Surface-Water Quality-Assurance Plan for the Tallahassee Office, U.S. Geological Survey

By Stewart A. Tomlinson

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ACRONYMS

ADAPS	Automated Data Processing System
ADCP	Acoustic Doppler Current Profilers
ADR	Analog-to-Digital Recorders
CAP	Computer Program used to Compute Peak Discharge at Culverts
CARS	Center for Aquatic Resources Studies
CCWS	Center for Coastal and Watershed Studies
CD	Compact Disk
CSG	Crest-Stage Gage
CWRS	Center for Watershed Restoration Studies
DCP	Data Collection Platforms
EDL	Electronic Data Loggers
FISC	Florida Integrated Science Center
FRC	Federal Records Center
GIS	Geographic Information System
GPS	Global Positioning System
HIF	Hydrologic Instrumentation Facility
HYDRA	Computer Program within ADAPS
IT	Information Technology
JHA	Job Hazard Analysis
LRGS	Local Receiving Ground Station
NAWQA	National Water-Quality Assessment Program
NCALC	Computer Program used to Compute Manning's n Value
NWIS	National Water Information System
NWISWeb	National Water Information System Web
OSW	Office of Surface Water, USGS
PDF	Portable Document Format
PZF	Point-of-Zero Flow
QA	Quality Assurance
SAC	Computer Program used to Compute Peak Discharge with the Slope-Area Method
TWRI	Techniques of Water Resources Investigations
USGS	U.S. Geological Survey
WSPRO	Water-Surface Profile Computation Model

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Abstract

This Tallahassee Office Surface-Water Quality-Assurance Plan documents the standards, policies, and procedures used by the Tallahassee Office for activities related to the collection, processing, storage, analysis, and publication of surface-water data. This plan serves as a guide to all Tallahassee Office personnel involved in surface-water data activities, and changes as the needs and requirements of the Tallahassee Office, Florida Integrated Science Center, and Water Discipline change. Regular updates to this Plan represent an integral part of the quality-assurance process. In the Tallahassee Office, direct oversight and responsibility by the employee(s) assigned to a surface-water station, combined with team approaches in all work efforts, assure high-quality data, analyses, reviews, and reports for cooperating agencies and the public.

Introduction

Congress established the U.S. Geological Survey (USGS) on March 3, 1879 to provide a permanent Federal agency to perform the systematic and scientific "classification of the public lands, and examination of the geologic structure, mineral resources, and products of the national domain" (Rabbit, 1989). Previous to 2003, four Divisions in the USGS existed—the Geologic Division, the Biological Resources Division, the Geography (formerly Mapping) Division, and the Water Resources Division (WRD). Presently, the USGS is in the process of integrating the different disciplines to become a "seamless" agency. In Florida, the Florida Integrated Science Center (FISC) encompasses all the disciplines in the State under an umbrella of three science centers: 1) the Center for Aquatic Resources Studies (CARS), which include the primarily water-discipline offices in Tallahassee and Altamonte Springs, and the primarily biology-discipline office in Gainesville; 2) the Center for Watershed Restoration Studies (CWRS), which encompasses the primarily water-discipline Ft. Lauderdale and Ft. Myers offices; and 3) the Center for Coastal and Watershed Studies (CCWS) consisting of the primarily geologic-discipline office in St. Petersburg and the primarily water-discipline office in Tampa. The USGS mission of appraising the Nation's water resources includes surface-water activities in the Tallahassee Office. Federal, State, and local agencies use surface-water information, including streamflow, stage, and sediment data, for resources planning and management throughout the State. The general public uses stage and discharge data for informational purposes such as flood monitoring and recreation.

Purpose and Scope

The purpose of the Tallahassee Office Surface-Water Quality-Assurance Plan includes documenting the standards, policies, and procedures used for activities related to the collection, processing, storage, analysis, and publication of surface-water data. This plan identifies responsibilities for ensuring that stated policies and procedures are carried out. The plan also serves as a guide for all Tallahassee Office 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. Also, the quality-assurance plan provides information and guidelines for cooperating agencies and other agencies that furnish data to the Tallahassee Office.

The scope of this report encompasses discussions of the policies and procedures followed by the Tallahassee Office for the collection, processing, analysis, storage, and publication of surface-water data. Primary types of surface-water data collected by personnel of the Tallahassee Office include stage and streamflow data. Other data collected to refer to "Quality Assurance" includes water-quality, ground-water, sediment, meteorological, and evapotranspiration data. The Surface-Water Quality Assurance Plan also presents issues related to the management of the computer data base and employee safety and training. Although procedures and products of surface-water data collected for interpretive projects are subject to the criteria presented in this report, project chiefs must develop a separate and complete quality-assurance plan for their interpretive projects. Project chiefs should consult USGS publications for guidelines on quality assurance and work plans (Green, 1991; Schroder and Shampine, 1992; Shampine and others, 1992). The Tallahassee Chief of the Hydrologic Surveillance Section (Data Chief) reviews the Tallahassee Office Surface-Water Quality Assurance Plan at least once every 3 years to ensure that responsibilities and methodologies are current and that ongoing procedural improvements are effectively documented.

This Surface-Water Quality-Assurance Plan does not address, or briefly addresses, some topics. The Plan does not discuss proposed policy and issues for archiving data on permanent media, issues related to manpower and budget considerations, or methods to correct flaws in the current system. Nor does the Plan address sediment data in detail; personnel who collect and analyze sediment data refer to the published USGS Quality-Assurance Plan and guidelines (Knott and others, 1993; Knott and others, 1992; Porterfield, 1972).

Acknowledgements

The Tallahassee Office Surface-Water Quality-Assurance Plan utilizes the basic framework presented in “A Workbook for Preparing Surface-Water Quality-Assurance Plans for Offices of the U.S. Geological Survey, Water Resources Division” by Donald V. Arvin (U.S. Geological Survey, 1994) and released by Office of Surface Water Memorandum 95.03. Differences between the Workbook and the Tallahassee Office’s Surface-Water Quality-Assurance Plan include text additions and deletions, rewording of the text, reorganization of some sections, and inclusion of figures for quick reference.

Responsibilities

Quality assurance involves actively maintaining and improving high standards at all levels of responsibility. Maintaining high-quality standards for surface-water data, as well as other data, remain key to the integrity of the USGS. Clear delineations of responsibility sometimes become difficult to determine because of varying levels of expertise and duties in an office, combined with numerous types of gaging activities and instruments. While the Tallahassee Office Chief takes responsibility for overseeing the entire Tallahassee Office program, which includes surface-water data-collection and analysis, ultimately the person having the most impact on the quality assurance of the collected data is the field person who collects the data. Just as the author of a report in the Tallahassee Office oversees the manuscript through completion (U.S. Geological Survey, 1995), it is the employee who must ensure that accurate, timely data are collected and processed up to the point of final review and approval. Co-workers, supervisors, and managers in the Tallahassee Office organization (fig. 1) serve as resources for the employee. Teamwork and excellent communication between employees in collecting, analyzing, and reviewing data are critical to an effective Surface-Water Quality-Assurance Plan.

Specific responsibilities for various Tallahassee personnel are outlined below.

Office Chief, Tallahassee Office

1. Managing and directing the Tallahassee Office program, including oversight of all surface-water activities.
2. Ensuring that surface-water activities in the Tallahassee Office meet the needs of the Federal Government, the Tallahassee Office, State and local agencies, partner agencies, and the public.
3. Ensuring that all aspects of this Surface-Water Quality-Assurance Plan are understood and followed by Tallahassee Office personnel. This is accomplished by the Office Chief’s direct involvement or through clearly stated delegation of this responsibility to other personnel in the Tallahassee Office.
4. Providing final resolution of any conflicts or disputes related to surface-water activities within the Tallahassee Office.
5. Keeping subordinates briefed on procedural and technical communications from Regional offices and Headquarters.
6. Ensuring that all publications and other technical communications released by the Tallahassee Office are accurate, timely, and in accord with USGS policy.

Chief, Hydrologic Surveillance (Data Chief)

1. Advises Tallahassee Office Chief on all matters related to surface-water in the Tallahassee Office.
2. Responsible for developing, updating, and implementing the Tallahassee Office Surface-Water Quality-Assurance Plan.
3. Coordinates quality-assurance activities in the Data Section and Information Technology Section.
4. Ensures that surface-water projects within the Data Section satisfactorily address quality-assurance issues.
5. In conjunction with the Tallahassee Office Chief, coordinates surface-water quality assurance issues with Tallahassee Office, Regional, and Headquarters staff specialists.

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I	INTERMITTENT
PT	PART TIME
SCEP	STUDENT CAREER EMPLOYMENT PROGRAM

CONTRACTOR – EMPLOYEES HIRED THROUGH ETI SERVICES

Figure 1. Organizational chart of the Tallahassee, Florida office, September 2005.

Chief, Hydrologic Studies and Chief, Georgia-Florida National Water-Quality Assessment (NAWQA) Program

1. Review individual ongoing investigations that have surface-water data requirements and ensure that Tallahassee Office surface-water quality-assurance procedures, including appropriate data archiving, are being performed.
2. Coordinate and review any surface-water quality-assurance issues with the Data Chief.
3. Advise the Tallahassee Office Chief and Data Chief on current surface-water projects in the Studies and NAWQA Sections within the Tallahassee Office.

Surface-Water Specialist (same position as Data Chief—September 2005)

1. Advises Tallahassee Office Chief and Studies Chief of current surface-water quality-assurance policy and procedures.
2. Keeps abreast of current federal water policies, procedures, and practices regarding surface-water quality assurance.
3. Reviews project proposals involving surface-water data collection and analysis, and ensures that projects include a quality-assurance element.
4. Reviews surface-water reports produced by the Tallahassee Office and ensures that proper adherence to quality-assurance guidelines and procedures has been maintained in data collection and analysis.
5. Makes recommendations to Tallahassee Office Chief for improvements in localsurface-water quality-assurance programs and procedures.

Senior Hydrologic Technician

1. Responsible for ensuring that Data Section personnel follow the Tallahassee Office Surface-Water Quality-Assurance Plan.
2. In consultation with the Data Chief/Surface-Water Specialist, implements procedures to improve surface-water data collection methods when needed.
3. Provides input to Data Chief on surface-water quality assurance procedures used by Data Section personnel.

Field Personnel

1. Responsible for following the guidelines and procedures outlined in the Tallahassee Office Surface-Water Quality-Assurance Plan for all surface-water data-collection activities.
2. Notifies supervisor of any issues that make it difficult or impossible to follow the Tallahassee Office's Surface-Water Quality-Assurance Plan at field stations and recommends ways to correct the situation.
3. Regularly reviews real-time data to detect potential problems with the gage-height record.

Automated Data Processsing System (ADAPS) Data Base Administrator

1. Responsible for ensuring that data disseminated from the National Water Information System (NWIS) and NWISWeb have been quality-assured before release to the public.
2. Makes recommendations to the Tallahassee Office Data Chief for improvement of surface-water quality-assurance procedures regarding NWIS and NWISWeb.
3. Coordinates assignment of station numbers for surface-water stations with Data Chief.
4. Coordinates determination of drainage areas for new stations with Data Chief.
5. Responsible for mainatining the ADAPS database including: (1) creating new sites in ADAPS; (2) coordinating installation of ADAPS revisions, patches and other updates; (3) training personnel on correct usage of the ADAPS database including processing, flagging, and archiving data; and (4) coordinating problem resolution and responses to inquiries regarding the ADAPS database.

Collection of Surface-Water Data

Planning and resource management require reliable surface-water data because many anthropogenic activities, including industry, agriculture, energy production, waste disposal, and recreation, link closely to streamflow and water availability. A primary component of operating streamflow-gaging stations (referred to as "gaging stations" in this report) and conducting other water-resource studies performed by the USGS in the Tallahassee Office includes the collection of stage and discharge data.

Gaging stations operate with the objective of obtaining a continuous record of stage and discharge at the selected site (Carter and Davidian, 1968, p. 1). A system of instruments that sense and record water-surface elevation in the stream provide a continuous record of stage. Employees periodically make discharge measurements to define or verify the stage-discharge relation and to define the time and magnitude of variations in that relation.

In the Tallahassee Office, all personnel follow established USGS guidelines on the collection of stage and discharge data. Several USGS publications, such as Geological Survey Water Supply Paper 2175 (Rantz and others, 1982) and various Techniques of Water-Resources Investigations (TWRI, book 3) of the USGS rigorously discuss USGS guidelines on surface-water data collection. The USGS Office of Water Quality and Office of Surface Water memorandums (Appendix 1, accessed on the Internet at http://water.usgs.gov/admin/memo/) provide detail on some of these guidelines.

Gage Installation and Maintenance

Critical activities for ensuring quality in streamflow-data collection and analysis include proper installation and maintenance of gaging stations. Effective site selection, correct design and construction, and regular maintenance of a gage can make the difference between efficient and accurate determination of drainage-basin discharge, or time-consuming, poor estimates of flow.

Site selection for a gaging station depends on several criteria, including the purpose of the gage, hydraulic conditions, and access.   Criteria that describe the ideal gaging-station site (Rantz and others, 1982, p. 5) include unchanging natural controls that promote a stable stage-discharge or index-velocity relation, a satisfactory reach for measuring discharge throughout the expected range of stage, and a means of efficiently accessing the gage and measuring the location. Other aspects considered by Tallahassee Office personnel when planning gage-house installations include physical features such as rock riffles, overflow dams, and channel characteristics (Kennedy, 1984, p. 2).

The Data Section Chief or Project Chief, in conjunction with input from field personnel familiar with the area, selects the employee to be assigned the new gage. The Data Chief/Surface-Water Specialist selects sites for new gaging stations and oversees the gage construction through to completion. Factors considered in site selection include: (1) purpose of the gage, (2) hydraulic and hydrologic considerations, and (3) cost and accessibility. Selection of a new site involves consulting with the cooperating agency, checking terrain and drainage area on a topographic map, field reconnaissances, and file search and inventory for data on previous sites on the selected or nearby streams. The Data Section Chief or Project Chief ensure that agreements with property owners are properly documented and that all necessary permits have been obtained. In Florida, permits are required for installation of gages on bridges from the appropriate agency responsible for the bridge (County, State, Federal). Other permits may also be required. The Data Section Chief or Project Chief approve the site design, in conjunction with input from the employee who will be servicing the site and the crew installing the gage. The Data Section Chief or Project Chief approves the final gaging station product.

A program of careful inspection and maintenance of gages, gage shelters, and the gage record promotes the collection of reliable and accurate data. Allowing the equipment and structures to fall into disrepair may result in unreliable data and safety issues. Tallahassee Office policy requires field personnel to visually inspect a gaging station during each site visit, and to make a detailed inspection once a year. To prevent the buildup of mud or the clogging of intakes, employees flush intakes to stilling wells during each visit and de-silt the wells as needed (every 2-15 years) or after a major flood event. Other maintenance activities employees perform on a regular basis include checking all inside and outside staff gages, checking the bubbler rate and volume of gas left in the nitrogen tank, removing debris and silt from the pressure transducer, purging the transducer orifice line, checking/maintaining the battery voltage, noting outside high-water marks, and maintaining a log of gage activities in the gage (fig. 2).

Employees report any deficiencies that they cannot immediately repair on the gage inspection sheets (form P-17, Appendix B). The employee should work with the senior technical person, Data Section Chief, or Project Chief to remedy the noted deficiencies or hazards. The employee should never compromise safety for any reason and must accurately and immediately report and document station safety deficiencies to the senior technical person, Data Section Chief, or Project Chief. In addition to the annual inspections by the employee regularly servicing the gage, the Data Section Chief or their designee inspects each gaging site at least once every 3 years.

