



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 11, 2022

Mr. Shaun Sharrett
Swan Analytical USA, Inc.
225 Larkin Drive, Unit 4
Wheeling, Illinois 60090

Subject: Clarification for the Use of an Alternative Technology to Monitor the Turbidity in Drinking Water Produced by Membrane Units at Public Water Systems in Texas

Dear Mr. Sharrett:

On November 2, 2020, the Texas Commission on Environmental Quality (TCEQ) received an email from Swan Analytical USA, Inc., requesting the approval to use an alternative membrane turbidity monitor method to the Hach FilterTrak Method 10133 specified in Title 30 of the Texas Administrative Code (30 TAC) §290.42(g)(3)(C) and 30 TAC §290.111(f)(3)(B) for individual filter effluent turbidity measurements from membrane units provided for pathogen removal. You provided additional support documentation on July 6, 2021 and November 10, 2021. The request is for the use of the **AMI Turbiwell White LED (W/LED)** turbidimeter manufactured by SWAN Analytical USA, Inc. (SWAN), which does not utilize Hach FilterTrak (FT) Method 10133.

Your submittal included the following documentation:

- The turbidity method for the Swan AMI Turbiwell W/LED turbidimeter (Continuous Measurement of Turbidity Using a Swan AMI Turbiwell Turbidimeter, August 10, 2009, Swan White LED Method);
- SWAN AMI Turbiwell W/LED Operator's Manual, Version 6.23 and higher (A-96.250.511 / 230919);
- SWAN AMI Turbiwell W/LED Data Sheet (Data Sheet No. DenA25411700X);
- SWAN AMI Turbiwell Calibration Procedure;
- SWAN AMI Turbiwell GBRA Western Canyon Approval Request, which included test site data for one (1) facility and support documentation; and
- A copy of the Federal Register, Vol. 74, No. 216, Tuesday, November 10, 2009, Rules and Regulations, which contains United States Environmental Protection Agency (US EPA) approval for the SWAN AMI Turbiwell turbidimetric method.

The TCEQ evaluated the information submitted by Swan to consider the use of the SWAN turbidity measurement method as an alternative membrane turbidity monitor method to the Hach FT Method 10133.

Based on our review of the supporting information you have submitted, the proposed SWAN method and turbidimeter described below are **approved** by the TCEQ as an alternative membrane turbidity monitor method and technology for individual filter effluent turbidity measurements from membrane units provided for pathogen removal, as per 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B). A public water system (PWS) will not be required to submit an exception request

to the TCEQ Technical Review and Oversight Team for the use of the TCEQ-approved SWAN method and turbidimeter listed below:

- Method: The SWAN Continuous Measurement of Turbidity Using a SWAN AMI Turbiwell Turbidimeter, August 10, 2009; and
- Turbidimeter: SWAN AMI Turbiwell W/LED (SWAN Order Number A-25.411700.1)

Site Specific Design, Operation, Maintenance and Reporting Requirements

The TCEQ has determined that to satisfy the intent of 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B), PWSs that utilize a TCEQ-approved SWAN turbidimeter will be required to meet TCEQ's rules to use an alternative membrane-turbidity-monitor. The following requirements apply to the use of a SWAN AMI Turbiwell W/LED turbidimeter used by a Texas PWS to meet the indirect integrity monitoring requirements for individual filter effluent turbidity measurements from membrane units provided for pathogen removal stated in 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B):

- This TCEQ alternative membrane-turbidity-monitor method approval applies only to the SWAN method and turbidimeter stated in this approval letter. The approval does not apply to future revisions of the SWAN methods and does not apply to any design changes to the SWAN AMI Turbiwell W/LED turbidimeter;
- Accuracy of an alternative turbidity method turbidimeter must be verified once every seven (7) days, as per 30 TAC §290.46(s)(2)(B)(iv) and Appendix G: Equipment Calibration (Enclosure 1) of the TCEQ Regulatory Guidance document 211 (RG-211);
- Calibration of the alternative turbidity method turbidimeter must be performed once every ninety (90) days, as per 30 TAC §290.46(s)(2)(B)(iii) and must meet Quality Control Sample (QCS) criteria specified in the vendor methods;
- Records of calibrations and verifications must be maintained onsite by a PWS for a period of at least three (3) years and be available for TCEQ staff to review upon request as per 30 TAC §290.46(f)(3)(B)(iv);
- Individual Filter Effluent (IFE) readings must be maintained by a PWS for a period of at least five (5) years and be available for TCEQ staff to review upon request as per 30 TAC §290.46(f)(3)(C)(iv); and
- Records of a PWS's turbidity monitoring data must be recorded in the PWS Monthly Operating Reports (MOR) and the PWS is required to keep the MOR onsite for ten years, in accordance with 30 TAC §290.46(f)(3)(E)(i). MORs are required to be available for TCEQ staff to review upon request.

