West Virginia Water Science Center Surface Water Quality-Assurance Plan 2011 Water Year

Internal Draft Document

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Contents

Introduction

The Surface Water Quality-Assurance Plan (QA Plan) documents methods to ensure standards, policies, and procedures used by the Water Science Center (WSC) for activities related to the collection, processing, storage, analysis, and publication of surface-water and precipitation data meet the U.S. Geological Survey (USGS) policy requirements. The QA Plan also serves as a guide for all WSC personnel involved in surface-water activities and as a resource for identifying memorandums, publications, and other literature that describe in more detail associated techniques and requirements.

Responsibilities

Director

The Director manages the WSC program, including all surface-water activities, to ensure activities meet the needs of the Federal Government, state and local agencies, other cooperating agencies, and the general public. The Director may delegate responsibilities to other WSC employees. The Director prepares, implements, and adheres to the QA policies described in the QA Plan (Schroder and Shampine, 1992, p. 7) and ensures that all aspects of the QA Plan are understood and followed by WSC employees. The Director makes sure that technical reviews of all surface-water programs are conducted regularly and technical communications released by the WSC are accurate and are in accord with USGS policy. Additionally, the Director keeps employees briefed on procedural and technical communications from Regional Offices and Headquarters, implements USGS and WSC safety policies, and provides final resolution of any conflicts or disputes related to surface-water activities within the WSC.

Hugh Bevans is the Director.

Hydrologic Investigations and Surveillance Chief

The Hydrologic Investigations and Surveillance Chief manages the collection, processing, storage, analysis, and publication of surface-water and precipitation data. The Chief collaborates with WSC discipline specialists and may delegate responsibilities to the WSC discipline specialists or other WSC employees. The Chief ensures that data collection, analysis, and report activities conform to the goals and policies of the USGS, the Office of Surface Water (OSW), and the WSC. The Chief makes sure that field notes and computations are reviewed after each trip, gages are properly maintained, records for all gages are computed and checked correctly, records are reviewed annually, data are properly archived, data bases are maintained, and an annual data report is published. The Chief ensures employee work plans, the Surface Water QA Plan, and the Flood Plan are updated frequently. The Chief collaborates with the Safety Officer and other WSC employees to makes sure safety requirements are followed.

Ron Evaldi is the Hydrologic Investigations and Surveillance Chief.

Safety Officer

The Safety Officer assists the Director in implementing USGS, WSC-specific, and Occupational Safety and Health Act (OSHA) safety policies, coordinates safety needs and training for WSC employees, and serves as a resource for WSC employees seeking information pertaining to safety. The Safety Officer directs periodic inspection of all work places identifying job-safety and health hazards, instructs employees on job-safety hazards and mitigation requirements, reviews accident reports, and initiates corrective measures for violation of OSHA standards.

Melvin Mathes is the Safety Officer.

WSC Specialists

WSC Specialists advise the Director, Hydrologic Investigations and Surveillance Chief, and other WSC scientists on the technical adequacy of surface-water activities and provide assistance for data collection, computation, analysis and interpretation, and storage of surface-water data. The WSC Specialists support the WSC program development, report preparation and reviews, and recommend training needs.

Jeff Wiley is the Surface Water Specialist.
Doug Chambers is the Water Quality Specialist.
Kurt McCoy is the Ground Water Specialist.
Mark Board is the Information Technology Specialist.
Melvin Mathes is the Data Base Administrator.
Gary Crosby is the Cableway Specialist.
Fred Brogan is the ADCP Specialist.

Collection of Stage, Discharge, and Precipitation Data at Gages

The methods and policies for collection of data are described in a report by Rantz and others (1982), USGS Techniques of Water-Resources Investigations (TWRI) reports, USGS Techniques and Methods (TM) reports, and in numbered and unnumbered technical memorandums. All exceptions to the standard USGS methods and policies are documented, reviewed, and approved by USGS regional staff or WSC management. The WSC Flood Plan documents methods and policies for data collection during floods.