Measurement of Stage

Many types of available instruments measure the water level, or stage, at gaging stations. Gage types include non-recording gages (Rantz and others, 1982, p. 24) and recording gages (Rantz and others, 1982, p. 32). Because stage data may be used in a variety of ways, OSW policy requires that field personnel collect surface-water stage records at stream sites using specified instruments and procedures (Office of Surface Water Memorandum 93.07). These instruments and procedures usually provide sufficient accuracy to support computation of discharge from a stage-discharge relation. In some

GAGING STATION OPERATION AND MAINTENANCE

- **GAGE HOUSE INSPECTION INFORMATION MUST BE ON USGS MEASUREMENT F ORM 9-275F, OR SUBSTITUTE**
  - Name of field person or observer
  - Date of visit and readings
  - Outside staff gage readings
  - Inside staff gage, tape gage, or datalogger readings
  - Station number and name

- **CHECK BUBBLER SYSTEM AT PRESSURE TRANSDUCER SITES**
  - Read and record remaining pressure in nitrogen tank
  - Replace tank if less than 200 lbs. remaining
  - Check for leaks in system if tank has been replaced more than twice in a year

- **FLUSH INTAKES AND PURGE ORIFICE LINES**
  - Make sure water runs clear from stilling well
  - For submersible pressure transducers, remove and clean transducer
  - For nonsubmersible pressure transucers, purge orifice line

- **TAKE CORRECTIVE ACTION IF STAGES DIFFER BY MORE THAN 0.02 FT.**
  - Adjust and note datalogger offsets
  - Adjust and note tape stage indicator
  - Run levels to resolve reference gage accuracy issues
  - Establish temporary reference point for damaged gages

- **CHECK BATTERY VOLTAGE, REGULATOR/CHARGER, AND SOLAR PANEL**
  - Replace battery if voltage drops below 12.2 volts (use volt meter)
  - Check solar panel for cracks or bullet holes
  - Verify solar panel is good by using a 50-ohm resistor

- **CHECK DATALOGGER; DOWNLOAD DATA WITH FIELD COMPUTER**
  - Replace datalogger if it does not pass system check
  - Maintain laptop computer battery in charged condition
  - Keep spare battery pack with laptop computer
  - Keep log of programs for stations in field trip
  - Keep hard copies of programming sheets in field folder and gage house
  - Transfer downloaded data to compact disks or pen drives upon return from field

- **CUT GRASS, BRUSH, AND TREE LIMBS AROUND GAGE AND LINES AS NEEDED**

- **MAKE DISCHARGE MEASUREMENT AT SITE AS SCHEDULED**
  - Read gage heights before and after measurement and record
  - Record location of measuring section, control, and flow conditions
  - Follow criteria outlined in fig. 4

Figure 2. Gaging station operation and maintenance.

cases, because of poor hydrologic conditions, instruments that may not meet OSW standards, such as radar units, are used.

Gaging stations usually operate for the purpose of determining daily discharge, and instantaneous annual extremes in stage and discharge. This includes the goal of collecting stage data at the accuracy of 0.01 ft. or 0.2 percent, whichever is less restrictive for the stage being measured (Office of Surface Water Memorandums 89.08, 93.07, 96.05). In some cases, however, such accuracy is impossible. For example, some of the Tallahassee Office's large river stations show surge as much as + or -0.10 ft. But in some lakes and streams with wave action, employees cannot read staff gages more accurately than + or - 0.10 ft. In these cases, comments in the station analysis alert the data user to such irregularities. Office of Surface Water Memorandum 93.07 provides an explanation of USGS policy on stage-measurement accuracy as it relates to instrumentation.

The types of instrumentation installed at any specific gage shelter operated by the Tallahassee Office depend on a number of factors. These factors include the needs of the cooperating agency, availability of utility lines, terrain—including slope and aspect, configuration of the stream and its banks, and the expected range in stage. Types of continuous water-level recorders operated by personnel in the Tallahassee Office primarily include various manufactures of Electronic Data Loggers (EDLs) and Data Collection Platforms (DCPs) connected to stage sensors. However, partner agencies sometimes use analog-to-digital recorders (ADRs) and strip-chart recorders as backups for the EDLs in USGS gages. Sensors used to monitor stage include float and tape assemblages driving shaft encoders, submersible and nonsubmersible pressure transducers, and radar units. For instantaneous observation of stage, instruments used include steel tapes, staff gages, wire-weight gages, and electric-tape gages. The Data Section or Project Chief, in consultation with the cooperating agency and employee to be assigned the station determine which type of water-level recorders and sensors will be installed and operated at each gaging station.

Accurate stage measurement requires not only accurate instrumentation but also proper installation and regular monitoring of all system components to ensure that equipment and sensor accuracy do not deteriorate with time (Office of Surface Water Memorandum 93.07). Employees observe reference and primary gages to ensure that gage-house instruments accurately record the water levels of the body of water being investigated. The reference gage is a non-recording gage used to set the principal gage. The main purpose of the reference gage is to furnish periodic independent water-surface elevations to monitor the accuracy of the primary gage, and other gages (Kennedy, 1983, p. 10). The principal gage records the continuous or near-continuous record of surface-water elevations. For example, at stations with stilling wells, employees usually check the float recorder (the primary gage) against the inside staff gage or electric tape gage (the reference gage). At a station with a pressure transducer, the transducer (the primary gage) is checked against a wire-weight gage, outside staff gage (the reference gages), or crest-stage gage (CSG). In some cases, reference points (for tape-down to the water surface) may serve as reference gages because outside staff gages are regularly destroyed by trees and debris in the river or by vandalism. If they are not in the same pool, the relationship between the reference gage and the primary gage can change as the gage height increases (because of slope changes) and employees document these changes. In ADAPS, these changes can be accounted for by using an equation for input. Because of the potential changes in slope under such conditions, the primary gage is not usually adjusted to the reference gage during high flows.

The employee ensures that instrumentation installed at gaging stations, including stage sensors, is properly serviced and calibrated. This task is accomplished by visiting the site and observing any deficiencies. If observed deficiencies are minor, the employee should repair them on the spot using spare parts carried in the field vehicle. If the deficiencies are major, then the employee consults with the senior technical person, electronics specialist, construction crew, Data Section or Project Chief to formulate a corrective plan of action. Obviously, the nature of the observed problem will dictate which action to take. Individuals who have questions related to the calibration and maintenance of water-level recorders should contact the senior technical person, Data Section Chief, or Project Chief.

Secondary methods of data verification are valuable tools in the quality-assurance of data. In Florida, low gradients keep flows near peak or low levels for several days, which facilitates checking the accuracy of a peak or low. One goal of the Tallahassee Data Section is to provide more independent verification of peaks and lows, and CSGs will be installed at sites not having them to provide such verification. At some gages, cooperators maintain backup recorders which help assure a complete and accurate stage record at the gage. For example, a gaging station with a stilling well might contain two float-tape systems, one for the EDL, and one for a back-up recorder.

Gage Documents

Tallahassee Office procedure dictates that employees maintain field documents (fig. 3) in each gage shelter for the purpose of keeping an on-site record of observations, equipment maintenance, structural maintenance, and other information helpful to field personnel. Documents to be maintained at each gage shelter include: (1) a log of site visits updated by field personnel during each visit which describes control conditions and lists gage readings; *(2)* a copy of the most current rating and rating table; (3) a copy of the most recent station description detailing all the gages, reference marks, and measurement cross-sections; (4) a measurement summary which includes gage-house maintenance notes, equipment maintenance notes, and discharge measurements (Appendix figures 2-5); (5) a copy of the programming sheet

FIELD DOCUMENTS

GAGE HOUSE DOCUMENTS

- **USGS FIELD OFFICE GAGING STATION SERVICE NOTES**
  - Servicing party and date
  - Outside gage reading
  - For stilling well sites—inside and outside staff gages and/or wire-weight gage
  - For transducer sites, nitrogen tank pressure and bubble rate
  - As appropraite, datalogger readings
  - Battery voltage
- **MEASUREMENT INFORMATION**
  - Where measured
  - Equipment used
  - Maximum depth and velocity
  - Remarks on control, point-of-zero flow, high-water marks, minimum and maximum clip
  - Comments on flushing intakes or cleaning transducer
- **COPY OF EDL OR DCP PROGRAMMING SHEET; BASIC PROGRAMMING INSTRUCTIONS**
- **SPECIAL GAGE NOTES**
  - Special attention items
  - Maximum and minimum clip corrections
  - Telephone contacts
  - Copy of most recent station description
  - Copy of current rating and rating table
  - Gage house calendar
  - Past year hydrograph (optional)
- **FIELD FOLDER DOCUMENTS**
  - Map with instructions on getting to the site
  - Copy of most recent station description
  - Copy of current rating, rating table, and shift diagram
  - List of discharge measurements and preliminary shifts
  - Pertinent notes, letters regarding gages at site

Figure 3. Field documents.

for the EDL or DCP and brief instructions on how to access and program the EDL or DCP; (6) the Job Hazard Analysis (JHA) and Highway Safety Plan applicable for the site; (7) notes with important telephone numbers and any special quirks at the gage; and (8) notes regarding measurement procedures and safety rules at the station during extreme events, such as flooding and low flows. An optional document to include in the gage shelter might be a hydrograph of the previous year's mean daily flows. All documents should be kept in a sealed, hard plastic tube to protect them from moisture and pests.

The employee assigned to the gaging station ensures that outdated gage documents are regularly updated. When field personnel visit a gage shelter and identify a need to update one or more of the documents, they should replace documents as needed (note this may require some planning and forethought) or make a note to replace them on the next visit. Individuals having questions related to what documents should be kept in a gage shelter, when the documents should be replaced with newer documents, or appropriate methods of appending logs or plotting measurements should contact their senior technical person, Data Section Chief, or Project Chief.

Levels

The various gages at a gaging station are set to register the altitude of a water surface above a selected level reference surface called the gage datum. The gage's supporting structures--stilling wells, backings, shelters, bridges, and other structures--tend to settle or rise as a result of earth movement, static or dynamic loads, vibration, or damage by floodwaters and flood-borne debris. Vertical movement of a structure makes the attached gages read too high or too low and, if the errors go undetected, may lead to increased uncertainties in streamflow records. Employees use leveling, a procedure which uses surveying instruments to determine altitudinal differences between two points, to determine the gage datum, and to periodically check the gage for vertical movement (Kennedy, 1990, p. 1). Running levels periodically to all bench marks, reference marks, reference points, and gages at each station reveals if any datum changes have occurred (Rantz and others, 1982, p. 545). Three widely-dispersed reference marks need to be established at every gage, so that all of them would not be lost during a flood event. Another reason that three reference marks are needed is that if one gets disturbed, then the other two should still be in agreement and the bad reference mark can be determined. At sites with pressure transducers, levels are run to the orifice whenever possible.

Tallahassee Office procedure requires that levels are periodically run at all gages. Field personnel run levels at new gaging stations when installed, or at a minimum during the first year after the gage is constructed. They run levels to established gaging stations once every 3-5 years, after any major flood event, after any type of earth movement in the area, or any time unresolved gage-height discrepancies exist between the various gages at a station exist (Kennedy, 1990, p.14). Field notes are checked for satisfactory closure and arithmetic error prior to leaving the station. Employees reset gages to agree with levels when levels show greater than a 0.02 ft. vertical change. When gages are reset, field personnel document the reset on a miscellaneous note sheet or level note sheet (Appendix B, Form 9-275D and Form 9-276). For all levels at new stations, along with routine 3-5 year levels or levels used to reset a gage datum or establish reference points, field personnel use an engineer's level. For other checks when less accuracy is required, other types of levels, such as a laser level, become acceptable. Levels to the outside water surface should always be made.

Kennedy (1990) describes field and documentation methods used to run levels. Kennedy (1990) and Office of Surface Water Memorandum 93.12 detail level procedures pertaining to circuit closure, instrument reset, and repeated use of turning points. Field personnel maintain the level instruments in proper adjustment by running a fixed-scale test and/or a peg test (Kennedy, 1990, p. 12-14). Personnel document these tests on a miscellaneous note sheet that is kept as a peg-test log with the level notes.

The employee ensures that all field level notes are checked and that levels are run at the appropriate frequency. The employee enters the level information on the historical level-summary form within 2 weeks after the levels are completed. The summary should include changes in elevation of reference marks and the orifice, and corrections to be applied to the inside and outside staff gages. The senior technical person or Data Section Chief ensures that levels are run correctly and that all level notes are completed.

Site Documentation

Site documentation requires thorough qualitative and quantitative information describing each gaging station. This documentation, in the form of a station description and photographs, provides a permanent record of site characteristics, structures, equipment, instrumentation, altitudes, location, and changes in conditions at each site. These documents also provide a history of past flood events, nearby construction, or any unusual occurrences at the site.

Station Descriptions

A station description outlining basic gage information becomes part of the permanent record for each gaging station. Tallahassee Office procedure dictates that the station description for a new gage is written at the time the first year's records are computed. The employee assigned to service the gaging station ensures that the station description is prepared correctly and in a timely manner. Employees should obtain assistance from the senior technical person or Data Section Chief if they have a question on preparing and completing station descriptions. The employee reviews station descriptions every year and updates them if necessary. The senior technical person or Data Section Chief reviews all station descriptions to ensure that they are updated and complete.

Station descriptions outline specific types of information in a consistent format (Kennedy, 1983, p. 2). The station description includes information such as location of the station, date of establishment, drainage area above the site, description of the gages, history of activities at the station, reference and benchmarks, channel and control characteristics, floods, point-of-zero flow (PZF), the Job Hazard Analysis, site maps, and road/driving logs to the site. Other items employees should include are detail on discharge measurements and cross-sections, extreme stage and discharge, regulations and diversions, cooperative agencies, local observers, and other site-specific information (Kennedy, 1983, p. 3-5). Drainage areas determined using Geographic Information System (GIS) methods need to be checked against the original drainage area maps for consistency.

The employee maintains paper copies of the station description in the station folder and field folder, at the gage site, as well as electronic copies on the USGS computer. For new sites, employees work with coworkers to obtain latitude, longitude, and drainage area information from the most current USGS topographic maps. These should be verified with Global Positioning System (GPS) readings in the field. They obtain historical information from a variety of sources such as annual reports, investigative or open-file reports, or USGS and other-agency files. The ADAPS database administrator assigns the station number.

Photographs

Field personnel photograph gage shelters, station controls, channel conditions, reference marks, flood damage, indirect measurement sites, vandalism, and other important circumstances to document activity and conditions at the gaging station on an as needed basis. Field personnel should carry disposable cameras in their field vehicle to take photographs when they might be needed. The Tallahassee Data Section maintains a few digital cameras, which should be used for more extensive photographic needs. For hard-copy prints, the back of each photograph that is included with the station folder should be marked with a permanent-ink marker to document the station number, station name, date, gage height, and any other information needed to interpret the photo. Digital photographs for gages serviced by the Tallahassee Office are stored in data archive directories set up for each gage. Photographs should be named to document the event, location, and gage involved. Hard-copy prints or CDs of digital photographs for the current year are placed in the primary folder, while older photographs are placed in the station folder, or in the historic station files, for documentation.

Current-Meter Discharge Measurements

Employees make direct measurements of discharge with any one of a number of methods approved by the U.S. Geological Survey, the most common of which is the current-meter method. In the current-meter measurement, the sum of the products of the subsection areas of the stream cross section and their respective average velocities determines the discharge (Rantz and others, 1982, p. 80). Rantz and others (1982, p. 139), Carter and Davidian (1968, p. 7), and Buchanan and Somers (1969 p. 1) describe procedures used for current-meter measurements.

When personnel make measurements of stream discharge, they attempt to minimize errors. Sauer and Meyer (1992) identify sources of errors, which include: random errors such as depth errors associated with soft, uneven, or mobile streambeds; and uncertainties in mean velocity associated with vertical-velocity distribution errors and pulsation errors. Velocity distribution errors also include systematic errors, or bias, associated with improperly calibrated equipment or the improper use of such equipment.

To reduce systematic errors in direct-discharge measurements, Data Section Chiefs rotate most field trips every 3-5 years, or include informal check-measurement programs on all field trips. Because of complex, varied instrumentation and remote station locations, some field trips in the Tallahassee Office tend to be matched to expertise and physical capabilities, and thus are rarely rotated.

Tallahassee Office practices related to the measurement of discharge (fig. 4) by use of the current-meter method, in accordance with USGS policies, include such topics as depth criteria, number of measurement subsections, computation of mean gage height, check measurements, and corrections for storage.

Depth Criteria for Meter Selection

Tallahassee Office personnel select the type of current meter to be used for each discharge measurement based on criteria presented in Office of Surface Water Memorandum 85.07. Generally speaking, a Price AA meter should be used at depths greater that 1.5 ft., and a Price pygmy meter for depths below 1.5 ft. However, there are also velocity considerations. The reverse side of the pygmy meter rating table details all the specific information. Personnel should use current meters with caution when a measurement must be made in conditions outside of the ranges of the method presented in Office of Surface Water Memorandum 85.07, and downgrade the measurement accuracy accordingly.

Frequently, stream conditions fit guidelines between those for a pygmy meter measurement and AA meter measurement. In these cases, the meter most suited for the majority of the channel flow should be used. For example, if the cross section varies from depths of 0.7 ft. for 10 ft. of the cross section, then slowly increases to 2.5 ft. for 30 ft.

