

*Stage-discharge streamflow records.*

# Process of Analyzing, Approving and Auditing of Stage-Discharge Streamflow Records

## Analyzing Streamflow Records

Prior to beginning the record-analysis process, it is the responsibility of the hydrographer who performed the field work to finalize any field notes and process all measurements and levels to the point of completion (including any checks or verifications needed). As per [OSW TM 14.08](#), “All USGS Science Centers shall correct time-series stage and discharge data (by applying indicated datum, data, and variable shift corrections, etc.) and enter discharge measurements into NWISWeb within 2 business days of a field measurement if the computed real-time data on NWISWeb do not match the discharge measurement within its rated accuracy.” All entries to databases, archival of electronic files, and any other storage and updating of data collected, such as backup data or levels summaries, are to be completed by the party who collected the data, or by another designated person as per the Center’s surface-water quality assurance plan. Field data need to be verified for transcription errors and evaluated for consistency and proper technique prior to beginning the analysis process. The station description should be examined and updated if needed. A station analysis must be written using the established Station Analysis Template and stored in the Record Management System (RMS).

The record-period analyst executes the following steps to bring the time-series record to an analyzed state:

- If levels were due during the analysis period, they should be completed and approved first. If levels are overdue and the record is analyzed and then approved, revisions may be required as per established revision criteria outlined in [OSW TM 2017.07](#).
- Update the Station Description with any relevant changes that have occurred at the site during the analysis period, including any updates resulting from station levels.
- *[If station levels were run during the analysis period]* Examine the levels notes and any applied datum corrections to ensure they were applied correctly to both the current period and other previously approved periods since the last set of levels. Make adjustments to applied datum corrections as needed. Correct all reference gage observations and associated gage heights assigned to measured discharges for all site visits affected by a datum correction. Document the results of the level run, provide the reasoning / justification for any datum correction, and explain how the datum correction

was applied (including dates) in the **Gage Height Record: Datum** section of the station analysis.

- Merge any backup time-series data where needed and available. Document the source of the merged data, the reason for the gap in the primary time-series record, and the period that contains the merged data in the **Gage Height Record: Backup Data** section of the station analysis.
- Examine the recorded gage height time series. Identify periods affected by backwater (e.g., ice) and/or any erroneous values. Periods when recorded gage heights are affected by ice should be documented in the **Gage Height Record: Ice Affected** section of the station analysis. Edits should be made to erroneous values to remove them from further analysis. Discuss all edits to the recorded gage heights, including reasoning for the erroneous values and methods used in making edits, in the **Gage Height Record: Edits** section of the station analysis. Remaining periods with gaps in the data should be documented in this section, as well. The quality of the recorded gage height for the analysis period must be explicitly stated in the **Gage Height Record** first order heading of the station analysis.
- Review (or revise, if necessary) all applied gage height corrections for the analysis period. This includes comparing all reference gage readings to the recorded values and verifying the application period for the corrections. The analyst is responsible for making any adjustments to previously applied gage height corrections to the working period. The reasoning and timing for any gage height corrections must be clearly described in the **Gage Height Record: Gage Height Corrections** section of the station analysis for the analysis period.
- Ensure that any needed flushing- or purge-related corrections are applied to the record. The reasoning and application period for these corrections are to be documented in the **Gage Height Record: Other Corrections** section of the station analysis.
- Continue, or develop, any other types of corrections (not described above) as needed; e.g., an established draw-down correction curve. A detailed discussion on how such corrections were developed, their period(s) of applicability, and why they were deemed necessary must be included in the **Gage Height Record: Other Corrections** section of the station analysis.
- Determine the peak stage for the analysis period. This includes following the procedures of [OSW TM 14.06](#) "Requirements for the collection, validation, and input of peak-stage verification data at U.S. Geological Survey streamgages." The **Gage Height Record: Peak Stage** section of the station analysis must contain both the maximum recorded peak stage value and the independent peak stage value (including the independent peak stage device type and uncertainty associated with the value) for the analysis period. The results of the verification procedure should be documented. Indicate how this peak value compares to the previous peaks from previous periods of the same water year.
- Summarize the discharge measurements that were made during the analysis period in the **Stage-Discharge Relation: Discharge Measurements and Control Conditions** section of the station analysis. This should include the number of measurements made,

the range of discharge measured, the hydraulic controls that were in effect for each measurement, and the condition of the hydraulic controls for each measurement.