Gage Installation

Site-selection criteria for surface water gages are discussed by Sauer and Turnipseed (2010), Rantz and others (1982), and Kennedy (1984). Site selection criteria for precipitation gages are discussed in OSW Technical Memorandum 2006.01 (Revised December 2009). A Station Description is maintained permanently for each gage installation in the Site Information Management System (SIMS).

Gage Maintenance

Gages are inspected and maintenance preformed at regular intervals with findings and actions documented. Employee assignments are varied to ensure gages are inspected by more than one individual at least once each year. Selected gages are inspected by persons outside the WSC about every three years. All instruments, inside and out, are inspected on every visit (OSW Technical Memorandum 91.09). Gages collecting precipitation are calibrated once annually at a minimum (OSW Technical Memorandum 2006.01, Revised December 2009). Cableways are inspected annually by the Specialist and results documented, transferred to WSC Safety Officer, and reported to Area Safety Officer. Gage structures no longer in use but not yet demolished are inspected every two years, and recorded in the USGS WRD Discontinued Station Maintenance - Capital Improvement Database (DS-CI) (http://1stop.usgs.gov/discontinued/). Reference documentation is maintained at all gage structures which include Station Description, Job Hazard Analysis, Rating table (where applicable), and Traffic Control Plan (where applicable).

Photographs are taken to record significant changes to structures and channels, and taken intermittently to record gradual changes; photographs are maintained in permanent office files. Site maps and sketches that indicate structures, measuring sections, and reference marks are revised at the same frequency as gage levels and permanently filed. Station Descriptions are revised periodically, minimally at the same frequency as gage levels, and maintained on the USGS Web-based Site Information Management System (SIMS).

Leveling techniques described by Kenney (2010) are used to measure and correct for the vertical movement of gages and other structures where instruments or established references are maintained. Gage datum (elevation of zero gage height) is established to NAVD 1988 at gages by surveying from reputable bench marks or using a Geographical Positioning System (GPS). All instruments, tape-downs (where applicable), and a minimum of three independent reference marks are established and surveyed at all gages. Documentation of leveling-instrument service and repairs, and two-peg tests are maintained in logbooks. Level notes are checked and a Level

Summary for each gage is maintained. The frequency of levels follows rules presented by Keeney (2010).

Measurement of Stage

Stage is measured by recording and nonrecording instruments. Instruments are tested and quality assured through the USGS Hydrologic Instrumentation Facility (HIF). Quality assurance measures are documented, reviewed, and approved by USGS regional staff or WSC Specialists if instruments other than those supplied through HIF are used.

Routine surface-water stage data are collected with instruments and procedures that provide sufficient accuracy to support discharge computation from a stage-discharge relation (OSW Technical Memorandum 93.07). Stage is measured at an accuracy of + or - 0.01 foot (ft) or 0.2 percent, whichever is less restrictive for the stage being measured (OSW Technical Memorandums 89.08, 93.07, and 96.05). USGS policy on stage-measurement accuracy as it relates to instrumentation is presented in OSW Technical Memorandums 93.07 and 96.05. Stage accuracy is accomplished by precise instrumentation, proper installation, and continual monitoring (OSW Technical Memorandum 93.07). Independent stage instruments are located at gage stations ("inside" and "outside" instruments) to verify accurate stages are obtained. Additionally stage verification is obtained by 1) attaching maximum and minimum clips to float tapes to record the maximum and minimum stage on gages using stilling wells, 2) by surveying high water marks (HWMs) inside (from ground cork or debris) and outside (from debris or wash lines), and 3) installing crest-stage gages at all gages that use pressure transducer or radar instruments (OSW Technical Memorandums 91.09 and 93.07).

The stage corresponding to zero flow is determined at least annually for all gages with wadable controls following methods described in TWRI book 3, chapters A10 and documented.

