Application Note

Upgrading Your NOx Experience with the NT3100sc Nitrate Sensor

Monitoring Nitrate and Nitrite (NOx)

In wastewater systems where forms of nitrogen are limited by permit regulations or in systems where monitoring is required, nitrate and nitrite (NOx) concentrations through the system should be understood. Nitrate and nitrite play a role in wastewater treatment, sometimes more than we realize.

NOx monitoring can of course be done in the lab, but online monitoring provides important benefits and visibility to help produce a stable and cost-effective treatment system. Accuracy and reliability paired with a level of simplified maintenance is associated with many Hach products. The Hach Nitratax NOx sensor is well established here and has been a solid device for over 20 years. When replacement products come out, there can be differences in calibration procedures, sensor configurations, and applications. This note will cover findings from the field to apply to the new Hach NT3100sc sensor and provide comparisons between the sensors.

Anoxic

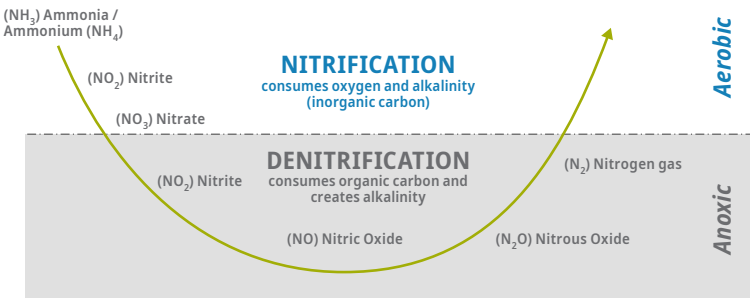
Oxic

Background: Nitrogen

Nitrification and denitrification efficiency and stability depends on many factors: proper pH, alkalinity, dissolved oxygen (DO), temperature, available carbon, solids retention time (SRT), internal mixed liquor recycle rates (IMLR), and anoxic conditions among other factors for each respective biological system.

Nitrification converts ammonia/ammonium to nitrate in oxic conditions with a stable population of nitrifying bacteria, proper oxygen (DO), alkalinity, pH, temperature, and solids retention time (SRT).

Denitrification converts nitrate ultimately to nitrogen gas (N_2) where it's removed from the system in anoxic conditions with adequate readily biodegradable carbon, proper detention time, temperature, and void of free oxygen (DO). If the system has an internal recycle (IR or IMLR) to aid in denitrification, proper recycle rates should be monitored. External carbon dosing is used when not enough carbon is available to meet denitrification needs.



Anoxic zone nitrate monitoring is important to understand the effectiveness of denitrification. In systems with swing zone capability online monitoring can be an indicator to facilitate either anoxic or oxic swing zone requirements.

In systems that perform biological phosphorus removal (BPR), nitrates should be monitored in a return activated sludge (RAS) flow that enters the anaerobic zone. Nitrates entering this zone reduce or stop key functions of biological phosphorus removal in this stage.

In activated sludge mixed liquor (ML), the concentration of nitrate and nitrite (NOx) at the end of the biological system before it enters secondary clarification is important to understand. Improper solids retention time (SRT) can lead to excessive solids detention in secondary settling and if nitrite/nitrate concentrations are high, this can lead to floating sludge, clarifier blanket denitrification and high effluent solids among other issues.

Effluent NOx monitoring may be needed for understanding total nitrogen (TN) or total inorganic nitrogen (TIN). In addition, incomplete denitrification can lead to increased chlorine disinfection costs due to nitrite demand.

Wastewater treatment is complex and monitoring treatment processes produce challenging environments that the equipment and staff must operate in. New products are being developed regularly to deal with these conditions. Changing needs in process control and/or new regulatory requirements can drive the introduction of new technology for wastewater monitoring. Technology companies also have internal drivers that weigh in on improvements to existing products from reliability and accuracy

to cost reductions that help produce quality products at a better value to end users.