DIRECT DISCHARGE MEASUREMENT GUIDELINES

- **IDEAL CROSS-SECTION SELECTION CRITERIA**
  - Nearly uniform bottom across section
  - Average velocity greater than 0.5 ft/sec; depth greater than 0.5 ft.
  - Straight channel whenever possible to avoid angles
  - Uniform flow free of eddies, slack water, and excessive turbulence
  - Cross section close to gage to avoid storage or inflow adjustments

- **METER SELECTION CRITERIA**
  - DEPTH OF WATER
    - If greater than 1.5 ft., choose a Price AA meter
      - Use low-flow AA meter for cross sections with average velocity less than 1 ft/sec
    - If less than 1.5 ft., choose Price pygmy meter

- **CURRENT METER QUALITY ASSURANCE/MAINTENANCE**
  - Perform spin test before each trip ad log, or perform each day
    - For Price AA meter, 1.5 minutes is acceptable, 4 minutes is ideal
    - For Price pygmy meter, 0.5 minute is acceptable, 1.5 minutes is ideal
  - Check meter and repair or replace bent cups and worn pivots
  - Clean and oil meter daily, or after each measurement in sediment-laden water

- **MEASUREMENT NOTES INCLUDE**
  - Date, party, meter type, suspension, and meter number
  - Name of stream and station number, or location for miscellaneous measurement
  - Stage readings before, during, and after measurement
  - Time measurement started and ended, with intermediate times
  - Bank of stream that measurement was started from
  - Control and flow conditions
  - Other pertinent information regarding conditions

- **NUMBER OF MEASUREMENT SUBSECTIONS**
  - Ideally about 25-30 stations
  - Target no more than 5 percent of flow in each section
  - Use fewer stations for rapidly changing stage, floods with lots of debris, or narrow channels

- **STOPWATCH**
  - Periodically test stopwatch with regular watch or another stopwatch
  - Allow 40-70 seconds for each vertical measurement
    - ½ counts are acceptable in rapidly-changing stages—record as ½ counts

- **CHECK MEASUREMENTS**
  - Perform second measurement if first is more than 5 percent from current rating or shift
    - Change meter and stopwatch
    - Use different stationing, or change cross sections

- **WORK MEASUREMENT IN FIELD WHENEVER POSSIBLE**

Figure 4. Direct discharge measurement guidelines.

of cross section, then gradually decreases to 1 ft. of depth over 10 ft., a Price AA meter is probably the best meter to use as most of the flow will most likely be in the deeper part of the cross section. The employee should recognize, however, that there will be some greater error in those parts of the measurement where the water is shallower than 1.5 ft. Ideally, a pygmy meter would be used for the parts of the cross section shallower than 1.5 ft. and a Price AA meter for areas deeper than 1.5 ft. However, this approach is generally not practical and probably not worth the perhaps slight gain in measurement accuracy. In cases where two channels exist, one deep and one shallow, then changing meters becomes more practical and reasonable. Personnel who have questions concerning the appropriate procedures for making stage and discharge measurements should address their questions to fellow employees, the senior technical person, or the Data Section or Project Chief.

Criteria for Sounding-Weight Selection

When a measurement must be made from a bridge or boat, employees must consider depth and velocity in choosing the correct weight to use. A general rule is to use a weight at least as heavy as the product of the fastest velocity and deepest depth in the cross section (Rantz and others, 1982, p. 146-147). However, heavier weights may need to be used in shallow, faster streams. Tags on the reel's line will allow for correct depths to be determined in fast water.

Number of Measurement Subsections

The spacing of observation verticals in the measurement section can affect the accuracy of the measurement (Rantz and others, 1982, p. 179). USGS criteria state that employees observe depth and velocity at a minimum number of about 30 verticals, which is normally necessary to ensure that no more than 5 percent of the total flow is measured in any one vertical. Even under the worst conditions the discharge computed for each vertical should not exceed 10 percent of the total discharge and ideally not exceed more than 5 percent (Rantz and others, 1982, p. 140). Exceptions to this policy prevail in circumstances where accuracy would be sacrificed if this number of verticals were maintained, such as for measurements during rapidly changing stage (Rantz and others, 1982, p. 174). Employees sometimes use fewer verticals than are ideal for very narrow streams (about 12-feet wide when an AA meter is used and about 5-feet wide when a pygmy meter is used). Since measurement of discharge is essentially a sampling process, the accuracy of sampling results often decreases markedly when the number of samples is less than about 25.

Computation of Mean Gage Height

Tallahassee Office personnel use procedures presented in Rantz and others (1982, p. 170) for computing mean gage height during a discharge measurement. The coordinates for plotting discharge measurements for a streamflow gaging site includes mean gage height of the measurement. Methods used to determine the mean gage height involve discharge-weighting or time-weighting the stage readings during the measurement. For this to be accomplished, it is essential that field personnel periodically enter times on the notesheet during the measurement so that the weighting procedures can be applied if needed.

Check Measurements

USGS policy states that if a discharge measurement plots more than 5 percent from the rating or shift currently in place, then employees should make a second discharge measurement to check it. Because many sites maintained by the Tallahassee Office have only fair to poor measurement conditions, consideration of site conditions is a major factor in deciding whether a check measurement is made. These conditions include characteristics such as control stability, bed movement, and growth of vegetation in the channel during summer. During recessions after peak flows, changes of 5 percent or more from the rating are common, whereas during low flows, a shift difference of plus or minus 0.02 ft. is acceptable. If an obvious control change is observed, this should be noted on the field sheet and no check measurement needs to be made. When making a check measurement to verify less obvious control conditions, employees change or check as much of the instrumentation and conditions as possible. These changes and checks include using a different current meter, changing stopwatches or checking the stopwatch with a regular timepiece, selecting different vertical sections in the cross-section, or choosing a new cross-section altogether (Rantz and others, 1982, p. 346). In cases where the second measurement verifies neither the original rating or shift, or the first measurement, a third measurement might be made and the closest 2 out of 3 used.

Corrections for Storage

Rantz and others (1982, p. 177) and Office of Surface Water Memorandum 92.09 discuss corrections for storage applied to measured discharges for the purpose of defining stage-discharge relations. These corrections involve an adjustment to the measured discharge based on the channel surface area and average rate of change in stage in the reach between the gage and point of measurement. Storage corrections generally apply only if the discharge measurement is made at some distance from the gaging station cross section.

Field Notes

A necessary component of surface-water data collection and analysis includes thorough documentation of field observations and data-collection activities. To ensure that clear, thorough, and systematic notations are made during field observations, field personnel record discharge measurements on standardized USGS measurement notes (Form 9-275 series, Appendix B). If these forms are not available, any substitute can be used, even a regular sheet of paper, so long as the field person includes all the necessary information in the notes (fig. 5). Field notes are considered original legal documents, and thus, employees should not erase original observations once written on the note sheet. Instead, they should make corrections to original data by crossing the value out, then writing the correct value. Some examples of original data on a discharge-measurement note sheet include gage readings, depths, measurement stations, current-meter counts or clicks, and time notations. Employees can erase derived or computed data, such as computed widths, velocities, section and total discharges, and mean gage height.

Information that should be included by field personnel on the measurement note sheet includes, at minimum, the initials and last name of all field-party members, date, times associated with gage readings and other observations, station name and number, control and channel conditions, outside and inside (if applicable) staff gage readings, readings from the EDL or DCP, condition of the battery and nitrogen tank (if applicable), type of instrument used for any discharge measurements, any observed HWMs, crest-stage gage readings, PZF estimates, and any other pertinent information regarding unusual gage or streamflow conditions. Points-of-zero flow should be collected at wadeable streams whenever feasible and included on the Form 9027 as well as the measurement notes. Mathematics for PZF estimates, reference-point elevations, and similar calculations should be shown on the measurement note sheet.

Employees document notations associated with miscellaneous surface-water data-collection activities on miscellaneous note forms (Form 9-275D, Appendix B) or any other sheet of paper so long as the necessary information is included (fig. 5). All miscellaneous notes include, at minimum, initials and last name of field-party members, date, time associated with observations, purpose of the site visit, and pertinent gage-height readings or other information.

Besides 9-275 series of discharge measurement notes, other types of field notes used in the Tallahassee Office include crest-stage gage notes (T-9335, Appendix B), level notes (9-276, Appendix B), and a field inspection sheet for dataloggers (Appendix B). A variety of pertinent station and conditions information, readings, observations, and calculations are required in filling out these notes (fig 5; Appendix B).

Generally, discharge measurements made during field site visits will be calculated onsite after the measurement is made. This allows check measurements to be made without having to make another station visit. During floods or other emergency situations, employees should calculate discharge measurements as soon as possible and phone results into the office for informational purposes. This is particularly important during major floods so that discharges the Tallahassee Office presents to the public and the media reflect the most current data possible.

The degree of review and checking of field note sheets depends on the experience of the employee. For new employees, fellow employees or the senior technical person check every measurement or field note right after the site visit to ensure that all required information and observations are made and noted correctly, and that discharge measurements are being completed according to standards and are correctly computed. Experienced employees with demonstrated competence generally need only periodic reviews of the measurements and field notes. In the event of unusual conditions, however, the measurement should be thoroughly reviewed and checked. Reviewers finding deficiencies in the content, accuracy, clarity, or thoroughness of field notes notify the employee of these facts by communicating USGS standards and requirements directly with them. Reviewers who find continued deficiencies in an employee’s measurement notes should notify the senior technical person, Data Section Chief, or Project Chief, who will then review USGS measurement notes standards with the employee. Clear, accurate, and thorough field notes are key to the quality assurance of surface-water data. Employees that consistently fail to remedy documented deficiencies will be subject to disciplinary action, including removal for serious and continued problems (Water Resources Division Memorandum 98.10).

Acceptable Equipment

The Tallahassee Office personnel use equipment for the measurement of surface-water discharge that has been certified acceptable by the USGS through use and testing. Usually, this equipment has been rigorously tested and calibrated by the USGS Hydrologic Instrumentation Facility (HIF). An array of acceptable equipment for measuring discharge includes current meters, timers, wading rods, bridge cranes, tag lines, and others (Rantz and others, 1982, p. 82; and Smoot and Novak, 1968). Although an official list of acceptable equipment is not available, Buchanan and Somers (1969), Carter and Davidian (1968), and Edwards and Glysson (1988) discuss the equipment used by the USGS.

Tallahassee Office personnel most commonly use the Price AA current meter and the Price pygmy current meter for measuring surface-water discharge. The HIF, who test a percentage of all new meters received to assure they meet USGS standards, supplies these current meters to the Tallahassee Office. Employees may use other current meters, provided that those meters have been fully tested, calibrated, and field-checked against the appropriate Price meter. Generally, the use of other meters will require an ongoing quality-assurance program to validate their regular use. Methods followed by Tallahassee Office personnel for inspecting, repairing, and cleaning these meters are described in Smoot and Novak (1968, p. 9), Rantz and others (1982, p. 93), and Buchanan and Somers (1969, p. 7).

FIELD MEASUREMENT NOTES

- **USE 9-275 SERIES NOTES FOR INSPECTIONS AND MEASUREMENTS**

- **STATION INSPECTION NOTES INCLUDE**
  Date and party
  Name of stream and USGS station number
  Outside and inside (stilling well) stage readings
  Datalogger or Data Collection Platform stages and times
  Readings and times for all other sensors
  Control and flow conditions
  Observed high-water marks and maximum/minimum clip readings
  Condition of battery and nitrogen tank (if applicable)
  Other pertinent information regarding equipment and conditions

- **IN ADDITION TO THE ABOVE, MEASUREMENT NOTES INCLUDE**
  Meter type and meter number
  Streamflow location for miscellaneous measurement
  Stage readings and times before, during, and after measurement
  Time measurement started and ended, with intermediate times
  Bank of stream that measurment was started from

- **MISCELLANEOUS FIELD NOTES**
  Used for almost anything
  Include party, date, time, station name, and number, and observations

- **CREST-STAGE GAGE NOTES**
  For crest-stage gage inspections and service
  Include party, date, time, station number, station name
  Include stick readings, quality of marks, high-water marks, and other observations

- **LEVEL NOTES**
  For running levels at streams
  Include station number, party, date, time, and level readings and calculations

- **INFORMATION ON ALL NOTES SHOULD BE WRITTEN AS COMPLETELY AND LEGIBLY AS POSSIBLE. ASK YOURSELF IF SOMEONE ELSE COULD UNDERSTAND THE NOTES COMPLETELY IN 10 YEARS TIME--THE ANSWER SHOULD BE "YES."**

Figure 5. Field measurement notes.

The ultimate responsibility for the good condition and accuracy of a current meter rests with the field person who uses it (Office of Surface Water Memorandum 89.07). A timed spin test made a few minutes before a measurement does not ensure that the meter will not become damaged or fouled during the measurement. Field personnel must assess apparent changes in velocity or visually inspect the meter periodically during the measurement to ensure that the meter continues to remain in proper operating condition. If there is any question regarding the performance of a meter, an immediate spin test may provide the answer.

Spin Tests

Tallahassee Office procedure requires spin tests prior to each field trip. When in the field, employees document spin-test results on their measurement note sheets. When spin tests are made in the office, or after a meter has been repaired or parts changed, spin tests are entered in a notebook with a log that is maintained for each instrument. Archived surface-water data include this log (Office of Surface Water Memorandum 89.07). Spin tests and visual inspections may identify needed repairs to meters. Field personnel note these repairs on the log for the particular meter being serviced. The senior technical person, Data Section Chief, or Project Chief reviews the logs periodically to assure that personnel perform regular spin tests, maintenance, and repairs to current meters. If deficiencies are observed during this review of the log, the senior technical person, Data Section Chief, or Project Chief orally communicates noted problems to the employee, who should immediately take the recommended corrective actions.

In addition to the timed spin tests performed prior to field trips, field personnel inspect the meter before and after each measurement to see that the meter is in good condition, that the cups spin freely, and the cups do not come to an abrupt stop. Descriptive notations made at the appropriate location on the field note sheet concerning the meter condition, such as “OK” or “free” or other such comments denote that an inspection has been completed. To ensure that field personnel carry out their responsibilities in maintaining the equipment they use, the senior technical person, Data Section Chief, or Project Chief inspect equipment semiannually. They communicate noted deficiencies directly to the employee responsible for the meter, and the employee takes immediate corrective actions.

Regular repairs involve replacing a variety of parts that make up the current meter. The Data Section keeps an inventory of spare parts for use in maintaining current meters. The combined responsibility of all employees maintains this inventory and apprises the senior technical person when supplies. Employees replace or repair damaged cups immediately because damaged cups can change the standard meter calibration. For meters that fail spin tests, employees should change the pivot, pivot bearing, head assembly, or yoke until they obtain a spin test that meets OSW guidelines. The office disposes of broken parts, but retains worn or slightly damaged parts for conditioning by the HIF. Periodically, the senior technical person will return the aggregated used parts to the HIF for refurbishment, replacement, or recalibration. Metal parts that cannot be refurbished are recycled.

Alternative Equipment

New conditions and the development of new technology sometimes involve the collection of surface-water data with alternative equipment that has not been fully tested or accepted by USGS. To demonstrate the quality of surface-water data collected with alternative equipment, offices must thoroughly document procedures and observations.

Presently, the Tallahassee Office routinely uses the Acoustic Doppler Current Profilers (ADCPs) to measure some streams. USGS Water Supply Paper 93-2395 (Simpson and Oltmann, 1992), Open File Reports 95-70 (Lipscomb, 1996), 95-4218 (Morlock, 1996) and Office of Surface Water Memorandums 96.01, 96.02,and 97.02 deal with ADCP instruments, tests, and issues, including a quality assurance plan for USGS. The OSW has formed a Hydroacoustics Section, which maintains a web page including information on quality assurance procedures for ADCP’s at:

http://il.water.usgs.gov/adcp/

ADCP technology is evolving quickly and new procedures and methods will evolve as well. Training employees and encouraging communication between staff and experts in this technology will help assure that ADCPs are consistently used in an appropriate manner to collect and prcoess data to USGS standards of accuracy.

The Tallahassee Office may cooperate or contract work with another agency which uses alternative equipment, such as Swoffer current meters. Quality-assurance programs between alternative meters and Price meters will be developed between the USGS and the other agency or contractor to assess whether the alternative meter can be regularly used. Such a program would entail testing both types of meters under controlled and field conditions under an array of stream discharges to validate or invalidate use of the alternative meter. In addition, the other agency or contractor must provide the Tallahassee Office with the procedures that they use for ensuring proper calibration of their current meters.

