

Continuous ammonium and nitrate monitoring helps Ohio EPA troubleshoot biological nutrient removal

Online monitoring reveals process conditions that grab samples can miss



VARiON sensor deployed in the final effluent

Ohio EPA's Compliance Assistance Unit helps water resource recovery facilities identify treatment problems, meet compliance targets, and maintain reliable performance under their NPDES discharge permits.

As nutrient limits became more common, the team needed a better way to evaluate nitrification and denitrification. Traditional field tests and grab samples remained useful, but they provided only snapshots of process conditions. Short-duration disturbances, overnight changes, and weekend events could occur between sampling rounds and go undetected.

To close that information gap, Ohio EPA evaluated an online [YSI IQ SensorNet](#) system for continuous ammonium and nitrate monitoring at the Millersburg, Ohio, wastewater treatment plant. The online measurements closely followed reference trends, remained stable through six weeks of operation, and helped the team identify biological treatment problems more quickly.

Facility

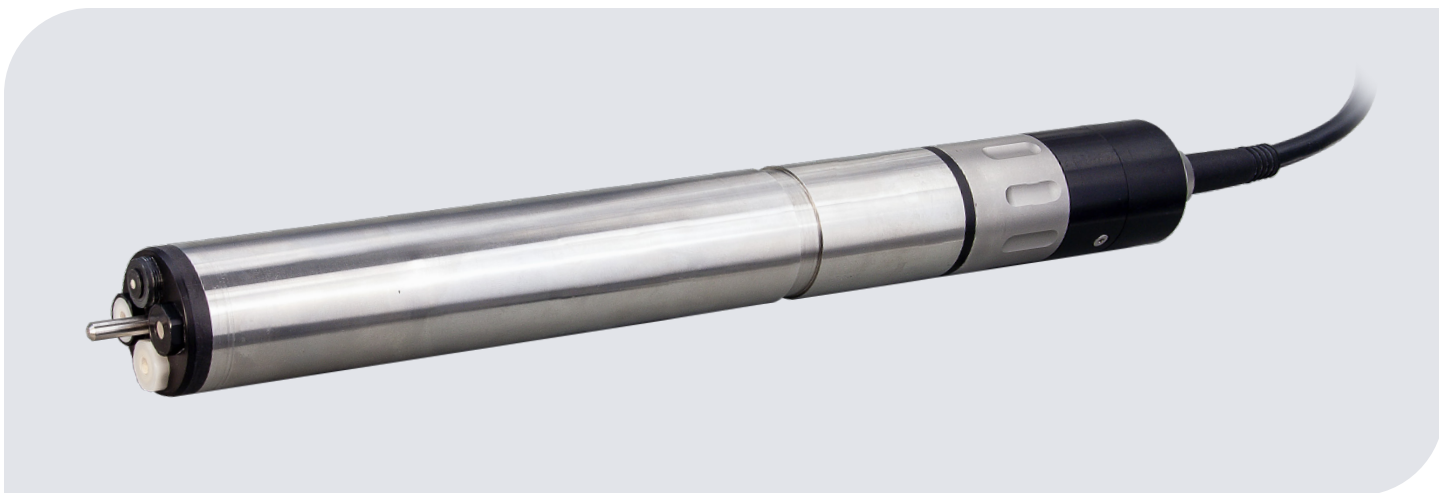
Millersburg Wastewater Treatment Plant, Ohio

Organization

Ohio EPA Compliance Assistance Unit

Project results

Continuous trend data supported faster identification and confirmation of biological treatment problems



IQ SensorNet VARIION sensor

The need for continuous process data

Ohio EPA's Compliance Assistance Unit has helped dozens of water resource recovery facilities investigate treatment problems and return to compliance. Its field toolkit has traditionally included batch-test equipment, handheld instruments, and laboratory or portable colorimetric methods.

Each tool serves an important purpose, but intermittent measurements cannot fully characterize a biological process that changes throughout the day. Grab samples show the conditions present at a single moment. They may not reveal when a process disturbance began, how long it persisted, or how the plant responded before and after the event.

This limitation is especially important at facilities facing stringent nutrient limits, where operators need a more complete view of nitrification and denitrification performance. Nitrification and denitrification are affected by changing influent loads, aeration, internal recycle rates, temperature, alkalinity, carbon availability, and other operating conditions. Problems may also occur overnight or during weekends when operators are not present to collect samples.

