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Strengthening Arsenic Measurement Capability to Support Clean Drinking Water in the Philippines

NMLPHIL coordinated proficiency testing schemes with the use of certified reference materials to build capacity for commercial laboratory arsenic testing in water and food

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The Challenge

Access to safe drinking water remains a critical challenge globally, with arsenic contamination posing a significant public health risk. Arsenic is a naturally occurring element that can contaminate groundwater through both geological processes and human activities. In the Philippines, particularly in communities near volcanic regions, groundwater is a primary source of drinking water, thereby increasing the risk of arsenic exposure. This case addresses the need for reliable water quality monitoring systems to ensure compliance with international safety standards, such as the World Health Organization guideline of 10 mg/L for arsenic in drinking water. Despite existing policies,^{1,2} arsenic contamination often goes undetected due to limited access to accredited water-testing laboratories and inconsistent, non-metrologically traceable measurement results.

A major challenge was the inability to measure arsenic in drinking water accurately and consistently. Detecting arsenic at very low levels in a water matrix is technically difficult, and many laboratories lack access to reliable calibration standards and reference materials to calibrate their equipment and validate their results, respectively. Further, opportunities to participate in proficiency testing (PT) programs to ensure their performance were very limited. Because of these limitations, test results could vary between laboratories or fail to detect contamination altogether. This increases the risk that arsenic-contaminated water may go unnoticed, potentially leading to serious health problems for the general population, such as cancer and heart disease. In addition, unreliable data and weak monitoring systems make it harder for authorities to enforce regulations. This ultimately limits the ability to make effective comparisons across laboratories or regions and delays important policy decisions, thereby reducing public trust in water quality data.

The Solution

To improve the accuracy of arsenic testing in water, coordinated efforts were implemented to strengthen the quality and reliability of laboratory results. Testing laboratories were encouraged to participate in proficiency testing schemes and to use certified reference materials in analysis as part of good laboratory practice, through promotional activities at conferences and focus group discussions. The Philippine Reference Material (PRM) 0301, As

¹ World Health Organization (WHO). Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda. Geneva: World Health Organization, 2022. ISBN 978-92-4-004506-4.

² Department of Health (Philippines). Philippine National Standards for Drinking Water of 2017. Administrative Order No. 2017-0010. Manila: Department of Health, 2017. Available from: DOH Administrative Order No. 2017-0010.

and Hg in Drinking Water, was developed and subsequently used as a PT item to ensure reliable, comparable test results worldwide. Mercury (Hg) was included because it is a mandatory parameter for drinking water quality assessment under the Philippine National Standards for Drinking Water and was also included in the PT item. All measurements were traceable to the International System of Units (SI). This was achieved by using certified reference materials with known uncertainty values, calibrating instruments with internationally traceable standards, and applying gravimetric methods during sample preparation. These practices align with international agreements under the CIPM Mutual Recognition Arrangement (CIPM MRA), which ensures that measurement results produced by different countries are consistent and globally accepted.

In 2021, the two agencies of the Department of Science and Technology (DOST) of the Philippines, namely the Philippine Council for Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD) and the Industrial Technology Development Institute (DOST-ITDI), jointly organized a Focus Group Discussion for the testing laboratories. The results showed that arsenic in drinking water is a high-priority analyte under toxic elements, as presented in **Figure 1**. Laboratories identified arsenic in drinking water as a top-priority measurand, which was driven by regulatory requirements, quality assurance, and client demand. Many laboratories already have the capability to analyze toxic elements in water, including arsenic, but there remains a need for a complete metrological solution that includes PT schemes, certified reference materials, and improved SI traceability to support reliable measurements.

In the same year, the National Metrology Laboratory of the Philippines (NMLPHIL), under DOST-ITDI, launched an accuracy-based proficiency testing scheme for arsenic in drinking water. Eight (8) local testing laboratories participated in this program. The results showed that seven (7) out of the 8 participating laboratories achieved satisfactory performance. Of these, four (4) laboratories demonstrated a level of competence that qualified them to pursue accreditation under ISO/IEC 17025, an international standard for competent testing laboratories. These results are shown in **Table 1**.

A Quantifiable Impact

Participation in the NMLPhil PT schemes for arsenic analysis in water and food increased nearly 4-fold (from 8 to 31) during the period 2021 -2025. This reflected greater engagement and improved awareness of local PT services and available reference materials to support the commercial testing laboratory network.