When an existing product has a legacy of great performance it can be a concern for end users to move to a new product. Finding the balance of support, accuracy and cost is important in supporting our municipalities, industries, and the communities we help provide clean water to.

The Hach Nitratax has been the industry leader in monitoring nitrates for over 20 years, its successor needs to match that reputation. The new Hach NT3100sc sensor has entered the market with a design that incorporates the strengths of Nitratax with a production value that provides a solid cost reduction for end users. The question is how does it perform and how can we get the most value from this sensor?

In a case study conducted with a freshly serviced Nitratax and a new NT3100sc, these sensors were put to the test at a municipal Water Resource Recovery facility in the western US. The sensors were placed next to each other just downstream of a swing zone and set up to measure NOx-N. Both sensors were equipped with 2-mm optical path length (OPL), configured with identical settings, and then adjusted to the wastewater solids using available calibration procedures.

Comparing performance:

While the sensor design principals are the same between the Nitratax and NT3100sc, there are some differences in how to achieve the best performance. Both sensors have an option for using a factor or an offset adjustment to compensate for wastewater interferences such as water turbidity and other absorbing compounds.

Figure 1 demonstrates that the difference between using a factor vs an offset may be significant for each unit. Using the factor adjustment produced large differences between the sensors at multiple concentrations. In this test the factor values for each sensor were calculated at higher daily concentrations, therefore when total NOx values were low, the sensors did not compensate for the loss of NOx as well, as seen in the left graphs and lab reference of Figure 1.

The graphs to the right show data from when the factor was removed, and an offset was calculated and applied. The offset calculation was done at higher daily concentrations as well. With the offset in place the data between the sensors became much tighter and each sensor was able to compensate properly even when total NOx concentrations were low. Lab comparison data confirms the improved accuracies as seen in Figures 1-4.