Measurement of Discharge

Instruments purchased through HIF for measuring discharge are tested and quality assured. Quality assurance measures are documented, reviewed, and approved by USGS regional staff or WSC management when using instruments other than those supplied through HIF. Discharge is measured using direct and indirect methods.

Discharge measurements at gages are periodically made by a different individual and different equipment to investigate problems with techniques and equipment. Typically, every gage is measured at least once by a different individual annually, with groups of gages being measured by different individuals every 3-5 years. Equipment is replaced or training is provided when problems are identified that indicate greater than 5 percent error in discharge measurements.

Direct Discharge Measurements

Direct measurements of discharge are made using Price pigmy and AA meters or an Acoustic Doppler Velocimeter (ADV) following methods described by Turnipseed and Sauer (2010) and Rants and others (1982). Direct measurements of discharge are made with an Acoustic Doppler Current Profiler (ADCP) following methods described by Muller and Wagner (2009) and Oberg and others (2005).

Techniques for measuring under ice follow those presented by Buchanan and Somers (1969, p. 42). The Price AA meter with polymer cups is used on streams where slush ice is present (OSW Technical Memorandum 88.18). The Price AA meter or pigmy meter with conventional metal-bucket rotors or ADV is used on ice-covered streams where no slush ice is present (OSW Technical Memorandum 92.04). The Price AA meter with winter-style yolk is sometimes used on the ice-covered streams if cutting the required larger holes through the ice is not feasible.

The Price pigmy and AA meters are inspected, cleaned, and repaired following procedures described by Turnipseed and Sauer (2010) and Rants and others (1982). Meters are visually inspected for damages before and after each measurement. Meters are cleaned and repaired as needed, and meters are cleaned after each field trip. Spin tests are preformed before and after repairs and between field trips. A log of spin tests is maintained and archived (OSW Technical Memorandum 89.07). A meter not used for a year is inspected, cleaned, and repaired prior to a spin test and use. A random sample of meters are removed from use and tested by HIF about every 3 years.

Care for an ADV follows procedures described by Turnipseed and Sauer (2010). A quality-control test (QCTest) is conducted and stored with each measurement. A BeamCheck is preformed when there are anomalies in the QCTest or when there is any possible physical damage (drop, and so forth), firmware upgrade, or repair. Every AVC is tested and repaired by HIF every three years (OSW Technical Memorandum 2010.02).

Measurements made with Price meters and ADV contain no more than 5 percent of the total flow in a vertical section and velocities are calculated for a minimum of 40 seconds, except under atypical circumstances where measurement quality is downgraded. Measurements are allowed to have more than 5 percent in a vertical section when using procedures for rapidly changing flow. Very narrow streams may not physically allow for less than 5 percent of the total flow in a vertical. Any deviation from meeting the instrument-selection criteria (proper depth and velocity requirements) is documented and measurement accuracy is downgraded. All measurements that plot greater than 5 percent from the rating are checked and reviewed.

Care for an ADCP follow procedures described by Mueller and Wagner (2009). Diagnostic tests are conducted and stored with each measurement. Tests include system information (the system firmware and hardware configuration), the beam transformation matrix, electronics diagnostics tests, internal system tests, and sensor verification tests. Temperature is measured independently from the ADCP and recorded. The ADCP is not used to make a measurement and is repaired if the diagnostic tests fail or the temperature difference between the ADCP and the independent instrument is greater than 2 degrees Celsius. Salinity is measured and documented when measurement is not in fresh water. The internal clock is set when timing is important for rapidly changing flow and the internal compass is adjusted prior to measurements when using the digital global positioning system.

The ADCP measurement has a moving bottom check that is documented whether or not a correction is applied to the measurement. Measurements are allowed to have as few as 2 transects (one in each direction across the stream) when using procedures for rapidly changing flow. A standard measurement consists of a minimum of 4 transects (2 in each direction across the stream) with all 4 transects within 5 percent of the mean discharge; an additional 4 transects (2 in each direction across the stream) are obtained if the first 4 transects were not within 5 percent of the mean discharge. All individual transect discharges are within 10 percent of the mean after replacing transects with data-quality problems. The critical data-quality problem is documented for all replacement transects. Measurements made with the ADCP are backed up daily at a minimum and processed, reviewed, and archived within 5 working days after returning to the office.

