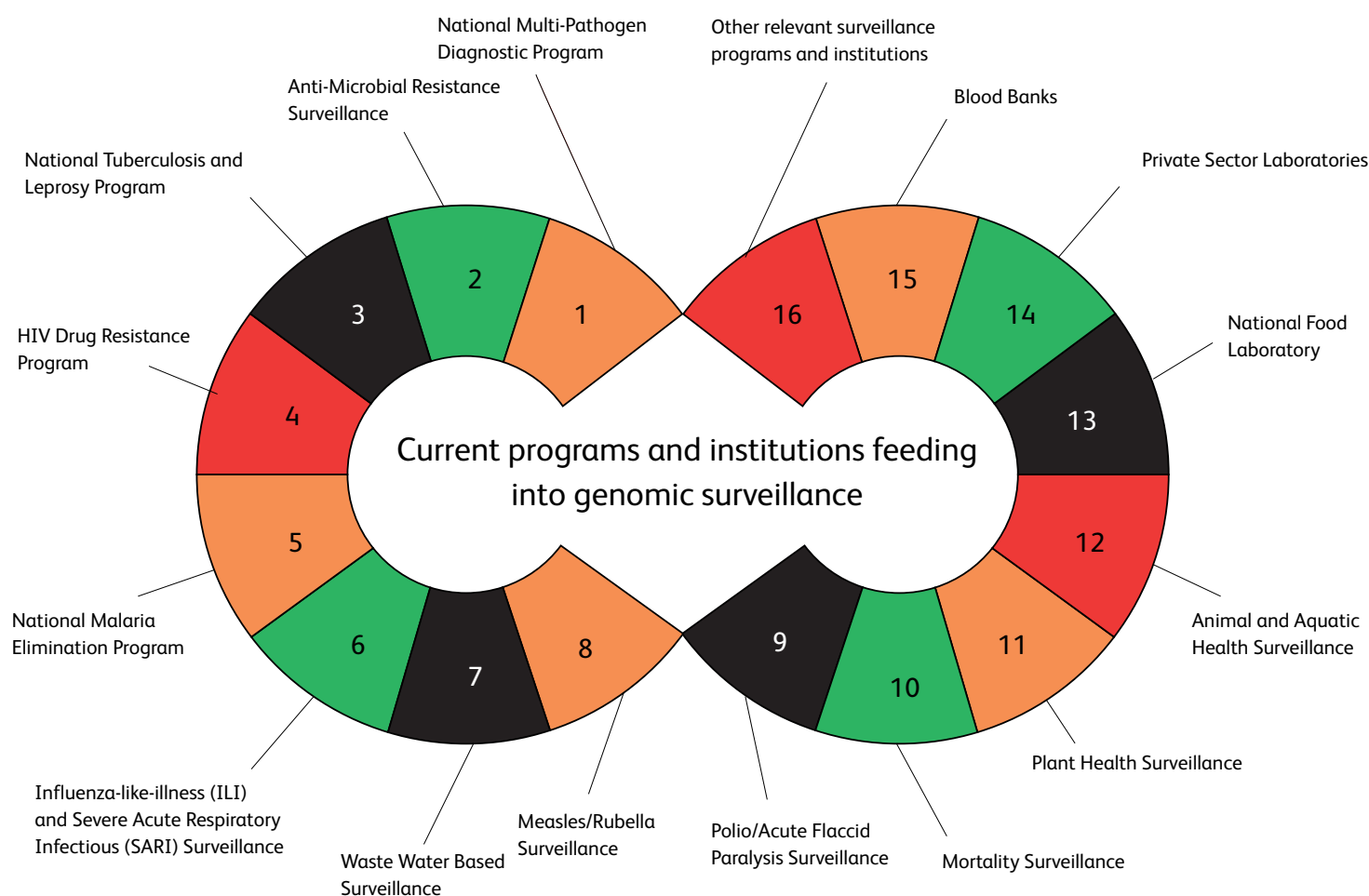
or onward transmission to open PCR laboratories. Open PCR Laboratories will conduct molecular testing and ship to genomic sequencing laboratories.



