EP-DIR-SOP-10022, R.0

MANAGING ELECTRONIC STAGE AND DISCHARGE DATA FROM STREAM GAGE STATIONS

Effective Date: 4/12/12

Procedure Owner:	Signature:	Date:
Steven Veenis	/s/Steven Veenis	04/04/12

REVISION HISTORY

Document No./Revision No.	Issue Date	Action	Description
EP-DIR-SOP-10022, R0	4/12/12	New document	Initial release

TABLE OF CONTENTS

1. PURPOSE AND SCOPE

This standard operating procedure (SOP) states the individual and institutional responsibilities for managing stage and discharge data collected at streamflow gaging stations in the Los Alamos National Laboratory (LANL) surface water programs. The data described in this SOP comprise automatically-recorded water level ("gage height" or "stage") values and manually-measured water flow rate ("discharge") values.

Electronic data management processes include: downloading electronic stage data from data loggers in the field, processing the raw data files, uploading the processed data into Hydstra ©, and reviewing the data for accuracy. This SOP integrates the criteria of EP-DIR-QAP-0001, *Quality Assurance Plan for the Environmental Programs*, hereinafter referred to as the Quality Assurance Plan.

This SOP also describes the process for assigning data qualifier codes to the stage and discharge data, recording code-assignment rationale, adjusting the stage data when appropriate, and updating rating curves for computation of discharge values from stage data.

This procedure is to be used by field operations personnel assigned to operation and maintenance of the stream gage network, and project technical personnel familiar with operation of the Sutron data loggers used with the stream gage network and/or the use of Hydstra © applications.

2. REFERENCES

EP-DIR-QAP-0001, *Quality Assurance Plan for the Environmental Programs*
PD1020, *Document Control and Records Management*
P1020-1, *Laboratory Records Management*
EP-DIR-AP-10005, *Records Processing*
EP-DIR-PLAN-10002, *ADEP Directorate Records Management Plan*
EP-DIR-AP-10003, *Records Management Procedure for ADEP Employees*
EP-DIV-SOP-10005, *Operation and Maintenance of Gage Stations for Storm Water Projects*

3. BACKGROUND AND PRECAUTIONS

3.1 Background

Measurement, collection, and management of stage data and computed discharge are required by the Memorandum of Understanding (MOU) between the U.S. Department of Energy and the Buckman Direct Diversion (BDD) Board for Los Alamos (LA) and Pueblo Canyons, and as part of ongoing environmental surveillance surface water monitoring efforts throughout LANL for the annual site report. The discharge data at E050.1, E060.1, and E109.9 are used as an early notification system for the BDD Project to make decisions regarding facility operations, including temporarily ceasing diversion of water from the Rio Grande. In addition, the discharge data are used to trigger automated water quality samplers in LA/Pueblo Canyons and at surveillance-specific sites, and to compute the mass flux of sediment and contaminants at specific locations.

3.2 Precautions

Before initiating the Sutron data download process, user(s) must check and set a watch or clock to the precise time via their cell phone or by logging onto the time page at www.time.gov. Gage station equipment clock time, including the Sutron data logger, must be synchronized and verified within one minute (plus or minus). Station equipment clocks must be set to Mountain Standard Time (MST) at all times, with no daylight savings time adjustments made.

4. PREREQUISITE TRAINING

To download Sutron data files and upload the data files into Hydstra ©, workers must have familiarity with:

- Sutron data loggers, including using a laptop with the appropriate Sutron software installed and cable to connect to the Sutron data loggers while physically at a stream gaging station.
- The Hydstra © commercial off-the-shelf application configuration for LANL stations for uploading electronic stage data files.

To complete processing, validation, and verification of stage data, workers must have familiarity with:

- Stage measurement equipment, including: Milltronic ultrasonic probes, Sutron Accubar bubble sensors, and shaft encoder/float/stilling well systems.
- Operational, hydrological, and meteorological issues that may affect recorded stage values.
- The Hydstra © commercial off-the-shelf application configuration for LANL stations for manipulating electronic stage data, including: adjusting data when appropriate; adjusting rating curves for datum, time, or stage shifts; and assigning qualifier codes and adding comments whenever data or rating curves are adjusted.

