ELECTRONIC NOTES APPLICATION FOR ON-SITE RECORDING AND STORAGE OF U.S. GEOLOGICAL SURVEY FLUVIAL-SEDIMENT DATA

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Abstract The fully electronic Sediment Data and Information Web-based (SEDWE) application enables use of a range of hand-held platforms to efficiently and accurately record U. S. Geological Survey (USGS) fluvial-sediment sample and ancillary data before departing the sediment-monitoring site. The field data are subsequently transferred to the USGS National Water Information System (NWIS) and USGS Sediment Laboratory Environmental Database System (SLEDS) via the USGS Sediment-sample LOGIN (SedLOGIN) application. The ensuing permanent NWIS record includes all relevant field data conveyed via SEDWE and sample-analytical results conveyed via SLEDS.

SEDWE provides a standardized paperless alternative for documenting fluvial-sediment data collected in the field, while retaining relevant metadata. The application, which functions on smart phones, tablets, and personal computers, is anticipated to become a standard tool for use by the USGS to capture, store, and share a more useful and explanatory record of fluvial-sediment sample and ancillary data.

INTRODUCTION

The U.S. Geological Survey (USGS) Sediment Data and Information Web-based Application (SEDWE) enables field-data collectors to efficiently and accurately record and store USGS fluvial-sediment and related ancillary data at a sediment-monitoring site (hereafter referred to as a “USGS sediment station”). These data are recorded on a hand-held electronic device in the field, and subsequently uploaded to the USGS National Water Information System (NWIS) (USGS, 2015) through the intermediary Sediment-sample LOGIN (SedLOGIN) application (USGS, 2010). The ensuing permanent NWIS record includes all relevant field data conveyed via SEDWE and sample analytical results conveyed via SLEDS.

The fully electronic SEDWE application was designed to increase the efficiency, completeness, and accuracy of field-data collection and subsequent storage in USGS databases. For storage of fluvial-sediment data collected as part of a larger suite of water-quality samples, USGS personnel are encouraged to continue to use the Personal Computer Field Form (PCFF) (Wilde, 2008). The use of the SEDWE and PCFF applications is preferred over paper-based field notes. SEDWE is anticipated to become a standard tool for use by the USGS to document a more useful and explanatory set of ancillary data associated with collection of fluvial-sediment samples.

Background Sediment-discharge measurements in the U.S. began in 1938 when Captain Talcott sampled the Mississippi River (Skinner, 1989). The formation of the Federal Interagency Sedimentation Project (FISP, 2015; Gray and Landers, 2015) in 1939 led to the development of quality-assured fluvial-sediment data-collection instruments and methods that remain in use today (Diplas and others, 2008). FISP instruments and methods are widely used for collecting fluvial-sediment data by most Federal agencies; many Tribes, States, and local governments;
and many countries around the world (Gray and Demas, in press). Sediment data produced by the USGS are collected, analyzed, and stored following guidelines and policies described by Porterfield (1972), Johnson (1997), Edwards and Glysson (1999), Nolan and others (2005), Koltun and others (2006), Diplas and others (2008), and Gray and Landers (2014), and Gray and O’Halloran (2015).

Until 2010, the only formal requirement for storage of data associated with USGS sediment stations included mean-daily values of streamflow, time-weighted suspended-sediment concentration, and suspended-sediment discharge, along with discrete particle-size data (if analyzed). In 2010, the USGS issued mandatory guidelines for storing a larger suite of discrete fluvial-sediment data and associated ancillary information. In addition to water-sediment samples collected manually or automatically in the field, ancillary parameters required by the SedLOGIN application include information on water temperature, sampler type, and method of deployment (USGS, 2010).

The SedLOGIN application was released in February 2010 as part of USGS policy to facilitate recording and storage of discrete sediment and ancillary data collected at USGS sediment stations. Its purpose is to assist USGS field personnel with database entry of fluvial-sediment sample information.

