

Beyond Monitoring: HORIBA's Digital Approach to Water Quality and Environmental Solutions

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As today's water industry faces challenges such as aging infrastructure and environmental pollution, water quality monitoring is becoming more and more essential to address these issues. To reduce downtime and enable quick decision-making, real-time water monitoring is crucial. Advances in sensor technologies and cloud-based systems have made it possible to continuously collect and remotely monitor data, facilitating rapid decision-making and optimizing operations. As a result, the demand for Data as a Service (DaaS) solutions is increasing, where companies provide and manage water-related data for customers. Especially in the UK, where HORIBA MIRA is located, new laws and regulations are being implemented to address surface water pollution due to aging infrastructure. HORIBA aims to tackle these issues by integrating its water quality measurement technology with HORIBA MIRA's data science and AI, and HORIBA Test Automation's data management platform to provide solutions which goes beyond just water monitoring. In this article, we introduce our initiative to utilize HORIBA's water quality monitoring technologies and digital transformation (DX) solutions to address water-related environmental issues in the UK.



Introduction and Background

With growing human population, increasing urbanization and industrialization, and impacts of climate change, the management of our freshwater resources is an international priority and in some cases a crisis. The delivery of clean and safe drinking water, treatment of wastewater and elimination of pollution in our rivers, lakes and seas are all areas of growing concern which is leading to development and expansion of technology and business.

Today, HORIBA plays a significant part in the control of water quality by producing a wide variety of water quality monitoring instruments. In fact, HORIBA's very first product was a pH meter. HORIBA Advanced Techno (HAT) manufactures a range of water quality measuring instruments, and its main business is sales of these hardware instruments mainly through distributors. However, there is also the consulting sector of the water industry which is significant and is in a state of high growth, driven by new regulations and a national demand to clean up polluted rivers and lakes. The demand for this already

researched in UK^[1]. HORIBA is looking to enter this consulting sector of the global water business. The new Consulting & Applied Solutions (CAS) group and HAT are leading this initiative together, with support from HORIBA Test Automation (HTA).

The CAS team, based at HORIBA MIRA in the UK have established a base, where the team can develop solutions using HAT instruments and data services with HTA software platform STARS Enterprise. A “Field Lab” has been established at a reservoir within the HORIBA MIRA proving ground, where HAT instruments can be integrated, developed, and proven for application to the new surface water regulations.

Why set this up in the UK? Apart from being the main location of HORIBA MIRA, the center of the CAS organization, there will be major changes to the UK water industry within the next 5 years. There is new legislation to control spills of wastewater and monitoring of surface water. In addition, funding is increased to upgrade wastewater network infrastructure and to implement “smart” networks with sensors, telemetry, and AI-driven control systems. The UK water industry regulator OFWAT has approved a total budget of £104 Billion to be spent by UK water companies for infrastructure improvement^[2]. This budget will cover procurement of sensors and smart systems with the objective of eliminating wastewater spillage into rivers and lakes, and improved monitoring.

In this article, our initiative to utilize HORIBA's water quality monitoring technology and DX solutions to address water environmental issues in UK, is introduced. First, some unique HAT water quality products are introduced briefly and then, there is description about HORIBA MIRA and HTA capabilities and how we are trying to integrate HAT, HORIBA MIRA and HTA capabilities to provide solutions to mitigate water environmental issues is also explained.

HAT Water quality monitoring technologies

Water quality monitoring is vital for protecting human health, preserving ecosystems, and ensuring safe drinking water. It helps detect pollutants, supports regulatory compliance, and guides environmental management. HORIBA Advanced Techno (HAT) specializes in developing water quality sensing equipment for various industries and applications. HAT core technologies are electrochemical and optical measurements and using these core technologies HAT has developed several unique water quality monitoring products. While HAT has a large portfolio of water quality monitoring equipment, in this article some unique and essential products which can also be useful in

improving UK water quality issues are introduced.

Ammonium probe (AM-2000)

While Ion Selective Electrode (ISE) ammonium electrodes tend to drift in the low ranges, HAT unique AM-2000 (Figure 1) ammonium probe based on ISE technology remains stable even at low range below 1 ppm. As more and more wastewater treatment plants (WWTPs) now use ammonium monitoring as an indicator to control aeration rather than dissolved oxygen for better efficiency, HAT AM-2000 can contribute to energy consumption reduction (10 to 30% or further (from HORIBA's survey)) of WWTPs. Since ammonium is also an important indicator of environmental water (rivers, lakes, etc.) health, this product is suitable for monitoring the surface water and for monitoring the WWTPs.