Other Direct Methods of Measuring Discharge

Tallahassee Office procedures dictate that USGS OSW techniques and guidelines are followed when discharge measurements are made with any selected method of measurement. These methods include the moving boat method, the tracer-dilution method, volumetric methods, and use of portable weirs and flumes (Rantz and others,1982; Buchanan and Somers, 1969; and Kilpatrick and Schneider, 1983).

Indirect Measurements

In north Florida, floods often last several days to weeks because of relatively low gradients in terrain and stream channels. Thus, the office has historically relied on obtaining peak discharges by direct measurement. However, in some situations, especially extreme floods, it is impossible or impractical to measure peak discharges by means of a current meter. There may not be sufficient warning for personnel to reach the site to make a direct measurement, or physical access to the site during the event may not be feasible. A peak discharge determined by indirect methods becomes, in many situations, the best available means of defining the upper portions of the stage-discharge relation at a site (Rantz and others, 1982, p. 334). Because the results may be unreliable, USGS generally does not accept extrapolation of a stage-discharge relation, or rating, beyond twice the measured discharge at a gaging station.

The Tallahassee Office follows data-collection and computation procedures presented in Benson and Dalrymple (1967). That report includes policies and procedures related to site selection, field survey, identification of high-water marks, the selection of roughness coefficients, computations, and the written summary. The Tallahassee Office also follows procedures for measurement of peak discharge by indirect methods presented in Rantz and others (1982, p. 273).

In addition to the general procedures presented in Benson and Dalrymple (1967), the Tallahassee Office follows guidelines presented in other reports that describe specific types of indirect measurements suited to specific types of flow conditions. Barnes (1967) and Dalrymple and Benson (1967) describe the slope-area method used by the USGS, which is based on the Manning equation. Arcement and Schneider (1989) describe procedures for selecting the roughness coefficient. Office of Surface Water Memorandums 97.01 and 96.32 discuss the computer-based tools, program SAC (Fulford, 1994), used for computing peak discharge with the slope-area method, program CAP (Fulford, 1995), used to compute peak discharge at culverts, and program NCALC, used to compute Manning's n value from a known discharge, water surface profile, and cross-section properties. Bodhaine (1982) describes procedures for the determination of peak discharge through culverts, based on a classification system which delineates six types of flow. Models described by Matthai (1967), along with the Water-Surface Profile Computation model (WSPRO) described by Shearman (1990), show how peak discharge can be estimated at sites where open-channel width contractions occur, such as flow through a bridge structure.

General guidelines that are followed by the Tallahassee Office when making indirect measurements include those discussed in Office of Surface Water Memorandum 92.10 and in Shearman (1990). Violation of any one of the general guidelines does not necessarily invalidate an indirect measurement (Office of Surface Water Memorandum 92.10), but should be cause for careful scrutiny and analysis. Criteria that might invalidate an indirect measurement include possible presence of a hydraulic jump, a discontinuous water-surface slope, inadequate fall between cross sections, or evidence of bed changes between the time of the flood and the indirect measurement.

The Data Chief or Project Chief ensures that indirect measurements are performed correctly. In all indirect measurements, the computations should be documented with all plots as shown in the TWRI's and should include the field notes, photos, and a formal summary page. The Tallahassee Office Data Chief/Surface-Water Specialist reviews indirect measurements to ensure that they are being performed properly. If deficiencies are found during the review, actions taken to remedy the situations include discussing the deficiencies with the person or persons completing the indirect measurement or providing proper training. The Tallahassee Data Chief/Surface-Water Specialist refers questionable and difficult indirect measurements to other Florida Office Surface-Water Specialists, or to the Regional Surface-Water Specialist for resolution.

The senior technical person or Data Section Chief determines when and where indirect measurements are made. Generally, an indirect measurement should be performed when the estimated discharge is more than twice the highest direct measurement made at the site. For quality assurance, validation, and training purposes, a few indirect measurements should be made annually.

The employee should identify and flag high-water marks as soon as possible after the flood, and after obtaining permission from property owners. Because the quality and clarity of high-water marks are best just after a flood, personnel traveling in the field need flagging equipment such as nails and plastic markers, spray paint, paint sticks, and brightly-colored flagging tape in their field vehicles.

After the computation of each indirect measurement, the Section or Project Chief, Data Chief, or Surface- Water Specialist checks graphs, field notes and data, plotted profiles, maps, calculations or computer output, and written analyses associated with the measurement. A single labeled folder organizes the information, which is then included with the primary folder for use in computing or reviewing the record. Historic indirect measurements become part of the archived indirect measurement files.

The Tallahassee Office maintains and updates the peak-flow data files, including computer data-base files (Office of Surface Water Memorandum 92.10). The Section Chief or Project Chief ensures that appropriate indirect-measurement results are entered correctly into the peak-flow files.

Crest-Stage Gages

Crest-stage gages, or CSGs, are used as tools throughout the USGS for determining peak stages at otherwise ungaged sites, confirming peak stages at selected sites where recording gages are located, confirming peak stages where pressure transducers are used, and determining peak stages along selected stream reaches or at other locations, such as upstream and downstream from bridges and culverts. To provide the most effective high-water marks, CSGs need to be installed in the same cross-section as the transducer. These data are invaluable for performing indirect measurements. At sites without CSGs, employees must depend on obtaining a number of high-water marks to obtain flood profiles. The OSW requires quality-assurance procedures comparable to those used at continuous- record stations for the operation of CSGs and for the computation of annual peaks at CSGs (Office of Surface Water Memorandum 88.07).

Part of the Tallahassee Office's surface-water program includes operation of CSGs. There is currently a 21-station CSG program in the Tallahasseee Office. The Tallahassee Office follows procedures in the operation of CSG's presented in Rantz and others (1982, p. 9, 77, 78). One or more gages at each selected site mark peak water-surface elevations. Culvert stations, or other sites where water-surface elevations are required to compute the amount and type of flow through the structure, require upstream and downstream CSGs.

When CSG data are used to determine peak flows, field personnel develop stage-discharge relations from direct measurements, indirect high-water measurements, or programs for theoretical flow through a culvert or other structure. Employees run levels to the gage every 3-5 years, or as soon as possible after significant changes in the gage because of damage to the gage, reconstruction, or other such situations. An outside high-water mark confirms recorded peak stages whenever possible. The employee flags this mark as soon as possible after the event so that personnel can determine the elevation of the high-water mark the next time levels are run.

Field personnel write CSG observations on a CSG note sheet (Appendix B), measurement note sheet, or any other note sheet (Appendix B), so long as they include all the necessary information. Properly completed CSG field notes contain, at a minimum, initials and last name of field personnel, date, time of observation, the reading above the base bolt, mathematics used to calculate elevation, and any pertinent notes regarding the conditions the data were collected under. The CSG readings are entered into the electronic 9-207 form in ADAPS.

The Section Chief ensures that correct data-collection procedures are used by personnel in installing, maintaining, and reading CSGs. The Chief periodically reviews CSG note sheets and orally communicates any observed deficiencies to the appropriate employee, along with recommendations to correct them. The Section Chief assures that employees are properly trained in operating CSGs.

Artificial Controls

Artificial controls, including broad-crested weirs, thin-plate weirs, and flumes, are built in stream channels for the purpose of simplifying the procedure of obtaining accurate records of discharge (Rantz and others, 1982, p. 12). Such structures serve to stabilize and constrict the channel at a section, reducing the variability of the stage-discharge relation. In the Tallahassee Office, these structures are most often used in low-flow projects rather than long-term stations.

In situations where artificial controls are installed as permanent structures, determination of stage-discharge relations depends on the design rating when direct measurements cannot be made. In most cases, however, employees regularly make volumetric or current meter measurements to validate the artificial control estimates. Tallahassee Office personnel use portable weir plates and flumes in situations that include low flow controls. Buchanan and Somers (1969, p. 57) and Rantz and others (1982, p. 263) describe the methods used in applying these portable devices.

The Section or Project Chief ensures that field personnel use artificial control designs appropriate for the gaging site and that they use correct methods to install and operate the control. When installing an artificial control, the Tallahassee Office personnel take into account the criteria for selecting the various types of controls, principles governing their design, and the attributes considered to be desirable in such structures (Carter and Davidian, 1968, p. 3; Rantz and others, 1982, p. 15 and 348; and Kilpatrick and Schneider, 1983, p. 2 and 44).

During field inspections of artificial controls, employees write specific information pertaining to control conditions on field note sheets for the purpose of assisting in analysis of the surface-water data. These notes include height of water above the control, the amount of free fall and submergence at weirs, time and date of observation, station number and name, name or initials of the field person, and comments on channel conditions upstream and downstream of the artificial control. Regular maintenance at artificial controls includes cleaning the control, cleaning the staff plate, and checking for and repairing any observed leaks. Field personnel should consult the senior technical person, Section Chief, or Project Chief for help in solving issues associated with artificial controls.

Flood Conditions

Flood conditions present issues that otherwise do not occur on a regular basis. These issues can include difficulties in gaining access to a streamflow gage or measuring site because roads and bridges are flooded, closed, or destroyed. Debris in the channel can damage equipment and present dangers to personnel collecting the data. Rapidly changing stage or conditions requiring measurements to be made at locations some distance away from the gage can create difficulties in associating a gage height to a measured discharge. Because of the difficult and changing conditions, field personnel follow a series of specific guidelines during floods (U.S. Geological Survey, 1992).

The Tallahassee Office maintains a flood plan so that high-priority surface-water data associated with flood conditions are collected correctly and in a timely manner. The flood plan describes responsibilities before, during, and after a flood, informational-reporting procedures, and field-activity priorities. The flood plan serves as a central reference for emergency communications, telephone numbers for key Tallahassee Office personnel, information for accessing streamflow gages equipped with telemetry, and methods of obtaining the most current data.

The Data Chief ensures that the flood plan includes all appropriate information, reviews the flood plan annually, and makes updates to the plan as required. The Data Chief provides copies of the flood plan to all Section personnel and key project personnel who may assist in flood measurements and monitoring. Each individual that receives a copy of the plan keeps the document near their desk or with their field folders, and maintains copies of key information, such as telephone numbers, in their field vehicle. The senior technical person, Section Chief, or Project Chief ensure that individuals who receive a copy of the plan are fully versed on the plan's contents.

During a flood, the Section Chief, in conjunction with the Data Chief, coordinates flood activities. For personnel that are not already in the field during flood conditions, they should first contact the Section Chief or senior technical person for their assignments. If the Section Chief or senior technician are not available, field personnel should come directly to the office with an overnight bag in case of extended work hours. For personnel that are already in the field, their first responsibility during flood conditions is to contact the Section Chief or senior technical person for their assignment. If neither of these people can be reached, they should call and consult with other technical persons or coworkers in the office, and using the Tallahassee Office Flood Plan as a guide, decide what station they should proceed to. Personnel who arrive at a gaging station to find that a flood has occurred should make a discharge measurement, note and flag high-water marks as appropriate, and record any pertinent observations about the flood or weather conditions before proceeding to their next site. Tallahassee Office personnel apply methods described by Rantz and others (1982, p. 60) such as observing high-water marks inside and outside wells, flagging debris lines, and taking CSG readings to determine peak stage at gaging stations.

Tallahassee Office personnel follow policies and procedures stated in a number of publications and memorandums when collecting surface-water data during floods. Rantz and others (1982, p. 159-170) present techniques for current-meter measurements of flood flow. Benson and Dalrymple (1967, p. 11) discuss procedures for identifying high-water marks for indirect discharge measurements. Office of Surface Water Memorandum 92.09 and Buchanan and Somers (1969, p. 54) present information on adjustments applied to make measured flow hydraulically comparable with recorded gage height when discharge measurements are made a distance from the gaging station. It is the responsibility of all personnel with questions about particular policies or procedures related to flood activities, or who recognize their need for further training in any aspect of flood-data collection, to address their questions to the senior technical person or Data Chief.

The Data Chief reviews all activities related to floods. This review includes seeing that guidelines and priorities spelled out in the flood plan are followed and that the guidelines appropriately address Tallahassee Office requirements for obtaining flood data in a safe and thorough manner. The Data Chief communicates orally or in writing any deficiencies in following the flood plan directly to Data Section employees and to other Section Chiefs, who in turn provide corrective measures and/or training for field personnel, as appropriate.

Low-Flow Conditions

Because of less-frequent precipitation during fall in north Florida compared to the rest of the year, low flows occur at many streams in late fall and early winter. Low flows may also occur during periods of drought during any season of the year. Tallahassee Office procedure requires that field personnel make point-of-zero-flow determinations at least once annually during low flow at wadable stations. These data help employees extend rating curves down and determine the offset, thus timing is important. Tallahassee Office personnel use DCP data to decide when best to visit a site to obtain low-flow discharge measurements near the lowest flows of the year.

Low-flow conditions differ from those observed during periods of medium and high flow. Low-flow discharge measurements define or confirm the lower portions of stage-discharge relations for gaging stations, and as part of seepage runs, identify channel gains or losses. Additionally, low-flow data help in the interpretation of other associated data, such as well readings. Low-flow measurements also help define the relation between low-flow characteristics in one basin and those of a nearby basin for which more data are available (Office of Surface Water Memorandum 85.17). The designated wading measurement location must be documented in the station description.

In many situations, factors during low flows reduce the accuracy of discharge measurements. These factors include algae growth that impedes the free movement of current-meter buckets, and larger percentages of the flow moving in the narrow spaces between cobbles or fractures in the rock. When natural conditions exist in the range considered by the field personnel to be undependable, they physically improve the cross section for measurement by removing debris or large cobbles, constructing dikes to reduce the amount of non-flowing water, or take other measures (Buchanan and Somers, 1969, p. 39). In some cases, field personnel must clean the control, but only after reading and recording the gage height before cleaning. After modifying the cross section or control, personnel allow the flow to stabilize before initiating a discharge measurement. Since the modification will almost certainly affect the stage, personnel record gage-height readings on the field notes before and after they modify the channel so that appropriate adjustments to the gage-height record can be made. They should also note these readings on gage-house documents.

The senior technical person, Data Chief, or Project Chief ensure that Tallahassee Office personnel use appropriate equipment and procedures during periods of low flow. Reviewing field measurement notes during the records review, or more often in the case of drought conditions, accomplishes this task. During periods of low flow the Data Chief/Surface-Water Specialist or Project Chief provide answers to questions from Tallahassee Office personnel pertaining to data collection during periods of low flow.

Cold-Weather Conditions

Surface-water activities in the Tallahassee Office do not typically include making streamflow-discharge measurements during prolonged freezing weather conditions. Sub-freezing air temperatures, near-freezing water temperatures, wind, sleet, and ice can create difficulties in collecting data as well as dangers to field personnel. Employee safety remains the highest priority in collecting streamflow data.

Processing and Analysis of Surface-Water Data

The computation of streamflow records involves the analysis of field observations and field measurements (including the stage record), the determination of stage-discharge relations, adjustment and application of those relations, and systematic documentation of the methods and decisions that were applied. The Tallahassee Office computes streamflow records and annually publishes those data. The procedures followed by the Tallahassee Office pertaining to the processing, analysis, and computation of streamflow records are based on those described in Rantz and others (1982) and in Kennedy (1983).

Measurements and Field Notes

The gage-height information, discharge information, control conditions, and other field observations written by personnel onto measurement note sheets and other field note sheets form the basis for records computation for each gaging station. The USGS stores measurements and field notes that contain original data indefinitely (Hubbard, 1992). The Tallahassee Office stores measurements and other field notes for the water year that is currently being computed in the primary station folder. The Data Section stores previous water year's measurements and notes for each station in the designated filing place.

Tallahassee Office procedure regarding checking discharge measurements varies depending on the measurement and experience of the employee. Generally, Section personnel check discharge measurements made by employees with less than about 3 years of experience. Measurements made by experienced employees that calculate within the check-measurement criteria for their station, and are less than the highest measurement of the year, generally do not have to be checked. However, Data Section employees should check measurements that define a substantial part of the rating or shift, or were made during significant floods or low flows. Measurements that reflect a change in the rating should be checked. Procedures involved in checking a measurement include reviewing the mathematics, velocities, width calculations, gage heights and corrections, comparing the measurement gage heights with those from the recording instruments in the computer files, and other items (Kennedy, 1983, p. 7.)

The Tallahassee Office enters measurements into the the NWIS computer files using ADAPS and keeps the original measurement notes made during the year in the primary station folder. The employee enters the measurement into NWIS within 2 weeks of the field trip in which the measurement was made, unless there are extenuating circumstances, or other arrangements have been made by the Section Chief and Data Chief.