Once data are entered in SedLOGIN, a Sediment Laboratory Analytical Request (SLAR) form is automatically generated, printed, and included with the samples shipped to the sediment laboratory. The sample data and associated field parameters are automatically transferred from SedLOGIN to both the Sediment Laboratory Environmental Database Systems (SLEDS), and QWDX (the water-quality data transfer system). Results of sample analyses are also transferred by the laboratory into QWDX, from which the sample-associated data are transferred to the QWDATA module of the NWIS.

All new data derived from fluvial-sediment (discrete suspended-sediment, bedload, and bottom-material) samples collected must be stored in QWDATA using methods described by Johnson (1997), Edwards and Glysson (1999), Nolan and others (2005), Diplas and others (2008), and Gray and Landers (2014), and selected metadata as described by the USGS (2010). These storage requirements also include results of analyses of replicate samples identified by appropriate medium codes as environmental and/or quality-control samples. Data associated with physical samples collected by hydrographers, observers, and by automated means are also stored.

Entry of selected ancillary data to QWDATA prior to the aforementioned 2010 mandate was encouraged but not compulsory. Until the development of SEDWE, a limiting factor had been that SedLOGIN (or direct entry of data into QWDATA) required manual data entry using an office computer with appropriate USGS-access rights. In the past, paper forms or non-standardized electronic notes were used to record information in the field for subsequent largely manual transcription to standardized electronic media upon return to the office (Figure 1).
Figure 1 Schematic of procedure for collecting and recording fluvial-sediment data prior to the availability of the SEDWE application.

**ATTRIBUTES OF SEDWE ELECTRONIC FIELD NOTES**

SEDWE enables one-time electronic recording of fluvial-sediment and ancillary data for subsequent entry to the SedLOGIN application (Figure 2). The use of SEDWE has advantages over paper-based record keeping, including:

1. a reduction in arithmetic and recording errors,
2. elimination of the need to produce and archive paper notes,
3. improved consistency in, and more complete capture of field observations,
4. decreased project costs by reducing time spent on data entry and management, and
5. an increase in the overall quality and reliability of the sediment-station records concomitant with a decrease in the requisite time and effort to produce the records.

SEDWE enables USGS field hydrographers and sediment-station observers to accurately enter, view, modify, submit and print ancillary data associated with fluvial-sediment samples in accordance with USGS data-collection, management, and storage protocols (Porterfield, 1972; Koltun and others, 2006; USGS, 2010). SEDWE guides the user through a step-by-step process to complete all data entry successfully. SEDWE is secure, available any time, and can help expedite the sharing of USGS data.
SEDWE can be used in “offline mode” when the recording platform is not connected to the Internet, allowing the user to view and edit the recorded fluvial-sediment and ancillary data before submission. The available features, while on offline mode, include recording of fluvial-sediment sample data, and some tutorial information. External links and upload functionality are enabled when Internet access is restored.

Figure 2 Schematic of steps for collecting and recording sediment data using SEDWE.

**SEDWE User Environment** SEDWE is a field- and web-based system which operates on a variety of devices such as a PC, tablet, or smartphone. The application provides an independent platform for field-client operations. It was developed using Hypertext Markup Language 5 (HTML), jQuery mobile, Cascading Style Sheets (CSS) and PHP programming languages. USGS users can access SEDWE using any of the following browsers: Mozilla Firefox®, Apple Safari®, and Google Chrome® (use of firm or brand names is for information only and does not constitute endorsement by the U.S. Government).

