Integrated Sampling is the Answer to Protecting the World's Most Precious Resource

Drinking water suppliers around the world face unique challenges: They must deliver the most essential ingredient for life on a grand scale, whilst also navigating complex issues surrounding public safety, regulations and infrastructure. In the U.S., for instance, 240 million people rely on more than one million miles of pipes for clean drinking water, but water infrastructure is aging fast. In the U.S. alone, large sections of it are 50, even 100, years old, and estimates to replace the system range from $335 million by 2027 (the Environmental Protection Agency (EPA)) to $1 trillion by 2035 (the American Water Works Association). In light of these challenges, how do water suppliers ensure that the millions of people around the globe who use public water receive a safe, reliable product?

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One common answer is comprehensive sampling and analysis of the water supply. To comply with strict new standards, follow business best practices and, of course, keep customers safe and happy, water suppliers manage enormous testing programs, collecting and testing millions of water samples from myriad sources. Conducting and analysing these tests is an immense undertaking, but laboratory information management systems (LIMS), which automate sample planning and laboratory processes and integrate analytical data from across the lab and outside – even in the most remote locations – help modern labs keep pace.

This article will illustrate how the world's leading water suppliers integrate the sample collection and analysis process, and use LIMS to maximise the efficiency of these programs. As a best practice example, we'll highlight Northern Ireland Water, a government-owned company that supplies water to 800,000 properties in Northern Ireland.

The Challenges of Water Sampling Today

Over the last decade, the National Environmental Laboratory Accreditation Program (NELAP) and the EPA in the U.S., along with other regulatory bodies around the world, such as the European Commission and the Drinking Water Inspectorate in the UK, have instituted rigorous new standards for water testing. The EPA's Safe Drinking Water Act, for example, empowers the agency to specify the legal limits for levels of contaminants in drinking water, and the EPA also determines the water testing methods and sampling schedules that water providers must follow. These regulations provide a set of protocols outlining what is acceptable within a multi-disciplinary water laboratory in accordance with internationally-accepted standards.

Stringent requirements dictate new labour-intensive procedures to ensure compliance, such as sample tracking, chain of custody (COC), record keeping, demonstration of capability (DOC), document control, reagent and standard traceability, proof of training and reporting. And since water testing labs must work closely with municipalities, municipal utility districts, water control and improvement districts and federal and state regulatory authorities, the number of tests and the data they generate create a massive amount of information.

Water sampling includes tests for both process control and safety/regulatory compliance. Process control tests help streamline water treatment and increase throughput, whereas safety and regulatory compliance sampling ensures that the water supplier provides a consistently clean, appealing product that complies with

government mandates. Many samples – collected by either field technicians at reservoirs or online instruments within processing plants – help proactively address process, safety and quality concerns early enough to adjust treatment processes if necessary. An example familiar to all water suppliers is the requirement to continuously measure turbidity (cloudiness) with online monitors and in the lab with optical turbidimeters. Turbidity may seem like a strictly aesthetic quality, but it is a safety concern as well. Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. While the human eye can't detect turbidity below 10 NTU (nephelometric turbidity units), water systems in the U.S. that use conventional or direct filtration cannot allow turbidity to exceed 1 NTU at any time, and must maintain a level less than 0.3 NTU 95 percent of the time.

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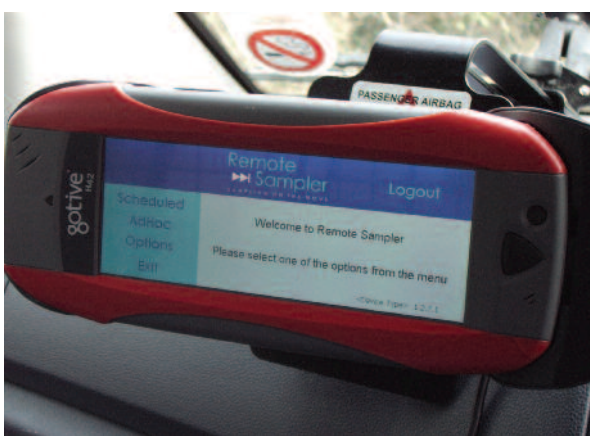
Not all regulations are strictly mandated by law – some are employed by water suppliers not for compliance reasons, but because they are best practices. One secondary U.S. EPA regulation (recommended but not required) pertains to tracking the amount of total dissolved solids (TDS) in water. TDS such as sodium, carbonate, chloride, sulphate and others can corrode pipes and equipment and diminish water's taste, so most suppliers use electrode-based conductivity meters as a surrogate measurement to consistently monitor for TDS.

Other tests, such as weekly monitoring of customer taps, occur later in the process for safety and compliance purposes. As every water treatment professional knows, on-site tests for free chlorine – using devices such as Thermo Scientific Orion portable colorimeters – and total coliform (the presence of bacteria) are crucial to ensuring a clean, high-quality product is delivered. Typical chlorine residuals can range from 0.5 to 1.3 mg/L. If the chlorine residual is too low, the U.S. EPA requires further testing to assess the potential for a bacteria-, yeast- or mold-related public health concern. However, if chlorine is too high, customers may not like the taste of the water and there can be increased risk of forming hazardous disinfection byproducts. Similar requirements are made by water authorities throughout Europe and in other parts of the world.