## Annex 3: List of Institutions with Genomic Sequencing Capacity

1. Zambia National Public Health Reference Laboratory (ZNPHRL)
2. Act of Parliament as National Health Research and Training Institute (NHRTI)
3. University Teaching Hospital Virology Laboratory (UTHVL)
4. Churches Health Association of Zambia (CHAZ)
5. University of Zambia School of Veterinary Medicine (UNZA SVM)
6. Macha Research Trust (MRT)
7. Central Veterinary Research Institute (CVRI)
8. Center for Infectious Diseases Research in Zambia (CIDRZ)
9. Zambia AIDS Related Tuberculosis (ZAMBART) Project

## Annex 4: Programs and Institutions feeding into the National Genomic Surveillance System



## Annex 5: Implementation Plan

The plan covers the activities that will be implemented for the period of five years.

| <b>Objective 1.</b> Acquire improved genomic sequencing platforms and technologies, and ensure access to resources, to increase the geographic representation of genomic surveillance sample sourcing and data output across all health sectors. |                                                                                                                                                                            |      |            |            |            |             |              |                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------------|------------|-------------|--------------|----------------|
| Strategic Action                                                                                                                                                                                                                                 | Activities                                                                                                                                                                 | Lead | 2025       | 2026       | 2027       | 2028        | 2029         | Total cost ZMW |
| 1.1. Strengthen genomic sequencing platforms and technologies                                                                                                                                                                                    | 1.1.1. Conduct infrastructure needs assessment                                                                                                                             | ZGSC | 180,000    |            | 120,000    |             |              | 300,000        |
|                                                                                                                                                                                                                                                  | 1.1.2. Develop guidelines for specialized laboratory infrastructure (including NGS)                                                                                        | ZGSC | 2,592,000  |            |            |             |              |                |
|                                                                                                                                                                                                                                                  | 1.1.3. Upgrade and or construct laboratories in line with the guidelines (including equipment and accessories)                                                             | ZGSC | 13,000,000 | 13,000,000 | 13,000,000 | 13,000,000  |              | 52,000,000     |
|                                                                                                                                                                                                                                                  | 1.1.4. Procure reagents and supplies in bulk for genomic sequencing platforms and accessories in support of NGS                                                            | ZGSC | 4,036,800  | 4,440,480  | 4,884,528  | 5,372,980.8 | 5,910,279.08 | 24,645,067.88  |
|                                                                                                                                                                                                                                                  | 1.1.5. Procure service and maintenance contracts                                                                                                                           | ZGSC | 275,000    | 275,000    | 275,000    | 275,000     | 275,000.00   | 1,375,000      |
|                                                                                                                                                                                                                                                  | 1.1.6. Build local capacity for service and maintenance of equipment and accessories (conduct mapping of biomedical engineers specialized in genomic sequencing equipment) | ZGSC | 20,000     |            |            | 20,000.00   |              | 40,000         |
|                                                                                                                                                                                                                                                  | 1.1.7. Establish an integrated system for equipment service through the ZGSC                                                                                               | ZGSC | 598,000    | 50,000     | 50,000     | 50,000      | 50,000       | 798,000        |
|                                                                                                                                                                                                                                                  | 1.1.8. Setup servers at each sequencing laboratory and a central server at ZNPHI for backup                                                                                | ZGSC | 4,800,000  | 5,100,000  | 5,100,000  | 5,100,000   | 600,000      | 20,700,000     |
|                                                                                                                                                                                                                                                  | 1.1.9. Establish equipment calibration and maintenance program                                                                                                             | ZGSC | 1,000,000  | 1,000,000  | 1,000,000  | 1,000,000   | 1,000,000    | 5,000,000      |
|                                                                                                                                                                                                                                                  | 1.1.10. Advocate for domestic funding to reduce on over-dependence on donors                                                                                               | ZGSC | 100,000    |            |            |             |              | 100,000.00     |