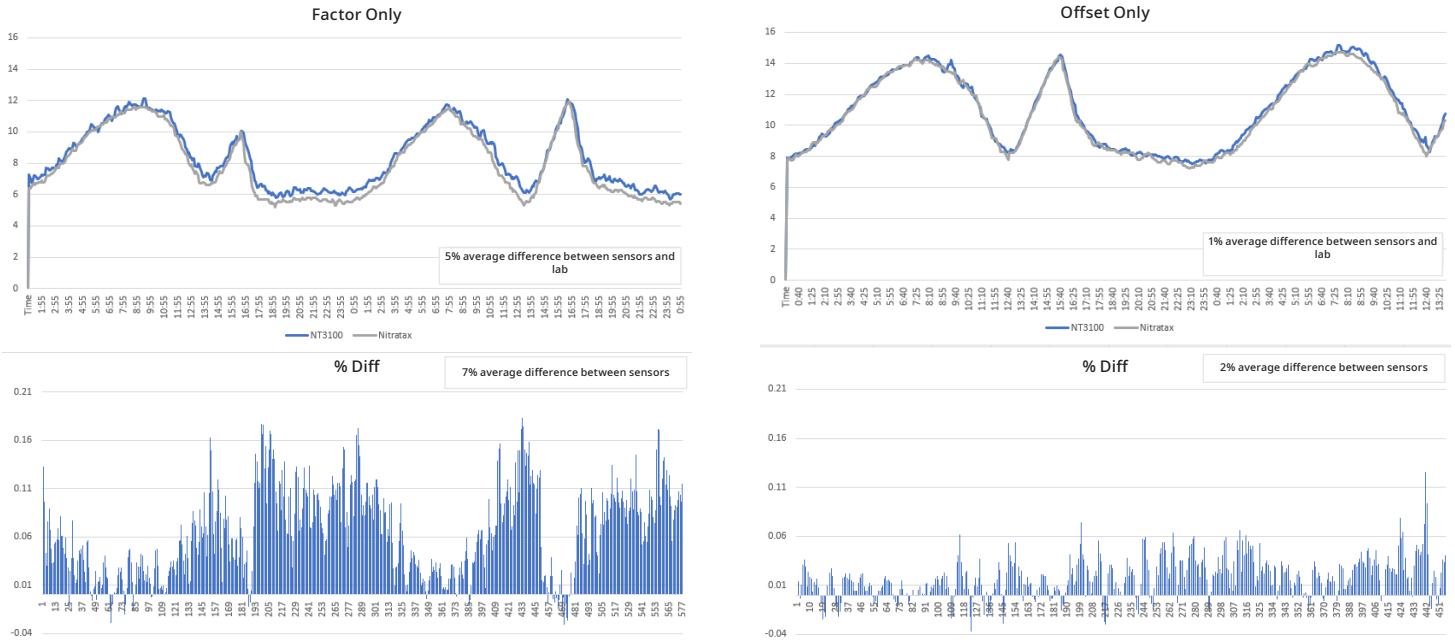


Figure 1. Demonstration of effectiveness of Factor vs Offset when comparing NT3100sc and Nitratax.

Lab Comparison

Data in Figures 2-4 represent weeks of online values and overlaid lab data. All samples were filtered immediately at the sampling point (aeration basins) and then taken to the lab. The samples were analyzed using a Hach DR6000 Spectrophotometer and TNT 835 for Nitrate and TNT 840 methods for Nitrite. All results are expressed as NOx-N, (Nitrite + Nitrate), solids/absorbance compensation for factors and offsets were done using NOx-N.

The data shown in Figure 2 shows the NT3100sc performed well with a factor adjustment compared to lab values.

