



The Role of Data in Optimizing Wastewater Systems

Data is a critical, but often overlooked component of industrial wastewater treatment, especially for water-intensive sectors. The quality of their data systems can make or break the operational and financial viability of a facility's production. Many clients we speak to focus their efforts on meeting minimum effluent requirements for their municipality, but this is often insufficient for mapping the full picture of a system's performance. Without robust, accurate monitoring practices across all phases of production and treatment, facilities risk impacting their bottom line, if not outright hindering production capacity.

Building Trustworthy Data Streams

At the heart of good data collection is trust. Reliable data streams for a wastewater system require thoughtful setup, regular testing, proactive maintenance, and robust analysis. Failures at any point in this process can reduce the ability to identify and quickly resolve anomalies. Gaps in data analysis can also obfuscate the real source of a system's failure, resulting in operational blindspots that require excessive investments of time and money to resolve. Sensors are the first line of defense in a wastewater data streams, passing key information on water quality, flow, and chemical makeup at each phase of treatment. While the accuracy and longevity of sensors have continued to increase in recent years, even the best quality ones

lose value if they're poorly placed or managed. Gaps in data, sensor drift, and inconsistent sampling intervals can skew data trends and decision-making, leading to false conclusions about system performance. By ensuring correct placement at key process inflection points and calibrating them regularly, facilities can ensure this first-line data reflects real system behavior they can trust.

Another example is the difference between automated and manual sampling. Manual sampling allows for important spot checks, especially when combined with automated data sets. However, the timing and consistency of these tests can create issues, as they can easily miss short-term anomalies, such as rapid spikes and overnight swings in performance. By building automated monitoring processes, plant managers can fill their gaps in data, creating a complete and trustworthy picture of their system's performance day-by-day and over time.

Finding the Right Partner for Your Data

For most industrial facilities, the challenge with their data lies in finding the time, expertise, and resources to manage it consistently and correctly. High-quality wastewater data requires constant oversight, from sensor validation to trend analysis and timely intervention. With teams already focused on production and compliance, it can feel like an impossible feat to develop and maintain the necessary level of data collection internally, even when they know it affects their core operations and creates undue risk.

In these cases, the right partner helps facilities return to their core competencies. At Cambrian, data is foundational to how we design, operate, and optimize wastewater systems over their full lifecycle. Through continuous monitoring, real-time analysis, and performance-based operations, we take responsibility for data integrity alongside treatment outcomes. By owning and operating systems on behalf of our clients, we reduce operational burden, transfer risk, and ensure decisions are made using a complete, accurate picture of system performance. Our partnership model provides teams with the confidence that their water infrastructure is built to perform, adapt, and scale over time with comprehensive, data-backed insights.