| Strategic Action                                                                               | Activities                                                                                                       | Lead | 2025       | 2026       | 2027       | 2028       | 2029       | Total cost ZMW |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|------|------------|------------|------------|------------|------------|----------------|
| 1.2. Distribute resources equitably                                                            | 1.2.1. Conduct needs assessments in sequencing laboratories                                                      | ZGSC | 180,000    |            |            |            |            | 180,000        |
|                                                                                                | 1.2.2. Hold stakeholders engagement meetings                                                                     | ZGSC | 598,000    | 598,000    | 598,000    | 598,000    | 598,000    | 2,990,000      |
|                                                                                                | 1.2.3. Hold meetings for resource mobilization through grant applications.                                       | ZGSC | 180,000    |            | 180,000    |            | 180,000    | 540,000        |
|                                                                                                | 1.2.4. Engage suppliers to establish agreements for purchase of reagents and consumables                         | ZGSC | 200,000    |            |            |            |            | 200,000        |
|                                                                                                | 1.2.5. Develop the resource allocation plan                                                                      | ZGSC | 180,000    |            |            |            |            | 180,000        |
| Strategic Action                                                                               | Activities                                                                                                       | Lead | 2025       | 2026       | 2027       | 2028       | 2029       | Total cost ZMW |
| 1.3. Advocate for the value of genomic surveillance with policy makers                         | 1.3.1. Stakeholders engagement with policy makers and partners                                                   | ZGSC |            | 180,000.00 |            | 180,000.00 |            | 360,000.00     |
|                                                                                                | 1.3.2. Stakeholders engagement with policy makers and partners focused on import permit waiver, i.e., ZAMRA, ZRA | ZGSC | 110,000.00 |            |            |            |            | 110,000.00     |
|                                                                                                | 1.3.3. Disseminate genomic sequencing result at annual conference                                                | ZGSC | 598,000.00 | 598,000.00 | 598,000.00 | 598,000.00 | 598,000.00 | 2,990,000.00   |
|                                                                                                | 1.3.4. Use multimedia platforms to disseminate information                                                       | ZGSC | 60,000.00  | 60,000.00  | 60,000.00  | 60,000.00  | 60,000.00  | 300,000.00     |
| <b>Sub-Total</b>                                                                               |                                                                                                                  |      |            |            |            |            |            |                |
| <b>Objective 2.</b> Ensure continued genomic surveillance workforce development and retention. |                                                                                                                  |      |            |            |            |            |            |                |
| Strategic Action                                                                               | Activities                                                                                                       | Lead | 2025       | 2026       | 2027       | 2028       | 2029       | Total cost ZMW |
| 2.1. Train workforce in genomics and bioinformatics                                            | 2.1.1. Conduct training in genomic sequencing                                                                    | ZGSC | 372,000.00 | 372,000.00 | 372,000.00 | 372,000.00 | 372,000.00 | 1,860,000.00   |
|                                                                                                | 2.1.2. Conduct training in bioinformatics                                                                        | ZGSC | 372,000.00 | 372,000.00 | 372,000.00 | 372,000.00 | 372,000.00 | 1,860,000.00   |

|                                                                       | 2.1.3. Mainstream genomics and bioinformatics in curriculum of academic institutions                | ZGSC | 598,000.00   |              | 598,000.00   |              |              | 1,196,000.00   |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------|--------------|--------------|--------------|--------------|--------------|----------------|
|                                                                       | 2.1.4. Conduct technical assistance and twinning programs in genomics sequencing and bioinformatics | ZGSC | 288,000.00   | 288,000.00   | 288,000.00   | 288,000.00   | 288,000.00   | 1,440,000.00   |
| Strategic Action                                                      | Activities                                                                                          | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 2.2. Strengthen communities of practice and knowledge exchange        | 2.2.1. Support collaborative research and use cases for genomics and bioinformatics                 | ZGSC | 200,000.00   | 200,000.00   | 200,000.00   | 200,000.00   | 200,000.00   | 1,000,000.00   |
|                                                                       | 2.2.2. Establish a community of practice for genomics and bioinformatics through symposiums         | ZGSC | 500,000.00   | 500,000.00   | 500,000.00   | 500,000.00   | 500,000.00   | 2,500,000.00   |
| Strategic Action                                                      | Activities                                                                                          | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 2.3. Implement external quality assessment programs                   | 2.3.1. Develop a quality assessment framework                                                       | ZGSC | 750,000.00   |              |              |              |              | 750,000.00     |
|                                                                       | 2.3.2. Develop and implement audits and assessments plans                                           | ZGSC | 744,000.00   | 139,000.00   | 139,000.00   | 139,000.00   | 139,000.00   | 1,300,000.00   |
|                                                                       | 2.3.3. Enroll laboratories into proficiency testing programs                                        | ZGSC | 500,000.00   | 500,000.00   | 500,000.00   | 500,000.00   | 500,000.00   | 2,500,000.00   |
|                                                                       | 2.3.4. Develop quality management systems to evaluate and monitor supplies                          | ZGSC | 2,018,400.00 |              | 2,442,264.00 |              | 2,955,139.54 | 7,415,803.54   |
|                                                                       | 2.3.5. Develop remediation plans                                                                    | ZGSC | 140,000.00   |              |              |              |              | 140,000.00     |
| Strategic Action                                                      | Activities                                                                                          | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 2.4. Establish capacity building and retention programs for workforce | 2.4.1. Develop retention strategies                                                                 | ZGSC | 598,000.00   |              |              |              |              | 598,000.00     |
|                                                                       | 2.4.2. Establish capacity building initiatives                                                      | ZGSC | 576,000.00   | 576,000.00   | 576,000.00   | 576,000.00   | 576,000.00   | 2,880,000.00   |
|                                                                       | 2.4.3. Scholarships and fellowships for staff development                                           | ZGSC | 1,200,000.00 | 1,200,000.00 | 1,200,000.00 | 1,200,000.00 | 1,200,000.00 | 6,000,000.00   |