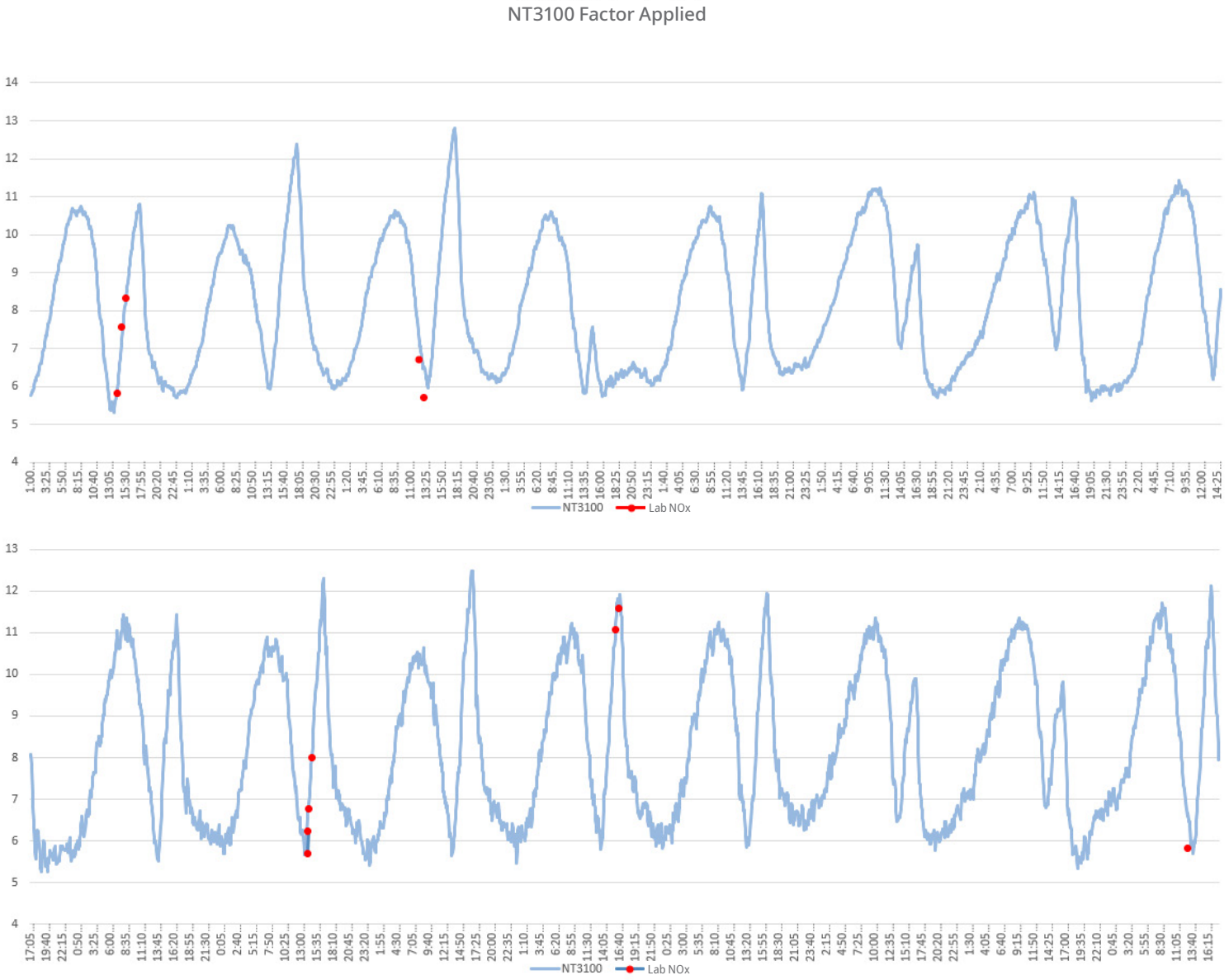


Figure 2. Demonstration of effectiveness of Factor when comparing laboratory analysis to NT3100sc.

The data shown in Figure 3 shows further improvement in the sensor values to the lab when an offset was used instead of a factor.