Continuous Record

The Tallahassee Office collects surface-water gage-height information as continuous record data (hourly, 30-minute, 15-minute, or 5-minute values, for example) in the form of electronic readings in a data logger, telephone modem, and transmissions by satellite. Personnel apply stage-discharge relationships to convert gage-height record to discharge record. Therefore, the accuracy of gage-height record, in great part, reflects the accuracy of computed discharges.

Tallahassee Office policy dictates that real-time data be the primary record whenever possible. Exceptions are for stations with many regularly-missing transmissions and(or) other extenuating circumstances. All real-time data ratings and shifts are updated at midnight. ADAPS will automatically calculate a mean daily value unless more than 120 minutes of data are missing from the DCP transmissions. Under some circumstances, ADAPS will automatically calculate a mean daily value with up to 600 minutes of missing data. If the time gap crosses midnight between two days, then ADAPS will not calculate a mean for either day. Backup record is inserted from data-logger data using ADAPS when needed to fill in gaps so that a mean daily value may be calculated.

Employees assemble the gage-height record for the period of analysis in as complete a manner as possible. They identify periods of inaccurate gage-height data, then correct those data using datum corrections, gage-height corrections, or flag the data erroneous using the program HYDRA within ADAPS, as appropriate. Authors discussing the assembly of gage-height record and procedures for processing those data include Kennedy (1983, p. 6), and Rantz and others (1982, p. 560 and p. 587).

The Tallahassee Office utilizes a variety of methods for entering stage data in the computer NWIS files. For stations with DCPs, the computer uses specific software (ADAPS) to “automatically” store stage data transmitted from the satellite. In ADAPS, the primary instrument (data descriptor) for current records is denoted with an asterisk. Personnel transfer data from EDLs to portable laptop field computers, then transfer the data into the USGS computer files using appropriate software for that purpose.

Gage-height record is never estimated except in special circumstances. In ADAPS, flags after the original data denote the source: “e” from EDLs; “s” from DCPs; “*” for values edited by USGS personnel, “@” for values reviewed by USGS personnel, and “~” for computer-interpolated values. Employees flag estimated mean daily flow data in the computer with an “e” before the value. In all cases, the employee checks the data for missing and erroneous values using computer software for that purpose.

Personnel may fill periods of bad or missing data with data from backup recorders operated by cooperating agencies, if available. For DCP sites, data from the EDL may be entered to fill in periods when the DCP transmissions were missed. Personnel enter these data into ADAPS using computer programs if possible, or by hand, and check for consistency in number and timing with other electronic data on either side of the bad or missing period. For DCP stations, data for missing transmissions will be entered from backup sources. Exceptions are made for peak flow or minimum flow events to document instantaneous extremes. When personnel use data from backup recorders and enter those data in the computer, they document the periods and source of the data in the station analysis in the primary station folder. Likewise, employees document periods and sources of estimated data on the station analysis in the primary folder. Typically, the employee who operates and maintains the gage is the one who enters, maintains, and documents the stage data in ADAPS.

Procedures for Computing, Reviewing, and Publishing Records

The employee follows through with the processing of records for their assigned stations, working the first computation for all associated records. After the first computation, a different employee reviews and checks the work. Finally, a senior technical or designated employee reviews the record and makes any required changes. When major changes are required, the record is returned to the employee assigned to the gage to make those changes.

After the records are completed, the Data Section, along with assistance of the Publications Unit and NWIS database adminstrators, compiles the data, prepares the annual data report, arranges for printing of the report, duplicates and distributes CDs of the report, and makes the report available on the Internet. The current annual data report is available at the following web address:

http://water.usgs.gov/pubs/wdr/#FL

Key elements for a Surface-Water Quality-Assurance Plan include ensuring the thoroughness, consistency, and accuracy of streamflow records. These records entail a variety of data, which include the gage-height record including instantaneous extremes, levels, ratings, datum and gage-height corrections, shifts, hydrographs, station analyses, furnished records, and the daily values table. The goals, procedures, and policies for each component differ.

Gage Height

The accuracy of surface-water discharge records depends on the accuracy of discharge measurements, the accuracy of rating definition, and the completeness and accuracy of the gage-height record (Office of Surface Water Memorandum 93.07). Computation of streamflow records includes ensuring the accuracy of gage-height records by comparisons with gage-height readings made from independent reference gages, comparison of inside and outside gages, examination of high-water marks, comparisons of recorded peaks and troughs with those at auxiliary recorders or adjacent gages, examination of data obtained at CSGs, and confirmation or updating of gage datums by levels.

Employees examine the gage-height record to determine if the record accurately represents the water level of the body of water being monitored. As part of this examination, they identify periods of time during which inaccuracies have occurred and, whenever possible, determine the cause for those inaccuracies. When appropriate, personnel flag inaccurate gage-height records in ADAPS and place notes to that effect in the primary station folder.

Gage-height record documentation involves detailing observations in several parts of the record to clearly document stage changes at the station. Employees must document all gage-height corrections by entering them in ADAPS and including a hardcopy of the file in the primary folder. They should note gage heights observed during field inspections or discharge measurements directly on the primary record on the day of observation to assure agreement between the observed and computed gage heights. Additionally, employees note the source of gage-height data used to fill in periods of missing or erroneous gage-height data on the primary record sheet as well as on the station analysis within the primary station folder. Generally, the person assigned to the station will be the one who flags erroneous data or inserts backup data in ADAPS. The employee keeps hard copies or computer diskettes of the replacement data in the primary station folder.

Levels

By running levels, employees can detect errors in gage-height data caused by vertical changes in the gage or gage-supporting structure, and can reset gages or adjust gage readings by applying corrections based on levels (Kennedy, 1983, p. 6). Procedures for computing level records for each station include ensuring that the front sheet has been completed for each set of levels, checking levels, ensuring that the level information was listed in the historical levels summary, and ensuring that information was applied in ADAPS appropriately as datum corrections. Information on how to run and compute levels is available in TWRI 3-A19 (Kennedy, 1990). The individual computing the record checks field notes for indications that the gages were reset correctly by field personnel. If the gages were not reset to agree with the levels, then corrections must be applied to the record to make them do so, and the employee responsible for the station will reset the gages on their next field trip to the site and document that action on a measurement note sheet. The individual computing the records makes appropriate adjustments to the gage-height record by applying datum corrections.

Rating

One of the principal tasks in computing the discharge record includes the development of the stage-discharge relation, also called the rating. The rating is usually the relation between gage height and discharge (simple rating). Ratings for some special sites involve additional factors such as velocity (index-velocity ratings), rate of change in stage, or fall in slope reach (complex ratings; Kennedy, 1983, p. 14). Tallahassee Office personnel follow procedures for the development, modification, and application of ratings that are described in Kennedy (1984). Tallahassee Office personnel also follow guidelines pertaining to rating and records computation that are presented in Kennedy (1983, p. 14) and in Rantz and others (1982, Chap. 10-14 and p. 549).

For each gaging station, the most recent digital rating table can be obtained by accessing the rating table files in the computer using ADAPS. Additionally, the employee maintains a paper copy of the rating table in the station primary folder, the field folder, and the gage house. A graphical plot of the most recent rating can be obtained by using the computer to plot the rating, or accessing the original paper version or copy in the station primary folder, or copies in the field folder.

Various Tallahassee Office procedures apply to ratings. Typically, the employee assigned to the station develops new ratings; however, sometimes a reviewer or checker develops the new rating. Employees obtain in-house reviews of ratings and shifts before they are distributed outside the office. Final ratings will be approved by the Section Chief or senior technical person. Employees generally apply shifts to the rating when measurements indicate a change in the rating or previous shift of more than 5 percent. Shifts that extend over the entire range of the rating and/or persist more than one year may reflect a fairly stable control change and should be analyzed and drawn up as new ratings. Ratings should generally be extended no more than twice the discharge of the highest direct measurement. Employees should include all measurements made to develop the new rating, along with the highest 10 measurements made at the site. The old rating should be outlined lightly on the same sheet as the new rating. Sheets showing the new and old rating should show the numbers of the ratings and the dates they were first applied and ended, station name and number, measurement numbers, the offset, and values for the x and y axis (discharge and stage). The Data Chief/Surface-Water Specialist or senior technical person provide the ultimate guidance to Tallahassee Office personnel regarding ratings.

Datum Corrections, Gage-Height Corrections, and Shifts

Datum corrections, as measured by levels, represent a correction applied to gage-height readings to compensate for the effect of settlement or uplift of the gage (Kennedy, 1983, p. 9). Employees apply datum corrections to gage-height record in terms of magnitude (in feet) and in terms of when the datum change occurred. In the absence of any evidence indicating exactly when the change occurred, employees must assume that the change occurred gradually from the time the previous levels were run, and they prorate the correction with time (Rantz and others, 1982, p. 545). This may require records revision for previous years. Datum corrections apply when the magnitude of the vertical change becomes greater than 0.02 ft.

Gage-height corrections compensate for differences between the primary gage and the reference gage (Rantz and others, 1982, p. 563). These corrections apply in the same manner as datum corrections. Employees apply gage-height corrections to make recorded data agree with reference gage data. They apply these corrections when the difference between the primary (recording) gage and the reference gage is greater than 0.02 ft.

A shift represents a correction applied to the stage-discharge relation, or rating, to compensate for variations in the rating. Shifts reflect the fact that stage-discharge relations are not permanent but vary from time to time, either gradually or abruptly, because of changes in the physical features that form the control at the gaging station (Rantz and others, 1982, p. 344). Applied shifts vary in magnitude with time and with stage (Kennedy, 1983, p. 35). Generally, employees do not apply shifts unless a measurement, or series of measurements, vary more than 5 percent from the rating. A stage-shift diagram documents shifts, plotting a measurement's shift from the rating against the measurement's gage height. Evidence from the hydrograph, rating, and plotted measurements determines how the shift diagram is drawn and applied. In the Tallahassee Office, time shifts are normally only used when a stage shift cannot be justified by the available data. For some streams with very mobile bed material, time shifts may be more appropriate for working the record. Once shifts are applied, measurements should vary from the rating by less than 5 percent (measurement rated good), 8 percent (measurement rated fair), or more than 8 percent (measurement rated poor).

The employee documents datum corrections, gage-height corrections, and shifts in the computer and station files. Datum and gage-height corrections, along with shift data, in the computer are located in ADAPS. Paper copies of these files are maintained in the primary station folder. After final review, copies of the datum corrections, gage- height corrections, and stage and time shifts are maintained with the station analysis as part of the historic record. Generally, transitions in gage-height corrections and shifts should be smooth between water years. However, so long as the computed discharge difference is less than 5 percent, or less than the rating quality of the data (fair, 5-8 percent; poor, more than 8 percent), no changes are made to the previous year's record.

Hydrographs

A discharge hydrograph is a plot of daily mean or unit value discharges versus time. The horizontal axis represents the date and the logarithmic vertical axis represents the discharge. In the process of computing station records, this hydrograph becomes a useful tool in identifying periods of erroneous information, such as incorrect shifts or datum corrections. Additionally, hydrographs help in the estimation of discharges for periods of undefined stage-discharge relation, such as during backwater conditions and periods of missing record.

Information placed on the hydrograph for each station includes station name, station number, water year, date the hydrograph was plotted, drainage area, plot of daily mean or unit value discharge data, plots of measurements, and hydrograph of the streamflow stations with which the hydrograph was compared. Personnel generally compute the hydrograph on the computer and print it out on a plotter. Reviewers check and finalize hydrographs during the final review.

Hydrographic comparison helps verify the reasonableness of the computed discharge data. Stations appropriate for comparing with another station include the following: (1) sites downstream or upstream of the station being analyzed; (2) sites in adjacent watersheds; or (3) sites with comparable drainage areas in the same general vicinity. Comparisons can also be made by adding or subtracting stations, which is useful for streams with diversions. Large differences noted by the hydrographic comparison need to be explained in the station analysis and included with the hydrograph as part of the review package. Final hydrographs should become part of the archive file.

Station Analysis

The station analysis documents the data collected, procedures used in processing the data, and the logic upon which the computations were based for each year of record for each station. The analysis serves as a basis for review and as a reference in case questions arise about the records at some future date (Rantz and others, 1982, p. 580). Topics discussed in detail in the station analysis include equipment, hydrologic conditions, gage-height record, datum corrections, rating, discharge, special computations, hydrologic comparisons, remarks, and recommendations. The section on gage-height record includes information on instrument issues, and maximum and minimum recorded stages. The section on datum corrections provides information on levels and the zero of the gage. The rating section details the control conditions for the gage, type of bed material, rating and shifts used during the analysis, and maximum and minimum computed discharges. The discharge section provides information on the rating and hydrographic comparison used. Finally, the remarks section details record accuracy and miscellaneous information on the station record such as rating irregularities, estimated record, assumptions and/or reasoning needed to interpret the record, or recommendations for station operation and maintenance. The employee responsible for maintaining the station generally writes the station analysis.

The Tallahassee Office maintains electronic files for all station analyses. Personnel in Tallahassee access these files on the computer by going to the following directory:

\\fltlhsr001\archive\analysis\xxxx

where xxxx is the water year.

Communication is a key element in records-working, processing, and review. The Tallahassee Office encourages persons checking the record to review and discuss all changes with the person working the record. Such interaction not only allows the opportunity to educate the records-worker as to errors they may have made in procedure or analysis, but also enables the records-worker and checker to knowledgeably discuss any changes made to the record with future reviewers. The Section Chief, or designee, decides differences that cannot be resolved by mutual discussion and agreement between the records-worker and the checker. The reviewer assures that the station analyses are properly completed and stored on the computer and in the final record.

Furnished Records

The Tallahassee Office receives surface-water data collected under the supervision of other agencies, organizations, or institutions. The Tallahassee Office performs quality-assurance reviews and publishes these data in the USGS annual data report. The quality-assurance program for data collection includes at least two annual check measurements and gage inspections. The assurance program for the furnished data, which includes mean daily discharge values and extreme stages and discharges, involves annual records reviews. These reviews include checking the daily values summary, list of discharge measurements, copies of the front sheets for the discharge measurements, primary computation sheets showing gage-height and datum corrections and shifts, a hydrograph and hydrographic comparison with another station, rating tables and rating curves, shift diagrams, and the station analysis. In the case of errors in computation of the furnished record, or of questions regarding the standards under which the data were collected, the USGS will work with the furnishing agency to resolve these issues. If an issue cannot be resolved, or the record is determined to be unreliable, the record should be published as "poor." In extreme cases, the record should not be published. Documentation of the issues in these cases should be made part of the station record and the USGS should work with the furnishing agency to remedy the situation.

Daily Values Table

With few exceptions, for each gaging station operated by the USGS, ADAPS computes and stores a mean discharge value for each day. The daily values table generated by ADAPS displays mean daily discharges stored for each day of the water year. Employees compare the daily discharge values table with hydrographs to ensure reasonableness and accuracy of the tables. Paper copies of the daily values table kept in the primary station folder, which are periodically updated though the year, document the status of the record. The final manuscript is checked with these data. The mean daily discharges are published in the annual data report.

One possible exception to computing and publishing mean daily flows involves tidally-affected data. Currently, the Office of Surface Water is drafting a memorandum describing the acceptable methods for publishing and releasing tidally-affected flow, which may include running the data through digital filters to remove the tidal influence, or in only publishing extremes. Until this memo is finalized and realeased, Tallahassee will continue publishing mean daily flow data for all sites and include remarks in the manuscript for sites affected by tide and backwater.

Manuscript and Annual Data Report

When Tallahassee Office personnel have computed, analyzed, checked, reviewed, and finalized records for the water year, the surface-water data for that water year are published along with other data in the Tallahassee Office's annual report for northwest Florida, which is part of the "U.S. Geological Survey Water-Data Reports" series. Information presented in the annual data report includes mean daily discharges for the year, mean daily gage heights for the year (some stations), extremes for the year and period of record, and various statistics. Additionally, station description information presented in the annual data report supply important information details such as physical descriptions of the gage and basin, history of the station and data, and statements of cooperation. In preparing the annual data report for publication, the Tallahassee Office follows the guidelines presented in the report, "WRD Data Reports Preparation Guide" (Novak, 1985) and the Office of Information Technical Memorandums which are accessed at:

http://water.usgs.gov/usgs/publishing/Memos/

The Tallahassee Office Data Chief maintains responsibility for coordinating and producing the annual data report.

