

Water-quality records

Procedure for Analyzing, Approving and Auditing of Water-Quality Records

The process for analyzing and approving data for water temperature, Specific conductance, pH, dissolved oxygen, and turbidity records are specified in [Techniques and Methods 1-D3](#), (TM1-D3--Wagner and others, 2006) Guidelines and Standard Procedures for continuous water-quality monitors: station operation, record computation, and data reporting, beginning on p. 39. [Techniques and Methods 1-D5](#) (TM1-D5--Pellerin and others, 2013) offers guidelines for analyzing and approving nitrate records. WSCs operating chlorophyll, fDOM and other sensors using unapproved methods (those without a Techniques and Methods report) are required to define a standard operating and analysis procedure, as per USGS Fundamental Science Practices (Baker, 2011) and follow [TM1-D3](#) and [TM1-D5](#) where appropriate. All records are required to conform to the continuous records processing procedures of WRD Policy 2010.02 (Larsen, 2010), [OWQ memo 2017.02](#), (Cunningham and others, 2017a), and USGS Fundamental Science Practices (Aragon, 2017).

The following summarizes the recommended workflow and outlines procedural requirements. A station analysis must be written using the established Station Analysis Template and stored in the Record Management System (RMS). All record analysis, approval, and audit must meet the requirements of OWQ memo 2017.07 (Cunningham and others, 2017b).

Raw data

Use CHIMP (SVMAQ when it becomes available) to create an electronic field form where readings and observations can be recorded and uploaded to AQUARIUS. Field-visit data can be edited, reviewed, and approved in AQUARIUS.

Cross-section surveys of the physical parameters being measured should be made at least twice a year including at least one vertical transect to assess vertical mixing. Cross-section data are to be recorded electronically or on paper to be converted to an electronic format, for example PDF.

Data transmitted to the NWIS database must be checked on a daily basis, at a minimum, to determine if gross data errors need to be edited and to apply edits in a timely manner. Such erroneous data include, but are not limited to, data spikes from sensor errors or non-representative sensor readings caused by field visits, sensors out of water, or sensors buried in bed sediment. In addition, thresholds must be set for each parameter that automatically censor readings that are obviously in error because they are outside of a reasonable or operational range for the sensor or the site.

Analyzing data

It is the responsibility of the hydrographer who performed the monitor field visit to record field observations and data pertinent to sensor maintenance and calibration checks. This includes, but is not limited to, sensor-inspection notes, before and after calibration readings, and calibration notes as per [TM 1-D3](#), [TM 1-D5](#), and per procedures specified in the Water Science Center's (WSC's) QA plan. The hydrographer analyst (preferably the same hydrographer to perform the field visit) must complete the following steps at a minimum to bring the time-series to an analyzed state. Depending on the complexity of an individual record, an additional experienced hydrographer may be needed for a second analysis.

Initial Data Evaluation

- Ensure that required verification and evaluation of field data have been done and documented, as per [TM1-D3](#), [TM1-D5](#), and WSC procedures, before the analysis begins.
- Cross-section surveys made during the record period should be evaluated to determine if the stream is well mixed and if the sensor location should be adjusted or, in rare circumstances, a time-series correction is necessary, as per [TM1-D3](#).
- Examine raw time-series data for the period for completeness. Data missing from the transmitted record should be added, where possible, using the logged electronic data record. No water quality data should be estimated.
- Examine the recorded time series and identify periods of erroneous values. Erroneous values should be removed. Discuss all deletions to the record, including reasoning for the erroneous values. Remaining periods with gaps in the data should be documented.
- Update the Station Description with any relevant changes that have occurred at the site during the record period, including any relocation of the sensors or monitor or changes in the physical setup of the monitor.
- Censor instantaneous values that are outside the calibration or reporting interval and apply the appropriate data qualifier(s).

Application of Data Corrections

- Review time-series plots of raw and corrected data with site visits to determine when a fouling, calibration drift, or other corrections are needed.
- Apply corrections automatically or manually according to [TM1-D3](#) and [TM1-D5](#).
 - The magnitude and sign of the correction should correspond to improving the agreement of the uncorrected time series and the cleaned and calibrated time series. If this is not true, the analyst should review the readings and look for possible errors.
 - Most water-quality corrections are prorated over some period of time between field visits when cleaning and calibration checks were done. The timing of the correction start and end should typically correlate with the field visits, but can be

related to other events in the record that may cause fouling of drift. Use the field readings to determine start and end times.

- It may improve the analysis to plot data with other time-series data. For example, it may be useful to view conductance with temperature, pH with dissolved oxygen, pH and(or) dissolved oxygen with chlorophyll and(or) phycocyanin. Discharge also is a useful parameter to compare to.
- Use the comment field for the correction to record information about the correction as necessary. This information will be used in the station analysis.
- Corrections that exceed the maximum allowable limit (MAL) in [TM1-D3](#) and [TM1-D5](#) should be applied to the time series, then the instantaneous data that are corrected more than the MAL should be evaluated deleted from the record or justified and noted in the Station Analysis according to [TM1-D3](#).
- Review (or revise, if necessary) all applied corrections for the record period. This includes comparing all readings to the recorded values and verifying the application period for the corrections. The analyst is responsible for making any adjustments to previously applied corrections to the working period. The reasoning and timing for any corrections must be clearly described in the station analysis for the record period.
- Continue, or develop, any other types of corrections (not described above) as needed. An example would be the application of a cross-section correction. A detailed discussion on how such corrections were developed, their period of applicability, and why they were deemed necessary for the record period must be included in the station analysis.
- Review the daily values records and inspect the days when less than 100 percent of the instantaneous values are available (partial DVs). The analyst determines if the partial DVs are retained or deleted from the record according to procedures in [TM1-D3](#). Correction comments should be recorded for either action.
- Determine the maximum and minimum for the record period. The section of the station analysis must contain both the maximum and minimum recorded value.
- Provide any pertinent remarks or comments for the record period that are not contained in other sections in the **Comments** section of the station analysis.