5. EQUIPMENT

To download Sutron data files and upload the data files into Hydstra ©, the following equipment is required:

- LANL 32-bit laptop equipped with Sutron software applications for downloading data, and RS232 cable.
- LANL 32-bit workstation equipped with Sutron software applications for converting LOG files to PRN files.
- LANL stand-alone radio telemetry base station equipped with a remote data transceiver, radio antenna, and Sutron software applications for viewing and saving the data.
- Account license ("seat") for access to the Hydstra © application (contact Field Planning and Work Authorization Team Leader).
- Permissions to access the \Projects\Hydron folders on the \\win.lanl.gov\WES network drive (contact desktop support).

To complete processing, validation, and verification of stage data, the following equipment is required:

- Account license ("seat") for access to the Hydstra © application (contact Field Planning and Work Authorization Team Leader).
- Permissions to access the \Projects\Hydron folders on the \\win.lanl.gov\WES network drive (contact desktop support).

6. STEP-BY-STEP PROCESS DESCRIPTION

6.1 Downloading Electronic Data

Project Personnel

[1] **Designate Records Custodian**

During the primary monitoring season, work orders are issued to perform gage station equipment inspections on a weekly (LA/Pueblo Canyons, June 1 to October 31) to biweekly (surveillance-specific sites, April 1 to October 31) basis. During the remainder of the year, work orders are issued to perform gage station equipment inspections on a monthly basis for both the LA/Pueblo Canyons and surveillance-specific sites. Throughout the entire year, work orders are issued weekly to perform gage station equipment inspections at the three gages associated with the BDD Project (E050.1, E060.1, and E109.9). During these inspections, workers should download the gage data (see the Gage Station Equipment Inspection example form in Attachment 1), unless the gage data are retrieved remotely without errors.

[2] Verify that the station is functioning and record the appropriate data on the work order. Refer to EP-DIV-SOP-10005 for gage inspection instructions. If the site is not functioning properly, investigate and attempt to resolve the issue. If the issue cannot be resolved, note on the work order that follow-up maintenance is required. If the issue can be resolved, note what the issues were and what maintenance was performed. If the station is functioning sufficiently to perform a data download, download the data as instructed in items [3] and [4].

[3] Connect the appropriate end of the RS232 cable to the matching connector on the data logger. The cable will physically connect to only one connector on the data logger. If the necessary connector on the data logger is occupied by a cable to telemetry equipment, temporarily disconnect the cable during the data download. Connect the other end of the RS232 cable to the laptop.

[4] Perform the manual data download by saving the LOG data file to the laptop hard drive. On the work order, mark the data as retrieved and record the LOG data file name, start date, and size (KB). Once the download is complete, disconnect the RS232 cable from the data logger and laptop and reconnect the telemetry cable (if present) to the data logger. Verify that the data logger recording is on, and that the station is operating properly (refer to EP-DIV-SOP-10005).

6.2 Uploading Data into Hydstra ©

Project Personnel

[1] Use a flash drive to transfer the LOG data files from the laptop to the \\win.lanl.gov\WES\Projects\Hydron\Sutron directory on a workstation with access to Hydstra ©.

[2] Run the Sutron program LOGPRN4.EXE on each raw data file to convert it to a PRN file and save it in the same folder (\Hydron\Sutron).

[3] Log into Hydstra © and use the Data Managers Workbench (HYDMWB) > Import Data function to load each PRN file into Hydstra ©.

[4] If a file does not load properly, use a text editor (e.g., Notepad) to repair the file as needed so that the Import Data function runs without errors. If a file requires manual editing in order to properly import, describe the correction on the work order.

[5] After loading the data files into Hydstra ©, move each LOG file into a subfolder in the \Hydron\SW Log folder with the name "wateryearYYYY", e.g. for data recorded between October 1, 2010 and September 30, 2011, place the LOG file in folder \\win\WES\Projects\Hydron\SW Log\wateryear2011. These LOG files serve as the archived backups of the original, unprocessed data.