Crest-Stage Gages

The Tallahassee Office maintains CSGs to collect peak flow data at about 21 sites, located within small drainage basins. Culvert computations are used to estimate the peak discharges associated with these stages. When possible, direct measurements of flow are used to validate these computations. Additionally, some stations with pressure transducers have CSGs to document and/or verify peak stages. Procedures for computing CSG records should be similar to those for other gaging stations. The field notes are examined for correctness and accuracy. Peak stages recorded by CSGs are cross referenced with other available information; the dates of the peaks are determined by analyzing available precipitation data and peak data from recording gages within the same basin or from nearby basins.

For each station, a list of all measurements is maintained and each measurement is assigned a chronological number. For each station, a graphical plot of the current rating along with each recent and each notably high stage-discharge measurement is made readily available to those who check and review the station record. The original graphical rating plots are kept in the primary folder while copies are kept in the field folder. Current station descriptions and a summary of levels are maintained in the primary folder. A brief station analysis is written each year describing computation of the annual peak, identifying which rating was used and the type of flow condition, and describing how the dates of the peaks were determined.

Data Section personnel update the Peak-Flow File promptly after peak data have been finalized. A current listing of annual peaks become part of the station folder for review purposes (Office of Surface Water Memorandum 88.07).

Real-time Data

Of the continuous-record gages maintained by the Tallahassee Office, about 85 percent provide real-time data. However, the Tallahassee Office plans to have real-time data available at all gages in the network by the end of FY 2006. Cooperating agencies and the public use these data for flood monitoring and warning, low-flow monitoring and fisheries interests, power production, reservoir and river management, recreational information, and other uses. The ADAPS database manager and Section personnel check the data coming from DCPs daily to quality assure the information. Additionally, most of these data are regularly checked and updated by field personnel who use the data for their primary record. As soon as field personnel enter measurements, shifts, rating changes, and datum corrections (usually within 2 weeks of their field trip) into ADAPS, these changes are also reflected in the real-time data on NWIS web. Any noted errors in the real-time data are corrected through a team effort between the employee responsible for the station and the ADAPS database administrator.

Computer software is used to monitor the data stream from the Local Receiving Ground Station (LRGS), data from individual stations, and the operation of the data links, WEB server, and the computer itself. The Information Technology Section provides technical support to the Data Section in resolving web, NWIS, and individual station problems, as well as other complex problems.

Real-time data from streamflow stations maintained by the Tallahassee Office are served from computers located in Tallahassee. The NWIS Web software is used to conform data to national USGS standards. Current hydrologic data from real-time stations in the Tallahassee Office can be obtained on the Internet at:

http://waterdata.usgs.gov/fl/nwis/rt

while the Florida Integrated Science Center home page can be found at:

http://fisc.er.usgs.gov/

Water Resources Division Technical Memorandum 97.17 discusses release of real-time data on the Internet. This memorandum requires frequent and ongoing screening and review of the NWIS Web data, including daily reviews of hydrographs during normal office hours of operation. Additionally, "sniffer programs" established by the Office of Surface Water document spikes in the data stream and send automatic email notifications to the Tallahassee Data Section Chief and the ADAPS database adminstrator. The Tallahassee Office ADAPS Database Administrator works in conjunction with office personnel to review and screen real-time data on the Internet.

Error Handling

There are two general types of errors associated with streamflow data delivered by the real-time system and disseminated on the Internet. The first type of error results from persistent problems, which are usually associated with some type of equipment failure in data collection or transmission. Because of the nature of the problem, the errors generally persist for more than a single data-collection interval. The second type of error results from intermittent problems, which are often the result of a data transmission error. These often show up as either a zero or unreasonably large or small value. By checking Internet hydrographs of the data, employees can determine if the gage's instruments are working correctly. Zero values and unusually high or low numbers alert the employee to possible errors, which can be dealt with immediately.

Data Qualification Statements

Water Resources Division Memorandum 95.19 requires that streamflow data made available on the Internet be considered provisional until the formal review process has been completed. To ensure that everyone who accesses the data from the Internet is aware of this status, data qualification statements are included at key locations with a clickable heading "Provisional Data Subject to Revision" on all real-time data pages. For Florida, the station list of al-time data sites includes this provisional statement.

Office Setting

Maintaining surface-water data and related information in a systematic and organized manner increases the efficiency and effectiveness of data-analysis and data-dissemination efforts. Good organization of files reduces the likelihood of misplaced information; misplaced data and field notes can lead to analyses based on inadequate information, with a possible decrease in the quality of analytical results.

Work Plan

No Section in the Tallahassee Office maintains a formal work plan. Section Chiefs regularly communicate verbal work assignments to their staff. Employees in Tallahassee perform most major gage construction. Occasionally, a contractor installs a new gage when specialized equipment or unusual gage installations are required. Minor or routine gage maintenance and installation usually remain the responsibility of the employee assigned to the gage. In 2005, Tallahassee Data Section employees spent 35 percent of their time on field activities, 52 percent on working and reviewing records, 10 percent on special projects, and 3 percent on related work activities such as meetings and training.

File Folders for Surface-Water Stations

Files in the Tallahassee Data Section include a separate set of folders for each gaging station, organized by station number in downstream order. Separate folders for current year data and previous-year data, as well as gaging-station history and special studies such as indirect measurements, are kept in one main station folder. Extraneous items are removed from the current files after records are finalized each year. Station review folders keep about 5 years of final record data, the set for each year including mean daily and extreme discharge sheet, hydrograph, station analysis, station manuscript, measurements list, datum correction values, variable shift values, stage-discharge rating shift analysis, summary of extreme events, shift diagrams, annual statistics, station description, surface-water review notes, and any other pertinent items.

The set of current files for each station varies. For all stations, a current-year folder holds all measurement notes, preliminary primary-records computations, shift diagrams, ratings, datum and gage-height correction notes, and other current-year information. The technical folder contains continuously updated information like the station analysis, historical list of measurements, station description, station statistics, and level notes, as well as items such as memorandums to the record, letters regarding the station, access information, old ratings, maps, photographs, and any historical data or information on the gage. Another folder contains any indirect measurements that had been made at the site. Current digital photographs of the gages and gaging activities are compiled and maintained on a laptop computer devoted to that purpose, with back-ups of the photographs on CDs, all of which is maintained by the Tallahassee Data Chief. Future plans include making CDs of photographs for individual stations and including these CDs with the station folder.

Historical records are filed in a variety of ways. Past-year primary record files, measurement notes, strip charts, ADR tapes, indirect measurement analyses, and CSG records are kept in historical files for each type of data and are filed by station number. Records over 20 years old are archived appropriately and records of their whereabouts are maintained in the station folder. However, original discharge measurements should not be archived, but maintained in files onsite. Some historic measurements prior to 1971 were archived, however, and are not in the Tallahassee Office files.

Field-Trip Folders

Tallahassee Office employees maintain a separate group of folders for each field trip area. The primary purpose of these folders is to compile driving logs, maps, station descriptions, station lists, and other pertinent information, allowing field personnel to run the trips effectively at a moment's notice and with a minimum of time spent on last-minute preparations. The employee responsible for maintaining the station updates the folder for that station.

Levels

The Tallahassee Data Section files level notes in a central file. These data are not archived, but maintained in the files for the period of record of the station. All stations, current and discontinued, are included. Files are organized by station number in downstream order.

Station Analyses and Descriptions

The most recent station analysis and station description files exist on the Tallahassee Office computer, and employees keep paper copies of these documents in the station folder. Current water year files contain copies of the previous year's station analysis. Historical station analyses become part of the archived data.

Discontinued Stations

The Tallahassee Office has no special treatment for files from discontinued stations. Annual data from these stations is filed with historical data from active stations. Measurements are filed by station number with other stations, current or otherwise, in the Tallahassee Office's measurement files.

Map Files

The Hydrologic Studies Section in Tallahassee maintains files for USGS maps of Florida. Map scales include 1:100, 1:250, 1:24,000 (7.5 min. series), and 1:62,500 (15 min. series). The Tallahassee Office files the 1:100 and 1:250 maps in separate drawers while they combine the 1:24,000 and 1:62,500 maps and file them in alphabetical order by map title in a series of drawers. Any of these maps can be marked on and used as work maps. When the user takes the next-to-the last map, they must contact the Hydrologic Studies Section, which orders new maps to replace those used.

Archiving

The USGS directs all personnel to safeguard all original field records containing geologic and hydrogeologic measurements and observations (Water Resources Division Memorandum 77.83). Selected material not maintained in Tallahassee Data Section files are placed in archival storage. In the Tallahassee Office, the Administrative Section maintains detailed information on what records have been removed to archival centers. This information includes detailed letters of transmittal and accession numbers, so the data can be retrieved when needed. Data targeted for archival include, but are not limited to, recorder charts and tapes, original data and edited data, observer's notes and readings, station descriptions, analyses, and other supporting information (Water Resources Division Memorandum 92.59 and Hubbard, 1992, p. 12). At this time, an agreement between USGS and the Federal Records Centers (FRC) of the National Archives and Records Administration provides for archiving original-data records (memorandum from the Chief, Branch of Operational Support, May 7, 1993).

Electronic data are archived on hard disks or CDs. All basic DCP data (gage height, discharge, and precipitation for example) are archived, while DCP performance data are only kept for the last 30 days. Any back-up record is included in the archive.

The Tallahassee Office sends surface-water information from the Sections to the FRC in Atlanta, Georgia, every 20 years on average. The Section Chiefs in Tallahassee decide what information is sent to the FRC and when that information is sent. The Administrative Section ensures that the information is properly packed and logged, and ascertains that the information is received by the FRC. In their office files, the Administrative Section maintains records of exactly what has been archived. For the Tallahassee Data Section, these data include original measurements for some stations prior to 1971, recorder charts, primary sheets, gage-height books, rating tables, and observer notebooks and cards for most gages prior to 1990. In Tallahassee, measurements since 1971, and all level notes are maintained in files onsite. Discharge measurements prior to 1971 are maintained in the Data Section files for some stations.

Questions concerning archiving procedures should be addressed to the Data Chief. Personnel who receive requests for information that require accessing archived records should notify the Tallahassee Office Data Chief. In some cases, the Data Chief can provide the information directly, in others, the Data Chief can guide the requester through the steps needed to fulfill their needs, and in other instances, the Data Chief must ask the Administrative Section to make a special request to the FRC.

Project Chiefs ensure that surface-water data collected as part of their project are appropriately archived. Presently, no Tallahassee Office policy addresses archival of investigative surface-water data. However, all time-series surface-water data should be included in the appropriate office files. Project-related streamflow data incorporated in ADAPS that are published in the annual data report are archived with other stations from the Tallahassee Data Section. However, it still remains the responsibility of the Project Chief to coordinate with the Data Section for proper archival and storage of charts, ADR tapes, streamflow measurements, indirect measurements, and other original data. Archiving procedures for specialized surface-water data, such as drainage area delineations, rainfall-runoff models, and other hydrologic models, or related information such as evapotranspiration, depend on programs set up by the Project Chief and the Information Technology (IT) Section. In most cases, Project Chiefs archive their own data on permanent media such as CDs. The Publications Section files, then archives, with other pertinent project information and data, all original technical review comments, letters of approval, and other original information related to the processing, review, and publication of the report.

Publication and Review of Surface-Water Data Reports

The text, “Suggestions to Authors of the Reports of the United States Geological Survey” (U.S. Geological Survey, 1991, p. 36-41), summarizes procedures for publication and requirements for manuscript review by USGS. All interpretive reports written by USGS scientists in connection with their official duties must be approved by the Center Director, or designated Deputy Center Director for the Director, an authority currently accomplished at the Regional level. Non-interpretive reports can be approved by a Deputy Center Director in the Science Center. The Water Discipline of the USGS requires at least two technical reviews of each report (U.S. Geological Survey, 1991, p. 36). Competent and thorough editorial and technical review is the most certain way to improve and assure the high quality of the final report (Moore and others, 1990, p. 24). Moore and others (1990, p. 24-49) present principles of editorial review and responsibilities of reviewers and authors. The Water Discipline of the USGS does not require editorial reviews for Open-File Reports, but they are reviewed for policy and reproducibility (U.S. Geological Survey, 1991, p. 36).

Types of Publications

Various types of book publications released by the USGS are available in which surface-water data and data analyses are presented. Publications of the formal series include the Professional Paper, the Circular, the Techniques of Water-Resources Investigations, and other special reports. Publications in the informal series include the Scientific Investigations Report, Scientific Investigations Map, the Open-File Report, Data Series, Administrative Report, and Fact Sheet. Included in the Open-File Report series are data reports. Surface-water data collected by the Tallahassee Office are published each year in a hydrologic data report that is part of the annual “U.S. Geological Survey Water-Data Reports” series. Green (1991, p. 14) presents factors the Tallahassee Office should consider when deciding which form of publication to utilize in presenting various types of information.

Annual Data Report

The Tallahassee Office Annual Data Report receives several reviews and proofs before and after it is published. After all station reviews are completed, scripts are run and a Portable Document Format (PDF) is created for the report. This PDF is reviewed and edited, as needed, to afford Section 508 compliancy and is maintained on a persistent URL at the following address: http://water.usgs.gov/pubs/wdr/#FL. Then, the pdf is formatted onto a CD and reproduced for distrbution. Since 2005, no hard copies (printed books) are procured or distributed; however, paper copies can be produced as needed from the online PDF or CD versions.

Publication Policy

The USGS has created specific policies pertaining to publication of data and interpretation of those data. All USGS personnel, including those of this Tallahassee Office, are required to abide by those policies. The Publications Guide of the Water Discipline of the USGS (U.S. Geological Survey, 1986, p. 4-37) summarizes publication goals, procedures, and policies.

All information obtained through investigations and observations by the staff of the USGS or its contractors is provisional until made available to the public through USGS-approved formal publication or other means of public release, such as on-line publication. Provisional data may be released to the public after review by USGS personnel for accuracy; SW data from real-time gages on NWISWeb fall into this category.

All interpretive writings in which the USGS has a proprietary interest, including abstracts, letters to the editor, and all writings that show the author's title and USGS affiliation, must be approved by the Director before release for publication. The objectives of the Director's review are to perfom a final check of the scientific integrity and technical quality of the writing and to make certain that it meets USGS publication standards and is consistent with policies of the USGS and Department of the Interior. Director's approval ensures that (1) each publication or writing is impartial and objective, (2) conclusions that do not compromise the USGS's official position, (3) an unwarranted advocacy position is not implied, and (4) statements do not criticize or intimate competition with other governmental agencies or the private sector (U.S Geological Survey, 1991, p. 10).

Safety

Performing work activities in a manner that ensures the safety of personnel and others remains the highest priority for the USGS and the Tallahassee Office. Beyond the obvious negative impact unsafe conditions can have on personnel, such as accidents and personal injuries, they also can have a direct effect on the quality of surface-water data and data analysis. For example, errors may be made when an individual's attention to detail is compromised when dangerous conditions create distractions. To ensure that personnel are aware and follow established procedures and policies that promote all aspects of safety, the Tallahassee Office communicates information and directives related to safety to all personnel through in-house and out-of-office training classes, memorandums, and videotape sessions.

In the Tallahassee Office, a designated Safety Officer heads the Tallahassee Office Safety Committee, identifies and provides direction on safety issues, manages the safety budget, coordinates safety training, prepares safety reports forthe Regional Office, and deals with new and ongoing safety issues. Currently, the USGS Safety Plan provides policy and guidelines for safety-related issues in the Tallahassee Office. The Tallahassee Office Safety Committee is working on a Safety Plan for the Tallahassee Office. The Tallahassee Office Safety Committee meets quarterly and consists of 6 members: the Tallahassee Office Safety Officer; one member from each of the three Sections; one member representing administration and management; and one specialist in boat safety. Until the Tallahassee Office Safety Plan is completed, specific policies and procedures related to safety reside in a series of letters, memorandums, and other documents kept and updated by the Tallahassee Office Safety Officer. Personnel who have questions or concerns pertaining to safety, or who have suggestions for improving some aspects of safety should direct those communications to their supervisor or the Tallahassee Office Safety Officer.

Training

Ensuring that personnel obtain knowledge of correct methods and procedures is a vital aspect of maintaining the quality of surface-water data and data analysis. By providing appropriate training to personnel, the Tallahassee Office increases the quality of work and eliminates the source of many potential errors.

In-house and out-of-town training sessions supplement the employee's work experience and self-training. These sessions provide experience in areas where the employee is unfamiliar, or needs more practice to become proficient. The Section Chief or the designated supervisor arranges for the employee's training. For most needs, however, "on-the-job" training is the most important aspect of the employees training experience in the Tallahassee Office.