Ultrasonic Cleaner (UH-16A series)

To reduce the maintenance frequency of the probes, HAT provide unique ultrasonic cleaner (Figure 2, Figure 3). It operates with burst oscillation and sweep function which makes it stain-resistant and enhances cleaning effect and also reduces sensor damage.



Figure 1 Ammonium Probe (AM-2000).
https://static.horiba.com/fileadmin/Horiba/Products/Process_and_Environmental/Process_Water/Brochures/HC-200NH/HC-200NH_Brochure_English.pdf



Figure 2 Ultrasonic cleaner with ammonium probe.



Figure 3 Effect of ultrasonic cleaning on Ammonium Probe: Without (left) and with (right) cleaner after 60 days.
<https://static.horiba.com/fileadmin/Horiba/Products/Water/Download/Brochures/HAE-T0257.pdf>

Self-cleaning pH electrode (6122 series)

HAT patented and unique self-cleaning pH glass electrode (Figure 4, Figure 5) uses a UV LED within the electrode and the surface of the glass electrode is coated with a photocatalyst (titanium oxide). The irradiation of UV light activates titanium oxide coating and prevent the adhesion of organic contaminants on the electrode which in result reduces the maintenance frequency and cost.

Multiparameter Water Quality Checker U-50 series

U-50 series can measure 11 parameters simultaneously including pH, ORP, turbidity, dissolved oxygen, and conductivity (Figure 6). One of the features is simultaneous one-point automatic calibration of all the sensors with a single standard solution. The model U-53 of this series has wiper inside the turbidity sensor for automatic cleaning. The main applications of U-50 series are river and lake water quality inspection. One U-50 can simultaneously measure all the basic parameters needed to monitor the river water quality.



Figure 4 Self-cleaning pH electrode.



Figure 5 Without (left) and with (right) self-cleaning function after 3 months.
<https://www.horiba.com/int/water-liquid/products/other/self-cleaning-ph-electrode/>

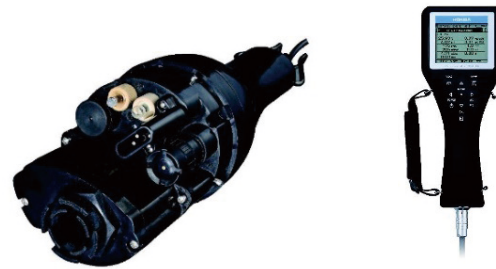


Figure 6 U-50 series probe (left) and controller (right).
https://www.horiba.com/fileadmin/uploads/Process-Environmental/Documents/Downloads_Catalog/Catalog_Water_Quality/U-50_brochure_en_HRE1930E.pdf



Figure 7 EL200 connected with multiple probes (Reproduced from HORIBA Readout No. 59, page 83).

Multiparameter Transmitter (EL200)

HORIBA acquired HORIBA Advanced Techno France (HATFR (known as Tethys Instruments before the acquisition)) in 2023. HATFR core technology is UV spectroscopy. One of the featured products of HATFR is multiparameter transmitter EL200 (Figure 7). On the other hand, most of the HAT transmitters are single parameter. With the inclusion of HATFR in our group, we are working on a project to connect HAT sensors to EL200 and connectivity of some of the sensors is already achieved. These type of multiparameter instruments will be critical in UK river water monitoring.

HORIBA MIRA and HORIBA Test Automation (HTA) capabilities and their integration with HAT water quality monitors

Historically, HORIBA MIRA has had no business with the water industry. However, the future needs of the water industry are based on efficient gathering of information-rich data, data processing, data analytics and safe & secure data-science and control systems. All these key future solutions have already been developed and proven in the automotive industry by HORIBA MIRA and HTA. This expertise is what HORIBA's CAS can also bring to the water industry which would separate it from existing consultants in the water industry.

The key areas of technology that HORIBA MIRA brings are:

- Data capture and processing
- Cyber security
- Functional safety
- Simulation, digital twinning & AI

In addition to the areas of technical expertise that HORIBA MIRA automotive experience brings, the HORIBA MIRA site and proving ground provides the ideal proving ground for water quality monitors, services, and analytics. Figure 8 outlines the many and different water systems that are present on HORIBA MIRA's 800-acre site. The HORIBA MIRA site includes potable water (drinking), wastewater (sewerage), stormwater and surface water. The site also benefits from a long-range wide area network (LoRaWAN™)*1, which can be considered as a long-range outdoor Wi-Fi®*2 system that links sensors to the internet. The site is also covered by 4G and 5G networks.