A second discharge measurement is made for checking when the first measurement differs from a rating curve by more than the measurement-quality percent, departs from the trend of recent measurements, or is suspect. A reason for not taking a second measurement is documented on the first measurement note sheet. Acceptable reasons for not taking a second measurement include affects of ice and leaves on the control or when the resulting shift conforms to expectations. Equipment and location will be changed for the second measurement if possible. Exceptions to the second-measurement requirements for specific locations can be made by obtaining approval from the WSC management and documenting a site-specific rule.

Occasionally, direct discharge measurements are made using the tracer-dilution method, float or volumetric techniques, and portable weirs and flumes following procedures described by Turnipseed and Sauer (2010), Kilpatrick and Schneider (1983), Rants and others (1982), and Buchanan and Somers (1969).

Indirect Discharge Measurements

Detailed descriptions of the procedures used in collecting field data and in computing the discharge are given by Benson and Dalrymple (1967), Dalrymple and Benson (1967), Bodhaine (1968), Matthai (1967), and Hulsing (1967), which are in TWRI book 3, chapters Al–A5. Roughness values for corrugated metal culverts have been revised from those presented in TWRI book 3, chapters A3, to those presented in OSW Technical Memorandum 93.17. Procedures for determining roughness values are also presented by Barnes (1967) and Arcement and Schneider (1989). The WSC maintains an unpublished notebook of selected pictures showing channels and roughness values for additional guidance in determining roughness values. Methods to identify debris-flow conditions, which are most common in small mountainous basins, are presented in OSW Technical Memorandum 92.11.

The computer-based tool Slope-Area Computation (SAC) program is used to compute peak discharge using the slope-area method (Fulford, 1994). The computer-based tool Culvert Analysis Program (CAP) is used to compute peak discharge at culverts (Fulford, 1995). The computer-based tool Water Surface Profile (WSPRO) is used to compute peak discharge at sites where open-channel width contractions occur, such as flow through a bridge structure (Shearman, 1990).

Indirect measurements are checked and reviewed by the WSC. Measurements that are questionable or difficult to assess may be reviewed outside the WSC. Summaries of measurements are sent to USGS regional staff for an immediate cursory review, and this staff reviews selected measurements about every 3 years. Errors determined in reviews are promptly corrected. Measurements are permanently filed at the WSC, and electronic files of measurement computations (since about 1985) are permanently stored.

Measurement of Precipitation

Precipitation data are collected using methods described by OSW Technical Memorandum 2006.01 (Revised December 2009).

For precipitation data collected for intervals of 15 minutes or less and stored permanently, 1) instruments are calibrated annually at a minimum; 2) Station Descriptions, annual Station Analyses, calibration forms, and original field inspection notes are archived; and 3) data are published. Instrument adjustment or repair is made if tipping bucket gages are not within 5 percent of actual volume or if weighing bucket gages are not within 0.1 inch of actual volume. Records associated with field calibration results having errors in excess of 10 percent (tipping bucket gages) or 0.1 inch (weighing bucket gages) are not published.

For precipitation displayed on the web for 60 days, 1) a standard qualifier accompanies data, 2) Station Description is archived, and 3) data are maintained in National Water Information System (NWIS) database with the Data Descriptor (DD) flagged “Primary” and never flagged as “Approved.”

Processing and Analysis of Stage, Discharge, and Precipitation Data

Mostly, gage data is automatically transmitted to the USGS Automatic Data Processing Software (ADAPS) data base and additionally manually downloaded to electronic files in the field that are transferred to electronic files in the office for use during periods when automated transmission fails. Gage data without automated transmission are downloaded to electronic files or written on standardized paper forms and manually transferred or keyed into ADAPS. Manually collected field data are electronically stored or written on standardized paper forms and manually transferred or keyed into ADAPS or the USGS Site Visit software. Electronic files of gage data without automated transmission and electronically stored field data are backed up in the field on a separate storage device a minimum of once daily.