Summary

Information included in this Tallahassee Office Surface-Water Quality-Assurance Plan documents the policies and procedures of the Tallahassee Office that ensure high quality in the collection, processing, storage, analysis, and publication of surface-water data. The roles and responsibilities of Tallahassee Office personnel for carrying out these policies and procedures are presented, as are issues related to management of the computer data base, including real-time data, and issues related to employee safety and training. In the Tallahassee Office, the employee responsible for operating and maintaining their assigned surface-water stations works with their fellow employees in a team effort to assure high quality data, analyses, reviews, and reports for cooperating agencies and the general public.

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APPENDIXES

Appendixes

Appendix A. Water Resources Division Memorandums Cited

The following memorandums were cited in the report; the text of these memos can be found on the Internet address: *http://water.usgs.gov/osw/pubs/oswtechmemosum.html*

Office of Surface Water Memorandum 97.02
Office of Surface Water Memorandum 97.01
Office of Surface Water Memorandum 96.01
Office of Surface Water Memorandum 95.03
Office of Surface Water Memorandum 93.07
Office of Surface Water Memorandum 93.12
Office of Surface Water Memorandum 93.07
Office of Surface Water Memorandum 92.11
Office of Surface Water Memorandum 92.10
Office of Surface Water Memorandum 92.09
Office of Surface Water Memorandum 92.04
Office of Surface Water Memorandum 90.01
Office of Surface Water Memorandum 89.08
Office of Surface Water Memorandum 89.07
Office of Surface Water Memorandum 88.18
Office of Surface Water Memorandum 88.07
Office of Surface Water Memorandum 87.05
Office of Surface Water Memorandum 85.17
Office of Surface Water Memorandum 84.05
Water Resources Division Memorandum 98.10
Water Resources Division Memorandum 96.32
Water Resources Division Memorandum 95.19
Water Resources Division Memorandum 92.59
Water Resources Division Memorandum 77.83

Memorandum from the Chief, Branch of Operational Support, May 7, 1993.

Appendix B. Tallahassee Office Note Sheets for Recording Surface-Water Data

P-17.(Rev. 2-77)

U.S. GEOLOGICAL SURVEY
GAGING STATION SAFETY AND MAINTENANCE INSPECTION

STATION NAME: ____________________ NUMBER: ________

SUMMARY:

	YES	NO
STATION IS SAFE		
MAINTENANCE IS REQUIRED		

SIGNED: ____________________ DATE: ________

GAGE:

ARE THE FOLLOWING SOUND, SECURE, & SAFE ?

	YES	NO *
Shelter		
Well		
Ladder		
Walkway/steps		
Access Trail		
Measuring bridge		
Boat section		
Other		

* List maintenance & improvements required: (paint, intakes, warning signs, fence, etc.)

Front

P-17 (back)
(Rev. 2-77)

CABLEWAY:

Design sag: ________ As found: ______ As left: ________

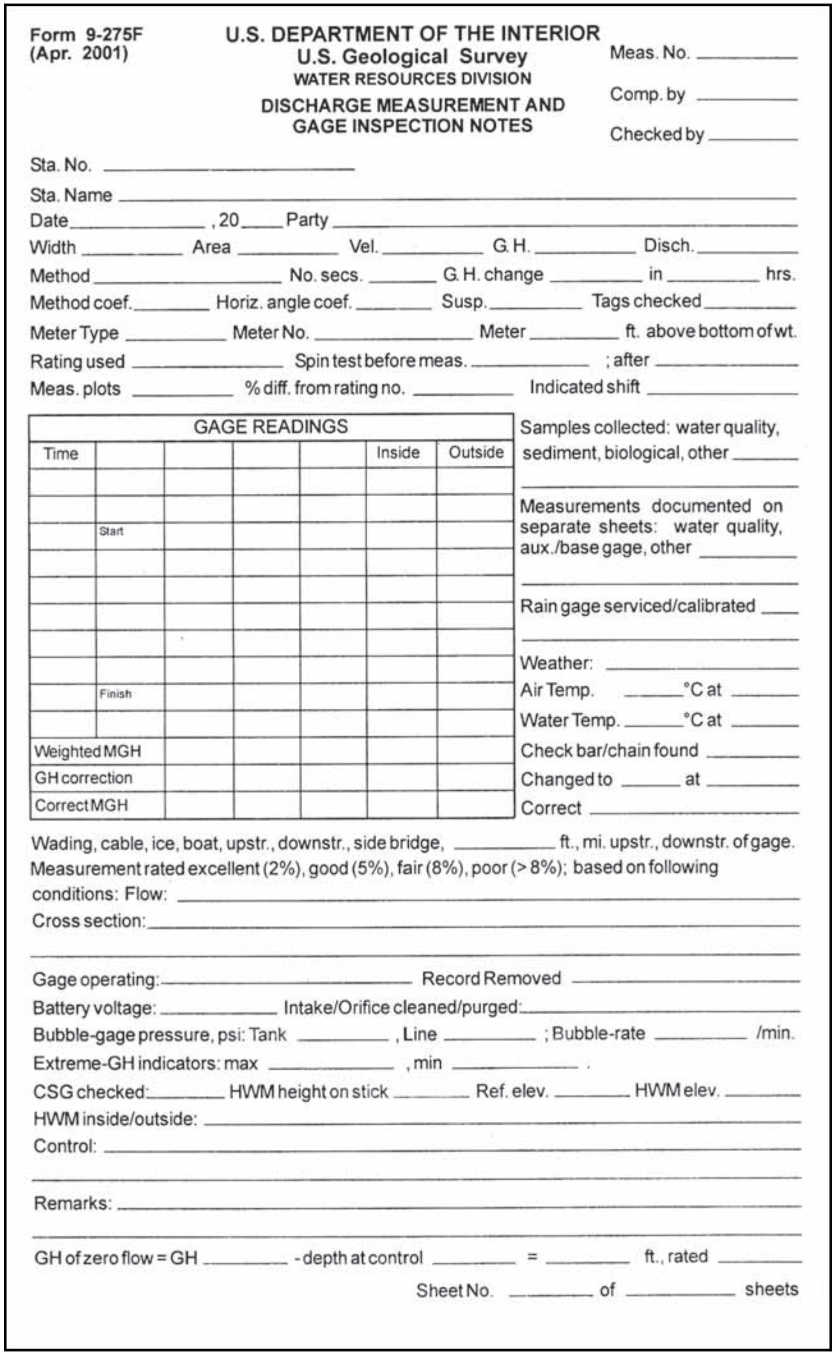
ARE THE FOLLOWING SOUND, SECURE, & SAFE ?

	LB YES	LB NO*	RB YES	RB NO*
Cable (cable rustfree, clips tight)				
Tree (alive, sufficient lagging)				
A-frame				
Anchor (bar rustfree, clear of debris)				
Cablecar (all bolts tight)				
Platform				
Ladder				
Access trail				
Other				

* List maintenance & improvements required: (fence, backstay guard, brush cutting, bearing grease, stationing marks, etc.)

Back

Appendix B1. Form P-17, U.S. Geological Survey gaging station safety and maintenance inspection.



Form 9-275F
(Apr. 2001)

U.S. DEPARTMENT OF THE INTERIOR
U.S. Geological Survey
WATER RESOURCES DIVISION
DISCHARGE MEASUREMENT AND
GAGE INSPECTION NOTES

Meas. No. ________
Comp. by ________
Checked by ________

Sta. No. ________
Sta. Name ________
Date ________, 20____ Party ________
Width ________ Area ________ Vel. ________ G.H. ________ Disch. ________
Method ________ No. secs. ________ G.H. change ________ in ________ hrs.
Method coef. ________ Horiz. angle coef. ________ Susp. ________ Tags checked ________
Meter Type ________ Meter No. ________ Meter ________ ft. above bottom of wt.
Rating used ________ Spin test before meas. ________ ; after ________
Meas. plots ________ % diff. from rating no. ________ Indicated shift ________

GAGE READINGS						
Time					Inside	Outside
	Start					
	Finish					
Weighted MGH						
GH correction						
Correct MGH						

Samples collected: water quality, sediment, biological, other ________

Measurements documented on separate sheets: water quality, aux./base gage, other ________

Rain gage serviced/calibrated ________

Weather: ________
Air Temp. ________ °C at ________
Water Temp. ________ °C at ________
Check bar/chain found ________
Changed to ________ at ________
Correct ________

Wading, cable, ice, boat, upstr., downstr., side bridge, ________ ft., mi. upstr., downstr. of gage.
Measurement rated excellent (2%), good (5%), fair (8%), poor (> 8%); based on following conditions: Flow: ________
Cross section: ________

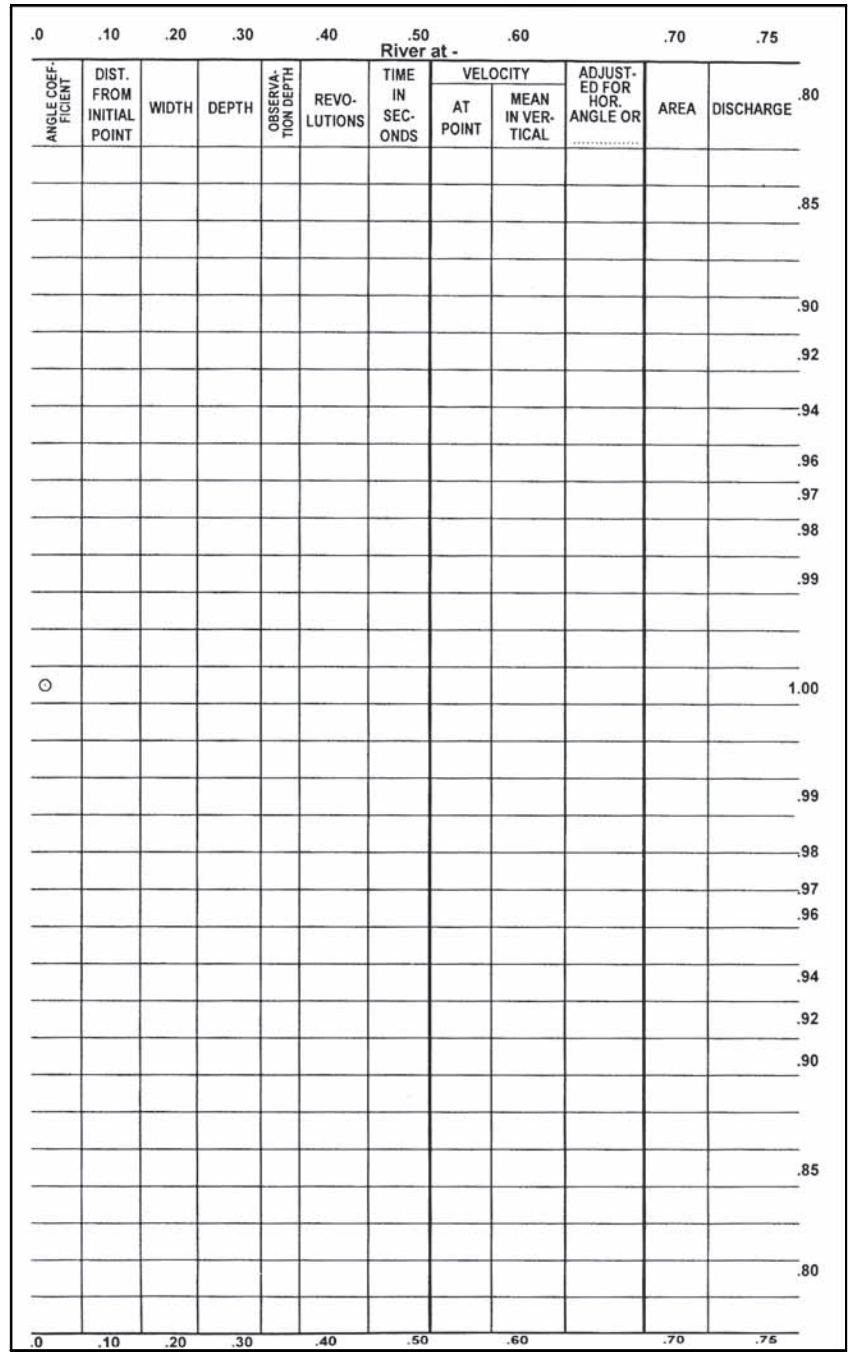
Gage operating: ________ Record Removed ________
Battery voltage: ________ Intake/Orifice cleaned/purged: ________
Bubble-gage pressure, psi: Tank ________, Line ________; Bubble-rate ________ /min.
Extreme-GH indicators: max ________, min ________.
CSG checked: ________ HWM height on stick ________ Ref. elev. ________ HWM elev. ________
HWM inside/outside: ________
Control: ________

Remarks: ________

GH of zero flow = GH ________ - depth at control ________ = ________ ft., rated ________

Sheet No. ________ of ________ sheets

Front



.0 .10 .20 .30 .40 .50 .60 .70 .75

River at -

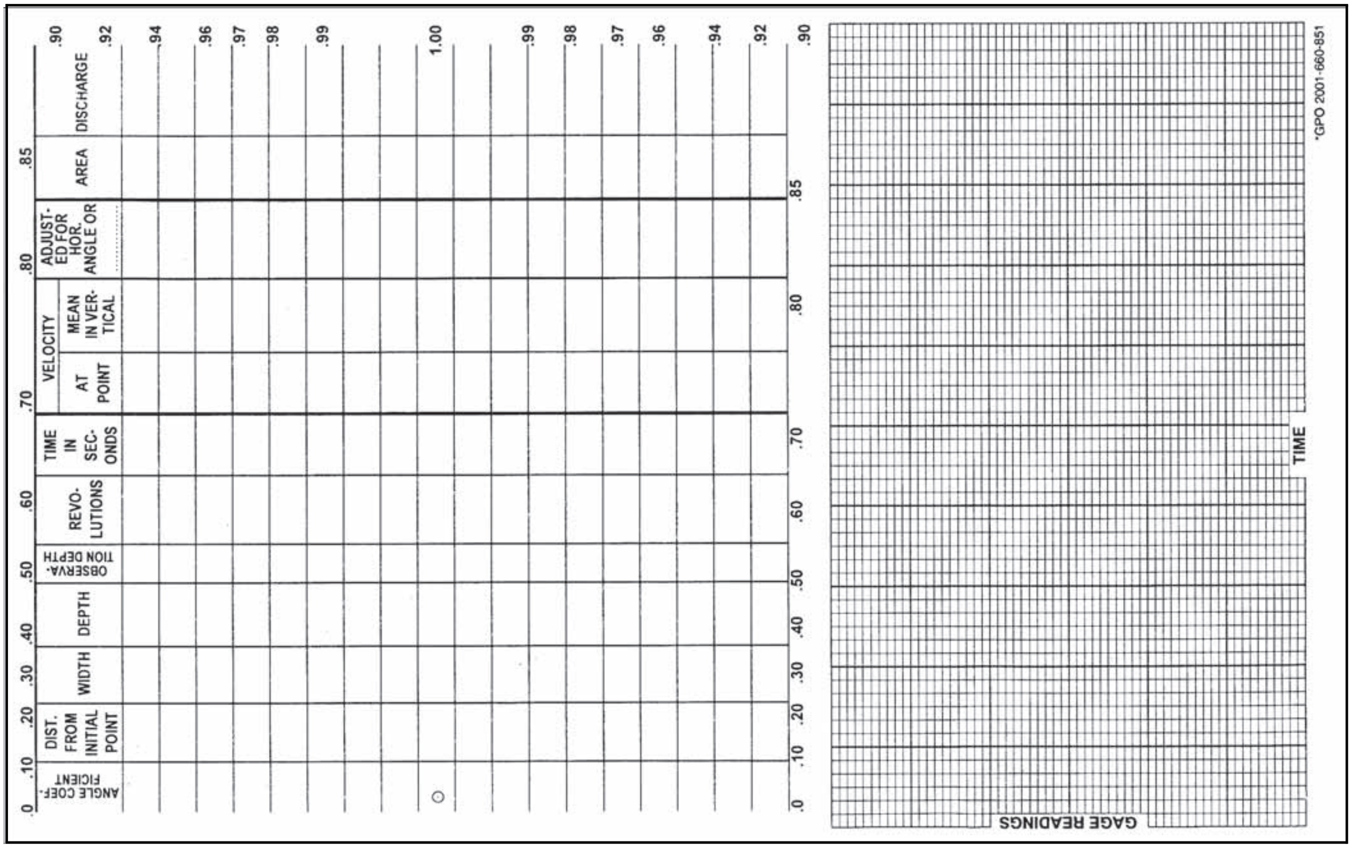
ANGLE COEF-FICIENT	DIST. FROM INITIAL POINT	WIDTH	DEPTH	OBSERVA-TION DEPTH	REVO-LUTIONS	TIME IN SEC-ONDS	VELOCITY AT POINT	VELOCITY MEAN IN VER-TICAL	ADJUST-ED FOR HOR. ANGLE OR	AREA	DISCHARGE