The HORIBA MIRA site can also be a development hub for the UK water industry. To demonstrate the potential of the site and to demonstrate new prototype water monitoring systems, a "Proof of Concept" (PoC) field-laboratory (Figure 9) has been established at HORIBA MIRA. It is located on the shore of the site's own water reservoir. The reservoir collects rainwater which is used to feed the wet test-tracks for developing vehicle wet-handling and wet-road safety which is why it can also be a proving ground for investigations into the nature of tyre-borne microplastic particles. For the PoC, the reservoir represents natural lake and river water. In the UK, new legislation, known as "Section 82" is forcing all water companies to measure river water quality up and downstream of any wastewater or stormwater discharge points along rivers. The data should be available to public through telemetry.

*1 "LoRaWAN" is a trademark of Semtech Corporation.

*2 Wi-Fi is a registered trademark of Wi-Fi Alliance.

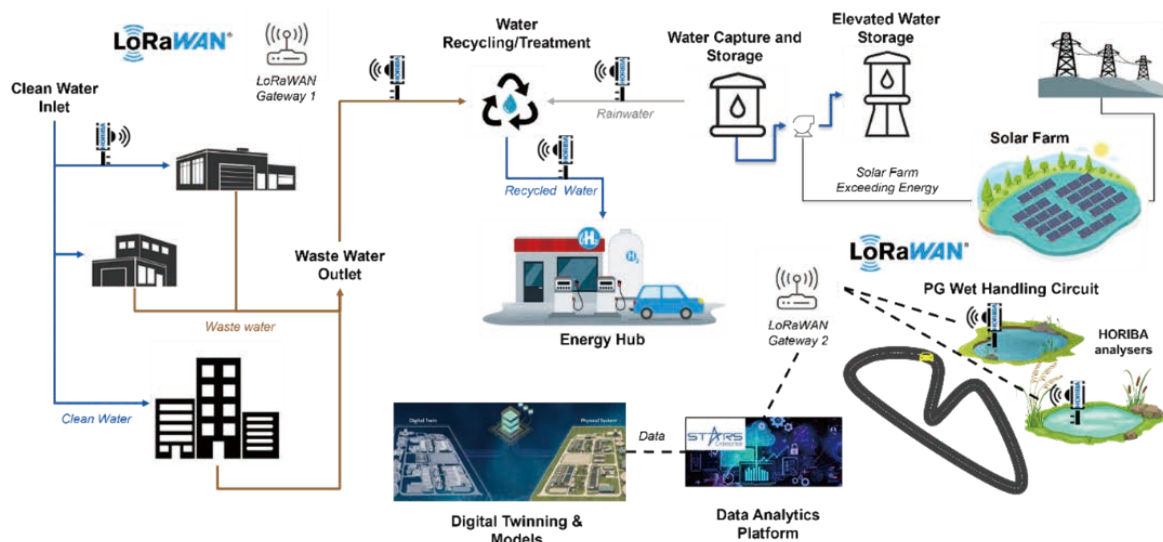


Figure 8 Water systems of the HORIBA MIRA site.



Figure 9 PoC (Proof of Concept) Field lab developed at the HORIBA MIRA site.

HORIBA’s STARS Enterprise platform, developed by HORIBA Test Automation (HTA), is ideally placed to meet this need. Originally developed to underpin HORIBA’s market-leading position as a provider of test automation and laboratory management systems in the mobility sector, this cloud native data management and process automation platform has transferred readily to the water data management domain, providing a flexible, proven backbone upon which to implement a range of water data solutions (Figure 10).

Capabilities provided by STARS Enterprise include:

- Multiple data ingress options, including HTTPS endpoints and MQTTS client.
- High-capacity storage of structured, unstructured and time series data.
- Scalable, concurrent execution data processing pipelines (analytical services).
- Powerful Grafana based no-code dashboards for visualization.
- Extensibility through the addition of solution specific microservices, web apps and mobile apps.
- Flexible role-based user management, with OIDC support.
- Tenancy-based data siloing.
- Best in class security features.