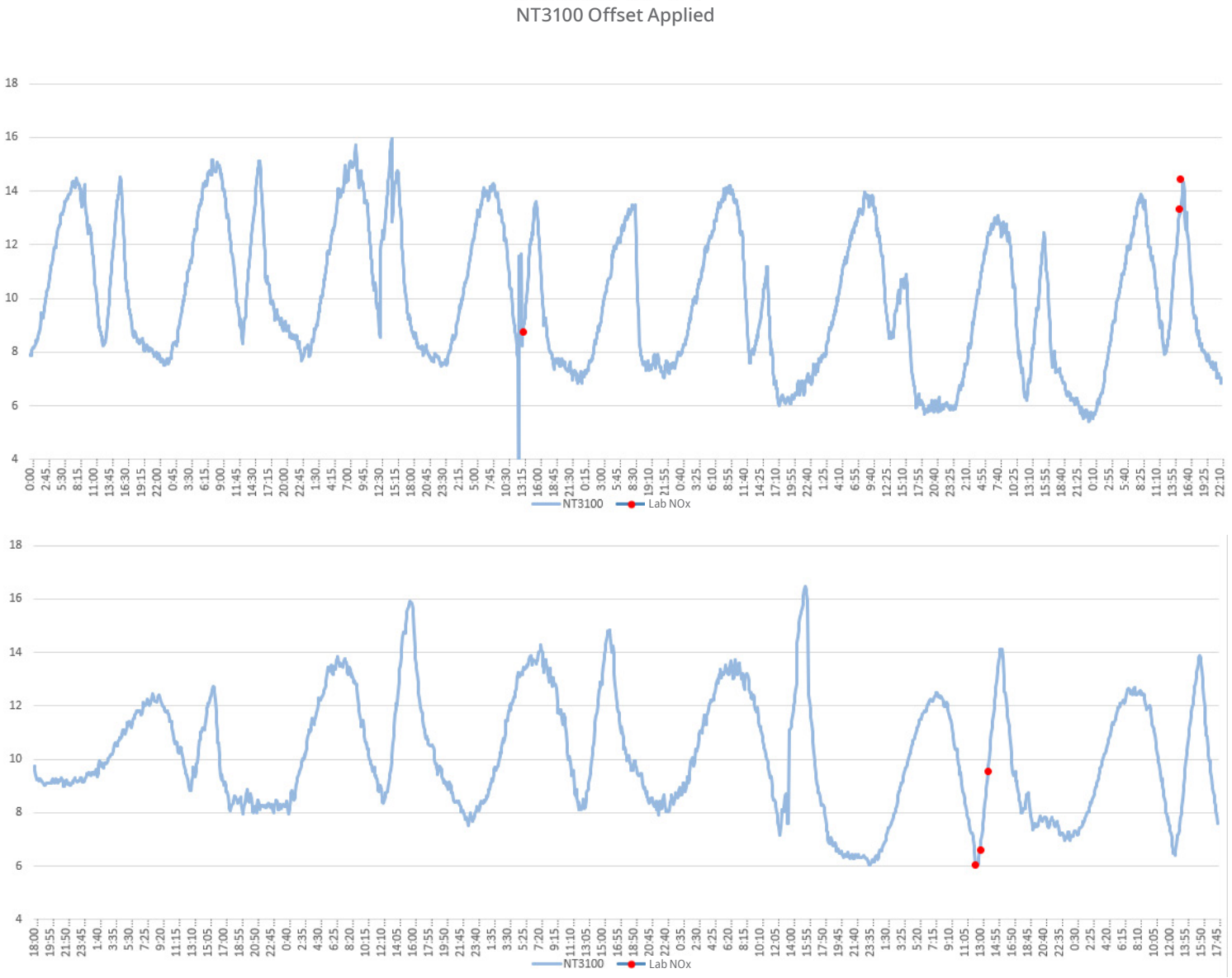


Figure 3. Demonstration of effectiveness of Offset when comparing laboratory analysis to NT3100sc.

The data in Figure 4 shows the deviations between each sensor and lab measurements. Using a factor produced a variance to the lab from 0 - 15%. Using an offset produced variance to the lab from 0 - 5%. With an offset in place, the municipal wastewater Process Analyst at the site comments: *"Those values are wet-chemistry analyzer accuracies."*

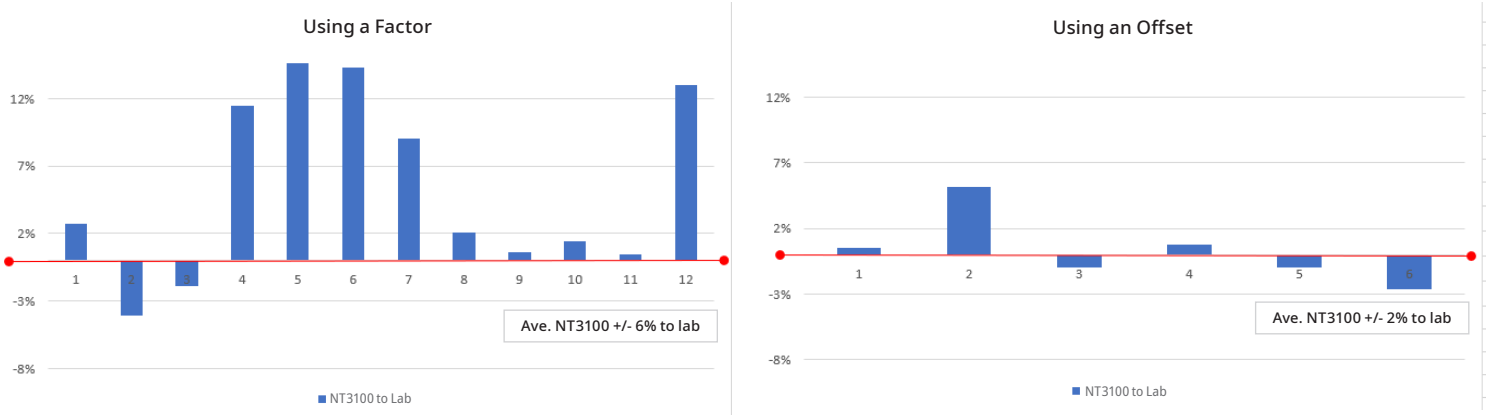


Figure 4. Demonstration of the comparison when using a Factor vs Offset on NT3100sc when comparing to laboratory analysis.