| Sub-Total                                                                                                                     |                                                                                                                           |      |              |              |              |              |              |                |
|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------|--------------|--------------|--------------|--------------|--------------|----------------|
| Objective 3. Establish an overarching data governance to enhance data quality, sharing, utilization, protection, and storage. |                                                                                                                           |      |              |              |              |              |              |                |
| Strategic Action                                                                                                              | Activities                                                                                                                | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 3.1. Harmonize data and metadata standards                                                                                    | 3.1.1. Develop national guidelines for data and metadata                                                                  | ZGSC | 400,000.00   |              | 450,000.00   |              |              | 850,000.00     |
|                                                                                                                               | 3.1.2. Develop standardized data and metadata protocols                                                                   | ZGSC | 500,000.00   |              |              |              |              | 500,000.00     |
|                                                                                                                               | 3.1.3. Conduct training workshops on data standardization                                                                 | ZGSC | 1,200,000.00 | 1,000,000.00 | 1,000,000.00 | 1,000,000.00 | 800,000.00   | 5,000,000.00   |
|                                                                                                                               | 3.1.4. Implement a centralized data management system                                                                     | ZGSC |              |              |              |              |              | -              |
|                                                                                                                               | 3.1.5. Conduct regular audits of data and metadata to ensure compliance with established standards                        | ZGSC | 950,000.00   | 950,000.00   | 950,000.00   | 1,000,000.00 | 1,000,000.00 | 4,850,000.00   |
| Strategic Action                                                                                                              | Activities                                                                                                                | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 3.2. Establish data sharing agreements and access principles                                                                  | 3.2.1. Development of MOUs and MOAs                                                                                       | ZGSC | 150,000.00   |              |              |              |              | 150,000.00     |
|                                                                                                                               | 3.2.2. Adoption of data sharing and access principles based on the Data Protection Act No.3 of 2021 of the laws of Zambia | ZGSC | 250,000.00   |              |              |              |              | 250,000.00     |
|                                                                                                                               | 3.2.3. Development of genomic data sharing and access plan                                                                | ZGSC | 650,000.00   |              |              |              |              | 650,000.00     |
| Strategic Action                                                                                                              | Activities                                                                                                                | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 3.3. Harmonize norms, standards, benchmarks and reference matters in the sequencing laboratories                              | 3.3.1. Develop standardized SOPs for genomic sequencing laboratories                                                      | ZGSC | 250,000.00   |              |              |              |              | 250,000.00     |
|                                                                                                                               | 3.3.2. Adoption of standardized testing procedures results                                                                | ZGSC | 300,000.00   |              |              |              |              | 300,000.00     |
|                                                                                                                               | 3.3.3. Create a standard benchmark level for each sequencing laboratory                                                   | ZGSC | 350,000.00   |              |              |              |              | 350,000.00     |