Gage data automatically transmitted to ADAPS are stored as raw data. Automated filters are used to remove most data that are erroneously transmitted, and automated processes are applied to store edited data and to calculate provisional data that are viewable on the USGS National Water Information System (NWIS) public webpage as “Real-time data.” Real-time data are reviewed every workday to correct or remove erroneous transmissions missed by automated filters, and to cursory assess gage operations.

Gage data without automated transmission are manually transferred or keyed into ADAPS and stored as raw data. Raw data are edited and processes to calculate provisional Real-time data within two weeks after returning from the field.

Measurements and field notes that contain original data are stored indefinitely (Hubbard, 1992) (OSW Technical Memorandum 2006.01, Revised December 2009). Paper forms are filed in office cabinets and electronic data are stored in office computer files in addition to storage in SIMS, ADAPS, and Site Visit.

Computing Continuous Discharge Data

Procedures for computing continuous discharge data follow those described by Kennedy (1983) and Rantz and others (1982). A continuous (unit value) record is data at intervals less than or equal to 60 minutes. Continuous discharge records are computed by converting continuous stage record to discharge record through application of rating curves (stage-discharge or stage-velocity relations). At gages having more than one recording instrument, one instrument is designated as the primary data source, the “base gage.”

The primary continuous stage record is processed in ADAPS by editing permanently stored raw data by deleting bad data, adding data from another recording instrument, estimating missing data (when possible), and adding remark codes. These processed raw data are permanently stored as edited data. The edited data are processed by applying datum corrections to adjust for the vertical movement of gages using techniques discussed by Kenney (2010) when the magnitude of the vertical change is greater than 0.015 ft. The datum-corrected data are processed by applying stage (gage-height) corrections to agree with the base-gage data when the difference is equal to or greater than 0.02 ft or when the difference is 0.01 ft and there is greater than 5-percent change in discharge. The stage (gage-height) corrections are determined by (1) comparing stage readings made from independent reference gages, (2) comparing inside and outside stage gages, (3) examining high-water marks, (4) comparing redundant recordings of peaks and troughs by use of maximum and minimum indicators, and (5) examining data obtained at crest-stage gages. All edits, datum, and stage (gage height) corrections applied to data for the primary continuous stage record are documented as to what, when, and why in the Station Analysis.

Rating curves are developed from discharge measurements following procedures described in Kennedy (1984) and Rantz and others (1982). Rating curves consist of stage-discharge relations, stage-area and index-velocity relations, and relations involving the rate of change in stage, the fall in slope through a defined stream reach, and a stage factor or complex equation (polynomial). Temporary changes in ratings that vary from time to time, either gradually or abruptly are defined using rating shifts commonly caused by scour, fill, shifting sand or gravel, algae and grass growth, and leaf or debris buildup. Generally, shifts are applied to ratings when the difference between the measured discharges and rated discharges are greater the accuracies assigned to the measurements. Ratings and shifts are computed using ADAPS and the USGS Graphical Rating and Shift Application Tool (GRSAT). All rating and shift development applicable to the primary continuous stage record are documented as to what, when, and why in the Station Analysis.

Continuous discharge data are computed and permanently stored by applying datum and stage (gage-height) corrections to the stored edited stage data and processing with the rating curve and shifts. Daily-mean discharge data are computed and permanently stored from the continuous discharge data. ADAPS is used for these processes and a "primary computation" is output from the software to document these calculations.

Daily-mean discharge data are plotted against time to produce a "hydrograph." Hydrographs among stations are compared to identify periods of erroneous information, such as incorrect shifts or datum corrections, to estimate daily discharges for periods of undefined stage-discharge relation, such as during backwater or ice conditions, and to estimate daily discharges for periods of missing record. Climate data, such as daily precipitation totals and maximum and minimum air temperatures, are either included on a hydrograph or plotted separately to help evaluate the validity of daily discharges. Data are reworked when erroneous information is determined and estimates of daily discharges are documented to what, when, and why in the Station Analysis.