After completing the above described tasks, the record period is set to the analyzed state in NWIS and in the records tracking system (RMS) by the analyst.

Approving data

Each water-quality record is subject to a quality-control process that involves a thorough examination of the methods and procedures used, and to verify the accuracy and interpretations of the analyzed record period. The examination includes checking for gross errors in the record computation process, as well as verifying that interpretations and justifications for the decisions made during analysis are sound and valid. Verification of the analyst's work may require updates to the analyzed period. Record periods that are determined to have errors are documented and returned to the record analyst for corrections. Contentious changes are negotiated among the parties, with the Project Chief or Water-Quality Specialist resolving any

disputes. After all issues are resolved, the record period is set to the approved state in NWIS and the records tracking system.

An approver must be designated by the Science Center Director and must have the necessary skill, experience, and knowledge to evaluate a record analysis for approval. This includes at least 2 years of experience analyzing and reviewing records of the same type and the completion of QW2298, *Guidelines for Operation and Record Computation of Water-Quality Monitors*, or equivalent training. The record-period approver executes the following steps to bring the time-series record period to an approved state:

- Verify that field notes were reviewed and the reviews were documented in accordance with [TM1-D3](#) and WSC procedures.
- Ensure the Station Description is current and relevant and has been properly updated to reflect any changes made or observed during record period.
- Evaluate the accuracy and documentation of any corrections. This includes verifying the magnitude of the correction, verifying that application of the correction start and end times, and ensuring any adjustments to corrections were properly documented.
- Verify that any edits to the record were done properly, and that they were documented in NWIS-TS and the station analysis. The approver should verify the record period(s) of missing data.
- Evaluate the accuracy and documentation of all defined and other types of corrections (set 3) such as a cross-section correction. This includes verifying the reasoning for the correction, the correction values, and that the application of the correction is valid.
- Ensure partial daily values were verified or removed from the record.
- Determine if corrections that exceed the MAL were noted and data affected were evaluated in accordance with existing guidance.
- Provide a brief written final assessment of the record period in RMS.

After completing the above described tasks, the record period will be set to the approved state in AQUARIUS and RMS by the approver.

Audited data

Routine Auditing of Water-Quality Records

Water-quality records should be audited at intervals of about 1 year or less. More frequent audits are welcome, however no less than 10 percent of the data can be left un-audited for longer than fifteen months. More frequent audits should be conducted when the following conditions occur: (1) at the beginning of a data record when performance at the site is being established, (2) for parameters and(or) sites that are more prone to fouling or drift and that are more inherently variable such as turbidity, and (3) for new, more experimental parameters, that have not yet been covered in a T&M. If significant issues are found at a number of sites during routine audits, the percent of stations being audited should be expanded. Routine audits are

performed by Field Office Chiefs, senior hydrographers, water-quality specialists or Project Chief. It is highly encouraged to have a subset of routine audits done by other offices within the WSC or offices in other WSCs. The purpose of the routine audits is to ensure proper methods were applied throughout the process of obtaining water-quality data and computing the record. Errors found during a routine audit are to be revised if they meet revision criteria ([OWQ memo 2017.03](#)--Cunningham and others, 2017b).

An auditor must have the necessary skill, experience, or knowledge to evaluate a record analysis for approval. This includes at least 2 years of experience analyzing, reviewing, and approving records of the same type and the completion of QW2298, *Guidelines for Operation and Record Computation of Water-Quality Monitors*, or equivalent training. Contentious changes should be coordinated among the parties, with the Center designee resolving any disputes. It is the responsibility of the record auditor to review the following:

- Station analysis
- Approval documentation
- Deletions to recorded water-quality data
- Fouling corrections, calibration corrections, and other types of corrections
- The station description should be reviewed for completeness and accuracy.
- Review the continuous record in Aquarius for unusual temporal patterns, erroneous shift corrections, or large periods of missing data.

Non-routine Auditing of Streamflow Records

Non-routine audits occur anytime an aspect of an approved record is examined outside of the previously defined routine audit process. For example, an end user may have a question about turbidity record for May and June two years ago. Errors found during non-routine audits are subject to defined error threshold criteria for revisions ([OWQ memo 2017.03](#)--Cunningham and others, 2017b). Non-routine audits do not have any required tasks aside from documentation of the audit to include; the date of the audit, the auditor, what was examined, why it was examined, and the outcome of the audit to include a discussion of potential revisions, if any. Another example of a non-routine audit would be a record that is examined during a triennial discipline review. In this case, most aspects of a designated record period are examined (superficially or in detail) and the documentation should include the notes or forms that were filled out by the reviewer. Non-routine audits are to be documented by filling out the Audit Template in RMS.

References Cited

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