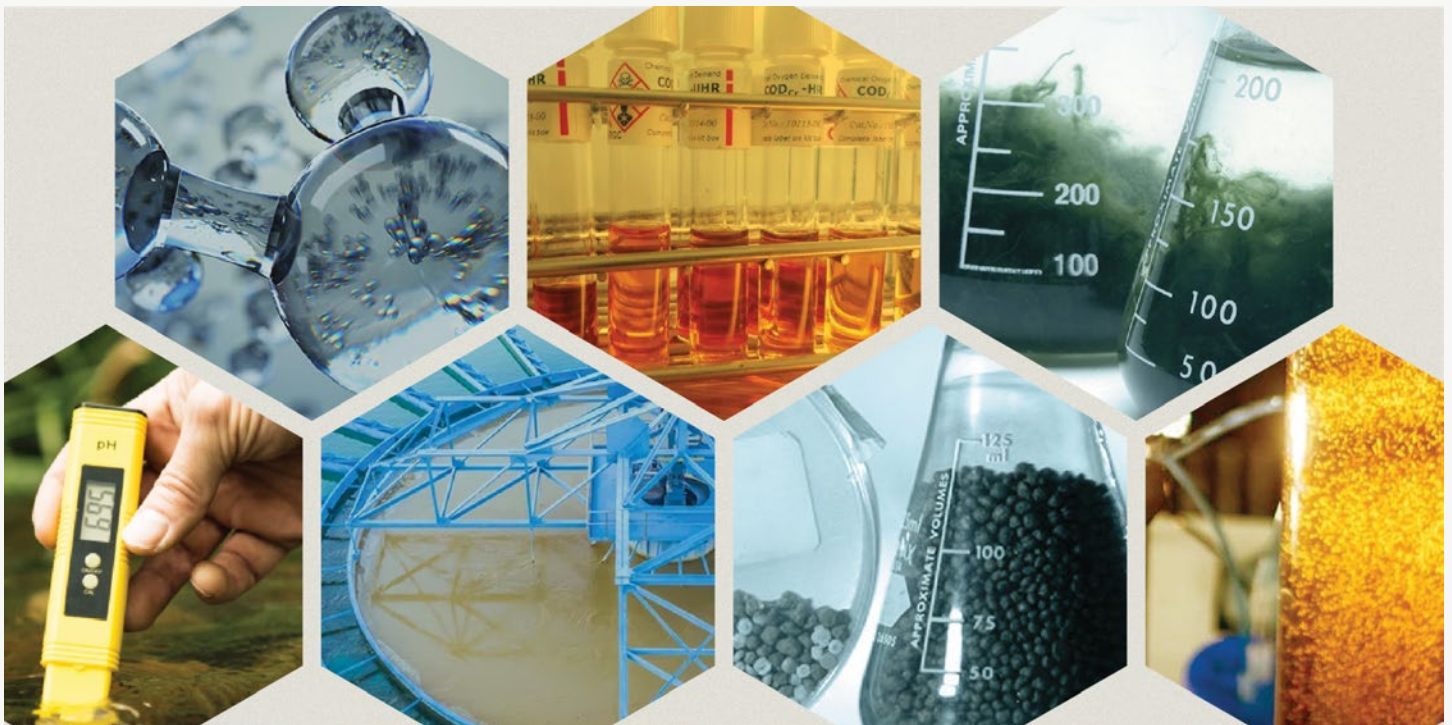
Effluent Data: Compliance, Surcharges, and Risks

Most facilities doing in-house water treatment have some data on their effluent for ensuring compliance with regulators and local utilities. For basic treatment, this usually means periodic testing for key parameters like BOD, COD, TSS, nutrients, and pH. However, facilities who treat data as a secondary priority often face the largest challenges when something goes unexpectedly wrong. Systems can work for years without issue, but for those who do not

have a complete picture of their effluent data, the consequences can quickly become a major hindrance.

Testing levels for the key parameters listed above typically define how a facility is viewed by regulators and utilities. Those who consistently remain below defined levels can become complacent, and for those who are facing small surcharges, it can simply become the cost of doing business. But what if things change? Often, facilities who overlook these small issues face significant challenges when new surcharges or high capital requirements arise unexpectedly. By implementing robust effluent data collection, facilities are much better equipped to anticipate surcharge exposure and long-term treatment costs.

Additionally, meeting permit limits does not always mean avoiding surcharges. Many facilities remain “in compliance” while paying avoidable fees due to how municipalities structure volume and concentration-based charges. The added pressure on utilities in recent years has also led to restrictions in their capacity to handle unexpected increases in high-strength treatment streams. As such, the costs of inconsistent effluent data continue to rise for industrial clients. Regular, reliable data collection enables facilities to ensure they understand not just compliance status, but cost drivers over time.



Many water-intensive facilities track essential effluent characteristics, but often lack the processes to comprehensively predict and respond to anomalies in real time.

Influent Data: Designing Pretreatment for Real-World Conditions

While effluent is typically the central focus for wastewater teams, the best systems also have a strong understanding of their influent requirements, as well as any pretreatment needed. This is especially true in industries that require strict water makeup for production, such as electronics, pharmaceuticals, textiles, and steel production, as well as those who are re-using water for production purposes, such as closed-loop or ZLD systems. For these sectors, influent quality affects every downstream process, not just their effluent. By maintaining a real-time picture of incoming water, they can design a system that matches the variability of real-world operating conditions.