**Overview of SEDWE Interfaces** The SEDWE application consists of three interfaces selectable based on the type of user: Observer, Hydrographer, and Administrator. The Observer Interface only is accessible to USGS sediment-station observers. The Hydrographer Interface only is accessible to USGS personnel who collect and process fluvial-sediment data, or their designees. These interfaces are used for recording pertinent data before departing the USGS sediment station. The Administrator Interface is accessible by any registered USGS Hydrographer who has access rights in QWDX/SedLOGIN. It is used for configuring the SEDWE users and their designated USGS sediment stations. Hydrographers who access the Administrator Interface will share the same access rights as the SEDWE Administrator within the Administrator Interface at the USGS Water Science Center level.
Hydrographer and Observer Interface The Observer and Hydrographer interfaces require USGS user authentication. The application will display the corresponding USGS sediment stations assigned to a particular user. The assigned stations are registered and set by a USGS administrator in the Administrator Interface. Observers and Hydrographers are able to add, modify, and delete records prior to submitting the data via an email containing the XML data file to a designated reviewer (QWDX-authorized user). Once reviewed, the XML file can be imported into SedLOGIN. Until further notice, the XML file will be delivered by email for later processing into SedLOGIN.

The Open XML option allows the user to view data stored in an XML file generated by other users. When the data stored in the local cache of the device are cleared, the user can open a previously generated XML file. Once the data are loaded into SEDWE, the user can either review or continue editing the data.

The Observer and Hydrographer Interfaces include three links or tabs, which are referred to as Shipments Manager, Manage Images, and Tutorials (Figure 3). Depending on the type of user (either Observer or Hydrographer), the corresponding form for recording sediment-sample data is shown. In each category the user enters the sediment data into a custom-designed electronic spreadsheet for each set or group of samples until all metadata are entered for later processing.

![Figure 3 SEDWE main menu screen for the Observer and Hydrographer Interfaces.](image-url)

The Shipments Manager tab allows the user to record data by selecting the “Add sets or groups of samples” button, and to edit or review the recorded data with the “Current Shipment” button, both of which use the same Data Recording screen (Figure 4).
The Manage Images screen (Figure 5) allows the user to send an image of field conditions at the sediment station to the designated hydrographer by selecting it from the device picture gallery or by taking the picture using a camera-equipped device. The Tutorial includes a user’s manual and helpful links, videos, and educational resources about field sediment-sampling protocols and procedures.

**Figure 4** SEDWE Data Recording screen.  **Figure 5** SEDWE Manage Images screen.

**Administrator Interface** The SEDWE Administrator Interface stores information related to users and stations for use by the SEDWE application. The SEDWE Administrator Interface consists of three main screens: Users, Stations, and Import from SedLOGIN. The Users and Stations screens allow the Administrator and the registered Hydrographer to query the Users and Stations stored in the SEDWE database, and to add a new user or station. The Users and Stations functionalities include:

1. add a new user or station,
2. modify an existing user or station, and
3. delete an existing user or station.

The Import from SedLOGIN screen allows a user to specify project(s) in SedLOGIN from which to import one or both of the project’s stations or the project’s users into the SEDWE database.

**Connecting to SedLOGIN** Programing codes, parameters, and validation in SEDWE prevents errors because the same codes, parameters, and validation are used by SedLOGIN. Hydrographers must log into SedLOGIN to import the XML file from SEDWE, and can import SEDWE data into any SedLOGIN project that the hydrographer is authorized to access. SedLOGIN will enforce data validation if there are any missing required parameters. Hydrographers can review and edit an XML file before importing the file into SedLOGIN by using the “Open XML” option in SEDWE.
SUMMARY

The SEDWE application serves as a standardized USGS resource to document ancillary data associated with fluvial-sediment sample collection prior to departing a USGS sediment station. SEDWE was designed to interface with other USGS sediment software to accomplish efficient transfer and accurate storage of these data. A range of electronic, hand-held platforms are supported to record and store USGS data associated with fluvial-sediment samples. The data subsequently can be transferred to the NWIS database, and to the USGS SLEDS application through the SedLOGIN application, and ultimately to the QWDATA database of the NWIS. SEDWE electronic forms serve to standardize and facilitate capture of ancillary data associated with fluvial-sediment sample collection. Benefits of using SEDWE include reductions in transcription errors due to one-time data entry; elimination of the need to archive paper records; improved data consistency and capture; decreased project costs; and an overall increase in the quality and reliability of USGS sediment-station records.

REFERENCES