NOTE: Moving the data files out of the main Sutron folder into the archive subfolder also serves as a tracking milestone. It is important to observe this protocol to help avoid missing locations or duplicating work.

[6] Indicate on the work order that data conversion and import into Hydstra © was successful. Delete the PRN files to save disk storage space.

[7] Communicate to the field planning and data manager via e-mail when upload to Hydstra © is complete, including which gage stations and what time period was uploaded.

[8] Sign and date the block for completion of Hydstra © data upload on the Gage Station Equipment Inspection (Attachment 1) or Station Maintenance Form (Attachment 2).

[9] Deliver the work order form to the field planning and work authorization data manager.

6.3 Reviewing and Qualifying Stage in Hydstra ©
Field Planning and Work Authorization Data Manager

[1] Once data are uploaded into Hydstra ©, gather all work orders related to the gage station(s) for the dates of the uploaded data. Examine the work orders, making note of any information that may explain departure from "normal" or baseline stage values in the recorded data. This information may include, but is not limited to, the presence of flow or recent flow in ephemeral streams, increased or decreased flow in perennial or intermittent streams, channel silting or scouring, presence of ice or debris, re-calibration of equipment by the field team, equipment malfunction, and/or data not recorded or not retrievable.

[2] View the plot of stage vs. time in Data Manager's Workbench in Hydstra ©. Examine the data plot for period(s) of potentially erroneous data, such as data gaps, extreme peaks or troughs, peaks or troughs unassociated with a typical "smooth" discharge curve, erratic values, unrealistic rates of increase of decrease, or flat lines at stages other than the usual no-flow stage. Examine the stage record in the context of the work order information, and also vice versa, to form the most complete and accurate assessment of the accuracy of the data record.

[3] A qualifier of "140 – Data not yet validated" is automatically assigned to data when uploaded into Hydstra ©. If no problems are found and the data looks reasonable (i.e., no extreme peaks or troughs, no flat lines besides zero stage, no other non-natural type patterns, etc.), change data qualifier to "1 – Good continuous records." If issues are found, determine which one of the following situations applies to the data, change the qualifier code(s) as instructed, and record any relevant notes (e.g. suspected cause(s) of error(s) – if any found, method of addressing/correcting error(s), justification/rationale for assigning the chosen qualifier code):

Note: a qualifier in the 1-150 range is considered "good" data, and a qualifier greater than 150 is considered "bad" data. For all intents and purposes, bad data is considered not viable.

[4] **SMALL DATA GAP** (small number of incorrect or missing measurements due to unknown circumstances, e.g., an animal walking under the probe, etc.)

- Determine if discharge was measured at surrounding stations and if precipitation was measured at surrounding gages.

- If there was no flow or precipitation, fill in gap with zeros. NOTE: in general, a "no flow" scenario can be filled for a longer period of time than a "flow" scenario, depending on the season (i.e., winter precipitation tends to be regional, but summer monsoonal precipitation can be very localized, thus do not assume a "no flow" scenario during the monsoon season without relatively strong supporting evidence).

- If there was flow or precipitation, interpolate between the measurements before and after the missing data point(s) and assign this value to the missing data point(s). NOTE: this should only be done for one or two missing points (5 or 10 minutes, respectively).

- Change data qualifier to "2 – Good quality edited data." Record the suspected cause of the error (or "unknown"), the method used to correct the error (e.g. interpolation, reference to outside gage measurement), and the justification for considering the estimated values "good quality".

[5] **SILTING** (stage measurements increase during a runoff event but do not decrease to pre-event stage) or **SCOURING** (stage measurements increase during an event but decrease to below pre-event stage)

- Adjust rating curve for time period the stilling well and/or channel was silted/scoured using "Ratings Stage Shift Workbench" and applying a "Datum Shift" from the peak of the hydrograph to a point after the hydrograph flattens out (i.e., streamflow stops or returns to baseflow conditions).

- At the peak, the shift will be zero. At the point when streamflow stops or returns to baseflow conditions, the shift will equal the negative stage for silting and positive stage for scouring. Add comments when adding the shift values (i.e., start of silting/scouring, end of silting/scouring).

- Change data qualifier to "3 – Silting or scouring."