Basis for Approving the Request

The requirements in 30 TAC §290.46(s)(2)(B)(iv) contain a provision which allows for the use of a comparison method to verify the accuracy of an online turbidimeter. Guidance for the comparison method in 30 TAC §290.46(s)(2)(B)(iv) is detailed in Appendix G of RG-211. RG-211 provides a method for comparing on-line turbidimeters with bench top turbidimeters but does not provide criteria for comparing on-line turbidimeters in use on membrane units with other on-line turbidimeters. The TCEQ used the RG-211 comparison criteria as the basis for determining comparison criteria when the instruments being compared are on-line turbidimeters for use on membrane systems provided for pathogen removal. For the studies summarized in this letter, the criteria in RG-211 was adjusted to account for the low turbidity levels found in water treated by membrane units and the low regulatory turbidity trigger levels set by the EPA and the TCEQ (see Figure 1).

Figure 1: Comparison Criteria used to Analyze Alternative Turbidity Methods for Individual Filter Effluent Turbidity Measurements from Membrane Units Provided for Pathogen Removal

NTU Range	Requirement
≤1.0 NTU	On-line turbidimeter reading cannot differ by more than 0.05 NTU from a reference turbidimeter reading (±0.05 NTU difference).
>1.0 NTU	On-line turbidimeter reading cannot differ by more than 10% from a reference turbidimeter reading (±10% difference).

The decision to approve these turbidimeters for use by Texas PWSs for individual filter effluent turbidity measurements from membrane units provided for pathogen removal was based on the following substantiated documentation. This documentation was used to determine if the SWAN AMI Turbiwell W/LED turbidimeter generated results that are comparable to a Hach FT 660 turbidimeter.

- You submitted the following information for the SWAN AMI Turbiwell W/LED turbidimeter:
 - The SWAN Continuous Measurement of Turbidity Using a SWAN AMI Turbiwell Turbidimeter, August 10, 2009.
 - The Federal Register, Vol. 74, No. 216, Tuesday, November 10, 2009, where the SWAN AMI Turbiwell Method is approved by the EPA as “equally effective relative to approved EPA Method 180.1.”
 - The SWAN AMI Turbiwell Operator’s Manual, A-96.250.511 / 230919, Revision 8. The manual contains specifications, operation details, calibration, and calibration verification instructions for the SWAN AMI Turbiwell turbidimeters.
 - The SWAN Analytical Instruments AMI Turbiwell Calibration Procedure which details the materials, solutions, and instructions necessary to calibrate the turbidimeter.
 - The SWAN Analytical Instruments AMI Turbiwell W/LED Data Sheet No. DenA25411700X, which details specifications, model numbers, and electrical connection scheme for the turbidimeter.
 - Test site data from San Jacinto River Authority (SJRA) GRP Surface Water (SW) Treatment Plant public water system (TCEQ PWS ID: 1700822). The comparison testing was performed at the SWTP - 11998 Pine Valley Drive (TCEQ Facility ID No.: TP410875) water treatment plant, which is a conventional filtration plant with flocculation coagulation and multi-media filtration which treats surface water.

The test site data includes the following:

- Quality assurance information, to include standard preparation and analytical results for calibration verification and quality control standards; and
- Side-by-side comparison test results between the SWAN AMI Turbiwell W/LED and a Hach FT 660 turbidimeter.