Sensor Maintenance: Nitratax vs NT3100sc

Another consideration when selecting any online sensor is maintenance. The Nitratax was a groundbreaking technology for accurately measuring nitrates in challenging water and wastewater application without the need for reagents or even filtration in most applications.

In the same way, the NT3100sc has taken that design and added improvements to maintenance. A notable improvement is the toolless wiper change. The Nitratax used a cap to secure the wiper that required time and careful attention to change. The new sensor design allows for a quick change without a cap, or any tools as shown below.

Nitratax wiper replacement using a tool to remove and replace the wiper cap:

NT3100sc wiper replacement done without tools:

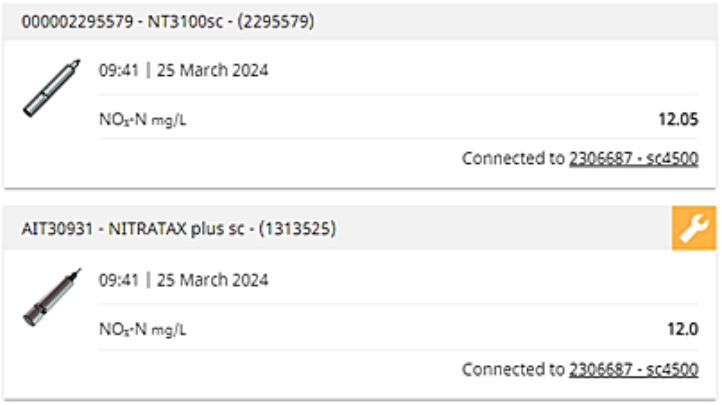
In additon to simplified wiper replacement other wear items for the NT3100sc have been improved to allow for longer replacement cycles. Some wear part replacement cycles remain the same as Nitratax but a few larger ones have improved from 12 month replacement to 24 month replacement schedules.

Conclusion

Several critical factors come into play when selecting a new sensor or replacing an existing one: accuracy, ease of maintenance, reliability, and manufacturer support. After multiple weeks of field testing and operator maintenance activities, it becomes evident that the new NT3100sc sensor stands out as an exceptional choice for our complex wastewater environment. It's important to understand next generation sensors are not always identical in operation. Improvements to technology sometimes warrant new or different procedures to make sure the best performance is achieved. The NT3100sc performs the best by always calculating and applying an offset on startup and/or when the water matrix is expected to be different such as after significant process changes or moving the sensor to a new location.

Accuracy is paramount and the NT3100sc delivers. The sensor achieved an average accuracy of +/- 2% when compared to lab measurements. Considering the intricacies of sampling techniques, lab methods, sample timing, and the dynamic nature of wastewater conditions, these results are excellent. Moreover, on average, the NT3100sc exceeded our engineering specifications, outperforming the published +/- 4% lab accuracy threshold.

Maintenance for the new NT3100sc proved to be much simpler and faster than its predecessor. The staff at the municipality were pleased to not have to deal with the "stupid cap" from the Nitratax when replacing the wiper. The maintenance was straight forward and fast. Once a month, sensor optics are rinsed with water and cleaned with a standard spray cleaner as detailed in the manual. The toolless wiper needs changing only every 2-3 months, depending on settings.



In summary, the NT3100sc sensor emerges as a reliable and efficient solution, combining accuracy, simplified maintenance, and value. It's a testament to progress in wastewater monitoring technology.

World Headquarters: Loveland, Colorado USA | hach.com

United States	**800-227-4224**	fax: 970-669-2932	email: orders@hach.com
Outside United States	**970-669-3050**	fax: 970-461-3939	email: int@hach.com

DOC043.53.30795.Jun24