Toxic Elements

Legend:

← Prioritization of measurand

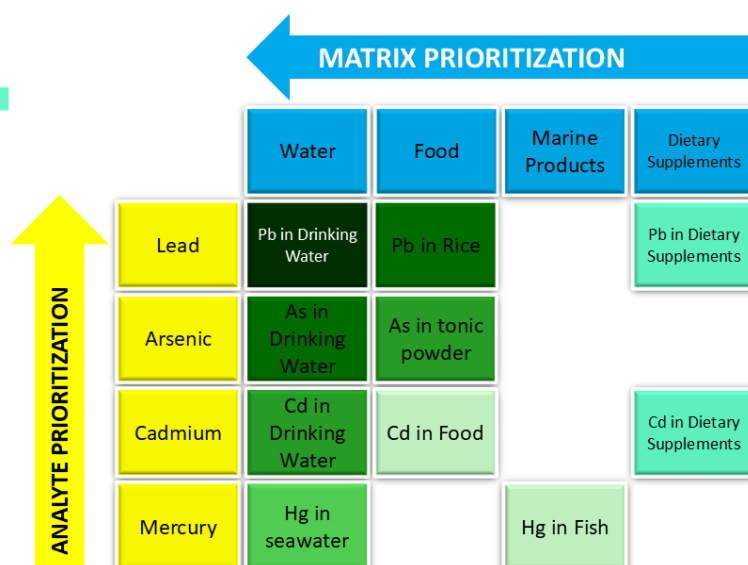


Figure 1. Priority of measurands in toxic element analysis for testing laboratories.

Table 1. Participants' results for the determination of arsenic in drinking water in the 2021 PT scheme.

Laboratory Code	z-score	Performance	ISO/IEC 17025 Accreditation?
101	-0.2	Acceptable	Yes
102	-0.5	Acceptable	Yes
103	-1.4	Acceptable	No
104	1.1	Acceptable	No
106	-4.8	Not acceptable	Yes
107	-1.3	Acceptable	Yes
108	0.4	Acceptable	No
109	-1.3	Acceptable	No

Participation provided laboratories with objective evidence of their measurement performance, helping them identify potential sources of error and implement appropriate assurance, personnel competency assessment, and compliance with ISO/IEC 17025 requirements. Several laboratories subsequently achieved ISO/IEC 17025 accreditation and demonstrated their technical competency through the PT schemes. Collectively, these outcomes have strengthened laboratory capability, increasing confidence in analytical results used in regulatory and public health decision-making.

The reliability and comparability of arsenic measurements were further supported by metrological traceability to the SI. Arsenic was measured using Hydride Vapor Generation–Atomic Absorption Spectrophotometry (HVG-AAS), with instrument calibration supported by Standard Reference Materials (SRMs) from the National Institute of Standards and Technology (NIST), together with gravimetric sample preparation. This measurement framework established a documented traceability chain for the assigned values used to evaluate the results of all participating laboratories.

Another key initiative undertaken by the NMLPHIL to strengthen the country's chemical measurement capability is the proposed legislation to transform the NMLPHIL, currently a division under ITDI, into an independent institution through the establishment of the National Measurement Institute of the Philippines (NMIPhil). The proposed NMIPhil will serve as the country's central authority for national measurement standards, calibration systems, and metrological traceability, providing a stronger institutional framework to support accurate and internationally recognized measurements.

The proposed Bill has raised policymakers' awareness of the critical role of metrology in enabling accurate and reliable measurements for evidence-based decision-making. This has further emphasized the need for a strengthened national measurement system to ensure metrological traceability, measurement comparability, and data quality across sectors, particularly in water quality monitoring and public health. This integrated system of quality infrastructure reinforces the importance of metrology in supporting effective regulation and building confidence in measurement results.

The findings of this case study highlight the need to further strengthen the national system that ensures the reliability of laboratory measurements, particularly for arsenic testing in drinking water. This is especially important given the observed variability in laboratory capabilities and the need for consistent, accurate results to support public health decisions. In this context, the proposed NMIPhil Bill provides a relevant policy direction by aiming to establish a stronger national system that ensures measurements used in laboratories, industry, trade, and public health, including the analysis of arsenic and other contaminants in drinking water are accurate, consistent, and comparable across the country. This is critical because reliable measurements form the basis of trustworthy laboratory results and sound regulatory decisions. If enacted, the NMIPhil would strengthen the country's measurement infrastructure by centralizing measurement standards and improving coordination among

laboratories and institutions, which in turn would ensure that arsenic results from different laboratories are comparable and dependable, supporting more confident assessment of drinking water safety and ultimately enhancing evidence-based decision-making, regulatory enforcement, and public health protection in areas where contamination risks may be present.

Acknowledgments. This case study is based on work by the DOST-ITDI, DOST-PCIEERD, and DOST-PCAARRD, as well as contributions from international metrology organizations, including NMIA and NMIJ. References include the WHO Guidelines for Drinking Water Quality and scientific literature on arsenic contamination in groundwater.

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