- Determine whether the existing rating curve is deemed valid for continuation throughout the analysis period or if a new curve should be constructed. If continued in use during the analysis period, document the date the rating was first developed / put in effect in the first order heading **Stage-Discharge Relation**.
- If a new curve needs to be constructed, the analyst develops the rating curve and defines the starting date and time of the new rating. WSC rating approval and activation procedures are followed through to completion before any further analysis is done. Rating development and approval must be thoroughly documented and stored in SIMS station description element *RATING (OPS)*. All rating descriptions should be contained in this element with the newest (active) description at the top.
- Shift curves that were developed throughout the analysis period are to be reviewed and adjusted as necessary by the analyst. If a new rating was developed, as per previous step, the analyst is responsible for developing any new shift curves that are needed. The **Stage-Discharge Relation: Shift Curves** section write-up should include a discussion of the hydraulic control(s), and physical significance of shift-curve merge and hinge gage heights associated with each shift. This discussion should include presumed causes for observed shifts, as well as any observed trends associated with the plotting position of the measurements.
- Review and adjust, as needed, the application of shift curves that were used during the analysis period. If new shift curves were developed, as per the previous step, the analyst is responsible for applying them to the time series. An explanation of how the developed shift curves are applied in time are to be documented in the **Stage-Discharge Relation: Application of Shift Curves** section of the station analysis. This application should agree with the discussion of the causes for the needed shift curves in the **Stage-Discharge Relation: Shift Curves** section of the station analysis.
- Indicate rating(s) by number that were active for analysis period. Include information on when the rating was initially activated and when it was created. Provide general assessment of how measurements made during analysis period plot on active rating curve in the **Stage-Discharge Relation** first order heading of the station analysis.
- Develop estimates of unit value discharges for any identified gaps in the time series, including periods with ice affected gage heights. Estimates should be developed by following recommended best practices (reference pending policy release). Periods of estimated discharge and the methods used in developing the estimates are to be documented in the **Computed Discharge: Estimates** section of the station analysis.
- Compare the computed discharge time series for the analysis period to the discharge time series from a different site. The station(s) used in the comparison and the methods used for comparison are to be documented in the **Computed Discharge: Hydrographic Comparison** section of the station analysis. The results of the comparison, to include periods that compared both favorably and not, should be discussed and reasons why periods did not compare well should be provided. If a reasonable comparison station does not exist, a statement to that effect must be made in the **Computed Discharge: Hydrographic Comparison** section of the station analysis.

- Determine the the maximum computed peak streamflow value during the period, with consideration of the peak verification results discussed in **Gage Height Record: Peak Stage** section. Indicate how this peak streamflow value relates to the previous peak streamflows for the water year. Document in the **Computed Discharge: Peak Streamflow** section of the station analysis.
- Discuss the quality of the computed discharge record, the range of flow experienced in relation to recent measurements of discharge, and uncertainty in the computed discharge in the **Computed Discharge** first order heading of the station analysis.
- Provide any pertinent remarks or comments for the analysis period that are not contained in other sections in the **Comments** section of the station analysis.

After completing the above described tasks, the analyst should set the record for the analysis period to the analyzed state in NWIS and in the records tracking system.