STARS Enterprise for Water Data Solutions

While the roots of the more mature STARS platforms lay in the mobility business field, the opportunity to deploy STARS solutions in other business fields in which HORIBA operates is clear. STARS Enterprise in particular, being a robust, secure and performant cloud-based platform upon which to implement modular solutions, offers huge potential in this respect.

The containerized microservice architecture of STARS Enterprise supports unlimited horizontal scaling with zero downtime, allowing cost effective deployments to be provisioned for solutions ranging from data management in small scale R&D facilities to regional scale water network monitoring and analytics.

The generic, extensible architecture of the STARS Enterprise platform ensures that whatever shape of data solution is called for, HORIBA will be able to meet the need. Powerful analytics and modelling are accommodated through features such as integrated Python module execution support. Where the services and apps of the core platform cannot address all the requirements of a solution, the platform is easily extended by the additional solution specific microservices and apps. Complex water network modelling, analysis and control solutions can thus be realized on the STARS Enterprise platform.

While STARS Enterprise solutions may be deployed in the customer’s IT infrastructure, an increasingly popular option is to take advantage of HORIBA’s SaaS capability to obtain a fully HORIBA operated Solution as a Service. With this approach, the customer is free to focus on core business, while HORIBA manages the entirety of creating and operating the data solution. The customer is relieved of operational burden, receiving only the data insights and actionable outputs that bring value to their enterprise.

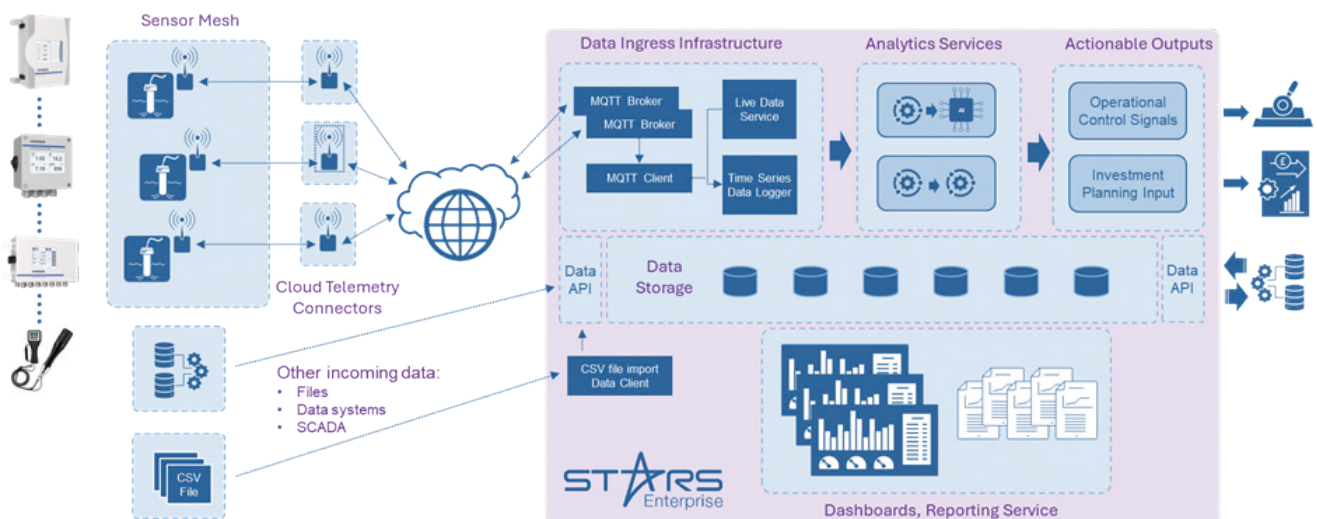


Figure 10 STARS Enterprise Cloud Platform.

HORIBA's prototype "Section 82 (S.82)" solution showcases STARS Enterprise in the role of a cloud-based data collection and forwarding platform. S.82 of the UK's Environment Act 2021 requires sewerage undertakers to continuously monitor the quality of the receiving water upstream and downstream of their assets, allow assessment of the impact of discharges from their assets on the receiving watercourse^[3]. In its base implementation, our S.82 solution does just that - collects data from distributed monitoring installations via low power long range telemetry, harmonizes these data and transmits them to the water authorities.

Dashboards and statistics are provided as part of this service to provide visibility of the data (Figure 11). Such dashboards are easily configured without coding and give

the customer instantaneous, real-time information, along with access to historical data reaching back to the very start of the monitoring activity.

With the S.82 base solution as our springboard, we can leverage the flexibility of the STARS Enterprise platform and move on to offer value-add opportunities such as insightful predictive analytics to S.82 customers.