All calculations of continuous discharge data are computed, checked, and reviewed. A final review assures 1) datum corrections, stage (gage-height) corrections, and shifts are documented in the Station Analysis, 2) the Station Analysis is signed and dated by the individual that worked the record and the individual that checked the record, and 3) a permanent paper record contains the primary computation, Station Analysis, and pertinent graphs and calculations.

Computing Instantaneous Peak Data

Instantaneous peak data are determined from continuous records where continuous discharge is processed by examining the primary computations and independent stage instruments. For gages located on unregulated streams, peaks above a discharge expected to occur on the average of once a year (base discharge) are assembled. For gages located on regulated streams, only the annual data are assembled. When backwater conditions affect gages where the maximum stage and maximum discharge occur at different times, both peaks are assembled and explained.

Instantaneous peak data are determined from continuous records where continuous discharge is not processed by completing a datum, stage (gage height), and rating study for the period when the maximum discharge for the year occurred.

Instantaneous peak data are determined at crest-stage gage only locations by examining field notes documented during gage visits. The peak stages are processed to determine the annual peak by completing a datum, stage (gage height), and rating study. The date of the peak is determined by analyzing available precipitation and peak data from continuous gages located nearby.

All computations of instantaneous peak data are computed, checked, and reviewed. A final review assures 1) datum, stage (gage height), and rating studies are documented in the Station Analysis, 2) the Station Analysis is signed and dated by the individual that worked the record and the individual that checked the record, and 3) a permanent paper record contains the computation, Station Analysis, and pertinent notes. All instantaneous peak data are entered into ADAPS files and checked for accuracy.

Computing Continuous Precipitation Data

Procedures for computing continuous precipitation data follow those described by OSW Technical Memorandum 2006.01 (Revised December 2009). The continuous precipitation record is processed in ADAPS by editing permanently stored raw data by deleting bad data. These processed raw data are permanently stored as edited data. The edited data are processed to calculate and store daily totals. Estimates of daily values of zero rainfall may be made for short periods of missing record by comparison with other gages. All edits and corrections applied to data are documented as to what, when, and why in the Station Analysis.

All computations of continuous precipitation data are computed, checked, and reviewed. A final review assures 1) all bad data are deleted, 2) the Station Analysis is signed and dated by the individual that worked the record and the individual that checked the record, and 3) a permanent paper record contains the primary computation, Station Analysis, and pertinent graphs and calculations.

Management and Storage of Stage, Discharge, and Precipitation Data

The USGS Records Management System (RMS) is used to track and coordinate processing and analysis of surface water data. Check lists for individual gages and a list for all gages in the WSC are also maintained to manage processing and analysis of surface water data. Archival of data follow the guidelines established by the WSC in the internal document “Policy and Procedures for the Management and Archival Storage of Data Collected for Basic Data and Hydrologic Investigations, U.S. Geological Survey, West Virginia.” Most historic water-year folders are maintained in back-files in the WSC. Most charts, digital tapes, and observer books containing historic records are maintained at the Federal Records Centers (FRC) of the National Archives.

Field Folders are maintained for each gage containing Station Description, maps, measurement list, Traffic Control Plan (where applicable), Job Hazard Analysis, and any other information that might be helpful when visiting a gage. Field Folders are stored in a file cabinet in the WSC, but typically are found on top the desk of individuals responsible for maintenance of the gage.