## Approving Streamflow Records

Each streamflow record is subject to a quality control process that involves a thorough examination of the methods and procedures used, and verification of the accuracy and interpretations of the analyzed record period. The examination includes checks 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. The record approver documents this examination in RMS using the established Approval Guidance. analysis 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 Data Chief or Field Office Chief resolving any disputes. After all issues are resolved, the analysis period will be set to the approved state in NWIS and the records tracking system. The record-period approver executes the following steps to bring the time-series period to an approved state:

- Verify that discharge measurements, field notes, and level notes were reviewed and the reviews were documented in accordance with WSC procedures. This task must be completed before continuing on with the remaining approval tasks.
- Ensure the Station Description is current and relevant and has been properly updated to reflect any changes made or observed during analysis period.
- Determine that levels are up-to-date, and, if levels were run during the period, ensure they were done in compliance with [T&M 3-A19](#); that is, they are valid for verifying that the reference gage is properly set to gage datum. Periods wherein levels are overdue, or when levels policies were not fully satisfied, should not be approved until a proper set of levels are run and any needed changes are made to the record. If levels are overdue, or determined to be invalid, and the record is approved, follow established revision criteria if the reference gage is found to have moved when levels are eventually run (as revisions to approved record may be required).
- Evaluate the accuracy and documentation of any defined datum correction (set 1). This includes verifying the correction value, verifying that application of the correction in time

is valid, and ensuring all adjustments to observed reference gage readings were done properly.

- Verify that any edits to the recorded gage height record were done properly, and that they were documented in the station analysis. The approver should verify the period(s) identified as affected by ice.
- Evaluate the accuracy and documentation of all defined gage height corrections (set 2). This includes verifying the correction value and verifying that application of the correction in time is valid.
- Evaluate the accuracy and documentation of all defined other types of corrections (set 3) such as drawdown, flushing, or purge corrections. This includes verifying the correction value and verifying that application of the correction in time is valid.
- Ensure peak stage values were verified following the requirements of [OSW TM 14.06](#) and peaks for the analysis period were compared with previous peaks from the water year.
- Verify that all ratings active during the analysis period were documented and approved in accordance with WSC procedures. This task must be completed before continuing on with the remaining approval tasks.
- Verify that the active rating represents the current stage-discharge relation and that the range of computed discharges have been verified by recent measurements.
- Evaluate the shapes of any developed shift curve with respect to the hydraulic control(s) and base rating.
- Verify that the application of shift curves based upon the hydrograph is valid and agrees with the interpretation provided in the station analysis.
- Determine if estimates are appropriate, consistent, and were done using appropriate methods and data.
- Evaluate the adequacy and documentation of the hydrographic comparison.
- Ensure peak streamflow values were adequately determined and that peak streamflows for analysis period were compared with previous peak streamflows for the water year.
- Provide a brief written final assessment of the analysis period.

After completing the above described tasks, the approver should set the record for the analysis period to the approved state in NWIS and in the records tracking system.

## **Auditing Streamflow Records**

### **Routine Auditing of Streamflow Records**

Streamflow records should be audited at intervals of about 1 year or less. More frequent audits are welcome, however no streamflow data can be left un-audited for longer than fifteen months. Routine audits are performed on all records by Field Office Chiefs, senior hydrographers, surface-water specialists or the Data 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 the surface-water data and computing the record. Errors found during a routine audit are to be revised if they meet revision criteria. Contentious changes should be coordinated among the

parties, with the Center designee resolving any disputes. Routine audits are to be documented by filling out the Audit Template in RMS. It is the responsibility of the record auditor to review the following:

- Station analysis
- Approval documentation
- Datum corrections, gage height corrections, and other types of corrections
- Edits to recorded stage data
- Rating curves active during water year
- Shift curves including shape and application
- Peak stage and streamflow values for water year
- Estimated values
- Hydrographic comparisons
- Stated record quality
- The station description should be reviewed for completeness and accuracy.

### 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 the gage height record for May and June two years ago. Errors found during non-routine audits are subject to defined error threshold criteria for revisions. 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.