| Strategic Action                                                                                               | Activities                                                                                                   |      | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------|--------------|--------------|--------------|--------------|--------------|----------------------|
| 3.4. Make use of genomics in routine surveillance practice                                                     | 3.4.1. Conduct TSS to strengthen laboratory capacity in genomic sequencing                                   | ZGSC | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 4,000,000.00         |
|                                                                                                                | 3.4.2. Conduct genomic surveillance awareness trainings                                                      | ZGSC |              | 400,000.00   |              | 500,000.00   |              | 900,000.00           |
|                                                                                                                | 3.4.3. Conduct surveys on acceptability of genomic surveillance with end users                               | ZGSC |              |              | 4,000,000.00 |              |              | 4,000,000.00         |
| <b>Sub-Total</b>                                                                                               |                                                                                                              |      |              |              |              |              |              | <b>22,050,000.00</b> |
| <b>Outcome 4. Strengthen partnerships and systems to promote uptake and broader surveillance applications.</b> |                                                                                                              |      |              |              |              |              |              |                      |
| Strategic Action                                                                                               | Activities                                                                                                   | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
| 4.1. Strengthen specimen handling, referral and sharing                                                        | 4.1.1. Conduct specimen collection from sentinel or healthcare facilities                                    | ZGSC | 1,300,000.00 | 1,350,000.00 | 1,400,000.00 | 1,450,000.00 | 1,500,000.00 | 7,000,000.00         |
|                                                                                                                | 4.1.2. Monitor the quality of specimens collected                                                            | ZGSC | 0            | 0            | 0            | 0            | 0            | 0                    |
|                                                                                                                | 4.1.3. Conduct data completeness audits for specimen referral                                                | ZGSC | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 4,000,000.00         |
|                                                                                                                | 4.1.4. Develop or utilize existing digital platforms for sharing data and results                            | ZGSC | 1,200,000    |              | 700,000.00   |              |              | 1,900,000.00         |
|                                                                                                                | 4.1.5. Conduct trainings in sample management                                                                | ZGSC | 2,100,000    | 2,100,000    | 2,100,000    | 2,100,000    | 2,100,000    | 10,500,000.00        |
|                                                                                                                | 4.1.6. Procurement of additional sample packaging equipment                                                  | ZGSC | 8,000,000    |              | 9,000,000    | 9,000,000    |              | 26,000,000.00        |
|                                                                                                                | 4.1.7. Establish specimen exchange programs that facilitate the exchange of specimens between institutions   | ZGSC | 0            | 0            | 0            | 0            | 0            | 0                    |
| Strategic Action                                                                                               | Activities                                                                                                   | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
| 4.2. Increase network linkages at local, regional                                                              | 4.2.1. Participate in online networking platforms and forums to connect, share information, and collaborate. | ZGSC | 0            | 0            | 0            | 0            | 0            | 0                    |

| and global levels                                                                                                                                                                                                                         | 4.2.2. Initiate collaborative projects that involve partners from different regions and countries, e.g., symposiums | ZGSC |              | 2,000,000.00 |              |              | 3,000,000.00 | 5,000,000.00         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------|--------------|--------------|--------------|--------------|--------------|----------------------|
|                                                                                                                                                                                                                                           | 4.2.3. Hold in-country stakeholder meeting                                                                          | ZGSC | 800,000.00   | 900,000.00   | 1,200,000.00 | 1,200,000.00 | 1,200,000.00 | 5,300,000.00         |
|                                                                                                                                                                                                                                           | 4.2.4. Formation of partnership with local and regional organization, e.g., exchange visits                         | ZGSC | 1,200,000.00 | 1,200,000.00 |              | 1,200,000.00 |              | 3,600,000.00         |
| Strategic Action                                                                                                                                                                                                                          | Activities                                                                                                          | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
| 4.3. Strengthen networks in routine, epidemic and pandemic contexts                                                                                                                                                                       | 4.3.1. Promote the establishment of bioinformatics and genomic sequencing networks                                  | ZGSC | 200,000.00   |              | 250,000.00   |              |              | 450,000.00           |
|                                                                                                                                                                                                                                           | 4.3.2. Conduct simulation exercises and drills                                                                      | ZGSC | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 800,000.00   | 4,000,000.00         |
| <b>Sub-Total</b>                                                                                                                                                                                                                          |                                                                                                                     |      |              |              |              |              |              | <b>67,750,000.00</b> |
| <b>Outcome 5.</b> Strengthen and sustain national public health emergency management to effectively respond to public health threats through preparation, collaboration, rapid response, and risk communication and community engagement. |                                                                                                                     |      |              |              |              |              |              |                      |
| Strategic Action                                                                                                                                                                                                                          | Activities                                                                                                          |      | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
| 5.1. Establish a taskforce to respond to public health emergencies                                                                                                                                                                        | 5.1.1. Develop the response plan                                                                                    | ZGSC | 250,000.00   |              | 255,000.00   |              |              | 505,000.00           |
| Strategic Action                                                                                                                                                                                                                          | Activities                                                                                                          |      | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW       |
| 5.2. Timely resource mobilization and deployment                                                                                                                                                                                          | 5.2.1. Development of harmonized budgets                                                                            | ZGSC | 60,000.00    | 60,000.00    | 60,000.00    | 60,000.00    | 60,000.00    | 300,000.00           |
|                                                                                                                                                                                                                                           | 5.2.2. Conduct joint planning meetings                                                                              | ZGSC | 250,000.00   | 250,000.00   | 250,000.00   | 250,000.00   | 250,000.00   | 1,250,000.00         |