The Compliance Assistance Unit needed continuous measurements with data logging to capture these changing conditions and provide a more complete view of biological treatment performance.

Requirements for a practical troubleshooting system

Because the system would be used at multiple facilities, Ohio EPA needed a monitoring tool that was:

- **Continuous**, with data logging to reveal process changes between operator rounds
- **Low-maintenance**, particularly for smaller facilities with limited staff
- **Multiparameter**, allowing the team to evaluate ammonium, nitrate, and potential ionic interferences at the same time
- **Cost-effective**, with the potential to reduce troubleshooting time and unnecessary energy or chemical use

The system also needed to support field deployment without creating a complicated installation or requiring extensive new infrastructure.

The trial installation

YSI provided a trial IQ SensorNet system for evaluation at the Millersburg wastewater treatment plant.

Two [VARiON](#) ion-selective electrode sensors were installed:

- One sensor in the anoxic basin
- One sensor in the final-effluent channel

Each sensor was configured to measure ammonium and nitrate and included a compensation electrode, reference electrode, and temperature measurement.

The two monitoring locations were connected through the same IQ SensorNet network. A wireless communication module was used in the original installation to reduce the need for additional signal cabling between the measurement points.

Understanding ion-selective measurements

VARiON uses ion-selective electrode (ISE) technology to measure ammonium and nitrate directly in the process without reagents or sample transport.

Because ion-selective measurements can be influenced by other ions in the wastewater, proper commissioning is important. Compensation electrodes and a site-specific matrix adjustment help account for common interferences and align the online measurements with the wastewater characteristics at the installation.

Once the initial matrix adjustment was completed during the Millersburg trial, the measurements remained stable without further adjustment during the six-week evaluation.

Ammonium monitoring in the anoxic basin

Continuous ammonium readings from the VARiON sensor were compared with daily measurements from grab samples analyzed using a portable colorimeter.

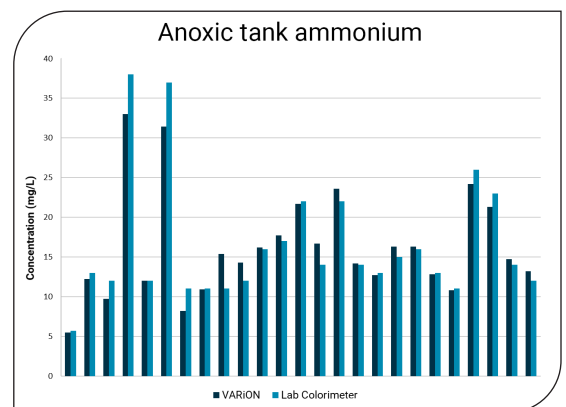
The two methods generally followed the same concentration trends and showed close agreement in most cases. The continuous sensor data also provided information between the daily reference measurements, allowing the team to see changes that would not have been captured through grab sampling alone.

The comparison demonstrated the value of pairing continuous trend data with periodic reference testing. Rather than relying on isolated measurements, the team could evaluate both the current concentration and the pattern of change over time.



A VARiON sensor was installed in the anoxic basin to continuously monitor ammonium and nitrate during the trial.

A site-specific matrix adjustment helps account for wastewater composition and supports reliable continuous nitrate and ammonium measurements.



Continuous ammonium measurements in the anoxic basin generally followed the same trends as daily colorimeter measurements while providing additional visibility between sampling events.

Comparing measurements in the final effluent

At the final-effluent location, VARiON measurements were compared with readings from the plant's existing cabinet analyzer and with grab-sample measurements.

The VARiON sensor and cabinet analyzer followed similar concentration trends, although the VARiON generally reported values approximately 0.5 to 2.0 mg/L higher. The portable colorimeter results sometimes agreed more closely with VARiON and at other times more closely with the cabinet analyzer.

The comparison did not conclusively establish that one method was more accurate than the others. Instead, it highlighted an important consideration for online monitoring: operators should evaluate both trend agreement and site-specific measurement bias.

Continuous process sensors should be commissioned and verified using an appropriate reference method. When a consistent offset is observed, a matrix adjustment or other site-specific correction may be required.