Together, HORIBA MIRA and HTA provide a "rainbow" of new solutions and services (Figure 12) that are desperately needed by an ailing water industry. These new solutions form the business strategy of the new CAS Water consultancy. With hardware from HAT, HORIBA can provide an end-to-end, "one-stop-shop" solution to customers.

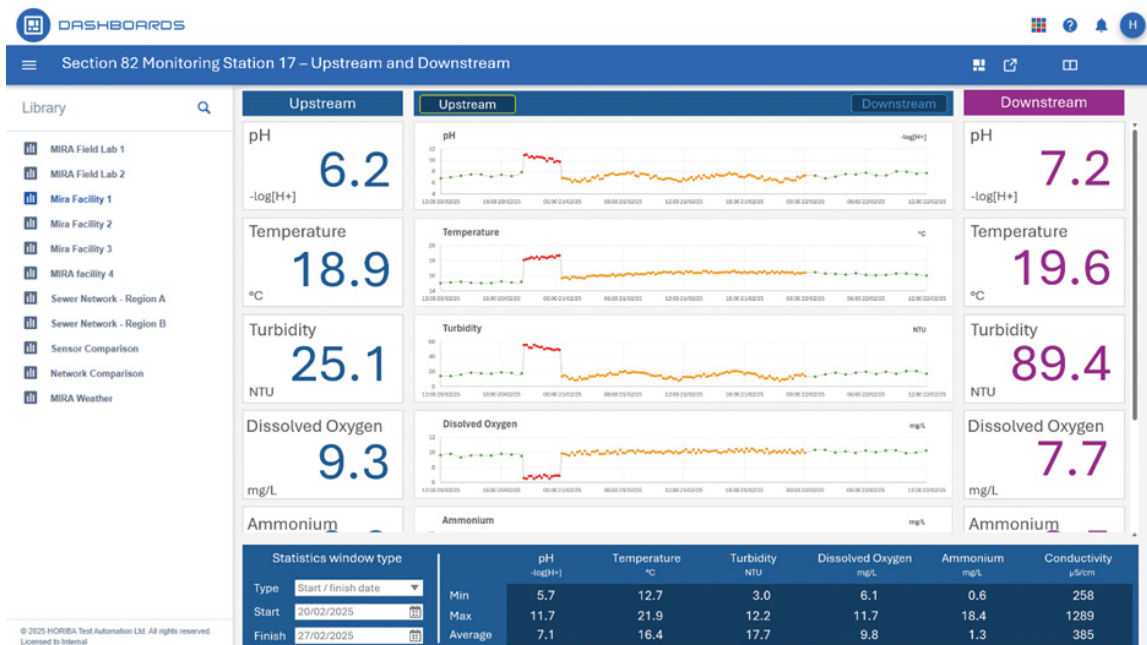


Figure 11 Section 82 Dashboard using STARS Enterprise.