SJRA GRP SW Comparison: The results of the comparison testing conducted at the SJRA GRP SW site are summarized in Tables 1 through 5. The data included a total of 15 weekly standard verification measurements made using primary standards to create a 0.100 NTU standard solution for the SWAN AMI Turbiwell W/LED turbidimeter and weekly readings from a Hach Verification Quick Check Kit for the Hach FT660 turbidimeter. The study also included 10,883 parallel readings from each turbidimeter for effluent from a membrane treatment unit in use at the SJRA GRP SW treatment facility.

Table 1: 0.100 NTU Weekly Standard Verification for SWAN AMI Turbiwell W/LED turbidimeter

Average Result of 0.100 NTU Standard	0.100 NTU Range of %Recovery	Lowest 0.100 NTU Verification Standard	Highest 0.100 NTU Verification Standard	% Relative Standard Deviation of 0.100 NTU Verification Standards
0.101 NTU	93.0 - 108.0%	0.093 NTU	0.108 NTU	3.77%

Table 2: 1.11 NTU Weekly Standard Verification for SWAN AMI Turbiwell W/LED turbidimeter

Average Result of 1.11 NTU Standard	1.11 NTU Range of %Recovery	Lowest 1.11 NTU Verification Standard	Highest 1.11 NTU Verification Standard	% Relative Standard Deviation of 1.11 NTU Verification Standards
1.116 NTU	98.2 - 103.6%	1.09 NTU	1.15 NTU	1.82%

Table 3: 0.037 NTU Weekly Standard Verification for Hach FT660 Turbidimeter

Average Result of 0.037 NTU Standard	0.037 NTU Range of %Recovery	Lowest 0.037 NTU Verification Standard	Highest 0.037 NTU Verification Standard	% Relative Standard Deviation of 0.037 NTU Verification Standards
0.038 NTU	94.6 - 113.5%	0.035 NTU	0.042 NTU	7.25%

Table 4: 0.040 NTU Weekly Standard Verification for Hach FT660 Turbidimeter

Average Result of 0.040 NTU Standard	0.040 NTU Range of %Recovery	Lowest 0.040 NTU Verification Standard	Highest 0.040 NTU Verification Standard	% Relative Standard Deviation of 0.040 NTU Verification Standards
0.041 NTU	95.0 - 110.0%	0.038 NTU	0.044 NTU	4.72%

With the exception of one 0.037 NTU verification standard reading for the Hach FT660 turbidimeter, the standard verification recoveries summarized above meet the $\pm 10\%$ quality control criterion stated in Environmental Protection Agency (EPA) Method 180.1: Determination of Turbidity by Nephelometry. As per Appendix A of Title 40, Chapter I, Subchapter D, Part 141, Subpart C (40 CFR §141), the SWAN method dated August 2009 is an EPA approved alternative test method for EPA Method 180.1.

For the one verification standard which was greater than the $\pm 10\%$ EPA Method 180.1 quality control criterion, the TCEQ review notes that a Hach proprietary verification standard was used which has a ± 0.05 NTU quality control limit and that at low NTU levels (< 0.15 NTU), percent recovery can vary greatly with small variances in NTU. The use of the Hach Verification Quick Check verification standard and the associated ± 0.05 NTU quality control limit are acceptable for the purposes of the SWAN comparison study.

A comparability study was performed on membrane effluent water at 0.0227 NTU (average turbidity levels). For the study, 10,883 replicates of membrane effluent water were analyzed at ten-minute intervals from July 13, 2019 through October 24, 2019. The average turbidity level NTU referenced in Table 5 is based on the Hach FT 660 readings. The results of the special study are shown in Table 5 below.

Table 5: Average Turbidity Level: 0.0214 NTU (Membrane Effluent Water)

Turbidimeter	Average Result of 0.0214 NTU Standard	Average (AVG) Absolute Difference (ABS DIFF) from Hach FT660	AVG % Deviation from Hach FT660	Minimum ABS DIFF / % Deviation from Hach FT660	Maximum ABS DIFF / % Deviation from Hach FT660
Hach FT 660	0.0214 NTU	n/a	n/a	n/a	n/a
SWAN AMI Turbiwell	0.0240 NTU	0.0068 NTU	28.98%	0.0000 NTU / 0.0020%	0.1209 NTU / 162.25%