File cabinets contain folders for processing and analyzing data for the current water year including a folder for the previous water year. Older water-year folders are stored in back-files maintained in the WSC. Recent discharge measurements and field inspection notes are stored with current water year files and entered into Site Visit, and older measurements and field inspection notes are stored in back-files maintained in the WSC. All Indirect discharge measurements are entered into Site Visit and stored in back-files maintained in the WSC. Recent levels are stored with current water year files and entered into SIMS, and older levels are stored in back-files maintained in the WSC; level summaries are stored in SIMS and copies are filed with current water-year folders. Station Descriptions and Station Analyses are stored in SIMS and copies are filed with water-year folders. Level 2-peg tests logs and meter spin-test logs, are maintained in permanent files in the WSC. Inspections of discontinued gages are in back-files maintained in the WSC.

Locations of electronic files follow:

Job Hazard Analysis --------- all users have access\safety\Job.Haz.Ana
Traffic Safety Plans ----------- all users have access\safety\Traffic Safety Plans
Indirect measurements -------- all users have access\HISS\Indirects
Flood Plan ---------------------- all users have access\HISS\flood_plan
SW Quality Assurance Plan - all users have access\HISS\SW_QA_PLAN
Peak File updates -------------- all users have access\HISS\peakfile
Data Archive Plan ------------- all users have access\HISS\Federal Records Center
SIMS --------------------------- *http://simsmd.er.usgs.gov/field/sqlsims/StationsRpts.asp*
ADCP measurements --------- \\gs.doi.net\CharlestonWV-W\
Gage photographs ------------- \\gs.doi.net\CharlestonWV-W\
Gage instrument data files --- \\gs.doi.net\CharlestonWV-W\

Publication of Surface Water Data

Surface water data are published on the Annual Water Data Report Mapper Website (*http://wdr.water.usgs.gov/adrmapper/*) following guidelines presented in the report titled, "WRD Data Reports Preparation Guide," by Charles E. Novak, 1985 edition when processing for a water year is completed and data are flagged as “Approved” in ADAPS. A Station Manuscript is updated and maintained electronically in the USGS SIMS. The Station Manuscript, tables, and statistics for the report are organized, checked, and reviewed. Approval for publication is obtained from the WSC Director prior to submission to the Annual Water Data Report Mapper website.

Interpretive and non-interpretive (may contain previously published interpretive material) studies of surface water data are published using the USGS Information Product Data System (IPDS). There are at least two technical reviews and an editorial review of each manuscript, and approval for publication is obtained by the USGS Director for interpretive studies and the WSC Director for non-interpretive studies. Colleague reviewers' memorandums, authors' response memorandums, and marked up review copies are electronically maintained with the draft manuscript that is submitted for approval in IPDS.

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Office of Surface Water Technical Memorandums Cited

http://water.usgs.gov/osw/pubs/techmemos.html

Office of Surface Water Technical Memorandums:

88.18 Makes recommendations concerning current meter and ice weight usage when making discharge measurements under ice cover.

89.07 Establishes policy that assigns responsibility for maintenance of current meters. Defines the purpose and use of the timed spin test.

89.08 Discusses policy as it relates to the measurement of stage for the purpose of determining stream discharge a regular daily discharge gaging stations. Reaffirms the accuracy goal of plus or minus 0.01 ft.

91.09 Provides information relating to the concerns that have been expressed about the accuracy of stage measurements made with U.S. Geological Survey gas-purge manometer and pressure-sensor systems (bubble gages).

92.04 Provides guidelines on the correct current meter to use for discharge measurements when ice is present.

92.11 States the importance of flow-process identification in mountain streams and provides guidance on how to properly identify flow processes, particularly when debris flows are possible.

93.07 Stage Accuracy Requirements (http://water.usgs.gov/admin/memo/SW/sw93.07.html)

93.17 Provides tables of Manning's n values for types of corrugated pipe not covered in the TWRI, Book 3, Chapter A3, and revises the values given for multiplate culverts in the TWRI. Recommends revision of some culvert computations.

96.05 Policy Concerning Accuracy of Stage Data

2006.01 (Revised December 2009), Collection, Quality Assurance, and Presentation of Precipitation Data

2010.02 Flow Meter Quality-Assurance Check - SonTek/YSI FlowTracker Acoustic Doppler Velocimeter