These examples are, of course, just the tip of the iceberg: Water suppliers must also test for pH, temperature, fluoride, nitrates and much more. Even when tests do not detect any issues, the results, location and other information about a sample must be logged, organised and submitted to state departments of environmental protection for compliance purposes. It is clear that laboratories need to automate and integrate as many manual processes as possible and streamline sample throughput to keep compliance costs from spiraling out of control. A system that identifies and builds sampling efficiencies, secures data and improves scientist and lab professional productivity is necessary.



Why a LIMS is Critical

LIMS are the key to addressing growing challenges with monitoring and compliance, and they have become more necessary and more prevalent in today's labs. Paper-based systems can no longer handle the volume of sample throughput, data management and reporting complexity in an effective manner. A LIMS schedules and holds sampling plans, which are then used to generate a collection run for each sampler. The collection run defines where samples must be taken, what sample bottles must be collected and what onsite tests must be performed. Samples are then analysed in the laboratory and water-quality data, as well as details of testing carried out in the field, are entered into the LIMS. This is important, as water companies must collect and analyse their water samples in a closely-regulated environment, maintaining complete quality control records for submission to regulatory bodies or in case of audits.

An automated solution also provides water plant or utility managers with the data they need to make informed decisions that increase control and quickly resolve environmental issues and risks. A LIMS enables water companies to more easily comply with strict regulatory guidelines while simultaneously providing the flexibility necessary to cope with changing demands and practices as regulations and testing protocols change. A LIMS can even improve operational efficiency, as it provides the laboratory with a centralised tool for comprehensive sample record keeping, management and reporting. By integrating the LIMS with laboratory instrumentation, online monitors and external sample collection, time-consuming manual processes and transcription errors can be eliminated.

While a LIMS can offer built-in functionality specifically designed for the water and environmental industry, it can also be configured to meet a company's evolving business model practices. With the right LIMS, a laboratory can be confident that the data system does not dictate how operations are run. Instead, its flexibility can allow the system to codify how a company wants to operate.

Integrated Water Sampling In Action: Northern Ireland Water

Northern Ireland Water provides an example of a sophisticated water sampling program that takes full advantage of a LIMS. The government-owned company is the sole provider of water to Northern Ireland, serving 1.7 million people at 800,000 properties. Like U.S. water suppliers, the company must comply with strict regulations – in Northern Ireland Water's case, both EU and UK standards, which in common with EPA regulations are derived from the World Health Organisation (WHO) Guidelines for Drinking Water Quality. These entail running more than 150,000 tests each year on samples collected from reservoirs, water treatment facilities and customers' homes.

To ensure that Northern Ireland Water continues to be a trusted and reliable public service provider, the agency transitioned from an in-house, customised LIMS to Thermo Scientific SampleManager LIMS, a more robust and efficient solution purpose-built for water testing laboratories and other process industries. The LIMS was employed for three main tasks: Receipt of samples for chain of custody from field procurement, sample login and storage at Northern Ireland Water laboratories and results and reporting to management and regulatory agencies.

Northern Ireland Water also took steps to automate the collection of field samples, integrating this program with the LIMS without making samplers' jobs any more difficult or onerous. New, ruggedised personal digital assistants (PDAs) made the field sampling process more efficient and improved the audit trail. The small, easy-to-use devices feature built-in GPS, GPRS, bar code readers, Wi-Fi and Bluetooth, which provide more accurate data on sample location and identification. Remote sampler PDAs deliver sample information directly to SampleManager LIMS, and the LIMS feeds collection and workflow data back to the PDAs so field personnel are continuously updated on priorities, sample collection locations and specific testing requirements.

The integration of a remote sampler field testing system with an enterprise-level LIMS has delivered essential transparency between data gathered in the field and management reporting

generated by the LIMS. The automation of both the front-end sample collection and back-end reporting has eliminated manual transcription errors and the quality of Northern Ireland Water samples and reporting have been significantly enhanced. The LIMS has also contributed to cost savings, reducing the water sample reception process by more than two hours per day.

Northern Ireland Water has also improved the integrity of samples and subsequent accuracy of data across two geographical areas. Enhanced field sampling allows the company to record precise locations for each sample – the GPS verifies customer tap sample locations by matching addresses against an on-board database. This portability also allows sampling staff to move around and exchange workloads to suit Northern Ireland Water's business needs: Samplers no longer require knowledge of local geography because the onboard GPS software gives them turn-by-turn directions to the sample point.

The results of this integrated program are impressive. In 2011/2012, the company delivered £12 million in operational cost efficiency savings after setting a goal of £10.4 million. Northern Ireland Water also improved wastewater compliance for the last six years in a row and won the Royal Society for the Prevention of Accidents Gold awards for health and safety in 2010 and 2011. Better still, last year less than one in 100 customers experienced an unplanned interruption lasting longer than six hours.

Conclusion

Stringent testing regulations imposed in the U.S., UK, EU and other regions around the world help maintain clean, reliable water supplies. But this vigilance has a cost, and water suppliers are turning to technology for help. For many, the laboratory automation and instrument integration offered by a LIMS is the solution that offers time and cost efficiencies, as well as improved productivity and compliance by managing the ever-higher data volumes demanded by regulators.

The advanced information management capabilities of a LIMS, including integration with other enterprise systems and even remote sampling tools, have delivered water suppliers important new innovations that can minimise the burdens of their testing programs. And as water standards change, a LIMS can evolve in parallel, helping water suppliers to streamline operations while simultaneously ensuring water is always safe to drink.