In many cases, given the additional operational challenges of maintaining influent and effluent data streams, influent data is measured by extrapolating averages. However, this can create inconsistent data sets, smoothing out the very events that cause operational failures. Short-term peaks in flow or loading can overwhelm systems, even when daily averages appear normal. It is critical for facilities to maintain a multi-faceted data collection system, as focusing around averages or a single “typical” value ignores peaks, shocks, and variability that ultimately drive treatment risk and cost. In doing so, they extend the life of their equipment and protect further system damage downstream.

Effective pretreatment starts with understanding what’s truly entering the system. Working off assumptions or incomplete datasets can be devastating to production in ways that take significant time and effort to identify. When variability is overlooked, systems either become massively oversized to compensate or under-built and creating chronic issues. Both scenarios increase lifecycle cost and operational pain. By working to avoid relying on assumptions or legacy data, facilities can implement targeted pretreatment rather than taking a reactive approach or blanket over-engineering.

Understanding Variability: Normal Fluctuation or Red Flag?

Key to data collection, both influent and effluent, is the understanding of variability in water streams. Of course, not all variability is bad. There is a reason most water requirements are set by ranges and maximum levels, not exact numbers. Even the most robust, modern systems face fluctuations in output. However, it is still essential that teams have a strong understanding of these variations and their sources. By distinguishing routine seasonal shifts from internal production or process-driven changes, it becomes much easier to accurately interpret data and identify anomalies from equipment failures or other external factors.

Implementing trend-based indicators also allows teams to catch problems earlier than those

who solely watch for systems exceeding set parameters. By watching how fast and how much these parameters change, operators are typically able to intervene long before issues escalate. In making a concerted effort to understand their "normal" operating conditions, facilities can be much better prepared for these fluctuations, enabling calm and predictable responses. Proactive planning removes the need for emergency chemical usage, unplanned waste hauling, or any expensive operational fixes that could inflate costs.

Notably, facilities who maintain well-documented, time-series data are also much better situated to work with their municipality in the case of unexpected effluent fluctuations. Coming from a position of comprehensive knowledge of their production's output provides defensibility during audits and enforcement actions. Additionally, it allows facilities to demonstrate control, respond quickly to anomalies, and avoid reactive, high-cost responses under regulatory pressure.



As operations scale, so do the financial and operational effects of poor data collection practices.

Understanding Variability: Normal Fluctuation or Red Flag?

As we've noted above, there are countless ways that poor data quality and management can create added costs for wastewater systems. Unfortunately, when communication fails and a systems' accuracy drops, many of these can quickly become hidden costs that tick up in the background unnoticed. For example, incomplete or low-resolution data can obscure when surcharge thresholds are repeatedly crossed. Over time, these can get chalked up to the cost of doing business, slowly becoming meaningful, and often invisible, operating expenses.

Additionally, some issues have many potential sources, which, in lacking proper data, can make them exceedingly difficult to diagnose, fix, and most importantly, prevent in the future. Equipment degradation and process drift are some of the most common examples. As a piece of equipment, such as a membrane or filter, experiences excessive wear or fails, the issue compounds, creating countless new downstream challenges. Often, once these secondary failures become visible, they are far more difficult to fix than proactively replacing the part or making the needed changes before it fails.

When designing treatment trains, those who do so based on weak data tend to overbuild to cover gaps in their knowledge. In these situations, engineers tend to design for worst-case scenarios. This practice, while understandable from an engineering standpoint, causes facilities to end up locked into higher capital and operating costs on unnecessary equipment that persist for decades. Unfortunately, even an overbuilt system cannot make up for poor data quality, as these gaps can mask excess wear and stress on the system. Without clear, trend-based and historical data, components are often replaced either too early, or too late, shortening their useful life and creating unnecessary costs.

Let's Talk

Whether you're exploring a new operational model or looking to upgrade without the capital, Cambrian is ready to partner for long-term success.

Your next liquid asset is already on site. Let's put it to work.

Schedule a conversation with Cambrian:

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