|                                                                 | 5.2.3. Conduct joint grant applications                                                                                                                       | ZGSC | 100,000.00   | 100,000.00   | 100,000.00   | 100,000.00   | 100,000.00   | 500,000.00     |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------|--------------|--------------|--------------|--------------|----------------|
|                                                                 | 5.2.4. Partner and stakeholder engagements for budget support                                                                                                 | ZGSC | 250,000.00   | 250,000.00   | 250,000.00   | 250,000.00   | 250,000.00   | 1,250,000.00   |
| Strategic Action                                                | Activities                                                                                                                                                    | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 5.3. Capacity building for local production                     | 5.3.1. Establish and strengthen regional capacity for the local production of genomic reagents and consumables through procurements reagents                  | ZGSC | 1,300,000.00 | 1,430,230.00 | 1,560,000.00 | 1,690,000.00 | 1,820,000.00 | 7,800,230.00   |
|                                                                 | 5.3.2. Conduct needs assessment of purification systems and demand creation of products                                                                       | ZGSC | 700,000.00   | 700,000.00   | 700,000.00   | 700,000.00   | 700,000.00   | 3,500,000.00   |
|                                                                 | 5.3.3. Implement scope of ZAMRA to add molecular consumables and reagents in monitoring good manufacturing practices                                          | ZGSC | 2,018,400.00 |              |              |              |              | 2,018,400.00   |
|                                                                 | 5.3.4. Advocate for capacity building for local entrepreneurs in designing and production of genomic reagents and consumables through stakeholder engagements | ZGSC |              |              |              | 2,000,000.00 |              | 2,000,000.00   |
| Strategic Action                                                | Activities                                                                                                                                                    | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 5.4. Test the surge and stretch of genomic surveillance systems | 5.4.1. Develop capacity for monitoring and evaluation of the implemented genomic surveillance systems.                                                        | ZGSC | 600,000.00   | 600,000.00   | 600,000.00   | 600,000.00   | 800,000.00   | 3,200,000.00   |
| Strategic Action                                                | Activities                                                                                                                                                    | Lead | 2025         | 2026         | 2027         | 2028         | 2029         | Total cost ZMW |
| 5.5. Establish or sustain projects to maintain capacities       | 5.5.1. Integrate genomic surveillance program into existing systems                                                                                           | ZGSC | 700,000.00   |              | 600,000.00   |              |              | 1,300,000.00   |
|                                                                 | 5.5.2. Develop diversified and sustainable funding strategies to support the program                                                                          | ZGSC | 0            | 0            | 0            | 0            | 0            | -              |
|                                                                 | 5.5.3. Regularly evaluate the effectiveness of the project in maintaining and utilizing genomic surveillance indicators.                                      | ZGSC | 0            | 0            | 800,000.00   | 0            | 800,000.00   | 1,600,000.00   |

| Strategic Action                                                      | Activities                               | Lead | 2025       | 2026       | 2027       | 2028       | 2029       | Total cost ZMW |
|-----------------------------------------------------------------------|------------------------------------------|------|------------|------------|------------|------------|------------|----------------|
| 5.6. Implement inter- or after action reviews to strengthen practices | 5.6.1. Hold inter-action review meetings | ZGSC | 500,000.00 | 500,000.00 | 500,000.00 | 500,000.00 | 500,000.00 | 2,500,000.00   |
|                                                                       | 5.6.2. Hold after-action review meetings | ZGSC | 500,000.00 | 500,000.00 | 500,000.00 | 500,000.00 | 500,000.00 | 2,500,000.00   |
| Sub-Total                                                             |                                          |      |            |            |            |            |            | 30,223,630.00  |
| Grand Total (ZMW)                                                     |                                          |      |            |            |            |            |            | 266,863,501.42 |
| Grand Total (USD)<br>(at 27 ZMW to 1 USD)                             |                                          |      |            |            |            |            |            | 9,883,833.39   |

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## Annex 7: List of Contributors

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UK Health  
Security  
Agency



U.S. CENTERS FOR DISEASE  
CONTROL AND PREVENTION



Tropical Diseases  
Research Centre



Ministry of Health



Japan International  
Cooperation Agency



Levy  
Mwanawasa  
Medical  
University



HOKKAIDO  
UNIVERSITY



THE WORLD BANK  
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APHL ASSOCIATION OF  
PUBLIC HEALTH LABORATORIES



ZAMBIA NATIONAL  
PUBLIC HEALTH INSTITUTE



AfricaCDC  
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and Prevention



World Health  
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ASLM  
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