.80 .85 .90 .92 .94 .96 .97 .98 .99 1.00 .99 .98 .97 .96 .94 .92 .90 .85 .80

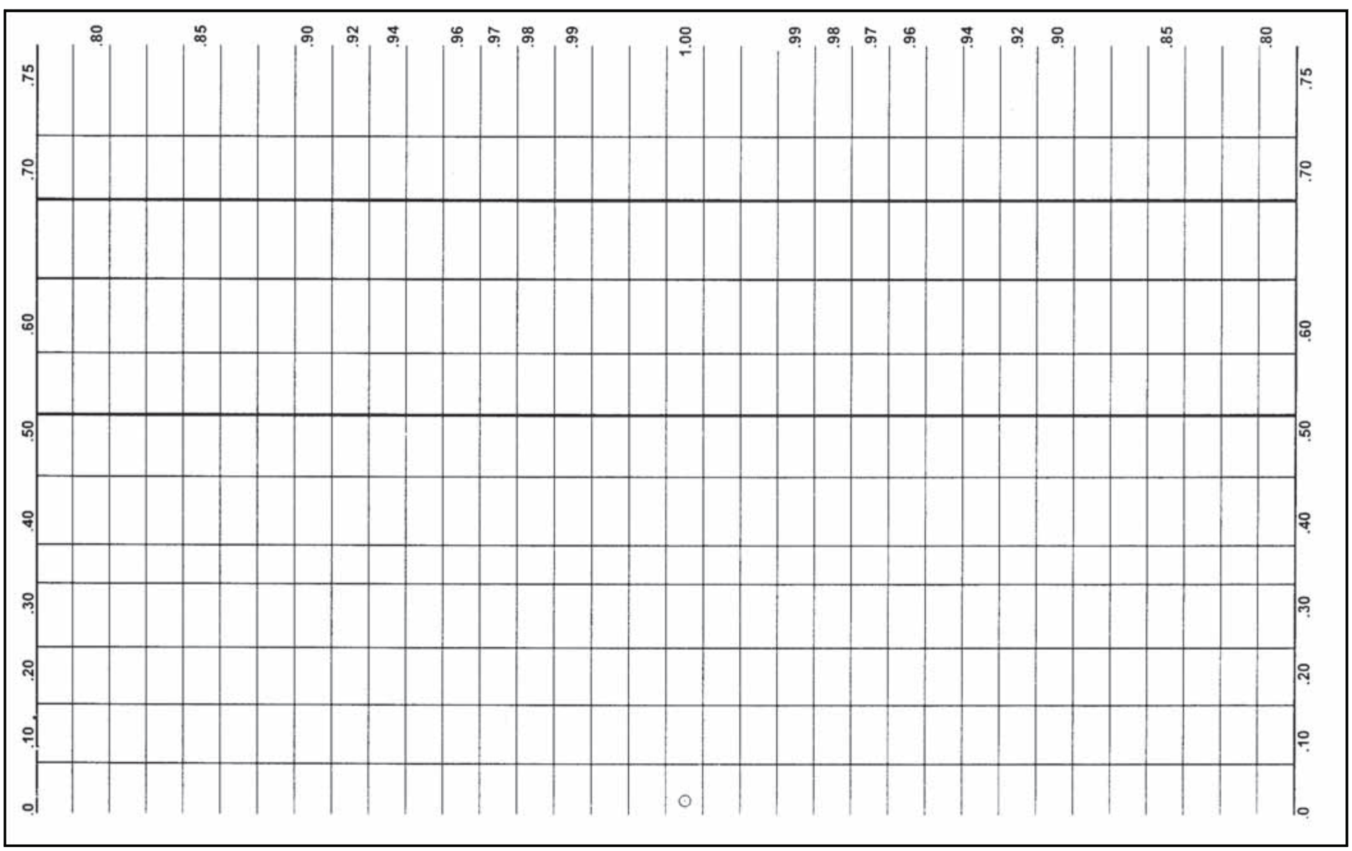
.0 .10 .20 .30 .40 .50 .60 .70 .75

Inside Top

Appendix B2. Form 9-275-F, Discharge measurement notes.



Back



Inside Bottom

Appendix B2. Form 9-275-F, Discharge measurement notes--Continued.

MAINTENANCE WORK

STATION NAME ____________

DATE ________ WORK PRIORITY: LOW MED HIGH

JOB DESCRIPTION: ____________

SKETCH/MEASUREMENTS: (OVER OR ATTACHED)

SUBMITTED BY: ____________

****

(WORK CREW)

DATE COMPLETED ____________

PERSONNEL REQUIRED/USED:

SHOP: NAME ____________ HOURS ______

NAME ____________ HOURS ______

FIELD: NAME ____________ HOURS ______

NAME ____________ HOURS ______

NAME ____________ HOURS ______

MATERIAL COST ____________

EQUIPMENT/INSTRUMENT COST ____________

OTHER COSTS ____________

CREW CHIEF COMMENTS: ____________

SAFETY OFFICER ____________ FIELD CHIEF ____________

Back

9–275d
(Feb. 1954)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Date ...., 19.......

MISCELLANEOUS FIELD NOTES

No. of sheets

GPO : 1983 O - 409-164

Front

Appendix B3. Form 9-275-D, Miscellaneous field notes.

T-9335 (Rev)
Sept. 1961

Crest-Stage Gage Notes

Party ______________________ Date ____________

Weather ____________________ Time ____________

Marks on gage sticks:

	Upstream		Downstream	
	Left bank	Right bank	Left bank	Right bank
Bolt elev.				
Highest stick reading				
Peak stage				
Quality of mark				
Additional gage readings				

Outside HWM's:

Quality, type of mark, and location	Distance from base bolt or top of stick

Date and time of peak ____________________

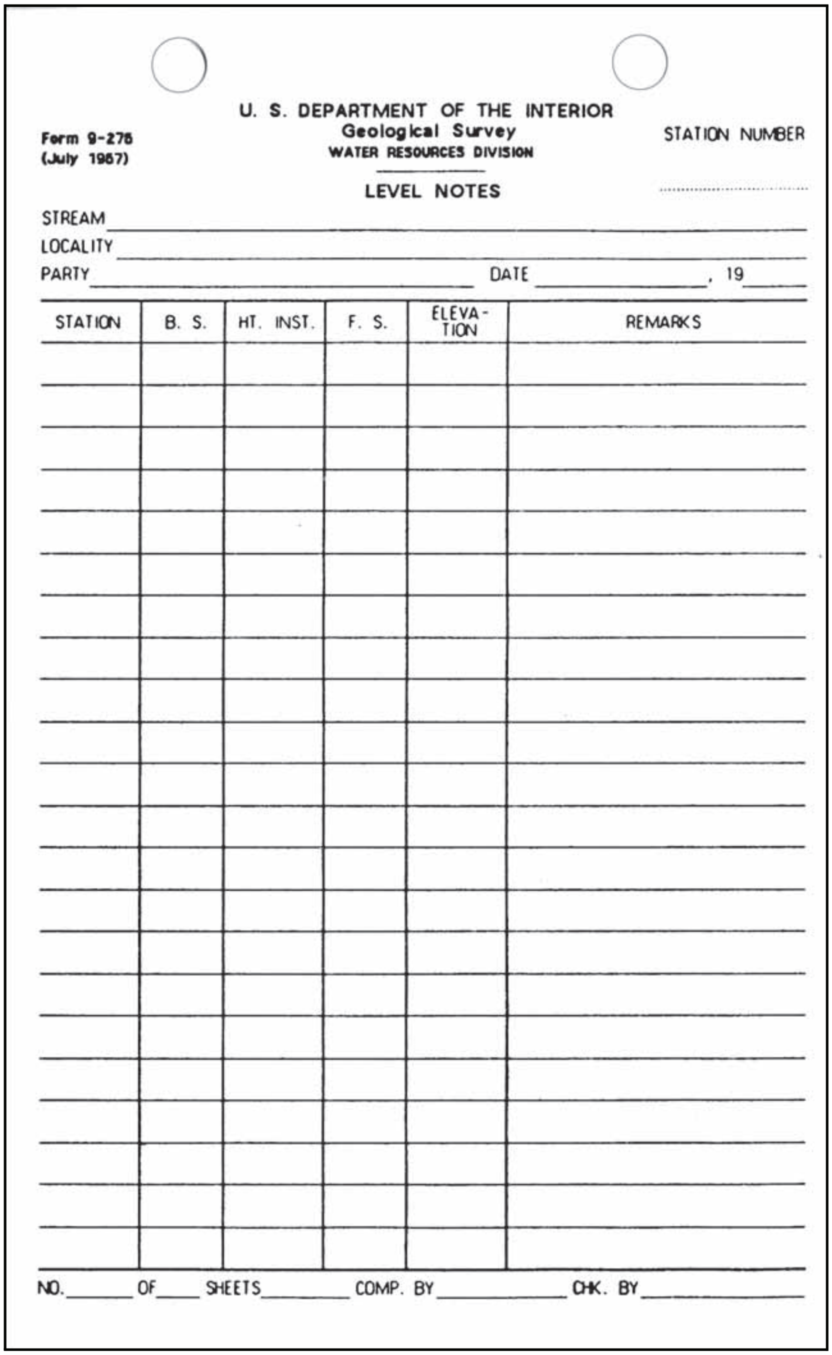
Condition of culvert ____________________

Condition of intakes ____________________

Do gages have cork? ____________________

Remarks ____________________

Appendix B4. Form T-9335, Crest-stage gage notes.



Form 9-276
(July 1957)

U. S. DEPARTMENT OF THE INTERIOR
Geological Survey
WATER RESOURCES DIVISION

STATION NUMBER

LEVEL NOTES

STREAM ______

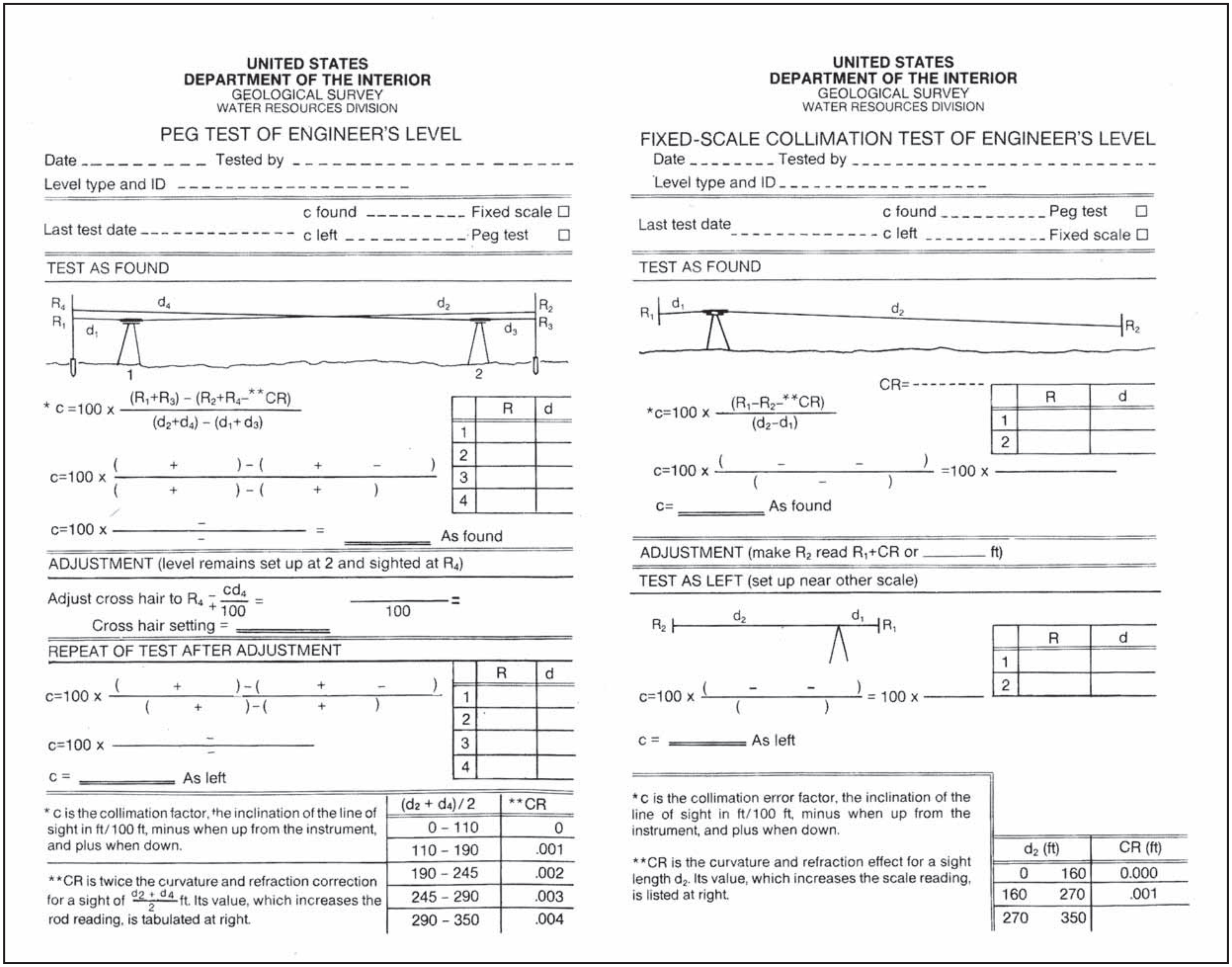
LOCALITY ______

PARTY ______ DATE ______, 19____

STATION	B. S.	HT. INST.	F. S.	ELEVA-TION	REMARKS

NO.______ OF____ SHEETS________ COMP. BY__________ CHK. BY__________

Appendix B5. Form 9-276, level notes.



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

PEG TEST OF ENGINEER'S LEVEL

Date ________ Tested by ____________________

Level type and ID __________________

Last test date ______________ c found _________ Fixed scale ☐ c left __________ Peg test ☐

TEST AS FOUND

$$*\ c = 100 \times \frac{(R_1+R_3) - (R_2+R_4-{}^{**}CR)}{(d_2+d_4) - (d_1+d_3)}$$

c=100 x (+) – (+ –) / (+) – (+)

c=100 x — / — = ______ As found

	R	d
1		
2		
3		
4		

ADJUSTMENT (level remains set up at 2 and sighted at R_4)

Adjust cross hair to $R_4 \mp \frac{cd_4}{100}$ = ______ 100 =

Cross hair setting = ______

REPEAT OF TEST AFTER ADJUSTMENT

c=100 x (+) – (+ –) / (+) – (+)

c=100 x — / —

c = ______ As left

	R	d
1		
2		
3		
4		

* c is the collimation factor, the inclination of the line of sight in ft/100 ft, minus when up from the instrument, and plus when down.

**CR is twice the curvature and refraction correction for a sight of $\frac{d_2 + d_4}{2}$ ft. Its value, which increases the rod reading, is tabulated at right.

$(d_2 + d_4)/2$	**CR
0 – 110	0
110 – 190	.001
190 – 245	.002
245 – 290	.003
290 – 350	.004

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

FIXED-SCALE COLLIMATION TEST OF ENGINEER'S LEVEL

Date ________ Tested by ________________________

Level type and ID ________________

Last test date ____________ c found __________ Peg test ☐ c left ____________ Fixed scale ☐

TEST AS FOUND

CR= ________

$$*c = 100 \times \frac{(R_1 - R_2 - {}^{**}CR)}{(d_2 - d_1)}$$

c=100 x (– –) / (–) =100 x ______

c= ______ As found

	R	d
1		
2		

ADJUSTMENT (make R_2 read R_1+CR or ______ ft)

TEST AS LEFT (set up near other scale)

c=100 x (– –) / ( ) = 100 x ______

c = ______ As left

	R	d
1		
2		

* c is the collimation error factor, the inclination of the line of sight in ft/100 ft, minus when up from the instrument, and plus when down.

**CR is the curvature and refraction effect for a sight length d_2. Its value, which increases the scale reading, is listed at right.

d_2 (ft)		CR (ft)
0	160	0.000
160	270	.001
270	350	

Appendix B6. Peg test of Engineer's level.

S.A. Tomlinson—**Surface-Water Quality-Assurance Plan for the Tallahassee, Office, U.S. Geological Survey**—Open-File Report 2006-1021

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