The comparison study performed on low NTU level membrane effluent demonstrates that at turbidity levels below 0.15 NTU, the SWAN AMI Turbiwell turbidimeter **produces comparable results** to a Hach FT 660 turbidimeter. As noted in Table 5, the average turbidity levels during the study were less than 0.03 NTU. For the study, the TCEQ review notes that 99.2% of the parallel readings had a difference of less than 0.03 NTU with an average difference of 0.007 NTU. The TCEQ review also noted that only 0.3% of the parallel results exceeded the ± 0.05 NTU turbidimetric comparison criterion stated in Figure 1, to include the study's maximum absolute difference of 0.1209 NTU.

In addition, the following was noted regarding the weekly turbidimetric verifications detailed in Tables 1 through 4 and the comparison study detailed in Table 5:

- The Hach FT660 turbidimeter was calibrated with a 0.816 NTU Hach StablCal turbidity standard. Two (2) quarterly calibrations were performed during the study period;
- For the Hach FT660 turbidimeter, a Hach FT660 Verification Quick Check verification standard was used and was assigned an NTU value immediately after a calibration was performed;
- The SWAN AMI Turbiwell turbidimeter was calibrated with a 20.00 NTU primary standard prepared from a 4000 NTU formazin stock solution;
- For the SWAN AMI Turbiwell turbidimeter, 0.100 and 1.11 NTU Hach StablCal verification standards were used to perform calibration verifications; and
- For the SWAN AMI Turbiwell readings compared to their respective Hach FT660 readings using the Figure 1 study criterion of ± 0.05 NTU difference

for readings less than 1.04 (≤ 1.0) NTU, the Hach FT660 readings were less than 1.04 (≤ 1.0) NTU, thus the application of the ± 0.05 NTU limit. For the 34 instances in the study for which an NTU absolute difference greater than 0.05 NTU was obtained, a difference greater than 0.05 NTU would indicate the need for verifying the operation of the turbidimeter, which may include the need for maintenance or recalibration of the SWAN AMI Turbiwell turbidimeter.

- Email correspondence to Mr. Richard Bosch of my staff providing clarification regarding the following:
 - On July 6, 2021, Mr. Shaun Sharrett provided an Excel spreadsheet detailing the collection of parallel turbidity data from the effluent of the membrane unit at the SJRA GRP SW treatment facility. The data was collected from June 15, 2019 through February 1, 2020. The study period of July 13, 2019 through October 24, 2019 was determined by the use of calibration and verification standards for that time period.
 - In December 2021, an SJRA representative provided the following support documentation for the Hach FT660 data:
 - Certificate of Analysis for the Hach 0.816 NTU StablCal standard;
 - SJRA GRP SW membrane facility turbidimeter calibration and weekly verification log for the Hach FT660 turbidimeter; and
 - Description of the procedure for the assigning of an NTU value to the Hach FT660 Verification Quick Check verification standard and how the value is noted on the SJRA calibration and weekly verification log.

Conclusion: The comparability studies data indicates that the SWAN AMI Turbiwell W/LED turbidimeter (SWAN Order Number A-25.411700.1) is adequate for meeting the requirements in 30 TAC §290.111(f)(2)(D)(v) for reading turbidity levels in the 0.15 NTU range for direct integrity testing of a membrane unit.

Approval for Use in Texas

Please provide a copy of this letter to each of your Texas PWS customers. This letter is **not** to be construed as:

- Approval of future revisions to the TCEQ-approved SWAN method or design changes to the approved turbidimeters;
- Approval of software updates. If there are software updates that impact the method, this TCEQ approval does not cover future revisions of the TCEQ-approved SWAN method;
- TCEQ approval for a Texas PWS to use unapproved SWAN turbidimeters to report regulatory individual filter effluent turbidity data from water produced by a membrane unit used for pathogen removal, or
- Approval of changes to a membrane filtration plant. Prior to initiating changes to a treatment plant, a water system is required to notify the TCEQ of the changes, submit plan and specifications to the TCEQ Plan Review Team, and receive TCEQ approval. Plans and specification documentation (engineering documents and other public water system information) can be submitted directly to:

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Ms. Vera Poe, P.E., Team Leader
Plan Review Team (MC 159)
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Additional information regarding the TCEQ plans and specification process is available on the TCEQ website:

<https://www.tceq.texas.gov/drinkingwater/planrev.html>

If you have any questions concerning this letter, or if we can be of additional assistance, please contact Mr. Richard Bosch, at Richard.Bosch@tceq.texas.gov or by correspondence at the following address:

Technical Review & Oversight Team (MC 159)
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Sincerely,

A handwritten signature in black ink, appearing to read "Joel Klumpp". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

Joel Klumpp, Manager
Plan & Technical Review Section
Water Supply Division
Texas Commission on Environmental Quality

JPK/rb/db

Enclosure 1: *TCEQ RG-211, Appendix G - Equipment Calibration*

Appendix G: Equipment Calibration

SWTP Calibration Requirements and Procedures

SWTPs are responsible for ensuring the accuracy of data used for monthly compliance reporting. One extremely important way to ensure accuracy is to properly calibrate your instruments and equipment. Proper calibration includes written calibration procedures, acceptance criteria, traceable standards, good record keeping, and corrective action, when necessary.

This document describes the calibration requirements for instruments and equipment used to generate data for monthly reporting. It also provides and/or references procedures to implement the requirements. In addition to the requirements and procedures described herein, all calibration procedures and acceptance criteria must comply with manufacturer instructions, applicable EPA approved methods of analysis, and other standards, as applicable.

The calibration requirements and acceptance criteria specified in this document reflect the minimum requirements defined by 30 TAC Chapter 290, Subchapter F, Section 290.46(s). More stringent and/or detailed requirements may be specified in the analytical methods, manufacturer instrument instructions, QA Standards, SOPs, etc. To ensure you meet all applicable requirements, follow the most stringent requirements.

Flowmeters

Flowmeters and other flow monitoring devices must be calibrated at least once every 12 months. The flowmeters may be checked using a pitot tube, a calibrated ultrasonic flowmeter, or similar calibration device. The accuracy of the meters may also be checked by filling or draining a known volume with water into (or from) a basin. If the meter does not read within the accuracy range specified by the manufacturer, recalibrate the unit, or implement corrective action.

pH Meters

Benchtop pH Meters

Bench top pH meters must be calibrated at least once each day according to manufacturer specifications. Each time you run a batch of samples you must verify the calibration with at least one buffer. If the pH meter does not accurately read the buffer, per the manufacturer instructions or analytical method, recalibrate the unit or implement other corrective action.

Online pH Meters

Online pH meters must be calibrated at least once every 30 days. The calibration must also be verified at least once each week with one of the following:

- Primary standard.
- Comparing the results from the online unit with the results from a properly calibrated benchtop unit.

If necessary, recalibrate the unit with primary standards or implement corrective action.

Turbidity Meters

Benchtop Turbidity Meters

Benchtop turbidity meters must be calibrated using primary standards at least once every 3 months. Each time you calibrate your meter with primary standards, you must standardize your secondary standards again.

Each time you run a batch samples, you must verify the calibration with secondary standards. If the unit does not produce an acceptable reading, per the analytical manufacturer's instructions or analytical method, then recalibrate with primary standards or implement corrective action.

Online Turbidity Meters

Once every three months, you must calibrate online turbidity meters using primary standards.

Once every week you must verify the calibration of online turbidity meters with one of the following:

- Primary standards.
- Secondary standards.
- Manufacturer proprietary confirmation device.
- Comparing the results with a properly calibrated benchtop turbidity meter. (See next section.)

Regardless of which method you use to verify the calibration of the online turbidity meter, you must recalibrate the unit using primary standards if the unit does not provide an acceptable reading.