- View discharge (variable 262 in Hydstra ©) to ensure the data were properly adjusted.

- **Note:** if stilling well and/or channel are cleaned/filled, another time shift needs to be added to compensate for this adjustment at the time of cleaning/filling.

[6] **GREATER THAN RATING CURVE MAXIMUM** (stage measurement is above the maximum value in the rating curve)

- Examine stage value and rating curve to determine if extrapolation of the rating curve is appropriate (i.e., the stage did not exceed the maximum for the flume or overtop the bank).

- If extrapolation is appropriate, extrapolate the discharge value for the stage and adjust the rating curve in the "Ratings Stage Shift Workbench" by adding a point to the maximum end of the rating table.

- If extrapolation is not appropriate, determine how to adjust the rating curve based on field cross-sectional surveys for over-bank flow.

- Change data qualifier to "4 – Greater than rating curve maximum."

[7] **DATUM SHIFT** (inside and outside stage measurements do not match)

- If the field notes indicate that the inside and outside stage measurements are not the same (due to numerous circumstances, but NOT silting and scouring) and the stage height was adjusted to align the inside with the outside stage, a datum shift is required.
- Adjust rating curve for time period the datum was incorrect using "Ratings Stage Shift Workbench" and applying a "Datum Shift."
- At the beginning of the period, the shift will be zero. At the point just before the stage height was corrected, the shift will equal the inside minus the outside (including the negative/positive sign). At the end of the period, the shift will be zero. Add comments when adding the shift values (i.e., inside and outside stage do not match).
- Change data qualifier to "5 – Datum shift."
- View discharge (variable 262) to ensure the data were properly adjusted.

[8] **DATA MISSING** (more than a small gap of stage measurements are missing for unknown reasons)

- Change data qualifier to "151 – Data Missing."

[9] **ICE** (stage measurements increase during winter but do not decrease or "flat line" at a particular non-zero stage height)

- Check nearest meteorological tower temperature data to determine if precipitation occurred and if it is feasible for the streamflow to be frozen.
- Change data qualifier to "152 – Ice present."

[10] **MAINTENANCE** (stage measurements are not real due to testing and/or maintenance being performed at the station)

- Based on visual inspections while at the station:
- If no flow, set stage height values to zero and change data qualifier to "1 – Good continuous records."
- If flow and outside gage measurements confirm that interpolation will result in an accurate stage record, interpolate the values and change data qualifier to "2 – Good quality edited data."
- If flow but there is no noted confirmation of stage during the un-recorded period, change data qualifier to "153 – Testing or maintenance performed."

[11] **EQUIPMENT MALFUNCTION** (more than a small gap of stage measurements is missing or not accurate due to equipment malfunction, i.e., data logger, bubbler, probe, battery, etc.)

- Special case: A continuous period with stage values of 0.00 requires further investigation, as 1) recorded stage is rarely exactly 0.00 in natural-channel measurements, and 2) 0.00 is the default stage value which would result from a malfunction-related data logger reset.
- Change data qualifier to "154 – Equipment malfunction."

[12] **NON-STANDARD FLOW** (i.e., water line breaks, fire hydrant testing, spills from a building or truck, etc.)

- Change data qualifier to "155 – Non-standard flow."

7. RECORDS PROCESSING

Data Manager

[1] When complete, add additional notes as needed to clarify existing entries on the Gage Station Equipment Inspection or Station Maintenance form, and sign and date the Validator block.

Record Identification	Record Type Determination	Protection/Storage Methods	Processing Instructions
Gage Station Equipment Inspection form (Attachment 1) Gage Station Maintenance form (Attachment 2)	Form	Submit records in accordance with EP-DIR-AP-10003, Records Management Procedure for ADEP Employees.	When the records are ready for final disposition, the record is transferred to Records Management in accordance with EP-DIR-AP-10003, Records Management Procedure for ADEP Employees.

8. ATTACHMENTS

Attachment 1: Gage Station Equipment Inspection Form
Attachment 2: Gage Station Maintenance Form

Click here for "Required Read" credit.