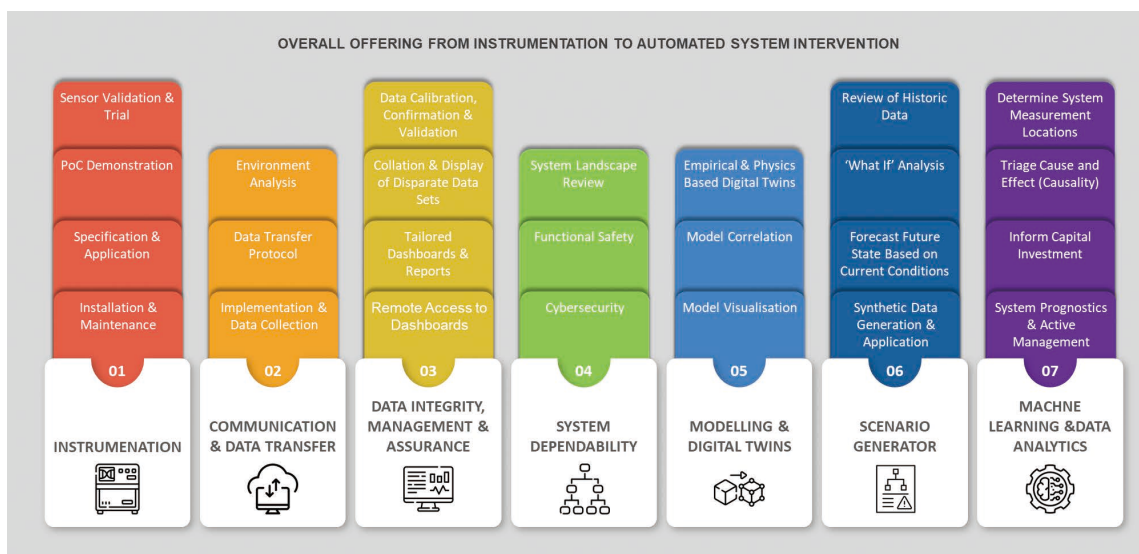


Figure 12 HORIBA one-stop-shop solution idea for water industry: from instrumentation to data analytics.

Vision on adding value to the current capabilities with Data Science

The water industry generates large quantities of data, but it is distributed sparsely across a large and complex system. There is a great need for further instrumentation to better understand and manage water industry systems and the surrounding environment. This increasing data volume and resolution presents opportunities for the application of data science and machine learning. Simply collecting data does little to increase understanding of the issues faced by the water industry, but effective application of the right tools to this data can extract the information it contains, providing useful, valuable, and actionable insights.

Data science and machine learning are powerful tools that can be applied in various contexts within the water industry. These range from broad network applications, through specific subsystem controls and down to the acceleration and enablement of individual measurements and analyses. At the smallest scale core HORIBA technologies, such as spectroscopy methods, can be accelerated through deep learning to provide rapid analyses and to enable the detection and measurement of new and emerging pollutants. This will help to better monitor and understand the scale of pollution and impacts on both the environment and public health. This monitoring will provide new information and enable new regulation of these pollutants. On a larger scale, whole networks of disparate sensors can be consolidated into a single measurement system, providing insights and prediction to tackle serious industry issues. This includes water supply scarcity, storm overflows of sewage into natural water bodies, and more fundamental issues such as the accuracy, validity and reliability of data and measurements in such an expansive system.

The operation of water industry systems is often heavily dependent on weather, influencing both the availability and demand for clean water, and impacting the capacity and efficiency of wastewater treatment. Machine learning based models are lightweight and outperform the simulation times of their physics-based counterparts by multiple orders of magnitude, often while maintaining equal or even improved accuracy due to a reduction in required assumptions and simplifications. This enables a scenario-based approach, which can incorporate variability and uncertainty inherent in weather prediction through a high volume of predicted scenarios. The result is a statistical view of the future system state with enough time in hand to act with increased pertinent information. There are significant implications for environmental impacts, operational efficiency, and functional safety in the water industry and more broadly across all HORIBA's Fields.

Conclusion and outlook

In this article, we described our initiative to utilize our water quality monitoring technology and DX solutions to provide analytical and data solutions to address these issues. Due to decades of under-investment, the UK's old infrastructure is leading to problems such as overflow of the sewage which is polluting every river in the UK. Water companies in UK are now legally obliged to monitor river quality and to complete a full deployment of a new sensor network within the next decade. The root cause of these problems is broken and aging infrastructure. Since rebuilding of the infrastructure is such a vast undertaking, limited by investment and resources, the other, more attractive solutions to tackle these problems are smart sensing and data solutions. The future of the water industry is with lots of data.

These issues are not just true of the UK. Many other nations suffer from the same problems. In Europe, France has similar issues. Notably, the river Seine in Paris was not fit for swimmers in the Paris Olympics, until fine weather limited the spills of wastewater upstream of the city. In India, there is a huge national project to clean up the river Ganges, the vast and holy waterway of the largest population on Earth.

HAT have been developing some unique product for water quality sensing. While these products have excellent measurement performance, they need to be smarter for data solution services. Performing data analytics and solving customers problems can provide a value-added end to end solution. This is where HTA and HORIBA MIRA capabilities can be explored. Together under the new Consulting & Analytical Solutions (CAS) Group, HORIBA can offer consulting and solutions to end-user customers.

This new HORIBA water business is starting out in the UK and focusing on helping to solve the UK water environment issues with new solutions. Once established, the new consulting business model can be expanded to other regions in Europe and globally. With a growing human population, the need for clean and safe water, the safe treatment of wastewater and the protection of the natural environment will continue to grow. Meeting this growing demand for new technology and services to ensure the health and safety of our planet and its inhabitants is a noble path for HORIBA to follow, and a profitable pathway too.

* Editorial note: This content is based on HORIBA's investigation at the year of publication unless otherwise stated.

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