Calibration Verification Procedure

To verify the calibration of an online turbidity meter against a bench top meter, we recommend the following procedure:

1. Ensure your benchtop turbidity meter is properly calibrated by verifying it against a primary or secondary standard.

2. Record a turbidity reading shown on the online turbidity meter.
3. Immediately collect a sample from the inlet or outlet of the online turbidity meter.
4. Measure and record the turbidity of the sample from the online turbidity meter with the benchtop turbidity meter.
5. Compare the turbidity readings from the two instruments. If the values differ by 0.10 NTU or less, a complete calibration of the online meter is not required.
6. If the values differ by more than 0.10 NTU, follow the manufacturer's instructions and recalibrate both the online monitor using primary turbidity standards.
7. Repeat Steps 1-6. If the values still differ by more than 0.10 NTU, implement corrective action which may include contacting the instrument manufacturer for further instructions.
8. If a continuous recorder is used, compare the value reported by the recorder with the value reported by the monitor. No adjustment of the recorder is needed if the values differ by 0.05 NTU or less.
9. Adjust the recorder, if the values differ by more than 0.05 NTU.

Note: If the calibration is conducted when turbidity levels are above 1.0 NTU, you may accept differences of up to 10% when comparing the results of two turbidity meters and of up to 5% when comparing the recorder results with that of the turbidity meter.

Chemical Disinfectant Residual Analyzers

Manual Method

If you are using a manual method to test for chemical residuals, you must verify the instrument's calibration at least once every 90 days using a solution with a known concentration. If the instrument and/or method does not produce an accurate reading (i.e., within 15% of the expected value) you must recalibrate the instrument or take other corrective actions.

Continuous Monitoring Method

If you are using a continuous chemical analyzer, you must verify the instrument's accuracy at least once every 7 days using one of the following:

- Solution of known concentration.
- Comparing the results with a calibrated benchtop instrument (see next subsection).

Calibration Verification Procedure

If you compare the results with a calibrated bench top instrument, we recommend the following procedure:

1. Ensure your benchtop meter is properly calibrated by verifying its accuracy against a solution of known concentration.
2. Collect a sample from the inlet of the online monitor.
3. Measure and record the residual of the sample collected from the online monitor using an EPA-approved drinking water method listed.
4. Compare the two residual readings. If the values differ by 15% or less, a complete calibration of the online monitor is not required.
5. If the values differ by more than 15%, follow the manufacturer's instructions and recalibrate the online residual monitor.
6. Repeat Steps 1-3. If the values still differ by more than 15%, implement corrective action which may include contacting the instrument manufacturer for further instructions.
7. If a continuous recorder is used, compare the value reported by the recorder with the value reported by the monitor. If the values differ by 0.10 mg/L or less, no adjustment of the recorder is needed.
8. If the values differ by more than 0.10 mg/L, adjust the recorder.

UV Meters

Normal duty UV sensors must be properly calibrated. The calibration must be verified once per month using a reference UV sensor that has been calibrated by the manufacturer within the last year or sooner. UVT analyzers must be calibrated once each week per the manufacturer instructions.

Conductivity Meters

Conductivity or TDS instruments used for reverse osmosis and nanofiltration membrane systems should be calibrated at least once every 12 months.

Thermometers

Thermometers and other temperature monitoring devices must be properly calibrated and verified according to manufacturer instructions and method requirements. Calibration requirements include but not limited to periodic (e.g., annual) calibration against a NIST traceable thermometer, use of correction factors (CF), etc. Otherwise, as applicable, we recommend you verify the accuracy of thermometers once each 90 to 180 days by stirring the thermometer in an ice bath. After two minutes, the thermometer should read 0°C or 32°F.

Pressure Sensors

Devices used to measure pressure during integrity tests must be calibrated once every 12 months, at a minimum.

Note: If the manufacturer of your pressure sensor(s) uses a different calibration or verification schedule, please provide us with the manufacturer's documentation. We will consider manufacturer documentation and may alter your pressure sensor calibration schedule accordingly.

Calibrations Records

Calibration records must be kept by the organization performing the calibration and be accessible for verification upon request, or during an evaluation. When applicable, hard copy or electronic calibration records include the following items:

- Manufacturer's name, serial number, and/or any other unique identity of items being calibrated.
- Name or initials of person performing calibration.
- Documentation of reference material.
- Calibration dates, results of calibrations, adjustments, correction factors, acceptance criteria, comments.
- Due date of the next calibration or the calibration interval.
- Details of any damage, malfunction, modification to, or repair of, the instrument or equipment.
- Corrective actions

The calibration records addressed must be retained for at least three years, at a minimum (see Chapter 1.4.)