ATTACHMENT 1

Page 1 of 1

Gage Station Inspection Form

Work Order ID: LAP-22073
Gage Station: E050.1
Project: BDD Gage Station Inspection 3/29/2012
Target Date: 3/29/2012
Route: 1
Sutron Datalogger Program:

Project ID: P-LAP-1772
Name/Z#:_____
Name/Z#:_____
Lead Signature:_____
"I confirm the information as recorded is true, accurate and complete."

Equipment	MFG	Model	Serial No.
Sutron Datalogger	Sutron	9210	000568
Encoder			
Bubbler			988223

GAGE AND DATALOGGER INSPECTION TASKS	Arrival Date:_____ Time:_____	Departure Date:_____ Time:_____
Is data recording on?	❒Yes ❒No _____	❒Yes ❒No _____
Is data logger time +/- 1 min (MST)?	❒Yes ❒No _____	❒Yes ❒No _____
Is bubbler/probe/encoder on?	❒Yes ❒No _____	❒Yes ❒No _____
Record inside gage measurement.	❒Yes ❒No _____	❒Yes ❒No _____
Record outside gage measurement.	❒Yes ❒No _____	❒Yes ❒No _____
Record battery voltage.	❒Yes ❒No _____	❒Yes ❒No _____
Is there indication of recent flow? If Yes, record the high water mark.	❒Yes ❒No _____	❒Yes ❒No _____
Is gage silted/isolated?	❒Yes ❒No _____	❒Yes ❒No _____
Is water flowing? If Yes, note PZF.	❒Yes ❒No _____	❒Yes ❒No _____
Is control clear?	❒Yes ❒No _____	❒Yes ❒No _____
Is Float/Bubbler/Probe compared to RP? If Yes, record reference gage height of RP.	❒Yes ❒No _____	❒Yes ❒No _____

MAINTENANCE

If any maintenance completed, check YES: Describe. ❒Yes ❒No
If follow-up maintenance is required, check YES: Describe. ❒Yes ❒No
Was discharge measurement taken? If Yes, attach USGS 9-275. ❒Yes ❒No

Stage and Precipitation Data

Retrieved data? ❒Yes ❒No
Is data file copied to Sutron folder? ❒Yes ❒No
Data File Name:_____
Start Date:_____ Size:_____ Kb

Additional Notes and Weather:

Continuation Form: ❒Yes ❒No

LANL PERSONNEL USE ONLY (Initials and dates)

Accepted _____ Tech QC _____ FTL _____

ATTACHMENT 2

Page 1 of 1

Gage Station Maintenance Form

Work Order ID: LAP-21674 **Project ID:** P-LAP-1730

Watershed : LAP-109.9 : E109.9 Date:_____ Time:_____

Project: Camera maintenance at E109.9 Name/Z#:_____

Target Date: 1/13/2012 Name/Z#:_____

Reason: Gage station maintenance at E109.9 to address camera night-time image quality problems Lead Signature:_____

"I confirm the information as recorded is true, accurate and complete."

Map ID: 1

Equipment	MFG	Model	Serial No.	Specification	Configuration
Bubbler	Sutron	Acubar	001458		
Encoder	Sutron	5600-0530-1A	10349	Trip level	0.4 Ft.
Relay	Opto 22	G4 ODC5R5		Connector	Normally Closed
Sutron Datalogger			909497	Program	BASIC Max

Station Maintenance	Note: If "No" provide correct information or explanation.	
Remove plexyglass window from the new camera security box and secure box with locks. This will solve the problem of night time back-reflection that impares the quality of the image.	❒Yes ❒No	
ON DEPARTURE		
Is data recording on?	❒Yes ❒No	
Record inside gage measurement. Record outside gage measurement.	❒Yes ❒No ❒Yes ❒No	
Record battery voltage. Is voltage acceptable?	❒Yes ❒No	
Is gage silted/isolated on departure? Is control clear upon departure?	❒Yes ❒No ❒Yes ❒No	
Retrieved data?	❒Yes ❒No	
MAINTENANCE		
Is follow-up maintenance required?	❒Yes ❒No	

Additional Notes:

LANL PERSONNEL USE ONLY (Initials and dates)

Accepted _____ Tech QC _____ FTL _____