Why trend data matters

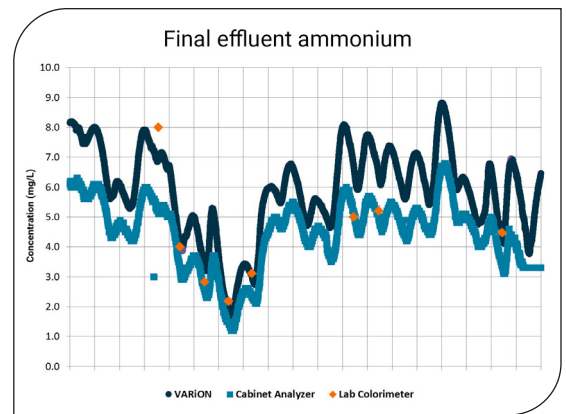
For process troubleshooting, the value of continuous monitoring extends beyond agreement with a single grab sample.

Trend data can help operators and technical staff determine:

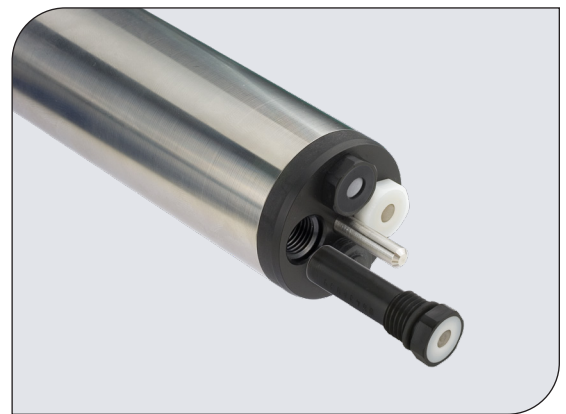
- When ammonium breakthrough begins
- Whether nitrification is stable throughout the day
- Whether nitrate is being removed effectively in the anoxic zone
- How the process responds to aeration or recycle changes
- Whether disturbances occur during unattended periods
- Whether a problem is isolated or recurring
- Whether corrective action produces a measurable response

This information helps narrow the range of possible causes and allows troubleshooting teams to focus their field investigations more efficiently.

Grab samples remain important for reference verification and compliance testing, but they do not provide the same time-based view of the treatment process.



VARiON and the existing cabinet analyzer followed similar final-effluent ammonium trends, although a consistent difference in reported concentration was observed.



VARiON features individually replaceable electrodes, allowing operators to replace only the ammonium, nitrate, potassium, chloride, or reference electrode that has reached the end of its service life, helping reduce maintenance costs and unnecessary waste.

Continuous ammonium and nitrate trends helped Ohio EPA identify and confirm biological treatment problems faster than intermittent sampling alone.

From trial system to field troubleshooting tool

The evaluation demonstrated that IQ SensorNet could provide the continuous ammonium and nitrate measurements Ohio EPA needed for troubleshooting nitrification and denitrification.

Based on the results, the Compliance Assistance Unit acquired two VARiON sensors, an IQ SensorNet controller, and communication equipment for deployment at multiple measurement locations.

The team subsequently used the system at other wastewater facilities. Continuous measurements helped identify and confirm treatment problems more quickly, saving troubleshooting time and improving the productivity of the Compliance Assistance Unit.

Conclusion

Grab samples remain essential for reference verification and regulatory compliance, but they cannot fully characterize a biological process that changes hour by hour.

During the Millersburg evaluation, continuous ammonium and nitrate measurements provided Ohio EPA with a more complete picture of nitrification and denitrification. The system revealed treatment trends between sampling events, closely followed reference measurement patterns, and remained stable during six weeks of wastewater operation.

Based on the trial, the Compliance Assistance Unit adopted IQ SensorNet as a troubleshooting tool for use at multiple facilities. Continuous monitoring helped the team identify and confirm problems more quickly while complementing its existing field and laboratory methods.

Acknowledgments

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YSI also acknowledges Kevin Vaughn, superintendent of the Millersburg wastewater treatment plant, and the facility staff for serving as the test site and performing reference measurements.

Reliable operation in a wastewater environment

Some solids and biological buildup developed on the sensors during the trial, as expected in an activated-sludge application.

Despite the visible accumulation, measurement reliability was not adversely affected during six weeks of continuous operation. The initial matrix adjustment remained stable, and no additional adjustment was required during the evaluation period.



Some buildup was visible after six weeks of continuous operation in the anoxic basin, but the sensor continued to provide usable process measurements.

YSI Inc.
1725 Brannum Lane
Yellow Springs, OH 45387

Tel +1 1937.688.4255
ysi.info@xylem.com
ysi.com

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